

# ESPOO REPORT

Nord Stream 2  
April 2017

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English Version

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## **APPENDICES**

### **APPENDIX 1**

NSP2 stakeholder issues and project responses

### **APPENDIX 2**

Protected species list

### **APPENDIX 3**

NSP2 modelling and NSP experience

### **APPENDIX 4**

Metals, organic contaminants, CWAa and nutrients analysed in sediment samples along the NSP2 route

## Abbreviations List

ADD	acoustic deterrent device
ADF	Admiral Danish Fleet
AIS	Automatic Identification System
ALARP	as low as reasonably practicable
AP	Affected Party
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BAC	background assessment criterion
bcm	billion cubic metres
BSPA	Baltic Sea Protected Area
BUCC	back-up control centre
BWM	
Convention	Ballast Water Management Convention
Cd	cadmium
CFP	EU Common Fisheries Policy
CHEMSEA	Chemical Munitions Search and Assessment
CHO	cultural heritage object
CI	confidence interval
CMP	Construction Management Plan
CMS	
Convention	Convention on the Conservation of Migratory Species of Wild Animals
CO	carbon monoxide
CO <sub>2</sub>	carbon dioxide
CR	critically endangered
Cu	copper
CWA	chemical warfare agent
CWC	concrete weight coating
DCE	Danish Centre for Environment and Energy
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEA	Danish Energy Agency
DHI	Danish Hydraulic Institute
DIF	Data and Information Fund
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DK	Denmark
DMA	Danish Maritime Authority
DNV	Det Norske Veritas
DO	dissolved oxygen
DP	dynamically positioned
E&S	environmental and social
EAC	Environmental Assessment Criteria
EE	Estonia
EEZ	exclusive economic zone
EHS	environment, health and safety
EIA	environmental impact assessment

EN	endangered
ENTSO-G	European Network of Transmission System Operators for Gas
EQS	environmental quality standard
ERL	effect range low
ERP	Emergency Preparedness and Response
ES	environmental study
ESMS	environmental and social management system
EU	European Union
EUGAL	European Gas Pipeline Link
FI	Finland
F-N	frequency-number
FOI	Swedish Defence Research Agency
GDP	gross domestic product
GE	Germany
GES	good environmental status
GHG	greenhouse gas
GRP	gross regional product
GRS	gas receiving station
H gas	high calorific gas
H <sub>2</sub> S	hydrogen sulphide
HAZID	hazard identification
HCB	hexachlorobenzene
HCH	hexachlorocyclohexane
HELCOM	Helsinki Convention
HSE	health, safety and environment
HSES	health, safety, environmental and social
HSES MS	health, safety, environmental and social management system
HSS	heat-shrink sleeve
IBA	Important Bird and Biodiversity Area
ICES	International Council for the Exploration of the Sea
IEA	International Energy Agency
IfAO	Institut für Angewandte Ökologie
IFC	International Finance Corporation
IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
KP	kilometre point
L gas	low calorific gas
LA	Latvia
LC	least concern
LFL	lower flammability limit
LI	Lithuania
LNG	liquefied natural gas
LTC	long-term contract
LTE	land termination end
MARPOL	International Convention for the Prevention of Pollution from Ships
MBI	major Baltic inflow
MCC	main control centre
MPC	maximum permissible concentration

MSFD	EU Marine Strategy Framework Directive
MMO	marine mammal observer
MSP	EU Maritime Spatial Planning Directive
M-V	Mecklenburg-Vorpommern
N	nitrogen
NEXT	Nord Stream extension
NGO	non-governmental organisation
NIS	non-indigenous species
nm	nautical mile
NO <sub>2</sub>	nitrogen dioxide
NO <sub>x</sub>	nitrogen oxides
NSP	Nord Stream Pipeline system
NSP2	Nord Stream 2 Pipeline system
NT	near threatened
NTG	North Transgas Oy
O <sub>2</sub>	oxygen
OPAL	Ostsee-Pipeline-Anbindungsleitung
OSPAR	Oslo-Paris Convention, Convention for the Protection of the Marine Environment of the North-East Atlantic
P	phosphorus
PAC	Project Affected Communities
PAH	polycyclic aromatic hydrocarbon
PARLOC	Pipeline and Riser Loss of Containment
Pb	lead
PCB	polychlorinated biphenyl
PDCA	plan-do-check-act
PEC	predicted environmental concentration
PID	Project Information Document
PIG	pipeline inspection gauge
PL	Poland
PM	particulate matter
PM2.5	particulate matter with diameter less than 2.5 microns
PNEC	predicted no-effect concentration
POM	particulate organic matter
PoO	Party of Origin
PSSA	Particularly Sensitive Sea Area
psu	practical salinity units
PTA	pig trap area
PTAG	Pig Trap Area Germany
PTAR	Pig Trap Area Russia
PTS	permanent threshold shift
QRA	quantitative risk assessment
ROV	remotely operated vehicle
RU	Russia
SAC	Special Area of Conservation
SAMBAH	Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise
SCI	Site of Community Interest
SE	Sweden

SECA	Sulphur Emission Control Area
SO <sub>2</sub>	sulphur dioxide
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	sulphur oxides
SPA	Special Protection Area
SPL	sound pressure level
SRB	sulphate reducing bacteria
SSC	suspended sediment concentration
SwAM	Swedish Agency for Marine and Water Management
TANAP	Trans-Anatolian Pipeline
TAP	Trans-Adriatic Pipeline
TBT	tributyltin
TSO	transmission system operator
TSS	Traffic Separation Scheme
TTS	temporary threshold shift
TW	territorial waters
UCH	underwater cultural heritage
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UXO	unexploded ordnance
VU	vulnerable
WFD	EU Water Framework Directive
Zn	zinc

## Definitions List

Aarhus Convention	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.
Affected Communities	Groups of people that may be directly or indirectly impacted (both negatively and positively) by the project.
Affected Party	The contracting parties (countries) to the Espoo Convention likely to be affected by the transboundary impact of a proposed activity.
anchor corridor	Offshore corridor within which pipe-lay vessels would be deploying anchors.
anchor corridor survey	Survey for sections where the pipeline may be installed by anchor lay vessel, to ensure that there is a free corridor for anchoring the lay vessel.
ancillary components	Activities in third-party facilities which are used exclusively for NSP2 project activities.
anoxia	Condition of oxygen depletion in the sea.
Appropriate Assessment	Environmental assessment of impacts required under the Habitats Directive of the European Commission. Appropriate assessment is required when a plan or project is potentially affecting a Natura site.
Area of Influence	Geographic area that is likely to be directly or indirectly affected by the project.
as-built survey	As-built surveys are conducted as a final record of pipeline installation after all pipeline construction activities are completed and confirm that the pipelines have been installed correctly as designed and to verify the as-laid position and condition of the pipelines
cathodic protection (sacrificial anodes)	Anti-corrosion protection provided by sacrificial anodes of a galvanic material installed along the pipelines to ensure the integrity of the pipelines over their operational lifetime.
chance find	Potential cultural heritage, biodiversity component, or munition object encountered unexpectedly during project implementation.
chemical warfare agent	Hazardous chemical substances contained in chemical munitions.
commissioning	The filling of the pipelines with natural gas.
construction support survey	A full survey spread equipped with multibeam sounders, side-scan sonar, sub-bottom profilers, pipe tracker, magnetometers and ROVs will be on standby during construction to perform touch down monitoring and ad hoc survey activities as required.
Contractor	Any company providing services to Nord Stream 2 AG.
core components	Facilities and activities that are under direct contractual control of the NSP2 project.
cultural heritage	A unique and non-renewable resource that possesses cultural, scientific, spiritual or religious value and includes moveable or immoveable objects, sites structures, groups of structures, natural features, or landscapes that have archaeological, paleontological, historical, cultural, artistic, and religious values, as well as unique natural environmental features that embody cultural values.
decommissioning	Activities carried out when the pipeline is no longer in operation. The activities take into account long-term safety aspects and aim at minimizing the environmental impacts.
descriptor	A high level parameter characterizing the state of the marine environment
detailed geophysical survey	Survey of a 130 m wide corridor along each pipeline route utilising side-scan sonar, sub-bottom profilers, swath bathymetry and magnetometer.
ES route	NSP2 route alternative that runs east of the existing NSP route.
EU Habitats Directive	Ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. The EU Habitats Directive also protects habitats.
exclusion zone	Area surrounding a cultural heritage, biodiversity component, or munition object within which no activities shall be performed and no equipment shall be deployed.
exclusive economic zone	An exclusive economic zone (EEZ) is a sea zone prescribed by the United



		Nations Convention on the Law of the Sea over which a state has special rights regarding the exploration and use of marine resources, including energy production from water and wind.
footprint area		The area occupied by the pipeline system, including support structures.
freespan		A section of the pipeline raised above the seabed due to an uneven seabed or the pipeline span between rock berms made by rock dumping.
FS route		NSP2 route alternative that runs west of the existing NSP route.
geotechnical survey		Cone penometer and Vibrocorer methods that provide a detailed understanding of the geological conditions and engineering soil strengths along the planned route. The geotechnical survey assists in optimising the pipeline route and detailed design including the required seabed intervention works to ensure long-term integrity of the pipeline system.
good status	environmental	The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive (Marine Strategy Framework Directive, Article 3).
halocline		Level of maximum vertical salinity gradient.
HELCOM Marine Protected Area		Valuable marine and coastal habitat in the Baltic Sea that has been designated as protected.
HSES		Health, Safety, Environmental and Social. "Safety" includes security aspects for personnel, assets and project affected communities.
HSES Plan		A written description of the system of HSES management for the contracted work describing how the significant HSES risks associated with that work will be controlled to an acceptable level and how, where appropriate, interface topics shall be managed.
hydrotesting		Hydrotesting involves a test where water is introduced into a pipeline and pressurised to inspect for any leakages in the material assembly. With the help of this test, pressure integrity, tightness, strength and any leakages are checked.
LIFE+ management standard		EU funding instrument for environmental and climate related actions. ISO management system standards provide a model to follow when setting up and operating a management system. The benefits of an effective management system include: more efficient use of resources; improved risk management, and increased customer satisfaction as services and products consistently deliver what they promise.
mattress		Rock material tied together by a steel grid laid on the seabed to raise the pipeline above the seabed. Typically used at crossings of cables and other pipelines.
micro-tunnel		Small diameter tunnels constructed at the German landfall crossing point. The pipelines are installed in the tunnels.
mitigation measure		Measures implemented to avoid, minimise or compensate for a social, economic or environmental impact.
munitions clearance		Removal of unexploded munitions found on the seabed in the construction area.
munitions survey	screening	Detailed gradiometer survey carried out to identify unexploded ordnance (UXO) or chemical warfare munitions that could endanger the pipeline or personnel during the installation and operating life of the pipeline system.
Natura 2000		EU-wide network of nature protection areas established under the 1992 Habitats Directive.
Nord Stream 2 AG		Project company established for the planning, construction and subsequent operation of the Nord Stream 2 Pipeline.
onshore surveys		Topographic surveys at the two landfall locations of the pipeline system. Activities included geotechnical investigations to determine soil conditions, groundwater levels and soils permeability with the purpose of establishing foundation requirements for civil structures, dewatering requirements for trenching activities, trench and micro-tunnel constructability and suitability of

	the soil for backfilling the trench. Geophysical investigations are also undertaken to determine soil stratigraphy and the potential presence of UXOs or cultural heritage objects.
open-cut	Conventional construction method utilizing an open-cut trench.
Party of Origin	The Contracting Party (country) or Parties (countries) to the Espoo Convention under whose jurisdiction a proposed activity is envisaged to take place.
PIG	Pipeline Inspection Gauges are pressure driven through the pipeline to clean and/or to investigate the condition of the pipeline.
pig trap area (PTA)	Pig trap areas are permanent above ground facilities located at the upstream and downstream limits of the NSP2 pipeline and used during the life of the pipeline to perform intelligent pigging operations, monitoring and control functions and certain maintenance operations.
pigging	Pigging in the context of pipelines refers to the practice of using devices known as "pigs" to perform various maintenance operations. This is done without stopping the flow of the product in the pipeline.
pipe-lay	The activities associated with the installation of a pipeline on the seabed.
Pipeline Operational Easement	Width of the onshore area above each of the two pipelines within which there may be some restrictions on land uses and land cover during operations.
pipeline RoW	Working corridor area within which construction of the on-shore open trench sections of the two parallel pipelines will be undertaken.
post-lay trenching	The burying of a pipeline in a trench on the seabed after the pipeline has been laid on the seabed.
pre-commissioning	Activities carried out before gas filling of the pipeline to confirm the pipeline integrity.
pre-lay trenching (dredging)	Pre-lay trenching is performed by dredgers prior to pipeline installation and backfilling of the trench. In the Espoo Report, the word dredging is synonymous with "pre-lay trenching".
Project	All activities associated with the planning, construction, operation and decommissioning of the Nord Stream 2 pipeline system.
project footprint	The onshore area that may reasonably be expected to be physically touched by project activities, across all phases. The project footprint includes land used on a temporary basis such as construction lay down areas or construction haul roads, and the pipeline RoW and pig trap areas.
project site	The onshore, above-ground operational area for the project activities.
pycnocline	A level of maximum vertical density gradient, caused by vertical salinity (halocline) and/or temperature (thermocline) gradients.
RA route	NSP2 direct route alternative that runs through an area where anchoring and fishing are discouraged.
Ramsar Convention	Convention on Wetlands of International Importance.
reconnaissance survey	Survey providing information on the preliminary pipeline route, including geological and anthropogenic features, the surveys typically cover a 1.5 km wide corridor and are performed by various techniques including side-scan sonar, sub-bottom profilers, swath bathymetry and magnetometers.
rock placement	Use of unconsolidated rock fragments graded in size to locally reshape the seabed, thereby providing support and cover for sections of the pipeline to ensure its long-term integrity. The rock material is placed on the seabed by a fall-pipe.
ROV	Remotely operated underwater vehicle which is tethered and operated by a crew aboard a vessel.
safety zone	An area surrounding a cultural heritage, biodiversity component, or munition object within which no activities shall be performed and no equipment shall be deployed.
seabed intervention works	Works aiming at ensuring the long-term pipeline integrity and including rock placement and trenching
seabed preparation	Preparatory works on the seabed before pipe-lay.

Stakeholders	Stakeholders are defined as persons, groups or communities external to the core operations of the project who may be affected by the project or have interest in it. This may include individuals, businesses, communities, local government authorities, local nongovernmental and other institutions, and other interested or affected parties.
Supplier	Any company supplying goods or materials to Nord Stream 2 AG.
territorial waters	Territorial waters or a territorial sea as defined by the 1982 United Nations Convention on the Law of the Sea, is a belt of coastal waters extending at most 12 nautical miles (22.2 km; 13.8 mi) from the baseline (usually the mean low-water mark) of a coastal state.
thermocline	Level of maximum vertical temperature gradient.
tie-ins	The connection of two pipeline sections. Tie-ins can be made on the seabed (called hyperbaric weld tie-ins) or by lifting the pipeline sections to be connected above water (called above water tie-ins).
trenching	Burial of the pipeline in the seabed.
vibro-piling	Piling carried out by vibration, possibly in combination with ramming to limit noise impacts.
weight-coated pipes	Pipe joints coated with concrete to increase weight.

## 0. NON-TECHNICAL SUMMARY

### 0.1 Overview

Nord Stream 2 is a project to build and operate a new twin pipeline through the Baltic Sea, which will transport natural gas from the world's largest reserves in Russia to the internal gas market in the European Union (EU). The new pipeline will largely follow the route and technical approach of the existing Nord Stream pipeline system, which became fully operational in 2012.

With the EU's domestic gas production projected to fall 50 per cent over the next two decades, the region needs to increase imports. The Nord Stream 2 pipeline system will have the capacity to supply gas for up to 26 million households. By supplementing existing transportation routes, it can contribute towards closing the EU's import gap and help to reduce imminent risks to supply security.

Countries which could be affected by the construction or operation of the Nord Stream 2 pipeline system have the chance to find out more about the project and share their views, before construction begins. Nord Stream 2 must assess the project's likely environmental impacts and consult with affected countries. This process is governed by the Espoo Convention – the Convention on Environmental Impact Assessment in a Transboundary Context.

This document is the Non-Technical Summary of the Espoo Report which was prepared for the non-specialist reader and summarises the approach and key findings of Nord Stream 2's Environmental Impact Assessments (EIAs<sup>1</sup>), which are further summarised as follows:

- Nord Stream 2 has undertaken thorough seabed surveys to identify a safe and optimal route through the Baltic Sea and alternate route options were compared in respect to environmental, safety, socio-economic and technical criteria;
- Nord Stream 2 has adopted the highest international standards for the design and construction of underwater pipelines. All design and construction works will be certified by an independent certifying agency, DNV GL;
- Nord Stream 2 has prioritised the identification of, and committed to implement, a range of measures – “inbuilt mitigation” - to avoid or minimise potential environmental impacts that could arise. This front-loaded approach to mitigation represents industry best practice and the EIAs reflect the situation with these measures in place;
- As a result of this approach, only a limited number of environmental impacts will occur, a majority of which will be negligible to minor due to their short-term duration and limited spatial extent; and
- Nord Stream 2 follows in the footsteps of the successful construction and operation of the existing Nord Stream pipeline system. Several years of environmental monitoring demonstrate that this existing system has had no significant environmental impacts.

The expert team behind Nord Stream 2 is committed to building a safe and sustainable subsea pipeline system that causes no significant or lasting impacts to the Baltic Sea, the onshore environment or local communities. You can read more details about the project and the assessed environmental impacts in the full Espoo Report, available via [www.nord-stream2.com](http://www.nord-stream2.com).

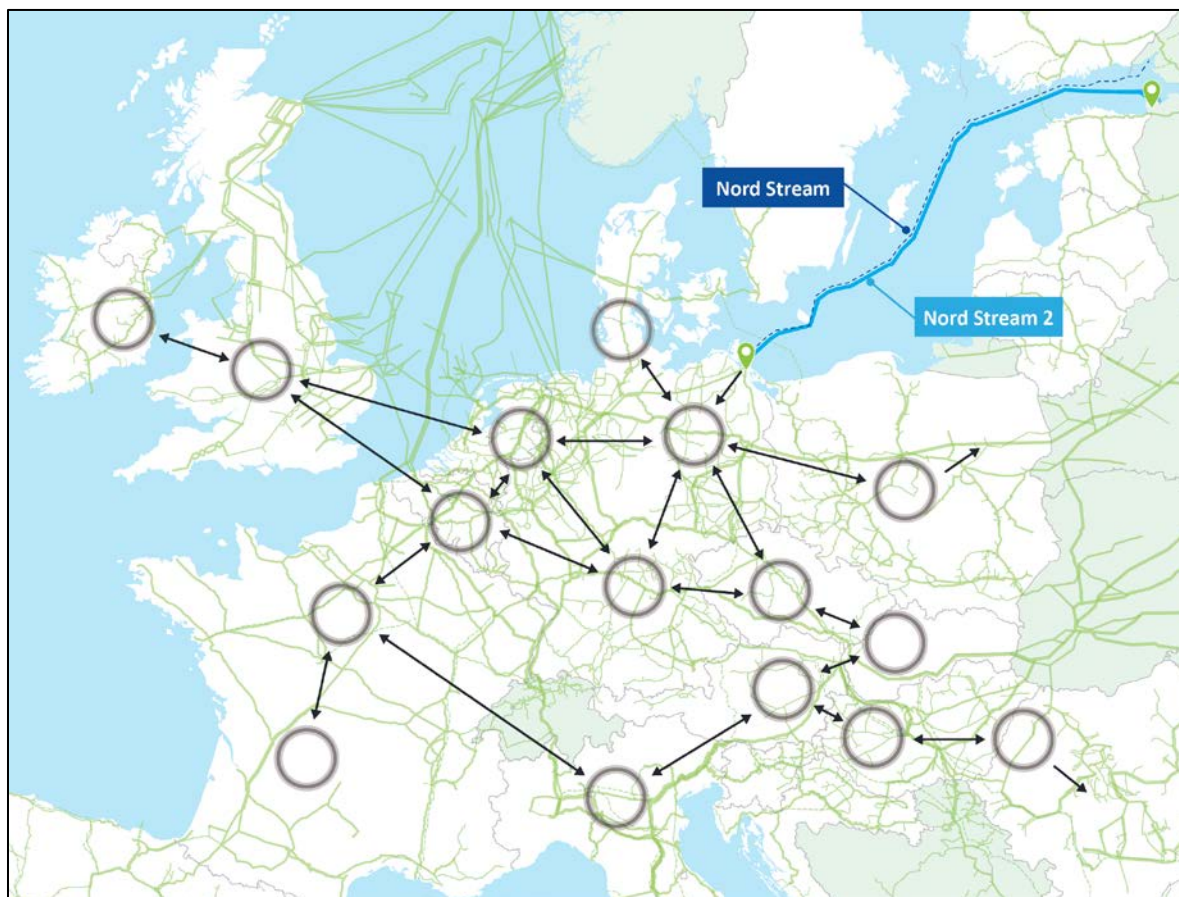
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<sup>1</sup> The term “Environmental Impact Assessment (EIA)” has been used in this NTS to refer to the relevant environmental studies that are being prepared by Nord Stream 2 AG. This includes EIAs, as required under the respective national legislation, as well as the Environmental Study prepared for Sweden (due to there being no legal requirement for an EIA), to evaluate the environmental impacts of the project components in each country where they are located.”

## 0.2 The Nord Stream 2 Project

Nord Stream 2 is a planned natural gas pipeline system that will increase transportation capacity into Europe to meet the region's growing import needs. The twin pipelines will run from the Baltic Coast in Russia, through the Baltic Sea, reaching landfall near Greifswald in Germany. Once the gas enters the EU internal market, it can be transported onwards to wherever it is needed.

Nord Stream 2 builds on the successful construction and operation of the existing Nord Stream pipeline system, which became fully operational in 2012 and has been recognised for its high environmental and safety standards, green logistics and transparent public consultation process.



**Figure 0-1** Once natural gas delivered by Nord Stream 2 reaches Germany, it can – in the future – flow anywhere in the EU's internal energy market.

Nord Stream 2 has spent several years conducting research and carrying out surveys around the proposed pipeline route. These investigations range from technical and environmental studies to examinations of social and socio-economic impacts at local, regional and international levels.

### Permitting, EIA and Espoo

- **Permitting:** The Nord Stream 2 Project is subject to national legislation in each of the countries whose Territorial Waters and/or Exclusive Economic Zones it crosses: Russia, Finland, Sweden, Denmark, and Germany. According to the requirements of country-specific national legislation, Nord Stream 2 submits its national permit applications and environmental impact assessments/study materials to competent authorities. Necessary permits must be obtained before construction can start in that jurisdiction. This process is known as “permitting”.
- **Environmental Impact Assessments (EIAs):** Nord Stream 2 is preparing thorough national Environmental Impact Assessments (EIAs) as part of the permitting process in each country whose waters the pipeline route crosses, namely, Russia, Finland, Sweden, Denmark and Germany. These national EIAs describe and evaluate the potential impacts originating in their respective countries.
- **Espoo:** Under the Convention on Environmental Impact Assessment in a Transboundary Context (“Espoo Convention”), certain industrial projects that have potential impacts that cross a national border, such as the Nord Stream 2 Pipeline project, need to take this assessment process a step further and assess impacts of a transboundary nature. Therefore, the Espoo Report addresses “transboundary impacts” that may originate in one country but affect another. It also uses this analysis to evaluate the overall impact of the project in its entirety, across all countries that may be affected by it. The Espoo Report thus helps decision-makers assess the implication of the project’s likely environmental impacts and make an informed decision about whether to permit the project to be built. Any interested party has the opportunity to read the report and contribute to the project’s consultation process.

The Nord Stream 2 project comprises the construction and subsequent operation of a twin subsea natural gas pipeline through the Baltic Sea. The pipeline route will stretch for some 1,200 km from Russia’s Baltic coast in the Leningrad region, reaching landfall near Greifswald in Germany. In addition to these two countries, the pipeline will pass through the jurisdictions of Finland, Sweden and Denmark.

The Nord Stream 2 project includes:

- Offshore pipelines;
- Onshore facilities at the Russian landfall Narva Bay, including buried pipelines sections of some 4 km and above ground facilities; and
- Onshore facilities at the German landfall Lubmin 2, including pipelines sections of some 0.4 km housed in twin micro tunnels, and above ground facilities.

During construction, Nord Stream 2 will make use of ancillary facilities that include:

- Coating plants in Kotka, Finland and Mukran, Germany; and
- Pipe storage yard at Karlshamn, Sweden; Kotka and Hanko, Finland; and Mukran, Germany.

The Nord Stream 2 system will have the capacity to deliver 55 billion cubic metres (bcm) of natural gas per year directly to the EU market in an environmentally safe and reliable way. This will be sufficient to supply 26 million households. Each pipeline will have an internal diameter of 1,153 mm (48 inches) and will be constructed from approximately 100,000, 24-tonne concrete-weight-coated steel pipes laid on the seabed. Pipe-laying will be carried out by specialised vessels handling the entire welding, quality control and pipe-laying process. Both lines are scheduled to be laid during 2018 and 2019, followed by testing of the system at the end of 2019, before gas begins to flow.

The availability of first-hand knowledge gained from the design, construction and operation of the existing Nord Stream pipeline has benefited the design and planning of Nord Stream 2. The new system will be independent from the existing pipeline, but they will run in parallel for a substantial distance.

### 0.2.1 Why is Nord Stream 2 needed?

Natural gas is expected to remain an important energy source with projections of stable or increasing demand in the coming decades. As countries seek to reduce their carbon emissions, gas offers a lower carbon alternative to coal. It can also supplement renewable energy, while renewables take on a growing share in the energy mix.

Domestic EU production of natural gas, however, is expected to fall by fifty per cent over the next two decades. As a result, the EU will have to import additional volumes of gas to secure supply from as early as 2020. Given the declining or insecure supply of gas via pipelines from Norway, North Africa and the Caspian Region/Middle East, new import routes will be needed – either as pipeline gas from Russia and/or as liquefied natural gas (LNG) from other holders of large gas reserves.

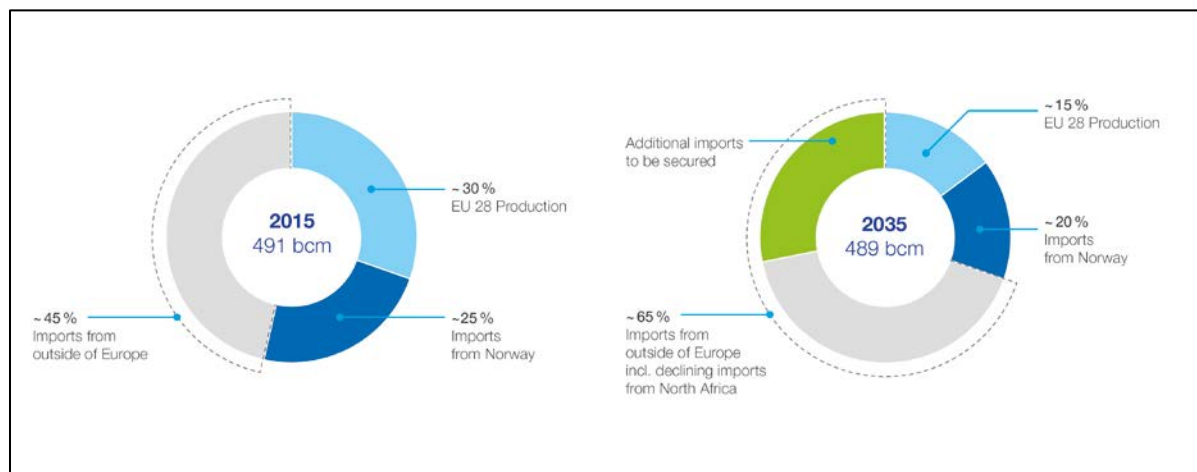


Figure 0-2 EU faces an import gap as domestic production declines.

Without a new direct gas pipeline supply from Russia, the EU will have to compete with other countries for LNG supplies, many of which, e.g. Asia, have been paying a premium for LNG over EU gas prices. Other imminent risks to supply security also need to be mitigated by having readily available back-up capacity.

Nord Stream 2 will provide a reliable and sustainable additional transportation route into the EU, under sound environmental and economic conditions. By supplementing other existing and planned import options, Nord Stream 2 can contribute towards closing the forecasted EU import gap and help to reduce imminent risks to supply security.

### 0.3 The international Espoo process

The international consultation process is an essential phase in the development of the Nord Stream 2 pipeline. National EIAs are being carried out in each of the five countries crossed by the pipeline route, namely, Russia, Finland, Sweden (Environmental Study), Denmark and Germany. Since Nord Stream 2 has the potential to cause transboundary environmental impacts, it is additionally subject to a transboundary EIA (documented in an Espoo Report) in accordance with the Espoo Convention.

### Nord Stream 2 will consult with nine countries

The Espoo Convention defines two important groups of consultees:

- **“Parties of Origin”** are the five countries in which Nord Stream 2 will be located: Russia, Finland, Sweden, Denmark and Germany; and
- **“Affected Parties”** are the countries which may be affected by Nord Stream 2 in some way, even if it is not located within their boundaries: Estonia, Latvia, Lithuania and Poland. For Nord Stream 2, the five Parties of Origin are also considered Affected Parties. For example, construction activities taking place in Russia may impact Finnish waters, meaning that Finland would be an Affected Party.

To ensure that a description of Nord Stream 2 and its potential environmental impacts are communicated clearly to all Affected Parties and stakeholders, the Espoo Report is written in English and is translated into the nine languages of all Affected Parties.



Figure 0-3 The proposed Nord Stream 2 pipeline route, Parties of Origin and Affected Parties.

#### 0.3.1 Previous consultation about the Nord Stream 2 project

Based on the process laid out under the Espoo Convention, a number of consultation steps relating to the Nord Stream 2 project have already been undertaken:

- November 2012 – Nord Stream (the predecessor company to Nord Stream 2) notified the five Parties of Origin about the Nord Stream Extension (now known as Nord Stream 2) and issued a draft Project Information Document.
- February 2013 – The Parties of Origin discussed the content of the Project Information Document and the procedures for the project under the Espoo Convention.
- March 2013 – Following this and taking comments into account, Nord Stream submitted the final Project Information Document to the Parties of Origin.
- April 2013 - The Parties of Origin submitted the Project Information Document to the Affected Parties.



Nord Stream 2 has subsequently engaged in active consultation on the final Project Information Document within all Baltic Sea countries. This included numerous meetings with the relevant authorities to ensure that the Espoo Report will address the issues that are important to them. In total, Nord Stream 2 held over 200 meetings with authorities, non-governmental organisations and other stakeholders, such as fishermen.

A list of the key comments received during the consultation process on the Project Information Document, as well as a description of how Nord Stream 2 has addressed these comments, is provided in the Espoo Report.

The process is ongoing and each Party of Origin will define the duration of the period within which comments can be submitted. The Affected Parties are responsible for organising hearings, meetings and other means of consultation on the Espoo Report in line with legal requirements. Nord Stream 2 has committed to attend such hearings and meetings if requested by the relevant authorities. The Parties of Origin will take the comments received during the consultation phase into account when making a final decision on whether to grant approval for the project.

#### Public feedback

Through the Espoo process, all countries and individuals potentially affected by the Nord Stream 2 pipeline have the opportunity to learn about the project and share their feedback.

Detailed information about the project and the potential transboundary impacts can be found in the Espoo Report. The Espoo Report is publicly available for anyone to read via [www.nord-stream2.com](http://www.nord-stream2.com).

This document is the Non-Technical Summary of the Espoo Report. It was prepared for the non-specialist reader to share the most significant findings from the main report.

Public feedback on the Nord Stream 2 project is welcome and it is a key element in the international consultation process. All views should be shared with the respondent's national authority. The national permitting authorities consider all comments as they make their decision on granting a permit for the project.

## 0.4 Alternatives to the Nord Stream 2 proposal

Several project routing, design and construction alternatives were evaluated during the planning process to ensure that the preferred option would, where possible, minimise environmental and socio-economic impacts, whilst maintaining international good practise in relation to health and safety, satisfying design standards and construction requirements, and maintaining the integrity and reliability of the system over its entire operational life. The selection of alternatives to consider, and the subsequent identification of the preferred option, involved substantial research and drew heavily upon the experience gained from the successful implementation of the existing Nord Stream pipeline system.

The evaluation of each alternative was centred around three main criteria:

- **Environmental** – Planners worked to avoid, where possible, crossing areas designated as “protected” or otherwise recognised as “environmentally sensitive” as important habitats for animal and/or plant species. Project planners also sought to minimise intrusive activities that have the potential to impact the natural environment.
- **Socio-economic** – Planners sought to minimise any restrictions on existing users, i.e. the shipping or fishery industry, the military, tourism and recreation users etc., as well as any interference with existing offshore installations, such as cables or wind turbines and onshore land uses. Project planners also sought to avoid munitions (deployed during or

after World Wars I and II) and cultural heritage sites, such as shipwrecks, wherever possible.

- **Technical** – Planners considered how to reduce construction time via the minimisation of potential disruptions of construction works, etc., while also minimising technical complexity, costs, and resource needs.

On the basis of the experience of the existing Nord Stream pipeline system, and taking the three main criteria described above into account, a thorough route corridor assessment was performed. This identified a number of feasible route corridor and landfall options as a basis for further planning, each of which were researched before selecting the preferred route.

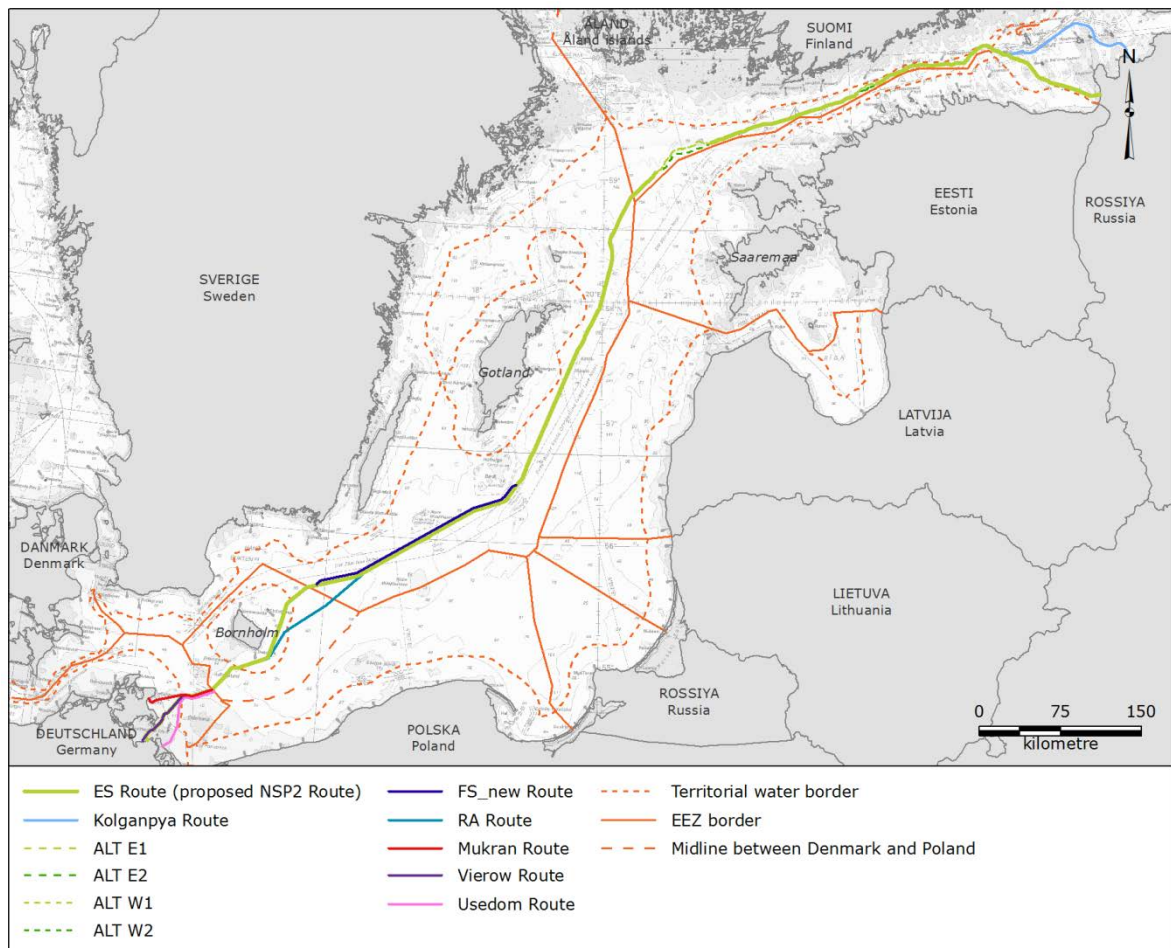


Figure 0-4 Nord Stream 2 route alternatives.

#### 0.4.1 Russia

Environmental, social and technical constraints, notably the requirement to adhere to a minimum safety distance from settlements, means it is not possible to follow the original Nord Stream route in Russia. Narva Bay and Cape Kolganpya were therefore identified as alternatives. Following environmental surveys and the assessment of the two routes, the Narva Bay option is preferred, due to: shorter onshore and offshore routing, leading to lower impacts and shorter construction timeframes; more favourable seabed conditions, meaning less dredging is required; and lower risks of accidents. Final decision on approval of this route will be given by the Russian Federation authorities based on a detailed analysis of environmental damage prepared for both options and evaluation of the final outcome of the Russian environmental impact assessment (EIA).

#### 0.4.2 Finland

In Finnish waters there are two sections where the pipeline has two alternative routes. The eastern section is located south of Porkkala and a second section is located in the western part of the Finnish EEZ.

### 0.4.3 Sweden and Denmark

Three route alternatives were identified through Swedish and Danish waters. The less favourable options required more seabed intervention works, were located closer to Natura 2000 sites and/or passed through the historical chemical munitions dumping sites, increasing risk of environmental impact. The preferred route is located more than 10 kilometres from Natura 2000 sites and from the island of Bornholm. As this route runs parallel to the existing Nord Stream pipelines, it also minimises restrictions on other marine uses.

### 0.4.4 Germany

The Pomeranian Bay was selected as the preferred landfall area on the German coast on the basis of environmental, socio-economic and technical evaluations. Four landfall locations – Lubmin West, Vierow, Mukran and Usedom – were evaluated. Usedom was discounted on the basis that it is near important tourism and residential areas. The three remaining route alternatives were assessed to: minimise offshore pipeline length, avoid environmentally sensitive areas, and optimise technical conditions, which led to Mukran being discounted. Lubmin West is the preferred option because it has a direct connection to the existing gas grid and the environmental impact will be lower than Vierow.

## 0.5 The 'zero alternative'

The 'zero alternative' is an evaluation of the situation in which Nord Stream 2 is not constructed. This would of course mean that neither the negative or positive environmental or socio-economic impacts that would arise from the implementation of Nord Stream 2 would be realised.

Although non-implementation of Nord Stream 2 would avoid the predominantly temporary, local and minor environmental and socio-economic impacts, it would also mean other ways of meeting Europe's growing energy demand would be required.

## 0.6 Planning, construction and operation of Nord Stream 2

### 0.6.1 The key considerations during the planning phase

Many years of research and analysis go into the planning phase for Nord Stream 2, to establish clear health and safety practices, understand the environmental context, and optimise the technical design. In the planning of construction and technical design, Nord Stream 2 has adopted industry best practice through its approach to limit environmental impact to a minimum by building mitigation measures into the design of Nord Stream 2 from the outset.

Examples of in-built mitigation measures are:

- Technical solutions:
  - Detailed route development and optimisation to reduce requirement for intervention works on the seabed, e.g. rock berms;
  - Use of a dynamically positioned lay barge in the heavily mined areas of the Gulf of Finland to minimise impacts from munitions clearance;
  - Controlled rock placement utilising a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material.
- Marine fauna:
  - Deployment of sonar locators to avoid fish and acoustic deterrent devices to drive marine mammals, away prior to munition clearance;
  - Construction activities, such as pipe-lay and rock placement, are not planned in winter ice conditions to prevent impacts on seals during the breeding season.
- Ship traffic:
  - Information on project vessels' plans and schedules will be provided in notices to Mariners.

- Underwater cultural heritage:
  - Implementing stringent measures to avoid impacts on cultural heritage during construction. In general, a safety distance should be assigned to each cultural heritage site.

#### **Health, Safety, Environmental and Social Management System (HSES MS)**

In the planning phase Nord Stream 2 has adopted a health, safety, environmental and social (HSES) policy, implemented through a management system (HSES MS), which is aligned to international standards. As part of the management system, Nord Stream 2 is developing environmental and social management plans to ensure compliance with the HSES policy throughout construction and operation.

The HSES MS enables Nord Stream 2 to identify and systematically control all relevant HSES risks arising during project planning and construction. It also covers the management of security where it may impact the safety of personnel and project-affected communities, the integrity of project assets and the reputation of Nord Stream 2. Once Nord Stream 2 is commissioned, the HSES MS will be adjusted to manage HSES issues for the operational phase.

#### **Environmental and Social Management Plan (ESMP)**

Nord Stream 2 is also developing Environmental and Social Management Plans (ESMP) for construction and operation of Nord Stream 2. The ESMPs contain the relevant, specific HSES commitments included in the national EIAs as well as conditions included in the permits issued by each country. ESMPs will apply to both Nord Stream 2's own staff and its contractors, and Nord Stream 2 will ensure that contractors adhere to the standards and requirements in the HSES MS and applicable ESMPs. HSES information will be proactively communicated internally and externally.

### **0.6.2 Pipeline construction**

Pipeline construction is governed by demanding international standards and certification processes at every stage. This helps to ensure the construction process is safe, precise and protective of the environment.

#### **0.6.2.1 Manufacturing, coating and storage**

At steel mills in Germany and Russia, the 12.2-metre pipe sections are fabricated to a precise specification, with a constant inner diameter of 1,153 millimetres and a wall thickness of up to 41 millimetres. From there, they are taken to specialised coating yards in Germany and Finland. The pipes are coated internally to reduce friction and externally to provide corrosion protection. An additional outer layer of concrete is applied to the pipes with a maximum thickness of 110 millimetres. This adds weight to the pipes to increase their stability on the seabed. Now weighing up to 24-tonnes, the pipes are stored in storage yards in Germany, Sweden and Finland, ready to be transported by special carrier ships to the pipe-lay vessel for immediate use.

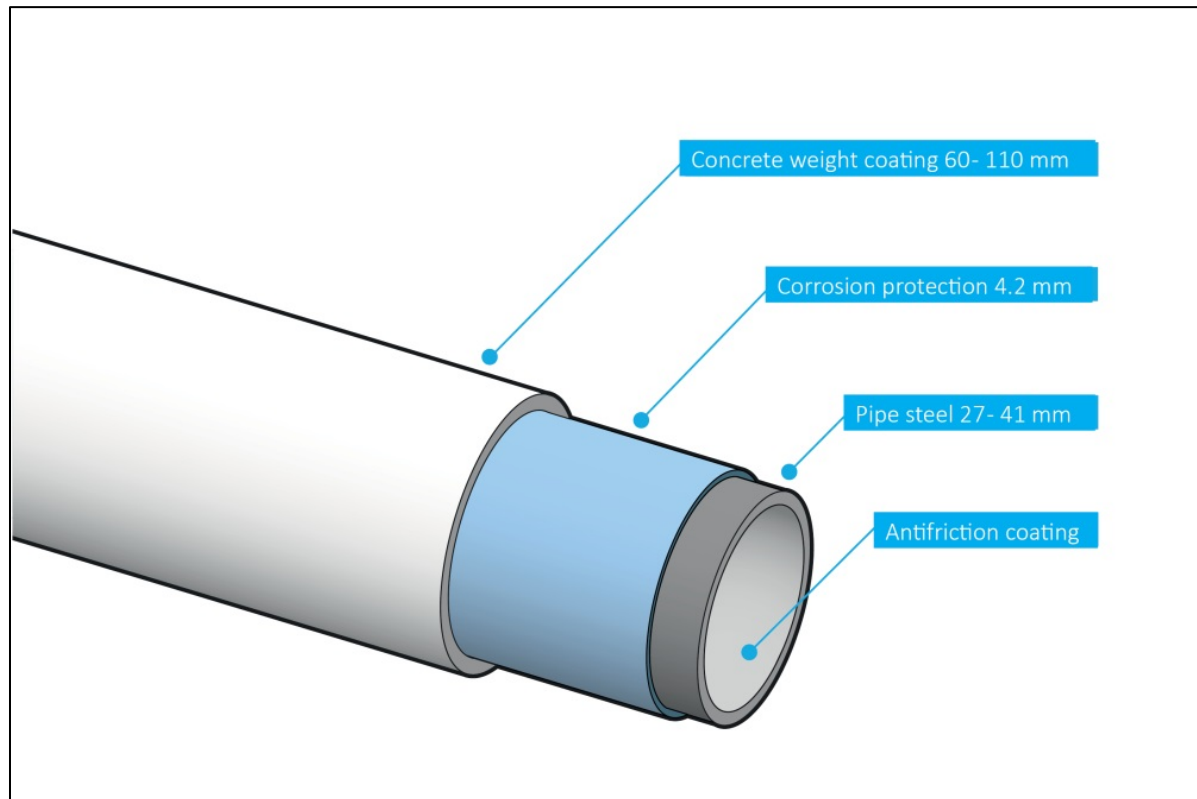


Figure 0-5 Pipe cross-section.

#### 0.6.2.2 Munitions clearance

During the two World Wars, many thousands of mines were laid in the Baltic Sea. While many have been cleared in the intervening years, Nord Stream 2 undertakes munitions surveys to identify remaining mines or munitions on the seabed. Where possible, Nord Stream 2 will avoid known munitions through localised re-routing, or relocate the munitions. Only where this is not possible on safety or responsibility grounds, will detonation in situ be undertaken with appropriate mitigation in place.

#### 0.6.2.3 Rock placement

In some areas along the route, crushed rock will be strategically placed on the seabed to support and stabilise the pipelines where needed e.g. where there is a free span<sup>2</sup> which needs support or to provide a solid foundation for a pipeline or cable crossing. The rock material will be placed by a fall-pipe, which improves accuracy. Rock placement activities will be carried out prior to and after pipe-lay.

#### 0.6.2.4 Dredging and backfilling

In the nearshore approaches to the Russian landfall and in German territorial waters, the pipelines will be buried entirely in the seabed to ensure that waves and sand movements will not affect their stability. This involves the excavation of a trench prior to pipe-lay, using dredgers of various types. The excavated materials will be removed, stored temporarily and used for backfilling where possible.

#### 0.6.2.5 Pipe-lay

On the pipe-lay vessel, the pipes are welded together and the welded joints are automatically 100% inspected through an ultrasound scan. Finally, after protecting each weld, the pipeline is fed out of the vessel onto a ramp structure called a "stinger", which prevents overstressing of the

<sup>2</sup> An area where the bathymetry is uneven, such that the pipelines would not be supported on the seabed.

pipeline as it enters the water. The process is carefully managed to maintain 24 hour continuous operation, so that pipe-laying vessels can lay up to three kilometres of pipeline per day.

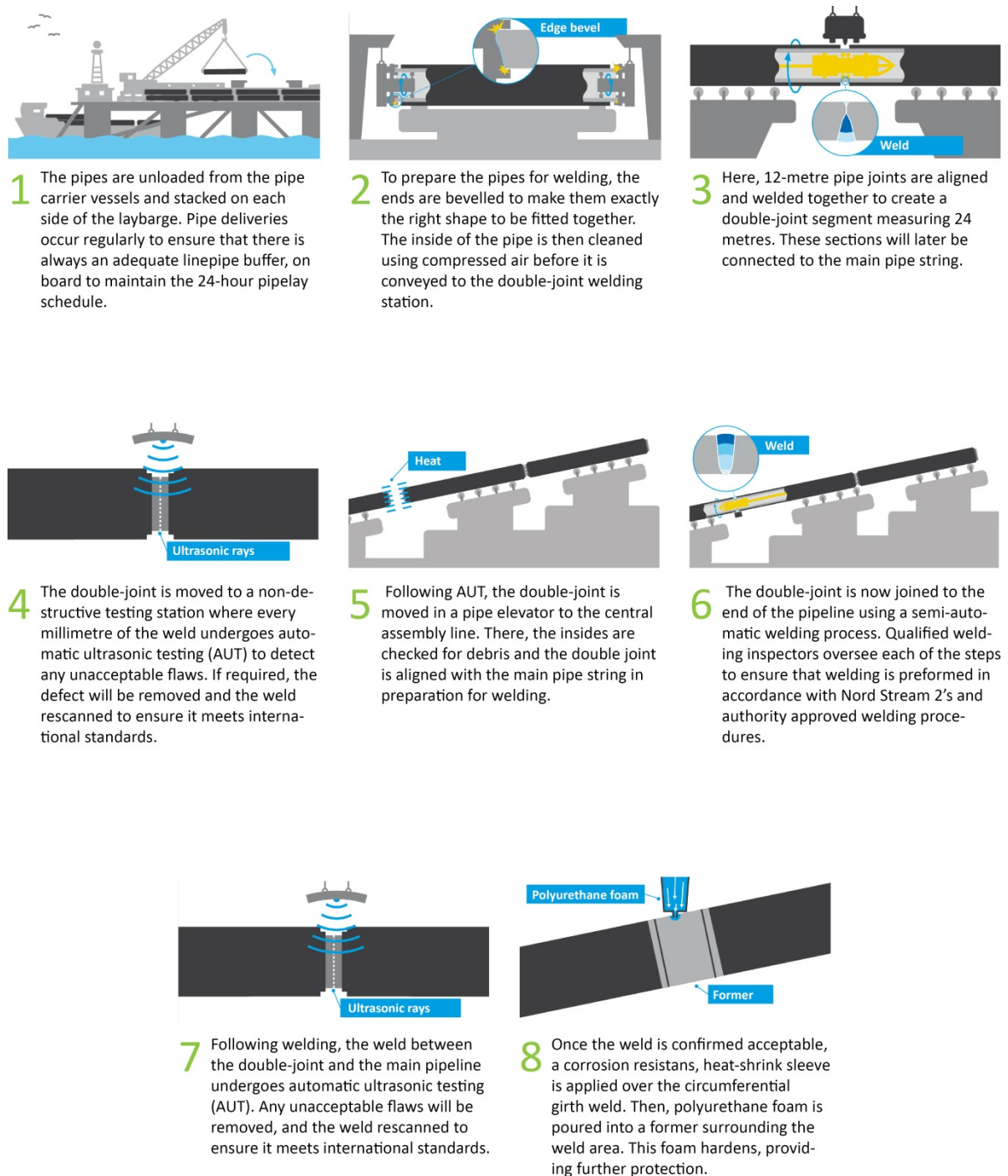


Figure 0-6 Constructing a subsea pipeline.

#### 0.6.2.6 Post-lay trenching

To provide additional protection or stabilisation against waves and currents, the pipelines will, in some areas along the route, be trenched into the seabed after they have been laid. Post-lay trenching is carried out using a pipeline plough which is deployed onto the laid pipeline from a vessel. The pipeline will be lifted into the plough and supported on rollers. A vessel will then pull the plough along the seabed, laying the pipeline into the ploughed trench as it advances. To minimise environmental impacts, the excavated material from the trench will be left on the seabed next to the pipelines so that natural backfilling will occur over time as a result of sea currents.

### 0.6.2.7 Onshore construction

In Russia, the base case construction method for the 4 km pipeline onshore section is conventional trenching methods utilising excavators. Side cranes will lower the welded pipeline sections into the trenches which are then backfilled and the work areas will be reinstated. The Nord Stream 2 pipelines will terminate at an above ground maintenance facility which will link with upstream feeder lines and compressor facilities owned by a third party operator.

In Germany, the pipeline installation at the shore crossing will be undertaken through the construction of twin micro tunnels which will house the onshore pipeline sections. The Nord Stream 2 pipelines terminate at a maintenance facility which will link with downstream feeder lines owned by a third party operator.

### 0.6.2.8 Pre-commissioning and commissioning

Once constructed, each pipeline on the seabed will be dry inside and filled with compressed air for cleaning and gauging. Thereafter the pipelines will be filled with natural gas until the required pipeline pressure to start normal operation is achieved.

### 0.6.3 Pipeline operation

During normal operation, pressurized natural gas will be continuously introduced at Narva Bay, Russia and taken out at an equal rate at Lubmin, Germany. Monitoring and maintenance are undertaken to ensure the pipeline operate safely.

#### 0.6.3.1 Monitoring of gas flow

Pressure and gas flow are remotely monitored 24 hours a day, and the intake and extraction volumes are balanced as needed to ensure that maximum pressure is never exceeded. Specialists are always on hand to take direct control to ensure safety in an emergency. The entire operational procedure is certified by the independent certification agency, DNV GL.



Figure 0-7 The Nord Stream Control Centre manages the daily operations of the existing Nord Stream pipeline.

#### 0.6.3.2 Maintenance

Maintenance and inspection are performed regularly throughout the operational life of the pipelines. In addition, routine surveys of the exterior of the pipelines, their support structures, and the seabed corridor, are carried out using a remotely operated vehicle and towed sensors. Based on the outcome of these surveys, any necessary actions are assessed.

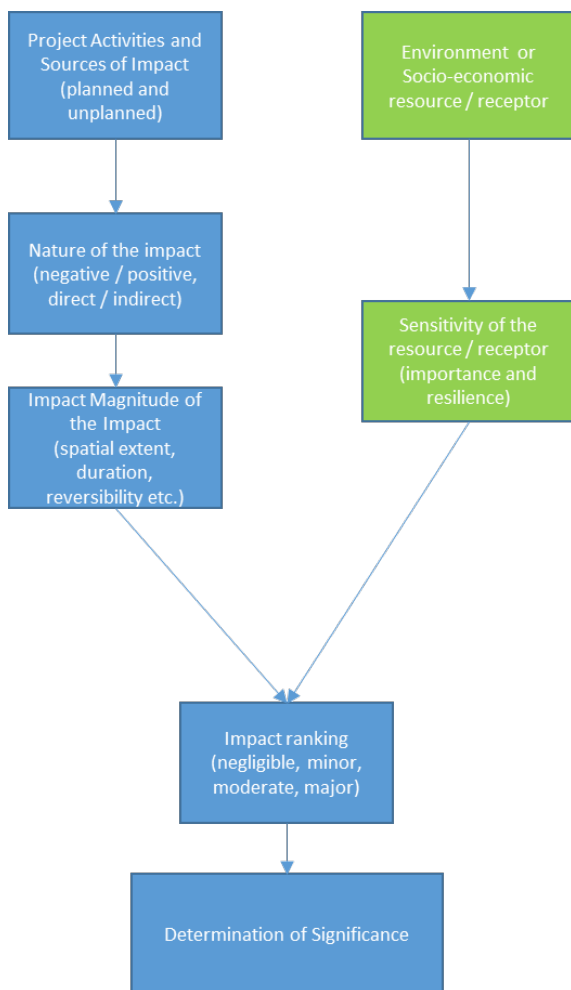
## 0.7 Methodology for the impact assessment

While the Espoo impact assessment took account of the EIAs undertaken for each country through which the pipelines pass, it has focused on providing an overarching assessment of Nord Stream 2. This approach ensures that an assessment of in-combination impacts on each

receptor group has been undertaken, including interactions between impacts arising in different national jurisdictions.

The assessment has drawn from a substantial body of empirical data generated by the monitoring programme of Nord Stream, undertaken during both its construction and operation. Targeted predictive modelling has also been undertaken in order to determine the areas which will be influenced by certain Nord Stream 2 activities (i.e. sediment spread and noise propagation).

As part of the assessment, possible cumulative and transboundary impacts have also been considered, and are described in the relevant sections below.



**Figure 0-8** Process for identifying and assessing potential environmental impacts from planned activities.

Initially, the **project activities** which had the potential to impact environmental (physical-chemical or biological) or socio-economic **resource/receptors** were identified.

The **nature and magnitude of the impact** (i.e. the type and scale of the change) was then determined based on spatial extent, intensity, duration, level of damage and reversibility of the impact, as well as the number or proportion of receptors affected.

The **sensitivity of a resource or receptor** to a particular impact was determined based on a combination of receptor importance (e.g. conservation status, or cultural/economic importance) and receptor resilience (the degree to which it can withstand an activity without a change to its status).

Based on this, the overall **impact ranking** was determined, and expressed as a qualitative ranking of negligible, minor, moderate or major. This took the implementation of inbuilt mitigation measures (envisaged in order to avoid and reduce significant adverse impacts) into account.

Impacts were determined as either potentially **'Significant' or 'Not Significant'**, to enable these evaluations to be taken into account as appropriate by the relevant decision making authority when determining whether to grant consent.

## 0.8 Results of the impact assessment

The following section includes a summary of the most noteworthy conclusions of the impact assessment on the *physical-chemical, biological and socio-economic environments*.

Under each of these environments it considers receptors in marine areas, through which the offshore pipelines will pass, as well as those in the vicinity of onshore landfalls at Narva Bay (Russia) and Lubmin 2 (Germany). As impacts associated with ancillary activities largely relate to noise and air emissions, employment and transportation, impact at these sites are only considered with respect to the physical- chemical and social environments.



Overall, only a limited number of environmental impacts will occur, and of these, the majority will be negligible to minor (and therefore not significant) often due to their short-term duration and limited spatial extent.

### 0.8.1 Impacts on the physical-chemical environment

The physical and chemical environment defines the conditions for the biological and the socio-economic environment and therefore is both a receptor in itself, and, more importantly, a carrier of the impacts from Nord Stream 2 activities to the biological and socio-economic receptors.

#### 0.8.1.1 Marine areas

The marine physical-chemical environment has been considered in terms of: marine geology, bathymetry and sediments; hydrography and seawater quality; and climate and air quality.

##### Marine geology, bathymetry and sediments

During construction, potential impacts on marine geology, bathymetry and sediments comprise: alterations to the seabed profile and the composition of surface sediments. Impacts will be greatest in areas where dredging or munitions clearance are proposed (Russia, Germany and Finland). However, in all areas, receptors will be restored back to pre-impact status either through human intervention or naturally over time (due to natural sediment transport processes). The majority of impacts have therefore been assessed to be **negligible**, with peaks of **minor** impacts predicted in Germany, Finland and Russia.

During operation, potential impacts comprise the introduction of a new hard surface on the seabed, alteration to seabed profile and change in temperature of the sediment. Impacts will be localised to the immediate vicinity of the pipelines and will generally be within natural variation. The majority of impacts have therefore been assessed to be **negligible**, with peaks of **minor** impacts predicted in Finland and Germany.

##### Hydrography and seawater quality

During construction, potential impacts on hydrography and seawater quality comprise: an increase in suspended sediment in the water column (reduced transparency of the water); and an increase in contaminants and/or nutrients in the water column. Impacts will be greatest in areas where dredging, munitions clearance or post-lay trenching are proposed (all countries). However, receptors will revert back to pre-impact status and therefore, impacts have been assessed to range between **negligible** to **minor**.

During operation, potential impacts comprise changes to the current patterns and inflows; change in temperature of the water column and increase in contaminants in the water column from anodes. Impacts will be greatest in areas where the pipelines are laid directly on the seabed, without trenching or rock placement. Regardless, all impacts have been assessed to be **negligible**, with the exception of a **minor** impact in Finland and Germany.

##### Climate and air quality

During construction and operation, potential impacts on climate and air quality comprise: an increase in greenhouse gases (e.g. CO<sub>2</sub>) and reduction in local air quality. Although Nord Stream 2 contributions will be detectable above natural variation in close proximity to the activities, quantities are small compared to annual emissions from normal shipping in the Baltic Sea and will not have a quantifiable impact on global climate or local air quality. Impacts have therefore been assessed to be **negligible**, with the exception of a **minor** impact in Germany.

#### 0.8.1.2 Onshore areas

The onshore physical-chemical environment has been considered in terms of: geomorphology and topography; freshwater hydrology; and climate and air quality.

### Narva Bay Landfall

A trench at Narva Bay will cause temporary impacts, though the trenched area will be gradually backfilled and the working area will be levelled to the original topography and revegetated after the installation of the pipelines. For the area where the construction will take place through a relict dune (2.5 ha), a special restoration plan to mitigate impacts is being developed. Impacts have been assessed to range from **minor** (for modified habitat) to **moderate** (for the primary forest and the relict dune).

Nord Stream 2 will require vegetation clearance, removal of the top layer of soil, ground-leveling and excavation of the trench. These activities have the potential to interfere with the local drainage patterns and hence the local hydrology. However, the soil to be used for trench backfilling will have the same filtration properties as underlying soils to ensure the adequate water drainage. There is also the potential for the release of surface water run-off to impact the quality of surface water bodies. However, a Water Management Plan will be implemented and the drainage systems will be designed to ensure that surface water discharges are maintained at greenfield run-off rates, resulting in impacts which have been assessed to be **negligible**.

Although Nord Stream 2 contributions increase in greenhouse gases (e.g. CO<sub>2</sub>) and air pollutants (e.g. SO<sub>2</sub> and NO<sub>x</sub>) will be detectable above natural variation in close proximity to the activities, quantities will not have a quantifiable impact on global climate or local air quality. Impacts have therefore been assessed to be **negligible**.

### Lubmin 2 Landfall

Due to the construction of a micro tunnel, the coastal section at Lubmin 2 will not be impacted by Nord Stream 2. However, due to the construction of the PTA, small sections of the forest will need to be cleared (approximately 190 x 190 m) and some areas of soil excavated. This will lead to a loss of trees and thus to a degradation of the landscape, as loss of naturally occurring dune relief (geomorphological specialty). Impacts have been assessed to be **minor**.

The micro tunnel will be approximately 10 m deep, which is below ground water level. As a result, the ground water level will be drawn down to 0.5 m below the floor of the pit, in order to keep the pit water-free during the tunnel construction (for approximately 9 months). However, the groundwater level will revert to pre-impact status shortly after ending the construction works. Impacts have therefore been assessed to be **minor**.

Similar to at Narva Bay, Nord Stream 2 emissions during construction or operation will not have a quantifiable impact on global climate or local air quality. Impacts have therefore been assessed to be **minor**.

### Ancillary Sites

At onshore ancillary areas (Kotka and Hanko, Finland; Karlshamn, Sweden; Mukran, Germany), used for pipe coating and storage and rock storage, emissions from Nord Stream 2 will be detectable above natural variation in close proximity to the activities, particularly in Finland and Germany. However, quantities will not have a quantifiable impact on global climate or local air quality. Impacts have therefore been assessed to be **negligible to minor**.

## 0.8.2 Impacts on the biological environment

### 0.8.2.1 Marine areas

The marine biological environment has been considered in terms of both species, notably plankton, seabed dwelling organisms (benthic flora and fauna), fish, marine mammals, birds; and areas designated for their conservation value.

The marine biology of the Baltic Sea is strongly influenced by its abiotic conditions, notably salinity temperature and oxygen, as well as available light. In general, the biodiversity is lower in open water and low salinity areas (such as the Bornholm Basin and inner Gulf of Finland) compared to coastal or sheltered areas (such as at the Pomeranian Bay and Greifswader Bodden) or other shallow waters (such as Hoburgs and Misdjö Banks). Along sections of the Nord Stream 2 route, less favourable abiotic conditions (e.g. low oxygen conditions at depth), reduce the natural biodiversity. Based on the assessments of impacts at species and habitat level, provided below, it has been evaluated that any in-combination impacts on marine biodiversity or ecosystem functioning that may arise from them, will not be significant.

#### Plankton

Although phytoplankton performs an important function as the basis of the marine food chain **negligible impacts** are generally predicted. This result from its fast regeneration time and that, due to its light dependence, it only occurs in the upper water levels which in general will not be affected by project activities. The exception is near the Russian landfall where dredging may result in a **minor** impact. Similarly **negligible impacts** on zooplankton, resulting from reduced food availability (due to limited impact on phytoplankton, their food source) are anticipated.

#### Benthic flora and fauna (Benthos)

Benthic flora provide habitat for many invertebrate and fish species, while benthic fauna constitute a central link between plankton and higher levels in the food chain. Along the pipeline route, benthic flora are largely confined to German waters while benthic fauna are largely absent from deeper waters. Several species of benthic fauna are included on the HELCOM and German Red lists, of which two in the latter category are classified as endangered.

The disturbance of the seabed, due to munitions clearance and seabed intervention works, may damage or destroy benthos and their habitats. The resulting suspension and resettlement of sediment could smother benthos as well as limit the growth of both benthic flora, through restricting light availability, and benthic fauna through reducing their food availability and clogging their respiratory apparatus. For benthic flora, the impact ranking in the Pomeranian Bay and Greifswader Bodden, where most flora occur, is **minor** but elsewhere along the route, due to their limited occurrence, is at most **negligible**. For benthic fauna, the impact ranking due to such suspension and resettlement of sediment is **minor** near the landfalls in Germany and Russia and **negligible** elsewhere.

The presence of the twin pipelines will introduce a new hard substrate (artificial reef) for benthic flora and certain epifaunal (non-burrowing) benthic species, and thus may result in a degree of **positive** impact for these species. It will, however, result in a loss of habitat for infauna (burrowing) benthic species which could result in a **moderate** impact in German waters due to the presence of faunal burrowing species of high conservation importance.

#### Fish

Owing to its brackish conditions, the Baltic Sea fish diversity is low but it nonetheless supports a number of species of both commercial and conservation interest, including several on the HELCOM Red List.

The demersal (seabed) spawning areas in Greifswalder Bodden and coastal areas close Narva Bay may experience **minor** impacts from damage to habitats from seabed works and introduction of

the new pipeline, and more notably from smothering of larvae and eggs from sedimentation, although elsewhere along the route such impacts will be **negligible**. As the concentrations of suspended sediment will be insufficient to clog gills of adult fish or affect viability of pelagic fish eggs (those in the water column rather than on the seabed) the ranking of such impacts is for most locations **negligible**. The exception is within the Pomeranian Bay and Greifswader Bodden and Narva Baay, where the proximity of pelagic spawning areas to the dredging sites could result in a **minor** impact ranking.

Underwater noise generation associated with munitions clearance may result in a degree of injury to fish in Russian and Finnish waters with a **consequent negligible** to **minor** ranking. Owing to the lower noise levels generated by other activities, notably rock placement, impacts elsewhere offshore will generally be **negligible**. Disturbance from vessel movement will typically result in short term avoidance behaviour and the impact will therefore generally be **negligible**.

The creation of an artificial reef and consequent colonisation for benthic communities (described above) could with time create habitat for pelagic fish species potentially resulting in a degree of **positive** impact

### **Marine mammals**

Four marine mammals are resident in the Baltic Sea: Harbour porpoise, grey seal, ringed seal and harbour seal. Of these, harbour seal and harbour porpoise warrant particular attention, as reflected in their inclusion in various Red Lists of threatened species and the EU Habitats Directive. The Gulf of Finland population of ringed seal also requires particular consideration as its abundance is very low making it vulnerable to impact. Other populations of ringed seals and grey seals are more abundant, making them less vulnerable.

Increased levels of suspended sediment, and hence turbidity resulting from munition clearance and seabed interventions may result in a degree of visual impairment in mammals. This is not, however, considered of key concern as harbour porpoise primarily use echolocation for orientation and prey location and seals are often found in dark water, where prey congregate. Although some short term avoidance behaviour may result, this will be similar to that occurring during a storm event. Its short duration will be insufficient to affect the reproductive success and functioning of the species and the impacts are therefore **minor** close to the landfalls due to dredging, and **negligible** in offshore areas.

The generation of underwater noise, notably from munitions clearance which will be limited to the Gulf of Finland i.e. Finnish and Russian waters, will be by far the largest generator of underwater noise during construction. This can impact on mammals through blast injury, onset of permanent or temporary hearing loss, masking of sound, avoidance and other behavioural responses. The degree of impact will depend on location due to both: the variations in the number of munitions detonated in each area; and the species (and specific populations) of mammals present, and their abundance.

For munitions clearance, the use of seal scarers prior to detonation will drive seals and harbour porpoises away from the detonation zone, substantially reducing the risk of lethal injuries for all mammal species, while those associated with onset of hearing loss and non-fatal blast injuries are as outlined below:

- *Harbour seal* – **No impacts** are predicted since this species is only present in areas too far from the pipeline to be affected by it.
- *Harbour porpoise* – The Gulf of Finland where munitions clearance will take place has very low densities of harbour porpoises. Any impact resulting from onset of permanent hearing loss or blast injury will affect insufficient numbers to influence species viability or functioning. Hence the impact will be **minor**.

- *Grey seal* – Although present throughout the Gulf of Finland, due its good environmental status and abundance, impacts are unlikely to affect the long term functioning of this population. In general, unless detonation of a large munition is required, areas where blast injury may be experienced will not extend into grey seal sanctuaries, colonies or sites protected for such species, around which their numbers will be highest. Impacts are therefore considered to be **minor** (except for the Kallbådan Natura 2000 area, see “Designated Sites” below).
- *Ringed seal* –The low abundance of the Inner Gulf of Finland Ringed seal populations makes this population of ringed seal particularly vulnerable to any impact that may occur, as it could affect a relatively large proportion of the small population resulting in a **moderate** impact from onset of permanent hearing loss or blast injury. This would, however, be restricted to the eastern part of the Gulf of Finland, where this population occurs. The Gulf of Riga and Archipelago Sea population of ringed seal, which is present in the western part of the Gulf of Finland, have higher abundance, so impacts associated with onset of permanent hearing loss and blast injury are ranked as **minor** for this population.

Impacts associated with onset of temporary hearing loss, masking, avoidance and other behavioural responses from munitions clearance are assessed as **minor** for all mammal species.

Rock placement may result in a degree avoidance and by masking of hearing of mammals. However the very short duration of each rock placement activity is insufficient to affect species functioning resulting in an at most **minor** impact ranking

### Birds

Near the Russian landfall, the islands, reefs and surrounding water provide valuable habitats for breeding and migratory birds, recognised through their inclusion within a Ramsar site. In German shallow waters the Pomeranian Bay and Griefswadder Bodden are both designated as Specially Protected Areas (SPA) and Important Bird and Biodiversity Areas (IBA). Both are important as a wintering and staging areas while the latter provides valuable benthic feeding areas for seabirds in the section crossed by the pipeline

Offshore, shallow waters, notably Hoburgs Bank and Midsjö Banks in Sweden (also IBAs) are important wintering areas and stop off points for migratory birds. Only a few bird species forage in the more open and deeper waters where the majority of the pipeline will be located

Increased levels of suspended sediment from munition clearance and seabed intervention works may affect feeding efficiency of birds that rely on fish and benthos, due to decreased visibility and avoidance of the areas by such prey. Due to the limited spatial and temporal extent of such events the impacts are assessed to be **negligible** in offshore areas where there are few birds, and **minor** in nearshore areas, including those designated for birds, where they are present in greater concentrations.

Underwater, the generation of noise from munitions clearance may affect diving seabirds. Based on the numbers potentially affected, impact rankings are **negligible** in offshore areas and **minor** in the Gulf of Finland. Above water, seabirds may be displaced temporarily from their territories, due to vessel disturbance. Depending on the location and hence species present, the impact ranking ranges from **minor**, close to the landfalls, to **negligible** in the shallow areas in Swedish waters.

### Designated sites

Impacts to nature conservation areas in the vicinity of the pipelines’ route may occur if the protected habitats and/or species, which are the qualifying interest of the designation, are affected. The pipeline crosses five Natura 2000 sites, four IBAs and several protected areas, although many of these designations overlap.

The potential for a **moderate** impact ranking, due to the onset of permanent hearing loss of grey seals, a designated species at the Kallbådan Islets and Waters Natura 2000 site (Finland) which includes the Kallbådan seal sanctuary, cannot currently be ruled out. Further analysis, including assessment, as required by the EU Habitats Directive, will be undertaken based on more accurate data on munitions locations and characteristics, to determine if this precautionary ranking can be reduced. A further five Natura 2000 sites/protected areas (four in Finland and one in Estonia) with seals as a conservation objective, may experience **minor** impacts due to the potential for onset of temporary hearing loss.

### 0.8.2.2 Onshore areas

The terrestrial environment in the vicinity of the landfall areas have been considered in terms of flora and fauna (mammals, birds, amphibians, reptiles, invertebrates), as well as biotopes/habitats.

#### Narva Bay landfall

The Narva Bay landfall is within an area that exhibits a high species diversity of flora and fauna.

Vegetation clearance, soil removal and earthworks notably that required constructing the pipelines will affect a spectrum of habitat types resulting in impacts rankings ranging from negligible to moderate on flora and habitats. The moderate impacts are associated with loss and fragmentation of old growth forest, with complex moss flora, and relict dune. For old growth forest some loss will be permanent with reestablishment in other areas occurring over a long time.

The forest areas and coastal and relict dunes also provide secure habitats for fauna. The loss of the supporting habitat combined with the loss of connectivity for some species beyond the area impacted result in a moderate impact ranking for fauna. Effects, associated with habitat fragmentation and loss of connectivity, will diminish as trees establish and canopy cover increase.

Other impacts relate to soil compaction, alteration to hydrological regime, emission to air, operational noise and light generation but due to their short term and reversible nature and limited spatial extent will have negligible to minor rankings. For species particularly sensitive to noise, impacts may reach moderate ranking during construction activities.

The project will require temporary construction activities within the Kurgalsky Nature Reserve and result in some long term changes to habitats. However, due to the small areas affected and the fact that the most valuable habitats will not be impacted and the overall integrity and functioning of the reserve will not be affected, the impact ranking on the protected area is evaluated as minor.

#### Lubmin 2 landfall

As the onshore section of pipeline will all be micro-tunnelled and the construction and operational areas accommodated within land zoned for industrial development the potential for impacts on flora or fauna at this site are **negligible** to **moderate** with the higher ranking relating to impacts at a very local scale.

## 0.8.3 Impacts on the socio-economic environment

### 0.8.3.1 Marine areas

Socio-economic receptors in marine area have been considered in terms of: People (recreational water users); commercial and other uses of marine areas, and underwater cultural heritage.

### People

The offshore nature of the majority of the construction activities and the short term nature of any nearshore activities results in a **negligible** impact on recreational water users.

### Commercial fisheries

The presence of the pipeline structures on the seabed during operation, which can result in a loss of fishing habitat, reduction in catch, or loss or obstruction of fishing gear, is ranked as **minor** () on a project-wide basis.

### Marine traffic

Due to the short term duration of safety zones around construction vessels in any location and their limited spatial extent, impacts are ranked as at most **minor**.

### Other uses of the marine environment

In addition to a range of other activities and uses of the marine environment occur in the Baltic Sea including windfarms sites (existing or proposed) military practice areas, raw material extraction sites or existing or planned cables or pipelines. Due to the ability to either avoid such sites, or agree measures to safeguard them with the relevant owners or operators, any impact will be **negligible**

Monitoring stations in Estonia, near the Narva Bay landfall could, under rough weather conditions, experience increases in suspended sediment levels for very short periods, but any interruption of the monitoring datasets can similarly be managed through coordination with the relevant authorities, so that potential impacts will also have a **negligible** ranking.

### Cultural Heritage

Underwater cultural heritage along the pipeline route largely comprises wrecks and their cargo. The presence of prehistoric features is highly unlikely due to environmental conditions.

Several possible cultural heritage objects detected within the vicinity of the pipeline route will be subject to visual survey and discussion with the relevant authorities to agree specific management measures. These may typically include local pipeline realignment, controlled lay or recovery. A chance finds procedure, also agreed with the authorities, will be applied in the event that previously unknown features are uncovered during construction. Such measures will ensure that any impact on cultural heritage is generally **negligible**, but may for specific features be **minor** if for example their removal is required, or alterations of their setting occur. The provision of survey data to relevant institutes will, however, result in a degree of **positive** impact on availability of research resources.

#### 0.8.3.2 Onshore Areas

Socio-economic receptors in onshore areas have been considered in terms of: People (residents and visitors); economic resources and uses of land, and cultural heritage.

##### Narva Bay

The distance of local communities or businesses from construction activities (taking place both on and offshore) limits the potential for impacts from noise, air emissions and visual intrusion which are thus generally **negligible**, but may be **minor** at the closest residential properties. As only a small part of the Kurgalsky Reserve will be affected, impacts on both local users of, and visitors to, this area will also be **negligible**. A **negligible** impact may also result due to restricted access to, or diversion of, an access road within the reserve leading to several villages and a military barracks. Roadside communities may, however, experience **minor** impacts due to the potential for congestion and risk of accidents associated with construction traffic.

Two Neolithic sites have been identified in the landfall area but these and any as yet undiscovered remains will be safeguarded through measures set out in the chance finds

procedure resulting in a **minor** ranking. Employment generation may bring some **positive** impacts locally and more broadly in the region.

### **Lubmin 2**

The onshore section of pipeline will be micro-tunnelled and construction and operational areas accommodated within land zoned for industrial development and surrounded by forests, which screen it from settlements and recreational users of the beach and forests. No traffic related impacts are anticipated due to the site's locally adjacent main road. Impacts from onshore activities are thus **negligible**. Communities and beach users could, however, be subject to very short term noise and visual disturbance from nearshore activities associated with dredging and micro-tunnelling, resulting in a **minor** impact. Employment generation may bring some **positive** impacts.

### **Ancillary Sites**

At onshore ancillary areas (Kotka and Hanko, Finland; Karlshamn, Sweden; Mukran Germany), used for pipe coating and storage and rock storage, employment generation will result in a degree of **positive** impact. The location of such sites within existing industrial areas limits negative impact on local communities, although transport of rock from sites of potential quarries to the Mussalo harbour at Kotka could result in a degree of disruption and risks to safety of people resulting in a **minor to moderate** impact ranking.

## **0.9 Monitoring of possible impacts during construction and operation**

Extensive environmental monitoring will take place during the Nord Stream 2 construction and operational phase in every country through which the pipeline passes. The purpose of environmental monitoring is to verify the assessments presented in the national EIAs and Espoo Report. Environmental monitoring will focus on areas where greater impacts are expected, or where there is uncertainty about possible impacts. Monitoring programmes are currently being developed based on the EIAs and the results and conclusions of the previous Nord Stream monitoring programme. The permit conditions and reporting requirements set by each national authority will also influence the design of the monitoring programme. Once the permit conditions and monitoring requirements by the authorities are set, and prior to the start of construction, Nord Stream 2 will finalize the monitoring programmes. As part of Nord Stream 2's commitment to open and transparent communication, all results of environmental monitoring will be made publicly available.

## **0.10 Marine spatial planning**

In addition to assessing potential environmental impacts, the Espoo Report also considers how Nord Stream 2 will comply with relevant EU legislation and programmes designed to protect the Baltic Sea environment and promote its sustainable use. This includes the Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD) and Baltic Sea Action Plan (BSAP), which together aim to improve the quality of European waters and create a common framework for marine spatial planning.

The assessment has concluded that Nord Stream 2 will not prevent achievement of the long-term goals, or be contrary to the objectives and initiatives set out in the MSFD, WFD and/or BSAP.

## **0.11 Decommissioning**

Nord Stream 2 will need to be decommissioned, or taken out of service, at the end of its operating life. The decommissioning programme will be developed during the pipeline's operational phase to ensure that it can take into account any new or updated legislation and guidance, good international industry practice as well as improved technical knowledge.

Since it is currently uncertain which decommissioning method will be used for Nord Stream 2, it has not been possible to undertake a detailed impact assessment for the decommissioning phase. However, consideration has been given to potential options and the associated potential impacts



within the Espoo Report. Current industry best practice guidelines for similar infrastructure indicate that leaving the pipelines on the seabed (*in situ*) would be the preferred option, with potential impacts likely to be similar to those predicted for the operational phase of Nord Stream 2. One alternative would be for the pipelines to be removed by a reverse pipe-lay process, divided into sections and then disposed of onshore. Impacts of this option would be similar, or greater, than those predicted for the construction phase of Nord Stream 2.

Ultimately, the same criteria that guided planning and construction of Nord Stream 2, including environmental, socio-economic, technical and safety considerations will guide the identification of the preferred decommissioning method. Regardless of the method chosen, Nord Stream 2 will comply with all applicable legal requirements for decommissioning at that time.

## 0.12 Risks from unplanned events

Comprehensive risk assessments are standard practice in the offshore pipeline industry to understand, mitigate or prepare for possible risks. Nord Stream 2 is committed to being an industry leader in this realm. Drawing from international agreements, industry guidelines and years of experience within the field, including the existing Nord Stream project, Nord Stream 2 has undertaken and will continue to undertake (as appropriate) thorough risk assessments that span the construction and operational phases of Nord Stream 2.

As part of this process, Nord Stream 2 has assessed risks to both the environment (e.g. oil spills, interaction with non-mapped munitions and gas release) and to personnel. Measures to reduce or avoid any unacceptable risks have been explored and incorporated (e.g. implementation of a safety zone around vessels and careful route planning). Based on the comprehensive risk assessments, all risks associated with Nord Stream 2 construction and operation have been found to be acceptable.

To prevent or mitigate potential impacts from accidents and unplanned events during construction and operation, Nord Stream 2 has developed a mitigation strategy which ensures compliance with international requirements and follows best practise. Furthermore, a chance finds procedure will be prepared by Nord Stream 2 to set out a protocol should an unexpected risk or impacts arise during the construction phase (e.g. identification of un-mapped munition). Nord Stream 2 will additionally develop and implement an emergency response plan for the operational phase of Nord Stream 2. Nord Stream 2 will only undertake activities for which the associated risk is assessed as acceptable.

## 0.13 Cumulative impacts

The Espoo Report also considers the potential for impacts arising from Nord Stream 2 to interact with impacts from other reasonably foreseeable planned projects ('cumulative impacts'). Impacts from these projects may not be significant when considered alone, but may have the potential to cause significant cumulative impact when the projects are considered together.

Based on the cumulative impact assessments undertaken within the national EIAs, projects were screened to identify planned projects which, in combination with Nord Stream 2, had the potential to cause significant cumulative impacts. Projects considered included: upstream facilities and Ust Luga Port developments, Baltic Connector pipeline, 50hertz cables, offshore wind farm projects, raw material extraction areas and downstream facilities. The potential for cumulative impacts from these projects in combination with Nord Stream 2 were then assessed. In response to a request during the Espoo consultation process, consideration was also given to the potential for cumulative impacts as a result of existing projects i.e. the existing Nord Stream pipeline system, in combination with Nord Stream 2.

The assessment concludes that there will be no significant cumulative impacts as a result of planned or existing projects in combination with Nord Stream 2.

## 0.14 Potential transboundary impacts

Transboundary impacts have been considered at two levels i.e. where the impacts may be primarily experienced at country level and where the impacts are primarily experienced at a regional or global scale.

The assessment at a regional and global scale considered:

- Climate - primarily greenhouse gas emissions;
- Hydrography - since changes on major Baltic inflows may affect conditions across the Baltic Sea as a whole;
- Shipping and Ship Traffic – due to the global importance of the Baltic Sea for cargo transportation;
- Commercial Fisheries – due to the regional importance of the Baltic Sea for commercial fishing operations;
- Existing and Planned Infrastructure – due to the transnational interconnection of Baltic Sea countries through communications and power cables;
- Biodiversity - given that the biodiversity of the Baltic Sea is influenced by regional pressures and is of regional and global importance;
- Marine Spatial Planning – given that the Maritime Spatial Planning Directive (and related EU Directives) require countries to cooperate at a regional scale to protect and create a framework for the sustainable use of marine waters in the Baltic Sea;
- Natura 2000 sites - since such sites together function as coherent network which spans several countries.

This assessment demonstrated that Nord Stream 2 will not lead to any significant transboundary impacts on a regional or global level, with potential impacts ranging from **negligible** to **minor**.

The assessment of country level transboundary impacts identified that only the generation of underwater noise from munitions clearance in two PoOs (Russia and Finland) has the potential to result in significant impacts. Three APs could be affected i.e. Finland (from activities in Russia), Russia (from activities in Finland) and Estonia (from activities in both Russia, and Finland). The impacts relate primarily to the potential for onset of permanent hearing loss that may be experienced by the Gulf of Finland ringed seal population, although the potential for a degree of non lethal blast damage cannot be excluded. The use of seal scarers will ensure that the risk of more severe blast injuries for all marine mammals is extremely low.

The country level assessments also considered where non-significant transboundary impacts may occur. A summary of the potential transboundary impacts (both significant and not significant) that may be experienced by each AP is provided below.

### 0.14.1 Transboundary impacts on Russia (from Finland)

Due to the low potential for munitions to be present close to the Russian - Finnish border there is a low likelihood of transboundary impacts on mammals in Russian water from detonations in Finnish water. However, as a precautionary approach, a **moderate** impact ranking has been applied for onset of permanent hearing loss and non-lethal blast injury on the Gulf of Finland breeding ringed seal population, and a **minor** ranking applied to the same impacts for grey seals and harbour porpoise.

Munitions detonation in Finnish water could also produce an onset of temporary hearing loss in all these species of mammals in Russian water, resulting in a **minor** impact ranking, while fish over a very small area could experience a similar temporary loss of hearing, resulting in a **negligible** impact ranking.

Release of sediments from munitions clearance in Finnish water may result in very small and short term increases in concentrations of suspended sediments. Any impact on seawater quality or sediment depths in Russian water will be minimal, resulting in a **negligible** impact ranking.

#### 0.14.2 Transboundary impacts on Finland (from Russia and Sweden)

For the reasons described above in relation to impacts on Russia, detonation of munitions in Russian water close to the border with Finland could result in a **minor** impact ranking on grey seal and harbour porpoise and **moderate** ranking on the Gulf of Finland ringed seals in Finnish waters, due to onset of permanent hearing loss and non-lethal blast injury and a **minor** impact ranking due to onset of temporary hearing loss. Similarly onset of temporary hearing loss in fish in Finnish water is assessed to have a **negligible** impact ranking.

There is a small risk that seals within the Natura 2000 site (FI0100078) Pernaja and Pernaja Archipelago and various sanctuaries in Finland which are designated for ringed and grey seal may experience a small degree of onset of temporary hearing loss from munitions clearance in Russia, but modelling has demonstrated that such impacts would be **minor**.

Release of sediments from munitions clearance in Russian water may result in a very small and short term increase in concentrations of suspended sediments. Any impact on seawater quality or sediment depths in Finnish water will be minimal, resulting in a **negligible** impact ranking.

Rock placement in Swedish waters close to the Finnish border may result in a small area being affected by noise levels which could cause onset of temporary hearing loss in marine mammals and fish in Finnish waters. However, due to the very short duration of each rock placement activity, it is considered insufficient to affect species functioning resulting in a **negligible** impact ranking.

#### 0.14.3 Transboundary impacts on Estonia (from Russia and Finland)

The risk, and degree, of impact in Estonia from underwater noise, due to munitions detonation in Russian and Finnish water will vary by location depending on the number of munitions detonated and the species and specific populations of mammals present.

Again a precautionary approach has been adopted resulting in a **moderate** ranking for onset of permanent hearing loss and non-lethal blast injury on the Gulf of Finland ringed seal population, and a **minor** ranking for the same impacts on Gulf of Riga and Archipelago breeding ringed seal population, grey seals and harbour porpoise. As the Gulf of Finland breeding ringed seal population is only present in the eastern part of Estonian waters, for a substantial length of the Estonian border with Finland the transboundary impact ranking will thus be minor

Onset of temporary hearing loss from munitions detonation in Finnish and Russian water could also be experienced by mammals in Estonian water, resulting in a **minor** impact ranking.

Ringed and grey seals in the vicinity of the Uhtju Natura 2000 site (SAC EE0060220) in Estonia may experience a small degree of onset of temporary hearing loss from munitions clearance in Russian water, but modelling results have indicated that any such impacts will be at most **minor**.

While dredging at the Narva Bay landfall will result in local increases in suspended sediments, under normal weather conditions these will not cross into Estonian water. Any impact on seawater quality or sediment depths in Estonian waters will be minimal resulting in a **negligible** impact ranking on these receptors. The potential for such changes in these parameters to impact on monitoring undertaken at stations south of the Narva Bay landfall in Estonia can be addressed through coordination with relevant authorities and is therefore also **negligible**.

Release of sediments from munitions clearance in Russian and Finnish waters or rock placement in Finnish waters may result in a very small and short term increase in concentrations of

suspended sediments. Any impact on seawater quality or sediment depths in Estonian waters will be minimal, resulting in a **negligible** impact ranking.

#### **0.14.4 Transboundary impacts on Germany, Denmark, Sweden, Lithuania, Latvia and Poland**

The main construction activities (i.e. dredging, post-lay trenching, rock placement and munitions clearance) in neighbouring countries which have the potential to cause transboundary impacts are located a sufficient distance away from the German, Danish, Swedish, Lithuanian, Latvian and Polish EEZs that no potential transboundary impacts have been identified.

#### **0.15 Share your views**

This Non-Technical Summary contains the key findings of the Nord Stream 2 Espoo Report. For more detail, any interested party including members of the public can read the full report via [www.nord-stream2.com](http://www.nord-stream2.com).

The full Espoo Report, like this summary, is publicly available and submitted to the relevant national authorities in those countries which the pipeline crosses, and in countries which may experience transboundary impacts from the pipeline.

The Espoo Report is a key element of the public consultation process and interested parties are invited to submit any feedback on the project proposals and related impact assessments. Comments should be submitted directed to the respondent's national authority.

The national authorities will keep a record of all comments and take into account this feedback as part of their decision on whether to grant a permit for the project. Before granting a permit, authorities may also set specific conditions of implementation which must be met by the Nord Stream 2 project.

# 1. INTRODUCTION

## 1.1 Nord Stream 2 Pipeline project

The Nord Stream 2 Pipeline system (NSP2) through the Baltic Sea will deliver natural gas from vast reserves in Russia directly to the European Union (EU) gas market. It will contribute to the security of supply of the EU by filling the growing gas import gap and by covering demand and supply risks expected by 2020.

The twin 1,200 km subsea pipelines will have the capacity to supply about 55 billion cubic metres (bcm) of gas per year in an economical, environmentally safe and reliable way. The privately funded €8 billion infrastructure project will enhance the ability of the EU to acquire natural gas, a clean and low carbon fuel necessary to meet its ambitious environmental and decarbonisation objectives.

NSP2 builds on the successful construction and operation of the existing Nord Stream Pipeline system (NSP), which has been recognised for its high environmental and safety standards, green logistics as well as the transparent public consultation process applied during its development. NSP2 is developed by a dedicated project company: Nord Steam 2 AG.

The NSP2 project envisages construction and subsequent operation of twin subsea natural gas pipelines with an internal diameter of 1,153 mm (48 inches). Each pipeline will require approximately 100,000 24 tonne concrete-weight-coated steel pipes laid on the seabed. Pipe-laying will be done by specialised vessels handling the entire welding, quality control and pipe-laying process. Both pipelines are scheduled to be laid during 2018 and 2019, to facilitate testing and commissioning of the system at the end of 2019.

The route will stretch from the Russian Baltic coast at Kurgalsky Peninsula in Narva Bay to the landfall near Lubmin, Germany. The NSP2 routing is largely parallel to NSP. The landfall facilities in both Russia and Germany will be separate from NSP. Atlas Map PR-01 shows the NSP2 route; landfall areas and ancillary facilities (see Figure 1-1 below).

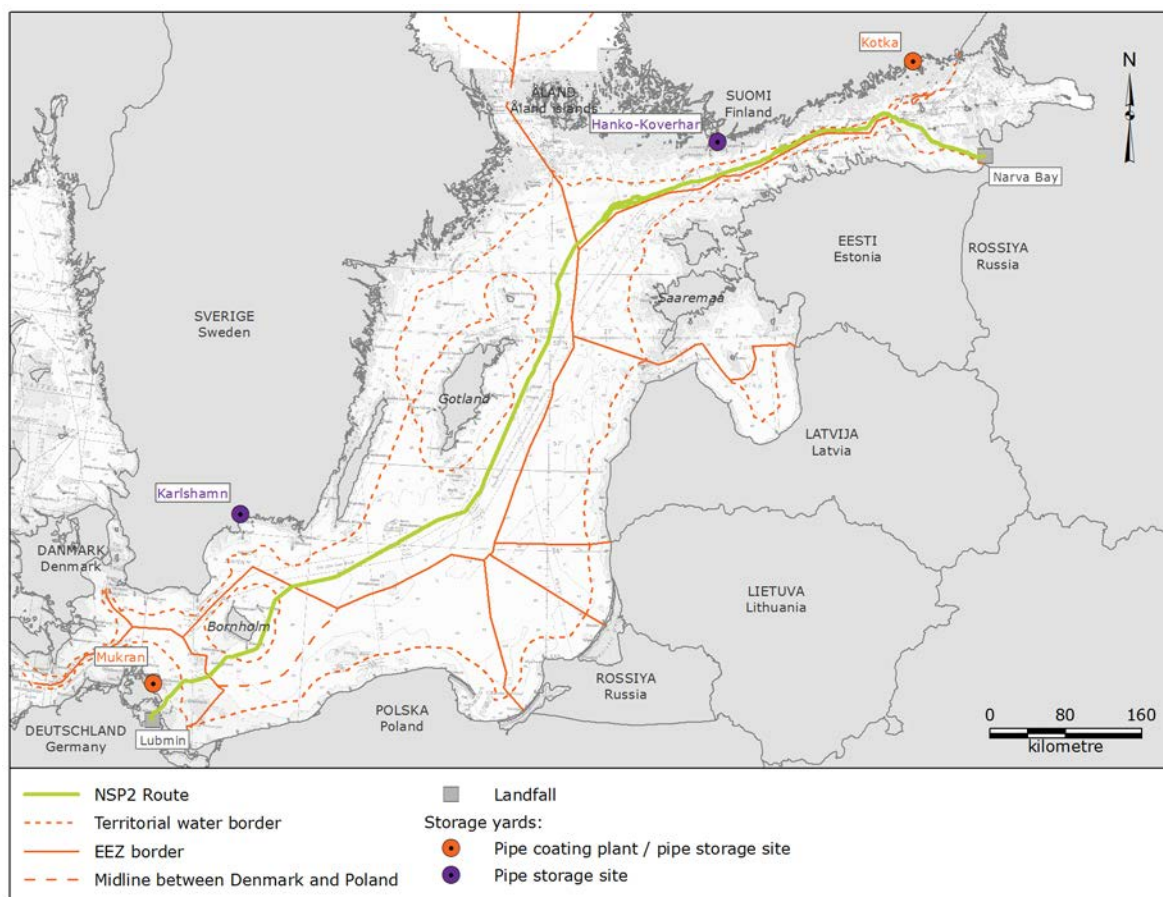


Figure 1-1 NSP2 route.

NSP2 – like NSP – will transport gas supplied via the new northern gas corridor in Russia from the fields on the Yamal Peninsula, in particular the supergiant<sup>3</sup> field of Bovanenkovo. The production capacity of the Yamal Peninsula fields are in the build-up phase, while the producing fields from the previously developed Urengoy area that feed into the central gas corridor have reached or passed their production plateau. The northern corridor and NSP2 are efficient, modern, state-of-the-art systems, with an operating pressure of 120 bar onshore and an inlet pressure of 220 bar to the offshore system.

NSP2 will be designed, constructed and operated according to the internationally recognised certification DNV-OS-F101, which sets the standards for offshore pipelines. Nord Stream 2 AG has engaged Det Norske Veritas and Germanischer Lloyd (DNV GL), the world's leading ship and offshore classification company and a world leader in independent assurance and expert advisory services, as its main verification and certification contractor. DNV GL will verify all phases of the project and confirm that the pipeline is successfully pre-commissioned.

The downstream transport of gas supplied by NSP2 to the European gas hubs will be secured by upgraded capacity (the Northern European natural gas pipeline) and newly planned capacity (the European gas pipeline link) developed simultaneously by separate transmission system operators (TSOs). Thus, the new downstream infrastructure will deliver gas to Germany and north-western Europe as well as to central and south-eastern Europe via the gas hub in Baumgarten, Austria, complementing the southern corridor. This will strengthen the gas infrastructure of the EU hubs and markets and complement the existing infrastructure.

<sup>3</sup> The largest class of natural gas fields with reserves of more than 850 bcm is called "supergiant fields".

The new state-of-the-art gas supply infrastructure will be privately funded (30% by shareholder financing and 70% by external financing sources). The project budget (capital expenditure, CAPEX) is about €8 billion.

## 1.2 Purpose of the Espoo Report and links to national permitting process

This Espoo Report has been compiled for the NSP2 project in accordance with the requirements of Article 4 of the United Nations Economic Commission for Europe (UNECE) Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (henceforth referred to as the Espoo Convention), the EU Environmental Impact Assessment Directive (Directive 2011/92/EU), and the national legislation which implements the requirements of the Espoo Convention and EIA Directive in Finland, Sweden, Denmark and Germany.

Where activities in one country, referred to as the “Party of Origin” (PoO), may result in significant adverse environmental impacts on another country, referred to as the “Affected Party” (AP), the Convention requires the PoO to follow a defined assessment process. This includes notifying the APs regarding potential transboundary impacts, transmitting and receiving information, preparing and distributing EIA documentation, and ensuring that there is both public participation as well as consultation between the parties throughout the process. The purpose of this report is to provide the EIA documentation that can inform subsequent participation through provision of:

- A statement of all potential transboundary impacts which clearly identifies where activities in one country may result in the occurrence of potentially significant impacts in neighbouring countries;
- An overall assessment of the impacts of the NSP2 project that evaluates “in-combination” impacts on each receptor group, irrespective of geopolitical borders.

Nord Stream 2 AG is required to submit national permit applications in the PoO countries (Russia, Finland, Sweden, Denmark and Germany) for approval to construct and operate NSP2. The applications are currently under way in each of the five jurisdictions and accompanied by a country specific EIA/environmental study (ES) prepared in accordance with the respective applicable national legislation. Each of these five national applications will be filed in accordance with the relevant procedures of national legislation for the respective countries concerned. This Espoo Report is based on information used to prepare the various national EIAs/ES.

## 1.3 Audience

NSP2 will pass through the territorial waters (TWs) and/or exclusive economic zones (EEZs) of Russia, Finland, Sweden, Denmark and Germany. Under the terms of the Espoo Convention, each of these countries is thus a PoO. Russia has signed but not ratified the Espoo Convention. However, for the purposes of this report, Russia is designated as a PoO. Russia, Finland, Sweden, Denmark and Germany, as well as the other littoral countries of the Baltic Sea, i.e. Estonia, Latvia, Lithuania and Poland, are each an AP, as these countries may be subjected to impacts from project-related activities and/or events that are initiated in a PoO.

This report will be made available in the national languages to all APs, including to the public for their comments. This enables the PoO to take comments from the APs into consideration before a final permitting decision is made.

## 1.4 Project history

NSP2 will be implemented based on the positive experience of construction and operation of the existing NSP. The NSP project, upon its completion, was hailed as a milestone in the long-standing energy partnership between Russia and the EU. It contributed to the achievement of a common goal: the secure, reliable and sustainable reinforcement of energy security in Europe.

The first NSP line was put into operation in 2011, and the second line came on-stream in 2012. The entire NSP project was completed on schedule and on budget. It received many accolades for high environmental and health, safety and environment (HSE) standards, green logistics, open dialogue and public consultation.

In May 2012, at the request of its shareholders, Nord Stream AG conducted a feasibility study for two potential additional pipelines with an operating life of at least 50 years. The study included technical solutions, route alternatives, EIAs and financing options.

The feasibility study confirmed that it was possible to extend NSP with two additional lines. It also identified additional import needs in the long-term development of the European gas market. As part of the feasibility study, Nord Stream AG developed three main route corridor options to be investigated further on the basis of reconnaissance level surveys, EIAs and stakeholder feedback in order to develop an optimised route proposal.

In 2012, Nord Stream AG submitted requests for survey permits in the relevant countries. The aim was to conduct further research on the route corridor options and to identify the optimal routing for the pipelines with minimum length and environmental impact.

In April 2013, Nord Stream AG published a Project Information Document (PID) on a potential NSP extension project as part of the initial notification and transmission of information as required by the Espoo process. The PID provided stakeholders in the nine potentially affected countries with an overview of the project, enabling them to determine their role in the future environmental and social impact assessments and associated permitting processes, in accordance with their country-specific laws and regulations.

In preparation for the further development of the extension project, Nord Stream AG discussed the programme proposals for the national environmental impact studies in the five countries (Russia, Finland, Sweden, Denmark and Germany) whose EEZs and/or TW the proposed route would cross. Initial consultations were also conducted with the authorities and stakeholders in other Baltic Sea countries (Chapter 4 – Espoo process).

The permitting, survey and engineering work initiated by Nord Stream AG for the extension project was taken over by a dedicated project company, Nord Stream 2 AG, which was established in July 2015. The extension project was renamed NSP2 (refer to Chapter 4 – Espoo process regarding the Espoo Consultation process and next steps).

## 1.5 The project company

Nord Stream 2 AG is a project company established for planning, construction and subsequent operation of NSP2. The company is based in Zug, Switzerland, and is owned by PJSC Gazprom. An ownership structure of equal EU and Russian interests in the project is envisaged, reflecting the significance of this new infrastructure for the future energy supply needs in Europe.

The headquarters of Nord Stream 2 AG has a strong team of over 200 professionals of over 20 nationalities, covering survey, environment, HSE, engineering, construction, quality control, procurement, project management and administration.

Based on the stringent procurement policy and international tender processes of Nord Stream 2 AG, leading companies have been contracted to supply materials and services. Europipe GmbH, Mülheim/Germany; United Metallurgical Company JSC (OMK), Moscow/Russia; Chelyabinsk Pipe-Rolling Plant JSC (Chelpipe) and Chelyabinsk/Russia have been selected to deliver approximately 2,500 km of large-diameter pipes with a total weight of roughly 2.2 million tonnes. Wasco Coatings Europe BV has been contracted for concrete weight coating (CWC), pipe storage and logistics. It will operate an existing CWC plant in Kotka, Finland, a second CWC plant in Mukran, Germany, as well as two storage yards located at Hanko in Finland and at Karlshamn in Sweden.



As with Nord Stream AG, Nord Stream 2 AG adheres to high standards with regard to technology, environment, labour conditions, safety, corporate governance and public consultation.

Nord Stream AG, the operator of the existing NSP, has been absolutely committed to safety and environmentally friendly solutions from the very start of the project, through the planning, construction and operational phases. In addition to developing a state-of-the-art technical design, Nord Stream AG demonstrated in a very transparent way its competence in the sustainable management of the environmental and social aspects associated with the implementation of a pipeline project. The implementation of an environmental and social management system (ESMS) enabled Nord Stream AG to monitor its contractors and closely follow up on all commitments and obligations. This ensures good management of construction and operational activities in an environmentally and socially responsible manner, as well as transparent and comprehensive reporting to authorities and stakeholders. The NSP system will be adopted and further enhanced for the NSP2 project.

Due to the strict requirements imposed through the management system, quality assurance by suppliers, contractors of Nord Stream 2 AG and the company itself will exceed the standards normally applied to other offshore pipelines and will guarantee the highest possible standard of operational safety. Nord Stream 2 AG is also committed to complying with the environmental and social standards of the International Finance Corporation (IFC).

Following completion of the project phase, the results from the environmental and social monitoring programmes of NSP demonstrated that pipeline construction did not cause any unforeseen environmental impacts in the Baltic Sea and confirmed the positive trend in environmental recovery after construction. So far, all monitoring results have confirmed that construction-related impacts were minor, local and predominantly short-term. Transboundary effects have also been verified as being insignificant. Nord Stream AG is sharing data with the scientific community through its Data and Information Fund (DIF) portal. The DIF portal contains data collected for pipeline route design as well as for the NSP EIAs and environmental and social monitoring during construction.

The results of previous surveys and the experience gained during the construction and operation of NSP will help to ensure that NSP2 will meet the same stringent environmental standards and can be built without any lasting adverse effects on the environment.

In line with the company's commitment to transparency and open dialogue, Nord Stream 2 AG has a dedicated website (<https://www.nord-stream2.com/>) where extensive project-related information can be reviewed and inquiries can be addressed.

## 1.6 Main consultants

This Espoo Report, including the Atlas Maps, was prepared by Ramboll and Nord Stream 2 AG. An overview of the main consultants and contractors involved in the various studies, surveys, modelling and assessments for the Espoo Report is presented in Table 1-1.

**Table 1-1 Companies/experts responsible for studies, surveys, modelling and assessments for the Espoo Report.**

Consultant/contractor	Scope of work	Country of origin
<b>Environmental impact assessment documentation</b>		
Ramboll Group A/S	Espoo Report	Denmark
Frecom	Russian EIA	Russia
Ramboll Finland	Finnish EIA	Finland
Ramboll Sweden	Swedish ES	Sweden
Ramboll Denmark	Danish EIA	Denmark
Institut für Angewandte Ökologie (IFAÖ)	German EIA	Germany

Consultant/contractor	Scope of work	Country of origin
<b>Technical design</b>		
Saipem S.p.A.	Main engineering contractor	Italy
<b>Certification</b>		
Det Norske Veritas (DNV)	Project certification	Norway
<b>Environmental surveys</b>		
Danish Hydraulic Institute (DHI)	Seabed sampling	Denmark
Eco Express Service	Offshore and onshore surveys	Russia
Institut für Angewandte Ökologie (IFAÖ)	Offshore and onshore surveys	Germany
Luode Consulting Oy	Environmental baseline offshore surveys	Finland
<b>Mathematical modelling</b>		
Danish Hydraulic Institute (DHI)	Modelling enhancement study	Denmark
<b>Environmental assessment</b>		
Danish Centre for Environment and Energy (DCE)	Marine mammals assessment	Denmark
Danish Centre for Environment and Energy (DCE)	Chemical warfare agents (CWAs)	Denmark
Finnish Institute for Verification of the Chemical Weapons Convention (VERIFIN)	Chemical warfare agents (CWAs)	Finland
Ympäristötutkimus Yrjölä Oy	Marine mammals, Finnish EEZ	Finland
Skepast & Puhkim OU	Transboundary assessment, Estonia	Estonia
ARK- Sukellus Rami Kokko	Cultural heritage, Finnish EEZ	Finland
Anders Stigebrandt, Ancylus HB	Hydrography	Sweden
Statens maritima museer (SMM)	Cultural heritage	Sweden

## 1.7 Report structure

The structure of the Espoo Report has been developed in accordance with the requirements outlined in Appendix II of the Espoo Convention. Considerable effort has been invested in the Non-Technical Summary (NTS) to maximise the potential to communicate effectively to the general public about the project and its transboundary impacts. Additionally, an Atlas Map book has been prepared comprising an extensive compendium of maps that are extensively referred to in this report.

This report is divided into 20 chapters as outlined in Table 1-2.

**Table 1-2 Espoo Report structure.**

Chapter	Title	Overview
1	Introduction	Provides information about the NSP2 project, the key objectives of this Espoo Report and information on the history of NSP2, the project developer and the main consultants involved with the project.
2	Project justification	Provides the context for why NSP2 is needed based on current projections, which show an increased import demand and the need for additional pipeline capacity to reinforce supply security.
3	Regulatory context	Describes the regulatory framework for pipelines in the Baltic Sea and the relevant international conventions and EU Directives that have influenced how the project has been developed and issues addressed in its assessment.
4	Espoo process	Outlines the process required by the Espoo Convention and how the various steps have been and will continue to be taken in relation to NSP2. It highlights in particular the role of the public consultation process both with respect to scoping the Espoo

Chapter	Title	Overview
		Report and with respect to using the report for informing the public about the project and the potential environmental impacts.
5	Alternatives	Describes and provides a high level comparison of the technological and pipeline routing alternatives considered for the project, as well as the situation without the project, and gives the rationale for the selected preferred option.
6	Project description	Provides details of the NSP2 project, including its design, construction and operational activities both onshore and in the marine environment.
7	Method adopted for production of Espoo environmental assessment documentation	Lays out the framework applied for preparing the Espoo Report, including how information contained in the national EIAs/ES has been analysed and presented to deliver a Joint EIA that considers the project in its entirety.
8	Identification of environmental impacts	Based on a review of the project description, the potential environmental impacts of the various activities and of the presence of NSP2 are identified, for making the basis for the subsequent impact assessment.
9	Environmental baseline	Describes the current status of the physical-chemical, biological and socio-economic environment within the project area of influence, to provide a baseline against which environmental impacts can be assessed.
10	Assessment of environmental impacts	Predicts and evaluates the level of environmental impacts resulting from routine operation of NSP2 on the physical-chemical, biological and socio-economic receptors described in Chapter 9 – Environmental baseline.
11	Marine strategic planning	Identifies the key directives relevant to marine spatial planning in the Baltic Sea and assesses the degree of compliance of NSP2 with their objectives and, where possible, targets.
12	Decommissioning	Provides an overview of the available scenarios for decommissioning the pipeline at the end of its operating life, identifies the preferred option and provides a high-level assessment.
13	Risk assessment	Evaluates the impacts from unplanned events that may occur during the construction and operation phases of the project and describes the emergency preparedness and response strategy developed by Nord Stream 2 AG to proactively manage such risks.
14	Cumulative impacts	Describes and assesses the potential additive or synergistic impacts that may arise from interaction between the NSP2 project and other projects with an overlapping spatial and temporal scope.
15	Transboundary impacts	Summarises on a country-by-country basis the potential transboundary impacts that may arise from project activities.
16	Mitigation measures	Provides a description of additional measures (beyond the embedded mitigation incorporated in the design) that Nord Stream 2 AG commits to take to avoid or reduce potential environmental impacts identified through the impact assessment process.
17	Health safety, environmental and social management	Describes the health, safety, environmental and social (HSES) management system developed by Nord Stream 2 AG to ensure that HSES risks including environmental impacts are identified and proactively managed.
18	Proposed environmental monitoring	Lays out the proposed monitoring programme for NSP2, the objective of which is to ensure that the relevant management and mitigation measures are implemented, and that the assumptions

Chapter	Title	Overview
		for and the order of magnitudes of the assessed environmental impacts are correct.
19	Knowledge gaps and uncertainties	Identifies areas where the available information is incomplete or imprecise and describes implications of such gaps and uncertainties for the assessment and how these have been addressed.
20	References	List of references used to support the information provided.

The following appendices have been included in the report:

- Appendix 1: Provides a summary of the key issues raised by stakeholders and how these issues have been addressed.
- Appendix 2: Lists protected species identified in the project area, including both common and Latin names.
- Appendix 3: Provides detailed modelling results and methodology, including sediment dispersion and sedimentation, underwater noise and air quality modelling results.
- Appendix 4: Concentration of contaminants in sediments along the planned NSP2 route.

## 2. PROJECT JUSTIFICATION

This section describes the occasion and reasons for the Nord Stream 2 project and proves why this project is required to secure the supply of gas to the European Union and its Member States. Nord Stream 2 AG has commissioned Prognos AG to prepare a study on the European gas balance, forecasting future gas demand and possible sources for demand coverage. In view of the above, Prognos AG, which advises decision-makers from politics, business and society in Europe providing objective analyses and forecasts, completed the study "Current Status and Perspectives of the European Gas Balance" in January 2017<sup>A</sup>.

The study area of this chapter is thus the European Union, consisting of 28 Member States (*EU 28*) – consistently including the United Kingdom (UK). A possible withdrawal of UK from *EU 28* ("Brexit") would have no significant impact on the natural gas flows between UK and other *EU 28* Member States as well as Norway, as UK's natural gas import requirements, and the *EU 28* total imports, would not change<sup>C</sup>. The geographic area will be extended within the following analysis, when required from an *EU 28* perspective i.e. non *EU 28* Member States are able to or have decided to cover their gas import requirements exclusively from the *EU 28*<sup>B</sup>. In the following this is discussed in detail.

It would not be appropriate to focus solely on those areas which are directly supplied by pipeline. The EU internal gas market is significantly influenced by the global LNG market.

Thus, an overall European gas balance has to be analysed in order to assess the extent of supply security. Ignoring the interdependencies with supply and the available sources, the complexity of the markets would not be treated appropriately and thus the requirements of a sound forecast would not be met. It is particularly important to consider the relevant geographic area when comparing the results presented below with other studies, as some studies focus on OECD Europe instead of *EU 28*. The main difference between OECD Europe and *EU 28* is that OECD Europe considers Norway (a large net exporter of natural gas) and Turkey (a large importer of natural gas). Further, the *EU 28* Member States Romania, Bulgaria, Croatia, Latvia and Lithuania are not part of OECD Europe. This leads to considerable differences in the respective quantitative balances.

The time horizon for projections in this document is usually 2020 until 2050 (depending on specific analyses). In view of the long forecasting period and the complexity of the subject – which is characterised by significant uncertainties – Prognos has analysed in detail numerous studies on future gas demand in its study<sup>D</sup>.

Figures in this document are rounded to the first or no decimal, potentially leading to slight deviations in shown totals.

The Nord Stream 2 pipeline project is essential for the secure, cost-effective and sustainable supply of natural gas to the general public for the following reasons.

Prognos differentiates between so-called target and reference scenarios. Target scenarios generally aim at an all-electric world fuelled by solar and wind-based power generation and show strongly declining fossil fuel demand trajectories to achieve politically set climate protection targets detached from the likelihood of achieving them (see Figure 2-1). Given their methodological approach they are not suitable for setting a reliable basis in order to forecast

<sup>A</sup> Prognos AG, Status und Perspektiven der europäischen Gasbilanz (2017).

<sup>C</sup> Prognos AG, Status und Perspektiven der europäischen Gasbilanz (2017), p. 5.

<sup>B</sup> Prognos AG, Status und Perspektiven der europäischen Gasbilanz (2017), p. 29.

<sup>D</sup> Please refer to Prognos, Status und Perspektiven der europäischen Gasbilanz (2017), p. 56ff.

future supply needs. Reference scenarios, on the other hand, take into account the risk of not complying with ambitious targets.

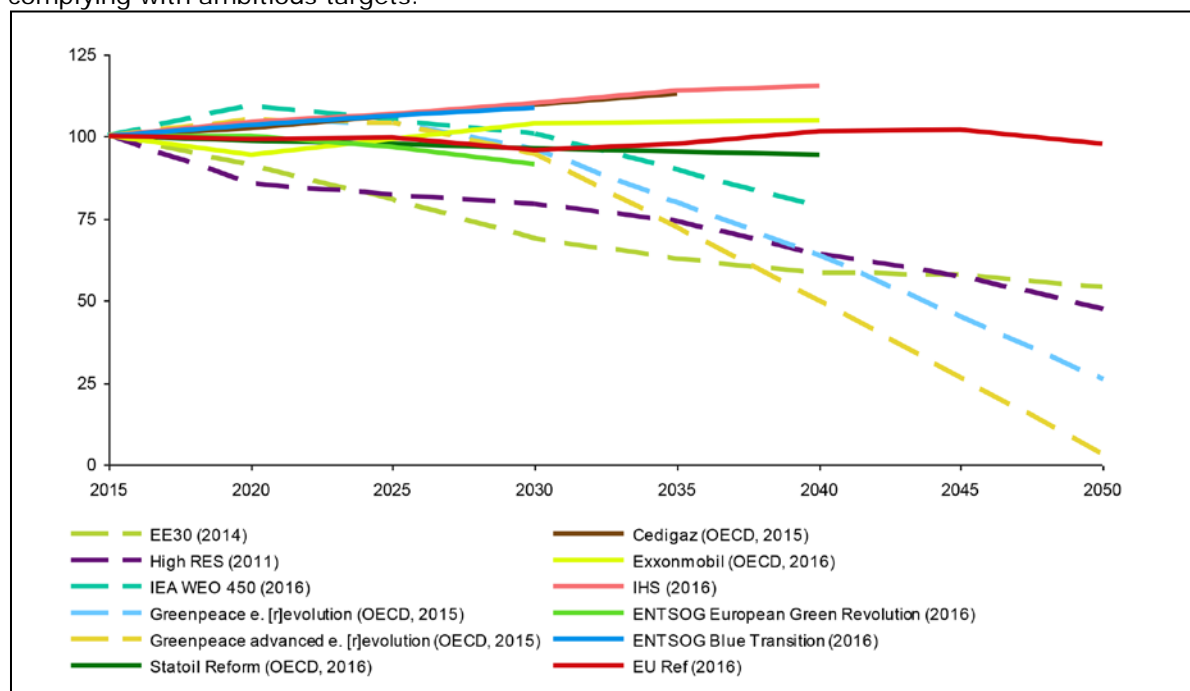


Figure 2-1 Natural gas demand scenarios for EU 28 and OECD Europe (indexed with 2015 = 100).

In order to ensure the security of energy supply of the *EU 28* with natural gas, particularly in the event of not fulfilling such objectives, it is necessary to base the medium- to long-term planning on reference scenarios. Prognos therefore bases its analysis on the *EU Reference Scenario* (2016), also taking into account recent developments. Prognos, as subject matter experts, consider the *EU Reference Scenario* as a good starting point to analyse *EU 28* energy demand and production, as its projections are based on present best practices (from a technological and legal perspective) and it is highly transparent. However, Prognos concluded that the *EU Reference Scenario* need to be adjusted where more up-to-date official production outlooks are available and extended to include projections for imports from the EU internal gas market by Switzerland and Ukraine to *EU 28* figures, in order to get a complete picture of future gas import requirements (*EU 28 Plus*).

Considering Switzerland and Ukraine, which are expected to import approximately 20 bcm/a of natural gas from the EU internal gas market as of 2020, demand of *EU 28 Plus* is projected to show an almost stable development from 494 bcm in 2020 to 477 bcm in 2030 and 487 bcm in 2050. At the same time however, *EU 28* domestic production is projected to decline by 55% between 2015 and 2050 (see Figure 2-2).

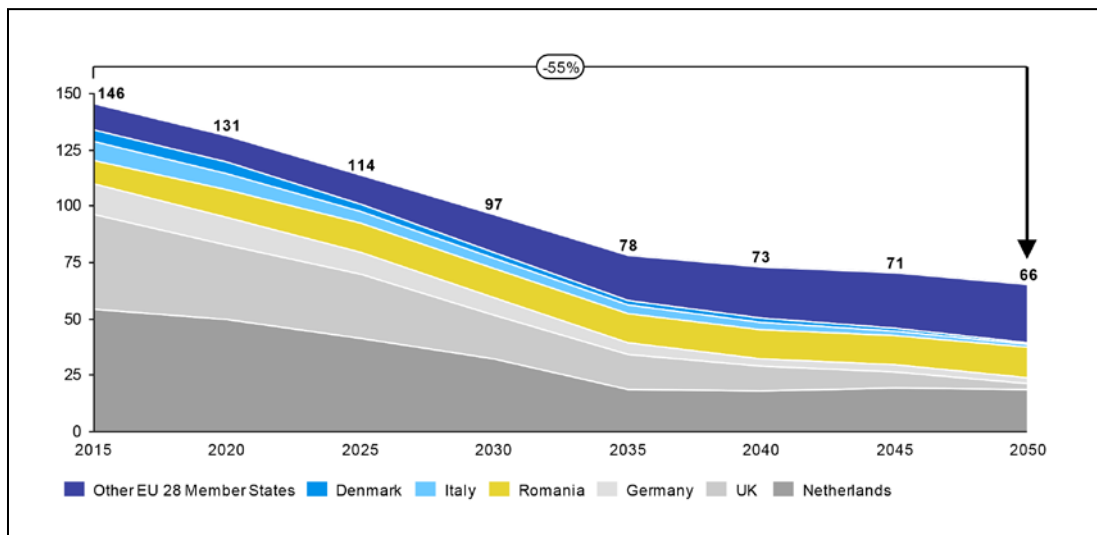


Figure 2-2 EU 28 natural gas production projections according to Prognos based on EU Reference Scenario 2016 (bcm).

According to Prognos, natural gas production is expected to decrease even further than projected due to recent decisions by the Dutch government to reinforce limitations on the natural gas production from the Groningen field, as well as lower projections for natural gas production in Germany and the UK.

After adjustments, EU 28 domestic production is projected to decline from 118 bcm in 2020 to 83 bcm in 2030 and 61 bcm in 2050 (see Figure 2-3).

In combination, the stable development of demand and the strong decline in production results in a constantly increasing natural gas import requirement of EU 28 Plus, developing from 376 bcm in 2020 to 394 bcm in 2030 and 427 bcm in 2050 (see Figure 2-3), with the result that additional gas supplies will be necessary to ensure the sustainable supply security of EU 28.

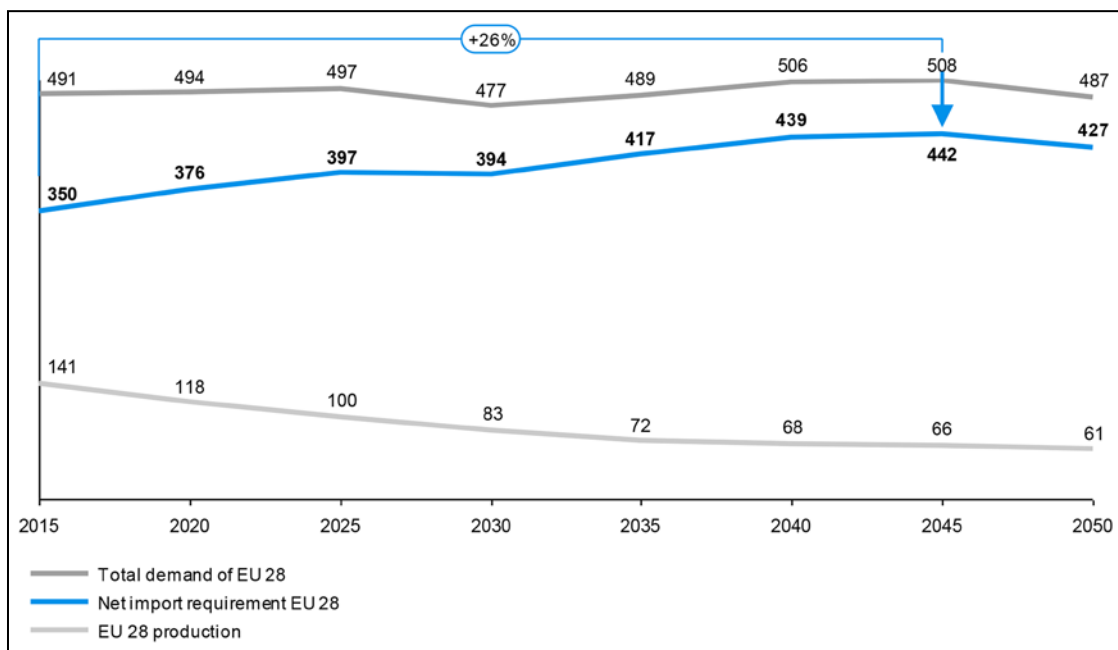


Figure 2-3 Natural gas demand, production and import requirement of EU 28 Plus (bcm).

According to Prognos, without Nord Stream 2, it cannot be ensured that this natural gas import requirement will be covered (securing energy supply) if these gaps cannot be filled with pipeline gas. The global LNG market is subject to drastic fluctuations; so that LNG cannot be assumed reliably cover any potential demand gaps. Therefore, the realization of the project is necessary in

order to eliminate uncertainties of supply and to facilitate a competitive situation with the aim of providing gas at low costs.

*Pipeline gas:* To cover the import requirement, pipeline gas and natural gas imported as LNG are available to *EU 28 Plus*. With regard to pipeline gas, however, all existing suppliers to the EU internal gas market with the exception of Russia (Norway, Algeria and Libya) are projected to supply decreasing volumes due to restrictions in future production and/or increases in domestic consumption (see Figure 2-4 and Figure 2-5).

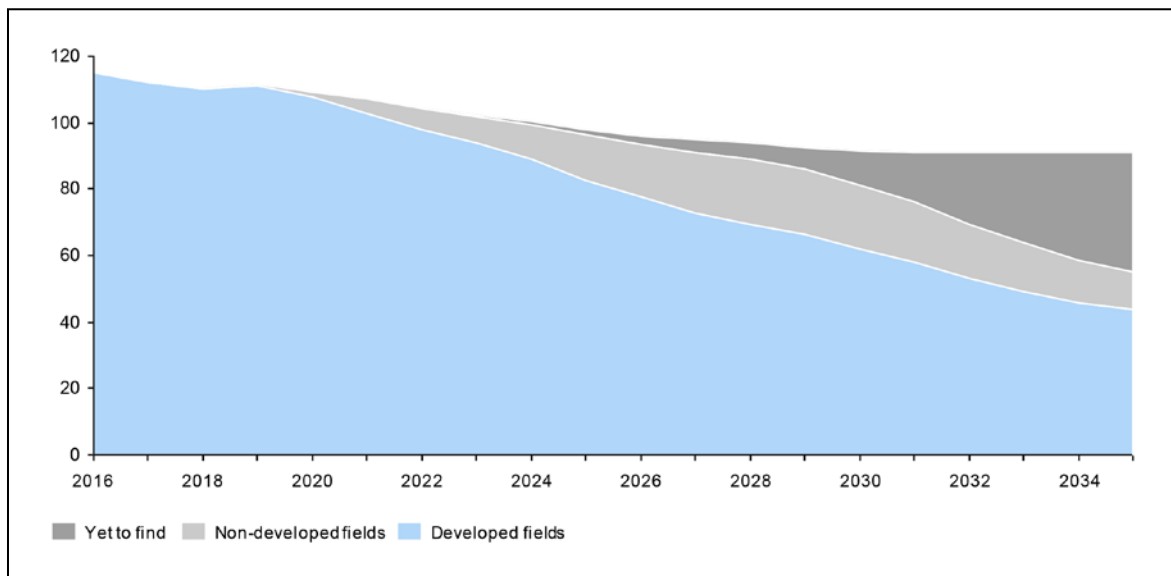


Figure 2-4 Natural gas production forecast for Norway (bcm).

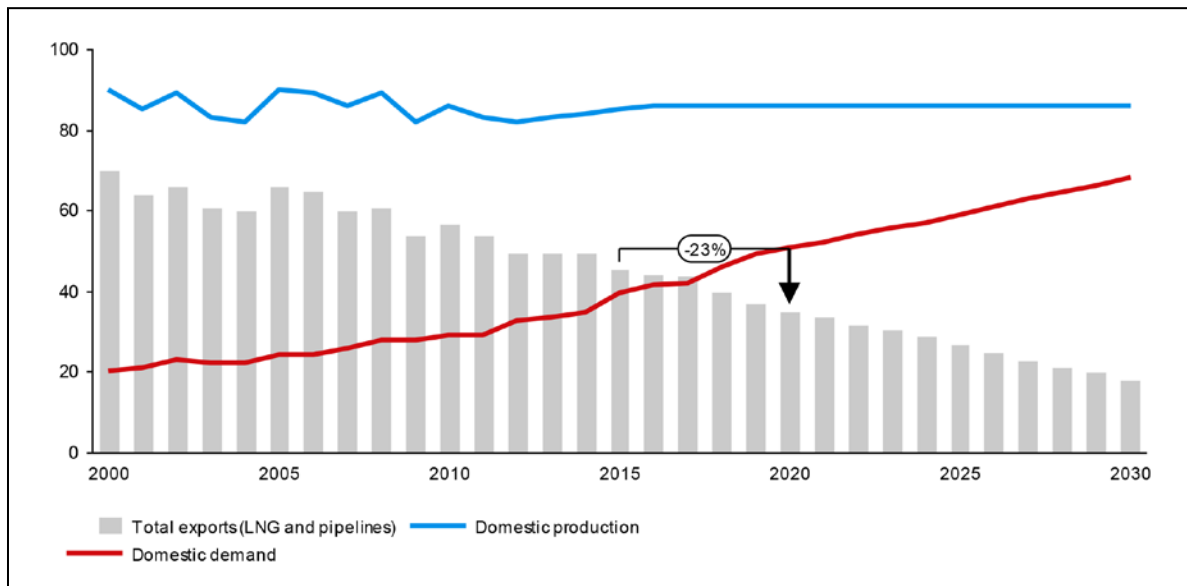


Figure 2-5 Natural gas balance forecast for Algeria (bcm).

Russia, in contrast, holds the largest proven natural gas reserves worldwide and has extensive production capacity to satisfy both domestic demand and export demands of *EU 28 Plus* and other countries (see Figure 2-6).





Figure 2-6 Distribution of global natural gas reserves (tcm).

With regard to the transportation of produced gas to the EU internal gas market, Nord Stream (1) and Yamal-Europe as well as Russian gas transports to the Baltic States (Estonia, Latvia, Lithuania) and Finland are reliably available. However, for the Central corridor through the Ukraine, further transport capacity of only 30 bcm/a can be considered as sustainably available. This transport capacity is only available if the required refurbishment, which is funded by EBRD (Europäische Bank für Wiederaufbau)/ EIB (Europäische Investitionsbank) emergency loans, is actually pursued. However, in order to ensure this transport capacity in the long term, substantial maintenance and refurbishment measures are required in the future, which has not been the case at least in recent years. In fact, the planned investment programme has been consistently under-fulfilled by the operator.

The inadequate condition of the system has resulted in an incident rate about 10-times higher than the European average. A situation likely to exacerbate, as pipelines enter the fourth and sometimes fifth decade of operation in 2020. Furthermore, the depleting Nadym Pur Taz region is substituted by gas production from the more north-western located Yamal region. The Nord Stream corridor running from the Yamal region to the EU internal gas market is not only technically more advanced, but also about one-third shorter than the Central corridor. This leads to a significantly lower gas consumption of the compressors for the transport and thus to a higher efficiency and profitability of the transport system. As a result, the respective demand gaps cannot be reliably covered by pipeline gas ensuring future gas supply.

With regard to pipeline gas potentially supplied from new source countries (Azerbaijan, Turkmenistan, Israel, Iraq and Iran) to the EU internal gas market, is clearly limited. Apart from additional volumes from Azerbaijan transported via the new TAP/TANAP pipeline project – currently under construction with a maximum capacity of 10 bcm/a – no additional pipeline gas coming to the EU internal gas market is conceivable. As a result, no additional import volumes are expected from these suppliers in the foreseeable future.

**LNG:** The global LNG market generally represents a possible supply source to import considerable additional volumes of natural gas to cover the future *EU 28 Plus* import requirement. However, due to its nature as a cyclical industry (see Figure 2-7) LNG cannot ensure to cover natural gas demand. Therefore, reliable medium and long term forecasts of the LNG market are hardly feasible.

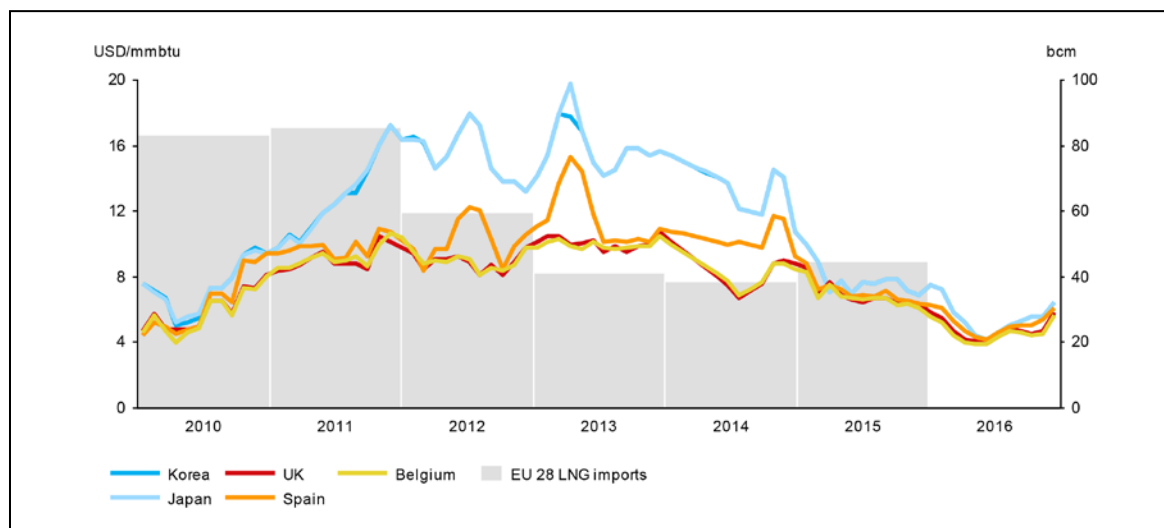


Figure 2-7 Development of regional landed LNG prices (USD/mmbtu) and EU 28 Plus LNG imports (bcm).

In addition, Prognos<sup>E</sup> and various other available studies<sup>F</sup> are assuming that the LNG demand will exceed the supply in the early 2020s, so that sufficient quantities for Europe are not guaranteed, resulting in an increased price competition. Natural gas imported as LNG into the EU internal gas market therefore is not a reliable supply option. Based on available LNG scenarios, LNG imports with an average of 67 bcm in 2020 and up to 95 bcm in 2030 are expected and considered in the following.

As a result, there would be an import gap without the implementation of the Nord Stream 2 project. This import gap will increase from 30 bcm in 2020 to 59 bcm in 2030 and 110 bcm in 2050 (see Figure 2-8). The construction of the Nord Stream 2 pipeline can close this import gap from 2020 onwards. This will increase Russia's sustainable transport capacity towards the EU internal gas market and thus avoid the additional reliance on volatile LNG. With its designed annual capacity of 55 bcm per year<sup>G</sup>, the Nord Stream 2 pipeline will contribute to the closure of the import gap from 2020 onwards, thus guaranteeing the security of supply with natural gas.

<sup>E</sup> Prognos, Status und Perspektiven der europäischen Gasbilanz, p. 69.

<sup>F</sup> See for example Royal Dutch Shell plc., LNG Outlook (2017), p. 13; The Boston Consulting Group, A Challenging Supply-Demand Outlook for LNG Producers (2016), p. 8.

<sup>G</sup> In Figure 2-8 a typical utilisation rate of 90% is applied to the designed annual capacity of Nord Stream 2 (55 bcm/a), which leads to average annual volumes of 50 bcm.

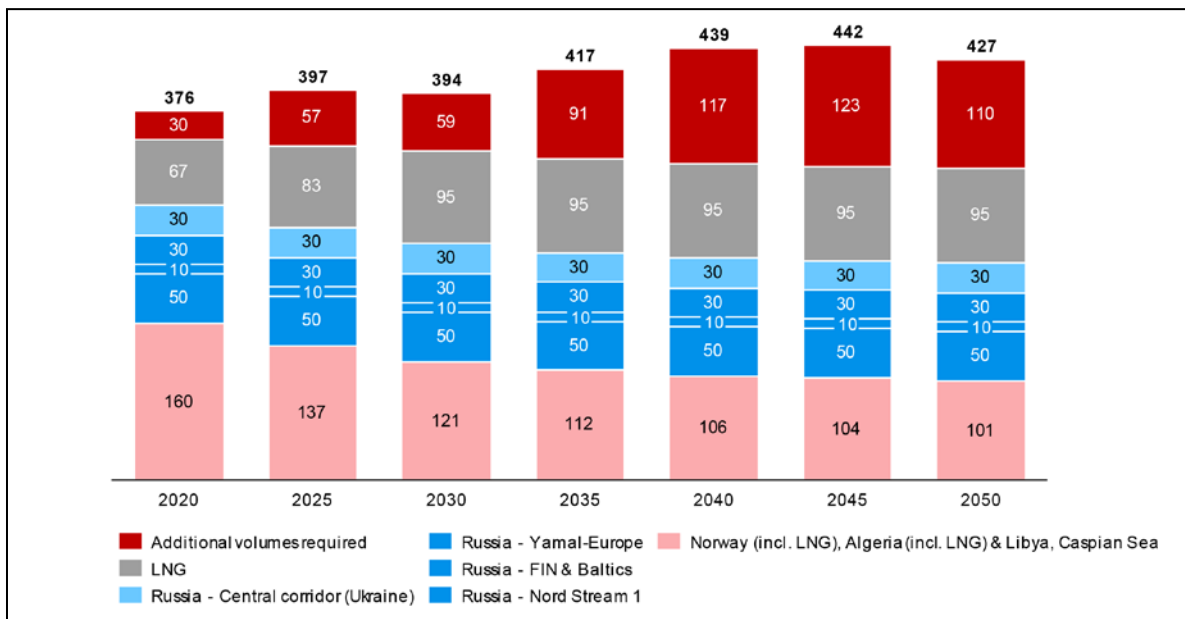


Figure 2-8 EU 28 Plus import gap forecast with average LNG and 30 bcm/a Ukraine transit (Reference Case) (bcm), figures for Russian supplies in the bar chart are arranged in the same order as used in the legend.

In view of the broad range and the complexity of possible forecasts, it cannot be excluded that other studies generate different results. However, these won't be able to prove that the EU's security of supply can be guaranteed in the future without the implementation of Nord Stream 2. On the contrary, there are additional risk factors which can currently lead to an increased threat to the security of supply. The Nord Stream 2 pipeline can help to ensure security of supply, particularly in terms of potential transit, supply and demand risks.

The most prominent risk factors are a complete halt of transit through Ukraine on commercial or legal grounds (see Figure 2-9) or low levels of LNG supply due to a tightening global LNG market (see Figure 2-10). Furthermore, demand or supply-side risks could be higher than assumed by Prognos, such as a complete stop of production from the Groningen field or a halt of exports from North Africa, which would endanger the security of gas supply of EU 28 Plus (see Figure 2-11).

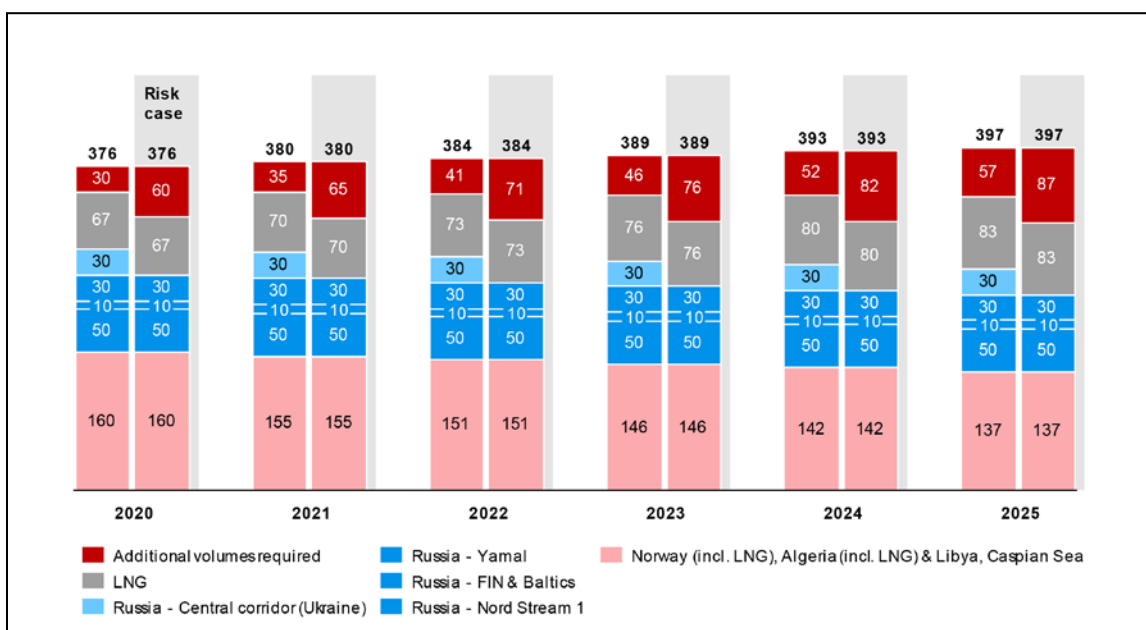


Figure 2-9 Risk case 1 for EU 28 Plus: 0 bcm/a Ukraine transit (bcm).

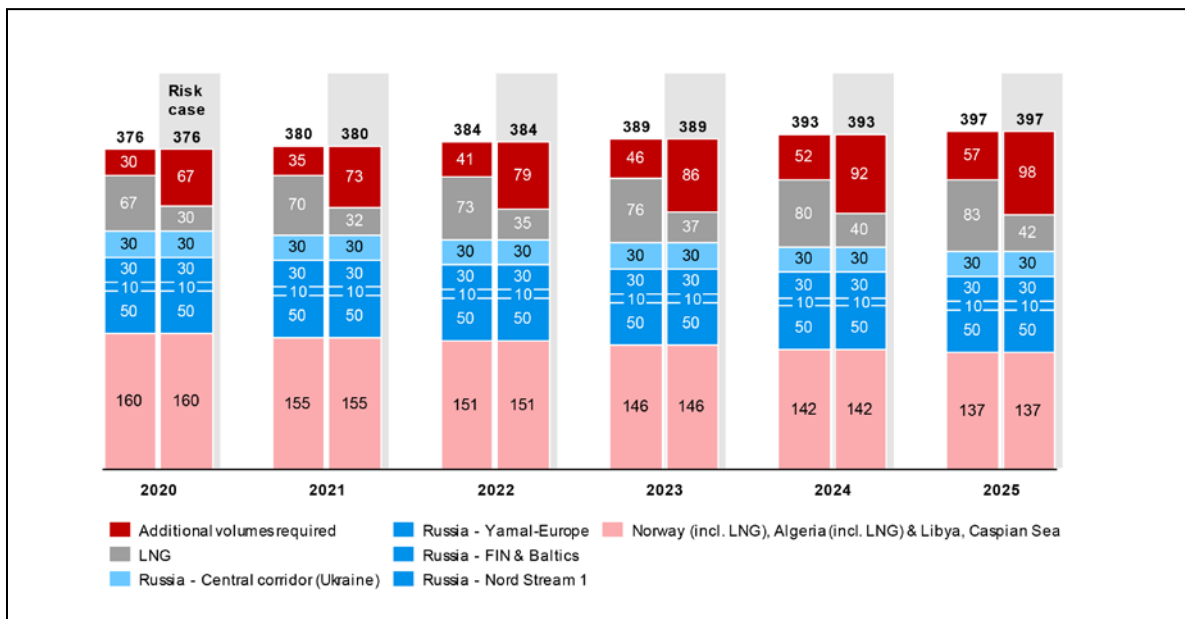


Figure 2-10 Risk case 2 for EU 28 Plus: Minimum LNG import by EU 28 Plus (bcm).

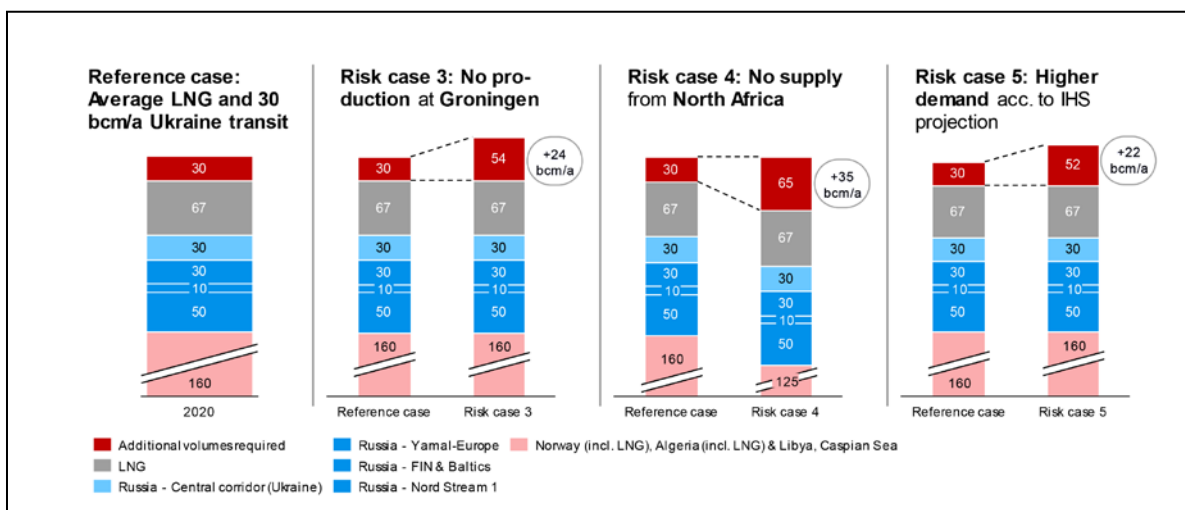


Figure 2-11 Other relevant risk cases for EU 28 Plus: No supply from Groningen (NL), North Africa or higher demand for natural gas (bcm).

In addition, Nord Stream 2 will increase competitive pressure on natural gas supplied to the EU internal gas market from different countries, resulting in lower gas market prices for end consumers and therefore contributing to the affordability of energy supply. Furthermore, Nord Stream 2 will trigger further integration of the EU internal gas market through additional downstream pipeline infrastructure.

Finally, the proposed project contributes to an environmental friendly supply of energy. This applies to natural gas as a fossil fuel and its general importance in the energy mix, but also to the project itself.

Natural gas, is a fuel with various applications in the heating, power generation, industry and transport sector of the EU 28 (see Figure 2-12). Being the fossil fuel with the least greenhouse gas (GHG) and other emissions resulting from combustion (e.g. particulate matter) – especially in comparison with coal and oil – natural gas can serve as both a transitional energy source, enabling a build-out of renewables as well as a back-up energy source guaranteeing overall security of energy supply. Thus, natural gas as an intermediary has the potential to accompany

and promote the transition to a low-carbon economy and will continue to play an important role in the *EU 28* energy supply in coming decades. Through the continued use of natural gas, ambitious targets set by the *Paris Agreement* of 2016 on climate change can be reached without jeopardizing the overall security of energy supply.

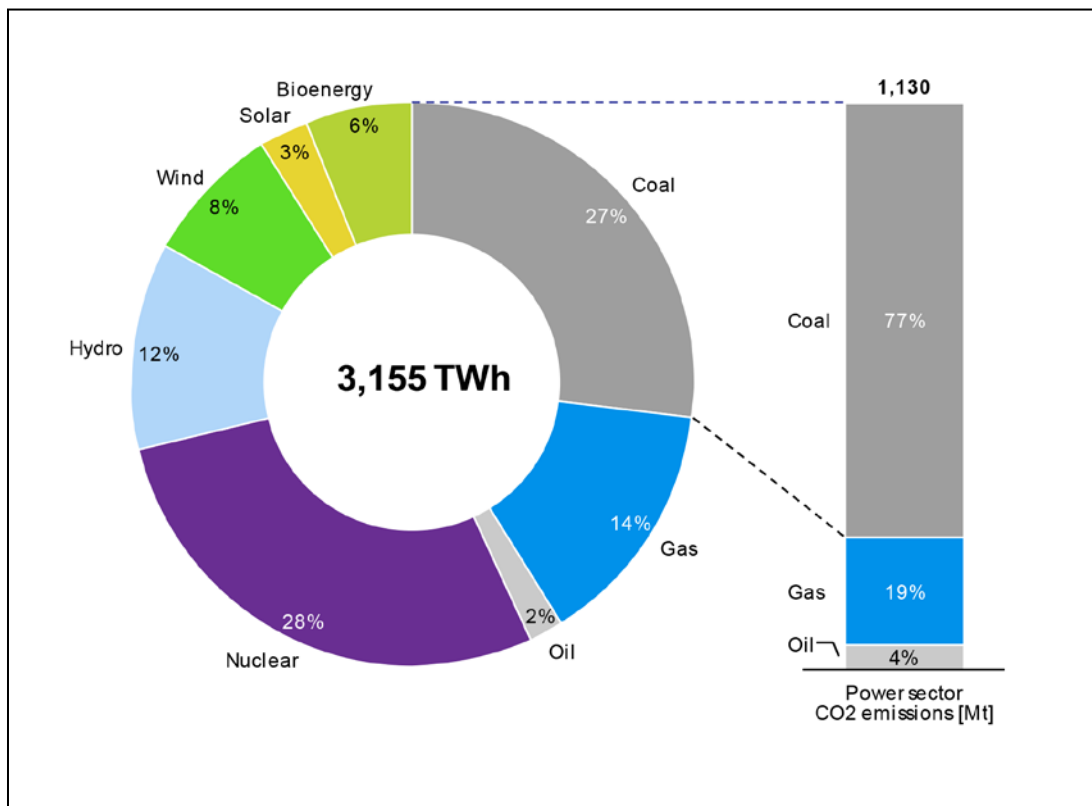


Figure 2-12 Electricity mix 2014 in EU 28 by energy source (TWh, %) and corresponding CO<sub>2</sub> emissions (Mt, %).

Also, from an environmental perspective Nord Stream 2 – combining state-of-the-art technical design with a much shorter route from the relevant production fields in Russia to the EU internal gas market (see Figure 2-13) – has significant advantages in terms of environmental and climate impacts.



Figure 2-13 Overview of Russian gas fields and pipelines to the EU (schematic).

This applies to both Russian gas supplied to EU 28 Plus via Yamal-Europe and the Central corridor as well as compared to important LNG supply options (Algeria, Australia, Qatar and US). Among the potential sources of gas supply able to significantly contribute to closing the EU 28 Plus import gap, Russian gas supplied via the Nord Stream corridor has the lowest carbon footprint. Compared to natural gas reaching the EU gas market via the Nord Stream corridor, the CO<sub>2</sub> footprint of alternative Russian pipeline gas routes is at least 46%, and that of LNG alternatives at least 131% greater (see Figure 2-14).

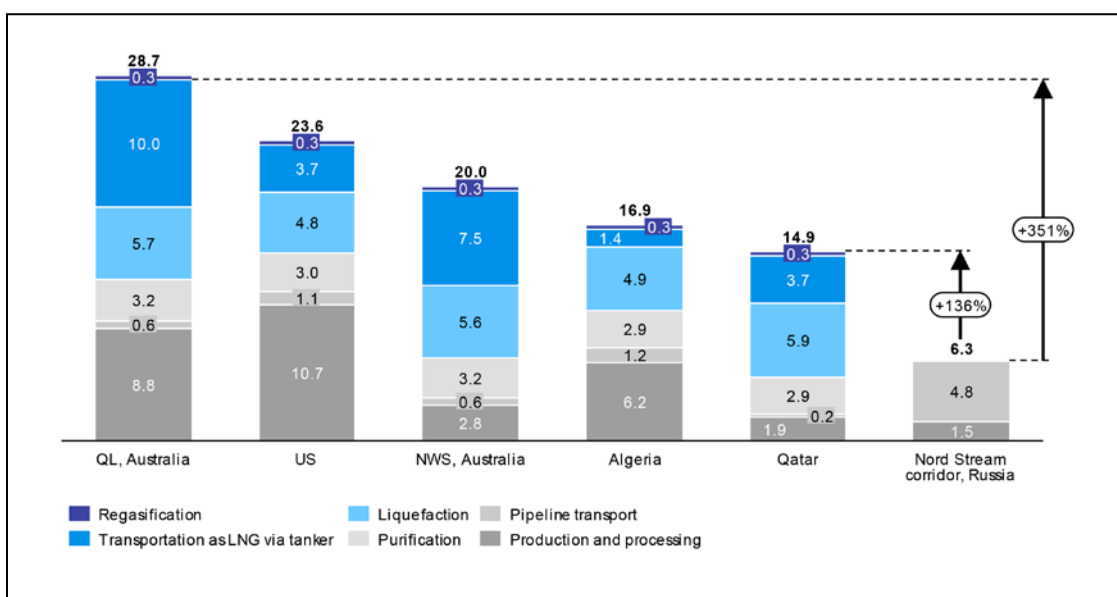


Figure 2-14 Carbon footprint of Russian pipeline gas coming to EU 28 via the Nord Stream corridor and from different sources via LNG (gCO<sub>2</sub>e/MJ).

Natural gas is poised to remain a backbone of *EU 28 Plus* energy supply, outpacing coal and oil and leading to lower GHG emissions. With a mostly stable natural gas demand, but rapidly decreasing gas production in *EU 28 Plus*, alternative gas supply is needed to cover the upcoming natural gas import gap starting already in 2020. The state-of-the-art transport system Nord Stream 2 can contribute to covering the upcoming import gap of *EU 28 Plus* as of 2020, while making the EU's gas supply more robust, more economically beneficial, more sustainable, more efficient – and more consumer-friendly.

### 3. REGULATORY CONTEXT

#### 3.1 Introduction

In the following sections, the overriding international directives and conventions relevant to the overall project are summarised. The national regulations in the individual countries through whose EEZ or TW the pipelines will pass are addressed in the national EIAs for Russia, Finland, Denmark and Germany and in the national ES for Sweden.

#### 3.2 Overall regulatory framework for pipelines in the Baltic Sea

The offshore route proposed for NSP2 passes through the TW or EEZs of five countries bordering the Baltic Sea (Russia, Finland, Sweden, Denmark and Germany), with landfalls in Russia and Germany.

The required national permits in the PoO including the respective legal provisions are listed in Table 3-1.

**Table 3-1 List of required permits including respective legal provisions.**

List of permits including the respective legal provisions	
<b>Russia</b>	<p><b>Permits for construction</b></p> <p>Two main permits for construction:</p> <ol style="list-style-type: none"> <li>1) Permit for construction (on-shore construction permit) (разрешение на строительство) according to Art. 51 Russian Urban Planning Code; Russian Government Resolution dated 06.02.2012 No. 92;</li> <li>2) Permit for pipe-laying (offshore construction permit) (разрешение на прокладку трубопровода) according to Art. 16 Federal Law 155-FZ on 31.07.1998, Art. 22 Federal Law No.187-FZ dated 30.11.1995, Russian Government Resolution No.68 dated 26.01.2000, Russian Government Resolution No.417 dated 09.06.2010, Ministry of Natural Resources Order No.202 dated 29.06.2012.</li> </ol> <p><b>Permits for operation</b></p> <p>Two main permits for operation:</p> <ol style="list-style-type: none"> <li>1) Permit for operation according Art. 55 Russian Urban Planning Code, Russian Government Resolution No. 92 dated 06.02.2012;</li> <li>2) License to operate a hazardous facility (Federal Agency for Environmental, Technological, and Nuclear Supervision) according to Art. 9 Federal Law 116-FZ on 21.07.1997, Art. 12 Federal Law 99-FZ on 04.05.2011, Russian Government Resolution dated 10.06.2013 No. 492, Rostekhnadzor Decree dated 11.08.2015 No. 305.</li> </ol>
<b>Finland</b>	<p><b>Permit for construction and use of EEZ</b></p> <p>Government consent for the activity and for the delineation of the pipe-lay corridor (the exploitation right) according to the Finnish Act on the EEZ (Act 1058/2004).</p> <p><b>Permit for construction and operation</b></p> <p>Permit for construction (including munitions clearance), operation, maintenance and repair according to Water Act (Act 587/2011).</p>
<b>Sweden</b>	<p><b>Permit for construction and operation</b></p> <p>Permit to construct the pipelines according to the Act on the Continental Shelf (Act 1966:314).</p>
<b>Denmark</b>	<p><b>Permit for construction:</b></p> <p>Permit to install a section of the NSP2 natural gas pipelines in Danish waters according to the Act on the Continental Shelf, Administrative Order (361/2006) on Pipeline Installations and Administrative Order (1419/2015) on Offshore Environmental Impact Assessment (EIA).</p> <p><b>Permits for operation:</b></p> <ol style="list-style-type: none"> <li>1) Permit to operate the Danish section of NSP2 pipeline A (west) in Danish TW and on</li> </ol>



List of permits including the respective legal provisions	
	<p>the Danish continental shelf according to the Continental Shelf Act, and Administrative Order (361/2006) on Pipeline Installations.</p> <p>2) Permit to operate the Danish section of NSP2 pipeline B (east) in Danish TW and on the Danish continental shelf according to the Continental Shelf Act, and Administrative Order (361/2006) on Pipeline Installations.</p>
<b>Germany</b>	<p><b>Plan Approval</b> Plan approval procedure for construction in TW and the landfall according to § 43, Energy Industry Act (EnWG).</p> <p><b>Permits for construction and operation</b> Two permits for construction in EEZ according to the Federal Mining Act (BBergG):</p> <p>1) Permit by the Mining Authority (Stralsund) according to § 133 Sec.1 No. 1 BBergG;</p> <p>2) Permit issued by the BSH (Hamburg) according to § 133 Sec. 1 No 2 BBergG.</p>

The United Nations Convention on the Law of the Sea (UNCLOS) /1/, Article 79, entitles all states to lay submarine cables and pipelines on the continental shelf of coastal states, the delineation being subject to the consent of such states. Hence, the project developer is required to submit various national permit applications in order to obtain country-specific permits from the states through whose waters the new pipelines are planned to pass.

A comprehensive assessment of environmental impacts is a key element in the permitting process for the construction and operation of a major natural gas pipeline system. Countries in the EU are bound to follow the Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (henceforth referred to as the EU EIA Directive) /12/ and the 1991 UNECE Convention on Environmental Impact Assessment in a Transboundary Context /13/ (henceforth referred to as the Espoo Convention), if applicable, whereas Russia has its own EIA legislation and has not yet ratified the Espoo Convention. Detailed EIA procedures in the TW and the EEZs of the Baltic Sea differ among the countries concerned. Therefore the EIAs of the project must follow the country-specific standards. Any transboundary impacts included in the national EIAs and ES are to be summarised in the Espoo documentation.

Consent of the coastal states through whose TW or EEZ the pipelines will pass is based on various national laws, such as EIA Procedure Acts, Water Acts, EEZ Acts, Continental Shelf Acts and Energy Acts, which are specific for each individual country. The standards to be upheld through the EIA process are also specified in the respective national legislation.

### 3.3 EU EIA Directive and Espoo Convention

The Espoo Convention aims to prevent, mitigate and monitor environmental damage by ensuring that explicit consideration is given to transboundary environmental factors before a final national decision is made as to whether to approve a project. A key requirement in the Espoo Convention is the identification and communication of potential transboundary impacts to stakeholders through an impact assessment to enable their comments to be considered prior to the granting of consent.

The EU has ratified the Espoo Convention, which makes it an integral part of the EU legislative framework and gives it precedence over secondary legislation adopted under the Treaty on the Functioning of the European Union (TFEU). This means that EU legal provisions should be interpreted in accordance with the Espoo Convention.

Article 2 of the convention sets out rules for conducting an EIA of activities located on the territory of one contracting party, defined as the PoO, which are likely to cause significant adverse transboundary impacts in another contracting party, defined as the AP /13/.

There are seven key steps in the EIA procedure carried out for large-scale transboundary projects /16/:

1. Notification and transmittal of information;
2. Determination of the content and extent of the matters of the EIA information (scoping);
3. Preparation of the EIA information/report by the developer;
4. Public participation, dissemination of information and consultation;
5. Consultation between concerned parties;
6. Examination of the information gathered and final decision;
7. Dissemination of information on the final decision.

With respect to NSP2, steps one and two were performed in 2012 and 2013 by Nord Stream AG. Step 3 was performed in 2015 and 2016 by Nord Stream 2 AG. Step 4 is being performed by submitting the Espoo Report for information and consultation to the public around the Baltic Sea.

Pursuant to Appendix II of UNECE, 1991 and Annex IV of 2011/92/EU, the EIA information must include at least the following /16/:

- Description of the proposed project and its purpose;
- Description, where appropriate, of reasonable alternatives (e.g. in terms of location, technology to be employed, etc.) and also the no-action alternative;
- Description of the environment likely to be significantly affected by the proposed project and its alternatives;
- Description of the potential environmental impact of the proposed project and its alternatives and an estimate of its significance;
- Description of the mitigation measures considered and an indication of the predictive methods, assumptions and data on which they are based;
- Outline of monitoring and management programmes and any plans for post-project analysis.

*Transboundary impact* means any impact, not exclusively of a global nature, within an area under the jurisdiction of a party caused by a proposed activity, the physical origin of which is situated wholly or in part within the area under the jurisdiction of another party /13/.

*Party of Origin* means the contracting party or parties to the Espoo Convention under whose jurisdiction a proposed activity is envisaged to take place /13/. For the NSP2 project, the PoOs are Russia, Finland, Sweden, Denmark and Germany. According to Article 3 of the Espoo Convention, the PoOs are responsible for the content and acknowledgement of receipt of notifications and for the exchange of relevant information to/from the potentially affected countries.

*Affected Party* means the contracting party or parties to the Espoo Convention which are likely to be affected by the transboundary impact of a proposed activity /13/. For the NSP2 project, the APs include the five PoOs as well as Estonia, Latvia, Lithuania and Poland. The PoOs are included as APs because construction activities occurring in one PoO may lead to impacts in another PoO.

The EU EIA Directive /12/ also includes (in Article 7) special provisions for cases in which a project implemented in one Member State is likely to have significant effects on the environment of another Member State /12/.

The main purpose of this Espoo Report is to document the environmental and social impacts of NSP2 in accordance with the Espoo Convention and the EU EIA Directive. Chapter 4 – Espoo process of this report outlines how the seven-step process specified in the Espoo Convention is being implemented for NSP2.

### 3.4 Other EU directives

#### 3.4.1 EU Habitats and Birds Directives: Natura 2000

Natura 2000 is an EU-wide network of nature protection areas established under the 1992 Habitats Directive /17/. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It comprises Special Areas of Conservation (SACs) designated by Member States under the Habitats Directive and also incorporates Special Protection Areas (SPAs), which are designated under the Birds Directive /18/.

The Habitats Directive /17/ ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right. With the Birds Directive, the Habitats Directive forms the cornerstone of Europe's nature conservation policy /18/ and establishes the EU-wide Natura 2000 ecological network of protected areas which are safeguarded against potentially damaging developments.

Natura 2000 is not a system of strict nature reserves from which all human activities would be excluded. The approach to the conservation and sustainable use of Natura 2000 sites is much wider, largely centred on people working with nature rather than against it. However, Member States must ensure that the sites are managed in a sustainable manner, both ecologically and economically.

As a result of these directives, special precautions need to be taken for areas of the NSP2 project that are located within or in close proximity of Natura 2000 sites in the Baltic Sea.

The Natura 2000 areas relevant for NSP2 are outlined in Section 9.6.6. The results of the assessment of possible impacts on the Natura areas are shown in Section 10.6.6.

#### 3.4.2 EU Marine Strategy Framework Directive (MSFD)

The EU Marine Strategy Framework Directive (MSFD) /19/ is the first encompassing piece of EU legislation specifically aimed at protecting the marine environment and natural resources and creating a framework for the sustainable use of marine waters. It establishes a framework within which the Member States shall take the necessary measures to achieve or maintain good environmental status (GES) of the marine environment by the year 2020 at the latest (Article 1).

Member States are required to follow a common approach that involves several actions. Those that are of most relevance to NSP2 comprise:

- Determining GES (/19/, Article 9);
- Establishing environmental targets to guide progress towards achieving GES (/19/, Article 10).

The national permitting procedures in Finland, Sweden, Denmark and Germany will ensure that the NSP2 project is in line with the provisions of the EU MSFD /19/.

The relationship between NSP2 and EU MSFD is outlined in Section 11.3.

#### 3.4.3 EU Water Framework Directive

The EU Water Framework Directive (WFD) /20/ is a key initiative aimed at improving water quality throughout the EU to achieve a GES for both groundwater and surface waters. While the main focus is fresh water, the WFD also covers transitional and coastal waters up to 1 nautical mile (nm) off the coast for ecological status and 12 nm with regard to chemical status.

The WFD requires an integrated approach to managing water quality on a river basin basis, with the aim of maintaining and improving water quality. River basin management plans are to be

prepared and renewed in six-year cycles. The first plans were issued in 2009 and updated in 2015.

For the NSP2 project, the WFD is relevant for the German landfall area and the offshore pipelines until 1 nm from the German coastline. The WFD is also applicable in Denmark offshore the island Bornholm and in the Gulf of Finland, with the exception of Russia.

#### 3.4.4 EU Maritime Spatial Planning Directive

In July 2014, the EU adopted the Maritime Spatial Planning (MSP) Directive /21/, which came into force in September 2014. It created the world's first legal requirement for countries to create transparent planning-at-sea systems and to cooperate with their neighbours to make that happen.

EU countries are now required to transpose the MSP Directive into national legislation and appoint competent authorities by 2016. The implementation of the directive in the jurisdictional waters of Member States must be achieved by March 2021; no formal plans have as yet been adopted. The MSP Directive focuses on four objectives linked to the legal bases (environment, fisheries, maritime transport and energy).

A number of EU directives are relevant to the MSP Directive. The directives that are relevant to marine areas are shown in Figure 3-1 (see also Chapter 11 – Marine strategic planning).

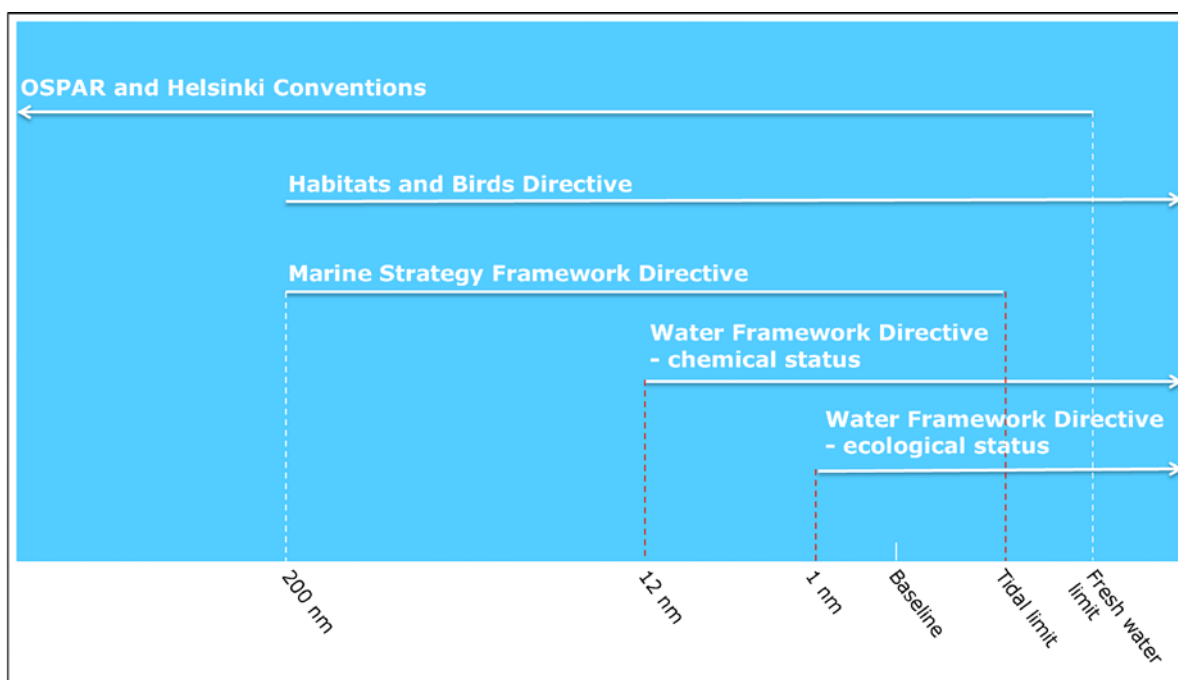


Figure 3-1 Marine areas covered by EU directives /22/.

### 3.5 Other international conventions

#### 3.5.1 UN Convention of the Law of the Sea, UNCLOS

UNCLOS, under Article 79, sets out requirements related to submarine cables and pipelines on the continental shelf /1/. These entitle all States to lay submarine pipelines on the continental shelf subject to conditions which include requirements regarding the prevention and control of pollution from pipelines, due regard for other uses of the seabed including cables or pipelines already in position and consent of the delineation of the relevant coastal State.

According to UNCLOS, the countries through whose EEZs the pipelines pass (Russia, Finland, Sweden, Denmark and Germany) have the sovereign right and obligation for permitting NSP2

with due respect to the aspects stated above. They are all parties to UNCLOS and have implemented the necessary legislation for the territorial sea, the continental shelf and the EEZ. UNCLOS sets the frame for the overall permitting of the part of NSP2 that is in the EEZs of the PoOs.

The Espoo Report constitutes the documentation of the possible environmental impacts of the project as required by Article 79, paragraph 2, of UNCLOS. The report is also relevant in connection with decommissioning of the pipelines, as outlined in Section 12.1.

### **3.5.2 International Convention for the Prevention of Pollution from Ships, MARPOL 73/78**

The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 Convention) /2/ was developed by the International Maritime Organization (IMO) to preserve the marine environment through eliminating pollution by oil and other harmful substances and to minimise accidental spillage of such substances.

For the NSP2 project, the subcontractor management processes will require vessels working for the project to comply with the applicable provisions of the MARPOL Convention. This includes requirements for quality of discharged ballast water and oil spill prevention measures.

The MARPOL requirement in relation to the risk of accidental spills is addressed in Chapter 13 – Risk Assessment.

### **3.5.3 International Convention for the Control and Management of Ships' Ballast Water and Sediments**

Invasive aquatic species present a major threat to marine ecosystems, and shipping has been identified as a pathway for introducing species to new environments.

The Ballast Water Management (BWM) Convention /3/ aims to prevent the spread of harmful aquatic organisms from one region to another by establishing standards and procedures for the management and control of ships' ballast water and sediments. The BWM Convention was ratified on 8 September 2016 and will enter into force on 8 September 2017.

Compliance with the applicable provisions of the BWM Convention will be ensured as part of the subcontractor management processes of NSP2.

The BWM Convention is relevant in connection with non-indigenous species (NIS), as outlined in Section 10.6.8.

### **3.5.4 London Convention and Protocol on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972**

The objective of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 /4/ (also known as the London Convention) is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea resulting from dumping of wastes and other matter.

In 1996, the London Protocol /5/ was agreed to further modernise the London Convention and, eventually, replace it. Under the protocol, all dumping of waste is prohibited, except for possibly acceptable wastes on the so-called reverse list. This list, which is included as Annex 1 of the London Protocol, includes e.g. dredged material; sewage sludge; inert, inorganic geological material (e.g. mining wastes); organic material of natural origin; and bulky items primarily comprising iron, steel, concrete and similarly unharmed materials.

The London Convention and Protocol are relevant in connection with decommissioning of the pipelines, as outlined in Section 12.1.

### 3.5.5 **Bern Convention on the Conservation of European Wildlife and Natural Habitats**

The Convention on the Conservation of European Wildlife and Natural Habitats /6/ (also known as the Bern Convention) came into force in 1982.

The Bern Convention aims to conserve wild flora and fauna and their natural habitats. Special attention is given to endangered and vulnerable species, including endangered and vulnerable migratory species specified in the appendices of the convention.

The safeguarding of flora and fauna in relation to NSP2 are addressed in Chapter 9 – Environmental baseline in the section on biological environment and in Chapter 10 – Assessment of environmental impacts, in the sections on impacts on the biological environment, which give particular focus (through their explicit consideration in the assessment criteria) to species that are endangered, vulnerable and migratory and to natural habitats.

### 3.5.6 **Bonn Convention on the Conservation of Migratory Species of Wild Animals**

The Convention on the Conservation of Migratory Species of Wild Animals /7/ (Bonn Convention or CMS Convention) is an intergovernmental treaty concluded under the United Nations Environment Programme. The CMS Convention aims to “conserve terrestrial, marine and avian migratory species throughout their range”. The convention facilitates the adoption of strict protection measures for endangered migratory species. Migratory species that need or would significantly benefit from international cooperation are listed in Appendix II of the CMS Convention.

Within the convention there are a number of agreements covering specific migratory species, including the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) of 1991.

The safeguarding of migratory species that may be affected by NSP2 is addressed in Chapter 9 – Environmental baseline, which gives particular focus (through their explicit consideration in the assessment criteria) to species that are listed in Appendix II of the CMS Convention and within ASCOBANS.

### 3.5.7 **UN Convention on Biological Diversity**

The UN Convention on Biological Diversity from 1992 /8/ is an international, legally binding treaty with three main goals: conservation of biodiversity, sustainable use of biodiversity and fair and equitable sharing of the benefits arising from the use of genetic resources. Its overall objective is to encourage actions that will lead to a sustainable future.

The concept of biodiversity embraces not only the variety of living organisms but also the genetic diversity within a species and the diversity of habitats and landscapes. Biodiversity and nature conservation were included as Article 15 of the revised Helsinki Convention (HELCOM) of 1992 (see also Sections 3.5.8 and 9.6.8).

### 3.5.8 **Helsinki Convention, HELCOM**

HELCOM /9/ entered into force on 17 January 2000 and covers the whole of the Baltic Sea area, including inland waters as well as the water of the sea itself and the seabed. Measures are also taken in the whole catchment area of the Baltic Sea to reduce land-based pollution.

The convention has a special focus on pollution of the Baltic Sea originating from many sources and introduced by anthropogenic sources.

The convention states the following with regard to EIAs (Article 7):

1. Whenever an environmental impact assessment of a proposed activity that is likely to cause a significant adverse impact on the marine environment of the Baltic Sea Area is required by international law or supra-national regulations applicable to the Contracting Party of origin, that Contracting Party shall notify the Commission and any Contracting Party which may be affected by a transboundary impact on the Baltic Sea Area.
2. The Contracting Party of origin shall enter into consultations with any Contracting Party which is likely to be affected by such transboundary impact, whenever consultations are required by international law or supra-national regulations applicable to the Contracting Party of origin.
3. Where two or more Contracting Parties share transboundary waters within the catchment area of the Baltic Sea, these Parties shall cooperate to ensure that potential impacts on the marine environment of the Baltic Sea Area are fully investigated within the environmental impact assessment referred to in paragraph 1 of this Article. The Contracting Parties concerned shall jointly take appropriate measures in order to prevent and eliminate pollution including cumulative deleterious effects.

The provisions of the HELCOM Convention have been addressed through compliance with the Espoo Convention.

### **3.5.9 Ramsar Convention**

The Convention on Wetlands of International Importance (the Ramsar Convention) is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation of wetlands. The convention requires contracting parties to formulate and implement their planning so as to promote the conservation of wetlands and as far as possible the wise use of wetlands in their territory /10/.

Ramsar areas in relation to NSP2 are addressed in Sections 9.6.7 and 10.6.7.

### **3.5.10 Aarhus Convention**

The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters /11/ (Aarhus Convention) is about government accountability, transparency and responsiveness. The Aarhus Convention establishes a number of rights of the public (individuals and their associations) with regard to the environment. The parties to the convention are required to make the necessary provisions so that public authorities (at the national, regional or local level) will contribute to these rights to become effective, including access to environmental information, public participation in environmental decision-making and access to justice.

The Aarhus Convention is implemented by the EU through the Environmental Information Directive /14/ and the Public Participation Directive /15/. Provisions for public participation in environmental decision-making are furthermore to be found in a number of other environmental directives, such as the EU Strategic Environmental Assessment Directive /22/, the EU WFD (Section 3.4.3) and the EU EIA Directive (Section 3.3).

## 4. ESPOO PROCESS

### 4.1 Introduction

The NSP2 project is subject to a transboundary EIA according to the Espoo Convention. This is because the NSP2 project can potentially have transboundary environmental impacts.

As outlined in Section 3.2, the Espoo process comprises several key steps. This section provides a summary of how that process is being implemented for NSP2.

### 4.2 Notification and transmittal of information

In November 2012, Nord Stream AG issued a PID covering the Nord Stream Extension, now called NSP2, for review and reference. In February 2013, a meeting between the PoOs was held to discuss the content of the PID and the procedures for the project according to the Espoo Convention.

Following this meeting and taking into account the comments, Nord Stream AG submitted the final PID to the PoOs in March 2013 /23/. In April 2013, the PoOs submitted the PID to the APs as prescribed by Article 3 (“Notification”) of the Espoo Convention. The public consultation phase on the PID subsequently took place in all countries in parallel with the display of the national EIA programmes as required by the national legislation of each country. All APs expressed their interest in participating in the Espoo procedure for the Nord Stream Extension and submitted comments on the PID resulting from the public consultation phase.

### 4.3 Preparing the Espoo Report

Following the notification and transmittal of information, comments from the notified parties were evaluated and taken into account by the project developer to ensure that issues raised are addressed in the Espoo Report.

Over 100 comments related to the PID were received from authorities, organisations and private individuals. The main issues brought up by the stakeholders are summarised in Table 4-1. The table also shows how these issues are addressed in the Espoo Report. Appendix 1 provides a list of comments received and the respective responses.

The Espoo Report is written in English and translated into the nine languages of all APs.

**Table 4-1 NSP2 summary of key areas of concern.**

Impacts on marine mammals, birds and fish spawning/nursery areas	
Concern was raised regarding potential impacts on marine mammals, birds and fish spawning/nursery areas.	<p>The Espoo Report includes a thorough assessment of these issues. The baseline chapters give an overview of the marine species and their habitats that may be affected by the construction activities. This includes the vulnerability of species during their various life stages and information on spawning/nursery areas, breeding grounds and other areas that are important for the species. Special attention is given to Natura 2000 sites.</p> <p>A number of mitigation measures have been taken when designing the project and when planning the construction and operation phases (see Chapter 16 - Mitigation measures). The detailed planning of the construction works will be outlined in the so-called Construction Management Plans (CMPs). For special precautions (e.g. avoidance of certain construction activities at certain times of the year), the CMPs will be incorporated in line with the results of the impact assessment outlined in Chapter 10 - Assessment of environmental impacts of this EIA. Monitoring during and after the construction works (see Chapter 17 – HSES Management System) is carried out to ensure that no unforeseen impacts occur. In such cases it will be evaluated whether construction</p>



	methods or similar should be adjusted.
<b>Minimising impacts on seabed and sediments</b>	
Concerns were raised regarding potential impacts on the seabed and sediments. This is in particular the case with respect to mobilisation of seabed sediments and the impacts on water quality (turbidity, release of particle-associated contaminants and nutrients).	The pipeline has been designed to minimise the amount of seabed intervention works. Moreover, the methods of seabed intervention works have been selected to minimise sediment spill (see Chapter 6 - Project description and Chapter 16 - Mitigation measures). Numerical modelling has been carried out for sediment spreading from the seabed intervention works (see Chapter 10 – Assessment of environmental impacts). Results from monitoring carried out during the NSP construction works showed that the modelling of the impacts was conservative, i.e. the actual impact can be expected to be lower than the modelled impact. Therefore the assessment of the potential impacts caused by the seabed intervention works is considered to be robust.
<b>Investigation of planned and future projects and minimising impacts on fishery, maritime traffic, cultural heritage and from CWAs</b>	
Concerns were raised regarding the project's interference with other planned and future projects in the Baltic Sea, as well as with maritime traffic and fishery. Concerns about possible interference with dumped chemical munitions containing CWAs and with cultural heritage were also raised.	In the section on the socio-economic baseline (Chapter 9 – Environmental baseline), the relevant existing and planned infrastructure are outlined, as is the maritime traffic and fishery. Likewise, the results of CWA and cultural heritage surveys are outlined. In the section on socio-economic impacts (Chapter 10 – Assessment of environmental impacts), the possible impacts are addressed. The means to reduce the impacts are addressed in Chapter 16 – Mitigation measures. The detailed planning of the construction works will be outlined in the CMPs, which will include measures taken to reduce interference with the above activities.
<b>Addressing direct and indirect cumulative impacts</b>	
Concerns were raised as to whether cumulative impacts are being addressed in relation to future developments in the Baltic Sea.	The cumulative impacts have been addressed in line with the above documents (see Chapter 14 - Cumulative impacts). All existing and known planned infrastructure and activities which can potentially add to the impact caused by the NSP2 project have been included in the assessment.
<b>Investigation of alternative routes and the zero alternative</b>	
Concerns were raised as to whether the zero alternative was investigated and whether alternatives were investigated in order to avoid vulnerable or protected areas such as Natura 2000 sites.	The zero alternative has been addressed (see Chapter 5 - Alternatives). In addition, offshore route alternatives have been analysed and the preferred route is outlined. The preferred landfall options in Russia and Germany, respectively, have been selected based on the optimal combination of minimising environmental impacts, the risks of accidental events, construction time and costs related to construction and operation. Land-based pipelines as an alternative to NSP2 have not been investigated as such, as they were already scrutinised and rejected as part of the preparation for the NSP project (see Section 5.3).
<b>Emergency preparedness</b>	
Concerns were raised regarding risk assessment and emergency response preparedness.	The EIA includes an analysis of the risk of major environmental accidents and an outline of the emergency preparedness in place (see Chapter 13 - Risk assessment). The more detailed emergency preparedness plans will be included in the CMPs for the various phases of the construction works. In addition to the above, the risk of major environmental accidents will be included in the quantitative risk assessment (QRA) for the pipeline project in line with the provisions of the EU Offshore Safety Directive 2013/30/EU /24/.

#### 4.4 Consultation and public participation

In addition to the consultation on the PID outlined above, Nord Stream 2 AG has had numerous meetings with Espoo Focal Points and/or Espoo Points of Contact in all PoOs and all potential APs. The aim of these meetings was to ensure that the content of the Espoo Report addresses all issues that are important to the different countries. Table 4-2 summarises where and when these meetings were held. In addition to these meetings, within the framework of the national permitting processes Nord Stream 2 AG had over 200 meetings with all relevant authorities, NGOs and other stakeholders, e.g. fishermen in the different countries.

**Table 4-2 Contact and meetings with Espoo Focal Points and/or Points of Contact.**

Date	Location	Authority
2015-09-16	Helsinki	Ministry of Environment
2015-10-18	Helsinki	Ministry of Environment
2015-12-01	Tallinn	Ministry of Environment
2015-12-08	Copenhagen	Danish Nature Agency for Water and Nature Management
2016-04-20	Stockholm	Swedish Environmental Protection Agency
2016-05-10	Berlin	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
2016-05-11	Copenhagen	Danish Nature Agency for Water and Nature Management
2016-06-06	Helsinki	Ministry of Environment
2016-06-21	Moscow	Ministry of Natural Resources and Environment
2016-06-30	Tallinn	Ministry of Environment
2016-09-02	Vilnius	Ministry of Environment
2016-09-23	Warsaw	General Directorate for Environmental Protection
2016-09-27	Riga	Ministry of Environmental Protection and Regional Development
2016-09-14	Berlin	Espoo Focal Points and/or Points of Contact from Germany, Finland, Sweden and Russia
2016-11-14	Berlin	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
2016-11-15	Stockholm	Swedish Environmental Protection Agency
2016-11-17	Helsinki	Ministry of Environment
2016-11-23	Moscow	Ministry of Natural Resources and Environment
2017-01-25	Stockholm	Ministry of Enterprise, Ministry of the Environment and Energy and Environmental Protection Agency
2017-01-27	Helsinki	Ministry of Environment, ELY Centre Uusimaa and Finnish Environment Institute (SYKE)
2017-02-08	Berlin	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
2017-02-22	Moscow	Ministry of Natural Resources and Environment

This Espoo Report is being disclosed to the public around the Baltic to fulfil the requirements for the PoOs to submit the Espoo Report to all APs in accordance with Article 2, paragraphs 2 and 6; Article 3, paragraph 8; and Article 4, paragraph 2, of the Espoo Convention.

The PoOs will define the duration of the consultation within which comments on the NSP2 Espoo Report can be sent to the PoOs. The APs will organise hearings, meetings and other means of consultation on the Espoo Report in line with legal requirements. Nord Stream 2 AG has committed to attend such hearings and meetings if requested by the relevant authorities.

#### 4.5 Decision-making

According to Article 6 of the Espoo Convention, the PoOs will take the comments received during the consultation phase into account when taking a final decision.

## 5. ALTERNATIVES

### 5.1 Introduction

Nord Stream 2 AG is faced with the challenge of transporting gas from its source in Russia to Germany and the European gas pipeline network. The company is committed to working to good international industry standards with regards to technology, environmental protection, social responsibility, labour conditions, safety, corporate governance and public consultation. Accordingly, Nord Stream 2 AG has planned and designed NSP2 through an integrated and iterative environmental management, survey and engineering design process which satisfies the following objectives:

- Minimise environmental and social impacts;
- Maintain international good practice in relation to health and safety;
- Satisfy design standards and constructability requirements;
- Ensure pipeline integrity and operate the system safely over a 50 year operational life.

This chapter describes the NSP2 planning and design philosophy with respect to avoiding and minimising environmental and social impacts and its application across the project with respect to alternatives for routing, technology and construction methodology. An overview of the options that were considered and rejected is presented below.

Historical route developments are described in Section 5.3, and route alternatives that are assessed in the various EIAs are described in Section 5.4. Chapter 6 – Project description addresses the preferred scheme that is assessed in the subsequent chapters of this report.

### 5.2 NSP2 planning and design philosophy

Nord Stream 2 AG is committed to designing, planning and implementing the pipeline project with the least impact on the environment as is reasonably practicable.

To manage the potential impacts of the NSP2 project, environmental and social considerations have been integrated into the engineering planning and design process. This has enabled mitigation measures to be developed and integrated into the various phases of the project in an iterative process. Mitigation measures have been identified through consideration of legal requirements, best practices, industry standards, applicable international standards (including World Bank Environment, Health and Safety (EHS) Guidelines and IFC performance standards), experience from the operational Nord Stream Project (NSP) and other infrastructure projects, and the application of expert judgement.

#### 5.2.1 Mitigation hierarchy

The EIA Directive (Article 5(3)) requires an EIA Report to include “a description of the measures envisaged avoiding, reducing and, if possible, remedying significant adverse effects”. For NSP2, mitigation refers to the elimination or reduction of the frequency, magnitude or severity of exposure to risks, or minimisation of potential environmental and social impacts.

In developing mitigation measures, priority has been given to preventing or avoiding potential impacts. If it has been impossible to avoid an impact (i.e. there is no other technical or economically feasible alternative), minimisation measures have been sought to reduce impacts. Where it is not possible to avoid impacts or reduce their severity through management actions, restoration and/or offset measures are considered.

This approach is driven by the policies of Nord Stream 2 AG, notably those related to the approach to environmental and social management, which specifies the requirement to “adopt a mitigation hierarchy”. This is also reflected in the cultural heritage and biodiversity policies.

The mitigation hierarchy is described further below.

### **Mitigation approach**

#### **Avoidance**

Avoidance or prevention of potentially negative impacts can be achieved through an iterative planning and design process. For example, it has been possible to prevent potentially negative environmental impacts by locating the pipelines, where feasible, away from sensitive or valuable receptors such as Natura 2000 areas and cultural heritage and by avoiding areas contaminated by chemical warfare agents. Avoidance reduces the need for later steps in the mitigation hierarchy.

#### **Minimisation**

For impacts that cannot be completely avoided, management actions can be implemented to minimise the duration, intensity, extent and/or likelihood of impacts (addressing noise levels, turbidity thresholds, discharge limits, communications and so on).

#### **Restoration**

Restoration involves the re-establishment of the composition, structure and function of an ecosystem with the aim of bringing it back to its original (pre-disturbance) state or to a healthy state close to the original state.

#### **Offset measures**

Generally considered as the final stage in the mitigation hierarchy, offset measures will be considered for impacts that cannot be avoided, minimised or reversed. "Offsets" can be physical (e.g. contributing to long-term biodiversity improvements) or economic (supporting socio-economic objectives in affected communities).

### **5.2.2 Avoiding impacts through planning and design**

Pipeline routing which factors in engineering design and environmental criteria is one of the most important considerations in avoiding or minimising impacts. To minimise seabed disturbance, Nord Stream 2 AG has implemented a number of mitigation measures (where reasonably feasible) with respect to routing. Environmental and social considerations that were integral to the process of identifying an optimal pipeline route included:

- Parallel routing as close as feasible to NSP so the combined footprint on the seabed is minimised;
- Minimisation of the overall pipeline length and number of route bends;
- Protected and environmentally sensitive areas, including fishing banks and nursery spawning areas;
- Cultural heritage;
- Existing and future infrastructure;
- Shipping lanes;
- Munitions;
- Military practice areas;
- Mineral extraction areas.

Routing considerations also included avoiding, where possible, sea bottom conditions that give rise to freespan and, therefore, the requirement for seabed intervention works (including trenching and rock placement) which have potential environmental impacts.

Alternatives that were evaluated in the routing of the pipelines are presented below.

### 5.3 Preliminary route development and optimisation

Comprehensive route considerations have been undertaken during several phases, starting with the North Transgas project in 1995 to the development of the NSP and subsequently also by NSP2. The previous assessed alternatives form the basis of the routing that is currently being considered for NSP2.

During the previous NSP, requests to consider an onshore alignment were put forward by the stakeholders during the permitting process. In the project's response to this it was apparent that onshore pipelines entail additional environmental and socio-economic effects in comparison with offshore projects. Onshore pipeline challenges include human settlements, roads, railways, canals, rivers, surface landforms, agricultural land, site reinstatement and potentially sensitive ecosystems and cultural heritage sites.

Furthermore, overland pipelines also require additional infrastructure sites such as compressor stations approximately every 200 km to maintain pressure for gas transport flow, which would require significant land and energy usage while emitting noise and emissions to air. Transmission is also less efficient compared with offshore pipelines.

Experience with NSP confirmed that impacts were localised and temporary and demonstrated that offshore pipelines are the most advantageous approach with respect to all considered aspects, including environmental, cost, supply capacity and security. For these reasons, there is no further consideration of an onshore alternative in this report.

The following sections address historic offshore route considerations, including:

- North Transgas (1995-2000);
- North European Gas Pipeline (2005-2006);
- Nord Stream (2006-2012).

The NSP2 route options and preferred alternatives, which have evolved from this early planning work, are documented in the following sections.

#### 5.3.1 Historic route considerations – North Transgas

The first detailed plans for transferring gas from the gas fields in western Siberia to western and central Europe through the Baltic Sea originate from the North Transgas Oy (NTG) study in 1995-2000. The scope of the NTG study was to conduct a thorough analysis of gas supply to Scandinavia and the use of Scandinavia as a transit region to western and central Europe.

Approximately 3,900 km in the Baltic Sea, Gulf of Finland and Gulf of Bothnia were screened in the study to identify one or several pipeline routes. Three different route options and 16 landfall sites were investigated. The three main route options, which included various landfall locations, were:

- Route option 1: overland Finland and Sweden, including marine crossing north of the Åland Islands.
- Route option 2: overland Finland, with a spur line to Sweden either north of the Åland Islands or north of Gotland Island.
- Route option 3: offshore route with delivery to Finland and Sweden through spur lines to Hanko and Nyköping respectively.

An offshore route through the Gulf of Finland was selected as the preferred design solution as planning evolved and previously identified offshore problems were resolved.

### 5.3.2 Nord Stream (2006-2012)

The North European Gas Pipeline Company, comprising a partnership between Gazprom, BASF and E.ON, was established in September 2005 and renamed Nord Stream AG in October 2006. During the feasibility study of the Nord Stream Project (NSP), various pipeline corridors were considered.

#### Route alternatives north and south of Gogland Island (in Russia)

Through Russian waters, two principal alternatives, north and south of the island of Gogland, were compared. On the basis of the assessment of the two route alternatives against the defined objectives, the northern route alternative was identified as the preferred option. The main reasons were:

- The southern route was closer to protected areas and areas of importance for species conservation.
- The southern route required the crossing of a busy shipping route and two cable crossings.
- The southern route posed a greater risk of damage to the pipelines owing to the proximity to busy shipping lanes and designated future dredging areas.
- The southern route was greater in length.

#### Route alternatives in the Gulf of Finland (Finnish section)

In the Finnish part of the Gulf of Finland, two options for part of the route in Finnish waters were considered, a northern and a southern route at Kalbådagrund. On the basis of the assessment of the two routes against the defined objectives, the southern route at Kalbådagrund was identified as the preferred option. The main reasons were as follows:

- The northern route involved more crossings of uneven hard outcrops and therefore required more seabed intervention works than the southern route, which offered advantages in respect of environmental impact and technical complexity.
- The northern route traversed the structural seabed features associated with Kalbådagrund and was located in slightly shallower waters, suggesting higher value benthic habitat. This indicates that the southern route would have lower potential for impacts on protected areas and ecologically sensitive species.

#### Route alternatives in Sweden – Gotland and Hoburgs Bank

Two alternative pipeline corridors in Swedish waters were considered: a route west of Gotland and a route east of Gotland. The route west of Gotland, between Gotland and the Swedish mainland, ran adjacent to Swedish TW around Gotland and continued along the border of the Swedish mainland TW before entering the Danish EEZ heading towards Bornholm. The pipeline route overlapped a shipping route between the northern tip of Öland Island and the north of Bornholm. This route to the west of Gotland was deemed not preferable in 2006 and consequently not chosen, e.g. due to its longer overall length and because a plan for a potential Swedish spur line was discarded.

The route to the east of Gotland was identified as the preferred option for the following key reasons:

- The eastern route avoided major shipping routes.
- The eastern route had fewer crossings of military and munitions areas.
- Considering a landfall at Greifswald, the eastern route in the Swedish sector was shorter.

On the eastern side of Gotland considerable efforts, including additional surveys and engineering, were invested into optimising the route with respect to the sensitive Natura 2000 areas of Hoburgs Bank and Northern Midsjö Bank, the deep water shipping lane and other infrastructure.

In 2009, Nord Stream AG also analysed alternatives on the eastern side of the deep water shipping lane in further detail during the permitting phase, due to requests from the authorities. However, it was concluded that such alternatives would not lead to overall improvements compared with the selected route. It was also observed that having pipelines on both sides of the deep water shipping lane would create an undesired 'box-in' effect, impacting potential future adjustments of the deep water shipping route. Therefore keeping the pipelines close together west of the deep water shipping lane was concluded to be preferred.

#### **Route alternatives in Denmark – Bornholm**

From 2006 to 2009, the NSP route through Danish waters was subject to a series of in-depth field investigations and assessments covering optional routes both north-west and south-east of Bornholm. Challenges in selecting a route included factors such as an unclear EEZ border between Denmark and Poland and intensive maritime traffic with several traffic separation schemes. Furthermore, the route needed to consider an important commercial fishery (with bottom trawling), particularly east of Bornholm, as well as the location of a World War II chemical munitions dumping ground, which limits the possibilities for seabed intervention in an area located in the vicinity of the Swedish EEZ border.

Based on these constraints and by applying the as low as reasonably practicable (ALARP) principle, the final route for NSP was advised by the Danish Energy Agency. The route north of Bornholm was abandoned, and the benefits of being far from the CWA areas and from the area with intensive commercial fishery were assessed to be secondary in comparison to the maritime safety risks.

#### **Route alternatives in Germany**

During the early stages of the NSP development, three alternative landfall areas in Germany were considered: Greifswald, Rostock and Lübeck. On the basis of an assessment against the defined criteria, the route to Greifswald was identified as the preferred route. The main reasons were:

- Shorter length and lesser requirements in terms of seabed intervention works resulting in far lower dredging volume.
- Shorter construction time.
- Lower risk of disturbance of shipping and lower risk of damage to the pipelines caused by shipping.
- Avoidance of impacts on seabed organisms from temperature differences between the gas and the surrounding environment resulting from the burial of the pipelines over a long distance.

## **5.4 Nord Stream 2 pipeline system – route development**

### **5.4.1 Nord Stream extension (2012-2013)**

After the construction of NSP, Nord Stream AG performed a feasibility study for the potential extension of NSP (NEXT) in 2012-2013. The objectives of the feasibility study were to identify and evaluate potential options for up to two additional pipelines in the Baltic Sea.

By this time, NSP had been built and therefore the spatial planning perspective needed to be considered through the planning of the additional pipelines, although all feasible options were reassessed. Three main route options, including a route through the Estonian and Latvian EEZs, were developed based on technical routing requirements, experience from NSP and various environmental interests:

- Finland-Sweden reference route (REF-FS-01.02);
- Estonia-Sweden reference route (REF-ES-01.03);
- Estonia-Latvia reference route (REF-EL-01.03).

In addition to the main corridors, a number of route options connecting the main routes and landfall areas were also investigated. Figure 5.1 shows the main routes and route options developed during the NEXT project.

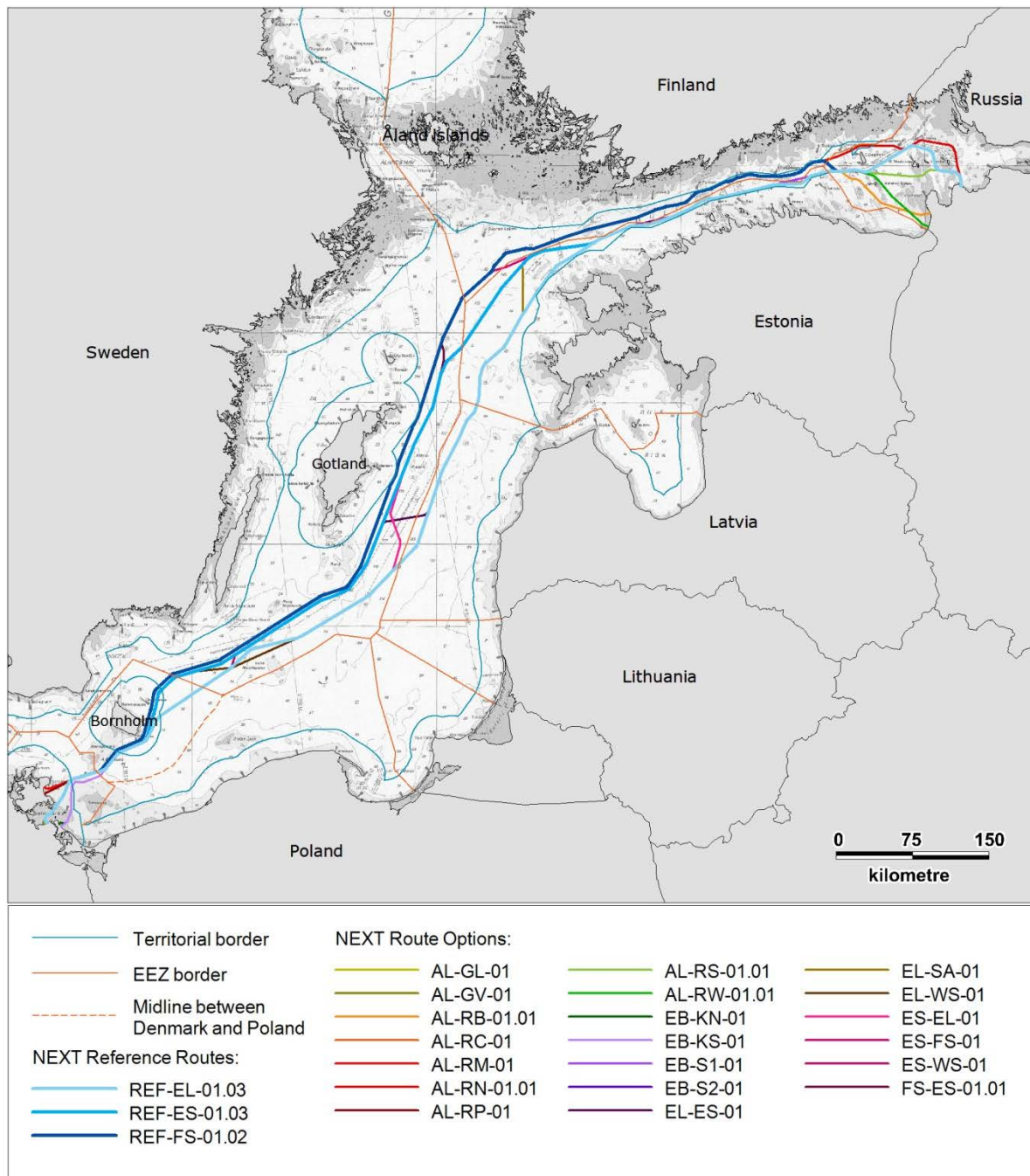


Figure 5-1 Route options considered during the Nord Stream Extension project.

Applications for survey permits were submitted in the corresponding countries for further investigations to optimise the pipeline routing. The Estonian government, however, decided in December 2012 not to grant a reconnaissance survey permit in the Estonian EEZ. Thus the originally identified three main route corridors were reduced to two. The remaining route alternatives and options all followed a routing from the landfall options in Russia through Finnish, Swedish and Danish waters to landfall options in Germany.

The route corridor options were developed on the basis of a routing assessment, in which numerous environmental constraints in the potential project area were considered.



The term "route corridor" means a spread on the seabed of in general 2 km in width. Select route corridors were further investigated by reconnaissance and detailed level surveys to establish seabed topography and to provide the required data for the technical basic design of pipeline routes.

Two locations along the south coast of the Russian part of the Gulf of Finland were identified as being potentially suitable for the landfall site:

- Kolganpya at the Soikinsky Peninsula;
- Narva Bay at the Kurgalsky Peninsula.

The routing assessment for the Gulf of Finland concluded that a route corridor entirely through Finnish waters was environmentally and technically feasible if adequate mitigation measures were adopted. The route corridor ran north of the existing NSP and to the south of the limit of Finnish TW within the Finnish EEZ, extending from the Russian/Finnish EEZ border to the Finnish/Swedish EEZ border.

The routing assessment for the Baltic Sea Proper concluded that in connection with the Gulf of Finland routing three routing options were feasible. The route corridor options entered Sweden in the northern part of the Baltic Sea Proper. They followed the existing NSP on either side through the Swedish EEZ and allowed for a total of three options to cross Danish waters before merging into one German landfall approach. The three routing options were:

- Routing option north and west of the existing NSP;
- Routing option south and east of the existing NSP;
- Routing option south and east of the existing NSP with a routing further east of Bornholm.

The German coastline was screened for feasible landfall locations. The Greifswalder Bodden was identified as a preferred region for a possible landfall location in view of its proximity to the existing Nord Stream infrastructure at Lubmin. Alternative possible landfall locations within the Greifswalder Bodden were to be investigated.

The study of the feasible route options for NSP2 was carried out on the basis of previous planning and experience from the existing NSP as concluded in the NEXT phase and supplemented by new route surveys and seabed investigations. Furthermore, experience from the installation of NSP contributed to the planning and technical design of NSP2.

A number of criteria were considered when selecting the optimal route. The first criterion was environmental aspects and focused on avoiding protected and/or sensitive designated areas and other areas with ecologically sensitive species of animals or plants. Minimising any seabed intervention works that may cause local environmental impacts was also taken into account.

The second criterion looked at socio-economic factors to minimise any interference with shipping, fishing, dredging, military practice areas, tourism and existing cables and wind turbines. No impacts on the existing raw material extraction activities should take place. Avoiding areas with known discarded conventional and chemical munitions was also a priority in the route selection process.

The third criterion covered technical considerations regarding pipeline design, component manufacture, installation methods, operations, and integrity and risk assessment results. These included water depth for pipeline stability, seabed roughness, minimum pipeline bend radii, installation, maintenance and repair, design options for cable and pipeline crossings as well as distance to and crossing of shipping lanes. Furthermore, minimising construction time, and

therefore any disruptions of construction works, as well as reducing the technical complexity of the operation to keep the use of resources low was considered.

On the basis of the experience of NSP and available data on the existing pipelines, and taking the selection criteria described above into account, a thorough route corridor assessment has been performed as a desk study which identified a number of feasible route corridor and landfall options as a basis for further planning.

#### **5.4.2 Alternative routes for NSP2 in Russian waters**

The planned NSP2 will be routed as far as possible along the existing NSP corridor. In the Russian sector, however, alternative locations for the starting point (the landfall facilities) and the offshore route had to be sought owing to technical, environmental and social aspects that constrained the location of the facilities in Portovaya Bay, which is the starting point of the Nord Stream system.

A comprehensive study of possible alternatives has been carried out and will be included in the EIA that will be submitted to the authorities of the Russian Federation. A summary of the study is included below. The assessment of route alternatives was carried out in three phases:

##### **Phase 1. Evaluation of the feasibility of following the existing NSP**

The first option that was considered in the feasibility study phase consisted of installing NSP2 alongside the existing NSP in order to bundle impacts at locations that had already been affected by the development and where significant knowledge on the social and environmental conditions had been acquired as part of the NSP project.

The detailed analysis of the capacity of the existing inland gas transport system showed that there are limitations regarding the supply of 55 bcm of gas from the existing pipeline network to territories located to the north of St Petersburg and that new inland gas supply pipelines would be required. In addition, a new compressor station would be required. The constraints associated with onshore routing of new, inland, high pressure gas supply pipelines across densely populated areas along the River Neva and securing suitable sites for the construction and operation of the compressor station led to the conclusion that the bundling option is not viable.

Additional considerations included an increased demand in natural gas by industrial customers in the south-west Leningrad region (west of St Petersburg), including the Kinginseppsky District, where ongoing industrial development has led to an increase in natural gas demand. Accordingly, the Russian territorial planning scheme maps out the southern side of the Gulf of Finland for gas pipeline connecting lines.

##### **Phase 2. Selection of route options on the southern coast of the Gulf of Finland**

The region west of St Petersburg to the borders with Estonia along the southern coast of the Gulf of Finland was considered for the purpose of selecting a potentially feasible location for the NSP2 landfall site and upstream facilities, comprising the compressor station and the inland gas supply pipelines, which will be built and operated by Gazprom.

Available public data and remote sensing methods were used to analyse the environmental and social constraints of the coastline to the west of St Petersburg and identify potentially feasible locations for further analysis. As a result, two options were identified and studied in more detail from a technical, environmental and social standpoint: Narva Bay and Cape Kolganpya.

The Narva Bay route crosses the southern section of the regional Kurgalsky nature reserve. The nature reserve is a wetland of international importance and included on the list of Baltic Sea territories protected under HELCOM. However, the proposed NSP2 route crosses the least valuable part of the nature reserve/wetland. The key biological components are located in the

northern part of Kurgalsky Peninsula, on nearby islands and on the so-called Kurgalsky reef and are not affected by the route.

### **Phase 3. Comparative analysis of the options Narva Bay and Cape Kolganpya**

In 2015, Nord Stream 2 AG conducted reconnaissance environmental surveys for both route options shown in Figure 5-2 and developed high level design concepts in order to make an informed comparison of the two options, see also Atlas Maps AL-01-Espoo and AL-02-Espoo.

Based on the outcome of this evaluation, the Narva Bay route option was found to be the preferred option. The main reasons are:

- The route is shorter for both onshore and offshore segments, thus resulting in a smaller impact area and a shorter construction time frame;
- Seabed conditions are more favourable; therefore the total volume of required pre-lay trenching and seabed intervention works is significantly less.
  - The total volume, and therefore duration, of required pre-lay trenching and seabed intervention works for the Narva Bay option is significantly less than for the Cape Kolganpya option.
  - The impact on the marine environment for the Narva Bay option would be significantly less than for the Cape Kolganpya option. The extent and duration of sediment dispersion for the Narva Bay option is much lower than for the Cape Kolganpya option, and known contamination levels of the seabed sediments are lower.
- The vulnerability of ecosystems as well as individual components of biodiversity and aquatic biological resources in the area of the Narva Bay route is lower than for the Cape Kolganpya option. However, for the onshore section of the Narva Bay route, mitigation is required to manage impacts on sensitive forest habitat. The Narva Bay route, therefore, would affect fewer valuable ecosystems and communities, including:
  - Important bird areas and ringed seal haul-outs, where the average distance from the Narva Bay route is significantly greater than for the Kolganpya alternative and underwater noise impacts on marine mammals are lower.

This option would provide significantly greater technical security for pipeline construction and operation, which would mean reduced risks of accidents and emergency situations and associated large-scale environmental impacts.

- The environmental and social impacts associated with the upstream gas pipeline that is required to supply the compressor station would also be greater along the Cape Kolganpya option because of its encroachment of the Kotelsky state complex nature reserve.

Final decision on approval of this route will be given by the Russian Federation authorities based on a detailed analysis of environmental damage prepared for both options and evaluation of the final outcome of the Russian environmental impact assessment (EIA). Detailed discussion and assessment of alternatives is provided in the Russian EIA and in an Assessment of Alternatives report which will be publically displayed as part of the national procedure.

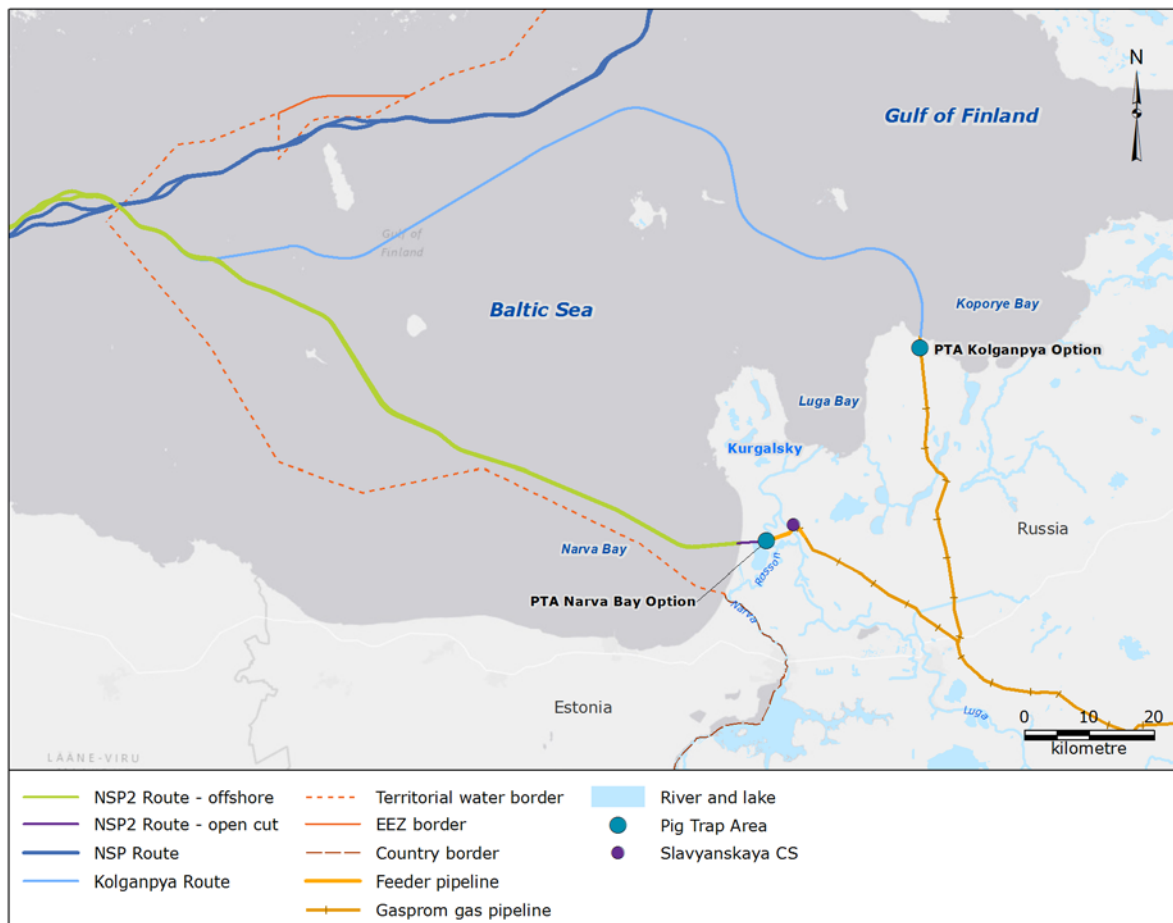


Figure 5-2 Project alternatives in the Russian Federation.

### 5.4.3 Alternative routes for NSP2 in the Finnish EEZ

In the Finnish EEZ, the proposed NSP2 route crosses the existing NSP pipelines immediately after entering the Finnish sector. The subsequent route lies north of the NSP pipelines.

The length of the Finnish section is approximately 378 km from KP 114 to KP 492). The Finnish EIA report includes assessments of the following alternatives: NSP2 route, sub-alternatives, non-implementation.

In the Finnish EEZ, there are two sections along the pipeline route where the route divides into two alternative routes, see /27/ and Atlas Maps AL-01-Espoo ro AL-02-Espoo. The eastern section is located south or south-west of Porkkala in the Gulf of Finland, and the sub-alternatives are called **ALT E1** and **ALT E2**. Another section is located in the northern Baltic Proper in the western part of the Finnish EEZ, and the sub-alternatives are called **ALT W1** and **ALT W2**.

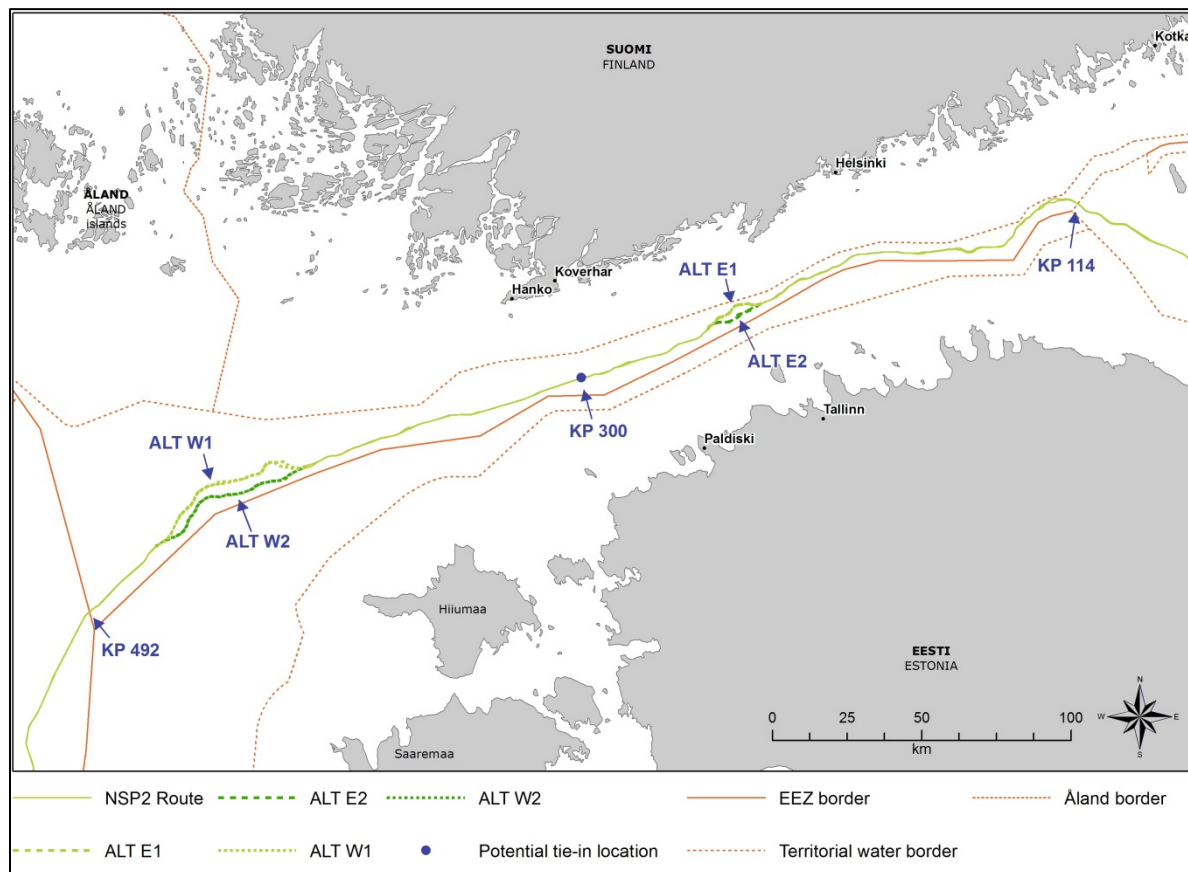


Figure 5-3 Pipeline route and route alternatives in the Finnish EEZ.

The main characteristics of the four sub-alternatives are shown in /27/.

Table 5-1 Comparison of sub-alternatives ALT E1 and ALT E2.

	ALT E1	ALT E2	ALT W1	ALT W2
<b>Length (km)</b>	20.5 – 20.8	19.8 – 20.1	59.1 – 60.1	56.3 – 57.0
<b>Rock volume (m<sup>3</sup>)</b>	121,000	279,000	340,000	282,000
<b>Freespans &gt; 100 m</b>	9	15	40	25
<b>Number of crossings</b>	18	8	8	4
<b>Minimum depth (m)</b>	33.2 – 35.4	45.9 – 48.5	45.2 - 54.9	82.9 – 87.1

**ALT E1/E2**

The southern sub-alternative ALT E2 is about 700 m shorter than ALT E1. The seabed profile along ALT E2 is more irregular. Therefore the estimated number of long freespans and the rock volume required for intervention works are higher. Both sub-alternatives are mostly in the range of 50-70 m water depth, but ALT E1 runs through a short shallow water section where the minimum water depth is 33 m. There are more cable crossings with ALT E1 than with ALT E2. ALT E2 is located closer to NSP than ALT E1 (0.2 km at its closest point).

**ALT W1/W2**

The southern sub-alternative, ALT W2, is about 3 km shorter than ALT W1. The seabed profile along ALT W1 is more irregular. Therefore the estimated number of freespans and the rock volume required for intervention works are higher. Both sub-alternatives are mostly in the range of 80-160 m water depth, but ALT W1 runs through a short shallow water section where the minimum water depth is 45 m. There are more cable crossings with ALT W1 than with ALT W2. ALT W2 is located closer to NSP than ALT W1 (0.2 km at its closest point).

The environmental impacts of the sub-alternatives are assessed on an equal basis in the Finnish EIA and in Chapter 10 – Assessment of environmental impacts.

#### 5.4.4 Alternative routes for NSP2 in the Swedish EEZ

Three different route alternatives have been identified during the design and planning of NSP2 through Swedish waters: the route east of NSP (ES route), the route west of NSP (FS-new route) and the alternative route (RA route), see Figure 5-4, Atlas Map AL-01-Espoo and Atlas Map AL-03-Espoo.

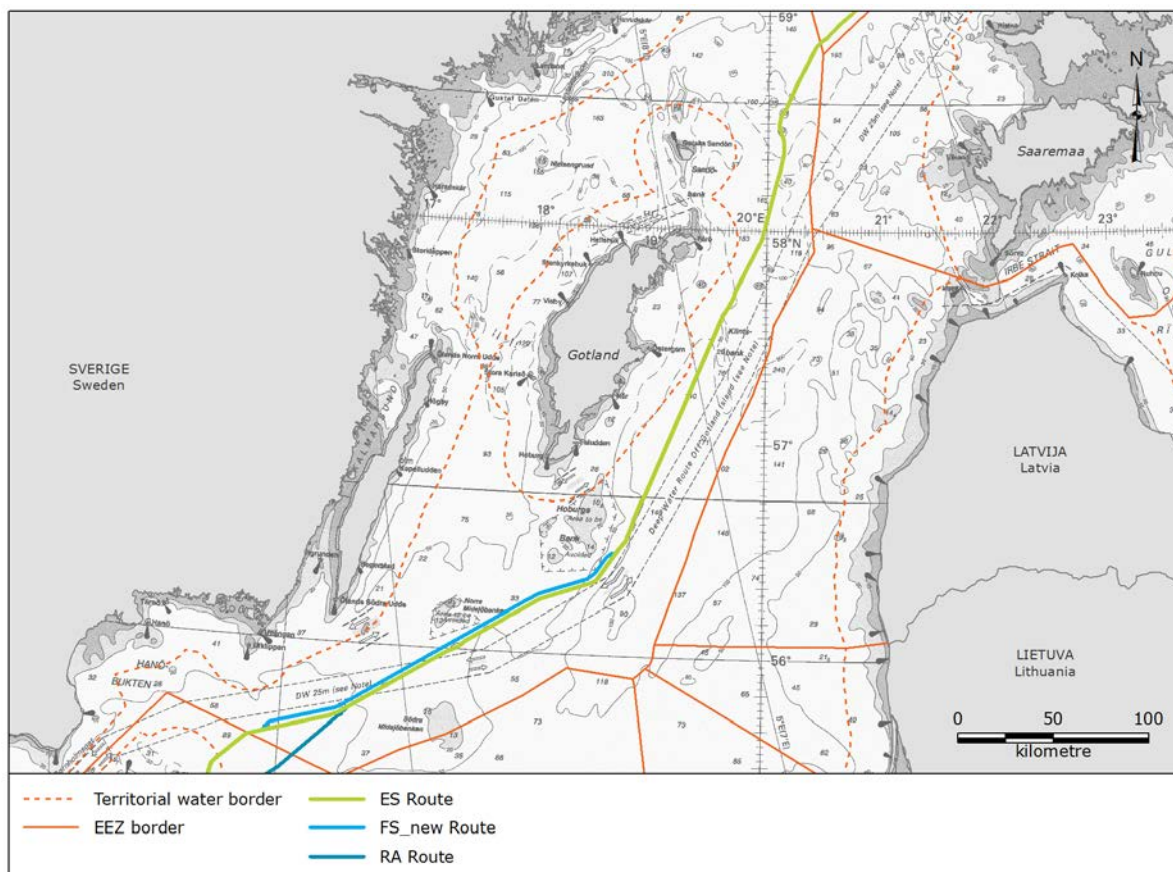


Figure 5-4 NSP2 route alternatives in the Swedish EEZ.

It should be noted that since the initial alternative route assessment was carried out, a new Natura 2000 area has been designated by the Swedish authorities, within the Swedish EEZ and named "Hoburgs Bank and Norra Midsjöbanken". The area is an extension of the existing sites Hoburgs Bank and Northern Midsjö Bank (see Section 9.6.6). This new protected area has been addressed and assessed in the national Swedish application documents.

##### ES route – east of NSP

The ES route branches off from the old FS route north-east of Gotska Sandön, crossing the existing NSP and running mostly parallel to the existing pipelines on the eastern and south-eastern side for the rest of the NSP2 section in the Swedish EEZ. The ES route has a greater distance from the Natura 2000 sites of Hoburgs Bank and Northern Midsjö Bank compared with NSP and is closer to the deep water shipping channel.

##### FS route – west of NSP

Originally the FS route was thought to run parallel to NSP on the west and north-western side for the entire section in the Swedish EEZ. On account of new circumstances, the FS route from the NEXT phase was amended and became the FS-new route. The FS-new route follows the ES route from the start of the Swedish sector at the Finnish border to midway through the Swedish EEZ to take into account the recently installed Sea Lion submarine cable between Finland and Germany. It then crosses NSP and joins the originally intended FS route down towards the Danish EEZ border, crossing NSP again and re-joining the ES route. The FS-new route is closer to the Natura

2000 sites of Hoburgs Bank and Northern Midsjö Bank than NSP. Consequently, the distance from the route to the deep water shipping channel is greater compared with the ES route.

#### **RA route – south of NSP**

The RA route is in the southern part of the Swedish EEZ that originates from the ES route, crossing the border to the Danish EEZ further south. The RA route enters the Danish border through the Bornholm Deep. This route is the shortest option, but it does not run parallel to the existing NSP. The route also passes through the anchoring restriction area that surrounds the chemical munitions dumping site east of Bornholm.

The three route alternatives for NSP2 in the Swedish EEZ have been considered in relation to the relevant technical, safety, environmental and socio-economic aspects. The routes have been compared and experience and alternatives from NSP and the NEXT feasibility study have been considered in the evaluation and selection of the preferred route.

For the majority of the aspects, the ES route is favourable compared with the FS-new route. The FS-new route includes two additional crossing sites of NSP compared with the ES and RA routes. The crossings will result in significantly increased intervention works. In addition, the ES route is located further away from the Natura 2000 sites of Hoburgs Bank and Northern Midsjö Bank, which is favourable from an environmental point of view.

The RA route alternative crosses the important fishing grounds of Bornholm Deep and therefore would interfere more with fishery than the ES route and FS-new route. In addition, the route deviates from the existing NSP, while the other alternatives remain parallel to NSP, and is therefore considered less favourable in relation to marine spatial planning. The majority of the RA alternative is located in the Danish EEZ, where it crosses an area that is potentially contaminated by CWAs associated with a chemical munitions dumpsite.

The preferred route in Sweden that has been selected for assessment in the Swedish ES and in Chapter 10 – Assessment of environmental impacts is the ES route.

#### **5.4.5 Alternative routes for NSP2 in Danish waters**

Two different route alternatives have been identified during the design and planning of NSP2 through Danish waters: the route east of NSP (ES route) and the alternative route (RA route), see Figure 5-5, Atlas Map AL-01-Espoo and Atlas Map AL-04-Espoo.

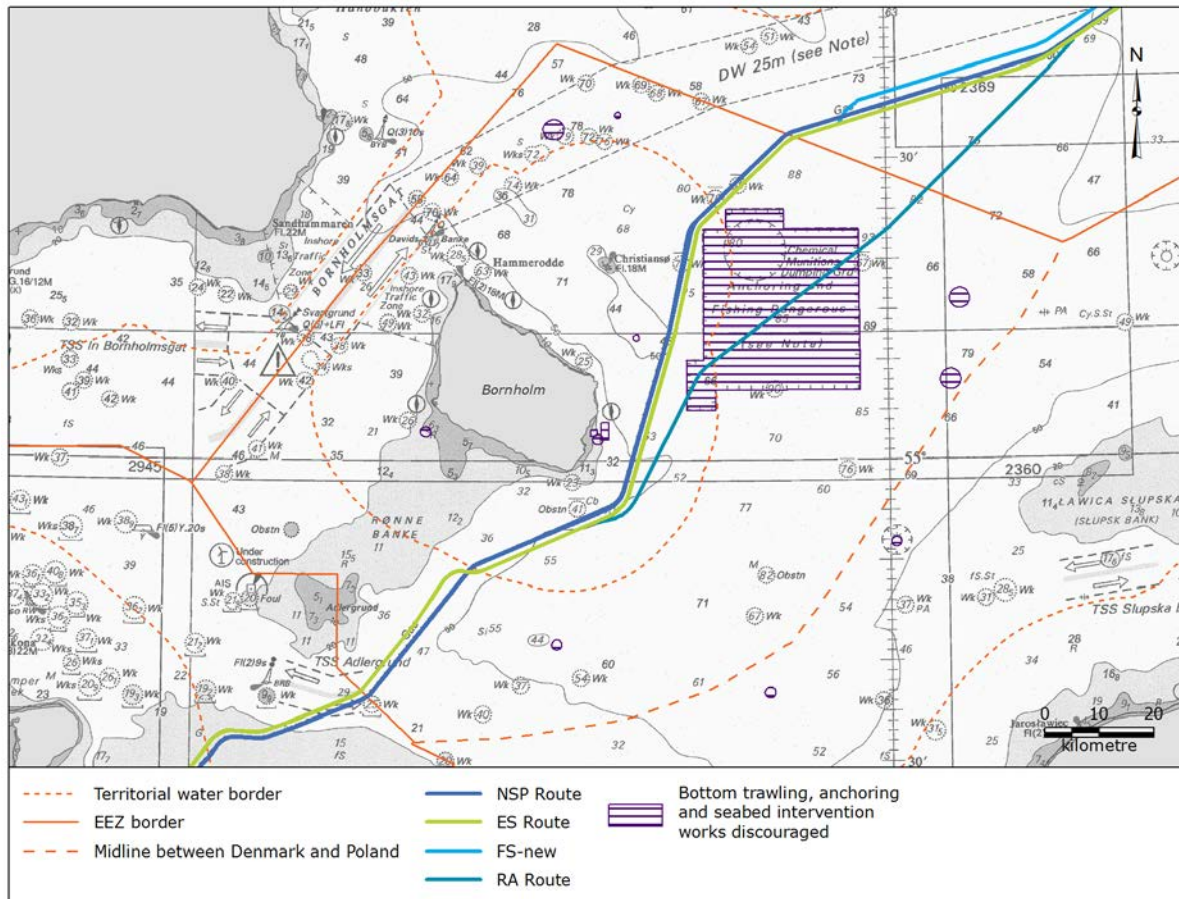


Figure 5-5 NSP2 route alternatives in Danish waters.

#### RA route – alternative route

The RA route does not run parallel to the existing NSP and crosses approximately 40 km of the area that has restrictions on anchoring and fishing due to the potential presence of chemical munitions or CWAs, see also Section 5.4.4. Although shorter, and therefore less expensive to install, it can be assumed that the risk of encountering chemical munitions is high compared with other areas. This would present health and safety concerns during construction and operation of the pipelines and has the potential to impact the marine environment.

#### ES route – east of NSP

The ES route runs parallel to the NSP route for the whole pipeline section inside Danish waters and is located outside the area that has restrictions on anchoring and fishing due to the potential risk of chemical munitions and CWAs. As the ES route runs parallel to the NSP route, this is advantageous in terms of marine spatial planning. The occupied area which could affect other uses of the seabed is thus reduced to a minimum.

Furthermore, it has been assessed in the Danish EIA that impacts, especially on CWAs, fishery and military areas, would be lower for the ES route than for the RA route /26/.

The preferred route in Denmark that has been selected for assessment in the Danish EIA and in Chapter 10 – Assessment of environmental impacts is the ES route.

#### 5.4.6 Alternative routes for NSP2 in German waters

The route planning and landfall assessment in Germany considered a wide area of options, which was narrowed to the selection of a preferred landfall alternative and route as follows (see also Atlas Map AL-01-Espoo and Atlas Map AL-04-Espoo):



### Step 1: Identification of regional landfall target areas

Target areas for the establishment of landfall facilities and connection to the onshore grid were considered at several locations along the German coast between the border of Poland and the Bay of Lübeck. One target area for a suitable landfall is the Pomeranian Bay. This target area conforms to the principle of bundling NSP2 with existing infrastructures (NSP) and the principle of selecting the shortest possible route. All other potential target areas are located further west, i.e. west of Rügen. As a precondition for further investigation of possible landfall areas west of Rügen, there must be a suitable pipeline corridor around the island of Rügen.

### Step 2: Evaluation and comparison of regional pipeline corridors

A pipeline corridor was defined from the border of the German EEZ towards each of the target areas east and west of Rügen. The suitability of both routes was evaluated against a number of technical, environmental and social criteria, which included: geotechnical conditions, bathymetric conditions, areas with potential occurrence of unexploded ordinance, military training areas, wind farms, shipping routes, subsea cables and pipelines, and nature conservation areas. The pipeline corridor option to a landfall west of Rügen (to Rostock and the Bay of Lübeck) has been eliminated owing to technical difficulties and environmental impacts (including large volumes of soft soils that have to be deposited onshore, obstruction of ship traffic along the highly frequented "Kadet-Rinne" during construction, and severe environmental impact resulting from intensive dredging of organic and contaminated soil). The pipeline corridor east of Rügen (in the Pomeranian Bay, i.e. to the east coast of Rügen /Greifwalder Bodden/Usedom) provides for spatial connections with existing or planned offshore infrastructure and was considered further.

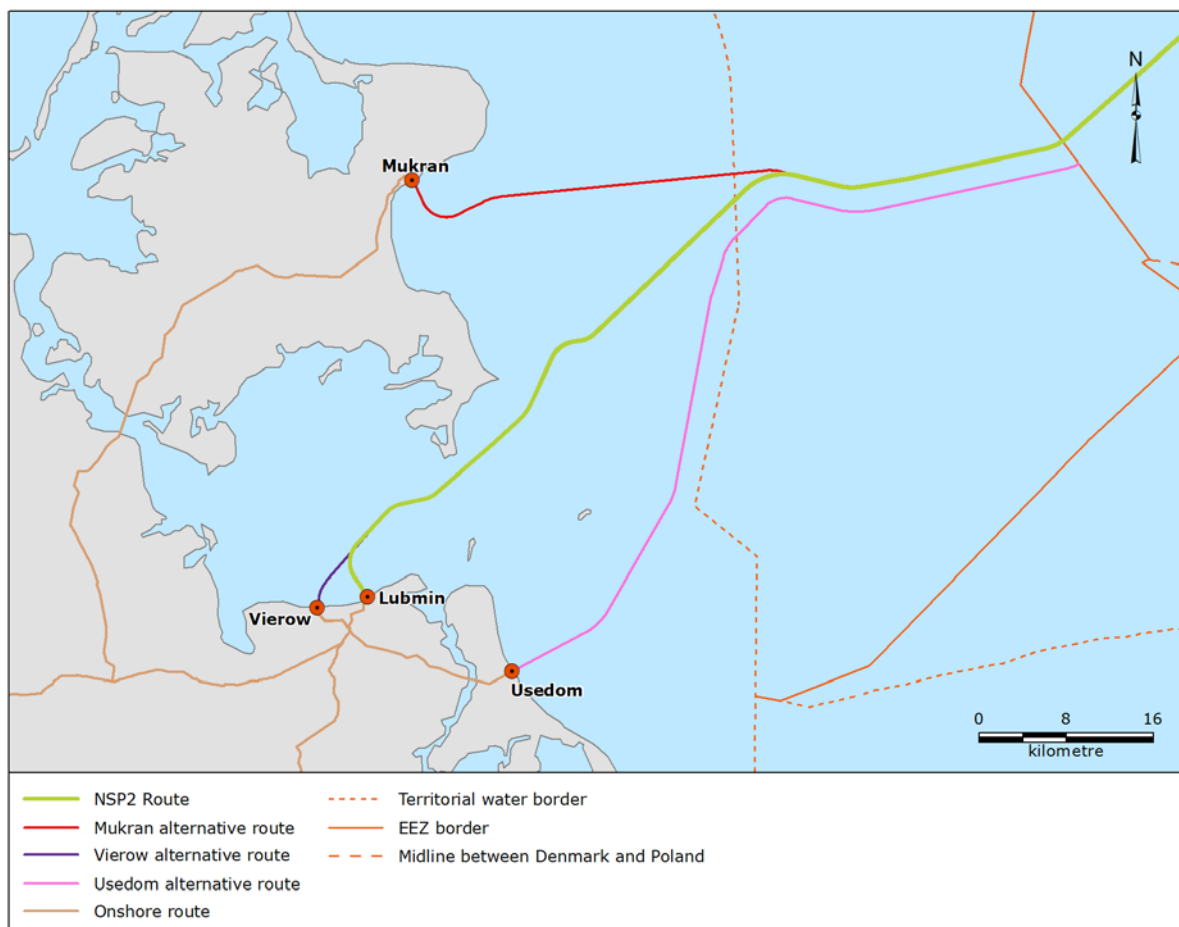


Figure 5-6 NSP2 route alternatives in Pomeranian Bay in Germany.

### Step 3: Identification of landfall options along the coastline of the Pomeranian Bay

Four potential locations for the pipeline landfall were identified in the Pomeranian Bay: Lubmin West, Vierow, Mukran (Rügen) and Usedom (see Figure 5-6 above). These four locations have

been evaluated against technical, environmental and social criteria, which included: the total length of the offshore pipeline route section, the onshore pipeline length between the landfall site and gas transportation grid connection points at either Wusterhausen or Dersekow, the availability of sufficient space for the receiving installations, and proximity to settlements and environmental protection areas. The landfall options at Lubmin West, Vierow and Mukran (Rügen) were assessed as potentially suitable. These landfall options are located at industrial sites. Usedom was eliminated from further consideration because it is located in an area of intense tourism and is near a residential area. Furthermore, the majority of the offshore route runs through a military practice area and crosses sensitive reef areas, and the connection to the gas transportation grid would entail crossing an SPA (Bird Protection Area) and require a link between Usedom and the mainland.

#### **Step 4: Evaluation and comparison of landfall options at Lubmin, Vierow and Mukran**

For the three preferred landfall options, potential routes for the offshore and onshore pipeline sections were further developed. These routes were assessed against criteria that included minimising the offshore pipeline length, bundling with existing linear infrastructure or designated linear corridors as feasible, avoiding environmentally sensitive areas and land uses, and suitable geotechnical and bathymetric conditions.

The Lubmin, Vierow and Mukran options were evaluated with regard to the overall length of their respective offshore and onshore sections and the overall areas affected by the offshore and onshore infrastructure. Additionally crossings of nature protection areas, sensitive habitats and other restricted areas, land uses and infrastructure or inshore waters were taken into account. Evaluation against these criteria led to Mukran being identified as the least favourable of the three options, as it would require a significantly longer onshore route potentially impacting on protected areas and would affect a large number of private properties.

#### **Step 5: Selection of preferred option**

An environmental appraisal was undertaken of the Lubmin and Vierow options. Both options were evaluated against a number of technical, environmental and social criteria. The offshore route to Vierow is comparatively longer, involves greater dredging volumes, crosses soft organic soils and impacts a nearshore reef of high ecological importance that would be difficult to restore. Unlike the Vierow landfall, the Lubmin landfall is located in an existing industrial site where a direct connection to the existing grid can be achieved. Thus routing to Vierow entails more technical effort and has comparatively greater impacts on environmental receptors. Therefore the pipeline route via Lubmin has been selected as the preferred alternative.

## **5.5 Design and construction method alternatives**

Routing to avoid environmentally sensitive areas and features that include cultural heritage, munitions and infrastructure is a primary impact avoidance strategy as discussed above.

In addition to routing aspects, Nord Stream 2 AG has considered the following mitigation measures in the planning and design process:

- Alternative construction methods for the shore crossings in Russia and Germany;
- Alternative approaches to pre-commissioning;
- Selection of the pipe-laying vessel.

These topics are addressed below.

### **5.5.1 Shore crossings in Russia and Germany**

The region in which a pipeline transitions from offshore to onshore is called a shore crossing. In shallow nearshore areas, marine pipelines require protection from wave action and ice scoring and are normally buried in a trench created by dredging prior to pipe-laying. The wet pipeline continues in a trench through a transitional zone incorporating the beach and dunes. Typically, a

temporary cofferdam is used to maintain an open trench across the dunes, beach and shallow water during the installation period. This approach may be described as “conventional open cut”.

#### 5.5.1.1 Germany

In Germany, the shore crossing point is characterised by a 200 m wide belt of sensitive coastal forest. A conventional open cut construction methodology through the forest belt would lead to a permanent loss of habitat and changes in landscape character, as the forest would not be reinstated due to the need to protect the pipelines from tree roots. Nord Stream 2 AG has explored the alternative of twin 700 m long micro-tunnels, with entry pits located within the onshore gas receiving facility and exiting in shallow waters.

The micro-tunnel shore crossing method, which has been assessed to be technically feasible, has been selected as the preferred construction method and is described in Chapter 6 – Project description. The advantages of micro-tunnelling as opposed to open cut pipeline installation in Germany include:

- Eliminating temporary environmental disturbance along the pipeline routes during construction with impacts limited to the tunnel portals;
- Avoiding the need for reinstatement of forest habitat in the temporary working corridor;
- Eliminating the need for a cofferdam for the shore crossing and associated construction impacts at the beach–sea interface;
- Avoiding direct impacts on tourism use of the beach area, as disturbance is confined to construction of the exit portal which is both small scale and of short duration;
- Avoiding permanent disturbance of habitat for the onshore pipeline section, as the tunnel would be beneath the root base, allowing for trees to be left in place without risk to the buried pipelines.

#### 5.5.1.2 Russia

In Russia, the preferred landfall location is Narva Bay, subject to final approval by the Russian Federaion authorities.

A wide-ranging series of trenching options were initially considered including various trenchless techniques. A shortlist of four technical options is being investigated in more detail by a team comprising environmental experts and engineers. For each option, vulnerability of the habitats that would be affected by the onshore section of the pipeline system and constructability constraints are being assessed. The habitats are identified in the figure below.



A = nearshore area. B = coastal dune. C = forest. D = secondary forest. E = relict dune. F = swamp. G = modified habitat.

**Figure 5-7 Habitat types along the pipeline onshore section in Russia.**

The base case method is for conventional open cut construction with an approximately 3,800 m open cut with 85 m wide right of way (ROW) from the pig trap area (PTA) to the shoreline. As an alternative to this base case, an optimisation is being considered. The optimised open cut alternative maintains an 85 m wide ROW through habitats G and F to the relict dune formation (habitat E) and then the ROW narrows to 56 m to traverse through the secondary forest and

forest (habitats D and C). Both open cut solutions cross the shoreline via a 300 to 500 m long cofferdam, which transitions into a trench extending some 3'300 m offshore.

Various trenchless options that are also being considered as an alternative to the base case method are:

- **Option 2:** open cut from PTA to east of dune (2 km) with a pipeline corridor width of 85 m. 1.5 km micro-tunnel through dune and forest shore crossing with cofferdam and nearshore trench.).
- **Option 4a:** open cut from PTA to west of dune (2.3 km) and pipeline corridor width of 85 m. 2.0 km micro-tunnel through forest and tunnel exit pit 500 m from shore dredged flotation channel for pipe-laying vessel.
- **Option 4e:** open cut from PTA to east of dune (2 km) and pipeline corridor width 85 m. 2.4 km micro-tunnel through dune and forest and tunnel exit pit 500 m from shore. Dredged flotation channel for pipe-laying vessel.

While it has been possible to select a micro-tunnel crossing for the German landfall, the significantly longer trenchless section involved at the Russian landfall poses a substantially greater risk with respect to constructability. The base case conventional open cut construction method is being evaluated by the NSP2 engineers and environmental experts in parallel with the trenchless alternatives. A decision on the construction method will be taken later in the year once engineering feasibility and constructability studies are complete.

#### 5.5.2 Pre-commissioning concept (offshore pipeline section)

Pre-commissioning activities are undertaken to confirm the integrity of the pipelines and ensure that they are airtight and that they are ready for safe operational use with natural gas.

##### **Wet pre-commissioning (for offshore pipeline section)**

Hydrostatic tests on pipelines are normally undertaken to test for strength and leaks. The test involves the filling of the pipe system with a liquid, usually water, and the pressurisation of the pipeline system to the specified test pressure. This approach is a standard approach to confirming pipeline integrity and is referred to as 'wet' pre-commissioning. For wet pre-commissioning, the pipeline would be tested as three separate sections which would be subsequently joined (utilising hyperbaric welds) on the seabed at locations in Finland and Sweden to create a continuous pipeline.

As an alternative to the wet pre-commissioning concept, Nord Stream 2 AG is considering a 'dry' pre-commissioning approach as described below.

##### **Dry pre-commissioning (for offshore pipeline section)**

The offshore pipelines will not be pressure tested with water. Cleaning and gauging will be performed using dry air as the pigging medium. An internal inspection will be carried out by intelligent pigging, also using dried air as the pigging medium. In addition, leak detection will be carried out through an external survey using a remotely operated vehicle (ROV). For dry pre-commissioning, the required air will be dried and compressed at the German PTA by means of a temporary air compression facility, and subsequently all pigs will be launched from Germany towards Russia. Thus the pipelines will not be filled with water and, consequently, no dewatering and subsequent dedicated drying will be required.

The comparative environmental aspects of the dry pre-commissioning method compared with the wet pre-commissioning method are:

- In the case of conventional pressure testing, seawater would be used to fill and pressurise the pipelines. Not performing a pressure test would avoid the filling of the pipelines with water (approximately 1,300,000 m<sup>3</sup> for each pipeline). Seawater contains dissolved

oxygen (DO) and bacteria, including sulphate reducing bacteria (SRB). Both DO and SRB, if not controlled, have the potential to cause corrosion and compromise the integrity of the pipeline system. Water treatment additives would be required to mitigate this risk. By applying dry pre-commissioning, the potential risk of corrosion would be eliminated. Since there would be no discharge of oxygen-depleted and treated water, potential impacts associated with the discharge of test water would be avoided.

- Another significant benefit of the dry pre-commissioning option is that it allows for the pipelines to be installed continuously and hence eliminates the need for subsea test heads and subsequent subsea (hyperbaric welds) tie-ins. Only above-water tie-ins to connect the shallow water sections in Germany and Russia would be required. The opportunity to avoid subsea tie-ins eliminates a critical operation from the construction sequence. Consequent environmental impacts are also eliminated, as the intervention works necessary to construct large rock berms otherwise required to prepare the subsea tie-in sites would not be required.
- In the case of dry pre-commissioning, a survey type vessel would be operating along the pipeline route for one month (for each pipeline). This results in significantly reduced emissions produced offshore compared with wet pre-commissioning. Wet pre-commissioning would require a construction type vessel with a pumping spread on board to operate at the subsea tie-in locations in Finland and Sweden for approximately six weeks on each line. Additionally, a dive support vessel would be required to operate at these locations for approximately four weeks on each pipeline during the hyperbaric welding process that would be required to create a continuous pipeline.
- For the dry concept, there are marginally higher emissions in Germany associated with the operation of compressors.

It should be noted that the onshore pipeline sections and PTAs are subject to conventional hydro-testing. This is addressed in the following chapter.

### 5.5.3 Selection of the pipe-laying vessel

Pipeline installation for various sections of the pipeline route will be undertaken with two different types of pipe-laying vessel: an anchored lay vessel and a DP (dynamically positioned) lay vessel. The position of the anchored lay vessel is controlled by a mooring system that consists of up to 12 anchors, anchor wires and winches. DP vessels utilise thrusters to maintain their position, which avoids the need for anchors and anchor-handling tugs. The selection of vessel type will depend upon the following factors:

- Water depth (DP vessels are limited to deeper waters);
- Presence of munitions on the seabed;
- Presence of cultural heritage;
- Presence of shipping lanes.

DP vessels will be selected for, e.g., areas in the Gulf of Finland, where there is a high concentration of munitions from World War I and World War II and where there is a risk of anchors coming into contact with munitions. Utilisation of a DP vessel in these areas avoids the munitions clearance activities required for a pipeline anchor corridor. Where NSP2 runs close to other Baltic Sea pipelines, the selection of a DP lay vessel can reduce the risk of contact with existing infrastructure. Conversely, in shallow waters, anchored lay vessels will be utilised as, amongst other things, their use avoids the potential scouring of the seabed associated with DP thrusters.

The final selection of the pipe-laying vessel type used in particular areas will depend on technical and environmental considerations.

## 5.6 Zero alternative

In the event that NSP2 is not constructed and operated in the Baltic Sea from Russia to Germany, non-implementation would mean that there will be neither adverse nor positive impacts from the project offshore, in the landfall areas or in the onshore ancillary areas. The impacts of the zero alternative therefore can be confined to be the natural changes from the baseline. As the construction of NSP2 is planned to last approximately two years, this time frame is used to define the period for natural changes in the environment from the baseline. During this relatively short period of time no essential natural changes are expected to occur in the physical and chemical environment in the Baltic Sea. Therefore no essential changes of the biological environment can be foreseen.

Initially it should be emphasised that NSP2 has been designed to avoid or minimise environmental and socio-economic impacts offshore and on land (landfall areas, ancillary areas). Short-term and local environmental and socio-economic impacts, however, can be expected along the route during the construction phase. Mitigation measures will be applied, and the impacts are assessed to be minor and generally limited to the pipeline corridor in sea and on land. The experience from the NSP project and the extensive monitoring carried out for NSP supports this assessment. The zero alternative, however, will avoid these temporary, local and minor adverse impacts and only natural changes are foreseen. In this context, it should be noted that if the NSP2 project is implemented, positive impacts will occur regarding certain socio-economic aspects. These positive socio-economic consequences, e.g. increase of employment and other revenues, will not occur if the project is not to be realised.

## 6. PROJECT DESCRIPTION

### 6.1 General

NSP2 involves the construction and operation of twin pipelines through the Baltic Sea. The pipeline system will have the capacity to deliver 55 bcm of natural gas per year directly to the EU market in an environmentally safe and reliable way for at least 50 years. The pipeline route will stretch for some 1,200 km from the Baltic Sea coast in the Leningrad region of the Russian Federation to a landfall near Greifswald in Germany.

Each of the pipelines will have a target capacity of 27.5 bcm per year and will require approximately 100,000, 24 tonne concrete-weight-coated steel pipes to be laid on the seabed. The pipelines will have an internal diameter of 1,153 mm (48 inches). Pipe-laying will be carried out by specialised vessels handling the entire welding, quality control and pipe-laying process.

The construction of the pipelines is planned to be complete by the end of 2019. The system will have an operating life of at least 50 years.

In Chapter 5 - Alternatives, the NSP2 planning and design philosophy was outlined and the application of the principles of the mitigation hierarchy with regard to the landfall and route selection in the various transit countries was described. The purpose of this chapter is to describe the overall technical concept for the project and to detail the technical components and activities that have been assessed in the national EIAs. The intention is to provide an overview of the key technical elements of the project to orientate the reader and to provide more detail on aspects that will be addressed in the assessment of environmental impacts in later chapters.

NSP2 is phased as follows:

- **Planning and design phase**, during which survey activities are undertaken;
- **Construction phase for onshore**, nearshore and offshore areas;
- **Preparation and testing phase** involving pre-commissioning activities;
- **Commissioning phase**, during which hydrocarbons are introduced into the pipelines;
- **Operation phase** for a design life of 50 years;
- **Decommissioning** at the end of the operating life of the pipelines.

The subsequent sections that follow in this chapter address the following topics:

- NSP2 scope and routing;
- Survey and engineering design;
- Munitions clearance;
- Installation logistics concept;
- Construction;
- Pre-commissioning and commissioning;
- Operation;
- Decommissioning;
- Schedule.

### 6.2 NSP2 scope and routing

#### 6.2.1 Project scope

NSP2 comprises two, approximately 1,200 km, 48" diameter subsea pipelines and onshore facilities at either end, Figure 6-1.

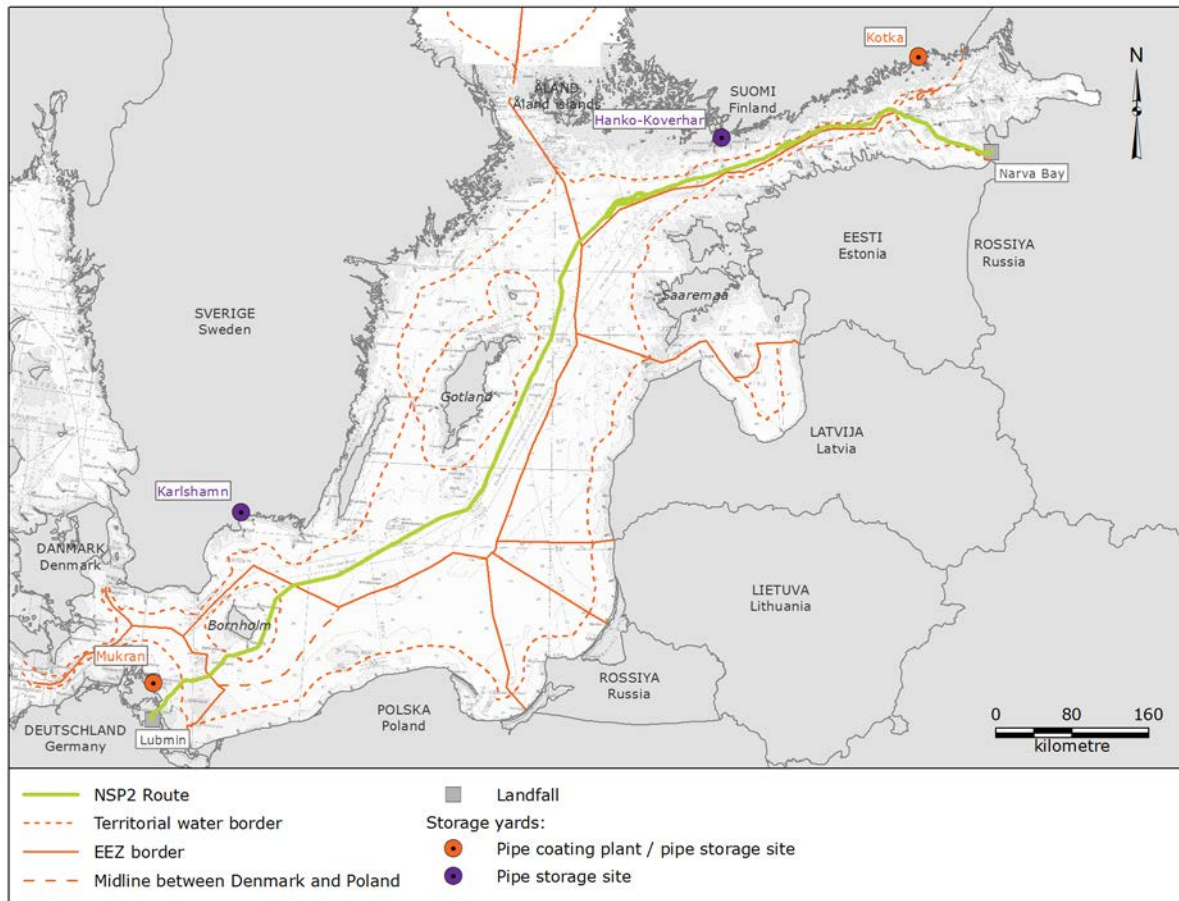


Figure 6-1 NSP2 route and storage yards.

The NSP2 onshore facilities in Russia comprise a buried dry pipeline section of approximately 4 km to an above-ground facility, the PTA, comprising valves, monitoring and routine maintenance equipment. The PTA is supplied pressurised gas from an upstream pipeline and compressor station.

NSP2 onshore facilities in Germany comprise a buried pipeline section to an above-ground PTA that is located adjacent to a gas receiving terminal and downstream pipeline system.

NSP2 project activities and facilities are categorised as follows:

- **Core components**, comprising facilities and activities that are under direct contractual control of the NSP2 project. These are new facilities and activities that are assessed in the EIAs with respect to both construction- and operations-related impacts.
- **Ancillary components**, comprising activities in third-party facilities that are used exclusively for NSP2 project activities. These facilities are already in existence, are owned by third parties and are not part of the core NSP2 project. Therefore they are assessed with respect to operational impacts that occur during the construction phase of NSP2.

Upstream and downstream infrastructure, comprising activities and facilities outside of the NSP2 project, include the compressor station and feeder lines in Russia and the gas receiving terminal in Germany. Third-party operators will construct, own and operate the upstream infrastructure in Russia (Gazprom) and the downstream infrastructure in Germany (Gascade Gastransport, OPAL Gastransport and EUGAL Gastransport).

Upstream and downstream facilities will be permitted through separate processes and associated impacts will be assessed within these separate permitting processes.



The facilities described above are listed in Table 6-1 below.

**Table 6-1 NSP2 project facilities.**

Category	Elements
Core components	<ul style="list-style-type: none"> <li>• Twin 48" subsea pipelines extending some 1,200 km across the Baltic Sea</li> <li>• Onshore facilities in Russia comprising an approximately 4 km pipeline section and a PTA and site offices covering an area of approximately 6.1 ha</li> <li>• Onshore facilities in Germany comprising an approximately 400 m pipeline section including twin micro-tunnels and a PTA covering an area of approximately 5.6 ha</li> </ul>
Ancillary components	<ul style="list-style-type: none"> <li>• Coating plants in Kotka, Finland, and Mukran, Germany</li> <li>• Pipe storage yard at Karlshamn, Sweden</li> <li>• Pipe storage yard at Kotka and Hanko, Finland</li> <li>• Pipe storage yard at Mukran, Germany</li> <li>• Interim storage of rock in Kotka, Finland</li> </ul>

**NSP2 project activities that give rise to potential impacts are listed in Table 6-2 and Table 6-3 and are the focus of the impact assessment sections in subsequent chapters.**

**Table 6-2 NSP2 project core activities.**

Country	Core activities
Russia	<ul style="list-style-type: none"> <li>• Construction activities including: <ul style="list-style-type: none"> <li>- Munitions clearance;</li> <li>- Pipe-laying (offshore and onshore);</li> <li>- Seabed intervention works (dredging (pre-lay trenching) and backfilling, rock placement);</li> <li>- Infrastructure cross-over installations;</li> <li>- PTA implementation;</li> <li>- Transportation of materials and equipment to and from construction sites.</li> </ul> </li> <li>• Pre-commissioning and commissioning activities</li> <li>• Worker accommodation and temporary offices</li> <li>• Operation</li> </ul>
Finland	<ul style="list-style-type: none"> <li>• Construction activities including: <ul style="list-style-type: none"> <li>- Munitions clearance;</li> <li>- Pipe-laying (offshore);</li> <li>- Seabed intervention works (rock placement);</li> <li>- Infrastructure cross-over installations;</li> <li>- Marine transportation of personnel, materials and equipment.</li> </ul> </li> <li>• Operation</li> </ul>
Sweden	<ul style="list-style-type: none"> <li>• Construction activities including: <ul style="list-style-type: none"> <li>- Pipe-laying (offshore);</li> <li>- Seabed intervention works (trenching (post-lay trenching) and rock placement);</li> <li>- Infrastructure cross-over installations;</li> <li>- Marine transportation of personnel, materials and equipment.</li> </ul> </li> <li>• Operation</li> </ul>
Denmark	<ul style="list-style-type: none"> <li>• Construction activities including: <ul style="list-style-type: none"> <li>- Pipe-laying (offshore);</li> <li>- Seabed intervention works (trenching (post-lay trenching) and rock placement);</li> <li>- Infrastructure cross-over installations;</li> <li>- Marine transportation of personnel, materials and equipment.</li> </ul> </li> <li>• Operation</li> </ul>

Germany	<ul style="list-style-type: none"> <li>• Construction activities including: <ul style="list-style-type: none"> <li>- Munitions clearance (removal but no <i>in situ</i> detonation);</li> <li>- Pipe-laying (offshore and onshore);</li> <li>- Seabed intervention works (dredging (pre-lay trenching) and backfilling, rock placement);</li> <li>- Temporary marine soil storage and onshore spoil storage;</li> <li>- Infrastructure cross-over installations;</li> <li>- Tunnels;</li> <li>- PTA implementation;</li> <li>- Transportation of materials and equipment to and from construction sites.</li> </ul> </li> <li>• Pre-commissioning and commissioning activities</li> <li>• Worker accommodation and temporary offices</li> <li>• Operation</li> </ul>
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Project ancillary activities will be undertaken in existing third-party facilities where operations-related activities for the NSP2 construction phase will be assessed.

The NSP2 project ancillary activities and the locations of activities are provided in Table 6-3.

**Table 6-3 NSP2 project ancillary activities.**

Country	Ancillary activities
Russia	<ul style="list-style-type: none"> <li>• None – all assessed as NSP2 core activities</li> </ul>
Finland	<ul style="list-style-type: none"> <li>• Operation of CWC plant at Mussalo Harbour, Kotka</li> <li>• Pipe storage yards at Mussalo Harbour and Hanko Koverhar</li> <li>• Shipments from CWC plant to pipe storage yards</li> <li>• Rock quarrying and transport to Mussalo Harbour</li> <li>• Interim storage of rock in Mussalo Harbour, Kotka</li> </ul>
Sweden	<ul style="list-style-type: none"> <li>• Operation of pipe storage yard at Karlshamn</li> <li>• Potential storage of rock at Okarshamn and associated transport activities</li> <li>• Potential operation of quarries in Sweden</li> </ul>
Denmark	<ul style="list-style-type: none"> <li>• None – all assessed as NSP2 core activities</li> </ul>
Germany	<ul style="list-style-type: none"> <li>• Operation of CWC plant at Mukran</li> <li>• Pipe storage yard at Mukran</li> <li>• Transport (import) of gravel backfill material and rock material</li> </ul>

## 6.2.2 Routing details

While routing through the Baltic Sea, the pipelines are independent from the existing NSP and run parallel to NSP for a substantial distance (with a minimum separation distance of 350 m or more for the deep water sections).

The pipeline route crosses the TW of Russia, Denmark and Germany and runs within the EEZs of Russia, Finland, Sweden, Denmark and Germany.

An overview of the route is shown on Figure 6-1, with more detail provided on Atlas Maps PR-01 - 03 and in Chapter 5 - Alternatives.

### 6.2.2.1 Russian landfall

Land termination end (LTE) in Narva Bay area is the preferred location for the pipeline landfall in Russia, subject to final approval by the Russian Federation authorities. The PTA is located approximately 3,8 km inland from the LTE on fallow agricultural land. The 3,8 km dry section

crosses the Kurgalksy Nature Reserve. The nearshore area of the Narva Bay option is characterised by a gentle seabed profile.

For the shore crossing and onshore section, the base case method as described in Section 5.5 is for a cofferdam and conventional open cut construction with the option of a reduction in working corridor width for habitat sections that vary in type and environmental sensitivity.

#### 6.2.2.2 Russian offshore sector

The Russian offshore section extends from the landfall at Narva Bay into the deeper waters of the Gulf of Finland and passes between the Malyi Tyuters and Bolshoi Tyuters islands. The route runs approximately from south-east to north-west.

Key characteristics of the Russian offshore sector include:

- Offshore pipe-laying at a water depth of 24-70 m and an overall length of approximately 114 km;
- Rock placement for pre- and post-lay freespan corrections, crossings of infrastructure, in-service buckling mitigation and seabed preparation for hyperbaric tie-in (total volume of rock placement of up to 900,000 m<sup>3</sup>);
- Presence of munitions with clearance required if rerouting is not feasible.

The route is characterised by generally low regional gradient for the first approximately 40 km from the shoreline, with locally extensive and high relief rock/glacial till outcrops in the remaining section.

#### 6.2.2.3 Finnish offshore sector

Key characteristics of the Finnish sector include:

- Offshore pipe-laying at a water depth of 33-184 m and an overall length of approximately 378 km;
- Rock placement for pre- and post-lay freespan corrections, crossings of infrastructure, in-service buckling mitigation and seabed preparation for hyperbaric tie-in with a maximum total volume of rock of 1,950,000 m<sup>3</sup>;
- Presence of munitions with clearance required if rerouting is not feasible.

Immediately after NSP2 leaves the Russian sector and enters the Finnish sector, it crosses the existing NSP. The route then turns west and runs through the Gulf of Finland in an approximately north-east to south-west direction, remaining to the north of NSP and to the south of the limit of Finnish TW within the Finnish EEZ.

The Finnish section of the route is characterised by highly variable conditions: there are areas of very smooth seabed with very soft clay sediment, alternating with areas of rough seabed comprised of coarse sediment, sand and outcropping bedrock.

#### 6.2.2.4 Swedish offshore sector

Key characteristics of the Swedish sector include:

- Offshore pipe-laying at a water depth of 30-210 m and an overall length of approximately 512 km;
- Rock placement for freespan corrections, pipeline crossings and cable crossings with a total rock volume of up to 900,000 m<sup>3</sup>;
- Post-lay trenching to bury the pipeline with a total trenched length of up to approximately 72 km for each pipeline;
- Munitions; clearance is not planned and rerouting will be undertaken as required (based on munitions survey results).

At the start of the Swedish sector the route turns south to follow the Baltic Sea Proper alignment of NSP in an approximately north to south direction. In the northernmost part of the Swedish sector, NSP2 runs to the north-west of the existing NSP. Approximately 50 km after entering the Swedish EEZ, NSP2 crosses NSP and then continues running broadly in parallel to NSP but remaining to the south-east.

The Swedish section of the route presents different seabed conditions. Sedimentary bedrock forms the geological basement in the central Baltic Sea. However, this bedrock basement is rarely detected along the Swedish section as there are long areas of smooth seabed comprised of very soft clay interchanged with smaller areas where the surface is comprised of coarse material, predominantly sand, gravel and glacial till. The northernmost and southernmost parts of this section are dominated by very soft sediment on the surface, in combination with high undulating seabed in the northernmost part and flat seabed in the southernmost part, while coarse sediment dominates south-east of Gotland Island.

In the northernmost part of the Swedish sector, the route encounters the maximum water depth of the NSP2 project, approximately 210 m. In the southernmost part of the Swedish sector, the route encounters the minimum water depth of the NSP2 project (excluding landfalls), approximately 30 m.

#### 6.2.2.5 Danish offshore sector

Key characteristics of the Danish sector include:

- Offshore pipe-laying at an approximate water depth of 28-95 m and an overall length of approximately 139 km;
- Rock placement for the NSP crossing with a total rock volume of up to 40,000 m<sup>3</sup>;
- Rock placement for potential above water tie-in of up to 20,000 m<sup>3</sup>;
- Trenching with an estimated total maximum length of 20.5 km for each pipeline;
- No conventional munitions present; objects assessed to be chemical munitions to be left undisturbed and safety zones established around identified objects.

In the Danish section, the proposed NSP2 route runs south of NSP, following its same S-shaped route to avoid crossing the area where anchoring and trawling are discouraged (due to the presence of CWAs) and remaining to the east and south of Bornholm.

South-west of Bornholm, the NSP2 route crosses to the west of NSP and continues to the German landfall while remaining to the north of NSP.

The Danish section of the route is mainly characterised by fine sediments, except close to Bornholm where there is the presence of coarse sediments, possibly rock.

#### 6.2.2.6 German offshore sector

The NSP2 route enters the German EEZ south-east of Adlergrund and runs in a south-south-west direction towards the German continental shelf. The route continues in a south-west direction up to the area of Landtief Tonne A. The nominal centre distance between the two pipelines in the northern part of the German section is approximately 55 m. Because of the seabed conditions, and in order to minimise the seabed intervention works, the pipelines are not routed strictly parallel in a number of sections. This may result in distances between the pipelines of up to 75 m.

In the southern part of the German section, both pipelines are laid in a common trench with a nominal centre distance of 6 m.

Between the area of Landtief Tonne A and the Boddenrandschwelle, the route runs parallel to the shipping lane Landtief. Near the Boddenrandschwelle, a large-diameter bend is introduced towards west. After another redirection, the pipelines run in a south-west direction towards the landfall. The landfall is located west of Lubmin Harbour. The length of the route in the German sector is approximately 83 km.

Key characteristics of the German offshore section include:

- Offshore pipe-laying at a water depth of 18-28 m and an overall length of approximately 55 km;
- Shallow-water pipe-laying up to water depth of 17 m and an overall length of approximately 28 km;
- Nearshore dredging and backfilling along a linear section of approximately 49 km;
- Rock placement volumes for above water tie-in, if required, of approximately 14,000 m<sup>3</sup>;
- Shore pull through twin micro-tunnels.

At the Lubmin 2 landfall, the route crosses the coast in a straight line from north-west to south-east and terminates at the PTA within the confines of the onshore receiving terminal.

#### 6.2.2.7 German landfall

The industrial area Lubmin in the vicinity of the former nuclear power plant Greifswald has been identified as the preferred location for the German landfall and for the construction of the PTA and the gas receiving station (GRS).

The shore crossing will be carried out by installation of two micro-tunnels. Each pipeline will have one dedicated micro-tunnel starting onshore, at about 300 m from the shoreline. The micro-tunnel exit points will be located in a minimum of 2 m water depth, approximately 400 m from the shoreline. The micro-tunnels will run underneath railway track, road, noise protection embankment, forest belt, dunes area, beach and shallow water areas in front of the beach.

The overall length of each micro-tunnel will be approximately 700 m.

### 6.3 Survey

The engineering design of the pipelines, including the detailed routing, and the environmental and social assessment of the potential impacts of the project rely on a large number of onshore and offshore surveys that have been carried out and will be carried out throughout the design and operations phases of the project.

Environmental, social and cultural heritage surveys are described in detail in the environmental and social reports that have been prepared to support the permitting and financing processes. These surveys are addressed in subsequent chapters of this document.

The engineering offshore survey programme gathered data on seabed conditions, topography, bathymetry and objects such as wrecks, boulders, munitions, etc. and included the following activities:

- **Reconnaissance survey.** Providing information on the preliminary pipeline route, including geological and anthropogenic features. The surveys covered an approximately 1.5 km wide corridor, and various techniques were deployed including side-scan sonar, sub-bottom profilers, swath bathymetry and magnetometers.
- **Geotechnical survey.** Cone penetrometer and vibrocorer methods provided a detailed understanding of the geological conditions and engineering soil strengths along the planned route, which assisted in optimising the pipeline route and detailed design including the required seabed intervention works to ensure long-term integrity of the pipeline system.

- **Detailed geophysical survey.** A 130 m wide corridor was surveyed along each pipeline route utilising side-scan sonar, sub-bottom profilers, swathe bathymetry and magnetometers. Detailed geophysical survey data assisted in more accurately defining the routes after the preliminary engineering carried out on the basis of the reconnaissance survey. This enabled all significant obstructions, geo-hazards and other potential constraints to be detected and detailed profiles to be acquired along the centre line of each planned pipeline.
- **Munitions screening survey.** A munitions screening (detailed gradiometer) survey is carried out to identify unexploded ordnance (UXO) or CWAs that could endanger the pipelines or personnel during the installation and operating life of the pipeline system. This is accompanied by visual surveys and analysis as required.
- **Anchor corridor survey.** For sections where the pipelines may be installed using an anchored lay vessel, a survey will be undertaken to ensure that there is a free anchoring corridor for the lay vessel. The survey corridor will typically be between 800 m and 1 km, on either side of the pipeline system, depending on water depth and the selected anchored lay vessel. Potential munitions, geological features, cultural heritage objects and environmental constraints that may interfere with the anchoring pattern of the pipeline installation vessels will be identified and mapped. Visual surveys of identified cultural heritage objects will be undertaken as required.
- **Pipe-laying survey.** This will be performed just prior to the commencement of construction to confirm the previous geophysical survey and to ensure that no new obstacles are found on the seabed. ROV bathymetric and visual inspection surveys will be undertaken for theoretical pipeline touchdown points on the seabed.
- **Construction support survey.** A full survey spread equipped with multibeam sounders, side-scan sonar, sub-bottom profilers, pipe tracker, magnetometers and ROVs will be on standby during construction to perform touchdown monitoring and ad hoc survey activities as required.
- **As-laid survey.** As-laid surveys utilising bathymetry and side-scan sonar measurements and visual inspection by ROV will be performed once the pipelines have been laid on the seabed to establish the as-laid position and condition of the pipelines.
- **As-built survey.** As-built surveys will be conducted as a final record of pipeline installation after all pipeline construction activities are completed to confirm that the pipelines have been installed correctly as designed, including trench depths and the extent of backfill and rock placement.
- **Onshore surveys.** Topographical surveys (LIDAR) have been undertaken at the two landfall locations of the pipeline system. Activities include geotechnical investigations to determine soil conditions, groundwater levels and soil permeability with the purpose of establishing foundation requirements for civil structures, dewatering requirements for trenching activities, trench and micro-tunnel constructability and suitability of the soil for backfilling the trench. Geophysical investigations are also being undertaken to determine soil stratigraphy and the potential presence of UXO or cultural heritage objects.

## 6.4 Engineering design

The design of NSP2 largely benefits from previous experience from the design and construction of the existing NSP, which has allowed for efficient planning through the use of first-hand knowledge and consideration of lessons learned.

The development of the technical design was and continues to be an ongoing and iterative process in which input from investigations of the route corridors, basic engineering, stakeholder consultation, environmental and social impact assessments and regulatory review are continuously used to optimise the design. Therefore minor changes to the description below may be made during the detailed design period. However, these modifications will not change the environmental performance, i.e. result in new environmental impacts or impacts that are worse than those set out in this document.

### 6.4.1 Technical specifications

The pipelines will be divided into three pressure segments.

**Table 6-4 Design operating conditions and technical specifications of NSP2.**

Property	Value (range)
Throughput	55 bcm/y (27.5 bcm per annum per pipeline)
Gas	dry, sweet natural gas
Design pressure	KP 0 – KP 300: 220 bar KP 300 – KP 675: 200 bar KP 675 – KP 1,225: 177.5 bar
Design temperature	+40°C max
Operating temperature	-10°C min
Pipeline inner diameter	1,153 mm
Pipeline wall thickness	34.6 mm, 30.9 mm and 26.8 mm (depending on the pressure range)
Buckle arrestor thickness	41.0 mm and 34.6 mm
Internal flow coating	Low solvent epoxy, roughness $R_z \leq 5 \mu\text{m}$ , 90 $\mu\text{m}$ minimum thickness
External corrosion coating	Three-layer polyethylene of 4.2 mm minimum thickness
Concrete coating thickness and density	60 mm to 110 mm, 2,250 kg/m <sup>3</sup> to 3,200 kg/m <sup>3</sup>
Corrosion protection anodes	Zinc-based anodes in low-salinity areas, aluminium anodes in other areas

To prevent damage to the pipelines as a result of buckling during installation when the pipelines are empty, buckle arrestors (pipe reinforcement) will be installed at specific intervals in susceptible areas. Buckle arrestors are full-length pipe joints with over-thickness that are installed in deep water sections with typically 927 m separation. The buckle arrestors are made of the same steel alloy as the pipelines and are machined at each end down to the wall thickness of the adjacent pipes to allow welding offshore. The material requirements and properties for the buckle arrestors are generally the same as for the line pipe.

#### Standards, verification and certification

The pipelines will be designed, constructed and operated in accordance and in compliance with the international offshore standard DNV OS-F101, Submarine Pipeline Systems, along with its associated recommended practices, issued by DNV GL.

Nord Stream 2 AG has appointed DNV GL as an independent third-party expert to confirm that the pipeline system, from pig trap to pig trap, has been designed, fabricated, installed and pre-commissioned in accordance with the applicable technical, quality and safety requirements. When DNV GL has completed third-party verification of all project phases and the pipeline system has been successfully pre-commissioned, a DNV GL certificate of conformity will be issued for each of the NSP2 pipelines.

In addition to the above, the Russian and German authorities, within the respective territorial areas of competence, will independently verify the integrity and safety of the pipelines.

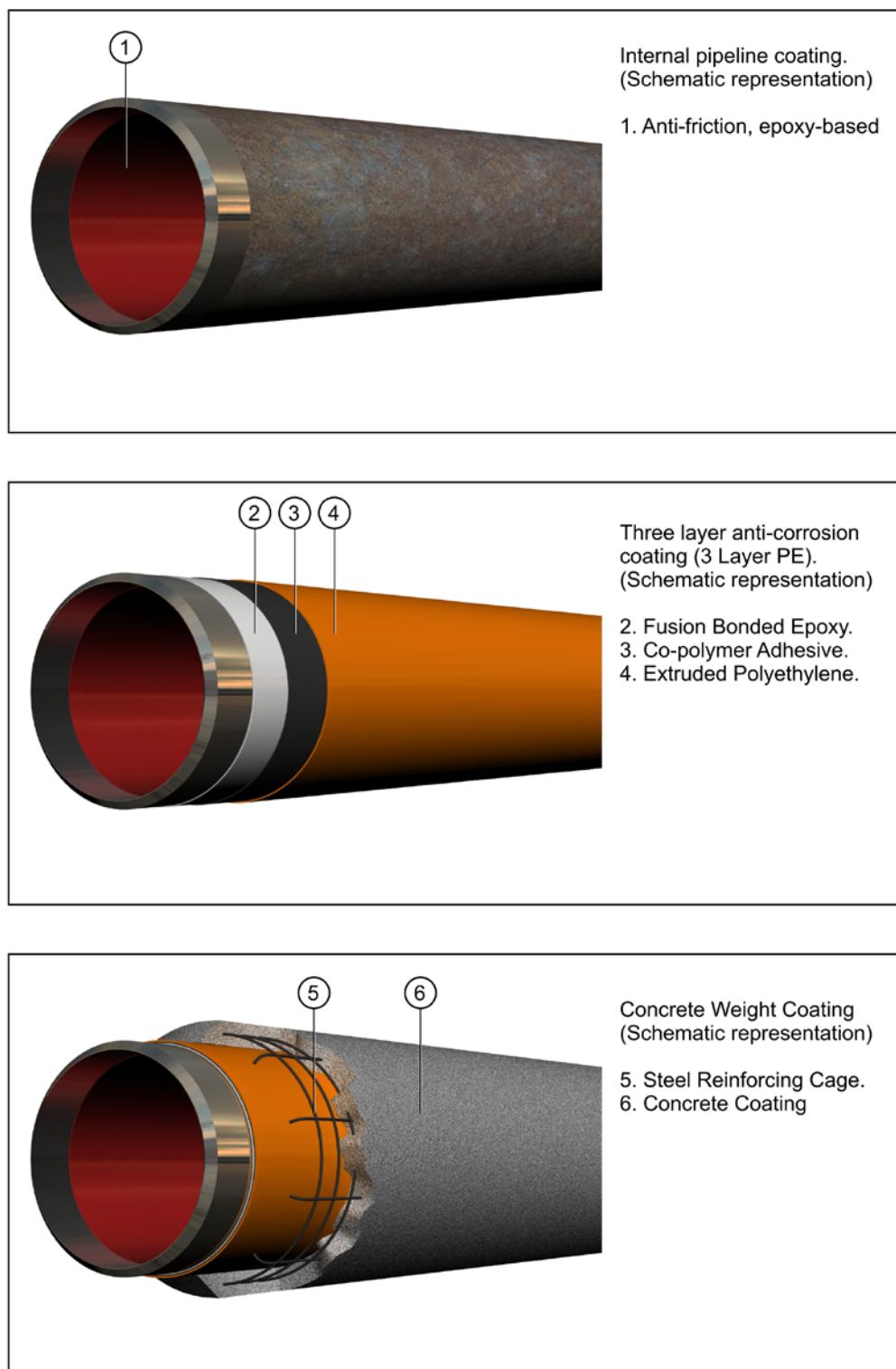
### 6.4.2 Materials and corrosion protection

#### 6.4.2.1 Line pipe

The pipelines will be constructed of steel line pipe with an average length of 12.2 m. The pipes will be welded together in a continuous laying process.

The line pipe will be internally coated with an epoxy-based material to reduce hydraulic friction, thereby improving the natural gas flow conditions.

An external three-layer polyethylene (3 layer PE) coating will be applied over the line pipe to prevent corrosion. This coating consists of an inner layer of fusion-bonded epoxy (FBE), a middle adhesive layer and a top layer of polyethylene, Figure 6-2.



**Figure 6-2** Line pipe design. Schematic representation of line pipe external anti-corrosion coating and concrete weight coating.

CWC containing iron ore will be applied over the external anti-corrosion coating. While the primary purpose of the CWC is to provide on-bottom stability of the pipelines, it will also provide additional external protection against external impacts. The concrete comprises of a mix of cement, water and aggregate (inert solid material such as crushed rock, sand, gravel). The CWC



will be reinforced by steel bars welded to cages. Iron ore aggregate will be added to increase the density of the weight coating. The cement used for the concrete will be a Portland cement suitable for marine use, Figure 6-2.

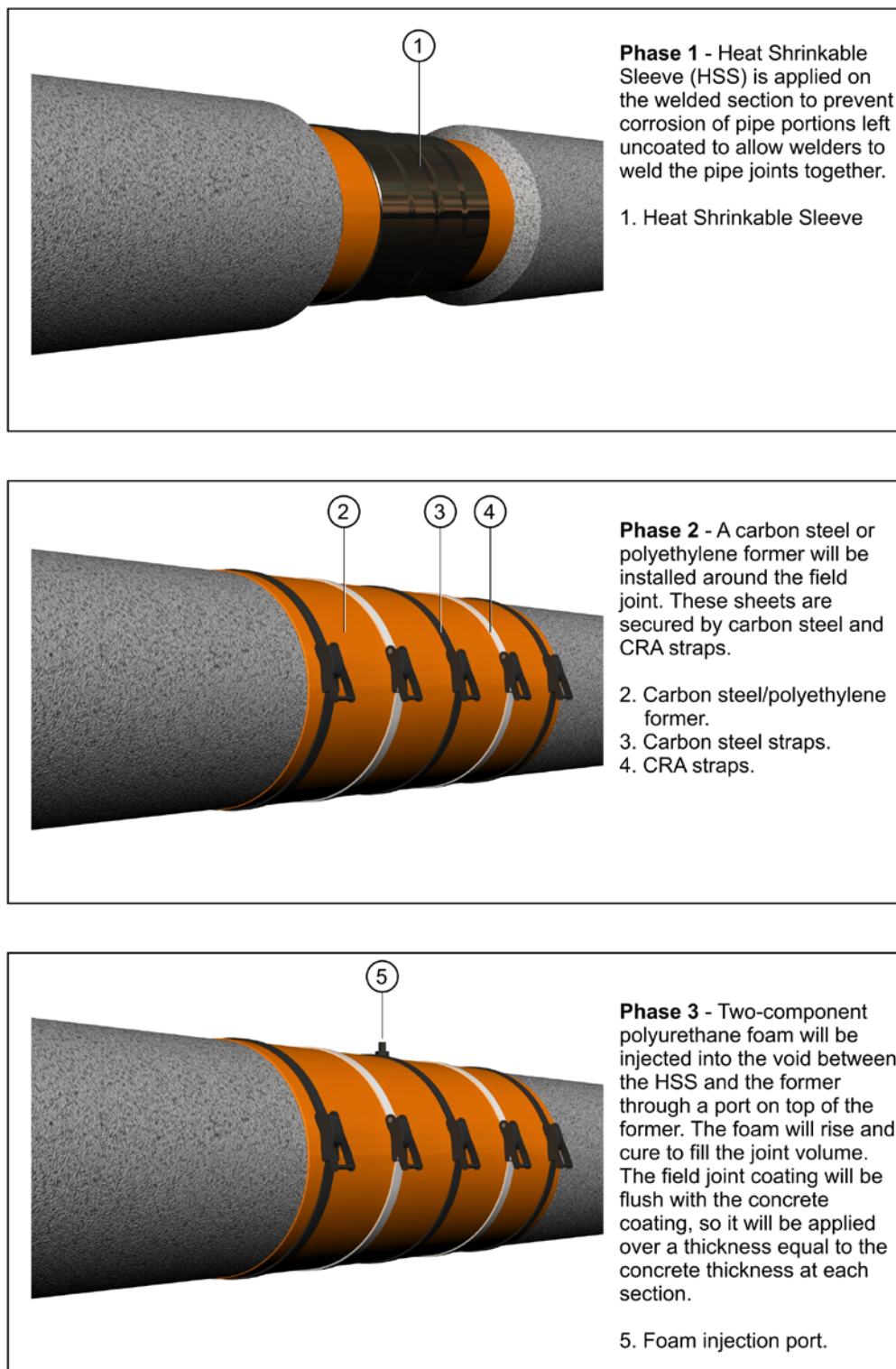


Figure 6-3 Schematic representation of field joint coating.

At the field joints a heat-shrink sleeve (HSS) will be applied to provide corrosion protection over the bare metal section, and high density foam will be applied as joint infill material to fill the gap to the outer diameter of the CWC, Figure 6-3.

#### 6.4.2.2 Cathodic protection (sacrificial anodes)

In addition to the external anti-corrosion pipe coating, secondary anti-corrosion protection will be provided by sacrificial anodes of a galvanic material to ensure the integrity of the pipelines over their operational lifetime. This secondary protection will be an independent system that will protect the pipelines in case of damage to the external anti-corrosion coating.

The performance and durability of different sacrificial anode alloys in Baltic Sea environmental conditions were evaluated with dedicated tests for the construction of NSP. The tests showed that the salinity of seawater has a major effect on the electrochemical behaviour of aluminium alloys. In the light of the test results, zinc alloy is foreseen for sections of the pipeline route where there is very low average salinity (Russia, Finland and part of Sweden). For the remaining sections, indium-activated aluminium will be used.

The anodes will be spaced 7-12 line pipes apart. The number of anodes to be installed in each country and the corresponding quantities of aluminium and zinc alloy are listed in Table 6-5.

**Table 6-5** Number of anodes (two pipelines) to be installed in each of the five countries of origin. The quantities are approximate and subject to final optimisation.

Anode type	Russia	Finland	Sweden	Denmark	Germany
Zinc (n)	1,920	2,788	781	0	0
Aluminium (n)	0	2,854	7,834	2,508	1,778

#### 6.4.2.3 Total materials used

The expected material consumption required for the pipeline sections in each of the five countries of origin is summarised in Table 6-6.

**Table 6-6** Summary of material consumption in the countries of origin. Quantities are approximate and subject to final optimisation.

Material	Russia	Finland	Sweden	Denmark	Germany	Total
Total length of two pipelines (km)	228	756	1,024	278	168	-
Steel (t) (including buckle arrestors)	230,900	723,500	844,510	217,700	131,660	2,148,270
Concrete weight coating (t)	224,500	757,800	1,069,620	320,200	206,820	2,578,920
Anodes Zinc (t)	1,703	2,472	896	0	37-45	5,108-5,116
Anodes Aluminium (t)	0	885	2,642	1,000	733-742	5,260-5,269

#### 6.4.3 Pipeline intervention works on the seabed

The pipelines will be subject to challenging metocean and operating conditions that will lead to the need for intervention works on the seabed aimed at addressing design criticalities such as:

- Pipeline static overstress due to seabed unevenness;
- Pipeline freespans exceeding allowable fatigue limits;
- Pipeline instability due to pressure and temperature loads (in-service buckling);
- Pipeline instability on the seabed due to waves and current loads;
- Pipeline interaction with iceberg keels during the winter season in shallow-water sections;

- Pipeline interaction with ship traffic;
- Requirement to create structures for crossing of existing facilities on the seabed (cables and pipelines).

Gravel supports (rock berms) are used for freespan sections and at crossings points for existing facilities.

Gravel supports may be engineered as pre-lay or post-lay intervention works, depending on the specific needs of the pipeline system.

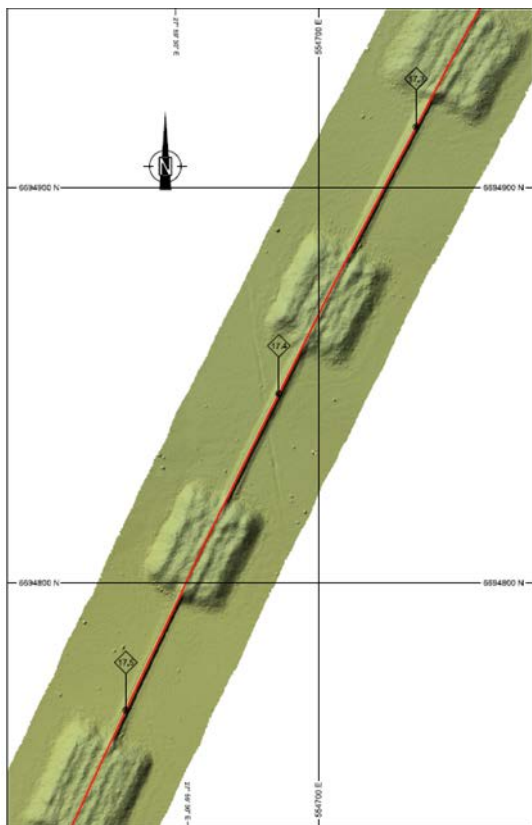


Figure 6-4 Typical spot rock berms.

Pipeline instability on the seabed due to wave and current loads is also typically mitigated by trenching (generally for longer sections, e.g. tens of kilometres) or rock placement (generally for shorter sections). The trenching operation may be performed pre-lay (by means of dredging, typically in shallow area) or post-lay (by means of post-lay trenching tools, e.g. ploughing tool). As an alternative to pipeline trenching, the stability of the pipeline can be guaranteed by installation of spot rock berms to keep the pipeline in the as-laid position.

### 6.4.4 Russian landfall

The preferred landfall in Russia is located at Narva Bay on Russia’s southern Baltic Sea shoreline and comprises an onshore pipeline section, PTA. Upstream facilities include feeder lines and a compressor station as depicted in Figure 6-5.

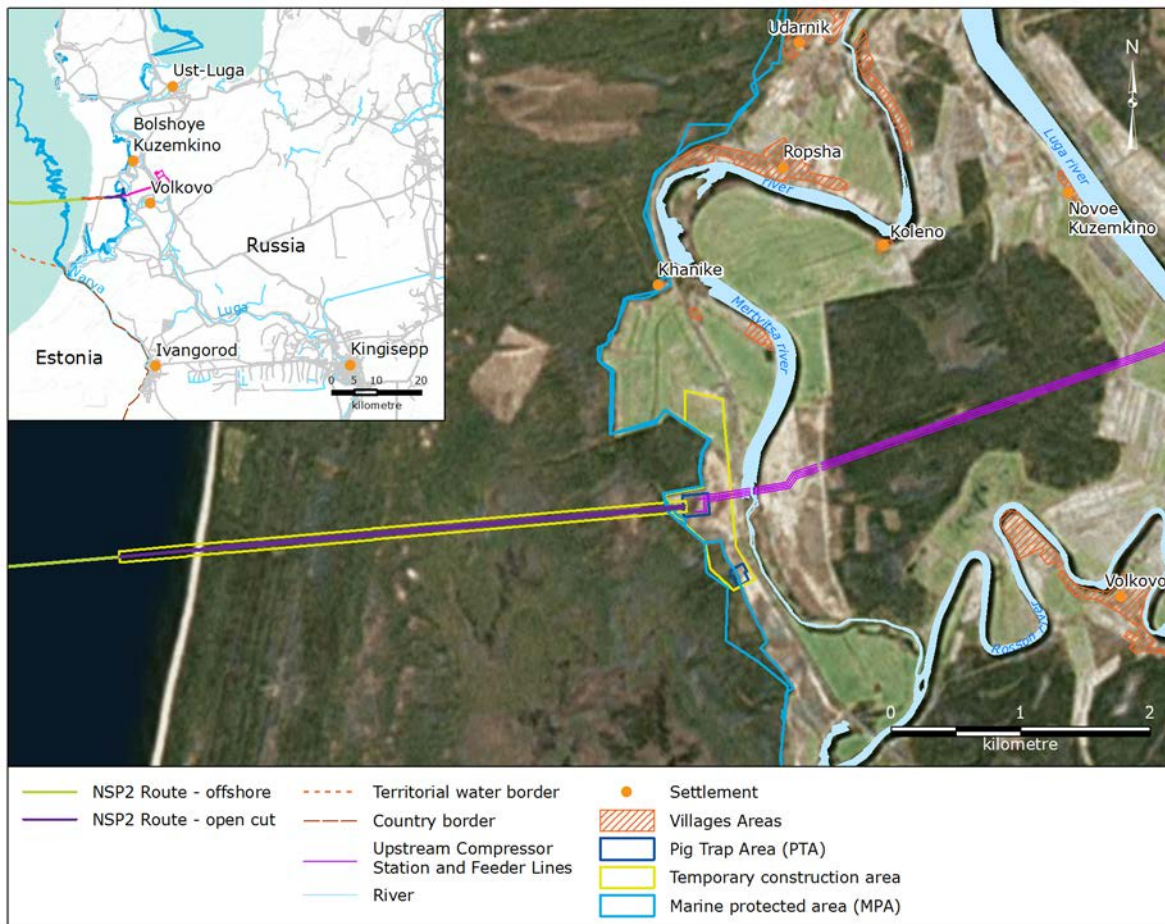


Figure 6-5 Onshore facilities in Russia.

The onshore pipeline will be buried, and the permanent above-ground facilities at the PTA will include pipeline pig launchers; isolation, shutdown and blow-down valves; a vent and blow-down system; pressure and temperature transmitters; gas flow meters; utility systems; and automation and telecommunications room equipment (Figure 6-6).



Figure 6-6 3D view of NSP2 PTA in Russia.

#### 6.4.5 German landfall

At the German landfall, NSP2 terminates at the receiving terminal. The receiving terminal comprises the PTA and the GRS. The PTA forms part of NSP2, while the GRS will be planned, built and operated by the downstream operator.

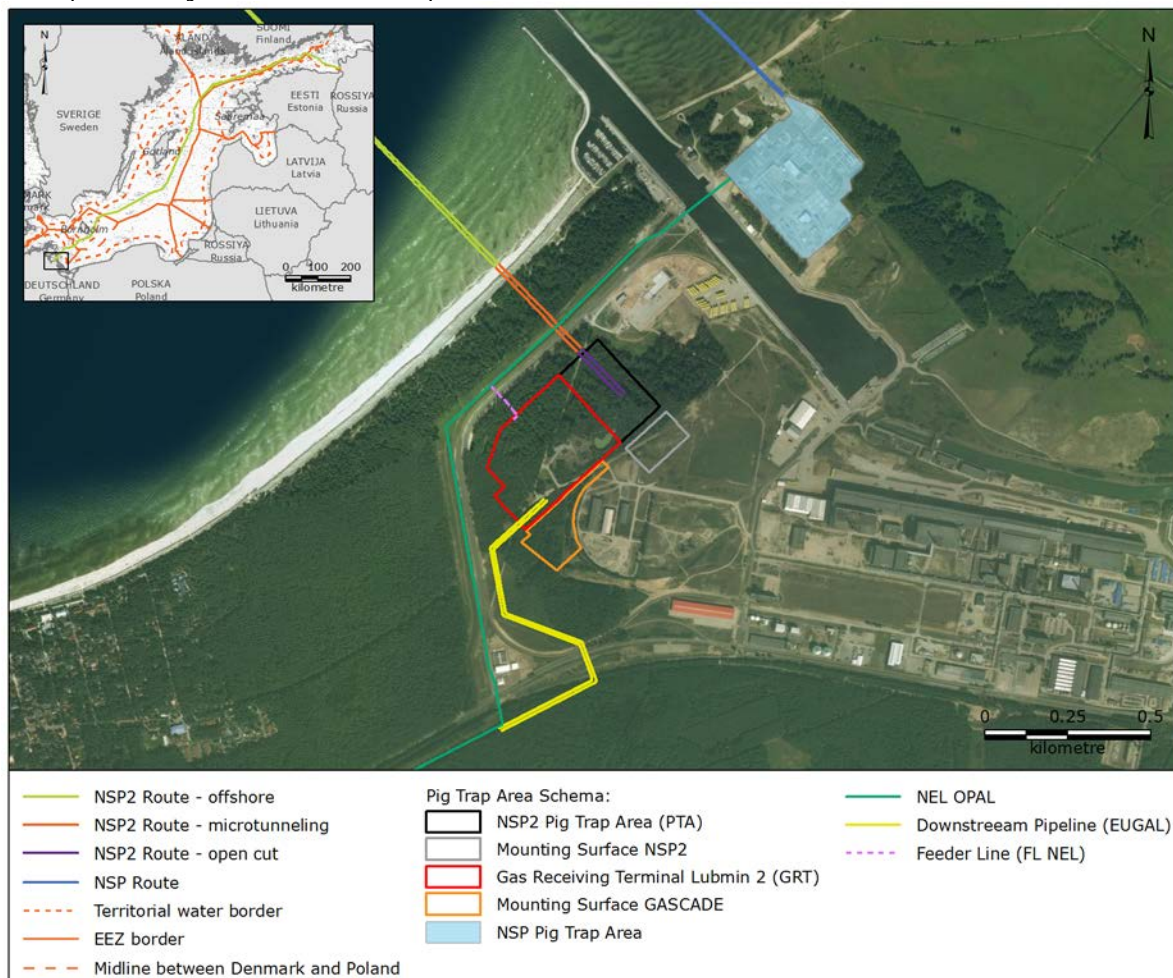


Figure 6-7 Onshore facilities in Germany.

The main facilities of NSP2 at the German landfall include:

- Pipeline pig receivers;
- Isolation, shutdown and blow-down valves;
- Vent and blow-down system for PTA;
- Blow-down system for 48" pipelines;
- Pressure and temperature transmitters;
- Gas meters (non-fiscal);
- Automation and telecommunication room (SCADA, telecoms, etc.), including a distributed server/client architecture for local operation;
- Electrical equipment rooms (switchgear, UPS, batteries, etc.);
- Security access system.

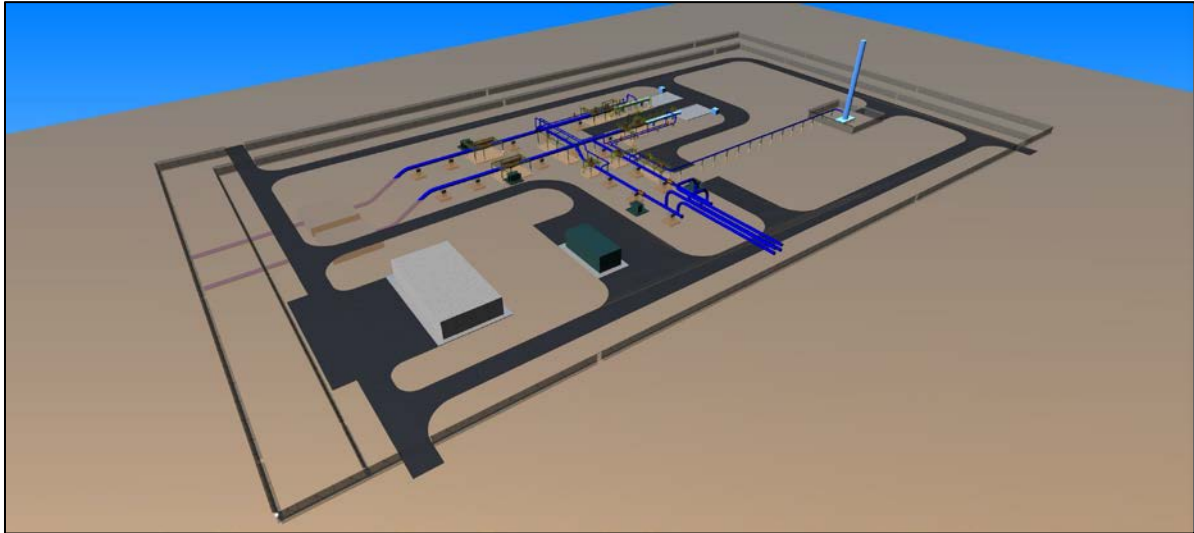


Figure 6-8 3D view of NSP2 PTA in Germany.

## 6.5 Installation logistics concept

Large-scale offshore pipeline construction works require considerable support from onshore support facilities, such as weight-coating plants and pipe storage yards. In addition to weight coating and storage of line pipe, the support facilities will provide general storage for the supply of consumables to the offshore fleet and managerial support for NSP2 and its contractors.

In order to achieve a safe and smooth supply chain, the NSP2 project plans on using onshore facilities comprising two weight coating plants in Kotka, Finland, and Mukran, Germany, and four pipe storage yards located in Finland, Sweden and Germany as shown in Figure 6-1. However, the logistics concept is subject to further optimisation, and Nord Stream 2 AG is currently investigating the possibility to use the Freeport of Ventspils in Latvia as an additional pipe storage yard.

### 6.5.1 Logistics concept

The logistics concept has been developed specifically for the project and includes:

- Transport of anti-corrosion coated pipes and CWC materials to the CWC plants;
- Transport of weight-coated pipes to the storage yards;
- Transport of weight-coated pipes to the lay vessels from the CWC plants and storage yards;
- Transport of material for rock placement from quarry to rock placement location.

A primary focus in the development of the logistics concept has been on minimising environmental impacts (onshore and offshore) and reducing costs. Preparation of the facilities will comply with national legislation and requirements and will be subject to independent, national permitting. Information about onshore facilities, however, is included here to give a better overview of the project logistics.

### 6.5.2 Weight coating plants and pipe storage yards

The choice of locations for the weight-coating plants and pipe storage yards is based on thorough analysis of a wide range of factors to minimise onshore and offshore transportation requirements, thereby minimising environmental impacts.

Nord Stream 2 AG and its contractors selected four locations from a shortlist of harbours located throughout the Baltic Sea region. The feasibility of these harbours has been evaluated based on factors such as distance to pipe-fabrication sites, train connections and other infrastructure, water depth in the harbour, other industrial use of the site and distance to the pipeline route, mainly to reduce transportation distances on all levels.

The line pipe logistics will be based on utilisation of existing ports within the Baltic Sea area. The port of Hamina Kotka (Mussalo) in Finland will serve as the weight-coating location and pipe storage yard for the eastern pipe route. The port of Mukran in Germany will serve as the weight-coating location and pipe storage yard for the western part of the route. Two additional ports will serve as pipe storage yards along the route:

- Hanko-Koverhar in Finland;
- Karlshamn in Sweden.

Line pipe will be produced at pipe mills in Russia (55%) and Germany (45%). At the mills, the line pipe will be internally coated with flow coating and externally coated with anti-corrosion coating before being transported to CWC plants in Kotka in Finland and Mukran in Germany.

Pipes will be transported directly by train from the manufacturing sites to the CWC plants and will be stored in stockyards close to the CWC plants and subsequently transported to the plants, where the steel cage reinforced CWC will be applied. CWC materials, such as cement and aggregate, will also be supplied to the CWC plants from mainly local sources and transported by vessel, train or, over short distances, truck.

After weight coating, the line pipes will be stored again, close to the CWC plant. From Kotka, they will be transported directly to the lay vessel or to the storage yard in Hanko-Koverhar. From Mukran, they will be transported directly to the lay vessel or to the storage yard in Karlshamn, which is closer to the middle section of the pipeline route, to minimise the sailing distance to the pipe-laying vessels.

In case that Ventspils would be used as an additional pipe storage yard, it would receive weight-coated pipes by rail from Russia (approx. 20,000 pipes) and by coaster vessels from Kotka (approx. 12,800 pipes). From Ventspils the pipes would be transported with pipe supply vessels to the lay vessels when in Swedish and Finnish waters. This would consequently mean that corresponding fewer pipes would be transported from Hanko and Kotka to the pipe-laying vessels than shown in Figure 6-9.

### **6.5.3 Offshore pipe supply**

The offshore pipe supply to the pipe-laying barges will be by means of pipe supply vessels. Load-out activities in all ports will be in parallel with the construction work for both pipelines.

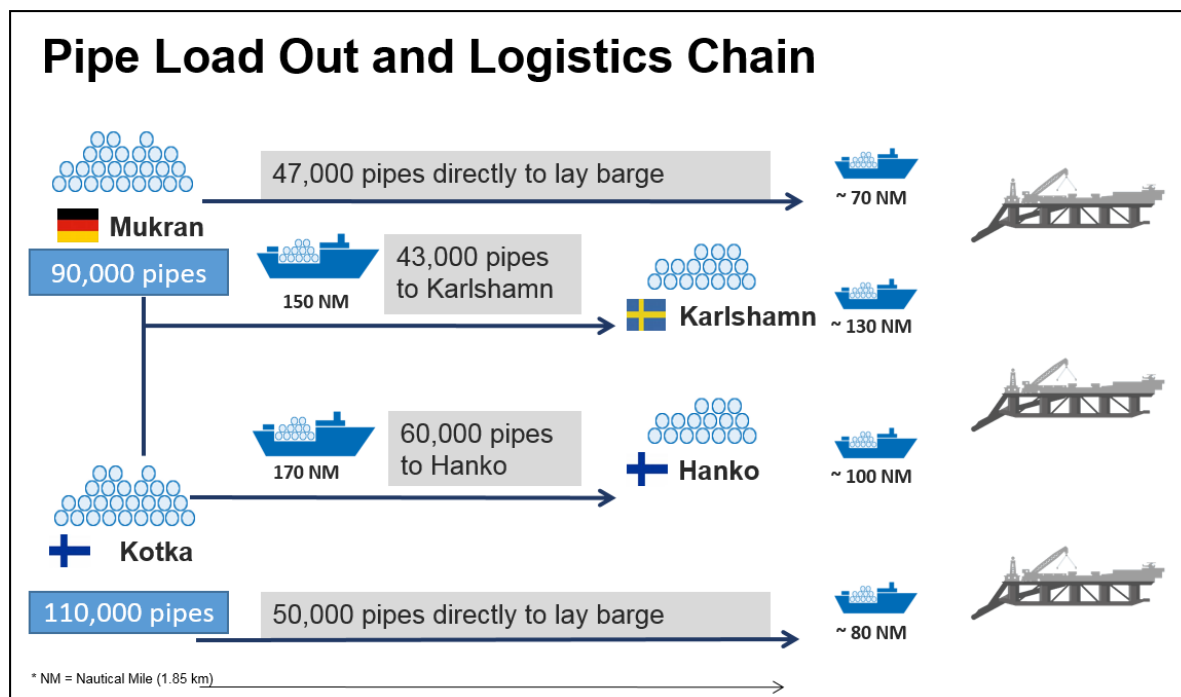


Figure 6-9 Concept for the pipe load-out and logistics chain.

#### 6.5.4 Transportation of rock placement material

Rock material for seabed intervention works will be extracted from third-party owned and operated quarries that may be in Finland or elsewhere in the Baltic Sea region, as the majority of rock material required for the pipelines will be used for seabed intervention works in the Gulf of Finland.

The crushed rock will be transported to the loading port. It is assumed that the transport to the loading port will be done by trucks. The load capacity of the trucks is approximately 40 tonnes.

Previous experience shows that 13-15 trucks may be used for transportation. Working hours are difficult to estimate, but 16 hours per day, five to six days per week, is possible.

Upon arrival at Mussalo Harbour, the crushed rock will be stored on the quay. The amount of rock in storage may be up to 25,000 tonnes (160,000 m<sup>3</sup>). The loading will be done directly from the quay using one or more conveyors. The assumed loading speed will be between 1,000 and 2,000 tonnes per hour. The vessels will be moored for half a day to one day during loading.

#### 6.6 Construction offshore

The construction methods and construction philosophy will generally be similar to those of NSP. Project pipeline scenarios were defined and have been analysed for typical offshore pipe-laying vessels. All of the route options have a water depth of less than 210 m, and the pipelines can be safely laid at these water depths.

##### 6.6.1 Munitions clearance

The Baltic Sea is an area with a history of significant strategic naval importance. The legacy of World War I and World War II is the presence of conventional and chemical munitions. The estimated number of mines laid in the Baltic Sea is over 170,000. Many of these have been cleared during the years, but many tens of thousands of mines may remain in the Gulf of Finland. In addition to the strategically placed mines, remnants of marine warfare such as torpedoes, artillery shells and air dropped bombs can be encountered.



The pipeline route will be optimised on the basis of survey results to avoid munitions to the extent possible. Nord Stream 2 AG will apply the following mitigation hierarchy to munitions clearance:

- Avoidance through localised rerouting where feasible;
- Clearance involving relocation of munitions where feasible and safe;
- For munitions that cannot be safely moved, detonation in situ with appropriate mitigation in place.

In Sweden, rerouting will be undertaken for any identified munitions. Munitions clearance involving in situ detonation on the seabed is not planned in Sweden.

In Germany, munitions will be visually inspected and cleared in close cooperation with the authorities. Pipelines will only be re-routed if munitions are unsafe to move. *In situ* detonation is not permitted in Germany.

Due to the density of munitions within the Gulf of Finland, avoidance through localised rerouting will not be possible in all cases. Consequently, munitions clearance will be required prior to construction. In Finland, munitions clearance is a permitted project activity and is assessed accordingly in the Finnish EIA.

In Russia, all munitions clearance is performed by and is the responsibility of the Russian navy. To the extent that is legally possible in Russian waters, Nord Stream 2 AG will endeavour to influence the manner in which clearance is undertaken and the application of mitigation for impacts on marine mammals.

The collective navies of the Baltic States have developed methods that are effective for the clearance of mines and other explosive underwater ordnance on the seabed of the Baltic. During NSP, clearance works were carried out by a disposal vessel with a munitions disposal team on-board. In addition, a work boat supported the operations and an ROV was used for several tasks, including:

- Relocation of munitions that could be safely moved;
- For munitions that could not be moved, survey of the munitions and seabed at the detonation site prior to detonation;
- Placement of the donor charge near the munitions in position for demolition;
- Confirmation of the demolition as well as scrap and equipment recovery after the detonation;
- Survey of any sensitive receptors near the munitions prior to and after the detonation.

The donor charge installed by ROV was fired once it was certain that there was no third-party shipping in the area.

Several measures were implemented to mitigate and monitor impacts on marine mammals, diving seabirds and fish. Visual observations were performed by marine mammal observers from one hour before the detonation to one hour after the detonation. A sonar survey to identify any fish shoals in the area was carried out by the work boat, and a passive acoustic monitor was deployed into the water column to record any vocalisation by marine mammals prior to detonation. In addition to observations, four acoustic deterrents (seal scramblers) were deployed and activated prior to detonations, and a small charge was detonated before firing the main donor charge to frighten away any seals or fish from the area. Figure 6-10 shows a typical example of the mitigation array used during NSP.

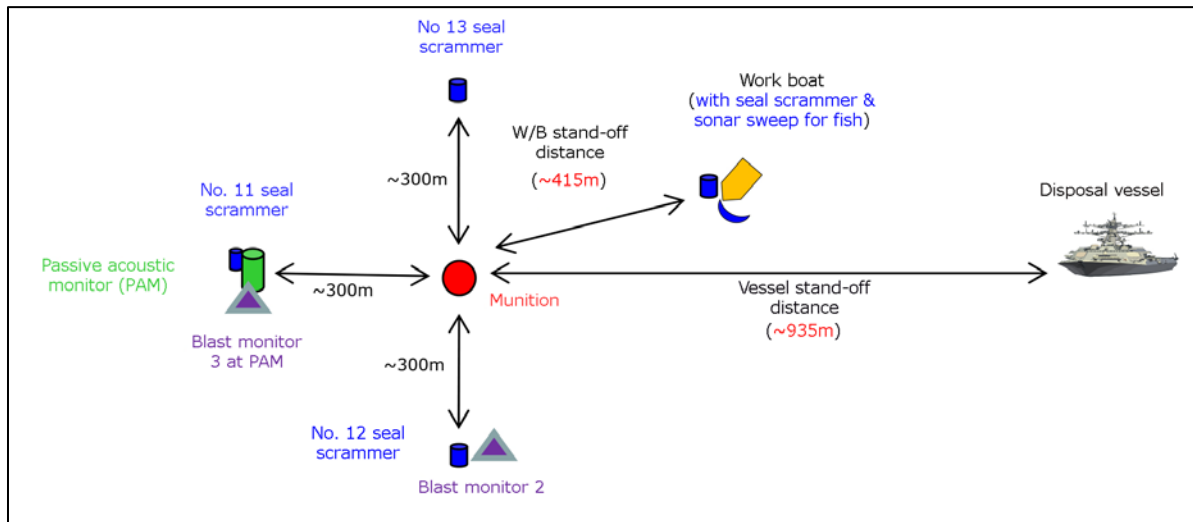


Figure 6-10 Layout of monitoring and mitigation equipment during munitions clearance for NSP.

In addition to the munitions clearance methods and mitigation techniques implemented for NSP, an assessment of alternative clearance methods and mitigation techniques is being undertaken for NSP2 to reduce the impact associated with underwater noise from in situ detonation. This study considers the munitions cleared during NSP as the munitions baseline. In general, the viability of alternative methods depends on the type and condition of the munitions and requires a risk assessment. Therefore the initial study will be complemented with a detailed assessment based on the findings of the NSP2 munitions surveys.

### 6.6.2 Pipe-laying offshore

Pipeline installation will be carried out by lay vessels adopting the conventional S-lay technique. This method is named after the profile of the pipe, which forms an elongated 'S' as it moves across the bow or stern of the lay vessel and onto the sea floor (see Figure 6-11). Individual pipe joints will be delivered to the lay vessel, where they will be assembled into a continuous pipeline and lowered to the seabed.

The process on board the lay vessel comprises the following general steps, which take place in a continuous cycle: welding of pipe, non-destructive testing of welds, field joint protection against corrosion and pipe-laying on the sea floor.

Both pipelines will be constructed in several continuous sections for subsequent interconnection. Temporary cessation of continuous laying of the pipelines may also become necessary if weather conditions make positioning difficult or cause too much movement within the system. The average lay rate is expected to be in the order of 2-3 km per day, depending on weather conditions, water depth and pipe wall thickness.



**Figure 6-11** The S-lay pipe-laying vessel and survey support vessels.

Pipe-laying will be carried out by either anchored or DP lay vessels.

Anchored lay vessels deploy anchors that interact with the seabed, thereby causing localised seabed disturbance. The position of the anchored lay vessel is controlled by a mooring system that consists of up to 12 anchors (weighing up to 25 tonnes each), anchor wires and winches. Independent, anchor-handling tugs place the anchors on the seabed at predetermined positions around the lay vessel to move the lay vessel forward and ensure tension can be maintained on the pipelines during laying. A typical anchor pattern is shown in Figure 6-12.

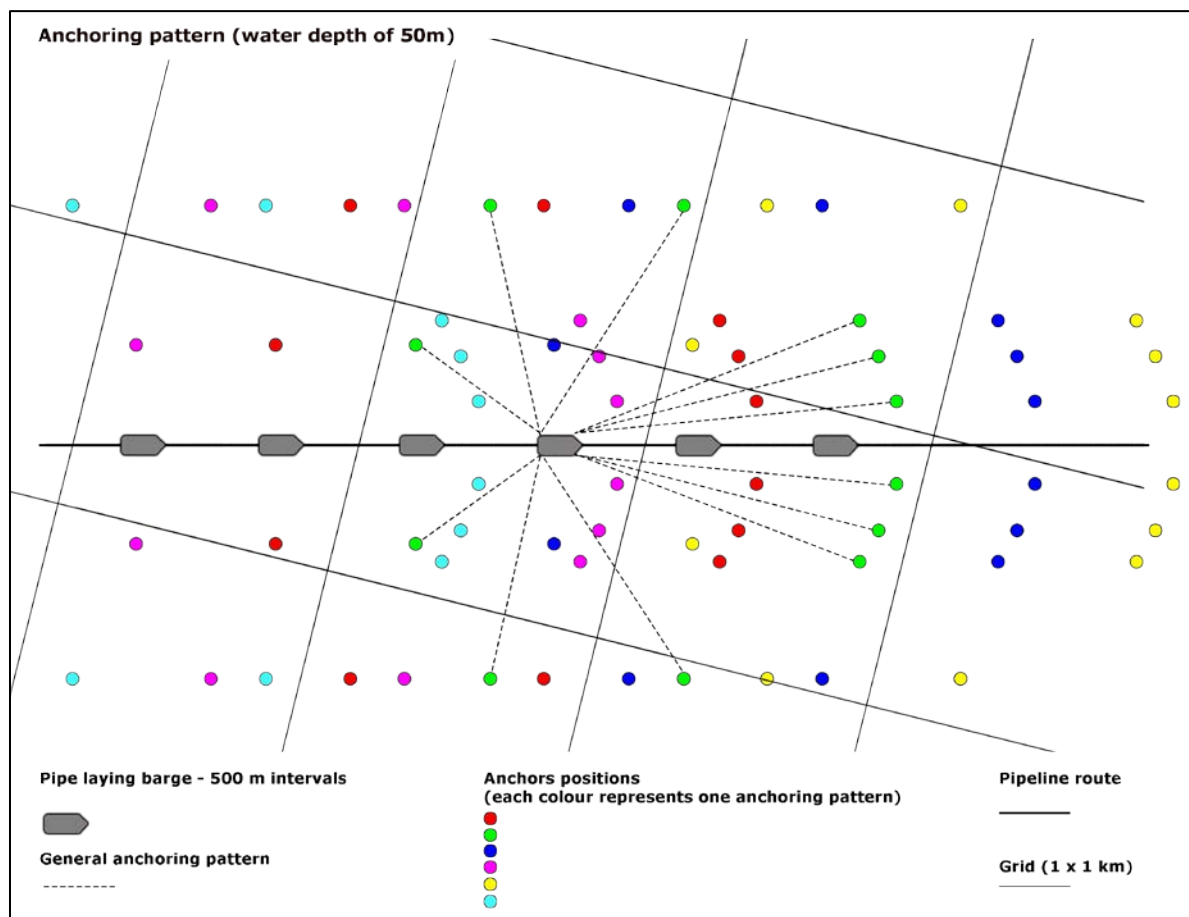


Figure 6-12 Anchor patterns on the seabed as the lay vessel moves forward.

A DP vessel is kept in position by thrusters that constantly counteract forces acting on the vessel from the pipelines, waves, current and wind. Pipe-laying with a DP vessel will not disturb the seabed. A lay vessel such as the *Castoro-Sei* (or similar) may be used to lay the pipelines in the deep water sections.

The *Castoro-Sei* (Figure 6-13) is a semi-submersible pipe-laying vessel with an anchor holding system. The vessel can lay large-diameter pipe with a maximum diameter of 1,524 mm (60 inches), including the weight coating.



Figure 6-13 Castoro-Sei pipe-laying vessel.

A typical DP vessel is the *Allseas Solitaire*, which was used to install the first 350 km of NSP in Russian and Finnish waters, see Figure 6-14.



Figure 6-14 Typical DP vessel – *Allseas Solitaire*.

Information about the position of a DP vessel is communicated from special sensors on the ocean floor, and a computerised system automatically employs the thrusters when it is necessary.

Additionally, satellite communications and weather and wind information are transmitted to the computer system, further helping it control the movements of the vessel. Using this information,

the computer automatically engages the thrusters to overcome any changes in the location of the vessel.

### 6.6.3 Seabed intervention works

Despite the extensive route optimisation carried out, the need for seabed preparation and modification cannot be avoided completely. Such seabed intervention works are traditionally carried out by pre- or post-lay trenching or by gravel or rock placement but may also involve additional structures.

In general, the seabed intervention works for the entire pipeline system will be carried out in three phases:

- Phase 1, comprising intervention works to be carried out before pipe-laying;
- Phase 2, comprising intervention works to be carried out after pipe-laying but before pressure testing;
- Phase 3, comprising intervention works to be carried out after pressure testing.

The anticipated seabed intervention works are summarised in Table 6-7. It should be noted that volumes may change during the final detailed design phase and following pipeline installation, when the actual extent of post-lay intervention works will be finalised.

The anticipated seabed intervention works for the route are shown in Atlas Map PR-02-Espoo.

**Table 6-7 Summary of intervention works covering both pipelines – approximate maximum volumes.**

	Russia	Finland	Sweden	Denmark	Germany
<b>Rock placement</b>					
Stress freespan correction (m <sup>3</sup> )	116,860	1,410,000	583,400	0	0
In-service buckling mitigation (m <sup>3</sup> )	656,735	390,000	0	0	0
On-bottom stability (m <sup>3</sup> )	0	0	193,000	0	13,785
Pipeline crossings (m <sup>3</sup> )	0	40,000	10,190	40,000	0
Above water tie-in (m <sup>3</sup> )	<44,000/1 <sup>4</sup>	0	0	≤20,000/1 <sup>4</sup>	0-<39,000/3 <sup>4</sup>
Hyperbaric tie-in (m <sup>3</sup> )	0	(80,000-110,00) <sup>1</sup>	(80,000-110,000) <sup>1</sup>	0	0
<b>Total (approx. m<sup>3</sup>)</b>	820,000	1,950,000	900,000	60,000	53,000
<b>Trenching (post-lay trenching)</b>					
Total length (km)/number sections	0	0	144/12	41/6	0
Total volume (m <sup>3</sup> )	0	0	896,909	254,000	0
<b>Dredging (pre-lay trenching) of open cut base case in Russia (common trench and cofferdam offshore) and dredging in Germany</b>					
Total length (km)	3.3 <sup>2</sup>	n/a	n/a	n/a	49.5 <sup>3</sup>
Total volume (m <sup>3</sup> )	205,000	n/a	n/a	n/a	2,500,000
<b>Dredging (for micro-tunnel option in Russia)</b>					
Total length (km)	2.8 <sup>2</sup>	n/a	n/a	n/a	n/a
Total volume (m <sup>3</sup> )	475,000	n/a	n/a	n/a	n/a
1: Not applicable if dry pre-commissioning.					
2: Common trench					
3: 20.5 km separate trench, 29 km common trench					
4: Amount of rock for above water tie-in/number of potential locations of above water tie-in.					

#### 6.6.4 Trenching (post-lay trenching)

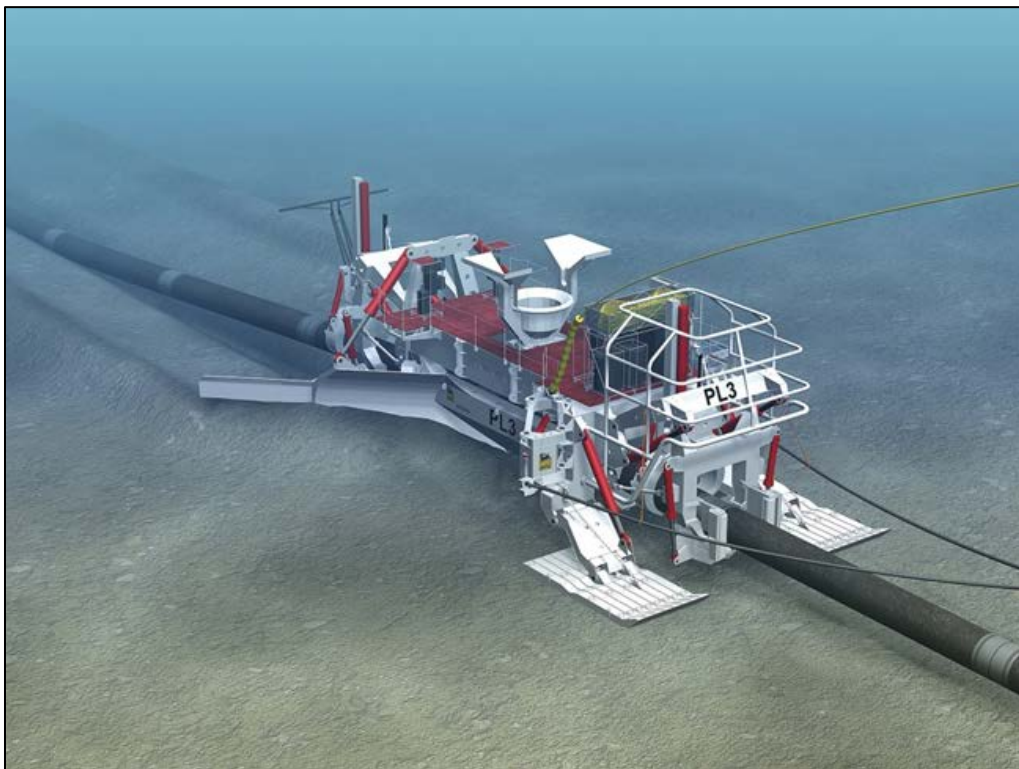
The offshore installation of the pipelines in some areas (especially in shallow waters) requires additional stabilisation and/or protection against hydrodynamic loading (e.g. waves, currents), which can be obtained by trenching the pipelines into the seabed. Pipeline installation in a pre-lay excavated trench is the preferred trenching method in these shallow water areas.

Post-lay trenching is the most widely used trenching method in deeper water. Post-lay trenching requires excavation only immediately underneath a pipeline, whereas pre-trenching involves excavation over a much larger width to allow for installation tolerances.

Typically, post-lay trenching can be carried out in minimum water depths of 15-20 m and up to a trench depth of approximately 1.5 m.

Post-lay trenching will be carried out using a pipeline plough (see Figure 6-15) deployed onto the pipelines from a vessel located above the pipelines. The pipelines will then be lifted by hydraulic grippers into the plough and supported on rollers at the front and rear ends of the plough. The rollers will be equipped with load cells to control the loading onto the pipelines during trenching. A tow wire and control umbilical will be connected to the plough from the vessel, which will pull the plough along the seabed, laying the pipelines into the ploughed trench as the plough advances. Post-lay trenching by ploughing is referred to as trenching in the following.

Typically, the vessel is capable of pulling the plough independently, although assistance from another vessel may occasionally be required, depending on the overall tow force generated.



**Figure 6-15 Pipeline plough in operation on the seabed.**

The excavated material displaced from the plough trench (also known as spoil heaps) will be left on the seabed immediately adjacent to the pipelines. Partial, natural backfilling will occur over time as a result of currents close to the seabed.

Forced or artificial backfilling will be undertaken in areas where active protection is necessary.

### 6.6.5 Dredging (pre-lay trenching)

At the landfalls in Russia and Germany, the pipelines will be buried entirely in the seabed to ensure that coastal sediment transport mechanisms will not affect their stability. The linear distance of the buried pipelines offshore in Russia is approximately 3.3 km, where a common trench will be utilised.

In Germany, 49.5 km of the pipelines will be buried in a combination of common and single trenches. The main reason for trenching in German shallow waters is to protect the pipelines against impact (mostly from ship or anchor collision).

Dredging by pre-lay trenching will be undertaken with a variety of dredger types.

A backhoe dredger will be used in shallow waters. The backhoe dredger deposits the seabed material in a self-propelled splitter hopper barge (Figure 6-16), which transports the material to a pre-determined soil storage area on the seabed.

The trailer suction hopper dredger dredges the soil using the suction pipe equipped with a trailing head on its bottom end, which is slowly pulled along the seabed. It can be used at greater depths than the backhoe dredger. The operating draft of these vessels typically ranges from 5 m for the smaller vessels up to 8-10 m for the larger vessels.



Figure 6-16 Backhoe dredger with splitter hopper barge moored alongside (right).

In Russia, the excavated material will be removed, either side casted or stored temporarily outside the 10 m isobaths, outside the marine protected area, and used for backfill. In Germany, the excavated material will be removed, and if considered suitable for backfilling, stored temporarily and used for trench backfilling. Unsuitable soil will be disposed onshore.

### 6.6.6 Rock (gravel) placement

Rock placement is the use of unconsolidated rock fragments graded in size to locally reshape the seabed, thereby providing support and cover for sections of the pipeline system to ensure its long-term integrity. The rock material is placed on the seabed by a fall-pipe (see Figure 6-17).



Rock placement will be adopted as the main intervention method for freespan correction and will use material extracted from quarries on land. The types of rock placement works that are envisaged for seabed intervention include gravel supports (pre-lay and post-lay) and gravel cover (post-lay) in discrete locations.

To prepare the seabed for pipe-laying, the entire route will be surveyed beforehand. Gravel berms will then be strategically placed in order to support the pipelines in areas of high seabed relief, to serve as basement structures at tie-in and pipeline crossing areas, and to stabilise the pipelines where required.



Figure 6-17 Rock placement on the seabed through a fall-pipe.

#### 6.6.7 Crossings of infrastructure (cables and pipelines)

The pipeline route corridor options cross power and communications cables (existing and planned), the two existing NSP pipelines and in future may cross the Baltic Pipe and Baltic Connector pipelines.

As successfully done for NSP, it is envisaged to develop specific crossing designs for each cable crossing, typically consisting of concrete mattresses and/or gravel, which will be agreed with the cable owners. Crossing of pipelines was not a consideration during NSP. A crossing design according to established industry practice, e.g. as implemented in the North Sea, will be developed and agreed on for NSP2. An example of the design of a cable crossing is shown in Figure 6-18.

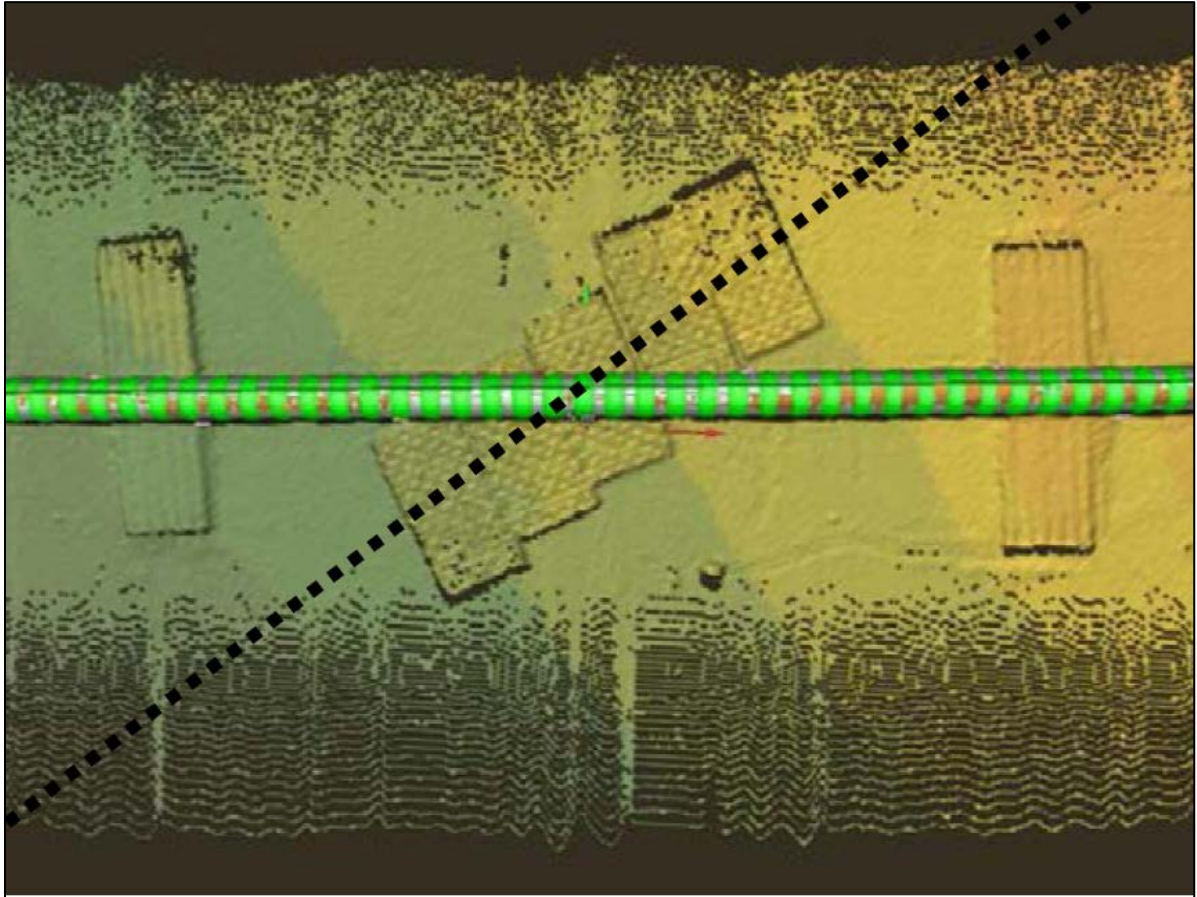


Figure 6-18 Typical cable crossing layout. Cable (black dotted line) is under the mattresses

#### 6.6.8 Above-water tie-ins

When pipe laying is complete and prior to pre-commissioning activities, the final tie-ins or joins between the offshore pipelines and the onshore sections in Russia and Germany will be performed as 'golden' welds.

A further two above-water tie-ins (AWTIs) have been planned as an option in German waters, one of which may be performed in the vicinity of the Germany and Danish EEZ borders with the precise location to be determined. The pipeline system will then be complete from pig trap to pig trap.

AWTIs will be carried out by a specific lay barge positioned over the tie-in location. Each pipe section will be lifted sufficiently clear of the water and suspended alongside the barge and welded together. Once tested, the pipe will be lowered to the seabed. The locations of the AWTIs will be confirmed following the selection of the pre-commissioning option.

#### 6.6.9 Waste generation offshore

Waste and garbage streams will be separated at the source and stored in designated containers on the lay vessel for metals, sand, sludge oil, chemicals and domestic waste. Waste containers will be secured by strap-down covers in order to prevent pollution of the sea. From the lay vessel, the waste will be shipped by supply vessels to ports in Finland, Sweden and Germany. At the ports, the waste will be transferred to skips and transported to licensed waste contractors and treated in compliance with local legislation.

The distribution of the offshore waste fractions from NSP is shown in Figure 6-19.

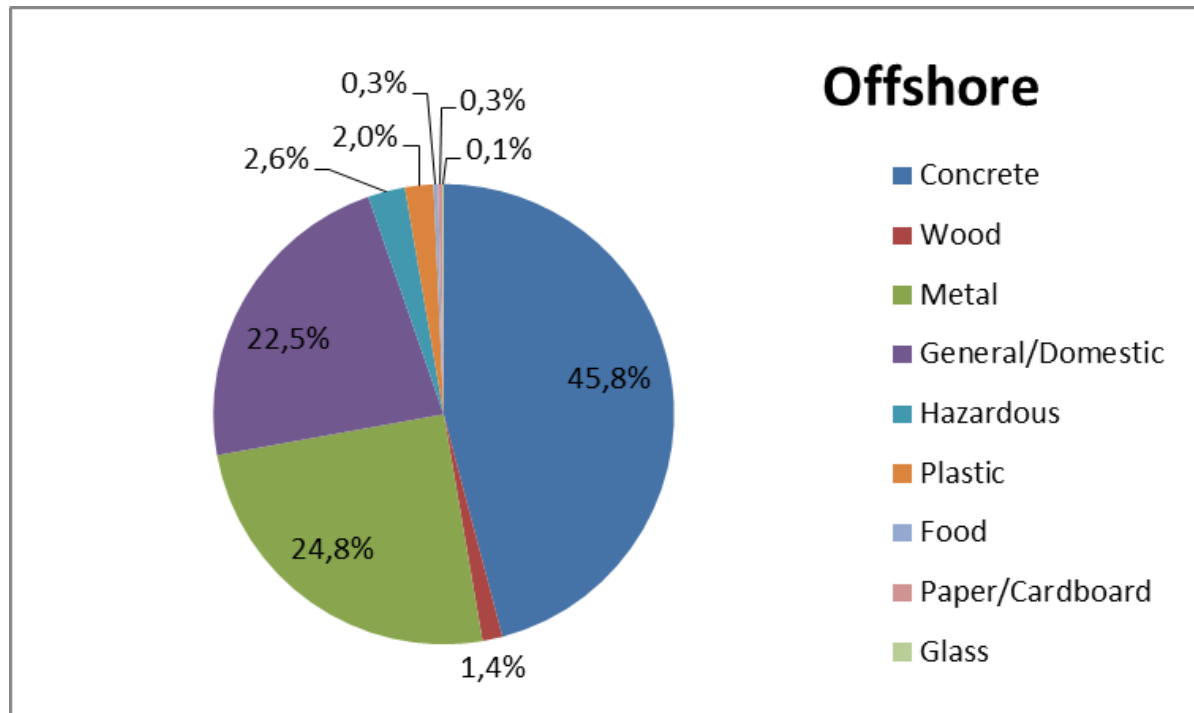


Figure 6-19 Waste fractions from pipe-laying vessels during NSP.

#### Concrete and flux

The majority of the waste generated by the pipe-laying vessel is derived from the concrete coating of the pipes. Concrete and flux comprise approximately 46% of the generated waste. Concrete waste is typically reused in road construction.

#### Metals

Metals comprise another large fraction of the generated waste and primarily comprise metal scraps from end millings from the bevelling and welding processes. On the basis of experience from pipe-laying for NSP, approximately 115 tonnes of metal scraps can be expected per month of pipe-laying. Metals comprised approximately 25% of the generated waste. Metal waste is recycled.

#### General/domestic (combustible)

Mixed waste containing plastic, paper, cardboard and food waste is generated as part of household processes and living quarters. This fraction comprises approximately 23% of the generated waste. Organic and biodegradable waste may be incinerated on site before being sent to shore for controlled disposal.

#### Chemicals and other hazardous waste

Hazardous waste consists of greases, other oils, contaminated materials, paints, light tubes, electronic waste, etc. Findings from NSP showed that hazardous waste comprises approximately 3% of the generated waste and approximately 25 tonnes of waste oil and sludge can be expected per month of pipe-laying. Hazardous waste is transferred to licensed hazardous waste companies.

#### Plastic

The majority of plastic waste from the pipe-laying process is generated as the protective sheet from the pipes is removed from the adhesive layer prior to installation. Plastic comprises 2% of the waste generated at the lay vessel.

The amount of HSS cut-offs is negligible, as these sheets are ordered at lengths specific to the NSP2 project. Spills from the polyurethane infill from field joint coating are also expected to be minimised due to process optimising.

### Wood

Pallets from materials for the pipe-laying process and household materials have been reported to comprise approximately 1% of the waste generated at the lay vessel.

#### 6.6.10 Waste generation onshore

Waste and garbage streams from construction and operation activities at the onshore sections in Russia and Germany will be separated at the source. All waste will be handled and disposed of in full compliance with the local requirements.

### 6.7 Construction at the landfalls

#### 6.7.1 Landfall Russia

A number of construction activities will be carried out in the landfall areas in order to bring the offshore pipelines ashore and create the onshore facilities.

NSP2 will start at the PTA in Russia. From the PTA, NSP2 will run to the edge of the Baltic Sea in an underground configuration and thereafter will continue underground further into the nearshore area. After several kilometres in the sea, the pipelines will emerge from the seabed and continue lying unburied, on top of the seabed, to the Finland border.

The two pipelines will be spaced approximately 20 m apart in the onshore area and approximately 100 m apart in the offshore area. On the inland side of the PTA, NSP2 will be connected to an upstream pipeline system. The key elements of NSP2 at the Russian landfall are:

- Workers camp, PTA and laydown areas (temporary development footprint of approximately 42 ha);
- PTA (permanent facility of approximately 6.1 ha);
- Conventional open-cut constructed pipeline section extending approximately 3,800 m towards the shoreline from the PTA and requiring a working corridor of 85 m;
- Construction of a causeway and cofferdam, which transitions into a trench that extends approximately 3.3 km offshore;
- Construction traffic from Ust Luga Port (approximately 40,000 heavy vehicle movements);
- Duration of construction (approximately 2 years);
- Pre-commissioning of onshore facilities;
- Simultaneous construction of upstream compressor station and feeder lines;
- Nearshore dredging and backfilling (linear extent of approximately 3 km);
- Shore pull (pipeline pull from offshore lay vessel to shore).

A causeway and cofferdam are required because vessel-based dredgers operate to a minimum water depth of 2.5-3 m; therefore land-based trenching equipment is deployed in the very shallow nearshore area. The key elements of the causeway and cofferdam are as follows:

- Causeway dimensions (from shoreline): approximately 300-500 m length x 22 m wide x 4 m high (above sea level).
- Cofferdam (created in centre of causeway): 10 m trench width with 6 m wide road on either side of the sheet piled walls of cofferdam.
- Sheet piles: buried depth 12-15 m (20 m high sheets).
- Causeway wave/surge protection: rock (sourced from inland quarries) is to be used on the outer margins of causeway to protect against wave action.
- Causeway core: imported fill and/or excavated sand from the cofferdam (if suitable).

- Construction duration: approximately 21 days.
- Trench spoil volume: approximately 20,000 m<sup>3</sup> (500 m x 10 m x 4 m).
- Piling method: vibro-piling.
- Working hours: daylight only.
- Construction method: causeway construction, sheet piling and excavation of cofferdam to happen simultaneously as the causeway pushes out from shoreline.
- Reinstatement: the causeway is to be progressively removed after pipe-laying. Causeway material is to be reused as backfill if suitable, otherwise removed from site.

Typical construction activities for the onshore pipeline section, comprise:

- Relocation of red list plant species and any animals prior to stripping;
- Vegetation stripping and grubbing (tree roots removal);
- Topsoil stripping and storage;
- Grading and subsoil storage;
- Installation of temporary drainage works;
- Placement of geotextile and gravel for temporary access roads;
- Phased trench excavation;
- Dewatering;
- Pipeline stringing (welded sections placed parallel to trench);
- Placement of bedding material in trench;
- Placement of welded pipeline sections in trench using side booms;
- Phased backfilling and compaction;
- Pre commissioning;
- Construction of permanent access road;
- Removal of construction equipment and materials;
- Technical reinstatement (grading and profiling of site), including installation of permanent drainage system;
- Reinstatement of groundwater hydrological characteristics as required;
- Biological reinstatement including topsoil cover and seeding.

The various construction activities are depicted in Figure 6-20 below.

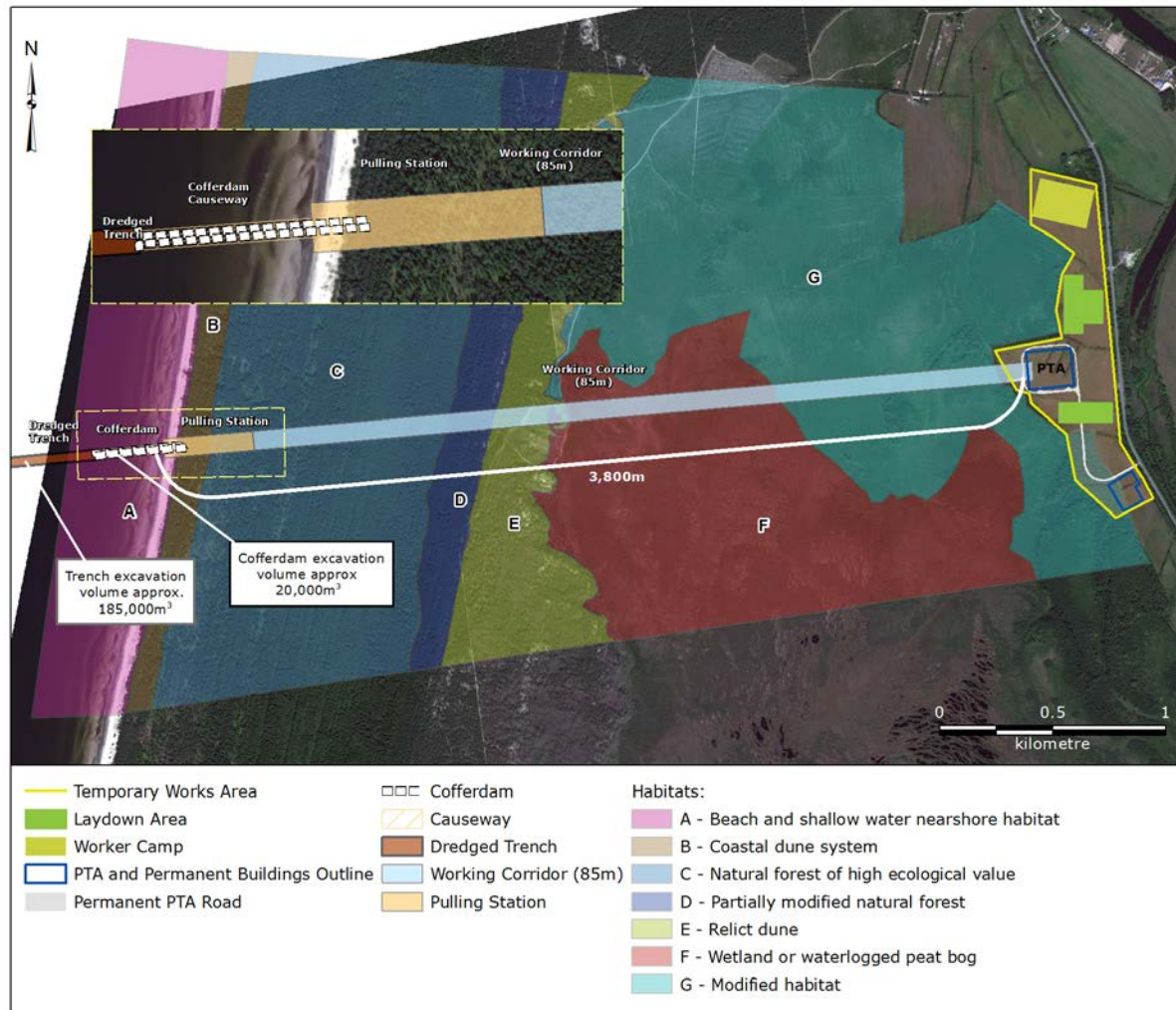


Figure 6-20 Construction of onshore facilities in Russia.

Pipes and equipment that are required for the onshore sections of the project will be delivered by road. The project may require the construction of some new temporary access roads for this purpose. Areas will also be needed for a number of temporary facilities throughout the various construction phases, such as pipe, equipment, materials and soil storage areas, and catering and sanitary facilities for workers. These areas will be rehabilitated following completion of the construction works.

Construction work will be confined to a narrow strip of land approximately 85 m wide with the option of narrower working corridors (where feasible for safe construction) in the sensitive forest section. Red list plant species will be relocated prior to vegetation clearing, and the topsoil layer will be removed by excavators and stored on site for subsequent reinstatement after completion of the pipeline construction activities.

Once the temporary and service roads are available, sections of 12 m pipe will be aligned along the route in preparation for the welding operations. The handling and lifting of these pipe joints will be carried out by mobile crane, side-boom tractors or excavators.

The pipeline trench is typically dug by excavators equipped with suitably profiled buckets. Once the trench is completed, the prefabricated pipelines will be lowered into the trench by means of side-boom tractors (see Figure 6-21).



Figure 6-21 Onshore pipeline trench excavation (left) and the pipeline being lowered into the trench.

After completion of the pipeline installation, the trench will be backfilled and compacted with the previously stored soil, up to the original ground level. In areas where a high ground water level is encountered, concrete weights may be laid over the installed pipelines to overcome the buoyancy effect of the water. The top layer of soil removed at the start of the construction activities will then be reinstated. Grass will be planted to finally reinstate the pipeline working corridor, but no trees will be allowed to grow over the pipelines.

#### **Nearshore dredging (trench excavation)**

In the nearshore section of the pipeline route, from the shore out to a water depth of approximately 12 m (a distance of approximately 3.3 km), dredging will be performed to excavate a trench into which the pipelines will be placed and subsequently covered. The excavation of the trench in the shore approach section will be executed by the following equipment:

- Backhoe dredger;
- Trailing suction hopper dredger.

Dredge volumes vary between the open cut base case and micro-tunnel shore crossing option. A cofferdam is required for the open cut method, and dredge volumes are approximately 205,000 m<sup>3</sup>. Conversely, for the micro-tunnel option, as a dredged channel is required for the pipe-laying vessel, some 475,000 m<sup>3</sup> of spoil is required to be dredged. A conservative approach has been adopted regarding sediment plume modelling for the impact assessment in Chapter 10 – Assessment of environmental impacts, and dredge volumes are based on the micro-tunnel option rather than the open cut base case scenario as this represents the ‘worst case’ with respect to dredging duration, maximum sediment concentrations and, therefore, potential impacts.

#### **Pipeline installation**

The planned methodology for the installation of the pipelines at the landfall is a shore pull technique. This typically involves the synchronised operation of a lay barge anchored close to the shoreline and a winch installed onshore. After the pipeline offshore trench is excavated to the required depth, the winch is installed and its wire is laid from the winch out along the bottom of the trench to the anticipated position of the lay barge.



Figure 6-22 Typical shallow water lay barge (with anchor tug and pipe transportation vessel).

The lay barge (Figure 6-22) is positioned as close as possible to the shoreline (subject to its operating draft), and the previously installed pull-in wire is retrieved and connected to the end of the pipeline that is being assembled on board the lay barge.

The trench requires backfilling after the pipelines are laid in the pre-dredged trench. For this purpose, the soil which had previously been dredged and temporarily stored is used as backfilling material.

In the shallow water section, close to the shoreline, the excavators used for dredging operations are also used for backfilling activities. In deeper water, backfilling operations are performed by a splitter hopper barge, which transports the soil from the storage area and dumps it into the trench.

### 6.7.2 Landfall Germany

The pipeline route in the German sector has a total length of approximately 83 km. In the section with water depth less than 17.5 m, the pipelines will be laid into a pre-dredged trench.

The key elements of NSP2 at the German landfall are:

- PTA working and laydown areas (temporary development footprint of approximately 8.2 ha);
- PTA (permanent facility of approximately 5.6 ha);
- Twin micro-tunnels of 700 m with entry portals within the PTA worksite and exit portals offshore;
- Duration of construction (approximately 2 years);
- Pre-commissioning of onshore facilities;
- Pre-commissioning equipment for offshore pipelines;
- Simultaneous construction of downstream GRS and feeder lines;
- Nearshore dredging and backfilling (linear extent of approximately 49 km);
- Shore pull (pipeline pull between offshore lay vessel and shore).

#### Pipeline installation

The burial depth of the pipelines varies along the pipeline route. The burial depth ranges between 0 m and 1.55 m in accordance with local safety requirements. Where shipping lanes are crossed in the shallow nearshore area inside the Greifswalder Bodden, the burial depth will be increased to take into account a possible deepening of the shipping lanes.



In order to minimise the underwater excavation works, and thus the environmental impacts, the selected trench profile has been adjusted to a width and a burial depth that is ALARP for safe construction and operation. In the sections in which both pipelines are laid in one single trench, the bed width of the trench will be 8.5 m in its straight sections.

### **Onshore activities**

The 800 m long landfall section of the pipelines is defined as the section between the seaward end of the twin micro-tunnels and the PTA. On the seaward side of the coastline, the pipelines will be located inside the trench, followed by two individual 700 m long micro-tunnels. Inside the micro-tunnels, the pipelines cross under the coastline, the beach, other pipelines, a road and a railway. Finally, the pipelines end in a construction trench at the PTA. In this section, the pipelines cover an elevation of 4.5 m.

The construction of start shafts for the micro-tunnels will commence at the landward side within the PTA construction site. The tunnelling equipment will be installed and set at the start shafts. When the tunnelling operations are completed, the tunnelling equipment and machinery will be dismantled and removed from the tunnels and then from the start shafts. Subsequently, the tunnel boring machines at the seaward tunnel ends will be excavated and recovered. Thereafter, the tunnel ends will be prepared for the shore pull-in of the pipelines.

In parallel to the tunnelling operations, the common pipeline trench within the Greifswalder Bodden will be dredged. The pre-lay trenching will continue across the Boddenrandschwelle and along the eastern slope of the Boddenrandschwelle.

The common pipeline trench will be backfilled and the seabed surface reinstated as pipe-laying progresses.

After the second-generation lay barge has completed the pipe-laying operations at KP 55, it will be relocated and set up at the seaward end of the tunnels, in order to facilitate the shore pull-ins of the two pipelines through the tunnels.

## **6.8 Pre-commissioning and commissioning**

Following construction and prior to operations, pre-commissioning and commissioning activities are undertaken.

Pre-commissioning refers to a series of activities carried out before the introduction of natural gas into the pipelines. Pre-commissioning serves to confirm the mechanical integrity of the pipelines and ensures they are ready for safe operational use with natural gas.

Commissioning activities include the filling of the pipelines with natural gas prior to operation.

### **6.8.1 Pre-commissioning – offshore pipeline sections**

After installation, the NSP2 pipelines will undergo a series of activities to prepare the pipeline system for use. These activities include cleaning, gauging and testing/leak detection.

The offshore pipeline pre-commissioning concept for NSP2 will be completed after receipt of the pipe-laying bids and finalisation of the pipe-laying scenario.

NSP2 plans a 'dry pre-commissioning' concept where the offshore pipelines will not be flooded and there will be no hydro-test or hyperbaric tie-ins as performed for NSP. DNV (certifying authority) has agreed to a conditional concession to the DNV design code OS-F101. Should the concept not be accepted by the national permitting authority, the back-up would be a 'wet pre-commissioning' solution, i.e. each section of the pipelines would be pressure tested with seawater which would be discharged in Russia outside the Kurgalsky nature reserve. Therefore, two options are under investigation.

These are:

- **Option 1:** Dry pre-commissioning without pressure testing using alternative testing methods and without hyperbaric weld tie-ins (HWTIs).
- **Option 2:** Standard wet pre-commissioning operations as done for NSP. For this option, HWTIs are required.

### **Option 1: dry concept**

For dry pre-commissioning, the offshore pipelines will not be pressure-tested with water. Only cleaning and gauging will be considered using dry air as a pigging medium produced by a bank of diesel-fired compressors located at the German landfall. Pipeline air pressure during these operations will be 30 bar.

The pipelines will not be water-filled and, consequently, no dewatering and drying is required. Leak detection will be carried out using an inspection pig or alternatively by an external ROV survey in conjunction with the cleaning and gauging of the pigging operation. As no water is used, there will be no additives and no such test water discharges offshore.

In accordance with this approach, hyperbaric tie-in operations will not be needed since laying activities from Russia to Germany will be performed by means of shallow and deep water barges, which will operate through multiple pipeline abandonments and recoveries. If this option is chosen, no rock embankments for hyperbaric tie-ins will be required.

For the dry concept, pre-commissioning activities affect the landfalls in Germany and Russia. There are no relevant pre-commissioning activities or impacts in the offshore sections of the pipelines in Finland, Sweden and Denmark.

### **Option 2: wet concept**

Wet pre-commissioning includes pressure testing with water. The offshore pipeline design is divided into three sections as listed below and tested at three different test pressure values:

- First offshore section from the pull head in Russia to approximately KP 300 (in Finland);
- Second offshore section from approximately KP 300 to approximately KP 675 (in Sweden);
- Third offshore section from approximately KP 675 to the pull head in Germany.

The following wet pre-commissioning activities are to be performed:

- Flooding, cleaning and gauging;
- Pressure testing.

Flooding, cleaning and gauging of each section will be performed using a pumping spread on board a suitably sized construction vessel at the HWTI locations. A pig train consisting of four bidirectional pigs fitted with aluminium gauge plates will be propelled through each of the offshore sections.

Filtered seawater sourced at the HWTI locations and dosed with an oxygen scavenger to prevent corrosion of the pipelines will be used for the operations. The active substance in the oxygen scavenger will be sodium bisulphite, NaHSO<sub>3</sub>. The concentration of the oxygen scavenger is 85 ppm. No other chemical additives are envisaged. Additionally, ultraviolet (UV) treatment may be required to reduce the number of bacteria present in the seawater.

Pressure testing of sections 1 and 2 will be performed at the HWTI locations (KP 300 and KP 675). Pressure testing of section 3 will be done from landfall Germany. All three sections will be pressure tested in accordance with DNV.

Temporary offshore pipeline pre-commissioning sites at the Russian and German landfalls are located outside the permanent PTAs. Both sites include temporary water storage facilities, of approximately 7,000 m<sup>3</sup> in Russia and 12,000 m<sup>3</sup> in Germany. Additionally, temporary pig traps, pressure test blinds, valves and various piping required at the landfall sites will be located within or in proximity of PTA.

After the performance of the pressure test, the segments will be connected by means of two subsea or HWTIs. Once all HWTI operations are complete, the following operations can take place for the completed offshore pipelines:

- Dewatering;
- Drying.

The wet pre-commissioning concept for the offshore pipelines is to supply seawater from a section break offshore and discharge seawater at the Russian landfall. Approximately 1,300,000 m<sup>3</sup> of seawater will be required to fill each of the two pipelines. All water will be taken from the hyperbaric tie-in locations at a water depth of 5-15 m.

During pre-commissioning operations, a limited discharge from the pipeline(s) is expected at the hyperbaric tie-in locations in Finland and Sweden. This water will not be treated with any additives. Discharge locations and amounts of water will depend on the actual sequence of operations.

During dewatering, a pig train will be launched from Germany towards Russia. The medium used to propel the pig train will be dried compressed air produced by a bank of diesel-fired compressors at the German landfall. As it travels through the pipelines, the pig train will push all 1,300,000 m<sup>3</sup> of treated water out of the pipelines. At the Russian end, discharged water will be routed via a temporary pipeline back into the sea.

#### **Hyperbaric weld tie-ins**

At least two subsea or HWTIs are required on each pipeline. The tie-in technique is used to connect two pipe sections that have previously been laid down during various phases of the construction works. Each of the project pipelines will be built in three sections with different wall thicknesses. The sections can be connected under water, using HWTIs (Figure 6-23) to form the complete pipelines.

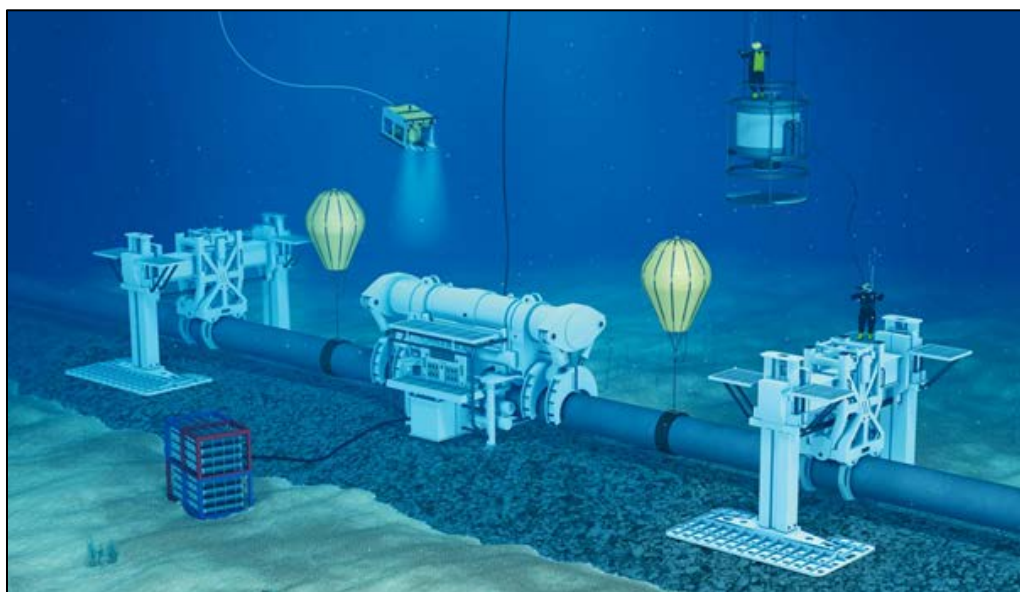


Figure 6-23 Hyperbaric tie-in setup

Hyperbaric tie-ins will consequently be conducted on the seabed at the two locations where the pipeline wall thickness changes. At both locations, gravel berms will be installed on the seabed to provide stability for the tie-in operations. Once a section of the pipeline is installed, a lay down head will be welded to the end of the pipelines before the pipe-laying vessel lays it down. This head provides an air- and water-tight seal.

At the tie-in locations, the ends of the two respective pipeline sections overlap. Then, for hyperbaric welding, they will be aligned using large H-frames and cut back. An underwater habitat or 'hyperbaric chamber' will be placed over the connection, and the pipelines will be welded together inside that habitat. The entire operation will be remotely controlled from a support vessel and assisted by divers. Once the tie-ins are finished, the habitat will be removed and a survey will confirm the correct position of the pipelines.

### 6.8.2 Onshore pipeline section and PTA

The pre-commissioning operations on the pipeline onshore sections and the PTAs at either landfall include the following pre-commissioning operations:

- Flooding, cleaning, gauging and pressure testing using untreated fresh water;
- Dewatering and drying;
- Nitrogen/helium leak testing of the PTA (PTA only);
- Leak testing of all valves 16" and larger (PTA only).

Testing shall be in accordance with relevant codes and authority requirements. The onshore sections will be left filled with nitrogen at 0.5 bar over-pressure upon completion of the pre-commissioning operations.

### 6.8.3 Commissioning

Commissioning comprises all activities that take place after pre-commissioning and until the pipelines commence natural gas transport, including filling the pipelines with natural gas.

Prior to the activity of gas-in, all pre-commissioning activities must be completed successfully and the pipelines will be filled with dry air that is close to atmospheric pressure. A nitrogen batch will be used to separate pipeline air content from injected hydrocarbon gases and to ensure that no intermixing is possible between air and hydrocarbons. Nitrogen and natural gas will be introduced into the pipelines from Russia.

The gas filling operation is carried out in two stages. The first stage comprises replacement of air and nitrogen by hydrocarbon gases. During this phase, the pipeline blowdown system in the PTA in Germany (PTAG) will be used to vent off the air as well as the nitrogen batch. During this phase the pipelines will not be pressurised.

The second stage comprises pipeline pressurisation. This will commence upon detection of on-spec hydrocarbon gas at the vent location in PTAG. At this point, the blowdown system will be closed and the PTAG will be set into operational configuration up to the first block valve in the downstream system.

Gas injection will continue from the Russian side until the required pipeline pressure to start normal operation is achieved.

## 6.9 Operation

Nord Stream 2 AG will be the owner and operator of the pipeline system. The system is designed for an operating life of at least 50 years. An operations concept and security systems will be developed to ensure the safe operation of the pipelines, including avoiding over-pressurisation,

managing and monitoring potential gas leaks and ensuring material protection. The operation system is currently planned to be very similar to NSP.

### 6.9.1 Main pipeline system facilities

The protection, control and monitoring strategy for NSP2 will rely on equipment at the landfall facilities (PTAs) in Russia and Germany. Management and supervision will be undertaken by the main control centre (MCC) in Switzerland with a back-up facility also located in Switzerland.

The PCCS is a general monitoring and safety system comprising various control, pressure safety and emergency shutdown mechanisms. As with NSP, the PCCS will be used in NSP2, and under normal operating conditions the MCC is the central point for control and monitoring. The back-up control centre (BUCC) will only be staffed in case of an emergency situation during which the MCC is not operational or undergoing function testing. For this reason, there will be redundant communication links between the PTAs in Russia and Germany, between the two areas and the control centres (MCC and BUCC) and between the centres themselves.

### 6.9.2 Normal pipeline operations

Normal operating conditions are those in which the pipeline system flow rate, pressures and temperatures are all within the pipeline design parameters and in which the flow rate is regulated in accordance with the notification requirements of the gas transportation agreement. The inlet flow of the pipelines will be controlled by the number of compressors at the Russian compressor station, while the outlet pressure of the pipelines will be controlled by the control valves of the GRS. The speed of the compressors will be adapted automatically in order to provide the necessary outlet pressure.

### 6.9.3 Maintenance and repair

Planned maintenance and scheduled inspections will be carried out in accordance with DNV GL requirements, statutory requirements as well as recognised good industry practice. Planned maintenance and inspections of the landfall facilities will be carried out throughout the year to ensure operation. Any large-scale maintenance activities will be performed during a yearly shutdown in non-winter months.

Based on experience from NSP, an extensive repair strategy will be developed for the onshore and offshore facilities of NSP2.

## 6.10 Decommissioning

NSP2 is designed to operate for at least 50 years, and the operational life of the pipelines could be extended beyond 50 years under certain circumstances. The technological options and preferred methods for decommissioning of offshore installations and pipelines most likely will have changed in 50 years' time, when the NSP2 pipelines may be decommissioned.

Therefore the decommissioning programme will be developed towards the end of the operations phase and will reflect technical know-how gained over the operational life of the pipelines.

Reference is made to Chapter 12 – Decommissioning on the legislative framework and current practices.

## 6.11 Schedule

### 6.11.1 Overall schedule

The project schedule is presented in Figure 6-24. It includes the following phases:

- **2012/13:** Feasibility study running concurrently with the EIA programme consultation phase;

- **2015 - 2017:** Permitting and EIAs running concurrently with surveys and engineering;
- **2015 – 2019:** Procurement and delivery and pipe logistics;
- **2018 – 2019:** Construction and commissioning;
- **2018 – 2020 and beyond:** Environmental monitoring;
- **2020 and beyond:** Operations.

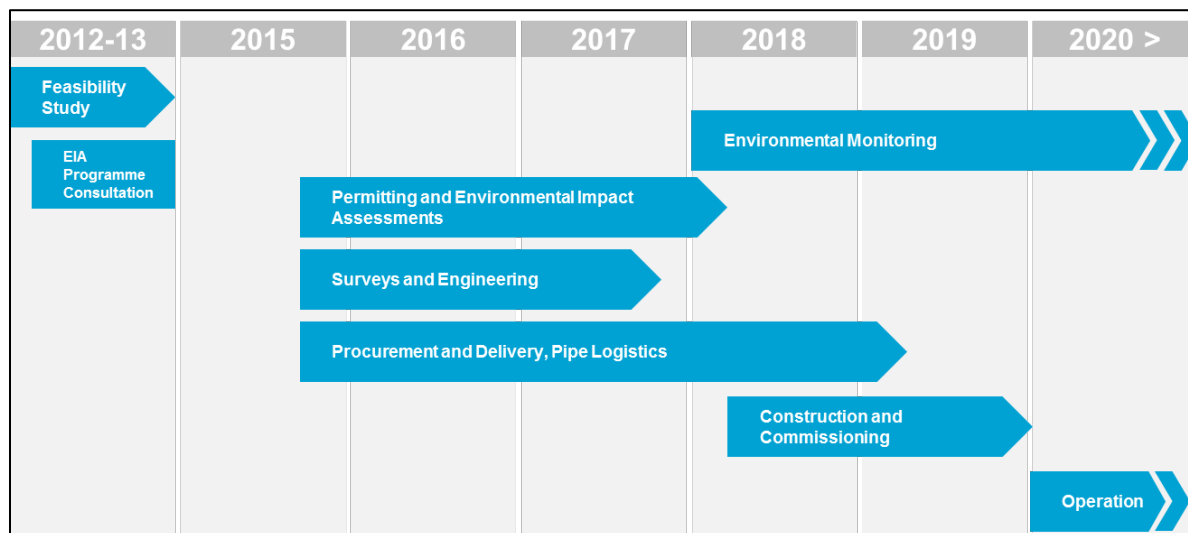


Figure 6-24 NSP2 project schedule.

### 6.11.2 Construction schedule

The construction schedule showing the timing for key construction activities is presented in Figure 6-25.

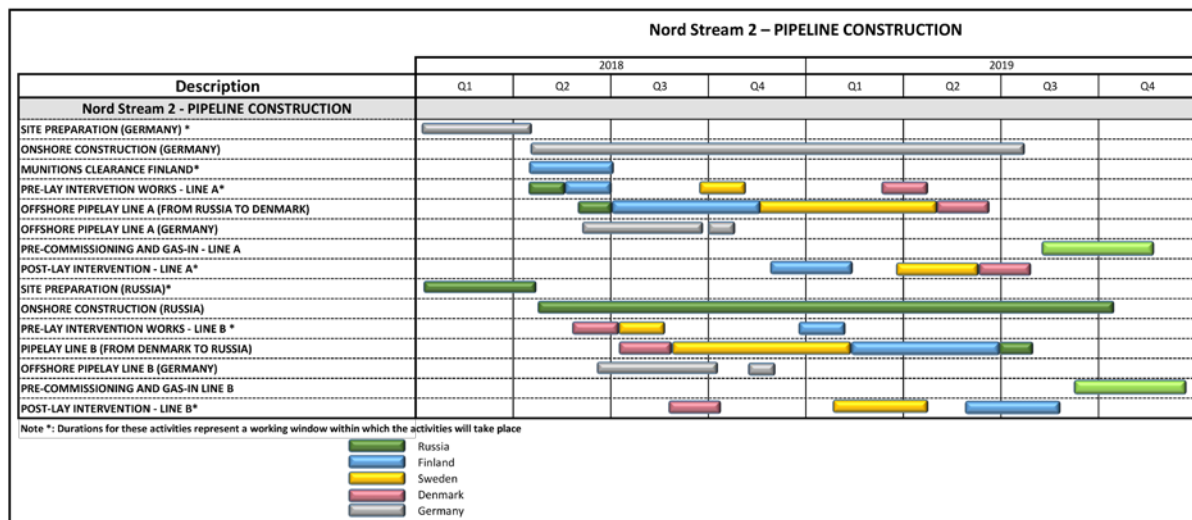


Figure 6-25 NSP2 construction schedule.

## 7. METHOD ADOPTED FOR PRODUCTION OF ESPOO ENVIRONMENTAL ASSESSMENT DOCUMENTATION

### 7.1 Introduction

As outlined in Section 1.2, the purpose of the Espoo Report is to provide:

- A statement on all potential transboundary impacts which clearly identifies where activities in one country may result in potentially significant impacts in neighbouring countries;
- An overall assessment of the impacts of the NSP2 project that evaluates 'in-combination' impacts on each receptor group, irrespective of geopolitical borders.

The environmental assessments draw on the findings of the national EIAs and ES and/or studies and assessments performed to prepare for the national EIAs and ES. These have been completed in compliance with the respective national permitting requirements of the five national jurisdictions where sections of the project will be located, i.e. the PoOs). The methodology outlined below therefore sets out how information contained in the national documentation has been analysed and presented to deliver the above outputs. It addresses impacts from planned project activities (i.e. impacts that may result from routine project implementation activities).

While highly unlikely to occur, impacts from unplanned or non-routine events (e.g. a fuel/oil spill during construction) could have substantial consequences and therefore also require consideration. A risk assessment has been undertaken in Chapter 13 – Risk assessment.

For the purpose of this report, the term 'environmental impact' is used to include environmental and social impacts.

### 7.2 General approach

In order to meet the requirements set out above, the following sequential steps have been undertaken:

- Scoping of potentially affected receptors, which have been addressed through the PID, the national EIAs/ES and subsequent consultation undertaken in 2013-2016 (Chapter 4 – Espoo process);
- Identification of the potential significant environmental and social impacts of the project;
- Baseline characterisation of the resources and receptors that could potentially be impacted;
- Assessment of potential impacts;
- Development of measures to address potentially significant impacts through mitigation;
- Assessment of potential transboundary impacts;
- Assessment of potential cumulative impacts.

These steps have been customised to take account of the specific context of NSP2 (see Table 7-1) and are further elaborated on in Sections 7.3 to 7.8.

**Table 7-1 Issues specific to NSP2 and adopted approach.**

Issues specific to NSP2	Espoo approach
<p><b>Challenges of multiple national permitting processes</b></p> <p>The requirement for national permitting necessitates dividing and assessing the project as five subprojects, with each assessment considering impacts (including transboundary impacts) arising</p>	<p>Preparation of an overarching report that considers the impacts of the entire project irrespective of national borders.</p> <p>The adopted approach comprises a summary of the impacts identified in each country as well as the</p>

Issues specific to NSP2	Espoo approach
<p>from activities within the respective national borders. Impacts arising from parts of the project that are located in other countries are not addressed.</p>	<p>consequences of their in-combination occurrence across national borders (within the overall NSP2 project) and interactions with other planned projects (cumulative impacts).</p>
<p><b>Complexity of project</b> The project is located in the TW and/or EEZ of five countries and there is a possibility of cross-border impacts in the jurisdictions of other APs as a result of onshore and offshore activities, which included core components (owned and operated by Nord Stream 2 AG) and ancillary facilities (owned and operated by third parties).</p>	<p>Design and application of a systematic, logical and transparent process for identifying, evaluating and addressing impacts and a clear reporting structure to ensure all issues (technical, temporal and spatial) are adequately considered in the assessment, with transboundary impacts in particular being highlighted.</p>
<p><b>Integration of different national requirements and approaches into an overarching EIA</b> The different requirements of national agencies and legislation with respect to the content and methodology (e.g. models) used in the national EIAs/ES and the applicable standards (e.g. protection status of species and habitats, environmental quality standards (EQSs) for contaminants) may constrain the ability to undertake a consistent in-combination assessment of each receptor group across the entire NSP2 project.</p>	<p>While the Espoo assessment has, wherever possible, applied a consistent approach to the evaluation of impacts arising in each PoO, it has, where relevant, highlighted differences in national requirements and their implications, if any, for the assessment of specific impacts.</p>
<p><b>Different standards in a transboundary context</b> Differences in national standards (e.g. EQSs, objectives and targets in relation to the WFD and MSFD etc.) of the PoO and APs may mean that the assessment of some transboundary impacts within the EIA of the PoO may not be consistent with the standards of the APs.</p>	<p>The clear identification of transboundary impacts and their nature within this report (Chapter 15 – Transboundary impacts) will enable each country where there is transboundary impact to review such impacts against their own national standards and targets and to address any perceived potential shortcomings in their consideration through consultations between concerned parties (Step 5 of the Espoo process in Section 3.2).</p>
<p><b>Ensuring and facilitating full participation of stakeholders and interested parties</b> A diverse audience including interested individuals, the general public, decision makers and politicians as well as special interest groups and technical experts in nine different countries.</p>	<p>The approach duly considered the requirements of the Espoo Convention to give the public in APs the opportunity to be informed and to express their views. This has been achieved through the translation of the Espoo Report into the nine languages of the PoOs and APs and through the provision of documentation that provides information at the appropriate level of detail that can be understood by the different target audiences, e.g. through production of the non-technical summary (for the general public), the main Espoo Report (for an informed non-specialist audience and decision makers) and the appendices to the Espoo Report (for technical specialists and advisors). This information has been widely publicised and disseminated, including online.</p>
<p><b>Addressing of stakeholder views</b> Stakeholder comments raised in response to the PID and consultation process.</p>	<p>The scoping of issues as well as attention given to them in the assessment process took account of the comments raised during consultations and included, where appropriate, the incorporation of stakeholder views in the assessment criteria.</p>



### 7.3 Identification of potentially significant impacts

Following the notification phase of the Espoo process (Section 3.2), the scope of the assessment was refined. The scoping exercise established the technical, spatial and temporal scope of the assessment. It was informed, amongst others, by the comments provided in response to the PID and those raised through various consultation events in the five PoOs and the four APs.

#### 7.3.1 Technical scope

The environmental and socio-economic resources and receptors which could potentially be impacted by NSP2 were identified through a review of the core and ancillary project components during the construction and operation phases, as well as the general nature of baseline conditions. The former were established through a review of the project description in Chapter 6 – Project description, whilst the latter were determined through desk studies, dedicated environmental surveys (see Table 9-1, in Chapter 9 – Environmental baseline) and reviews of relevant secondary information, including the national EIA/ES documents. The identified resources and receptors are summarised in Table 7-2.

**Table 7-2 Resources and receptors potentially susceptible to impacts from NSP2.**

Environment	Resources and/or receptors
Physical environment	Terrestrial geomorphology and topography
	Freshwater hydrology (surface and groundwater)
	Marine geology, bathymetry and sediments
	Hydrography and seawater quality
	Air quality and climate
Biological environment	Terrestrial flora and fauna
	Plankton
	Benthic flora and fauna
	Fish
	Marine mammals
	Birds (seabirds and waterbirds)
	Natura 2000 sites
	Other protected areas
	Marine biodiversity
Socio-economic environment	People
	Tourism and recreational areas
	Cultural heritage
	Traffic
	Commercial fisheries
	Raw material extraction sites
	Military practice areas
	Existing and planned infrastructure
	International/national monitoring stations

Chapter 8 – Identification of environmental impacts provides a short analysis of how the various project activities and components may affect the receptors and resources identified in Table 7-2.

Chemical and conventional munitions are not environmental receptors, and therefore are not included in Table 7-2. However, the consequences of their potential presence in the vicinity of NSP2 was identified during consultations as an issue requiring particular consideration. Therefore they are considered as a specific topic within the baseline characterisation (Chapter 9 – Environmental baseline) in order to document where such features may be present within the areas potentially affected by NSP2. Potential impacts (noise, scour, etc.) associated with the planned detonation of conventional munitions are addressed in Chapter 10 – Assessment of environmental impacts, while those arising from unplanned detonation are covered in Chapter 13

– Risk assessment. The potential for mobilisation of CWAs is addressed specifically within a special section within Chapter 10, and this information is then used, together with data on other contaminants, to inform the wider assessment of the release of contaminants from sediments within the relevant sections of Chapter 10 (sediment quality, water quality, etc.).

Similarly, marine biodiversity (variability within species, between species and between habitats, ecosystems, as well as ecosystem functionality) has been included as a special topic within the biological sections of the report to ensure due consideration has been given to potential impacts at an ecosystem level, particularly with respect to the interaction of the receptors/resources associated with the marine biological environment (in line with the requirements of the MSFD).

The analysis provided in Chapter 8 – Identification of environmental impacts has identified interactions which have the potential to result in significant impacts and therefore informed the determination of specific issues to be carried forward to the baseline characterisation and impact assessment stage, as discussed in Chapters 9 – Environmental baseline and 10 – Assessment of environmental impacts.

In addition to analysing potential impacts on specific resources/receptors, it is also important to consider the impacts of NSP2 in the context of relevant EU legislation designed to protect the marine environment (i.e. MSFD, WFD and Baltic Sea Action Plan). This is addressed in Chapter 11 – Marine strategic planning.

### 7.3.2 Spatial scope

The pipeline route is approximately 1,200 km in length. Onshore PTAs will occupy areas of 6.25 ha in Russia and 4 ha in Germany. There will be some restrictions above the buried pipeline section in Russia. Additional areas, both onshore and marine, will be occupied temporarily during construction. Ancillary activities will be accommodated within existing facilities. The geographical area that may be affected by the project (area of influence) varies depending on how the aspects<sup>4</sup> of each project activity propagate spatially from these project areas. The extent of such propagation therefore informs the environmental impact identification exercise reported in Chapter 8 – Identification of environmental impacts, as well as the area of influence for each impact discussed in Chapter 10 – Assessment of environmental impacts. Of particular relevance to this Espoo assessment is the identification and consideration of aspects where the area of influence extends across national borders (transboundary). These are therefore specifically highlighted in the assessment in Chapter 10 and summarised in Chapter 15 – Transboundary impacts.

The study area may extend beyond the area of influence for some receptors/resources. This arises as a result of the need to consider, as part of the assessment, the context in which the receptor 'exists'. For example, the magnitude of an impact on a particular species will be determined through consideration of the percentage of the regional population affected rather than merely the absolute numbers. Similarly, impacts on Natura 2000 sites, which form part of a larger network of protected areas, will be determined through consideration of which, if any, of the key species or sites are impacted and the potential for impacts to also affect the integrity and functioning of the wider network.

For the purposes of this report:

- **Marine areas** are defined as offshore areas of the Baltic Sea (with the exception of the Bothnian Bay and the western part of the Arkona Basin) and nearshore areas. Where receptors/resources are associated with both the terrestrial and marine areas (e.g. waterbirds) these are addressed within the "marine areas" sections of the report.

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<sup>4</sup> An aspect is a component of an activity that interacts with the environment (e.g. noise generation, sediment mobilisation). This is distinct from an impact, which is the consequence of the aspect (e.g. hearing loss, reduction in water quality).

- **Onshore areas** are defined as everything that is strictly onshore and has no offshore component, e.g. geomorphological characteristics, terrestrial habitats and species present in the landfall areas in Russia and Germany, together with the nearby communities present on land. It also applies to areas in the vicinity of the pipe storage yards, pipe coating facilities and roads used to transport materials.

### 7.3.3 Temporal scope

The temporal scope addresses both the timing of the project activities and the duration of the resulting impacts.

The project activities will occur in three phases:

- Construction (including pre-commissioning and commissioning);
- Operation;
- Decommissioning.

The construction phase of the two pipelines is planned to last approximately two years, while construction of the onshore facilities will last 21 months in Russia and 19 months in Germany.

The operational life of the pipelines is anticipated to be at least 50 years.

Given the uncertainty with regard to the method to be used for decommissioning (see Chapter 6 – Project description), a qualitative assessment of potential scenarios including their timing is provided in Chapter 12 - Decommissioning.

The duration of impacts will be highly dependent on their nature and the affected receptor. For example, the release of suspended sediment into the water column may have a short duration, as well as a short-term impact on water quality, whereas increases in the noise level, even though of short-term duration, could have long-term impacts on certain marine mammals. Therefore the duration of impact was a key element in the assessment of impact significance.

It should be noted that impacts during the construction phase will not occur along the full length of the pipeline route at the same time but will be restricted to specific areas (i.e. the area affected by pipe-laying activities will move forward in unison with the lay barge as it progresses along the pipeline route).

## 7.4 Baseline determination

Baseline conditions were determined through a review of the baseline sections of the national EIA/ES reports. These sections of the EIAs/ES were informed by analyses of secondary data, including relevant scientific literature, and results of surveys in both the marine and onshore environments undertaken specifically for NSP2. The marine surveys included those covering seawater, sediments, marine biology and cultural heritage features while those of onshore areas covered landfall and relevant ancillary areas and included social economic parameters, cultural heritage and terrestrial biology. A list of such surveys is provided in Section 9.1.

This information was synthesised to generate a baseline for the NSP2 project in its entirety and thus inform the impact assessment of the overall project.

A key element of the baseline determination was the appraisal of receptor importance according to criteria outlined in Section 7.5.2.

## 7.5 Impact assessment

While the Espoo assessment also took account of the assessments undertaken for each national EIA/ES, it focused on providing an overarching assessment of the NSP2 project in its entirety, rather than a summation of impacts identified at the national level. This approach ensures that an adequate assessment of in-combination impacts on each receptor group was undertaken, including interactions between impacts arising in different national jurisdictions.

The assessment was able to draw on a substantial body of information generated by the monitoring programme of NSP, undertaken during both its construction and operation. That programme provided a unique and valuable source of empirical data which could inform the prediction of the nature and scale of impacts that could be anticipated to arise from NSP2, which has a similar design, alignment and construction method to that of NSP.

The process for assessing environmental impacts is outlined in Figure 7-1. Following the identification of potential impacts and receptor sensitivity to the impact (importance evaluated in Chapter 9 – Environmental baseline and resilience to change evaluated in Chapter 10 – Assessment of environmental impacts), the process involves the determination of the nature and type of impact, as well as its magnitude and how it will affect receptors.

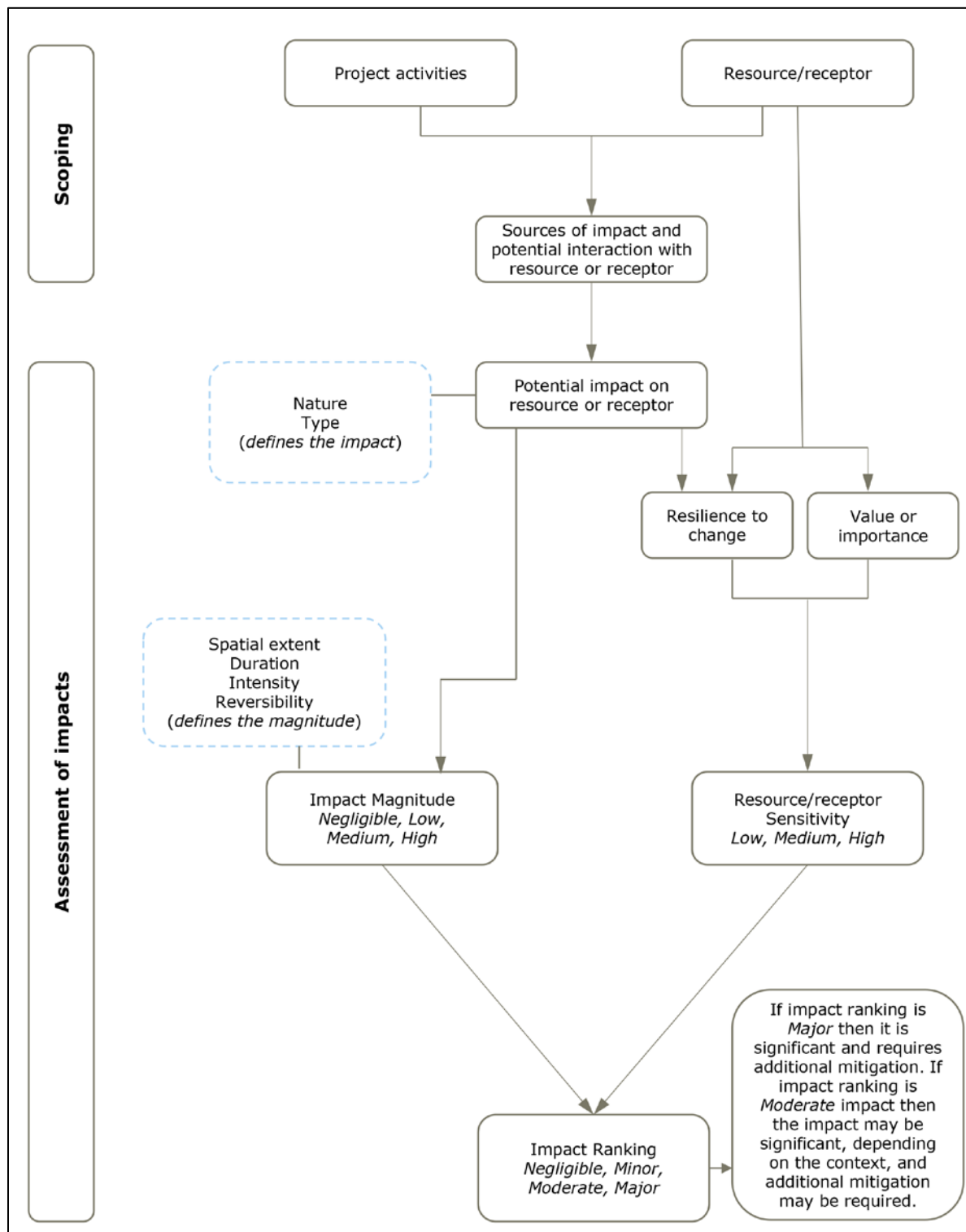


Figure 7-1 Process for identifying environmental impacts and assessment of potential impacts from planned activities.

The project activities/facilities that will be assessed are shown in Table 7-3, see also Section 6.2.1.

**Table 7-3 Definition of NSP2 assessment.**

Project activities	Assessment
Core activities	All project activities will be fully assessed in the national EIAs/ES and in the Espoo Report.
Ancillary activities	Operation of weight-coating plants, pipe storage yards, storage areas and associated transport activities will be assessed in terms of emissions (e.g. noise, air emissions) and, where applicable, socio-economic impacts.

### 7.5.1 Impact nature type and magnitude

Impacts are classified according to their nature (negative or positive) and type as outlined in Table 7-4. Such characteristics are relevant to the EIA process, in particular in developing the mitigation or enhancement measures that can be applied and in evaluating the degree to which the predicted impacts can be managed by such measures.

Transboundary impacts, which are a key focus of this Espoo Report, require particular consideration. The approach to identifying and addressing transboundary impacts is therefore specifically addressed in Section 7.8. Similarly, cumulative impacts also warrant attention and are considered in Section 7.8.

**Table 7-4 Nature and type of impact.**

<p><b>Nature of impact</b></p> <p><u>Negative</u><sup>1</sup>: impact that is considered to represent an adverse change from the baseline or to introduce a new, undesirable factor.</p> <p><u>Positive</u><sup>1</sup>: impact that is considered to represent an improvement to the baseline or to introduce a new, desirable factor.</p> <p><b>Type of impact</b></p> <p><u>Direct</u>: impact that results from a direct interaction between a planned project activity and the receiving environment (e.g. the loss of a habitat during pipeline installation).</p> <p><u>Indirect</u>: impact that results as a consequence of direct impacts or other activities that occur as a consequence of the project (e.g. an increase in fishery activity along the pipeline route due to the creation of an artificial habitat favourable to certain target species).</p> <p><u>Cumulative</u>: impact that may occur as a result of a planned project activity in combination with other planned infrastructure or activities. The individual projects may generate their own individually insignificant impacts, but when considered in combination, the impacts may have an incrementally significant cumulative impact on receptors.</p> <p><u>Transboundary</u>: impact that may occur within one EEZ/TW as a result of activities in the EEZ/TW of another country (e.g. the propagation of noise across national borders).</p> <p>Note<sup>1</sup>: In certain circumstances, it can be argued that an impact can be classified as negative and/or positive. Whether the impact is one or the other depends largely on expert opinion. In such cases, both classifications are argued.</p>
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The magnitude of an impact is a measure of the change in the baseline conditions and is described in terms of several parameters, including spatial extent (or number/percentage of receptors affected), duration, intensity and reversibility of the impact, as outlined in Table 7-5.

These parameters have been determined through a range of methods, including:

- Monitoring of sediment dispersion and underwater noise propagation undertaken during NSP;

- Modelling undertaken for the national EIA/ES studies, notably sediment dispersion modelling, underwater noise modelling and contaminants dispersion modelling (Section 10.1 and Appendix 3);
- Calculations of air emissions;
- Other monitoring data and experience from NSP;
- Reference to scientific literature and other relevant studies and guidance and experience of the project team.

Further details are provided in Chapters 9 – Environmental baseline and 10 – Assessment of environmental impacts.

**Table 7-5 Impact magnitude.**

<p><b>Degree of reversibility</b></p> <p><u>Reversible</u>: impact on resources/receptors that ceases to be evident, either immediately or following an acceptable period of time, after termination of a project activity (e.g. turbidity levels in the water column will return to normal levels shortly after the construction works in an area are finalised).</p> <p><u>Irreversible</u>: impact on resources/receptors that is evident following termination of a project activity and that remains for an extended period of time; impact that cannot be reversed by implementation of mitigation measures (e.g. occupation of the seabed by the pipelines).</p> <p><b>Spatial extent of impact</b></p> <p><u>Local</u>: impact in the immediate vicinity of the pipelines/construction site and restricted to the pipeline route corridor (approximately 5 km wide).</p> <p><u>Regional</u>: impact extending more than 5 km outside the pipeline corridor.</p> <p><b>Duration of impact</b></p> <p><u>Temporary</u>: impact that is predicted to be of very short duration and/or intermittent/occasional in nature and that will cease shortly after completion of the activity (e.g. reduced water quality as a result of suspended sediment during rock placement, avoidance behaviour in fish as a result of pipe-laying activities).</p> <p><u>Short-term</u>: impact that is predicted to last for only a limited time period and will cease within a few years (<math>\leq 3</math>-5 years) of completion of the activity, either as a result of mitigation/reinstatement measures or natural recovery (e.g. impacts and re-establishment of benthic fauna communities after trenching the pipelines into the seabed and after reinstatement of the seabed).</p> <p><u>Long-term</u>: impact that is predicted to continue over an extended period (<math>&gt; 3</math>-5 years) (e.g. restrictions on other marine activities/development in the vicinity of the pipelines, e.g. wind farms).</p> <p><b>Intensity of impact</b></p> <p><u>Low</u>: impacts may be forecast but they are frequently at the detection limit and do not lead to any permanent change in the structures or functions of the resource/receptor concerned, or there may be some permanent changes but they affect a small number or percentage of receptors.</p> <p><u>Medium</u>: there may be some detectable alterations to the resource/receptor concerned but its basic structure/function is retained.</p> <p><u>High</u>: the structures and functions of the resource/receptor are affected partially/completely.</p>
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The evaluation of impact magnitude has adopted a qualitative ranking of negligible, low, medium or high based on the parameters outlined in Table 7-14. The criteria for such rankings are both impact and receptor specific and are therefore outlined for each receptor type (physical-chemical, biological and social-economic) in Table 7-6, Table 7-7 and Table 7-8.

**Table 7-6 Impact magnitude – physical-chemical environment.**

Ranking	Definition
Negligible	Change to a physical resource/receptor that is local and within natural variations. The environment will revert to pre-impact status immediately after the activity causing the change ceases.
Low	A change to a physical resource/receptor that is localised and detectable above natural variations but within relevant quality standards. The environment will revert to pre-impact status once the impact ceases and there will be no long-term effect on the functioning of the ecosystem.
Medium	A change to a physical resource/receptor that may extend beyond the local scale and/or result in some local exceedances of relevant quality standards. It may alter the long-term functioning of the ecosystem on a local scale.
High	A change to a physical resource/receptor outside the natural variation which may result in exceedances of relevant quality standards at numerous locations and/or affect the long-term functioning of the ecosystem beyond the local scale.

**Table 7-7 Impact magnitude – biological environment.**

Ranking	Definition
Negligible	Change to the conditions of a habitat or individual/specific group of individual species may occur but is generally undetectable and within the range of normal natural variations and occurs locally and only for the period when the specific construction activity is carried out.
Low	<p>Measurable change to the conditions of a habitat, but it is within the range of natural variations and within a limited area and does not affect its viability or functioning. Conditions will revert to pre-impact status within a short period of time.</p> <p>Perceptible change to a species that affects a specific group of localised individuals within a population but is within natural variations and/or occurs over a short time period (one generation or less) and does not affect other trophic levels or the population itself.</p>
Medium	<p>Localised changes to habitat that are outside the range of natural variations but do not affect its long-term functionality.</p> <p>Clearly evident change from baseline conditions resulting in reduction in portion of a species population and may lower abundance and/or distribution over one or more generations but does not threaten the long-term integrity of that population or any population dependent on it.</p>
High	<p>Widespread and/or permanent disturbance or loss of habitat threatening the long-term functioning of habitats.</p> <p>A change on a species that affects an entire population or causes a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.</p>



**Table 7-8 Impact magnitude – socio-economic environment (excluding cultural heritage, see Table 7-9).**

Ranking	People	Economic/ other services
Negligible	Change to the levels of amenity, safety, well-being or other parameters. The impact is undetectable or within normal levels experienced within the households or community.	No perceivable change in levels of revenue generated by businesses at the national or local level.  No disruption of access to or functioning of public services.
Low	Perceptible difference to the amenity, safety, well-being or other parameters that affects a small proportion of households or communities and/or is of short duration.	Changes that may affect revenue-generating capacity of local businesses but are of short duration.  Changes that may affect a small proportion of the business sector at the national level and/or of short duration.  Disruption of access to, or functioning of, a small proportion of public services and/or of short duration.
Medium	Clearly evident difference in levels of amenity, safety, well-being or other parameters from baseline conditions with the impact affecting a substantial area or number of people and/or extending beyond short duration.	Changes that may affect revenue-generating capacity of local businesses beyond the short term.  Changes that may affect revenue-generating capacity for a substantial percentage of business in the sector at national level for a short duration or a smaller percentage but for a longer duration.  Disruption of access to, or functioning of, public services on a regional scale and/or of medium duration.
High	Change in levels of amenity, safety and well-being or other parameters. The impact dominates over the baseline conditions affecting the majority of the areas or population in the area of influence.	Permanent or long-term changes to revenue-generating capacity at national level that could be experienced over a regional or national area.  Permanent or long-term disruption of access to, or functioning of, public services on a regional or national scale.

**Table 7-9 Impact magnitude – cultural heritage.**

Ranking	
Negligible	No discernible change in the physical condition of the archaeological potential setting or accessibility and enjoyment of the site or feature.  No perceivable change in intangible resource/asset.
Low	Small part of the site is lost or damaged resulting in a loss of scientific or cultural value or archaeological potential. The setting undergoes a temporary or permanent change that has a limited effect on the perceived value of the site to stakeholders.  Public and expert access to the site/resource may be temporarily restricted.

Ranking	
Medium	<p>A large portion of the site is damaged or lost resulting in a loss of scientific or cultural value and perceived/actual value to stakeholders. The setting undergoes permanent change that diminishes the value of the site.</p> <p>Access to the site is permanently reduced or restricted.</p>
High	<p>The entire site or resource is damaged or lost, resulting in a loss of all scientific or cultural value or archaeological potential.</p> <p>The setting of the site or resource is impacted to such a degree as to cause almost complete loss of value to stakeholders and loss of access to the site or resource.</p>

### 7.5.2 Receptor sensitivity

The sensitivity of a receptor or resource describes the characteristics of the target of a certain impact, i.e. how the receptor or resource may be more or less susceptible to a given impact.

Two key criteria are used to determine the level of sensitivity:

- **Importance**, describing the qualities of the receptor, e.g. ecosystem functions and its value as recognised by e.g. its conservation status (e.g. International Union for Conservation of Nature (IUCN), its protection or prioritisation under EU or Baltic State legislation, plans, policies, etc.), its cultural importance or economic value, or its identification by stakeholders with a valid interest in the project. The importance of a receptor is an inherent characteristic, irrespective of project activities. Where applicable the importance has been graduated (low, medium, high), e.g. the biological sections, otherwise it is rated as important or not important. The criteria for determining receptor/resource importance for the physical-chemical, biological and socio-economic environment have been provided in Chapter 9 – Environmental baseline.
- **Resilience to change (or vulnerability)**, describing the degree to which a resource or receptor can withstand project activities without a change to its status. Resilience is thus also characteristic of a receptor but is not inherent to it, as it is also influenced by the nature of the impact to which it is subject. The resilience to change is discussed in Chapter 10 – Assessment of environmental impacts.

An evaluation of receptor sensitivity has been adopted in which a qualitative ranking of low, medium or high has been assigned based on the importance and resilience to change of a resource/receptor. The overall descriptions of the sensitivity that are used in Chapter 10 – Assessment of environmental impacts are outlined in Table 7-10, Table 7-11, Table 7-12 and Table 7-13. In the tables, the importance criteria are used to rank the resources/receptors in Chapter 9 – Environmental baseline and the overall sensitivity criteria are used in the impact assessment (Chapter 10).

As outlined in Table 7-12 and Table 7-13, socio-economic resources and receptors have been considered in terms of: 'People' (primarily the local communities, including residents, workers, visitors, tourists, recreational users and road users in terms of their amenity and safety levels); 'Economic resources' (including those associated with tourism, commercial fishery, marine transport, raw material extraction sites and other commercial uses of land and the marine environment); 'Other services' (non-commercial uses of land and marine areas, e.g. military practice areas, monitoring stations, roads, etc.) and 'Cultural heritage' (tangible and intangible).

All people are considered to be of high importance and therefore do not require a specific definition of importance ranking. An expansion on the factors influencing their vulnerability to impacts has been considered and outlined in Table 7-12, as these will be the main determinants of their levels of sensitivity to impacts.

**Table 7-10 Sensitivity criteria – physical and chemical environment.**

Ranking	Importance	Vulnerability
Low	A resource or receptor that is not important to the wider ecosystem function and/or services.	A resource or receptor that is resilient to change and will naturally and rapidly revert back to pre-impact status.
Medium	A resource or receptor that has an influence on the wider ecosystem function and/or services.	A resource or receptor that may not be resilient to change but can be actively restored to pre-impact status or will revert naturally back to pre-impact status over time.
High	A resource or receptor that is critical to the wider ecosystem function and/or services.	A resource or receptor that is not resilient to change and cannot be restored to pre-impact status.

**Table 7-11 Sensitivity criteria – biological environment.**

Ranking	Importance	Resilience to change /vulnerability
Low	Species that are not protected or are of least concern (LC) on IUCN and HELCOM Red Lists or other local conservation interest, and are locally common or abundant and not important to other ecosystem functions (e.g. as an important food source). Areas that are locally designated or support species of LC but are common and widespread in the region.	The receptor is resilient to changes (no detectable changes) and/or is resistant to change and will naturally and rapidly revert to pre-impact status once activities cease (within 1 year).
Medium	Species listed as vulnerable (VU), near-threatened (NT) or data deficient (DD) on IUCN and HELCOM Red Lists, Annex II of the Habitats and Birds Directives and/or are globally common, but rare/relatively rare in the Baltic region; and/or are important to ecosystem functions/services. Areas designated for protection at a national level. Habitats that support species of medium value and/or nationally significant concentrations of migratory species.	The receptor may not be resilient to change (detectable change) but can be actively restored to pre-impact status or will revert naturally over time (1-5 years).
High	Species listed in Annex IV of the Habitats Directive and Annex I of the Birds Directive and/or listed as critically endangered (CR) or endangered (EN) on IUCN and HELCOM Red Lists and/or specifically designated, protected or targeted for conservation in EU/Baltic States legislation (e.g. HELCOM) or national legislation and/or restricted range or endemic and/or identified as a key priority by relevant stakeholder. Areas designated under the Habitats Directive and/or support CR or EN species or those that are range restricted, endemic or with globally restricted range support significant concentrations of migratory or congregatory species that perform key ecosystem functions.	Receptor unable to tolerate or avoid impacts (not resilient to change), which will result in permanent or very long changes (>5 years).

**Table 7-12 Sensitivity criteria – socio-economic environment (excluding cultural heritage, see Table 7-13)**

Ranking	Importance			Vulnerability	
	Economic/ receptors	other resources	service	General criteria	Factors influencing vulnerability of People
Low	<p>Businesses, livelihoods or uses of land or marine areas that are key contributors to the economy or other service at the community/local level or contribute to a small extent to these at a wider level.</p> <p>Businesses whose viability is only indirectly dependent on availability of road transportation.</p>			High ability to adapt to changes brought about by the project.	<p>People undertaking activities, e.g. those working in industrial facilities or agricultural areas, where the activities are not reliant on amenity value (e.g. noise levels, views, etc.).</p> <p>Occasional road users or those using roads able to support high volumes of traffic.</p>
Medium	<p>Businesses, livelihoods or uses of land or marine areas that are key contributors to the economy or public service at the regional level or contribute to a small extent to these at a national level.</p> <p>Businesses whose viability may be dependent to some extent on availability of road transportation.</p>			Ability, at least in part, to adapt to changes brought about by the project, though there may be some areas of vulnerability.	<p>People undertaking activities, e.g. commercial activities, which may benefit from or be enhanced by amenity values but are not dependent on these for their functioning.</p> <p>Frequent or regular road users or those using roads designed to support moderate levels of traffic.</p>
High	<p>Businesses, livelihoods or uses of land or marine areas that are key contributors to the economy or other service at the national or international level (e.g. commercial fisheries, military practice areas or by national/international monitoring agencies).</p> <p>Businesses whose viability is entirely dependent on availability of road transportation.</p>			Unable to adapt to changes brought about by the project.	<p>People undertaking activities, e.g. tourism, residential, recreational, that are dependent on high amenity values, notably low noise levels, visual amenity, etc.</p> <p>Frequent high volume regular road user or those using roads unable to support high volumes of traffic, specific sensitive receptors, (e.g. children and non-motorised road users) that may be particularly vulnerable to increase in traffic movements including through risks to safety.</p>

Table 7-13 Sensitivity criteria – cultural heritage.

Ranking	Importance	Vulnerability
Low	Site is not protected under local, national or international laws or treaties. Site has limited or no cultural value to local, national or international stakeholders. Site has limited scientific value or similar information can be obtained at numerous sites in the region.	Site can be moved to another location or replaced by a similar site, or type of site is common in surrounding region.
Medium	Site is protected by local or national laws, but laws allow for controlled/regulated impacts; site has considerable cultural value for local and/or national stakeholders; site has substantial scientific value but similar information can be obtained at a limited number of sites in the region.	Site cannot be moved or replaced without compensation for stakeholders.
High	Site is protected by local, national and international laws or treaties; site has substantial value to local, national and international stakeholders; site has exceptional scientific value and similar site types are rare to non-existent.	Site cannot be moved or replaced without complete loss of cultural value.

### 7.5.3 Impact ranking and significance

Impact significance is determined through a combination of impact magnitude and receptor sensitivity as shown in Table 7-14. A qualitative ranking of negligible, minor, moderate or major has been assigned. Subsequently, impacts have been determined as either 'Significant' or 'Not Significant'. Since there is no statutory definition of a significant impact, the determination is necessarily subjective. For the purposes of the Espoo assessment, a significant impact is one that should be taken into account by the relevant authority when determining the acceptability of a project. Where, following assessment, no impact is anticipated, this is stated and no further discussion provided. In addition to the overall Espoo assessment, the national impact ranking/significance is presented in Chapter 10 – Assessment of environmental impacts.

Table 7-14 Impact ranking and significance matrix.

Impact ranking <sup>1</sup>		Impact magnitude			
		Negligible	Low	Medium	High
Sensitivity of receptor	Low	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Major
	High	Negligible	Moderate	Moderate	Major

<sup>1</sup> The matrix is provided for guidance in allocating the ranking of impacts listed below. Depending on the specific context, a ranking may be influenced by factors and consideration beyond those addressed by the matrix criteria, such that it may deviate from that predicted by the guidance in the matrix. In such circumstances, a justification has been provided in the text accompanying the ranking.

**Impact ranking and significance definitions**

**Negligible** Impacts that result in changes that are indistinguishable from the baseline environmental and socio-economic conditions or natural variations in them. These impacts are considered 'not significant'.

Minor	Detectable changes to baseline conditions beyond natural variation. In isolation these are not expected to damage, degrade or impair the function and value of the resource/receptor. They are unlikely to influence decision making and are thus considered 'not significant'. In combination with other minor impacts, however, they could become significant. These impacts should therefore be mitigated where feasible.
Moderate	Noticeable and lasting changes to baseline conditions that may cause some damage or degradation of the resource/receptor, which in general will continue to function but with a degree of impairment. These impacts may or may not be significant, depending on the context, and additional mitigation may be required in order to avoid or reduce the impact.
Major	Substantial changes to baseline conditions that are likely to disrupt the function and value of the resource/receptor and may have broader systemic consequences (e.g. ecosystem or social well-being) and/or result in a breach of standards. These impacts are a priority for mitigation in order to avoid or reduce the significance of the impact. These impacts are considered 'significant'.

The matrix above was used to identify adverse impacts. The Espoo assessment also identified positive impacts, but it did so based on qualitative terms rather than through the ranking adopted for adverse impacts.

While the approach and criteria applied to ranking of impacts applied in the Espoo Report and various EIA/ES of Russia, Finland, Sweden, Denmark and Germany are generally similar there are some minor variations between them, for example to address differing national requirements. In some instances there may therefore be some difference between the results presented in the Espoo Report and the results presented in the national EIAs/ES.

## 7.6 Natura 2000

An assessment of whether a project may result in significant impacts on Natura 2000 sites is required in accordance with the Article 6(3) and (4) of the Habitats Directive /17/. Therefore an assessment of potential impacts on Natura 2000 sites associated with NSP2 has been undertaken in the national EIAs/ES and in separate Natura 2000 assessment documents.

The methodological guidance for Natura 2000 assessment sets out four consecutive steps comprising screening, appropriate assessment, assessment of alternative solutions and assessment where no alternative solutions exist and where adverse impacts remain.

The initial step of the assessment is a Natura 2000 screening, which identifies the potential impacts of a project upon a Natura 2000 site(s), either alone or in combination with other projects or plans, and considers whether these impacts are likely to be significant.

Section 10.6.6 of the Espoo Report includes the results of the Natura 2000 screenings and appropriate assessments undertaken in relation to the national EIAs/ES.

## 7.7 Strictly protected species (Annex IV)

Article 12a of the Habitats Directive /17/ are aimed at the establishment and implementation of a strict protection regime for animal species listed in Annex IV(a) of the Habitats Directive within the whole territory of Member States.

In accordance with the Habitats Directive, the following is prohibited for strictly protected species:

- All forms of deliberate capture and keeping and deliberate killing;
- Deliberate damage to or destruction of breeding or resting sites;
- Deliberate disturbance of wild fauna particularly during the period of breeding, rearing and hibernation, in so far as disturbance would be significant in relation to the objectives of this Convention;
- Deliberate destruction or taking of eggs from the wild or keeping these eggs even if empty;

- Possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognisable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this Article.

In the Baltic Sea, the marine species on Annex IV are cetaceans. In addition, a number of Annex IV species can be found onshore in Germany. An assessment of potential impacts to strictly protected species is summarised in Chapter 10 – Assessment of environmental impacts as part of the impact assessment for Marine mammals and Onshore – landfall Germany.

## 7.8 Cumulative impacts

While the assessment of the NSP2 project will take account of the presence and impacts of other existing development in its vicinity (which form part of the baseline), there is also a need to consider the interaction between the impacts arising from NSP2 with those of other foreseeable developments which are not yet in existence but are likely to be under construction or to have been completed by the time NSP2 is constructed or operational. Such cumulative impacts have been considered through the identification of future planned development within the area of influence of NSP2 and a predominately qualitative assessment of the potential inter-project impacts with NSP2. In addition, the cumulative assessment of the existing NSP pipelines has been undertaken. This is addressed in Chapter 14 – Cumulative impacts.

## 7.9 Transboundary impacts

The Espoo Convention (Article 1 viii) defines a transboundary impact as:

“...any impact, not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party.”

The convention requires that assessments be extended across borders between parties of the convention when a planned activity may result in transboundary impacts. The key objective of an EIA in a transboundary context is thus the rigorous assessment and succinct communication of such anticipated transboundary impacts to the APs, including the public in these countries.

NSP2 crosses the jurisdiction of several countries and is being constructed in a marine environment, where an impact may propagate some distance from its source. As such, there is a potential for transboundary impacts. As identified above (Section 7.5.1), the identification of transboundary impacts has been a key element of impact classification. The assessment reported in Chapter 10 – Assessment of environmental impacts therefore specifically identifies which impacts may be transboundary in nature. All transboundary impacts are also summarised in Chapter 15 – Transboundary impacts to assist in the communication of transboundary impacts to each AP.

## 7.10 Approach to mitigation

The EIA Directive (Article 5(3)) requires the EIA Report to include “a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects”, while the Espoo Convention (Appendix II (e)) specifies similar considerations. For NSP2, such measures are termed ‘mitigation measures’. A mitigation hierarchy approach has been adopted, whereby priority has been given to:

- Avoiding or preventing impacts;
- Reducing impacts that cannot be avoided or prevented;
- If the above is not possible, offsetting impacts through repair (restoration or reinstatement) or, as a last resort, compensation.

This approach is driven by the policies of Nord Stream 2 AG, notably those related to its approach to environmental and social management, which specifies the requirement to “adopt a mitigation

hierarchy". This is also reflected in its cultural heritage and biodiversity policies. A draft commitment register has been produced in parallel with the preparation of the national ES/EIAs to take account of, or specify modifications to, the mitigation measures that will be imposed during construction and operation to avoid or limit the occurrence of potentially significant environmental impacts.

The mitigation measures and policies considered in the Espoo assessment can be divided into three types:

- Embedded mitigation that is provided through the design of NSP2;
- Mitigation to be delivered through the application of further standard mitigation measures, i.e. well established and tested procedures that are required to address regulatory requirements (e.g. as specified in the MARPOL Convention, HELCOM Convention, etc.);
- Further project specific mitigation measures required to address particular impacts that could arise from NSP2.

The hierarchy is described in Section 5.2.1

Embedded mitigation opportunities have been identified based on the experience of NSP and through the application of further considerations throughout the development and design of NSP2 and its associated construction and operational activities. Potentially significant impacts (negative) identified through the national EIA processes have been taken into consideration in the design process to determine whether they can be avoided at the source, reduced or otherwise mitigated in accordance with the mitigation hierarchy outlined above. This process has also been informed by issues raised during consultations. Examples of such measures include route alignment to avoid sensitive areas, selection of vessel types to minimise the footprint of the project and selection of trenching methods to minimise sediment mobilisation into the water column.

Where potentially significant impacts were identified, specific additional standard and project specific mitigation measures were developed. The national EIAs/ES evaluate the impacts remaining after application of such mitigation. All measures have then been captured within the commitment register to provide a complete list of mitigation requirements for NSP2 under the three categories.



## 8. IDENTIFICATION OF ENVIRONMENTAL IMPACTS

### 8.1 Introduction

This chapter outlines the results of the environmental impact identification exercise, which comprised the following sequential steps:

- Systematic review of the project infrastructure and activities described in Chapter 6 – Project description to determine which activities could potentially interact with each of the environmental receptors identified in the Espoo EIA scoping exercise;
- Identification of the propagation characteristics of key sources of impacts and determination of the nature of impacts that may materialise (Section 8.3).

The analysis above informed the establishment of the spatial area of study and hence the focus of subsequent baseline analyses and assessments (Chapters 9 – Environmental baseline and 10 – Assessment of environmental impacts), including in the identification of potential impacts that could be eliminated from further consideration.

### 8.2 Identification of project - receptor interactions

The first stage of the impact identification is based on an analysis of the project facilities and activities, the potential sources of impacts arising from its construction and operation, i.e. the elements of project activities that could interact with the various environmental receptors that may be present in its vicinity (decommissioning is addressed separately in Chapter 12 - Decommissioning). A summary of this analysis is provided in Table 8-1, Table 8-2 and Table 8-3).

Table 8-1 Project interactions with physical-chemical receptors.

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor				
			Terrestrial geomorphology and topography	Fresh water hydrology (surface and groundwater)	Marine geology, bathymetry and sediments	Marine hydrography and seawater quality	Climate and local air quality
CONSTRUCTION PHASE	<b>Onshore landfall areas</b> • Land acquisition and permanent • Site preparation and dewatering • Building of structures • Pipe-laying • Site restoration • Transportation to site • Work camp • Pre-commissioning activities  <b>Onshore ancillary</b> • Pipe coating (x2) • Pipe storage (x5) • Land transport material and rocks	Physical changes to landform or land cover (natural or man-made)	X	X			
		Light (from working areas)					
		Noise generation (work machines, traffic, power generation, etc.)					
		Emissions to air (chemical pollutants, GHGs and dust from earthworks plant, traffic, power generation, etc.)					X
		Land acquisition/use					
		Employment generation					
		Traffic movements					
		Releases to land and water		X			
		Change in local microclimate*					X

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor						
			Terrestrial geomorphology and topography	Fresh water hydrology (surface and groundwater)	Marine geology, bathymetry and sediments	Marine hydrography and seawater quality	Climate and local air quality		
	<b>Marine</b> <ul style="list-style-type: none"> <li>Vessel movements</li> <li>Munitions clearance</li> <li>Seabed interventions <ul style="list-style-type: none"> <li>Pre-lay trenching (dredging)</li> <li>Post-lay trenching (trenching)</li> <li>Rock placement</li> <li>Crossing of infrastructure</li> <li>Pipe-laying</li> </ul> </li> </ul> <b>Marine ancillary</b> <ul style="list-style-type: none"> <li>Shipment of coated pipes from Kotka to Hanko</li> </ul>	Physical changes to seabed features (natural and man-made features)			X				
		Release of sediments to the water column				X			
		Release of contaminants and nutrients to the water column (e.g. sediment associated contaminants and nutrients, CWAs, etc.)				X			
		Sedimentation on seabed			X				
		Generation of underwater noise (munitions clearance, rock placement, DP thrusters, etc.)							
		Presence of vessels (airborne noise, visual including light, vessel movement, conflict of marine space, etc.)							
		Safety zones around construction vessels							
		Release of air pollutants and GHGs from vessels					X		
		Introduction of non-indigenous species (NIS) (ballast or other pathways)							
		Employment generation							
		OPERATION PHASE	<b>Onshore landfall areas</b> <ul style="list-style-type: none"> <li>Presence of structures (buildings, PTA, etc.)</li> <li>Receipt and storage of waste</li> </ul>	Change to landform or land cover	X	X			
				Light (from buildings)					
				Noise generation					
Emissions to air							X		
Releases to land and water									
Land acquisition/ use									
Employment generation									
Traffic movements									
Change in local microclimate*							X		
<b>Marine</b> <ul style="list-style-type: none"> <li>Presence of pipelines</li> <li>Gas movement in the pipeline</li> <li>Inspection/ maintenance</li> </ul>	Presence of pipelines				X	X			
	Safety zones around inspection/maintenance vessels								
	Heat exchange between the pipelines and the surrounding environment				X	X			
	Presence of vessels (airborne noise, visual including light, vessel movement, conflict of marine space, etc.)								

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor				
			Terrestrial geomorphology and topography	Fresh water hydrology (surface and groundwater)	Marine geology, bathymetry and sediments	Marine hydrography and seawater quality	Climate and local air quality
		Underwater noise from the pipeline					
		Release of air pollutants and GHGs from vessels					X
		Introduction of NIS (ballast or other pathways)					
		Release of contaminants from pipeline anodes				X	

\* for Germany only in line with national EIA requirements

Table 8-2 Project interactions with biological receptors.

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor									
			Terrestrial flora and fauna	Plankton	Benthic flora and fauna	Fish	Marine mammals	Birds (seabirds and waterbirds)	Natura 2000 sites	Other protected areas	Marine biodiversity (including ecosystem)	
CONSTRUCTION PHASE	<b>Onshore landfall areas</b> <ul style="list-style-type: none"> <li>Land acquisition and permanent</li> <li>Site preparation and dewatering</li> <li>Earthworks and building of structures</li> <li>Pipe-laying</li> <li>Site restoration</li> <li>Transportation to site</li> <li>Work camp</li> <li>Pre-commissioning activities</li> </ul> <b>Onshore ancillary</b> <ul style="list-style-type: none"> <li>Pipe coating (x2)</li> <li>Pipe storage (x5)</li> <li>Land transport material and rocks</li> </ul>	Physical changes to landform or land cover (natural or man-made)	X							X		
		Light (from working areas)	X							X		
		Noise generation (work machines, traffic, power generation, etc.)	X							X		
		Emissions to air (chemical pollutants, GHGs and dust from earthworks plant, traffic, power generation, etc.)	X							X		
		Land acquisition/use	X							X		
		Employment generation										
		Traffic movements										
		Releases to land and water	X							X		
		<b>Marine</b> <ul style="list-style-type: none"> <li>Vessel movements</li> <li>Munitions clearance</li> <li>Seabed interventions                             <ul style="list-style-type: none"> <li>Pre-lay trenching (dredging)</li> <li>Post-lay trenching (trenching)</li> <li>Rock placement of</li> <li>Crossing of</li> </ul> </li> </ul>	Physical changes to seabed features (natural and man-made features)			X	X			X	X	X
			Release of sediments to the water column		X	X	X	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (e.g. sediment associated contaminants and			X	X	X	X	X	X	X	X		

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor									
			Terrestrial flora and fauna	Plankton	Benthic flora and fauna	Fish	Marine mammals	Birds (seabirds and waterbirds)	Natura 2000 sites	Other protected areas	Marine biodiversity (including ecosystem)	
OPERATION PHASE	infrastructure - Pipe-laying  <b>Marine ancillary</b> Shipment of coated pipes from Kotka to Hanko	nutrients, CWAs, etc.)										
		Sedimentation on seabed			X	X			X	X	X	
		Generation of underwater noise (munitions clearance, rock placement, DP thrusters, etc.)				X	X	X	X	X	X	
		Presence of vessels (airborne noise, visual including light, vessel movement, conflict of marine space, etc.)				X	X	X	X	X	X	
		Safety zones around construction vessels										
		Release of air pollutants and GHGs from vessels										
		Introduction of NIS (ballast or other pathways)									X	
		Employment generation										
	<b>Onshore landfall areas</b> <ul style="list-style-type: none"> <li>• Presence of structures (buildings, PTA, etc.)</li> <li>• Receipt and storage of waste</li> </ul>	Change to landform or land cover								X		
		Light (from buildings)	X							X		
		Noise generation	X							X		
		Emissions to air	X							X		
		Releases to land and water	X							X		
		Land acquisition/ use										
		Employment generation										
Traffic movements												
<b>Marine</b> <ul style="list-style-type: none"> <li>• Presence of pipelines</li> <li>• Gas movement in the pipeline</li> <li>• Inspection/maintenance</li> </ul>		Presence of pipelines			X	X	X	X	X	X	X	
		Safety zones around inspection/maintenance vessels										
		Heat exchange between the pipelines and the surrounding environment			X						X	
		Presence of vessels (airborne noise, visual including light, vessel movement, conflict of marine space, etc.)					X		X	X	X	
		Underwater noise from the pipeline							X	X		
		Release of air pollutants and GHGs from vessels										
		Introduction of NIS (ballast or other pathways)									X	
		Release of contaminants from pipeline anodes			X	X			X	X	X	

Table 8-3 Project interactions with socio-economic receptors.

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor											
			People	Cultural heritage	Tourism and recreational activities	Economic					Other services			
						Commercial fisheries	Traffic	Raw material extraction sites	Existing and planned infrastructure	Agriculture & other land based activities	Military practice areas	International/national Monitoring stations	Public services	
CONSTRUCTION PHASE	<b>Onshore landfall areas</b> <ul style="list-style-type: none"> <li>Land acquisition and permanent</li> <li>Site preparation and dewatering</li> <li>Earthworks and dewatering</li> <li>Building of structures</li> <li>Pipe-laying</li> <li>Site restoration</li> <li>Transportation to site</li> <li>Work camp</li> <li>Pre-commissioning activities</li> </ul> <b>Onshore ancillary</b> <ul style="list-style-type: none"> <li>Pipe coating (x2)</li> <li>Pipe storage (x5)</li> <li>Land transport material and rocks</li> </ul>	Physical changes to landform or land cover (natural or man-made)	X	X	X									
		Light (from working areas)	X		X									
		Noise generation (work machines, traffic, power generation, etc.)	X		X									
		Emissions to air (chemical pollutants, GHGs and dust from earthworks plant, traffic, power generation, etc.)	X		X									
		Land acquisition/use	X		X					X				
		Employment generation	X							X				
		Traffic movements	X		X									
		Releases to land and water												
	<b>Marine</b> <ul style="list-style-type: none"> <li>Vessel movements</li> <li>Munitions clearance</li> <li>Seabed interventions <ul style="list-style-type: none"> <li>- Pre-lay trenching and backfilling</li> <li>- Post-lay trenching (trenching)</li> <li>- Rock placement of infrastructure</li> <li>- Pipe-laying</li> <li>- Hydrotesting</li> </ul> </li> </ul> <b>Marine ancillary</b> Shipment of coated pipes from Kotka to Hanko	Physical changes to seabed features (natural and man-made features)		X						X				
		Release of sediments to the water column	X			X							X	
		Release of contaminants and/or nutrients to the water column (e.g. sediment associated contaminants and nutrients, CWAs, etc.)	X										X	
		Sedimentation on seabed		X										
		Generation of underwater noise (munitions clearance, rock placement, DP thrusters, etc.)					X							
		Presence of vessels (airborne noise, visual including light, vessel movement, conflict of marine space, etc.)	X				X							

PHASE	PROJECT COMPONENT	POTENTIAL SOURCE OF IMPACT	Receptor											
			People	Cultural heritage	Tourism and recreational activities	Economic					Other services			
						Commercial fisheries	Traffic	Raw material extraction sites	Existing and planned infrastructure	Agriculture & other land based activities	Military practice areas	International/national Monitoring stations	Public services	
OPERATION PHASE		Safety zones around construction vessels	X			X	X	X	X		X	X		
		Release of air pollutants and GHGs from vessels	X											
		Introduction of NIS (ballast or other pathways)												
		Employment generation			X									
	Onshore landfalls	<ul style="list-style-type: none"> <li>Presence of structures (buildings, PTA, etc.)</li> <li>Receipt and storage of waste</li> </ul>	Change to landform/cover	X	X	X								
			Light (from buildings)	X		X								
			Noise generation	X		X								
			Emissions to air	X		X								
			Releases to land and water											
			Land acquisition/use	X							X			
			Employment generation	X							X			
			Traffic movements	X										
	Marine	<ul style="list-style-type: none"> <li>Presence of pipelines</li> <li>Gas movement in the pipeline</li> <li>Inspection/maintenance</li> </ul>	Presence of pipelines		X		X	X		X				
			Safety zones around inspection/maintenance vessels	X			X	X	X	X		X	X	
			Heat exchange between the pipelines and the surrounding environment											
			Presence of vessels (airborne noise, visual including light, vessel movement, conflict of marine space, etc.)	X										
			Underwater noise from the pipeline											
			Release of air pollutants and GHGs from vessels	X										
Introduction of NIS (ballast or other pathways)														
Release of contaminants from pipeline anodes			X											

### **Chemical warfare agents and conventional munitions**

The potential sources of impacts associated with CWAs and conventional munitions relate to the detonation of conventional munitions and to mobilisation and redistribution of contaminated sediments from the seabed where CWAs are present. The resulting release of hazardous substances into the marine environment has the potential to impact plant and animal life directly or through the food chain. These impacts have therefore been identified as part of the project interactions with the physical-chemical, biological and socio-economic receptors highlighted for further study, as documented above in Table 8-1, Table 8-2 and Table 8-3.

During consultations, consideration of CWAs was identified as a particular concern by Estonia, Finland, Germany and Poland, notably in relation to the potential for transboundary impacts to occur as a result of project activities within the Bornholm Basin that may disturb CWAs. In order to reflect such concerns and give this issue due consideration and prominence, all impacts on the various receptors that could arise as a result of the disturbance of CWAs have also been summarised in standalone sections within the baseline and assessment chapters (Section 9.14 and 10.13). The location of conventional munitions is also considered in Section 9.13, even though these impacts are addressed under the relevant receptors (notably fish and mammals) in Chapter 10 – Assessment of environmental impacts.

## **8.3 Propagation characteristics of key sources of impacts**

Many of the NSP2 activities with the potential to generate environmental impacts take place in marine waters during the construction phase. In many cases, whether a significant impact will materialise will be influenced by the extent of propagation through the marine environment of the physical changes that arise from such activities. This is particularly relevant to the identification and consideration of transboundary impacts that may be experienced some distance from the location of the source of impact. Therefore an important early task in the Espoo EIA process was the determination of such propagation characteristics as a means to establish the areas of influence and hence the appropriate spatial focus for the baseline studies and subsequent assessments. This was undertaken through a review of the results of targeted modelling and monitoring studies undertaken as part of the national NSP2 EIAs/ES. The main findings that have determined the area of influence are outlined below. Further information is provided in Section 10.1 and Appendix 3, whilst potential impacts are assessed in Chapter 10 – Assessment of environmental impacts.

### **8.3.1 Physical changes of seabed features and sedimentation on the seabed**

Various seabed works, e.g. trenching (pre-lay trenching (dredging), post-lay trenching), rock placement, anchor handling and munitions clearance, will cause physical disturbance of the seabed and may also create new features on the seabed, e.g. spoil heaps (from trenching) and rock piles below and around the pipelines (Chapter 6 – Project description), while settlement of suspended sediment may increase the sediment layer.

The maximum distance on each side of the pipeline within which such direct seabed disturbance may occur will be 100 m for trenching, 100 m for rock placement and 1,000 m for anchor handling. Depending on the size and nature of the munitions being detonated, disturbance of the seabed may extend up to approximately 7-8 m from the detonation location /25/.

Outside the 100 m zone of immediate disturbance (described above), the suspended sediment is predicted to settle in areas close to the pipeline with only very small areas with sediment layers exceeding 1 mm. Further information is provided in Section 10.1 and Appendix 3.

### **8.3.2 Release of sediments to the water column**

Modelling undertaken for the national EIAs/ES indicates that increases in suspended sediment concentration (SSC) during construction of NSP2 will be driven primarily by trenching before pipe-laying (dredging), which takes place in nearshore areas, and after pipe-laying (trenching by ploughing), which would be required in selected sites offshore. Approximately 3.5 km and 50 km

of dredging are anticipated at the Russian and German nearshore areas, respectively. Ploughing is estimated to be required at approximately 7 locations over some 265 km of the route (see Atlas Map PR-02-Espoo to PR-05-Espoo). The release of sediment therefore will be localised to these areas, with its propagation, and subsequent sedimentation, dependent on water depth (which influences, e.g., grain size distribution) and hydrographical conditions.

Dredging activities at the landfalls will give rise to the largest sediment plumes. In the nearshore area along the coastline in Russia, the maximum distance of elevated SSC of 10 mg/l over a period of more than 24 hours is modelled to be 10 km south of and up to 30 km north of the dredging location. Furthermore, increased concentrations close to the dredging location are found up to 5 km from the coastline. Sediment dispersion in Germany varies from 200 m in the Pomeranian Bay to 500 m – 1 km in the Greifswalder Bodden. Further information on the duration and level of increase in SSC for such activities is provided in Section 10.1 and in Appendix 3.

Modelling of a worst-case ploughing scenario predicts that increases in SSC may extend up to 25 km from the ploughing site. However, only very low concentrations of suspended sediments reach that distance.

Rock placement will also release suspended sediment to the water column, but to a much lesser extent than dredging or ploughing activities. Modelling of SSC dispersion for rock placement predicts that while some increase in SSC could occur up to 10 km from the pipeline, the concentration would only be slightly above the average SSC and well within natural variations. Furthermore, because rock placement activities are restricted to discrete locations, subsequent impacts will similarly be limited to the very immediate vicinity of such activities. Further information is provided in Section 10.1 and Appendix 3.

Anchor handling and the thrusters of DP vessels may also disturb the seabed, resulting in the release of sediment to the water column. However, in the case of DP vessels this impact would be restricted to shallow waters and localised.

### 8.3.3 Release of sediment-associated contaminants to the water column

Release of sediment-associated contaminants to the marine environment is closely linked to the seabed intervention works undertaken. With regard to SSC, dispersion is dependent on the physical settings. Modelling undertaken in Finland and Russia indicated that munitions clearance in Finland and Russia will result in the greatest area of exceedance of predicted no-effect concentration (PNEC) values for the three modelled contaminants - BaP (PAH), PCDD (dioxins) and Zn. A total area of approximately 163 km<sup>2</sup>, 57.1 km<sup>2</sup> and 4.82 km<sup>2</sup> will occur for the three contaminants respectively. The maximum duration of the exceedance will be in the order of 3-19 hours, although this will only apply in an area much smaller than the total and close to the source. In nearshore and shallow waters, dredging will result in the greatest area experiencing an exceedance of PNEC values for the three modelled contaminants. A total area of approximately 172 km<sup>2</sup>, 108 km<sup>2</sup> and 53 km<sup>2</sup> respectively will experience an exceedance of PNEC<sub>BaP</sub>, PNEC<sub>PCDD/F</sub> and PNEC<sub>Zn</sub> values. The maximum duration of the exceedance will be in the order of 256-374 hours, although this will only apply to an area much smaller than the total and close to the source.

### 8.3.4 Underwater noise

Underwater noise can potentially arise from a range of NSP2 construction activities notably munitions clearance (by far the loudest activity), followed by rock placement. Beyond the immediate vicinity of the noise-generating activity, the noise level associated with trenching, pipe-laying, anchor handling, construction vessel movements and other construction activities will be generally undistinguishable from the background noise levels in the Baltic Sea, where there is already a large volume of ship traffic.



Noise modelling for munitions clearance, which may take place in Russia and Finland, show that in a worst-case scenario the threshold for impacts on marine mammals may be exceeded up to 23 km and 60 km from the detonation site for permanent and temporary hearing loss, respectively. The distance at which these levels will be experienced, however, depends on numerous parameters, such as water depth and seabed structure. Impacts (injury) on birds in the worst case may be experienced up to approximately 2 km from the munitions detonation site, while those for fish may occur up to 1.5 km from the detonation site.

Underwater noise predictions for rock placement show that thresholds above which receptors can be impacted are exceeded for mammals only in very close vicinity (0-80 m) to the construction activities (with the exception of avoidance reactions). Results from underwater noise modelling of vibro-piling and dredging show that noise propagations are even smaller.

### **8.3.5 Release of contaminants from anodes**

Sacrificial anodes of zinc and aluminium alloy will be attached to the pipeline to prevent corrosion. Beyond the immediate vicinity of the anode (i.e. <5 m), the concentrations of metal ions within the water column as a result of anode degradation during the operation phase will generally be undistinguishable from background concentrations. Within the immediate vicinity of the anode, PNEC values may be exceeded by zinc and aluminium. Monitoring along NSP showed that concentrations of heavy metals were below the detection limit approximately 1-2 m from the pipelines and hence well below the PNEC. The concentrations of cadmium and lead in the water column around both the aluminium and zinc anodes will be so low that they will fall below the ecotoxicological assessment criteria (EAC) and PNEC values. For further information see Appendix 3, Section 2.4.3.

## 9. ENVIRONMENTAL BASELINE

### 9.1 Introduction to the environmental baseline

This chapter describes the physical-chemical, the biological and the socio-economic environments that could be affected by the construction and operation of NSP2. This description will be used as the basis of the Espoo impact assessments.

The description has been prepared on the basis of:

- The national EIAs/ES of the PoOs for NSP2;
- Experience from NSP, including monitoring;
- Data and reports from national authorities;
- Publication of and data accessed from databases of multilateral agencies and nongovernmental organisations (NGOs) (e.g. HELCOM, IUCN, International Council for the Exploration of the Sea (ICES));
- Scientific literature, technical reports and data relevant for the Baltic Sea;
- Surveys commissioned by Nord Stream AG and Nord Stream 2 AG.

A consultation process was undertaken primarily with national and international agencies and experts contributing to the clarification of focus areas, see Chapter 4 – Espoo process.

Furthermore, a number of environmental field surveys have been conducted to ensure a solid basis for the baseline description and the subsequent environmental impact assessment, see Table 9-1.

**Table 9-1 Environmental surveys along the preferred NSP2 route undertaken in 2015-2016 in the five PoOs.**

Environmental surveys along the preferred NSP2 route in 2015-2016					
	RU	FI	SE	DK	GE
<b>Marine</b>					
Seawater					
- Turbidity, solid matter, currents		X			
- pH, conductivity, salinity, oxygen, temperature	X	X <sup>1</sup>	X	X	X
- Inorganic contaminants + nutrients	X	X			
- Total organic carbon (TOC)	X	X			
Sediment					
- Grain size distribution	X	X	X	X	X
- Inorganic/organic contaminants	X	X	X	X	X
- CWAs				X	
Plankton	X				
Flora (higher plants and macrophytes)	X				X
Benthic fauna	X	X	X	X	X
Fish	X				X
Birds	X				X
Marine mammals	X				X
Underwater noise		X			X <sup>2</sup>
<b>Onshore – landfall areas</b>					
Landform and topography	X				X
Hydrology	X				X
Geology and soil	X				X
Air quality	X				
Radiation	X				
Biotope mapping	X				X
Flora (higher plants, bryophytes (moss/liverworts), lichens, fungi)	X				X

Environmental surveys along the preferred NSP2 route in 2015-2016					
	RU	FI	SE	DK	GE
Insects	X				X <sup>3</sup>
Amphibian	X				X
Reptiles	X				X
Birds	X				X
Terrestrial mammals	X				X <sup>4</sup>
Social survey (resident survey for the rock transportation route, Kotka)		X			
Social survey (social impacts questionnaire)		X			
Cultural heritage (Narva Bay)	X				
1: no pH in Finland, 2: Background noise measurements during NSP construction 2010 and 2011, 3: Beetles, 4: Bats					

In compiling the information for the Espoo Report, an attempt has been made to be comprehensive without having to repeat the detailed information included in individual survey reports and national EIA/ES documents. Noting that the scope varies from survey to survey, the reader is referred to the original documents for methodological descriptions, survey objectives, the period covered and any underlying assumptions.

Reference is made throughout this chapter to the thematic Map Atlas produced by Nord Stream 2 AG as part of the environmental studies of the project. This atlas should be considered as an integral part of this report.

In the baseline descriptions, a measure of distance to NSP2 is often shown. The distance is based on information from the national EIAs/ES and therefore reflects what is required in the national EIAs/ES. In Finland, the distances are from the nearest pipeline considering the two sub-alternative routes, see description in Chapter 5 - Alternatives.

# Physical and chemical environment

## 9.2 Marine areas

The Baltic Sea is one of the largest brackish water bodies in the world, with a surface area of approximately 415,000 km<sup>2</sup>, a catchment area of approximately 1.7 million km<sup>2</sup>, and a total volume of approximately 21,700 km<sup>3</sup> /28/, /29/. It is located between 53° to 66° northern latitude and 10° to 26° eastern longitude and is bordered by the Scandinavian Peninsula, the mainland of northern Europe, Eastern Europe and central Europe, and the Danish islands.

The physical and chemical environment of the project area defines the conditions for the biological and the socio-economic environment. Therefore the physical and chemical environment can be considered as a receptor in itself and, more importantly, as a carrier of the impacts from the project activities to the biological and socio-economic receptors. It is therefore considered critical to the wider ecosystem function and/or services it provides. As such, all physical and chemical receptors are considered to be of high importance and discussed below.

### 9.2.1 Marine geology, bathymetry and sediments

#### 9.2.1.1 Marine geology and tectonics

##### Marine geology

The geology of the Baltic Sea comprises bedrock covered by sediments, as shown in Atlas Map GE-01-Espoo. The morphology of the bedrock is a result of fluvial and glacial erosion, with troughs and valleys created by erosion of less resistant bedrock layers forming pronounced seabed features.

The bedrock is covered by Quaternary sediment deposits formed during the last ice age and during different post-glacial Baltic Sea development stages /30/. The deposits are dominated by glacial till comprised of a mixture of grain sizes, from clay to boulders, varying in thickness from a few metres to several tens of metres. These till deposits are hard and possess high strength as a result of the pressure of the overlying ice. Late-glacial and post-glacial sediments occur upon the glacial deposits. The late-glacial sediments are mainly clay, silt and sand. These deposits are covered by even younger deposits of mainly clay and silt.

The distribution of sediments in the sea floor is a result of the Quaternary geological history of the Baltic Sea and the subsequent sediment dynamic in the marine environment. Bedrock without a cover of younger sediments is found only in nearshore areas in the northern Baltic Proper and the Gulf of Finland or where steep slopes are present on the seabed. Exposed till is found on top of or at the sides of topographical heights and on steep slopes at the sea floor.

##### Tectonics

The Baltic Sea is situated on the Eurasian continental plate, providing relatively stable geological conditions. The area is nearly devoid of earthquake activity in global terms /31/. However, seismic activity in the form of small-scale earthquakes occurs occasionally. This activity is mainly the result of stress release in the lithosphere caused by the uplift following the deglaciation at the end of the latest ice age. Along the proposed NSP2 route, the recent relative uplift varies between less than 3 mm/year to about -1 mm/year.

Atlas Map GE-03-Espoo shows incidents of earthquakes measured in the Baltic Sea during the period 2002-2015 in Finland, Sweden and Denmark, as well as the location of the so-called Tornquist Zone (a 30-50 km wide zone of extensive faulting developed in late Cretaceous/early

Tertiary time). All recorded incidents have a magnitude below 5 on the Richter scale, confirming the low seismic activity in the area.

A probabilistic seismic hazard assessment carried out for the NSP route corridor in 2007 concluded that the seismic hazard along the pipeline route is low /33/. This assessment is considered to remain valid for the proposed NSP2 route, due to the proximity to the NSP route.

During a marine geological mapping in 2005, the Geological Survey of Sweden (SGU) discovered scars of two submarine landslides in the south-east Baltic Sea. An additional landslide scar was identified in the Swedish EEZ in 2014. The location of the scars, in glacial sediments in areas of very gently sloping sea floor, strongly suggest that the slides were triggered by palaeoseismic activity, probably at the very end of the Late Weichselian or during the Early Holocene geological time periods /32/. Landslides have not been reported in the Baltic Sea in recent geological time.

#### 9.2.1.2 Bathymetry

The bathymetry of the Baltic Sea is determined by the geological settings and history as outlined above. The bathymetry is the subsea landscape, which is important for both the design of the pipeline route and for the marine life in the Baltic Sea.

The Baltic Sea is a semi-enclosed area connected to the surrounding oceans through the shallow-water and narrow Danish straits, which connect the brackish water of the Baltic Sea with the oceanic water of the North Sea. The bathymetry is characterised by basins separated by sills /34/, with a maximum depth of 459 m and average depth of 52 m /28/, /29/. Two sills in the transition zone between the North Sea and the Baltic Sea (the Darss Sill, with a water depth of 18 m, and the Drogden Sill, with a water depth of 8 m) effectively limit the inflow of saline, oxygen-rich water to the Baltic Sea to rare occurrences of storms from the west (see Section 9.2.2).

The proposed NSP2 route runs across several of the Baltic Sea sub-basins from the Gulf of Finland in the north-east to the south-western Baltic Sea (see Figure 9-1 and Atlas Map BA-01-Espoo). A depth profile showing the bathymetry along the proposed NSP2 pipeline route from the Russian landfall to the German landfall is shown in Figure 9-2. Figure 9-3 and Figure 9-4 show the detailed bathymetry at the Russian and German landfalls respectively.

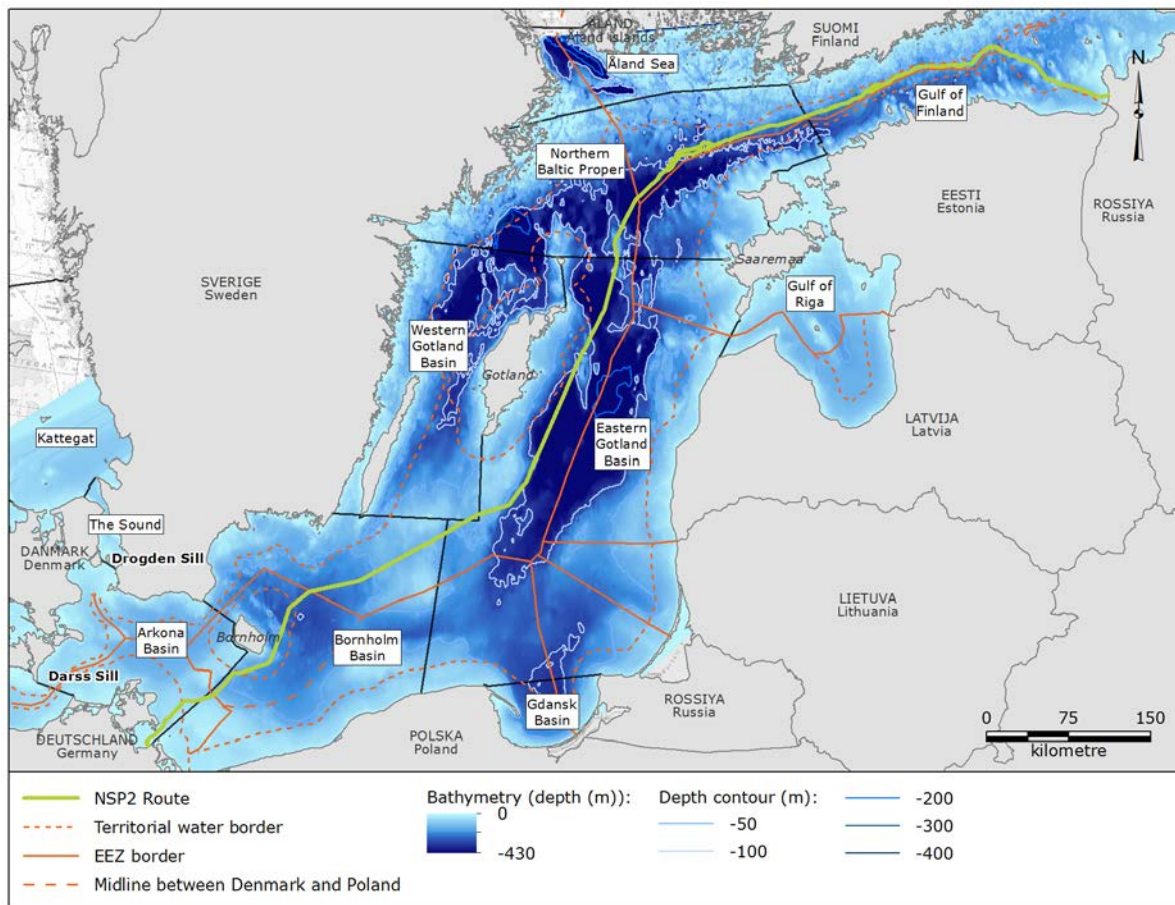


Figure 9-1 Bathymetry of the Baltic Sea, showing the preferred NSP2 route option and the various sub-basins. The Darss Sill and the Drogden Sill are shallow-water thresholds controlling the inflow of saline water to the Baltic Sea.

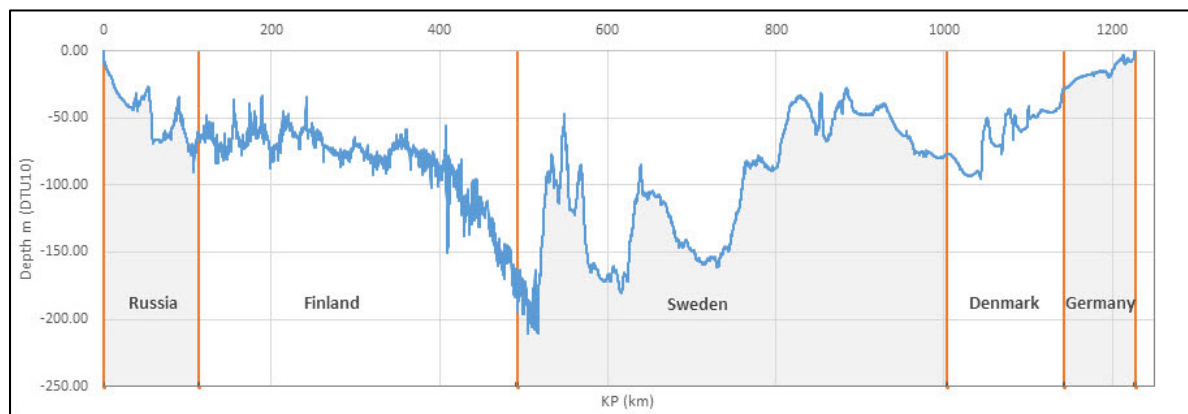


Figure 9-2 Water depth per KP along the NSP2 route, from the Russian landfall to the German landfall.

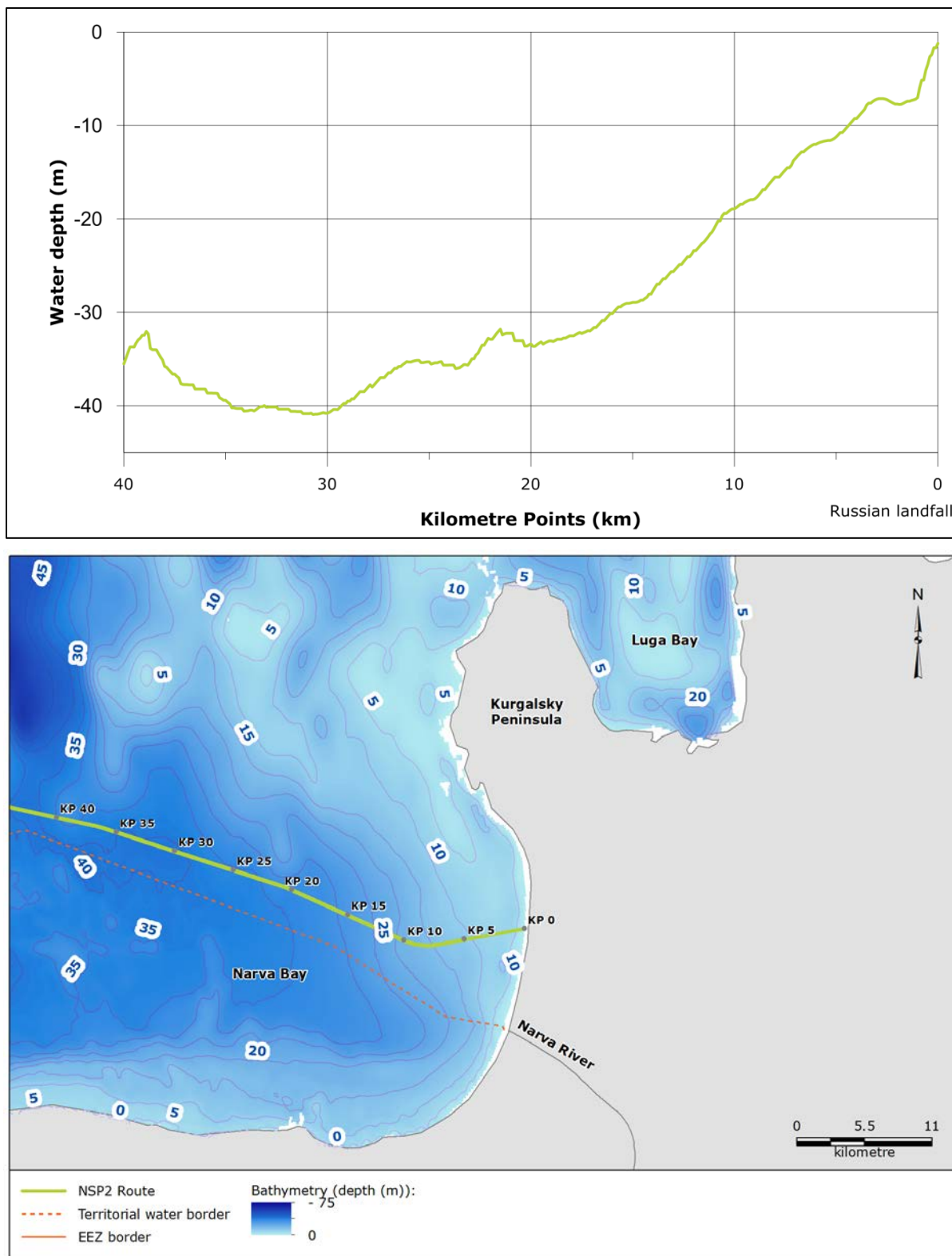


Figure 9-3 Bathymetry near Russian landfall area.

As shown in Figure 9-3, the bathymetry near the Russian landfall area increases smoothly from 0 m at the landfall to a depth of approximately 40 m at a distance of 30 km from the landfall.

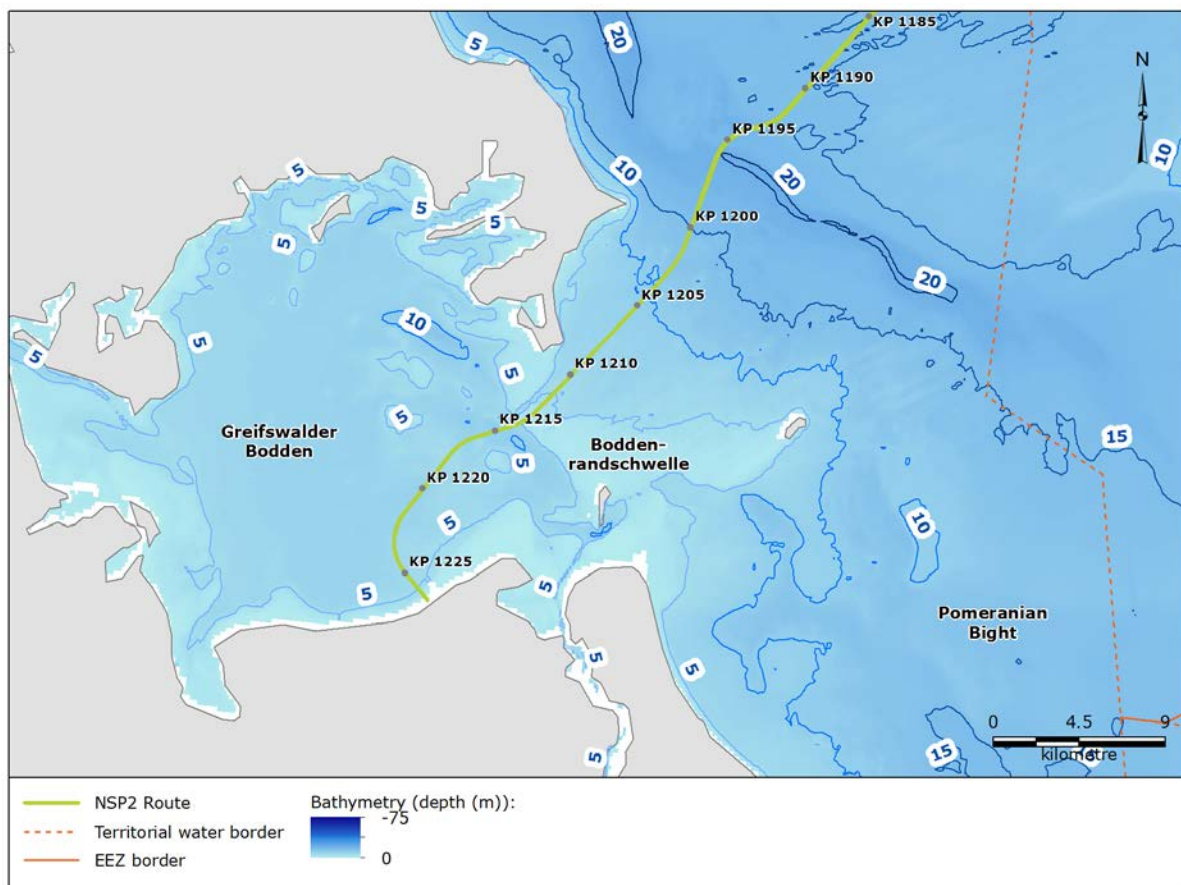
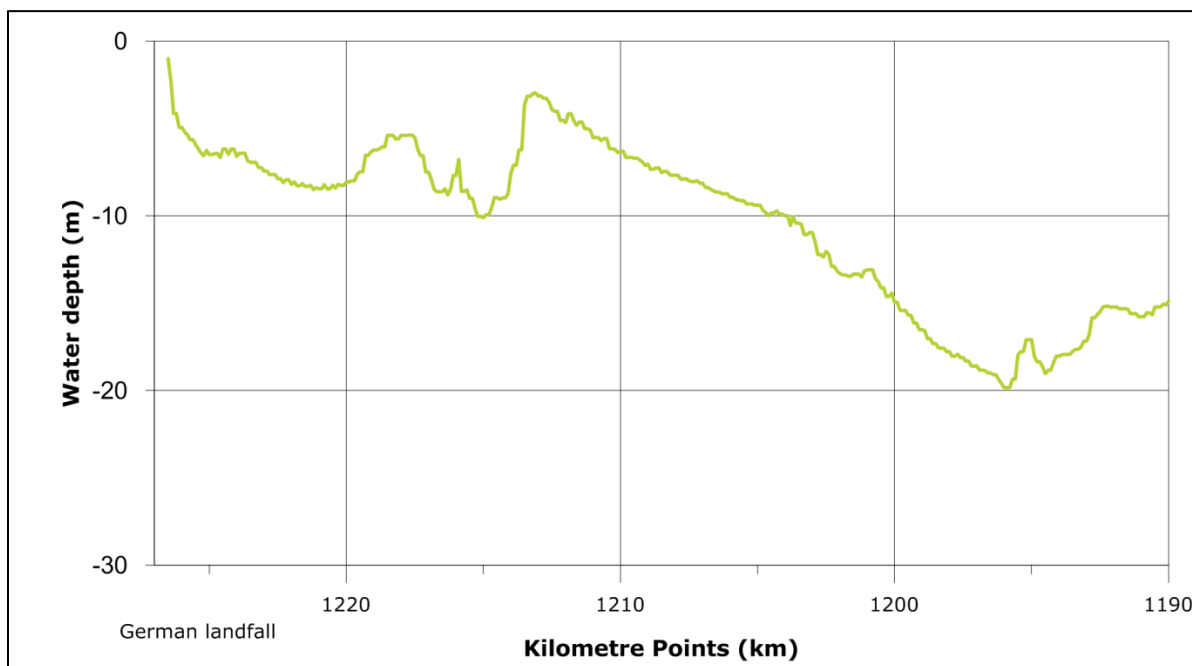


Figure 9-4 Bathymetry near German landfall area

As shown in Figure 9-4, the area near the German landfall is a shallow water region (in general depths less than 20 m) comprising the Pomeranian Bay and the Greifswalder Bodden. These areas are characterised by shallow banks (the Oderbank (not in figure) and the Boddenrandschwelle respectively) and artificially built navigation channels /35/.



### 9.2.1.3 Seabed sediment dynamics

The distribution of sediments in the Baltic Sea floor is governed by a number of factors, such as water depth, wave size and current pattern. Two general zones can be outlined: a 'zone of sedimentation' and a 'zone of erosion or non-deposition'.

Zones of net sedimentation are generally deep basins or sheltered areas, such as the Gulf of Finland and the Northern Baltic Proper, where seabed sediments consist mainly of unconsolidated fine-grained sediments (classified as "mud" in Atlas Map GE-02-Espoo). Zones of erosion or non-deposition are generally shallower waters and areas exposed to wave- or current-induced water motion. Such areas include the areas south and south-west of Gotland, where seabed sediments consist of coarser sediments (sand, gravel and stones) and lag sediments, typically eroded glacial clay till (see Atlas Map GE-02-Espoo).

The net accumulation rates have been estimated based on sediment layer dating using radioactive tracers. A study of sediments from 69 positions in the Baltic Proper, the Bothnian Sea and the Gulf of Finland has shown net sedimentation rates in the range 60-6,160 g/m<sup>2</sup>/yr /36/. Other investigations have shown net sedimentation of 1.5-4 mm/yr or approximately 400 g/m<sup>2</sup>/yr in the Gulf of Finland and 0.5-2.3 mm/yr in the Baltic Proper /36/. Measurements from the eastern Gotland Basin show net sedimentation rates in the range 0.17-3.0 mm/yr. Other studies of the sedimentation rate in the eastern Baltic Sea have shown values in the order of magnitude of 1 mm/yr /37/.

Seabed surface sediments may be re-suspended into the water column by the action of waves, currents, marine life and/or anthropogenic impact, i.e. there is a two-way dynamic interaction between the seabed sediments and the suspended sediments /38/. Suspended sediments are discussed further in the subsequent section.

### 9.2.1.4 Suspended sediments

Suspended sediments are inorganic and organic particles that remain in the water column as a result of turbulence. The SSC is measured either directly, as the unit mass of particles per volume unit of the mixture (mg/l), or indirectly, as turbidity (Nephelometric Turbidity Unit, NTU), which is the attenuation of light caused by the particles suspended in the water (see Section 9.2.2.8).

The natural concentration of suspended sediments in the water column depends on the balance between the following mechanisms:

- Sediments produced in the water column by chemical precipitation and/or by biological activity, e.g. algae growth (autochthonous sediments);
- Sediments advectively supplied, e.g. from riverine inflow and from the adjacent sea areas (allochthonous sediments);
- Upwards transport of sediments from the seabed provided by turbulent diffusion (resuspension);
- Settling of suspended sediments to the seabed (sedimentation).

Therefore the natural SSC in the Baltic Sea depends on a number of factors, including seabed sediment type, water depth, stratification of the water column, fetch (length of water over which a given wind has blown), algae growth, advection, etc.

Routine measurements of the natural SSC do not take place in the Baltic Sea. Therefore natural SSCs have been determined through a review of empirical monitoring data from the following research and construction projects:

1. NSP baseline monitoring at Hoburgs Bank and Norra Midsjöbanken, Swedish waters, November 2010 to August 2011 /39/.
2. Fehmarnbelt Fixed Link baseline monitoring, Fehmarnbelt, German and Danish waters, March 2009 to January 2010 /40/.
3. Øresund Fixed Link, the Sound, Swedish and Danish waters, 1992-1994 /41/.
4. NSP baseline monitoring, Greifswalder Bodden and Pomeranian Bay, German waters, April to December 2010 /42/.
5. The Baltic Sea System Study (BASYS) research project, Pomeranian Bay, Polish and German waters, 1996-1998 /43/.

Results from these investigations are shown in Table 9-2 below.

**Table 9-2 Level of SSC measured at various locations in the Baltic Sea.**

Project within the Baltic Sea	SSC in calm weather (mg/l)	SSC in rough weather (mg/l)
Hoburgs Bank and Norra Midsjöbanken, Sweden /39/ /38/	0-2	2-10
Fehmarnbelt, Germany, Denmark /40/	1-4 <sup>1</sup>	5-30
The Sound, Sweden and Denmark /41/	0-2 <sup>2</sup>	20-40
Greifswalder Bodden, Germany /42/	< 5	10-40 <sup>3</sup>
Pomeranian Bay, Germany /42/	< 5	5-60 <sup>4</sup>
Pomeranian Bay, Poland and Germany /43/	2-12	
1. Range of 1-2 mg/l and 1-4 mg/l at the surface/midwater and bottom waters respectively. 2. Range of 0-1 mg/l and 1-2 mg/l at the surface and bottom waters respectively. 3. Based on wave heights >0.5 m. 4. Range of 5-15 mg/l and 40-60 mg/l at wave heights of approximately 1-2 m and >3 m respectively.		

The data above show that SSC in the open Baltic Sea in calm weather is low, within a range of 0-5 mg/l, but higher in inner coastal waters. In rough conditions, the SSC increases to approximately 2-60 mg/l, mainly due to resuspension of seabed sediments. The increase in SSC is highest in shallow-water areas with unconsolidated seabed sediments exposed to wave-induced resuspension (Greifswalder Bodden and Pomeranian Bay) and in areas subject to strong currents and inflow of bottom water with a high SSC (the Sound). In contrast, the SSC in deeper areas with coarser and/or better consolidated seabed (Hoburgs Bank and Norra Midsjöbanken) is relatively low in both calm and rough conditions.

In addition to empirical monitoring data, modelling undertaken for the Gulf of Finland as part of the NSP permitting process has also been reviewed to establish the amount of sediments naturally suspended in the water column during a major storm. Calculations were carried out for water depths above 20 m for a storm occurring on average every 10, 50 and 100 years, respectively /44/. In the 50 year case, approximately 18 million tonnes of seabed sediments will be suspended in the water. The average SSC, if distributed evenly in a 10 m water column above the seabed, would be approximately 100 mg/l. If distributed in the entire water column, the SSC would be approximately 20 mg/l.

#### 9.2.1.5 Contaminants and nutrients in seabed sediments

Historical and present pollution of the Baltic Sea from contaminants and eutrophication from nutrients has led to some contamination of the underlying sediments. The Baltic Sea receives contaminants from several different sources including atmospheric, fluvial and point sources, although the situation is improving and much of the pollution is due to historic industrial discharges. Background concentrations of inorganic compounds (metals) depend on natural input (e.g. derived from the mineral composition of the geology), with further contributions from anthropogenic sources /45/. By contrast, the origin of organic contaminants is mainly

anthropogenic. The distribution patterns of contaminants in the Baltic Sea are complex, as they are often incorporated into particles on the seabed or adsorbed onto the suspended particles in the water. The majority of contaminants are associated with fine-grained sediments (e.g. silts and clays), due to their large surface area and the negative electrical charge of their surface, and particulate organic matter (POM).

Sediment samples from the NSP2 route were analysed for concentration of metals, organic contaminants and nutrients. The results of these surveys are summarised in Appendix 4. It should be noted that direct comparison of sediment data between countries is not possible because of differences in sampling methodology, analytical techniques and whether samples have been normalized to account for sediment properties.

In general, the results showed that seabed sediment concentrations of both metals and organic contaminants were highest in the Gulf of Finland and in the southern Baltic Proper. These areas coincide with sheltered and/or deep areas that are zones of sedimentation for fine-grained sediments and POM (see Section 9.2.1.3), as well as areas which are influenced by freshwater run-off (which may be impacted by industrialisation in the catchment area). For the most part, contaminant levels in the sediments only showed slight exceedances when compared against guidelines such as the Oslo-Paris Convention, Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) /46/, /47/ and HELCOM /48/, /49/.

The average concentrations of nitrogen and phosphorous in surface sediments along the proposed NSP2 route indicate a relatively uniform distribution, with a tendency for higher concentrations in areas of fine-grained sediment.

The following sections briefly describe the sediment contaminants recorded in each of the NSP2 baseline surveys with particular attention to given to where these concentrations exceeded guideline values. Appendix 4 sets out the contaminant concentrations (minimum and maximum values) recorded in the baseline surveys.

### **Sediments in Russian waters**

The survey in Russian waters was conducted in August 2016 at four stations along the proposed NSP2 route. Five sampling points were selected within each station. Analysis was performed for three layers within each sample: 0-2 cm, 2-10 cm, 10-30 cm. In the nearshore area, samples were taken from 11 locations along the proposed NSP2 route.

The concentrations of metals and organic contaminants in the samples were compared against the St. Petersburg regional norms for bottom sediments in the water bodies /50/. For the components not included in the regional norms, the Finnish guidelines for dredging and deposition of dredged materials /51/ have been used as the methodology for values normalisation, and the approach for sediment quality assessment is comparable.

On average, the results indicated that sediments in deeper waters (>60 m) had higher levels of contamination in all measured parameters. There was a strong correlation observed between the finer sediments found in deeper waters, which have a higher silt/clay fraction. These deeper areas represent zones of sedimentation where contaminants have accumulated over time. Samples taken from the nearshore sector showed no or only slightly contaminated concentrations.

Exceedances for metals were observed as follows (/51/):

- Concentration of copper exceeded the regional norm at nine sampling points within three stations (mostly at depths ranging between 65-70 m and for one sampling point at 36 m), with a maximum concentration of 1.36 times the regional norm;

- Concentration of lead exceeded the regional norm at one sampling station (68 m water depth), with a concentration 1.46 times the regional norm;
- Concentration of zinc exceeded the regional norm at two deep water sampling points (66 m and 70 m water depth), with a maximum concentration 1.13 times the regional norm.

Vertical distribution of heavy metals was relatively constant in all analysed depths (0-30 cm) and at the same level as other samples collected from the Gulf of Finland in the Finnish EEZ.

Concentrations of organotin compounds (tributyltin, TBT) were typically below the limit of detection. At the few stations where organotin compounds were detected, monobutyltin was the main constituent. No exceedances were observed when compared with Level IB (concentration level for the assessment of the eligibility for dumping of dredged material) and higher values in the Finnish guidelines /51/, as Russian norms do not have guideline values for these compounds.

Dioxin and furan levels were slightly higher in the deeper stations, with no clear difference between surface and deeper sub-samples. Polycyclic aromatic hydrocarbon (PAH) and polychlorinated biphenyl (PCB) levels were consistent across all stations both in spatial and vertical directions. No exceedances of the regional norms were detected.

In Russian waters, concentration of nitrogen reached 1%, phosphorus (5,440 mg/kg) in surface sediments, with a tendency for higher concentrations in samples taken from deep water stations.

### **Sediments in Finnish waters**

The survey in Finnish waters was conducted in December 2015 and included seven stations along the NSP2 route. Eight samples were collected from each station. The concentrations of metals and organic contaminants in the samples were compared against the guidelines for dredging and depositing dredged materials by the Finnish Ministry of the Environment /50/.

Based on all data, no major differences were detected in the level of contamination between stations, although the results show that concentrations of metals were highest in the western part of the route, where sediment properties are favourable to attachment by chemical compounds. Notwithstanding this, all metal concentrations were within the range of the lowest guideline value (1, 1A and 1B<sup>5</sup>). An exception was cadmium, which showed a slight exceedance of the lowest guideline value at three stations. In single samples, nickel and copper exceeded the higher guideline value 2<sup>6</sup> at three stations (four samples) and one station (one sample) respectively.

The normalised median concentrations of dioxins and furans were within the range of guideline values 1A and 1B<sup>7</sup> at all stations. The highest single concentrations that exceeded guideline value 2 were observed in three samples. Two of these samples were taken from the easternmost part of the proposed NSP2 route in Finland, near the Russian border (likely due to historic pollution from the River Kymijoki).

PCB concentrations of three congeners exceeded guideline value 2 at one station (one sample taken from the surface sediment at 0-2 cm depth) in the survey area closest to Koverhar. The remainder of samples were below the limit of detection, suggesting only localised contamination. PAHs were observed sporadically in eastern stations and more consistently in western stations within Finnish waters, with the exceedances of the lowest guideline values. Organotin

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<sup>5</sup> 1: concentration level represents naturally occurring background level. 1A: no harm is expected to be caused to aquatic organisms, even during long-term exposure; concentration level is below the PNEC level. 1B: no harm is expected to be caused to aquatic organisms during short-term exposure.

<sup>6</sup>

<sup>7</sup> HELCOM and OSPAR have developed environmental assessment concentration (EAC) values for organic compounds.

compounds, mainly TBT, were present at all stations. TBT concentrations were highly variable between stations, but all were within the range of one of the lowest guideline levels, 1A.

### **Sediments in Swedish waters**

The survey in Swedish waters was conducted in October 2015 and included 51 sampling stations for sediment analysis. One sample was collected from each station. The concentrations of metals and organic contaminants in the samples were compared against the Swedish Environmental Protection Agency (EPA) classification for the assessment of environmental quality /52/, Swedish Agency for Marine and Water Management (SwAM) thresholds (cadmium and lead) /53/ and HELCOM thresholds.

In general, the results showed that concentrations of heavy metals and organic contaminants were higher at greater depths, in zones of sedimentation in the eastern Gotland Basin (from east of Hoburgs Bank to the Swedish/Finnish border). According to the Swedish EPA classification, the average concentrations of metals along the proposed NSP2 route in Swedish waters were generally within class 1, meaning “no deviation from natural background concentrations”. However, the following exceedances were observed:

- Average concentrations of cadmium along the northern part of the route (comprising 17 stations) were classified as class 2, meaning there was a “small deviation from background concentrations”;
- Average concentrations of mercury along the central part of the route (comprising 17 stations) were classified as class 3, meaning there was a “deviation from background concentrations”.

In addition, samples from four stations in the middle part of the route exceeded the HELCOM effect low range (ERL) value for mercury, indicating “bad status”.

In terms of organic contaminants, the survey measured the concentrations of PAHs and PCBs, which have a high potential to accumulate on organic material in sediments and are resistant to degradation. Of the 10 PAH compounds measured, seven were below the EAC values at all stations. Two PAH compounds (indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene) exceeded the EAC values in several samples taken from stations along the northern and central parts of the route in Swedish waters and are considered to be present in “high levels” according to the Swedish EPA classification.

The levels of PCBs were below detection limits at the majority of stations along the proposed route. At the few stations where PCBs were detected, there were no exceedances of EAC values.

The levels of organochlorine pesticides (chlordane, hexachlorocyclohexane (HCH) isomers, dichlorodiphenyltrichloroethane (DDT) (and its degradation products dichlorodiphenyl-dichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD)) and hexachlorobenzene (HCB)) in sediments were generally below EAC values with the exception of two stations, which showed exceedances in the concentration of DDD.

The average concentrations of nitrogen and phosphorous in surface sediments indicate a relatively uniform distribution along the proposed NSP2 route in Swedish waters, with a tendency for higher concentrations in areas of fine grained sediment, particularly of nitrogen /32/. The concentration of total nitrogen also correlated closely with organic carbon in sediment. There was little variation in nutrient concentrations with sediment depth and no consistent trends were observed.

### **Sediments in Danish waters**

The survey in Danish waters was conducted in October 2015 and included 14 stations along the proposed NSP2 route for sediment analysis. One sample was collected from each station. The

concentrations of metals and organic contaminants in the samples were compared primarily against the background assessment criterion (BAC), ERL and the EAC developed by OSPAR<sup>8</sup> /46/, /47/.

In general, higher concentrations of metals were found in sediments taken from the deeper water stations located in the Bornholm Basin (and northern part of the route within Danish waters), where sediments are rich in organic content and have a high silt/clay fraction. The following exceedances were observed:

- Concentrations of lead, copper and nickel exceeded the BAC and/or ERL at nine stations in the northern and central part of the route;
- Concentrations of cadmium exceeded the BAC at one station in the northern part of the route;
- Concentrations of zinc exceeded the BAC at eight stations in the northern and central part of the route;
- Concentrations of mercury exceeded the BAC at four stations in the northern part of the route.

There were no exceedances of either the BAC or ERL of arsenic or chromium. No BAC or ERL is given for cobalt and vanadium.

The concentrations of PAHs were also highest in deeper water sediments that are rich in clay and where bottom waters have little to no oxygen. Exceedances of ERL were observed for three of the PAHs analysed, namely indeno-(1,2,3-cd)pyrene (at six stations), dibenz(a,h)-anthracene (at two stations) and benzo(ghi)-perylene (at six stations) along the northern and central part of the route.

All measurements of PCBs were below the EAC values, and in 6 of the 14 samples, all PCBs were below the detection limit.

The levels of organochlorine pesticides (chlordane, HCH, DDT (and its degradation products DDE and DDD) and HCB) in sediments were generally below ERL values with the exception of four stations in the northern and central part of the route, which showed exceedances in the concentration of DDE. Organotin compounds (TBT or its degradation products) were detected at most stations. However, an exceedance of the EAC threshold was only observed for TBT at six stations in the northern and central part of the route.

Concentrations of nitrogen did not show a correlation with water depth, with highest average concentrations recorded at both the deeper and shallower water stations. The lowest concentrations were recorded in those stations closest to Bornholm. Conversely, concentrations of phosphorous did show a correlation with water depth, with the highest average concentrations recorded at deeper water stations and the lowest average concentrations recorded in the shallower stations.

Given the proximity of the proposed NSP2 route to the chemical munitions dumping site, sampling in Denmark also considered concentrations of CWAs. The results are summarised in Section 9.14.2 and indicate that the highest concentrations of CWAs and their degradation products were found at stations along the middle and northern parts of the route, to the east and north-east of Bornholm.

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<sup>8</sup> The BAC is considered to represent background concentrations without anthropogenic influence, the ERL represents a limit above which negative effects may be expected, and the EAC represents the contaminant concentration in sediment and biota below which no chronic effects are expected to occur in marine species, including the most sensitive species.

### **Sediments in German waters**

The survey in German waters was conducted in winter 2015/spring 2016 and included 42 sample stations located within the sheltered Greifswalder Bodden and another 63 stations in the exposed Pomeranian Bay. The concentrations of metals and organic contaminants in the samples were compared against guideline values set by the Joint Transitional Arrangements for the Handling of Dredged Material in German Federal Coastal Waterways (GÜBAK) and waste law provisions (LAGA-TR20).

In general, higher concentrations of metals were found in sediments with high silt content, and levels of contamination were lowest in the Boddenrandschwelle shoal, an area between Greifswalder Bodden and Pomeranian Bay. However, concentrations were generally low, because the silt content of sediments along route is generally low as well. No exceedances of guideline values were detected.

Concentrations of organic pollutants (including PAH, PCBs, organochlorine pesticides and TBT) were generally low in both areas, mainly below detection limit, and no exceedances of guideline values were observed.

In general, nutrient concentrations also appeared to be low and showed a correlation with sediment properties such as grain size and TOC. Again, no exceedances of guideline values were detected. Average concentrations were highest in areas of fine-grained material such as Greifswalder Bodden /54/ .

## **9.2.2 Hydrography and seawater quality**

### **9.2.2.1 Salinity and halocline**

As noted in Section 9.2.1.2, the Baltic Sea is a semi-enclosed brackish water body. The salinity conditions are determined by the supply of fresh water (river run-off and precipitation) as well as the inflow of saline water from the North Sea (via the Danish Straits).

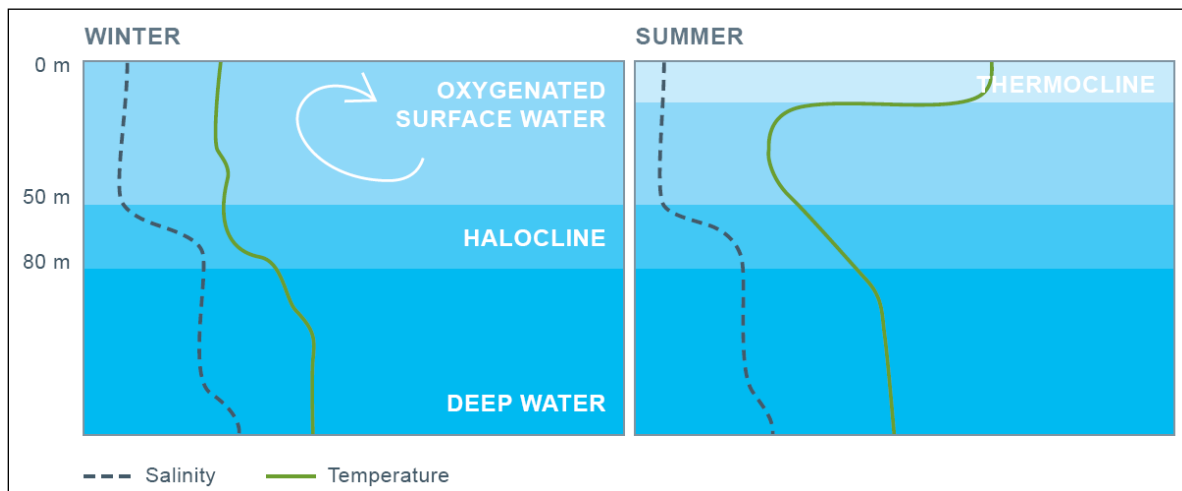
Due to the balance between the inflow of fresh water from the catchment of the Baltic Sea and a relatively low inflow of salt water from the North Sea via the Danish straits, the Baltic Sea is heavily stratified, both horizontally and vertically. The annual freshwater inflow to the Baltic Sea represents approximately 2% of its entire water volume /55/. The mean river run-off is approximately 15,000 m<sup>3</sup>/s /56/, of which approximately 20% enters into the Gulf of Finland via the Neva River at St. Petersburg /57/.

The salinity of the surface waters varies geographically, in general decreasing from 30-35 practical salinity units (psu) in the North Sea to almost 0 psu in the innermost Gulf of Finland. Within the Gulf of Finland in particular, the spatial distribution of salinity in the surface waters is generally characterised by an east-west rise from 1-2 psu to 6.0-6.5 psu throughout the year /58/. The salinity within the Greifswalder Bodden (near the German landfall) represents an exception to this general trend due to freshwater influences from the Oder and other rivers in Poland and Germany. In this regard, the salinity within the Greifswalder Bodden ranges between 5.5-10.7 psu /59/.

Atlas Map WA-04-Espoo shows the average summer (mean value of June-August) and winter (mean value of December-February) salinities in the Baltic Sea at five stations along the pipeline route for the years 2000-2015. The surface salinity decreases from approximately 8 psu near Bornholm to 4-6 psu in the Gulf of Finland. As shown in Atlas Map WA-04-Espoo, the surface salinity changes only slightly throughout the year.

Salinity in the Baltic Sea is also stratified by depth due to limited mixing between the saline water flowing in from the North Sea and the less dense, less saline water already present in the Baltic Sea. These results in the formation of two water masses, with the saline water flowing at the

bottom of the Baltic Sea and the less saline water flowing at the surface (see Figure 9-5 for a typical representation). A permanent halocline (a strong, vertical salinity gradient) is present in the southern and central parts of the Baltic Sea.



**Figure 9-5** Typical summer and winter variations in salinity and temperature in the Baltic Sea /60/. A halocline is the level of maximum vertical salinity gradient, and a thermocline is the level of maximum vertical temperature gradient. A pycnocline (not in the figure) is the level of maximum vertical density gradient, caused by vertical salinity (halocline) and/or temperature (thermocline) gradients.

As seen in Atlas Map WA-04-Espoo, the vertical salinity gradient varies geographically, with the change in the Gulf of Finland (from approximately 4-6 psu at the surface to approximately 7-9 psu at the seabed) much smaller than in areas of the southern part of the Baltic Sea (from approximately 8 psu to 18 psu). The depth of the halocline in various parts of the Baltic Sea is shown in Table 9-3.

**Table 9-3** Depth of the halocline in various areas of the Baltic Sea. Information from /61/, /62/. The intervals shown reflect both the vertical extent and the variability from year to year of the level of the halocline.

Area	Approximate depth of halocline
Gulf of Finland	60-80 m*
Northern Baltic Proper	55-80 m
Gotland Basin	50-75 m
Bornholm Basin	40-75 m
Arkona Basin	40-55 m

\* In the Gulf of Finland, the halocline is not as strong as in other parts of the Baltic Sea. In the western and central Gulf of Finland, the halocline is weak and seasonal and lies at a depth of approximately 60-80 m. In the eastern Gulf of Finland, the water is less saline, and a halocline generally does not exist /62/.

The formation of a strong halocline in the Baltic Sea prevents the mixing between surface and bottom waters, which makes upwards transport of particles and dissolved substances in the deep water layers to leave the system via the surface layers very limited (except for nitrogen gas in the denitrification process). Consequently, the Baltic Sea is an efficient trap for nutrients and pollutants. The presence of a halocline also contributes to the creation of temperature and oxygen gradients within the Baltic Sea, see Sections 9.2.2.3 and 9.2.2.4.

The typical salinity stratification and the overall circulation pattern of water masses in the Baltic Sea are illustrated in Figure 9-6.



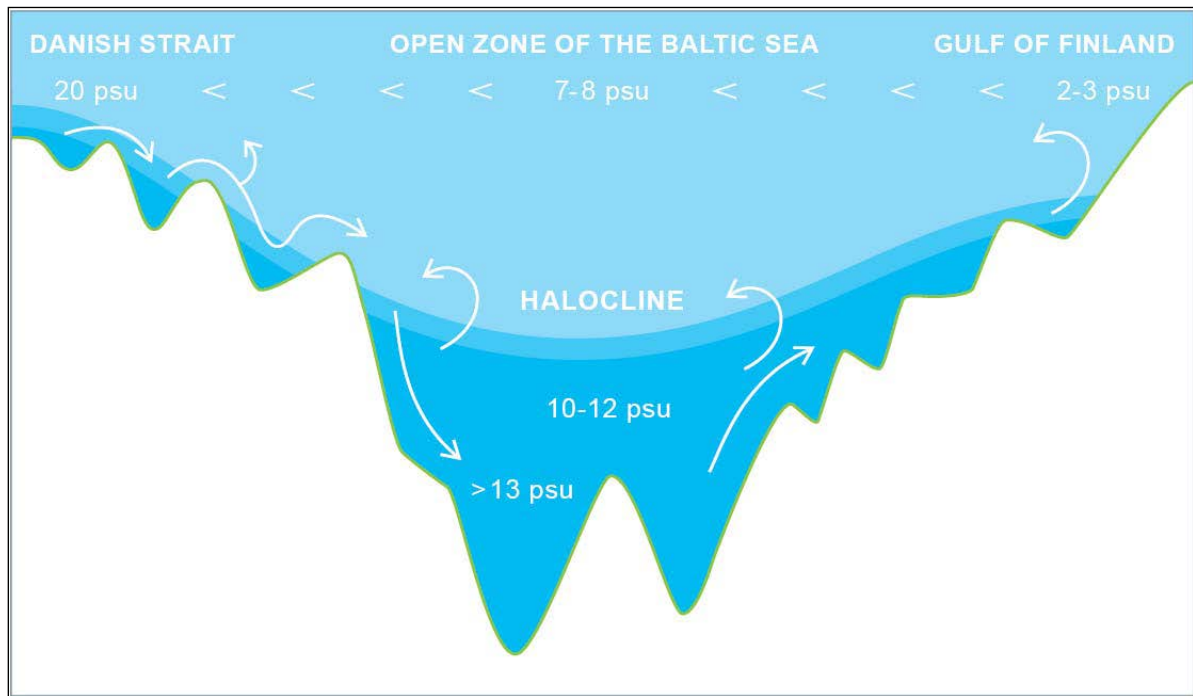


Figure 9-6 The heavy, saline water flows along the bottom, and the less saline surface water flows out of the Baltic Sea. The water becomes stratified, and a halocline separates the layers of varying salinity /63/.

### 9.2.2.2 Major Baltic inflows

The annual freshwater inflow to the Baltic Sea represents approximately 2% of its entire water volume /55/. The mean river run-off is approximately 15,000 m<sup>3</sup>/s /56/, of which approximately 20% enters into the Gulf of Finland via the Neva River (St. Petersburg) /57/. Conversely, major inflows of saline water enter from the North Sea via the Danish straits into the southern Baltic Sea.

The bottom current of inflowing saline water is driven by gravity. As the saline water passes the narrow cross-sections at the sills (Darss Sill and Drogden Sill; see Figure 9-1), the water flows down the sloping seabed towards the Bornholm Basin. Consequently, the water exchange is highly sensitive to physical changes in the transition area and not very sensitive to the bathymetric conditions in the open basins. However, increased flow resistance or other obstacles may lead to increased entrainment.

Before 1980, such major Baltic inflow (MBI) events were relatively frequent and could be observed on average once a year. Since then, however, they have become less frequent and take place during strong storms in the late autumn or winter months. In recent times, MBIs have occurred in 1993 and 2003 (see Atlas Map WA-01-Espoo Map), the latter of which only reached the Gotland Basin /64/, /65/. After nearly a decade without an MBI, a relatively large inflow was detected in the western Baltic in the winter of 2011-2012. This inflow, which could be traced until the southern part of the eastern Gotland Basin, ventilated the Bornholm Basin but did not renew the deep water /66/. MBIs account for approximately 30% of the total salt influx, whilst the remaining 70% of the salt influx is due to weaker inflow incidents /67/.

A weak MBI occurred in March 2014. Previously, two smaller inflow events in November 2013 and February 2014 already reached the Bornholm Basin. In December 2014, a strong MBI brought large amounts of saline and well oxygenated water into the Baltic Sea. Based on observations and numerical modelling, the inflow was classified as one of the rare very strong events. The inflow volume and the amount of salt transported into the Baltic were estimated at 198 km<sup>3</sup> and 4 Gt, respectively. The strength of the MBI considerably exceeded the 2003 event. Of the MBIs since 1880 /68/, the 2014 inflow is the third strongest event together with the MBI in 1913 /69/.

These inflows create clear salinity gradients geographically, temporally and vertically (see Section 9.2.2.1 and Atlas Map WA-04-Espoo).

### 9.2.2.3 Water temperature and thermocline

The water temperature of the Baltic Sea varies both temporally and geographically. Atlas Map WA-03-Espoo shows the average summer (mean value of June-August) and winter (mean value of December-February) temperatures at five stations along the proposed NSP2 route for the years 2000-2015.

It is noted that in January-March, the majority of the Gulf of Finland is usually covered by ice (see Atlas Map CL-01-Espoo). During this period, the water temperature in the eastern part of the gulf is close to 0°C. Typically, the ice clears in April or May /58/. Further information on the trends in ice cover is provided in Section 9.2.3.1.

During spring and summer, solar warming produces a warm layer of water throughout the Baltic Sea that is approximately 10-25 m thick. It is well mixed by the wind and therefore fairly consistent in temperature throughout its depth (on average 16-18°C in summer). The surface waters in the semi-enclosed and shallow bay of Greifswalder Bodden (near the German landfall), however, can reach higher temperatures, up to approximately 18-22°C in July-September /59/. Beneath the mixed surface layer, a thermocline develops which can result in temperature drops of 10°C within a few metres. The bottom water in the Baltic Sea is on average 4-8°C in summer and remains relatively constant throughout the year.

Similar to saline stratification, the stable thermocline in deeper areas prevents vertical exchange between the surface layer and the deeper layer, limiting the upward transport of particles and nutrients from the bottom layer to the euphotic zone. In addition, the thermocline isolates the bottom waters from the oxygen-rich surface layer /70/ (see Section 9.2.2.4).

### 9.2.2.4 Oxygen and hydrogen sulphide

Thermal and saline stratification, limited marine water exchange, eutrophication and weather conditions all affect oxygen concentrations in the Baltic Sea.

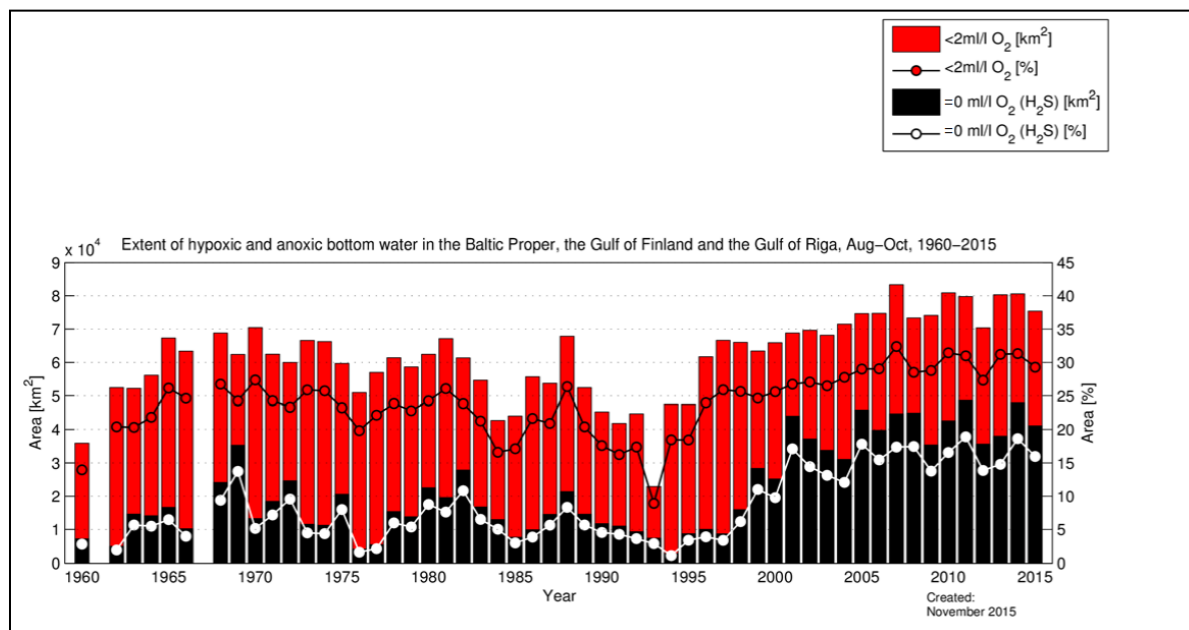
The surface waters of the Baltic Sea become saturated with oxygen (O<sub>2</sub>) by wind mixing – especially during autumn and winter – and in late spring and summer by photosynthesis, which leads to oxygen storage in the upper water layer /71/. The intermediate waters are also relatively well oxygenated because most of the water from the Kattegat and the Great Belt is supplied to this depth range. The basins of the Baltic Sea, however, frequently run out of oxygen because the water there is renewed only by major saline inflows from the North Sea. The lowest oxygen levels in the bottom waters usually are observed at the end of summer, between August and October, when detritus from biological activity in the surface waters has sunk and is decomposed by bacteria /71/.

Hypoxia is a condition that occurs when dissolved oxygen falls below the level needed to sustain most animal life. The concentration at which various animals are affected varies, but generally effects start to appear when oxygen drops below 2.8-3.4 ml/l (4-4.8 mg/l). Acute hypoxia is usually defined at 1.4-2.1 ml/l (2-3 mg/l). For the purposes of this report, hypoxia is defined as oxygen concentrations <2 ml/l.

Anoxic conditions, where no oxygen remains in the water, may occur at very low oxygen concentrations, or in the absence of oxygen, due to remaining available oxygen being consumed by microbial processes. Under anoxic conditions, hydrogen sulphide (H<sub>2</sub>S), which is toxic for all higher marine life, is formed. Anoxic conditions also lead to the release of phosphate and silicate from the sediments to the water column, which, due to vertical mixing, can reach the surface layer and the euphotic zone. High concentrations of phosphate can contribute to eutrophication (see Section 9.2.2.5) /72/.

From the end of the nineteenth century until the 1990s, the oxygen situation in the Baltic Sea deep basins was characterised by varying good and bad conditions. In 1999, there was a distinct regime shift, after which bottom areas with completely anoxic conditions increased. The consistently high levels of anoxia that are currently seen were observed only occasionally before.

The results of an analysis of the bottom areal extent of anoxic and hypoxic autumn conditions in the Baltic Proper, including the Gulf of Finland and the Gulf of Riga, for the period 1960-2015 are shown in Figure 9-7. The figure illustrates that extreme oxygen conditions in the Baltic Proper have prevailed since approximately 2000.



**Figure 9-7** Areal extent of anoxic and hypoxic conditions in the Baltic Proper, Gulf of Finland and Gulf of Riga. Results from 1961 and 1967 have been omitted owing to insufficient data from the deep basins /72/.

Atlas Map WA-02-Espoo shows the levels of oxygen and hydrogen sulphide in the bottom water in autumn 2012-2015, with the areas of hypoxic ( $\leq 2$  mg/l  $O_2$ ) and anoxic (0 mg/l  $O_2$ ) bottom water conditions indicated. Despite the major inflow in December 2014, extreme oxygen conditions in the Baltic Proper continued during 2015. The areal extent and the volume of anoxia since the regime shift in 1999 have been constantly elevated. There are no signs that the inflow in December 2014 reached and oxygenated the northern Baltic Proper or the western Gotland Basin, which still suffers from hypoxia and anoxia /72/.

#### 9.2.2.5 Nutrients and eutrophication

'Eutrophication' can be defined as the process of changing the nutritional status of a given water body by increasing the nutrient resources. As shown in Figure 9-8, eutrophication has a range of effects on the Baltic Sea ecosystem and is considered one of the most serious threats to biodiversity and an indicator of human impacts on the Baltic Sea /73/, /74/, /77/.

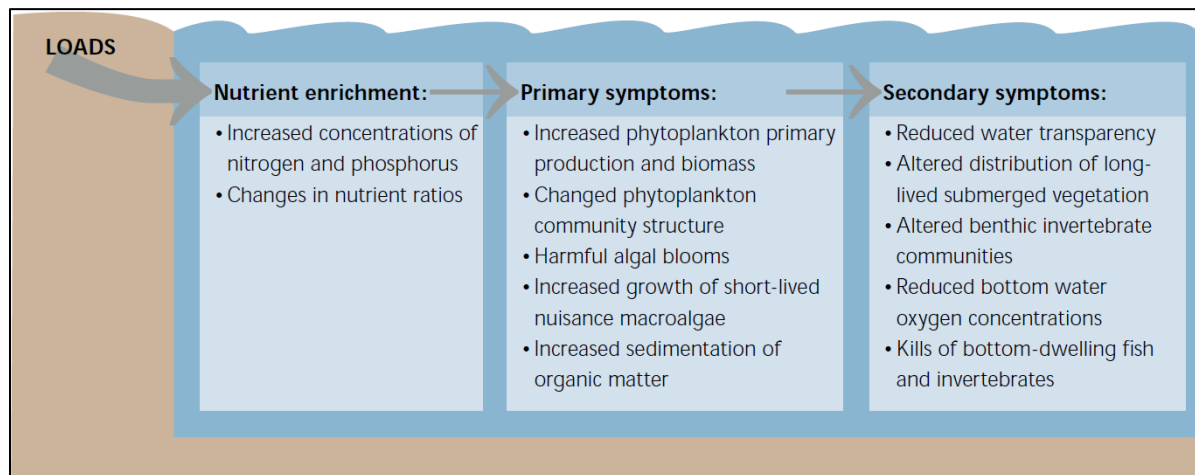


Figure 9-8 A simple conceptual model of eutrophication symptoms in the Baltic Sea /79/.

Phytoplankton is the dominant primary producer in the Baltic Sea, and its growth is influenced by levels of nitrogen and phosphorus. The main sources and pathways of nutrient inputs to the Baltic Sea are:

- Direct atmospheric deposition on the Baltic Sea water surface;
- Riverine inputs, including point sources and diffuse sources within the Baltic Sea catchment area;
- Point sources and diffuse sources discharging directly to the sea;
- Natural background sources, mainly referring to natural erosion and leakage from unmanaged areas and the corresponding nutrient losses;
- Phosphorus reserves accumulated in the sediments of the seabed released back into the water under anoxic conditions.

As outlined above, phosphorus reserves accumulated in the sediments of the seabed are released back into the water under anoxic conditions /78/. In a study of the role of internal biogeochemistry for the pool of inorganic phosphorus in the Baltic Proper and the gulfs of Finland and Riga using extensive monitoring data from 1970 to 2000, the largest single net increase of the phosphorus pool (indicating sediment release) was estimated as 90,000 t/yr, while the largest annual net decrease (indicating sediment binding) was about 110,000 t/yr. Both values are much larger than the external annual total phosphorus load and its variation, given as 23,000-37,000 t/yr into the basins studied /79/.

The nitrogen and phosphorus loads supplied to the different sub-regions in the Baltic Sea in the period 2010-2012 are summarised in Table 9-4 /80/. For comparison, inputs to the Baltic Sea in the year 2000 amounted to 1,009,700 tonnes of nitrogen and 34,500 tonnes of phosphorus /78/, /81/.

Table 9-4 Averaged normalised annual inputs of nitrogen ( $N_{tot}$ ) and phosphorus ( $P_{tot}$ ) during the years 2010-2012 in the different sub-basins to the Baltic Sea /80/. Units are in tonnes per year.

Baltic Sea sub-basin	$N_{tot}$	$P_{tot}$
Bothnian Bay	56,962	2,824
Bothnian Sea	72,846	2,527
Baltic Proper	370,012	14,651
Gulf of Finland	116,568	6,478
Gulf of Riga	91,257	2,341
Danish Straits	53,545	1,514
Kattegat	63,685	1,546
Total Baltic Sea	824,875	31,883

Atlas Map WA-05-Espoo and Atlas Map WA-06-Espoo show the average summer (mean value of June-August) and winter (mean value of December-February) concentrations of total nitrogen and phosphorus, respectively, at five stations along the pipeline route for the years 2000-2015. The total nitrogen concentration shows a marked variation between summer and winter in the uppermost 60-80 m of the water column, with summer concentrations being up to approximately 6 µmol/l lower than the winter concentration, as a result of phytoplankton growth during the summer. Conversely, total phosphorus concentrations show much less variation between summer and winter with the exception of the Gulf of Finland, but vary greatly vertically, with higher concentrations below the halocline. This is due to phytoplankton utilising phosphorus in the euphotic zone and the efflux of phosphorus from the seabed.

HELCOM has calculated the eutrophication status of the Baltic Sea in 2007-2011 based on a set of indicators (chlorophyll-*a*, dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP), Secchi depth and oxygen conditions (oxygen depletion)), which show that the status of the entire Baltic Sea (except for a few areas outside the project area in the Bothnian Bay) is below GES /73/. Target values for GES have been set by HELCOM for the various parts of the Baltic Sea with respect to concentrations of DIN and DIP /73/, /82/, as outlined in Chapter 11 – Marine strategic planning. As shown in Atlas Map WA-07-Espoo, the concentrations of DIN and DIP are above the GES thresholds in most parts of the Baltic Sea. Periodic observations in the Estonian parts of Narva Bay have shown that the diatom *Ceratoneis closterium* (a potential eutrophication indicator species) has become more frequent during the summer months, and based on Estonia data from year 2015, the ecological water quality in Narva Bay was classified as “moderate” /83/.

The total input of nutrients to the Baltic Sea has decreased since the late 1980s. The current input levels are equal to that of the early 1960s. Despite the reduced input, the concentrations of nutrients in the sea have not declined accordingly. The long residence time of water in the open Baltic Sea as well as feedback mechanisms, such as the release of phosphorus from anoxic sediments, and the prevalence of nitrogen-fixing cyanobacteria blooms in the sub-basins of the Baltic Sea are processes that slow down the recovery from the eutrophied state /84/.

#### 9.2.2.6 Heavy metals

The concentration of heavy metals in the Baltic Sea has generally decreased since the 1980s. However, it is still higher than the concentration in Atlantic waters, which are considered less influenced by human activities (Table 9-5) /81/.

**Table 9-5** Content of dissolved heavy metals (ng/l) in the waters of the North Atlantic and the Baltic Sea measured in the period 1993-2005 /85/, /86/, /87/, /88/.

Metal	North Atlantic (ng/l)	Baltic Sea (ng/l)
Hg	0.15-0.3	0.5-1.5
Cd	4±2	12-16
Pb	7±2	12-20
Cu	75±10	500-700
Zn	10-75	600-1,000

The main sources of heavy metals in the marine environment are diffuse sources (e.g. leakage from forest and agricultural soils) and industrial and municipal point sources /89/. Heavy metals are discharged directly, transported via rivers or deposited from the air. A significant proportion of the airborne heavy metal pollution originates from sources outside the Baltic Sea catchment area. The estimated yearly waterborne input of heavy metals to the Baltic Sea is shown in Table 9-6.

**Table 9-6 Waterborne heavy metal input (in tonnes) to the Baltic Sea in 2006 by sub-region. Input of mercury from rivers in Poland is not included /89/.**

Sub-regions	Cd (t)	Cr (t)	Cu (t)	Hg (t)	Ni (t)	Pb (t)	Zn (t)
Archipelago Sea	0.3	11.3	12.6	0.02	9.1	3.8	88.6
Baltic Proper	10.4	12.6	200.6	0.11	62.4	47.6	445.9
Bothnian Bay	1.3	43.6	136.7	0.22	136.9	20.8	404.5
Bothnian Sea	2.9	39.9	106.0	0.19	109.7	27.3	698.2
Gulf of Finland	29.5	20.3	290.3	0.19	185.3	145.9	918.9
Gulf of Riga	2.7	0.2	92.4	0.01	62.6	20.8	439.5
The Kattegat	0.4	21.8	39.8	0.07	23.4	13.8	138.4
The Sound	0.03	1.7	2.8	0.01	1.7	1.1	8.0
Western Baltic	0.05	0.2	5.0	0.01	0.9	1.0	15.4
<b>Total Baltic Sea</b>	<b>47.7</b>	<b>152</b>	<b>886</b>	<b>0.8</b>	<b>592</b>	<b>282</b>	<b>3157</b>

### 9.2.2.7 Organic contaminants

There has been substantial input of organic contaminants in the Baltic Sea from numerous sources over the past 50 years. Anthropogenic sources include industrial discharge, such as the organochlorines in effluent from pulp and paper mills, run-off from farmland, special paints used on ships and boats and dumped waste. Other sources include atmospheric deposition. Organic contaminants are usually adsorbed onto fine-grained particles in the water mass and carried to the seabed by sedimentation. The concentrations of organic contaminants in the sediment are therefore generally several orders of magnitude higher than in the overlying water mass /90/.

Several organic contaminants, such as DDT and technical-grade HCH isomers, have been completely banned since the 1980s. TBT, which belongs to the organotin compounds used as biocides, such as antifouling paints, was also banned under international law in 2003. Since the use of TBT was banned, its concentration has been decreasing in the Baltic Sea. TBT compounds are hydrophobic and bind to particles, especially organic matter, and ultimately deposit in sediments. Depending on the availability of light and oxygen, the half-life of TBTs in natural waters may range from a few days to several years, with the slowest degradation occurring in anoxic sediments. TBT compounds associated with sediments appear to be much less available to sediment-living organisms compared with TBT in the water column /91/.

Available data from the water column is limited, and much of it is outdated because it has become standard practice to measure organic contaminants and metals in sediment rather than in the water column. Table 9-7 presents HELCOM data on concentrations and trends for organic contaminants in the central and western Baltic Sea for the period 1994-1998.

**Table 9-7 Surface-seawater concentrations during the period 1994-1998 /90/.**

Organic contaminants in surface seawater
<b>PCB</b>
Surface seawater PCB concentrations were rather low. Thus, the concentration of PCB 153 (one of the main congeners) ranged from 10-24 pg/l (median values for the period 1994-1998). It was not possible to identify a temporal or geographical trend for the period 1994-1998, except for a general increase in concentration towards the coasts. Due to the high lipophilicity of PCBs, they are enriched in suspended matter and sediments.
<b>DDT, DDD and DDE</b>
Surface seawater DDT concentrations ranged from 2-77 pg/l. The highest concentrations were observed in the Pomeranian Bay, where the values for DDD and DDE ranged from 30 pg/l to 77 pg/l. In the rest of the southern and western parts of the Baltic Marine Area, the concentration range was 2-30 pg/l. Due to the low concentrations, the data set is rather limited and variability is high.
<b>HCB</b>
Surface seawater HCB concentrations ranged from <5-10 pg/l. Due to the low concentrations, no evidence

Organic contaminants in surface seawater
of any geographical variation within the Baltic Marine Area could be found.
<b>HCH isomers</b>
Surface seawater concentrations of the HCH isomers exhibited distinct geographical variation. In 1997 and 1998, the concentration of $\alpha$ -HCH ranged from 0.43 ng/l in the Bights of Kiel and Flensburg to 1.1 ng/l in the Baltic Proper. A clear concentration gradient was observed from east to west. The surface seawater concentration (outflow from the Baltic Marine Area) ranged from 0.54 ng/l to 0.75 ng/l, and the concentration in the deep water (inflow from the North Sea) was only 0.25-0.31 ng/l.
<b>Petroleum and other hydrocarbons</b>
Total hydrocarbon concentrations were 0.5-1.6 $\mu$ g/l in the summer months of 1997 and 1998 in the western and central parts of the Baltic Sea. In winter, the concentrations were significantly higher, ranging from 1.1 $\mu$ g/l to 3 $\mu$ g/l. The concentrations in the Gulf of Bothnia and the Gulf of Finland were similar, with the yearly average ranging from 0.2 $\mu$ g/l to 2.1 $\mu$ g/l. The concentrations in the Gulf of Finland were slightly higher than those in the adjacent waters.
<b>PAHs</b>
In the western and central parts of the Baltic Marine Area, the surface seawater concentrations of single PAHs ranged from <2 pg/l to 4.5 pg/l. The median concentration of the two- to four-ring aromatics (naphthalene to chrysene) in the open sea ranged from 0.02 ng/l to 2.1 ng/l. The mean concentrations of the more lipophilic five- to six-ring PAHs (benzofluoranthene to benzo[ghi]perylene) were <0.005-0.15 ng/l. Significantly higher concentrations were observed in winter as a result of higher input from combustion sources, slower degradation and a higher content of suspended matter in shallow areas.

#### 9.2.2.8 Turbidity and water transparency

Turbidity is a measurement of the light scattering caused by solid particles suspended in the water, i.e. the 'cloudiness', or water transparency. Turbidity is an important physical parameter for marine life as it influences light penetration through the water column and visibility. High turbidity means a low water transparency.

Turbidity mainly depends on the concentration and type of suspended particulate matter (see Section 9.2.1.4) and on the amount of coloured dissolved organic matter. Increased SSCs in the water column cause the turbidity to increase, i.e. reduce the water transparency. The increase in turbidity not only depends on the increase in SSCs, but also on the characteristics of the suspended sediments, in particular the grain size distribution and the type and shape of particles. The light scattering caused by suspended fine-grained sediments is several times higher than the light scattering caused by the same concentration of coarse-grained sediments.

Dissolved coloured substances (e.g. humic and fulvic acids leached out from soils and transported by rivers to the sea) also reduce light transmission in the water due to absorption by these dissolved substances.

The natural turbidity caused by suspended sediments is in general largest close to the seabed (due to resuspension of seabed sediments caused by current and/or wave impact) and in coastal areas (due to fluvial input, coastal erosion and frequent resuspension caused by wave impact on the seabed in shallow water).

The uppermost part of the water column, where there is sufficient light for photosynthesis to take place, is often referred to as the euphotic zone. The thickness of this layer is often indirectly estimated by measuring the depth in which 1% of the photosynthetically active radiation entering the water remains /92/. Increased turbidity can reduce the availability of sunlight and reduce the thickness of the euphotic zone.

Within the Baltic Sea, an increase in summertime turbidity has been observed over the last 100 years (based on data up to 2005) due to increased phytoplankton biomass and cyanobacterial blooms (caused by progressing eutrophication) /93/. This trend has been particularly pronounced in the northern Baltic Proper (where the thickness of the euphotic zone is

reported to have decreased from 9 m to 5 m in the summer) and the Gulf of Finland (decreased from 8 m to 4 m during the same period). Conversely, in the southern and eastern Baltic Proper, this trend has slowed, with turbidity levels now considered stable /93/.

#### 9.2.2.9 Underwater noise

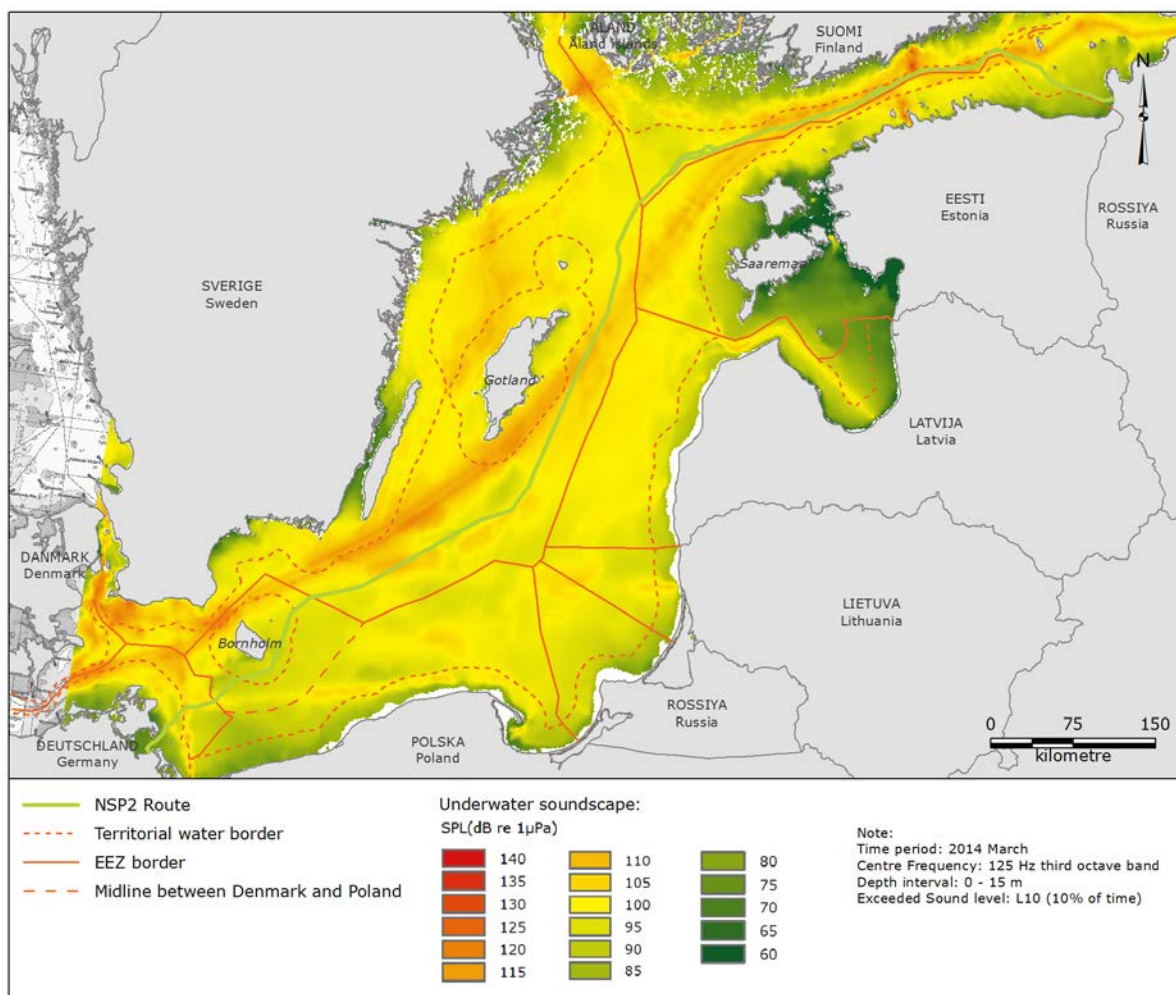
Within the Baltic Sea, the underwater noise environment comprises ambient noise (i.e. sound from rain falling on the surface, waves, marine animals, etc.) that ranges in frequency between approximately 50 Hz and 200 Hz, and noise from distinct and identifiable anthropogenic sources (i.e. sound from shipping, mechanical installations, construction activities, etc.). The noise generated from these sources comes from all directions and varies in magnitude, frequency, location and time. However, it is estimated to dominate at a frequency between 10 Hz and 100 Hz /94/.

The sound pressure level (SPL) of underwater sources varies. Generally, lightning strikes, seismic eruptions and underwater explosions are considered to be some of the loudest sound sources and generate SPLs of 260-280 dB re 1  $\mu$ Pa at 1 m (decibels, sound intensity level relative to 1 microPascal at 1 m). Loud ships can also generate SPLs of up to 190 dB re 1  $\mu$ Pa at 1 m. Sound sources can also be biological; dolphins have been known to produce SPLs of approximately 230 dB re 1  $\mu$ Pa at 1 m, whilst cod, when they grunt, produce an SPL of approximately 150 dB re 1  $\mu$ Pa at 1 m /94/. Quieter sound sources include wind and rain, which generate SPLs of 40-90 dB re 1  $\mu$ Pa.

As part of an ongoing project to study the influence of anthropogenic noise on the Baltic Sea (Baltic Sea Information on the Acoustic Soundscape (BIAS) project), a series of measurements were undertaken over one year (2014) at 38 locations covering the whole Baltic Sea (except the German landfall area). The results of these measurements have been extracted using the BIAS soundscape planning tool and are shown in Figure 9-9 /94/.

In general, the noise levels within the main shipping lanes were approximately 100-130 dB re 1 $\mu$ Pa, whilst levels outside the shipping lanes ranged between approximately 60-90 dB re 1 $\mu$ Pa. Underwater noise monitoring in Germany during construction of NSP in 2010 revealed mean SPLs of 112 dB re 1  $\mu$ Pa at 1 m for shipping lanes and 102 dB re 1  $\mu$ Pa at 1 m for remote parts of Greifswalder Bodden and Pomeranian Bay, respectively /95/. Most of the Baltic marine area is impacted at least by a level of noise that has been estimated to mask the communication of animals. Noise levels causing an avoidance reaction in mobile organisms are likely to occur only in areas with construction works, such as between Helsinki and Tallinn (resulting from cable construction) and at wind farm construction sites, e.g. in Kemi in the Bothnian Bay and Malmö in the Sound /96/.





**Figure 9-9** Underwater soundscape map of noise in the Baltic Sea measured during June 2014 under the BIAS project. Centred frequency 125 Hz third octave band, depth interval 0 m to bottom. Exceeded sound level L10 (10% of time). These results have been extracted using the BIAS soundscape planning tool, which was prepared within the EU LIFE project /97/.

## 9.2.3 Climate and air quality

### 9.2.3.1 Climate

#### Current climate

Meteorological forces over the sea, together with hydrographical processes, have a strong influence on the environmental conditions of the Baltic Sea. These processes influence the water temperature and ice conditions, regional river run-off and the atmospheric deposition of contaminants on the sea surface. Moreover, they also govern water exchange with the North Sea and between the sub-basins, as well as the transport and mixing of water within the various sub-regions of the Baltic marine area /90/.

The Baltic Sea is located in the temperate climate zone, which is characterised by large seasonal contrasts. The climate is influenced by major air pressure systems, particularly the North Atlantic Oscillation during winter, which affects the atmospheric circulation and precipitation in the Baltic Sea basin.

The near-surface wind climate exerts a strong impact on the ecosystem of the Baltic Sea. Storms are essential for the ventilation and mixing of the strongly stratified Baltic Sea, and inflow events importing salt and oxygen from the North Sea are very dependent on the wind climate and pressure differences between these two seas.

Surface air temperatures have shown an overall increase in the Baltic Sea region over the past 140 years. Since 1871, the annual mean temperature trends show an increase of 0.11°C per decade north of 60°N and 0.08°C south of 60°N, while the trend of the global mean temperature was about 0.05°C per decade for the period 1861-2000. The daily temperature cycle is also changing, and there has been an increase in temperature extremes. These changes are resulting in seasonal changes, e.g. the length of the growing season has increased and the length of the cold season has decreased /98/.

The amount of precipitation in the Baltic Sea area during the past century has varied between regions and seasons, with both increasing and decreasing precipitation. A tendency of increasing precipitation in winter and spring has been detected during the second half of the 20th century /98/.

In the Baltic Sea, ice can appear as fast ice or as drift ice. Fast ice is smooth and stationary and can be attached to islands, islets and shallow reefs. Fast ice usually appears at a water depth of up to 15 m /99/, /100/. In deeper waters in the open sea, ice is more dynamically formed, consisting of drift ice that moves along with the currents and winds. On stormy days, drift ice can move 20-30 km. Drift ice and deformed ice can easily get packed against each other or other obstacles, which can result in pack ice or in vast ice ridges /99/, /100/. In shallow areas, packing of drift ice can result in ice packs that grow vertically downwards to the sea bottom. This kind of seabed-attached pack ice has been observed down to water depths of 20 m /99/.

In Atlas Map CL-01-Espoo, the maximum ice cover is shown for a severe winter (2010-2011), an average winter (2012-2013) and a mild winter (2014-2015). As would be expected, the most severe ice conditions prevail in the most north-eastern part of the Baltic Sea, i.e. in the Gulf of Finland.

### **Future climate**

NSP2 has been designed for an operational life of at least 50 years. The purpose of this section is to describe how projected global climate change can be expected to affect the Baltic Sea region during this time.

Surface waters in the Baltic Sea have warmed since 1985, where the annual mean sea-surface temperature has increased by up to 1°C per decade from 1990 to 2008. At the same time, the annual maximum ice extent of the Baltic Sea has decreased about 20% over the past 100 years, and the length of the ice season has decreased by approximately 18 days per century in the Bothnian Bay and 41 days per century in the eastern Gulf of Finland /98/.

An oceanographic study carried out by the Swedish Meteorological and Hydrological Institute (SMHI) showed that average sea surface temperatures for the entire Baltic Sea could increase by some 2-4°C by the end of the 21st century /101/ (see Atlas Map CL-02-Espoo). This is estimated to decrease the ice extent in the Baltic Sea by 50%-80%. The average duration of ice cover for the period 1961-1990 is shown together with the expected duration of ice cover at the end of the 21st century in Atlas Map CL-03-Espoo.

Increased freshwater inflow and increased mean wind speeds may cause the Baltic Sea to reach a new steady state with significantly lower salinity. In the southern Baltic, oxygen concentrations may decrease and phosphate concentrations increase, resulting in increased biomass and cyanobacteria concentrations with a higher cyanobacteria-to-phytoplankton ratio.

A recent report issued by HELCOM largely confirms these findings /98/. It concluded that the summer sea surface temperature is likely to increase 2-4°C by the end of this century, and that there will be a marked decrease in the sea ice cover in the Baltic Sea. Model projections indicate that precipitation will increase in the entire Baltic Sea run-off region during winter, and extremes of precipitation are projected to increase. Atlas Map CL-04-Espoo shows the expected changes in

winter and summer precipitation during the 21st century. A sea level rise of 0.6-1.1 m is expected (see Atlas Map CL-05-Espoo), as well as a decrease in sea surface salinity. Increasing areas of hypoxia and anoxia are anticipated.

The mean and extreme wave heights at the end of the 21st century will probably have increased compared with today. The changes can be expected to be largest in the Bothnian Bay and the Bothnian Sea because of reduced ice coverage, causing unstable marine atmospheric boundary layers with increased surface speed /102/.

### 9.2.3.2 Air quality

The Baltic Sea is one of the world's most densely used sea routes with an estimated 2,000 vessels in traffic at any given time. Associated burning of fuel oil causes emissions to air, the most significant of which are nitrogen and sulphur oxides (NO<sub>x</sub> and SO<sub>2</sub>), particulate matter (PM), and GHGs, mostly carbon dioxide (CO<sub>2</sub>).

Emissions of these components are considered of interest for the following reasons:

- Nitrogen oxides can be harmful to human health, cause acidification of the aquatic environment and have an eutrophication effect;
- Sulphur oxides can be harmful to human health and cause acidification of the aquatic environment;
- PM can be harmful to human health;
- GHGs (in particular CO<sub>2</sub>) contribute to the climate change (global warming).

The air quality in the EU is defined, targeted and assessed by national implementation of EU Directives regarding air quality and cleaner air in Europe /103/. However, this legislation is only relevant for onshore areas. Therefore despite the relatively large annual emissions from shipping in the Baltic Sea (see /104/), air quality offshore is not as regulated. This is both due to the dispersal of pollutants and the low density and mobility of human receptors, and to the different regulatory regime offshore. Only in nearshore areas emissions from shipping vessels may in theory combine with onshore emission sources. In these areas, the ground level concentrations in the landfall areas are considered indicative of air quality conditions (see Sections 9.3.4, 9.4.4 and 9.5.1).

**Table 9-8 Air emissions in the Baltic Sea in 2015 /104/.**

Areas in the Baltic Sea	NO <sub>x</sub> (tonnes)	SO <sub>2</sub> (tonnes)	PM <sub>2.5</sub> (tonnes)	CO (tonnes)	CO <sub>2</sub> (kilotonnes)
Kattegat	67,867	1,953	1,994	4,496	3,038
Gulf of Finland	50,678	1,523	1,560	3,454	2,370
Gulf of Bothnia	23,201	830	831	1,636	1,289
Gulf of Riga	5,061	178	155	357	239
Other areas in Baltic Sea	196,061	5,786	5,896	12,851	8,980
<b>Total</b>	<b>342,868</b>	<b>10,270</b>	<b>10,436</b>	<b>22,794</b>	<b>15,916</b>

Notwithstanding the above, it is noted that the Baltic Sea is a designated Sulphur Emission Control Area (SECA). As of 1 January 2015, the maximum allowed sulphur content in fuel used within a SECA is 0.1%, meaning that ships must either use low-sulphur fuel or have an on-board desulphurization system. As a result of this designation, SO<sub>2</sub> emissions from vessels in the Baltic Sea have been shown to decrease by 88% between 2014 and 2015 /104/. Levels are expected to continue to decrease, although at a more modest rate.

## 9.3 Onshore landfall Narva Bay

### 9.3.1 General siting

The proposed construction and operation area required for the onshore part of NSP2 is situated on the south-western edge of the Kurgalsky Peninsula. The dominant landforms between the PTA and the shoreline comprise glacial moraines underlying a series of ancient dunes leading to a narrow beach to the west (Figure 9.11). Drainage on the west side of the dune lines tends to be east to west. To the east of these dune lines, impervious clay layers form a basin where rainfall-fed bogs have developed, with organic material accumulating to produce peat that is mainly shallow but in places reaches up to 2 m deep.

The onshore route cuts through the northern edge of one of these large bogs, the Kader swamp, where drainage is mainly south-west to north-east. A series of artificial ditches intercepts this flow and diverts it to the meandering and slow flowing Mertvitsa River. This river lies outside of the NSP2 area, to the east of the landfall site, and flows north and into the Luga River. The Gazprom gas supply pipelines cross the river.

The topography is steeper to the west, with two distinct dune ridges with a longer shallower profile to the east of the ancient dune ridge. Elevations are generally between 3-8 m with the highest elevation of 15 m being the ancient dune ridges (Figure 9-10).

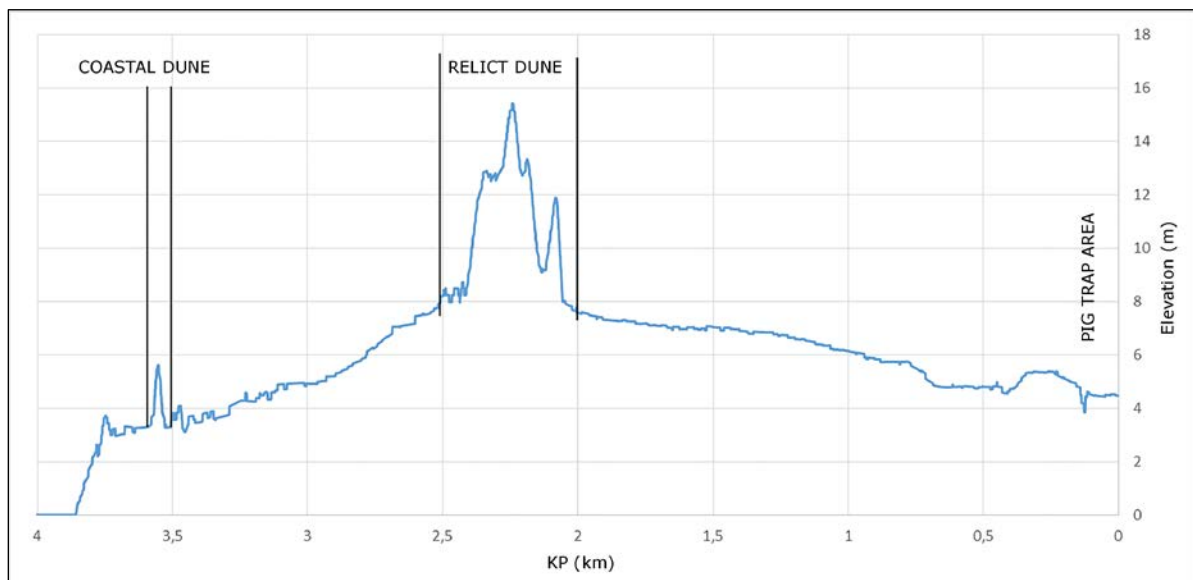


Figure 9-10 Cross section of the onshore route at the Russian landfall.

### 9.3.2 Geomorphology and topography

The preferred landfall in Russia is located in the north-western part of the Russian Plain within the Narva-Luga Klint Bay (see Figure 9-11 and Figure 9-12). It is a coastal lowland that has experienced slow but uneven land uplift and complex water level changes with alternating lacustrine (the build-up of sedimentary layers by lake formation) and marine stages /106/.

Marine transgressions between 7500–4000 years before present produced the Littorina Sea, which covered much of the present coastline. As water levels changed, a series of barrier beaches were formed that now form elongated sandy dunes parallel to the coast, up to 10-30 m high. The NSP2 onshore route will cross two dune ridges: a coastal dune up to 7 m high and a relict dune system that reaches an elevation of around 15 m approximately 1.5-2 km inland. The coastal landscape of Narva Bay is characterised by these beach ridges with dunes colonised with grass and lichen pine forests. This landform is known as the Nizhneluzhsky landscape and is typical of the coastal areas around the Gulf of Finland.

The landforms characterised by the coastal dune, natural forest, relict dune and Kader swamp show limited evidence of anthropogenic modification, while the modified habitat shows moderate signs of human intervention, as it contains a number of artificial drainage ditches.

The soil types of the landfall area are mainly podzols<sup>9</sup>, bog-podzols and bog soils, characterised by low humus content and high acidity. Poor drainage arising from the settlement of glacial silt in hollows produces extensive areas of bogs and lakes, most notably the Kader swamp. This area has shallow peat (maximum depth 2 m).

Erosion is associated with both permanent and temporary watercourses cutting into floodplain terraces, but gully erosion is confined to the steep slope of the sand dunes on the edge of the marine terrace. There is potential for dune erosion if vegetation is disturbed. No landslides have been observed.

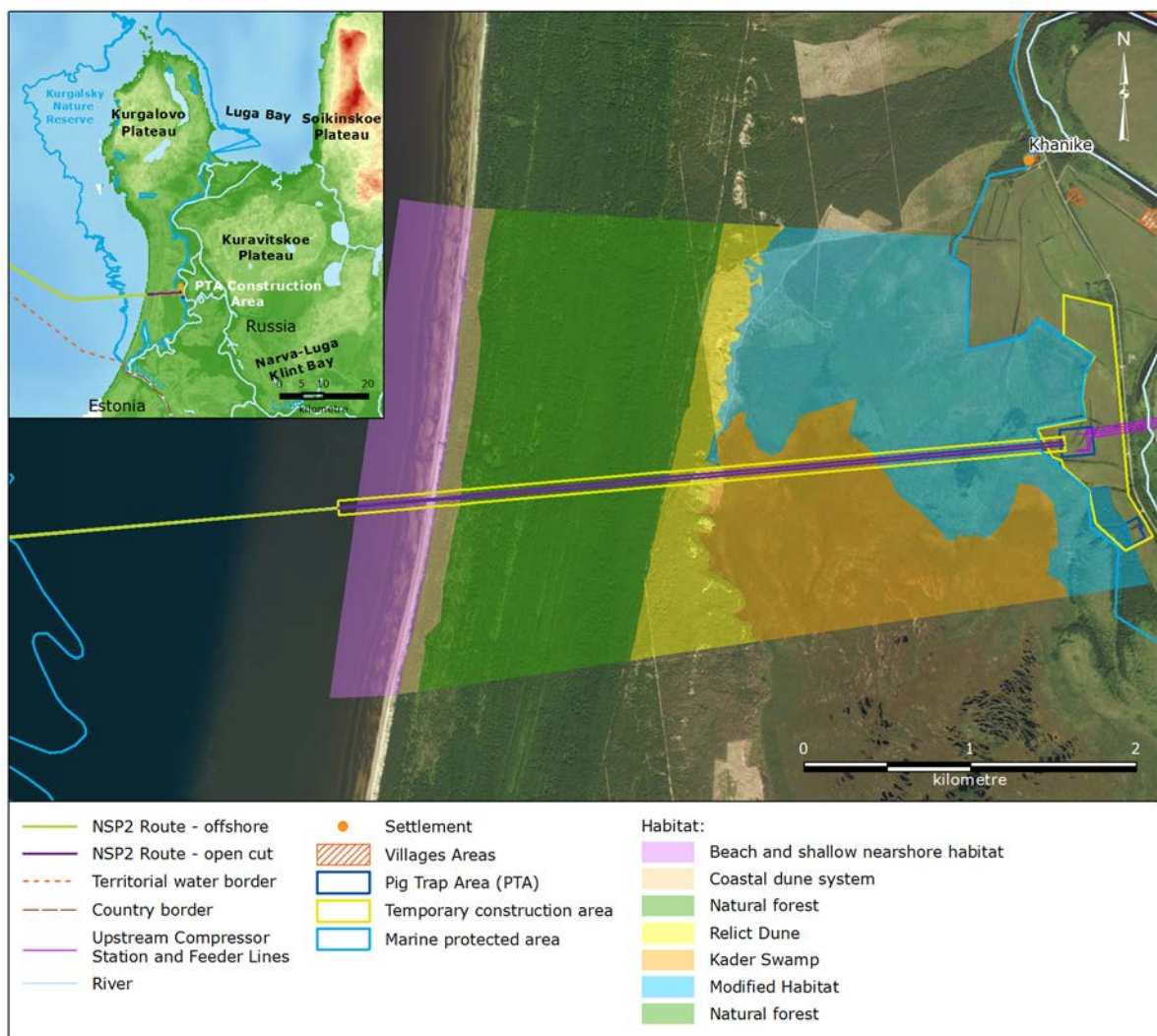


Figure 9-11 Landforms and digital elevation model of the preferred Russian landfall.

<sup>(9)</sup> Infertile acidic soil with an ash-like subsurface layer (from which minerals have been leached) and a lower dark stratum.



**Figure 9-12** Beach on the coast of Narva Bay, overgrown with reed up to 1.5 m high. The dip angle of the surface is approximately  $3^{\circ}$ . It is composed of fine-grained, light-grey sand with dark silt and a minor quantity of shells /76/.

### 9.3.3 Freshwater hydrology

There are two main hydrological features associated with the project area, the Kader swamp and the Mertvitsa River, and number of handmade ditches and channels which were created previously for agricultural purposes /76/.

The central part of the Kader swamp is a complex of pool-and-hummock ridges. The groundwater table varies between 1 m and 10 m from the surface. Plant communities at the periphery include sphagnum, sedges, cotton grass, sub-shrub and pine. The northern part of the Kader swamp has experienced natural fires in the last decade and land reclamation included planting of young pines and the creation of fire protection ditches (Figure 9-13). The bogs are mainly rainfall fed (ombrogenous) and drain north and east into the River Mertvitsa (Figure 9-14) via culverts in the A121 road. The river runs to the north and east of the landfall area and after a slow meandering course joins the Luga River.

**A**



**B**



**Figure 9-13** A. Northern part of the Kader swamp suffered from fire. B. Central part of the Kader swamp, 2.5 km south of the proposed landfall area /76/.

The water levels in the Mertvitsa River are largely dependent on the much larger Luga River to the east. The Mertvitsa River normally has no drift ice in it. As noted above, the NSP2 route does not cross the river, but the feeder lines of the upstream gas connection pipeline do.



Figure 9-14 The Mertvitsa River to the east of potential landfall area (riverbed width is 10 m) /76/.

### 9.3.4 Climate and air quality

#### 9.3.4.1 Climate

The location of the preferred landfall on the coast of the Gulf of Finland and the proximity of the Baltic Sea gives its climate the features of a marine climate. This is manifested, e.g., in the shift of the temperature minimum from January to February and the lower annual air temperature variation between the average temperatures of the warmest and coldest months. Owing to the frequent penetration of warm air masses from the Atlantic Ocean, the winters in the Russian landfall area are generally not severe /75/.

#### 9.3.4.2 Air quality

The calculated background concentrations of air pollutants in the Narva Bay landfall area are given in Table 9-9. The values shown were calculated by the state meteorological authority in Russia for the two villages closest to the landfall and represent the period 2014-2018.

Table 9-9 Background concentrations of pollutants in the atmospheric air of Khanike village and Ropsha village (Kingisepp area) /75/. The values (representing the period 2014-2018) are shown relative to the maximum permissible concentration (MPC) in the last column.

Parameter	Concentration	MPC	Concentration/MPC ratio
PM	195 µg/m <sup>3</sup>	500 µg/m <sup>3</sup>	0.39
SO <sub>2</sub>	13 µg/m <sup>3</sup>	500 µg/m <sup>3</sup>	0.026
NO <sub>2</sub>	54 µg/m <sup>3</sup>	200 µg/m <sup>3</sup>	0.27
CO	2.4 mg/m <sup>3</sup>	5 mg/m <sup>3</sup>	0.48

As shown in the table above, the calculated air quality conditions in the two villages is good, with no MPC values exceeded, and with baseline concentrations of all calculated pollutants less than 50% of MPC. The primary local sources of air pollution in the area are expected to be traffic and fuel combustion for local heating. As the above concentrations have been calculated in villages, baseline concentrations in areas with no human developments can be expected to be lower than the above values.

## 9.4 Onshore landfall Lubmin 2

### 9.4.1 General siting

The construction and operation area required for the onshore part of NSP2 in Germany is located in the north-east of Mecklenburg Western Pomerania. It borders the Greifswalder Bodden in the north and the Struck Peninsula, limited with the estuary of the Peene River, in the north-east. The area is characterised by dunes and kilometres of sandy beaches that are up to 50 m wide. The high banks are mainly wooded with pines. Height differences between the high banks and the beach can be up to 6 m.

### 9.4.2 Geomorphology and topography

The Lubmin 2 landfall area is located within the "Lubminer Heide", and the top layer in this region consists of fine and medium sand of different grain sizes (basin sands), deposited in a proglacial lake during retreat of the recent glacier of the Weichselian Glacial (Pleistocene). In the course of the Holocene, drifting sand covers and dunes were formed by aeolian sediment shifts, which superimposed paleosols and peat formations. The recent topsoil consists of forest soil and isolated fillings /105/.

Below the basin sands, a till horizon follows, of which only relicts remain in the present investigation area. This is underlain by glaciolacustrine or glaciofluvial fine to medium coarse sands. At the bottom of the fine and medium coarse sand layers, intercalations of silt, gravel and chalk blocks are present. This sand layer is underlain by a till horizon with lumps of clay and chalk blocks. The basement is formed by Cretaceous chalk.

The structural conditions within the German landfall area indicate strong deformations of the stratigraphic sequence below the upper till horizon. The deformation, characterised by strong imbrication and insertion of older strata in the superimposed layers, was caused by the foray of the youngest glacier of the shift icing that is represented by the upper till.

The area of the "Industriepark Lubminer Heide" in the south of the Lubmin industrial harbour is characterised by anthropogenic exaggerated soils (excavated and filled grounds). Natural bottom formation processes are partly inhibited due to total sealing. In the north-east of the area of investigation, the relief is flat and close to sea level, turning into flat-wavy southwards while slowly increasing to 20 m above sea level. No contaminated sites can be found within the German landfall area /54/.

The coastal area near Lubmin industrial harbour is characterised by a sandy beach and a dune. Both beach and dune are a result of intensive beach nourishment in 2005. To the east of the beach is an area of natural pine forest (see Figure 9-15).



Figure 9-15 Coastal area at the potential landfall area Lubmin 2.



The landfall area itself is located within the extensive pine forest complex "Lubminer Heide". This forest area grows on a dune area with flat-waved terrain topography.

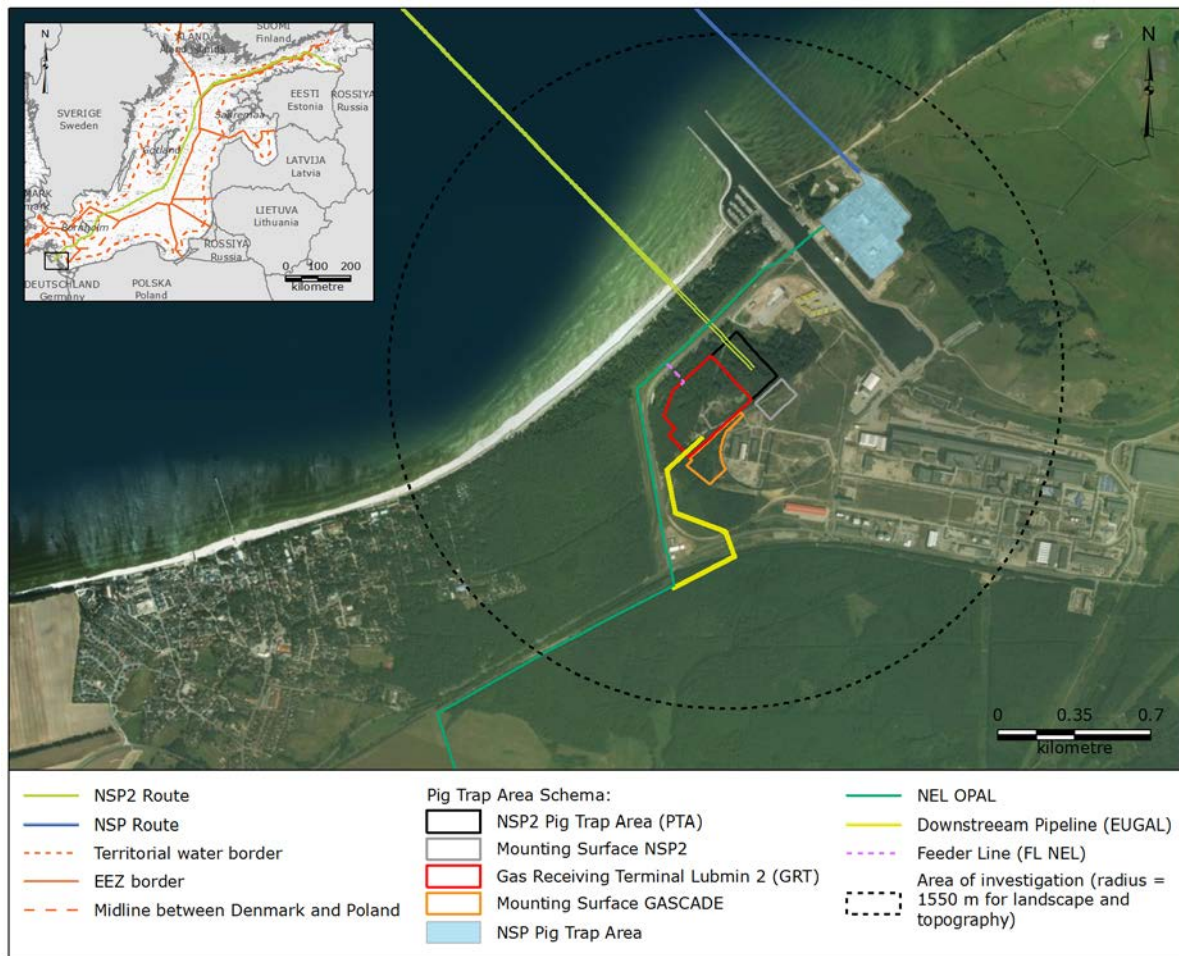


Figure 9-16 Overview of the industrial area Lubminer Heide.

### 9.4.3 Freshwater hydrology

#### 9.4.3.1 Surface waters

All surface waters in the German landfall area are of anthropogenic origin. These include the industrial harbour Lubmin located in the north-east of the area of investigation, the former inlet of the nuclear power plant located in the east and several drainage channels in the lowland area to the north-east. Furthermore, a trench runs through the Lubminer Heide to the inlet of the retention basin of the former nuclear power plant.

The banks of the harbour basin and the inlet to the former nuclear power plant are artificially stabilised and low in vegetation. The retention basins are not stabilised. Some of them are intensively maintained; others are left alone and no maintenance measures are applied. Large areas are occupied by pristine and riparian vegetation.

Information on the nutrient status of the different water bodies is not available. Owing to the direct connection to the eutrophic Greifswalder Bodden, the outflow channel (connection to the Peene River) and the shipping intensity, it can be assumed that the nutrient load of the harbour basin is very high.

#### 9.4.3.2 Groundwater

Three aquifers are located within the area of investigation. The upper one, consisting of glacio-fluvial sands and Holocene sands, is not confined on any site. Therefore it contains unstressed groundwater. The second aquifer, also consisting of sand, is covered by till that widely varies in depth. The third aquifer occurs only at the eastern edge of the study area. The permeability of all three aquifers lies between  $10^{-4}$ - $10^{-5}$  m/s (corresponding to fine sand). The thickness of the aquifers varies between 2 m and 10 m.

Groundwater levels are close to the mean sea level nearshore and increase to +5 m above the mean sea level at the southern edge of the study area. The groundwater is hydraulically connected to the water of the Baltic Sea, and the coastal groundwater can be influenced by brackish water. No drinking water protection zones are located within the area of investigation. The nearest drinking water protection zone is located 2 km south of the Lubmin 2 landfall area /54/.

#### 9.4.4 Climate and air quality

The climate of the Lubmin 2 landfall area is influenced by the sea, e.g. due to thermic attenuation properties of the adjacent water body (the Baltic Sea) and stronger winds throughout the year. The coastal climate of the German landfall area is furthermore characterised by high humidity, low daily and annual temperature variation in the colder early spring and the warmer autumn and low levels of anthropogenic air pollutants.

Due to the low density of vertical structures, the terrestrial area of interest is characterised as an area exposed to wind which acts to disperse any air pollutants that do arise.

Relevant air quality standards are specified in national legislation that implements an EU Directive regarding air pollution /103/. With respect to the air quality reports of the German federal state of Mecklenburg-Western Pomerania (e.g. air quality report for 2014 /107/), air quality in the landfall area is generally good. The concentrations of contaminants such as SO<sub>2</sub>, CO and benzene (C<sub>6</sub>H<sub>6</sub>) are at a very low level across the federal state and clearly below legal limits. Due to varying distances to urban structures, concentrations of NO<sub>2</sub> PM in particular vary between more rural- and urban-oriented gauging stations. Ozone values can exceed the legal limit on single days at some stations as a result of weather conditions. The NO<sub>2</sub> threshold (yearly average) is exceeded at a single gauging station.

Results from nearby monitoring stations, notably those in Zingst (UBA monitoring network) and Garz, located to the south of Rügen Island, indicate that all pollutant levels are below the relevant significant thresholds, with the exception of a single daily exceedance of ozone values as a result of weather conditions. Particulate matter PM<sub>2,5</sub> has been documented with an average concentration of 12 µg/m<sup>3</sup> within the last three years (station Rostock-Warnemünde /108/). The background presence of nitrogen is defined by a deposit value of 9 kg/ha per year for the landfall area and the surrounding water areas (referring to 2009 /109/).

Most parts of the onshore areas around Lubmin are in general defined as 'pure air areas', with only a slight negative influence on air quality. The air quality parameters documented by selected monitoring stations are clearly below the threshold level for the preventive protection of human health with regard to ecological aspects, apart from single stations in the vicinity of heavily trafficked roads. However, an anthropogenic basic load also exists for pure air areas, due to large-scale impacts on air quality on a European level (atmospheric deposition of nutrients, such as nitrogen, and trace elements, such as Cd, Cu, Zn, Pb, as well as persistent organic chlorine compounds and aeri ally occurring Hg).

### 9.5 Onshore ancillary areas

### 9.5.1 Climate and air quality

The onshore ancillary areas are all situated in coastal areas near the Baltic Sea and are therefore influenced by the adjacent water bodies. The climate, however, varies because the areas are at different degrees of longitude and influenced by, e.g., topography, winds, distance to the sea, etc.

Air quality varies between the sites as a result of differences in local and regional sources of air pollution, e.g., traffic, industry, dwellings, etc.

The existing conditions regarding climate and air quality are described for each individual area below.

#### 9.5.1.1 Kotka

The Kotka area is situated on the southern coast of Finland as well as on islands immediately adjacent to the coast. The influence of the Baltic Sea means that this part of Finland has the characteristics of a coastal climate, with moderate winter temperatures. For Finland as a whole, the mean temperature is much higher than other areas at the same longitude as a result of the rising temperatures of the Baltic Sea, inland waters and airflows from the Atlantic.

Air quality in the Kotka region is affected by various sources such as power plants, pulp and paper mills, harbours and transboundary emissions. Pulp mills and ship traffic produce the largest emissions. Direct and indirect emissions from road traffic are significant in heavily operated built-up and harbour areas; also particulate emissions from wood burning to heat residential buildings contribute. According to the monitoring results from recent years, air quality in Kotka has been mostly good or satisfactory. Typically, the air has had quite low annual and monthly concentrations of PM (PM<sub>10</sub>), nitrogen oxides (NO<sub>x</sub>) and total reduced sulphurs (TRS). Short-term concentrations during abnormal conditions have occasionally been high. In summary, air quality in Kotka does not differ from the air quality of similar cities in Finland. In recent years, air quality has been stable or has improved slightly. Ship traffic causes significant amounts of emissions into the air from Mussalo Harbour. Handling of dry bulk materials at the harbour can occasionally result in high peak concentrations of PM.

#### 9.5.1.2 Hanko and Karlshamn

These two ancillary areas will be used as storage yards for materials used in the construction of NSP2 (mainly weight-coated pipes).

The climate of Hanko is comparable to that of Kotka described above, as Hanko is also situated in the southern part of Finland and influenced by the same climatic factors.

Air quality in Hanko is mainly considered good. Air quality is affected by various sources such as industry, harbour operations, heating, energy production, transport and transboundary emissions. Emissions vary annually and there is no clear trend in emissions levels in recent years. The closure of the Koverhar steel factory has resulted in reduced emissions nitrogen oxides and PM. Monitoring of the general air quality in Hanko (concentrations in air) has not been conducted in recent years. In 2009, nitrogen dioxides (NO<sub>2</sub>) were measured in Hanko city centre, and the annual average concentrations were low (8–13 µg/m<sup>3</sup> NO<sub>2</sub>) compared with the threshold value of 40 µg/m<sup>3</sup>.

Karlshamn is situated to the south compared to the Finnish archipelago. The average temperature is therefore higher. However, in general the climate in this area is also strongly affected by the Baltic Sea with a coastal climate and moderate winter temperatures, supported by warm air masses from the Atlantic.

The air quality in Karlshamn is influenced by local sources such as emissions from ships in the harbour, traffic and industry. Other activities such as construction work and handling of, e.g.,

gravel, aggregates, etc. may contribute to occasional local dust nuisances. In general, however, the air quality in Karlshamn is considered to be only slightly impaired compared with clean air, and exceedance of air quality thresholds is not expected.

#### **9.5.1.3 Mukran**

As is the case with the German landfall area (see Section 9.4.4) the Mukran area is to a large extent influenced by the Baltic Sea, resulting in a coastal climate that is characterised by high humidity, low daily and annual temperature variations in the colder early spring and the warmer autumn and low anthropogenic air pollution. This means that the air quality in this area is considered as being under slight negative influence.

# Biological environment

## 9.6 Marine areas

Salinity, temperature and oxygen are physical parameters that act to constrain the biodiversity in semi-enclosed water bodies. The biology in the Baltic Sea, which is such a water body, is therefore influenced by both the physical and chemical environment. As described in Section 9.2, the Baltic Sea is a particularly brackish sea, with significant gradients in both salinity and temperature. In addition, the pycnocline (thermo- and haloclines) defines the water column profile of the Baltic Sea (see Section 9.2). In general, biodiversity and species richness increases with increasing salinity. Therefore diversity is generally lowest in the Gulf of Finland and increases towards Germany.

The ecosystem is composed of species or species groups, communities and habitats, and the interaction between the different trophic levels (feeding position in the food web). For the Baltic Sea, the relevant species or species groups (i.e. receptors) are plankton, benthic flora and fauna, fish, marine mammals and birds. The habitats are influenced by the specific combination of abiotic and biotic conditions which determine both the individual species and communities as well as the assemblages of species supported by them. For a further description of the overall ecosystem functions and biodiversity, see Section 9.6.8.

In the following sections, the terrestrial flora and fauna onshore at the landfall areas and the marine biology receptors, together with the protected areas of the Baltic Sea, are described in detail. Key areas used to describe the biological baseline are shown in Figure 9-1 (sub-basins) and Figure 9-17.

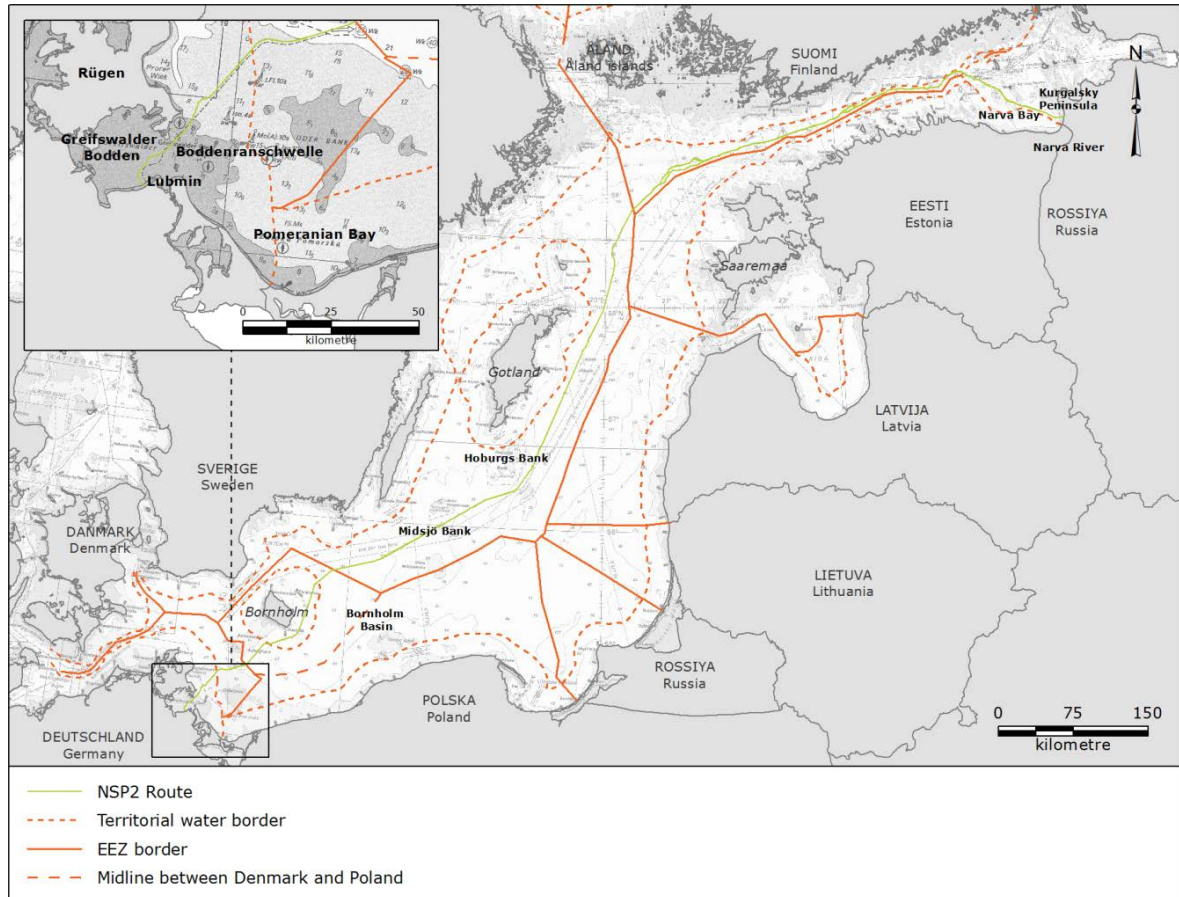


Figure 9-17 Key areas of the Baltic Sea used for the biological baseline description; see also Figure 9-1.

### 9.6.1 Plankton

Plankton comprises small organisms such as phytoplankton and zooplankton that live in the water column.

#### 9.6.1.1 Phytoplankton

Phytoplankton comprises a group of microscopic photosynthetic organisms (microalgae; e.g. diatoms, dinoflagellates and cyanobacteria). They are the main source of primary production in the Baltic Sea and form the base of the marine food web. Therefore phytoplankton are essential to the ecosystem function, as they provide the basis for the productivity of higher trophic levels (zooplankton, fish, etc.). Phytoplankton also perform a vital role in the biogeochemical cycles of many important chemical compounds (especially Carbon, Nitrogen, Phosphorous, Silicium-cycles), particularly the carbon cycle of the ocean. Carbon fixed by phytoplankton enters the food web, where it is consumed by mostly zooplankton. Detritus (dead organic material) subsequently sinks, often in areas away from the coast, which leads to the transport of carbon from the surface waters to the deep water. This process, known as the 'biological pump', is one of the reasons that the oceans constitute the largest (active) pool of carbon on earth.

Owing to its high dependency on light for growth, phytoplankton are restricted to the upper part of the euphotic zone, which in the Baltic Sea ranges from a few metres in coastal areas to 35 m in the central areas. The vertical and horizontal distribution of phytoplankton is also dependent on the turbidity of the water and the availability of nutrients (nitrogen and phosphorus), which are essential for growth, as well as climatic conditions and currents. A high nutrient load due to eutrophication can give rise to substantial increases in phytoplankton biomass, which leads to an increased detritus load to the seabed. The degradation of detritus in turn results in high oxygen consumption and a potential oxygen deficiency on the seabed, which can impact the benthic

communities (species living on the seabed), as discussed in Section 9.2.2.5 on eutrophication dynamics and the status of the Baltic Sea.

Chlorophyll a is the most abundant photosynthetic pigment among all photosynthetic organisms and can therefore be used to estimate phytoplankton biomass, and hence its horizontal distribution. The surface chlorophyll a concentration in European waters is measured continuously by the Joint Research Centre of the European Commission using satellite mapping (Ocean colour remote sensing). Surface chlorophyll a is shown for each of the months of 2012 (Figure 9-18, Atlas Map PE-02-Espoo) and for the month of July for the period 2004-2012 (Atlas Map PE-01-Espoo). This indicates that plankton is distributed throughout the entire Baltic Sea with the biomass in general highest in the summer months (June-August), with the highest levels occurring in the Gulf of Finland and in the eastern Gotland Basin (Figure 9-18, representing the year 2012) /110//111/.

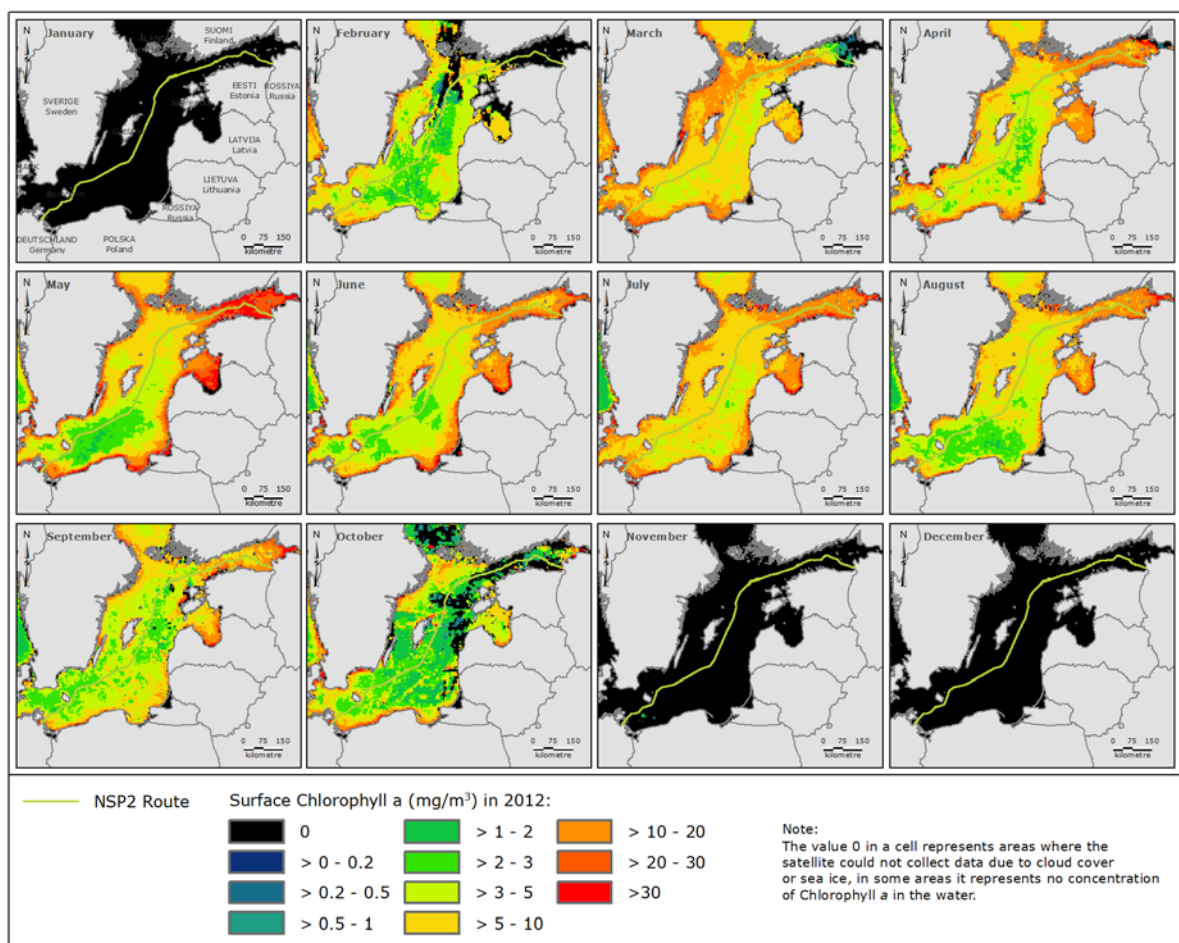


Figure 9-18 Surface chlorophyll a concentration (mg/m<sup>3</sup>) for each month in 2012 /110//111/.

Phytoplankton also exhibit significant cyclical changes in response to seasonal variations in sunlight and temperature. In general, there are three annual phytoplankton blooms in the Baltic Sea /110/, /111/, /112/, /113/. The timing of the blooms in the different areas depends on the above-mentioned factors. Although seasons vary slightly between regions, in general the timing of the phytoplankton blooms can be described as follows:

- In spring, when nutrients and light become available, the biomass of phytoplankton increases massively. The spring bloom typically consists mostly of diatoms and/or dinoflagellates. When the dissolved nitrogen is depleted, the algal biomass in the upper part of the water column decreases until it reaches the summer minimum.
- In summer, recurrent blooms of cyanobacteria usually dominate the coastal areas and surface waters /112/. Cyanobacteria blooms depend on the available amounts of

phosphate in the surface water and favourable weather conditions. Some cyanobacteria are capable of nitrogen fixation, i.e. uptake of nitrogen from the atmosphere, and can form massive visible surface accumulations of several weeks' duration throughout large parts of the Baltic Sea /114/.

- In autumn, as temperatures decrease and winds increase, water mixing typically increases the supply of nutrients from the nutrient-rich bottom water, which may lead to a third, minor naturally occurring autumn bloom.

As a result of the brackish conditions of the Baltic Sea, phytoplankton communities differ in composition from those in other marine areas, with the low salinity resulting in lower species richness compared with other areas. Approximately 1,700 phytoplankton species have been recorded in the Baltic Sea /112/, although many of these are only represented in very low numbers. Species diversity for phytoplankton does not follow the general pattern of low species diversity in areas with lowest salinity, as the most phytoplankton diverse areas in the Baltic Sea are in the Gulf of Finland, which has low salinity /112/. This is due to the influence of freshwater species. In the more saline waters (southern Baltic), phytoplankton are dominated by diatoms and dinoflagellates (marine species). The diversity is lowest in the Bornholm and Gotland Basins (central Baltic) owing to unfavourable salinity conditions for both marine and freshwater species. There are no records of species of phytoplankton on the HELCOM Red List or the IUCN Red List.

Bloom-forming cyanobacteria occur throughout the Baltic Sea (Atlas Map PE-03-Espoo). Some of these species are potentially toxic to fish, mammals and humans. Dominant bloom forming and potentially toxic species are *Aphanizomenon* (occurring primarily in the northern parts of the Baltic), *Nodularia* (occurring primarily in the central and southern parts of the Baltic) and *Dolichospermum* (which occurs in all regions) /113/, /114/.

The production of plankton can be very high due to a very low turnover time, which is on average 2-6 days for phytoplankton.

#### 9.6.1.2 Zooplankton

Zooplankton is a group of small planktonic animals that constitute a food source for zooplanktivorous fish. Therefore zooplankton is a key link in the food chain.

The zooplankton communities in the Baltic Sea comprise a mixture of freshwater, brackish and marine species. Approximately 1,400 species of zooplankton ranging from microzooplankton to macrozooplankton (0  $\mu\text{m}$  to more than 20 mm) have been recorded for the entire HELCOM area (Baltic Sea, Danish Straits and Kattegat) /112/. The species richness increases with salinity. Again, the brackish conditions restrict the diversity of the marine species and as a consequence of the salinity gradient in the Baltic Sea, the marine species dominate the southern Baltic Sea /115/. Microzooplankton is the most diverse group, dominated by ciliates and rotifers. The meso- and macrozooplankton is dominated by calanoid copepods (*Pseudocalanus*, *Temora longicornis* and *Acartia* spp.) and cladocerans (*Evadne nordmanni*). There are no records of species of zooplankton on the HELCOM Red List or the IUCN Red List.

Although zooplankton can occur throughout the water column, the temporal variation in vertical and horizontal distribution depends on the eco-physiological tolerances (e.g. salinity, oxygen level and temperature preferences) of particular species and the availability of food resources (e.g. phytoplankton and bacteria) /112/, /116/. The pycnocline (see Section 9.2.2.1) constrains the vertical distribution of zooplankton species and is thus a key determinant of the vertical assemblage patterns in the different layers of the water column /112/.

Zooplankton biomass is closely linked to the food source, i.e. phytoplankton and microzooplankton (ciliates and smaller flagellates). As a consequence, the zooplankton blooms follow the timing of phytoplankton blooms, with their intensity being linked to, but lower than, the blooms of phytoplankton. Therefore mid-summer (exact timing depending on region) is the



high season for zooplankton because of the abundance of food and fast growth and generation cycles as a result of high water temperatures.

The production of zooplankton ranges from hours for protozoans to a year for large zooplankton species.

### 9.6.1.3 Importance of plankton

Plankton plays a key role in the marine ecosystem as the base of the marine food chain, while phytoplankton has an additional key role in the carbon cycle. Although the Baltic Sea does not include any species of plankton that are on the HELCOM Red List, on the global or national IUCN Red Lists or protected under national legislation, plankton is considered to be of medium importance owing to its role in the food chain and carbon cycle.

### 9.6.2 Benthic flora and fauna

Benthic flora and fauna comprise organisms that live on or in the seabed. The structure of the benthic communities in the Baltic Sea is largely dependent on a number of factors, including oxygen concentration, salinity, light and substrate conditions as well as water movement. In addition, water quality, nutrient load, food supply, trophic competition with alien species, etc. also contribute to the community structure.

#### 9.6.2.1 Benthic flora

Benthic flora comprise macroalgae associated with hard substrates, species that are free-floating in the water column, and flowering plants (angiosperms) that can be found in soft bottom areas, primarily in the coastal areas. Owing to the importance of the Baltic Sea as a nursery, breeding and feeding area for invertebrates and fish, which in turn attract seabirds, benthic flora are a key component of the food chain of its marine coastal ecosystem.

Benthic flora are distributed in areas where the photic zone reaches the seabed (Atlas-Map BE-01-Espoo), which is in general in shallow coastal waters. At water depths greater than 35 m, microalgae are completely absent in the Baltic Sea /112/. The distribution on a local scale is structured by light availability (and water depth), substrate type and wave exposure /112/.

In relation to NSP2, the benthic flora of relevance are thus those occurring in the nearshore areas of Russia and Germany, see Atlas Map BE-01-Espoo.

Within the areas where benthic flora do occur, as for other biological components of the Baltic Sea (except plankton), the number of species is driven by the salinity gradient with an increase in species richness from Russia to Germany (although in Greifswalder Bodden the salinity and consequently the biodiversity of marine species decreases again as a result of the freshwater influence from land). In general, there is an increase in the presence of green algae species (Chlorophyceae) and a decrease in red and brown algae species (Rhodophyceae and Phaeophyceae) in the northern parts of the Baltic Sea /112/.

The surveys of benthic flora undertaken as part of the Russian and German EIAs for NSP2 identified the following key findings:

- In Narva Bay (Russia), benthic flora comprise a mixture of marine and freshwater species. As the environment is nutrient rich, the species are dominated by filamentous green algae and the distribution is sparse. Benthic flora are not observed at water depths greater than 5-6 m (see bathymetry map of Narva Bay in Figure 9-3). However, the area around the planned NSP2 route in the southern part of Narva Bay showed that there were no benthic flora in the immediate nearshore areas to the landfall. This is likely due to the sandy character of the seabed that is influenced by waves/currents and subsequent sand movements, which prevents settlement and growth of flowering plants. In addition, the area is without boulders and hence hard substrates on which macroalgae can attach.

- Within the Pomeranian Bay, macroalgae are dominated by the red algae *Coccotylus truncatus* at water depths between 4.4 m and 12.9 m.
- In the area of the 'Boddenrandsschwelle', (shallower water depth), macroalgae are detected at water depths between 2.8 m and 5.4 m.
- Scratch samples taken in reef areas in Germany near NSP, showed that red algae (*Polysiphonia fucoides*, *Polysiphonia fibrillosa*, *Ceramium diaphanum*, *Coccotylus truncatus*, Acrochaetiacea gen. sp.) dominated the area. *Sphacelaria arctica* is the dominant brown algae.
- The central parts of Greifswalder Bodden (nearshore area) are mostly free of macrophytes. Along the pipeline route in this area, benthic flora are only observed sporadically at water depths between 5.4 m and 9.6 m.
- At the landfall point Lubmin 2, the occurrence of flowering plants is observed from the swash zone to a depth of 1 m. The dominant flowering plant species is fennel pondweed (*Stuckenia pectinata*). Coverage of *S. pectinata* varies between 0% and 10%. In addition, horned pondweed (*Zannichellia palustris*) and beaked tasselweed (*Ruppia maritima*) are present in the landfall area.

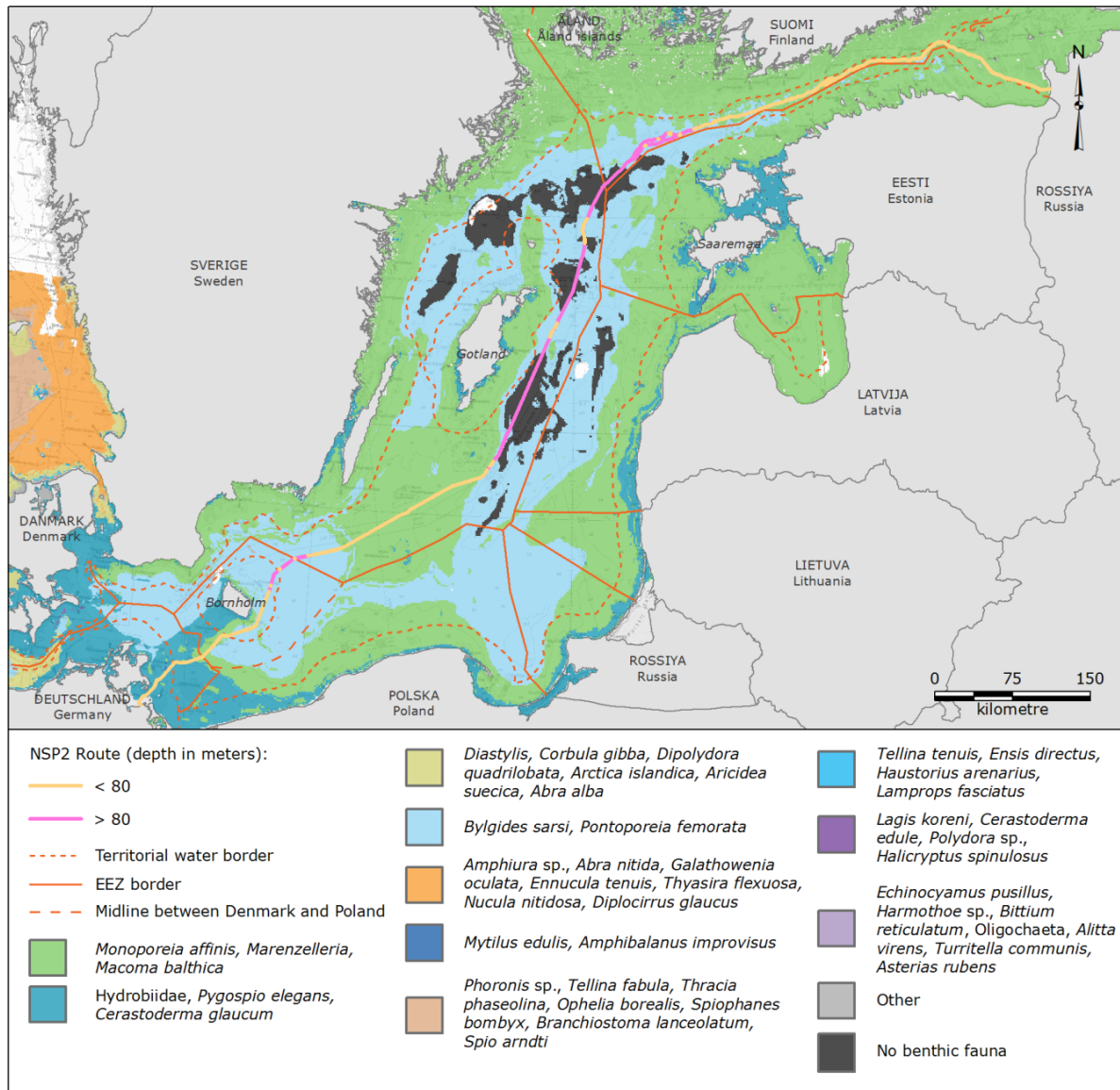
As a result of the strong salinity gradient, benthic flora are often at the border of their distribution range in the Baltic Sea and can therefore be less resilient to change than the same species occurring in other, more strictly marine or freshwater environments. In addition, the eutrophication status of the Baltic Sea is unfavourable, which has an impact on the diversity of the communities, as opportunistic species with high growth rates and very short lifecycles are favoured.

#### 9.6.2.2 Benthic fauna

Benthic fauna refers to invertebrates found on (epifauna) and in (infauna) the seabed. Among the invertebrate fauna three groups dominate, i.e. molluscs, polychaetes (bristle worms) and crustaceans. Benthic fauna constitute a central link between the primary producers (algae) and the higher levels of the food chain, often playing the role of 'habitat builders' (mussel beds).

The composition of benthic fauna communities depends on salinity (large scale), sediment type, water depth, temperature and oxygen availability. As for all other species, the number of benthic fauna species (macrozoobenthos >1 mm) decreases rapidly as the salinity decreases northward. The marine species are ultimately replaced by freshwater species in the north and in the coastal areas. As the distribution is also oxygen dependant, large areas without benthic faunal life are found in the deep areas of the western Gotland Basin and the northern Baltic Proper /112/. The most recent data on benthic fauna from the entire Baltic Sea collected and analysed during a study in January 2016 by Gogina et al. /117/ showed on the basis of abundance data that 10 benthic fauna communities dominate the Baltic Sea, and that only 4 of these are found along the pipeline route (see Figure 9-19) /117/.

As discussed above with respect to benthic flora, benthic fauna are for the same reasons less resilient to change than the same species occurring in other, more strictly marine or freshwater environments, and the diversity of the communities is subject to the effects of eutrophication. In addition, benthic fauna are often subject to stressors, such as hypoxic conditions or intensive trawl activities, which can reduce their resilience to change.



**Figure 9-19** Benthic fauna communities based on abundance, based on data from the period 2000-2013 /117/, showing the most abundant or characteristic species. It should be emphasised that monitoring has also shown that the presence of benthic fauna is limited at water depths >80 m as a result of oxygen deficiency /118/. See also Atlas Map BE-02-Espoo.

The surveys of benthic fauna undertaken to inform the various national EIAs/ES required for the permitting of NSP2 identified the following key findings:

- Key taxa occurring along the entire offshore route section of NSP2 comprise the polychaete *Marenzelleria* spp. (opportunistic species), the bivalve *Macoma balthica*<sup>10</sup> and the crustacean *Monoporeia affinis* (only found in well-oxygenated water).
- 23 taxa occurring in Russian nearshore waters are mostly represented by *Marenzelleria* spp., the oligochaete *Baltidrilus costatus*, the nemertea *Prostoma* sp., the crustacea *Chelicorophium curvispinum* and the bivalve *M. balthica*.
- In Russian waters, the variety of benthic faunal communities is very poor in areas shallower than 4 m due to unfavourable sandy substrate and an active wave regime. Benthic fauna that do occur in these areas comprise a very few species of oligochaete and polychaete, typically with very low abundance.

<sup>10</sup> *Macoma balthica* is referred to as *Limecola balthica* in the German EIA.

- In Russian waters deeper than 7-9 m, benthic fauna typically comprise the crustacean *Saduria entomon*.
- The highest abundance of zoobenthos was recorded at 20-35 m water depth, where *M. balthica* make up to 75% of the total biomass. The most abundant group was oligochaete.
- In Russian and Finnish waters, no, or only a few, opportunistic species were generally observed in deep waters (40-70 m), with *S. entomon* being the main species observed at these depths.
- In the more saline waters in Sweden and Denmark, the dominant species are blue mussels (*Mytilus* sp.), *Pygospio elegans* and *Scolopos armiger*, with up to 18-20 species being recorded in Swedish and Danish waters and 49 species (including 3 species only identified to a higher taxonomical level) being recorded in German waters.
- Key species observed in German waters in the Pomeranian Bay included molluscs such as *Peringia ulvae*, *Mya arenaria*, *Cerastoderma glaucum* and *M. balthica*.
- In Greifswalder Bodden, 39 species were observed, with the most abundant species being *P. ulvae* and *M. arenaria*.
- The nearshore areas close to the German landfall have the lowest species diversity within German waters, with only 10 species recorded and being dominated by *Bathyporeia pilosa*.

### 9.6.2.3 Importance of benthic flora and fauna

Benthic flora are a valuable part of the ecosystem of the coastal areas, where they can reach high biomass and form the living habitat for many species of invertebrates and fish. Benthic fauna constitute a central link between the primary producers (algae) and the higher levels of the food chain.

None of the species of benthic flora observed in the Baltic Sea that are included on global Red Lists have been observed close to the NSP2 route. Beaked tasselweed (*Ruppia maritima*) (characterised as Vulnerable in German Red List, see Appendix 2) occurs within the project investigation area.

Only three HELCOM Red List benthic fauna species (all Least Concern) were observed during the survey campaign: *S. entomon* (Russia, Finland, Sweden), *M. affinis* (Denmark, Finland, Sweden) and *Pontoporeia femorata* (Denmark, Sweden) (see Appendix 2). In addition, a number of species included on German Red List were observed. Of these, two species observed in German waters are classified as endangered: *M. affinis* and *Halitholus yoldiaearcticae* (for further information, see the German EIA /54/).

The overall importance of the benthic communities (both flora and fauna) is therefore assessed as medium.

### 9.6.3 Fish

Fish play an important role in the Baltic Sea food web as predators on e.g. benthic fauna, plankton (eggs, fish fry) and as a food source for higher trophic levels such as birds and marine mammals. Fish also perform a key provisioning ecosystem service to commercial fisheries throughout the Baltic Sea. Although fish diversity is generally low as a result of brackish conditions, the Baltic Sea nonetheless supports several species of both commercial and conservation interest.

Owing to the brackish nature of the Baltic Sea, only approximately 100 species have been recorded, of which 70 are marine species. Marine species dominate the Baltic Proper, while diadromous species and other species tolerant of varying salinity conditions occur in the coastal areas. Marine fish species composition in coastal areas, the Gulf of Finland is similar to that of the Baltic Proper, but a higher contribution of freshwater species /119/.

Marine species, notably cod (*Gadus morhua*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*), comprise the large majority of the fish community across the entire Baltic Sea, both in biomass and number (>75%). Other species include demersal marine species such as flounder (*Platichthus flesus*), plaice (*Pleuronectes platessa*) and turbot (*Psetta maxima*) living in the central and south-western parts of the Baltic Sea. An overview of their spatial distribution and spawning patterns is provided in Table 9-10 and shown in Atlas Map FI-01-Espoo.

Fish that dominate a community structure can be very important for the whole system, although their exact role may often be quite subtle. Cod is the main natural top predator on herring and sprat, and there is also some cannibalism on small cod. Herring and sprat, however, prey on cod eggs. The trophic interactions between cod, herring and sprat may periodically exert a strong influence on the state of fish stocks in the Baltic. Because herring spawn in coastal areas, the population is also subject to interactions with freshwater species in the coastal zone.

In comparison with that of truly marine areas, the contribution of diadromous species (species that live part of their lives in the sea and part in fresh water, where they also spawn) to the composition of the fish community is relatively large. Species include the three pelagic salmonid species (salmon (*Salmo salar*), sea trout (*Salmo trutta*) and grayling (*Thymallus thymallus*)) together with smelt (*Osmerus eperlanus*) and the demersal European eel (*Anguilla anguilla*). Other common marine species are snake blenny (*Lumpenus lampretaeformis*), four-bearded rockling (*Enchelyopus cimbrius*), bullrout (*Myoxocephalus scorpius*), sea snail (*Liparis liparis*), dab (*Limanda limanda*), brill (*Scophthalmus rhombus*), sand eels (*Ammodytes sp.*), twaite shad (*Alosa fallax*), whiting (*Merlangius merlangus*), whitefish (*Coregonus maraena*) and garfish (*Belone belone*). Populations of diadromous species may be especially sensitive to activities that disrupt or prevent their migration between the sea and fresh water, as this can prevent spawning.

European eel and grayling are the only threatened fish species classified as Critically Endangered on the IUCN and/or HELCOM Red Lists that potentially can be encountered in connection with NSP2. The European eel is also subject to CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) and the EU Eel Regulation<sup>11</sup>.

The European eel is a catadromous species and distributed throughout the Baltic Sea in coastal areas and adjacent freshwater rivers, streams and lakes. The whole European stock is considered to be a single panmictic population. Spawning takes place in the Sargasso Sea in early spring, and newly hatched eel larvae drift with the ocean currents to the continental waters of Europe and North Africa, where they metamorphose into glass eels. The growth stage (yellow eel) takes place in coastal areas, streams or rivers. Mature adult eels from the northern part of the Baltic Proper migrate along the Swedish coast, while eels from the eastern part also seem to migrate in the open part, including the waters around Bornholm /120/. The recruitment of glass eels to Europe has shown a sharp decline in the last 25 years. Management plans for the protection of the European eel have been implemented within the EU. Historically, there was a natural passage of eels into Narva River. However, this ceased when the hydroelectric power station was built in the 1950s. Therefore the eel population of the Narva river basin is now supported by permanent stocking of the upstream lake, with eels migrating naturally downstream through the Narva and into the Baltic. The main proposal of this management plan is to increase the annual stocking amount of eel /121/. During a field survey in Russia in 2016, no eels were observed, and the potential for their presence in the areas of influence of NSP2 is considered to be low. In Germany, the river systems of Warnow and Peene (river basin which includes Greifswalder Bodden) are most important for the migration of eels to and from the spawning sites. NSP2 crosses the transition route of the Peene system /122/.

<sup>11</sup> CITES and the EU Eel Regulation have the objective to ensure the protection and sustainable use of the stock of sustainable eels. This is achieved through requiring Member States to develop management plans for their territory.

Grayling inhabit coastal areas only sporadically in the Gulf of Bothnia, both in Sweden and Finland. Baltic Sea populations are considered critically endangered in Finland. Generally, grayling inhabit rivers with hard sand or stone bottoms and well-oxygenated, cold and fast-flowing water. However, grayling also occur in clear lakes and brackish part of the northern Baltic Sea /123/. Spawning takes place in shallow water in early spring. It is common for fry to spend only a short time in small streams before wandering out to calm waters or lakes /124/. The abundance of grayling has decreased during the last 20 years in Sweden and even longer in Finland. The exact level of decrease is difficult to estimate owing to the low number of individuals left. However, a 50%-90% decrease has been estimated. The situation for coastal spawning grayling is much worse than that of anadromous. The species is threatened by climate change, especially increasing temperatures in its southern distribution area. Regionally, the species suffers as a result of dam construction, river regulation, pollution and eutrophication /123/.

The typical freshwater species present in the vicinity of the NSP route include bream (*Abramis brama*), pike (*Esox lucius*), perch (*Perca fluviatilis*), pike-perch (*Lucioperca lucioperca*), roach (*Rutilus rutilus*), vendace (*Coregonus albula*) and burbot (*Lota lota*). In some years, three-spined stickleback (*Gasterosteus aculeatus*) also occur in large numbers. These species mostly occur along the coastline of the Baltic Sea.

The trends and pressures controlling the fish communities of the Baltic Sea and the resilience of fish communities to change depend on multiple factors. An important factor is the top-down regulation of species through fishing and predation, although these factors seem less important than resource availability and interspecific competition /125/. Climate-driven changes in the salinity, temperature and oxygen content of the water affect the recruitment and growth of cod, herring and sprat. Hydrographical climatic variability (i.e. low frequency of inflows from the North Sea and increasing temperatures) and heavy fishing over the last 10-15 years have thus led to a shift in the fish community from cod to clupeids (herring, sprat). This is due to weakening cod recruitment and subsequently more favourable recruitment conditions for sprat.

Further stresses on fish species are associated with the brackish nature of the Baltic Sea, which is too salty for most freshwater species and too fresh for most marine species, resulting in increased energy demands related to osmoregulation (regulation of salt concentration in bodily fluids). In addition, the water is relatively cold and thus many of the Baltic species – the majority of which are of marine origin – are at the periphery of their distribution range. As a result, the biota is particularly vulnerable to pollution and other anthropogenic stresses /119/.

### Commercially exploited species

The most important commercially exploited species in the Baltic Sea are cod, sprat and herring, which together make up 95% of the commercial catches in the Baltic Sea. Other commercially exploited species, especially in the southern part of the Baltic Sea, include flounder, plaice, turbot and salmon. The species distribution and spawning characteristics are shown in Table 9-10. Spawning and nursery areas are very important for the recruitment of fish species and hence are the focus of the analysis provide below.

**Table 9-10 Spawning time and areas (main table) and key characteristics (following text) of the seven most important commercial fish species in the Baltic Sea, including the distribution of fish species. W=west, S=south, N=north, E=east, win=winter.**

Spawning characteristics												
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod	X <sup>W</sup>	X <sup>W</sup>	X <sup>W</sup>	X <sup>E/W</sup>	X <sup>E/W</sup>	X <sup>E/W</sup>	X <sup>E</sup>	X <sup>E</sup>	X <sup>E</sup>			
Sprat	X <sup>win</sup>			X	X	X	X				X <sup>win</sup>	X <sup>win</sup>
Herring			X	X	X	X						
Flounder			X <sup>S</sup>	X <sup>S</sup>	X <sup>S/N</sup>	X <sup>S/N</sup>	X <sup>N</sup>					
Plaice	X	X	X	X								X
Turbot						X	X					

Salmon							X	X	X	X	X	
<b>Key characteristics of species</b>												
<p><b>Cod (demersal):</b></p> <p><i>Distribution:</i> Two populations are present: eastern and western Baltic cod. These stocks have different morphological characteristics and population genetics. They overlap in the Arkona Basin, east of Bornholm Island (DK). The eastern population is the largest, accounting for approximately 90% of the cod stocks in the Baltic Sea /126/. However, the sub-populations in the Gdansk Deep and Gotland Deep seem seriously reduced, in particular the Gotland Deep, where almost no spawning occurs /127/. In the Russian part of the Gulf of Finland, cod stocks are normally absent due to low salinity. Very occasionally, about once per 15-20 years, shoals of cod (or just a few specimens) may temporarily penetrate to the westernmost area of the Russian part of the Gulf of Finland, associated with strong intrusions of marine water from the Baltic Proper.</p> <p><i>Spawning:</i> Significant inter-annual variations occur in the spawning time of eastern Baltic cod (E) /126/, /127/ and a marked shift in the timing of spawning from April-June to June-August was observed in the 1990s. The spawning period for western Baltic cod – the Belt Sea cod (W) – is Jan-April /126/, /128/, /129/. Eggs are pelagic. Successful cod spawning requires a minimum salinity of 11 psu in order to keep the cod eggs afloat and an oxygen content of at least 2 ml/l for the eggs to survive and be able to develop /130/, /131/. The main cod spawning areas can be seen in Figure 9-20 (see Atlas FI-01-Espoo).</p> <p><b>Sprat (pelagic):</b></p> <p><i>Distribution:</i> Sprat live in schools throughout the Baltic Sea, although not as commonly in the Bothnian Bay, where the salinity is too low to support development of eggs. Sprat is an open-sea species that is rarely found along the coast.</p> <p><i>Spawning:</i> Winter spawning (Nov-Jan) of sprat (win) is followed by summers with exceptionally warm surface water in the Baltic Sea. However, the contribution of winter spawning compared with annual egg and larval production is negligible /132/, /133/. Eggs are pelagic and adapted to low salinity levels/134/. Spawning occurs from February to August, depending on the geographical area /135/, /136/. See distribution and spawning areas for sprat in Figure 9-20 (see Atlas FI-01-Espoo).</p> <p><b>Herring (pelagic):</b></p> <p><i>Distribution:</i> Herring occur in large schools throughout the Baltic Sea, with clearly distinct stocks in different areas. Herring tend to make seasonal migrations between coastal archipelagos and open sea areas, staying close to the coast during spring and autumn, while spending summer in productive and nutrient-rich open sea areas.</p> <p><i>Spawning:</i> Coastal areas (3-15 m depth) in most parts of the Baltic Sea /137/ see Figure 9-21 and Atlas Map FI-01-Espoo. Demersal eggs with an adhesive layer that attaches them to the substratum/vegetation in shallow waters /138/. Spawning periods for spring spawning stocks of different herring populations in the Baltic Sea:</p> <ul style="list-style-type: none"> <li>• Gulf of Finland (ICES 32): May-June, including the coastal areas of Narva Bay and around offshore islands in the eastern Gulf of Finland, although the landfall area has relatively low importance.</li> <li>• Central Baltic: April-May (ICES 25), March-May (ICES 26, Polish coastal waters), April-June (ICES 28), May-June (ICES 29).</li> <li>• Western Baltic: March-May; Greifswalder Bodden is a major spring spawning site for herring.</li> </ul> <p><b>Flounder (demersal):</b></p> <p><i>Distribution:</i> Flounder inhabit most of the Baltic Sea, except for the deeper parts of the Gotland Deep, and show wide tolerance to changes in salinity.</p> <p><i>Spawning:</i> There are two types of flounder in the Baltic Sea: a northern type (N) with demersal eggs, and a southern type (S) with pelagic eggs. The former may reproduce successfully in the northern Baltic Proper, the Bothnian Sea and the Gulf of Finland. The spawning period for the southern stock with pelagic eggs is March-June. The main spawning period for the northern stock is May-July /139/, /140/. The pelagic eggs are bigger and require a minimum salinity of 10 psu in order to float. The demersal eggs are smaller and more thick-shelled and require 6-7 psu in order to successfully develop /140/.</p> <p><b>Plaice (demersal):</b></p> <p><i>Distribution:</i> Plaice inhabit the western Baltic and are rarely found east of the Bornholm Basin. Plaice are less tolerant to low salinity and low oxygen content than flounder, which affects the distribution pattern.</p>												

*Spawning:* Occurs in Dec-May /139/. Eggs are pelagic.

#### **Turbot (demersal):**

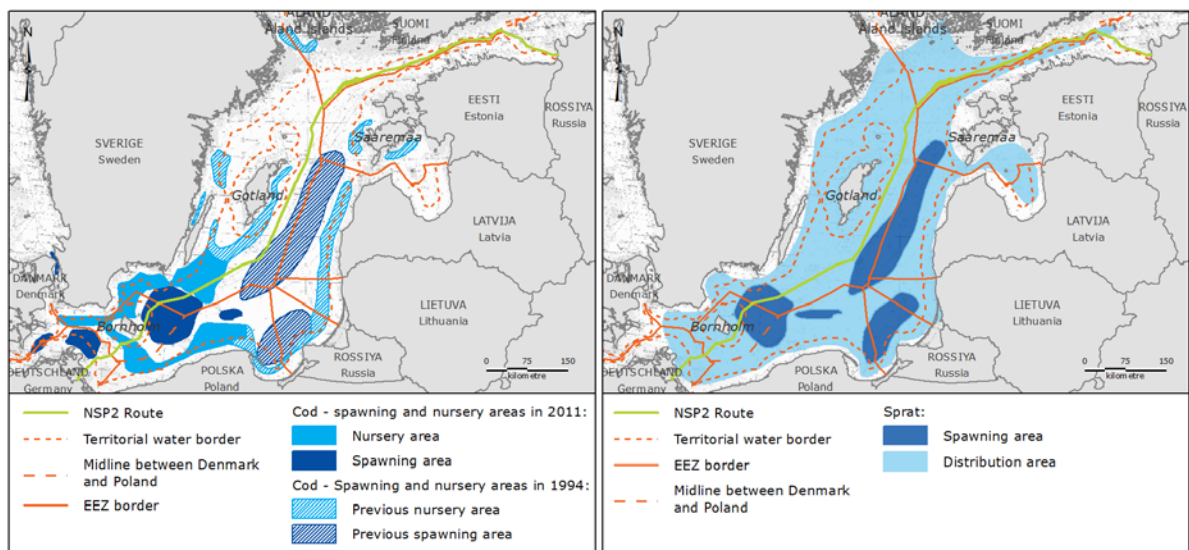
*Distribution:* Turbot occur in large parts of the Baltic Proper, but their abundance is relatively low.

*Spawning:* Successful spawning is possible in waters with a salinity of 6-7 psu or higher and takes place in shallow water at depths between 5-40 m, e.g. at the three banks south-east of Gotland (Hoburgs Bank, Northern and Southern Midsjö Banks) as well as the Oderbank in the Pomeranian Bay. After spawning in the spring, turbot reside in shallow areas during summer and return to deeper waters in autumn. Turbot eggs are demersal at the low salinities occurring in the Baltic Sea /125/. Turbot are mainly stationary, but they migrate in spring and autumn between shallow and deeper waters /142/.

#### **Salmon (pelagic):**

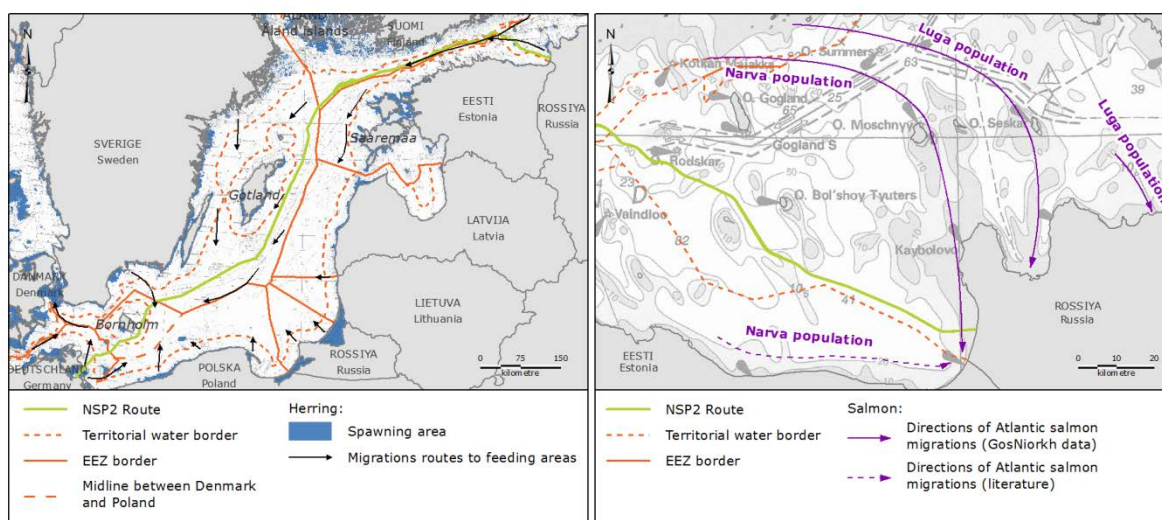
*Distribution:* Salmon is an anadromous species with long feeding migrations in the Baltic Sea from the Bothnian Bay and the Gulf of Finland. They show strong homing behaviour and return to their natal river to spawn, resulting in the development of genetically differentiated stocks.

*Spawning:* Spawning period for salmon depends on latitude and the geographical locations of the breeding rivers. Demersal eggs are buried in river gravel bottoms /141/. The management of salmon in the Baltic Sea is subject to the Salmon Action Plan adopted by the International Baltic Sea Fisheries Commission in 1997. Within Russian territory, three populations of river spawning migrations occur: salmon from Neva River, Luga River and Narva River (Natura 2000 Struuga - Estonia) /116/. Studies of the migration dynamics in 2015 showed that only the Narva River population crossed NSP2 /143/ (see Figure 9-21). The majority of the Narva River salmon population migrates to the Narva river mouth from the west along the Estonian coast of Narva Bay. A small part of spawning salmon also migrate along the Russian coast. The peak of salmon migration is normally October, however the migration period can last from the beginning of August until end of November.



**Figure 9-20** Important cod spawning and nursery areas in the Baltic Sea mapped in 2011 and in 1994 (left). Distribution and spawning areas of sprat (right). For larger figures see Atlas Map FI-01-Espoo.





**Figure 9-21** Important herring spawning areas (left). Main migration routes of the three Russian spawning populations of Atlantic salmon /116/ (right). For larger figure of herring see Atlas Map FI-01-Espoo.

### 9.6.3.1 Importance of fish and lamprey species

While the Baltic Sea fish diversity is generally low as a result of brackish conditions, it nonetheless supports several species of both commercial and conservation interest. As described earlier, fish play an important role in the Baltic Sea food web, as predators on, e.g., benthic fauna and plankton (eggs, fish fry) and as a food source for higher trophic levels such as birds and marine mammals. Fish also perform a key provisioning ecosystem service to commercial fisheries throughout the Baltic Sea. Such species and in particular their spawning grounds and migration routes are therefore to be considered of medium importance.

A number of the Baltic Sea fish species which occur regularly within the region are classified as threatened (CR, EN or VU) or near-threatened on the IUCN and HELCOM Red Lists, Table 9-11.

European eel and grayling are the only critically endangered species that occurs in the region of NSP2. Therefore these species are considered to be of high importance. For additional information on conservation status, see Appendix 2. Other species are considered of medium importance due to low/no presence (see Table 9-11 and Appendix 2) and/or conservation status.

**Table 9-11** Protection and conservation status of fish (see also Appendix 2).

Species	Habitats Directive	IUCN	HELCOM
Allis shad ( <i>Alosa alosa</i> )	Annex II	LC	NA
Twaite shad ( <i>Alosa fallax</i> )	Annex II	LC	LC
European eel ( <i>Anguilla Anguilla</i> )	-	CR	CR
Asp ( <i>Aspius aspius</i> )	Annex II	LC	NT
Barbel ( <i>Barbus barbus</i> )	-	LC	NA
Spined loach ( <i>Cobitis taenia</i> )	Annex II	LC	LC
Whitefish ( <i>Coregonus maraena</i> )	-	VU	EN
Bullhead ( <i>Cottus gobio</i> )	Annex II*	LC	LC
Lumpsucker ( <i>Cyclopterus lumpus</i> )	-	NE	NT
Four-bearded rockling ( <i>Enchelyopus cimbrius</i> )	-	NE	NT
Cod ( <i>Gadus morhua</i> )	-	VU	VU
River lamprey ( <i>Lampetra fluviatilis</i> )	Annex II	LC	NT
Burbot ( <i>Lota lota</i> )	-	LC	NT
Snake blenny ( <i>Lumpenus lampreaeformis</i> )	-	NE	LC
Whiting ( <i>Merlangius merlangus</i> )	-	NE	VU
Razor-fish ( <i>Pelecus cultratus</i> )	Annex II	LC	LC
Sea lamprey ( <i>Petromyzon marinus</i> )	Annex II	LC	VU
Minnow ( <i>Phoxinus phoxinus</i> )	-	LC	LC
Salmon ( <i>Salmo salar</i> )	-	LC	VU

Trout ( <i>Salmo trutta</i> )	-	-	VU
Turbot ( <i>Scophthalmus maximus</i> )	Annex II	NE	NT
Grayling ( <i>Thymallus thymallus</i> )	-	LC	CR
Eelpout ( <i>Zoarces viviparus</i> )	-	NE	NT
CR: Critically endangered, EN: Endangered, VU: Vulnerable, LC: Least Concern, NE: Not Evaluated			

#### 9.6.4 Marine mammals

Marine mammals are the top predators of the marine food web, contributing to the overall ecosystem dynamics. There are four resident marine mammal species in the Baltic Sea<sup>12</sup>: harbour porpoise (*Phocoena phocoena*), grey seal (*Halichoerus grypus grypus*, previously identified as *Halichoerus grypus macrorhynchus*), ringed seal (*Phoca hispida botnica*) and harbour seal (*Phoca vitulina*). As identified in Section 9.6.4.1, all of these mammals are listed on both global and HELCOM Red Lists and are subject to various treaties, agreements and legislation relating to their management, conservation and/or protection.

Occasionally, cetacean species such as minke whale (*Balaenoptera acutistrata*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaenangliae*), common dolphin (*Delphinus delphis*) and white-beaked dolphin (*Lagenorhynchus albirostris*) occur in the southern Baltic Sea /144/, /145/, /146/. Because these species are not native or regularly occurring they will not be described further.

##### 9.6.4.1 Harbour porpoise

The harbour porpoise is the smallest and also the most numerous cetacean in Europe. It is widely but unevenly distributed throughout European waters, with low occurrence in the Baltic Proper and practically no occurrence in the Gulf of Finland. Distribution is presumably linked to the distribution of prey /146/, which in turn is linked to parameters such as hydrography and bathymetry (preferring water depths less than 80 m) /148/. There are two sub-populations of harbour porpoises relevant to NSP2: the Baltic Sea population in the Baltic Proper and the Belt Sea population in the western Baltic (Belt Seas and southern Kattegat; outside project area). As indicated in Table 9-14, although both sub-populations are considered to have the same level of threat globally, the population in the Baltic Proper has a higher conservation status within the HELCOM area, being classified as critically endangered.

Two surveys of population size in the Baltic Proper estimated 599 individuals (95% confidence interval (CI) 200-3,300) in 1995 /149/ and 93 individuals (95% CI 10-460) in 2002 /150/. The Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise (SAMBAH) project ended in 2016 after having deployed 304 acoustic data loggers (C-PODs)<sup>13</sup> for two years covering all EU countries from Finland to Denmark and Germany (Figure 9-22 and Figure 9-23). As harbour porpoises prefer water depths less than 80 m, no data loggers were deployed at these water depths /151/. The project estimated the remaining number of porpoises in the Baltic Proper to be approximately 500 (95% CI 80-1,100) /151/. The Belt Sea population was estimated to be approximately 18,495 in 2012 /152/. The distribution of the two sub-populations is shown in Figure 9-22. For comparison, the total number of harbour porpoises in the north-east Atlantic continental shelf waters was estimated to be 375,358 (95% CI=256,304–549,713). This number includes all populations of porpoises in the North Sea as well as the majority of the spatial extent of the Belt Sea population.

Figure 9-22 shows that during their breeding period in the summer harbour porpoises congregate around the shallow banks in the Swedish EEZ. There is a clear drop in density towards all directions, confirming the isolation of this population.

<sup>12</sup> Information on the marine mammals in the following section is primarily based on a marine mammals baseline prepared by DCE for this current project /145/ and on baseline reports from Russia and Germany.

<sup>13</sup> C-PODs have been employed at water depth 5-80 m, because harbour porpoises prefer shallow waters <80 m.

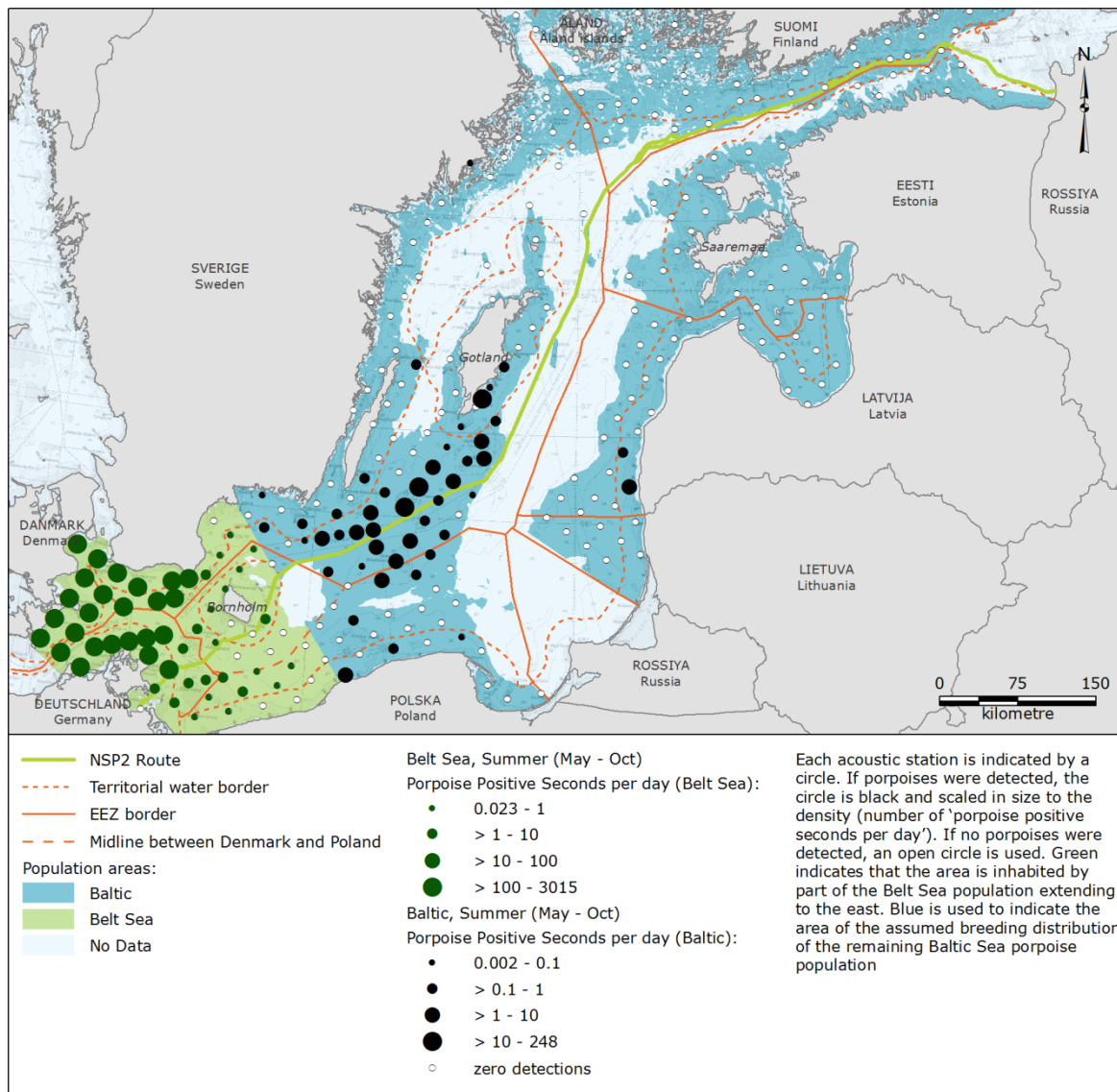
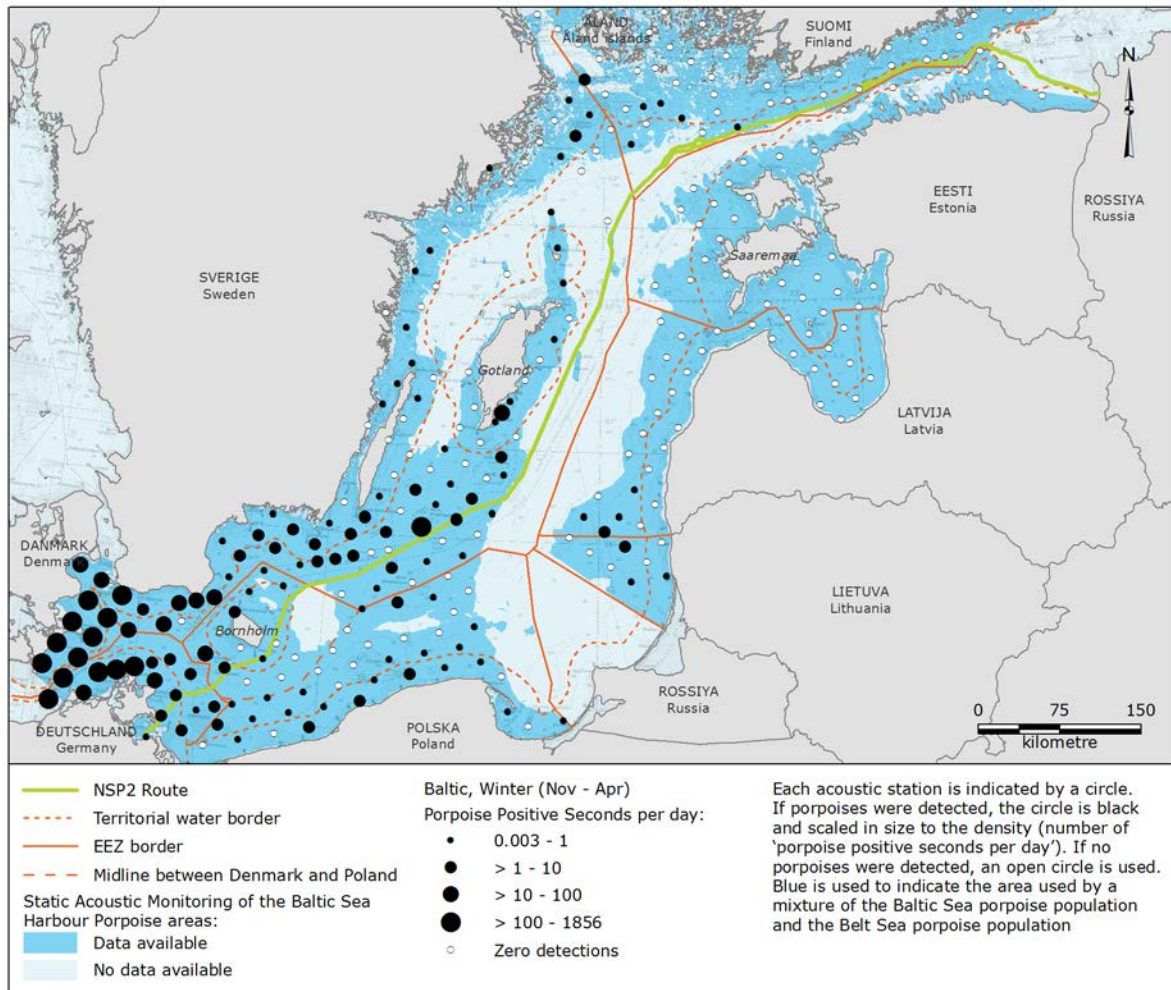


Figure 9-22 Summer distribution of harbour porpoises in the Baltic Sea /151/. See also Atlas Map MA-01-Espoo.

During winter, harbour porpoises are more widespread in the northern part of the Baltic Sea and along the coasts of Lithuania and Poland (Figure 9-23), again most likely due to the link between distribution and prey availability.



**Figure 9-23 Winter distribution of harbour porpoises in the Baltic Sea /151/. See also Atlas Map MA-01-Espoo.**

As seen from the data, harbour porpoises are rare in the northern parts of the Baltic Sea main basin, and the species does not breed in Finnish waters. The highest density of the Baltic Sea harbour porpoise population is found around the Midsjö Banks south of Gotland and in German waters. This area is considered a hot spot and the most important area during the breeding season for porpoises /151/. The proposed pipeline overlaps with the hot spot area over a stretch of at least 100 km in Swedish waters (Figure 9-23).

#### 9.6.4.2 Harbour seal

Harbour seals are found in temperate and Arctic waters of the northern hemisphere. In the Baltic Sea, harbour seals are found only in areas close to the mainland of Sweden (Kalmar population, approximately 1,000 individuals) and in the south-western Baltic (south-western population, approximately 1,500 individuals) concentrated around southern Denmark and in Inner Danish Waters /145/. In addition, a third population is found in Kattegat outside the project area.

According to the data presented in Atlas Map MA-02-Espoo, there is very little chance that harbour seals would be sufficiently close to the proposed pipeline at any time or can be impacted by the project activities, including from underwater noise from munitions clearance, as this activity is limited to the Gulf of Finland.

#### 9.6.4.3 Ringed seal

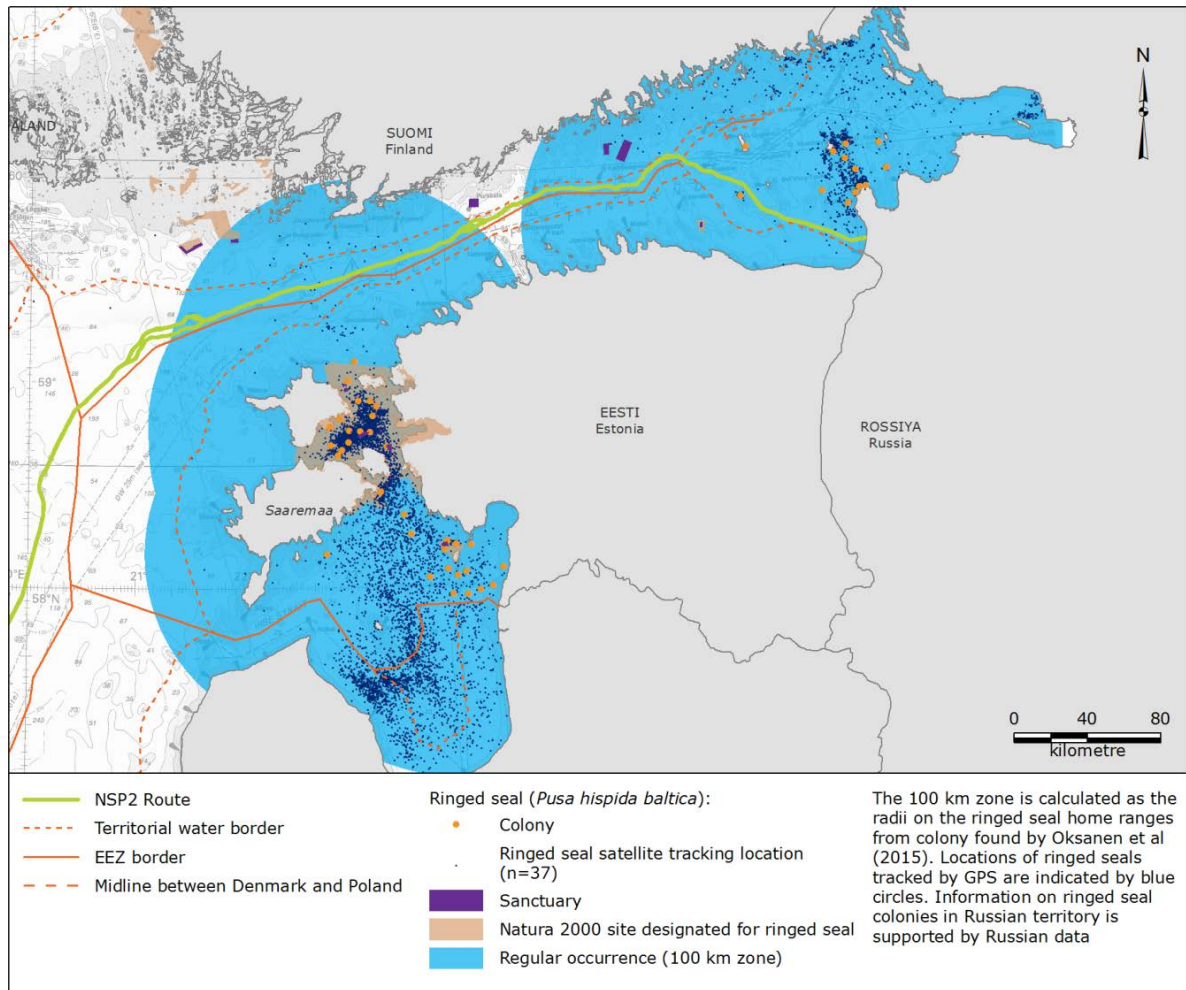
The ringed seal has a circumpolar Arctic distribution. It is associated with icy waters and is the primary food for polar bears. Although the world population is at least a few million and therefore classified on the global Red List as of least concern, the Baltic Sea population is assessed as

vulnerable due to the isolation of the population and impeded growth rates caused by the multiple anthropogenic pressures of the Baltic Sea /153/, /142/.

Aerial surveys of ringed seals hauled out on the ice in April-May 2014 estimated approximately 8,000 individuals /154/. When corrected for seals in the water, the total population in the Baltic Sea was estimated at approximately 11,500 individuals. Since 1988, the population has increased by 4.8% per year. However, in the spring of 2015 the ice conditions were exceptionally favourable during the population count and a surprisingly high total number of hauled out individuals (17,400) were estimated /155/. This was almost twice as many as expected due to as yet undetermined reasons. The estimated number of ringed seal species is hence considered between 11,500 and 17,400 individuals.

The ringed seal population in the Baltic Sea occurs in the Bothnian Bay (70%), Gulf of Finland (5%) and Gulf of Riga (25%) breeding areas /156/. Satellite tracking covering most of the year has shown that there is no overlap in the home ranges of the individuals tagged these three areas /156/. Small groups of 3-10 ringed seals are usually observed on the islands of Maliy Tyuters, Moshniy and Maliy, and single individuals haul out on the rocks along the coast of the northern part of Kurgalsky Peninsula as well as on the islands of Bolshoy Tyuters, Gogland and Seskar (Figure 9-24 and Atlas Map MA-02-Espoo). No ringed seals were observed hauling out at the proposed landfall location in Narva Bay. During the summer, when the water warms up, ringed seals move away from the mainland shore and rest only on rocks near small islands or on reefs at sea /157/.

Ringed seal populations tend to be disturbed by human presence including tourism, commercial fishing and underwater and airborne noise. Observations indicated that when a vessel approaches closer than 1 km to an individual it usually dives.



**Figure 9-24** Map of haul-out sites (colonies) used by ringed seals for resting, breeding and moulting and distribution (home range from colony - regular occurrence) /157/, /158/. As there are no ringed seals in the southern Baltic, the figure only shows a 'zoom in' of the relevant areas regarding this project. See Atlas Map MA-02-Espoo.

#### 9.6.4.4 Grey seal

The grey seal is the most abundant seal species in the Baltic, with approximately 40,000 individuals being recorded in 2014 /154/. About 100 years ago, the population comprised 80-100,000 individuals. However, by the 1970s, the population had declined to approximately 4,000, primarily due to Pocrine distemper virus. Since then, the abundance has steadily increased (albeit with fluctuations). The Baltic grey seal population is distributed from the northernmost part of the Bothnian Bay to the south-west waters of the Baltic Proper. During the breeding period, grey seals generally dwell on drift ice in the Gulf of Riga, the Gulf of Finland, the Northern Baltic Proper and the Bothnian Bay or on rocks in the north-western Baltic /145/, /146/.

Grey seals travel long distances in the Baltic Sea, as illustrated in Figure 9-25. Data on seals tagged in the southern Baltic Sea indicate that most seals from colonies in the southern Baltic Sea move far into the Baltic Proper. For example, a tagged female from southern Danish waters was observed with a pup in Estonian waters and then back at the original spot a month later. This indicates seasonal migrations that are closely related to the requirements for feeding and suitable breeding habitats /159/. Typically, however, grey seals feed more locally, foraging just offshore and adopting a regular pattern of travelling between local feeding sites and preferred haul-outs /160/, /161/. The main haul-outs of grey seals along the NSP2 route in the Russian waters of the Gulf of Finland are at the northern part of Kurgalsky Peninsula and around the islands of Mayi, Moschnyi and Seskar (Figure 9-25) /157/. Furthermore, Sandkällan, Stora Kölhällana and Kallbådan in Finland (seal sanctuaries, see Table 9-13 and Atlas Map MA-02-Espoo) are important grey seal areas. In Sweden, the colonies nearest to NSP2 are north of

Gotland (Table 9-13). In Denmark, the colonies nearest to NSP2 are at Christiansø, north of Bornholm (Table 9-13). There are no haul-out sites in German waters close to NSP2.

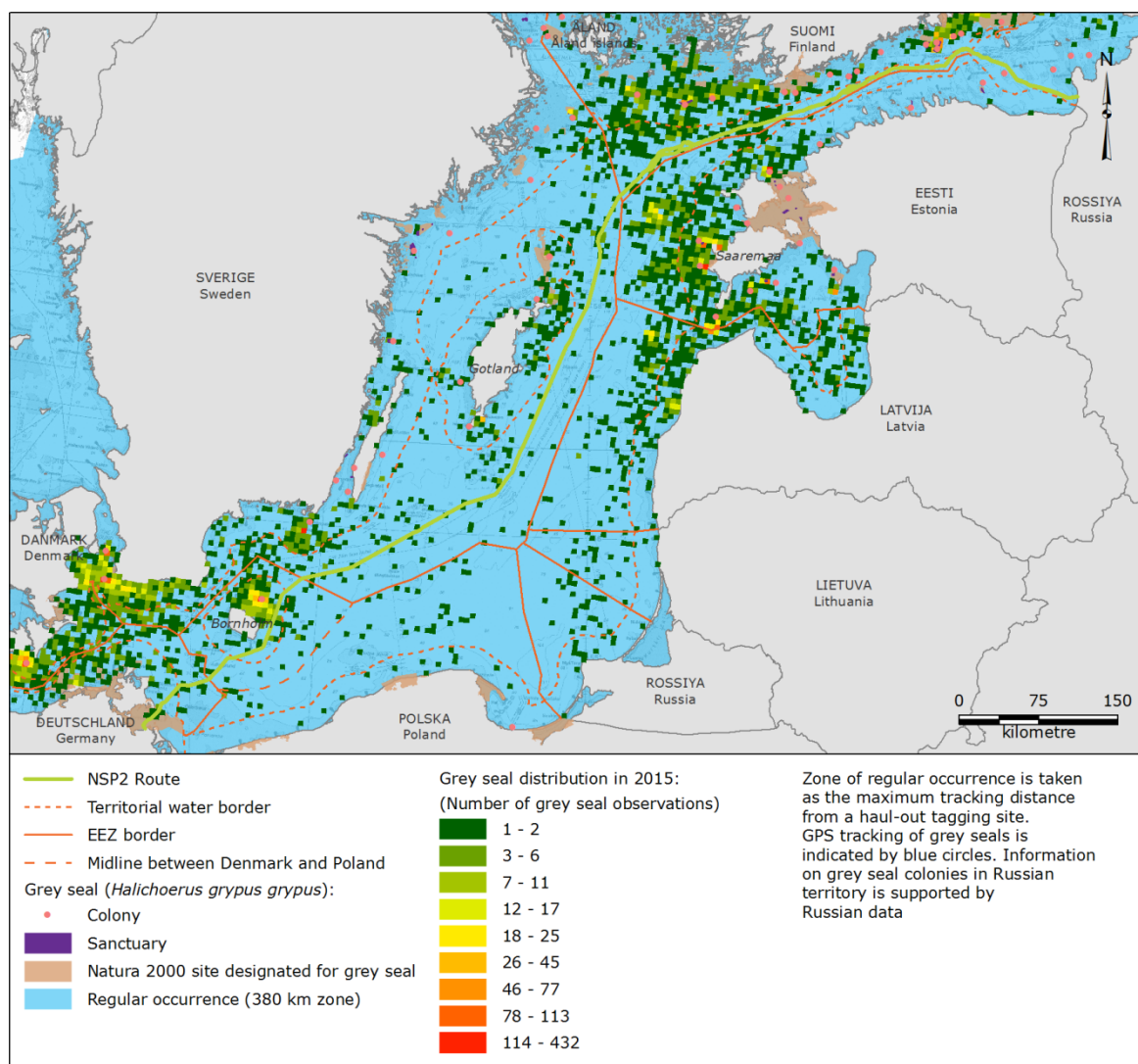


Figure 9-25 Map of haul-out sites (colonies) used by grey seals for resting, breeding and moulting and distribution (zone of regular occurrence)/157/, /158/.

#### 9.6.4.5 Critical periods and vulnerabilities for Baltic Sea mammals

The most vulnerable periods for seals in the Baltic Sea are primarily during their moulting, breeding and lactation periods, which are shown in Table 9-12. Harbour porpoises are also vulnerable during their breeding period, but the calves may also be vulnerable throughout their first year and in the first period after leaving their mothers.

**Table 9-12 Critical periods for Baltic Sea marine mammals during breeding, lactation and moulting. Country of occurrence where individuals can be encountered near NSP2 is indicated. Some species occur outside the critical periods and therefore are not listed below /145/, /146/.**

Species	Period		Country waters of occurrence
	Breeding and lactation	Moulting	
Harbour porpoise	May-March (nursing persists throughout the following year)	-	FI, SE, DK, GE, PL
Ringed seal	February-March	April-May	RU, FI, ES, SE
Grey seal	February-March	May-June	RU, FI, ES, SE, DK, GE, PL
*Species is not encountered near NSP2.			

The HELCOM Red List highlights a number of general threats and pressures to the different species of marine mammals /162/. For harbour porpoises, by-catch and pollution are the main threats. For ringed seals, by-catch, pollution and climate change are the main threats. Hunting and epidemics can be added to the list of main threats for harbour seal. There are no major threats identified for grey seal. The vulnerability of the four species of marine mammals is thus species specific, as the population sizes and the major threats to the populations differ (the existing pressure on species), with the Baltic harbour porpoise population being the most stressed. As described above, all of the marine mammals are sensitive to disturbance and in particular underwater noise, which will be described in more detail in Chapter 10 – Assessment of environmental impacts.

#### 9.6.4.6 Seal sanctuaries

Seal sanctuaries are established to protect mainly grey seals and their habitats. In Finland, these areas are also important for the conservation status of ringed seals. However, in the Gulf of Finland ringed seals are very rare around these sanctuaries. Seal sanctuaries are presented in Table 9-13 and Atlas Map MA-02-Espoo.

**Table 9-13 Seal sanctuaries, see Atlas Map MA-02-Espoo.**

Site number	Seal sanctuary	Distance to planned NSP2
HYL010001	Sandkallan (FI)	12.4 km (Line A), 12.6 km (Line B)
HYL010001	Stora Kölhällan (FI)	17.0 km (Line A), 17.3 km (Line B)
HYL010002	Kallbådan (FI)	8,1 (ALT E1, line A) 9,8 (ALT E2, line A)
-	Gotska Sandön (SE)	25 km
-	Uhtja Island (ES)	26 km (RU), 36 km (FI)

Natura 2000 sites where marine mammals are included in the designation basis are presented in Section 9.6.6.

#### 9.6.4.7 Importance of marine mammals

A summary of the IUCN and HELCOM conservation status and the treaties, agreements and legislation applicable to the various mammal species identified above is provided in Table 9-14.

**Table 9-14 International treaties and agreements and legislation for marine mammals (see also Appendix 2).**

Species	Protection/conservation status			
	Habitats Directive	IUCN	HELCOM	Other*
Harbour porpoise (Baltic sub-population)	Annex II, IV	VU	CR	Bern Convention (Appendix II) Bonn Convention (Appendix II)
Harbour porpoise (Belt Sea sub-population)		VU	VU	Washington Convention (Annex II) ASCOBANS <sup>1</sup>



Harbour seal (south-western sub-population)	Annex II	LC	LC	Bonn Convention
Harbour seal (Kalmar sub-population)		EN	VU	
Ringed seal (Baltic)	Annex II	LC	VU	Bern Convention (Appendix III)
Grey seal	Annex II, V	LC	LC	Bern Convention (Appendix III) Bonn Convention (Appendix II)
<sup>1</sup> Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas. CR: Critically endangered, EN: Endangered, VU: Vulnerable, LC: Least concern *Bonn, Bern and ASCOBANS conventions are described in Chapter 3 – Regulatory context.				

Harbour porpoises are listed on Annex IV of the Habitats Directive, which requires that "*Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV (a) in their natural range, prohibiting: ... (b) Deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration ...*" (Article 12).

The highest proportion of the critically endangered (HELCOM Red List) Baltic Sea harbour porpoise population is found around the Midsjö Banks, while the endangered (IUCN) harbour seal (Kalmar sub-population) is not present within the areas of influence of NSP2.

Due to the high conservation and protection status of harbour porpoises (Baltic sub-population) and the high conservation status of harbour seals (Kalmar sub-population), these species are considered to be of high importance during the most critical periods shown in Table 9-12. The harbour porpoise (Belt Sea sub-population) and ringed seal (Baltic sub-population) are considered to be of medium importance during the critical periods, while the harbour seal and grey seal are of low importance.

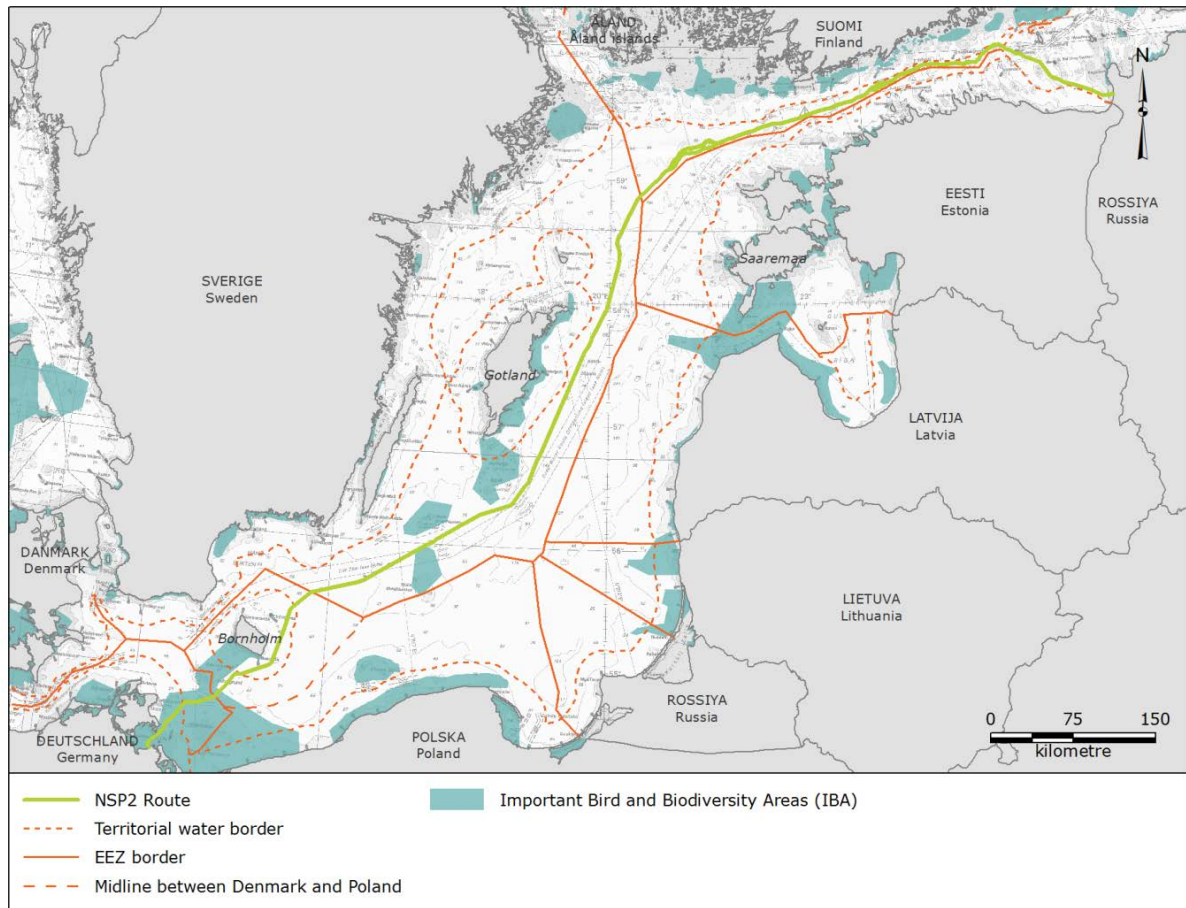
### 9.6.5 Birds

Birds have an important role in the Baltic Sea food web as predators on fish, benthic fauna, plankton (eggs, fish fry), etc., while some species are a food source for raptors. Birds thus contribute to the overall ecosystem dynamic. The birdlife of the Baltic Sea and along the NSP2 route has been considered in terms of species and distribution as well as in terms of areas used by birds, notably Important Bird and Biodiversity Areas (IBAs). Consideration of the role of protected areas in supporting bird communities is addressed in Section 9.6.6. This section covers birds that are primarily associated with the marine environment as well as waterbirds that use marine coastal areas.

IBAs and birds wintering and staging areas during migration in the Baltic Sea are shown on Atlas Maps BI-01-Espoo and BI-02-Espoo.

#### 9.6.5.1 Important Bird and Biodiversity Areas

IBAs are key sites for the conservation of birds that have been identified by BirdLife International /163/, /164/, /165/. There are numerous IBAs in the Baltic Sea (Figure 9-26), and some of these areas will be crossed by or are located in proximity to the NSP2 route. Although IBA designations are not legally binding, several IBAs or parts of them overlap with areas that are protected under legislation and conventions such as Habitats and Birds Directives, the Ramsar Convention, etc. IBAs that coincide with legally binding conservation areas (SPAs, Ramsar sites, etc.) are addressed as part of the consideration of such sites (Section 9.6.6 and 9.6.7).



**Figure 9-26** IBAs in the Baltic Sea /165/. Only marine areas are shown in the figure. See also Atlas Map BI-01-Espoo. IBA (HELCOM) is an additional site identified in the HELCOM data zone, but not in the BirdLife data zone.

The IBAs in the Baltic Sea are shown in Figure 9.9, while those within a 25 km radius of the NSP2 route are listed in Table 9-15, together with the species for which they were designated.

**Table 9-15** IBAs within a 25 km radius of the NSP2 route /165/. Areas are described from west to east. Terrestrial bird species are included only for the landfall areas in Russia and Germany. Distances from NSP2 to individual sites are provided in Section 9.1 based on the national EIAs. B = breeding birds, P = passage migratory birds, and W = wintering birds. IUCN/HELCOM Red List status indicated in Appendix 2.

IBA	Species	Season	Distance to planned pipeline route
<b>Russia</b>			
RU1048: Kurgalsky Peninsula	Bean goose ( <i>Anser fabalis</i> )	P	7.3 km
	Barnacle goose ( <i>Branta leucopsis</i> )	P	
	Long-tailed duck ( <i>Clangula hyemalis</i> )	P	
	Common goldeneye ( <i>Bucephala clangula</i> )	P	
	Red-breasted merganser ( <i>Mergus serrator</i> )	P	
	Great crested grebe ( <i>Podiceps cristatus</i> )	P	
<b>Finland</b>			
FI072: Eastern Gulf of Finland National Park (Itäinen Suomenlahti National Park)	Common gull ( <i>Larus canus</i> )	B	23.5 km (Line A)
	Lesser black-backed gull ( <i>Larus fuscus</i> )	B	
	Caspian tern ( <i>Hydroprogne caspia</i> )	B	
	Arctic tern ( <i>Sterna paradisaea</i> )	B	
	Razorbill ( <i>Alca torda</i> )	B	
Black guillemot ( <i>Cepphus grylle</i> )	B		
FI098: Espoo-Helsinki	Long-tailed duck ( <i>Clangula hyemalis</i> )	P/W	13.5 km (Line A)

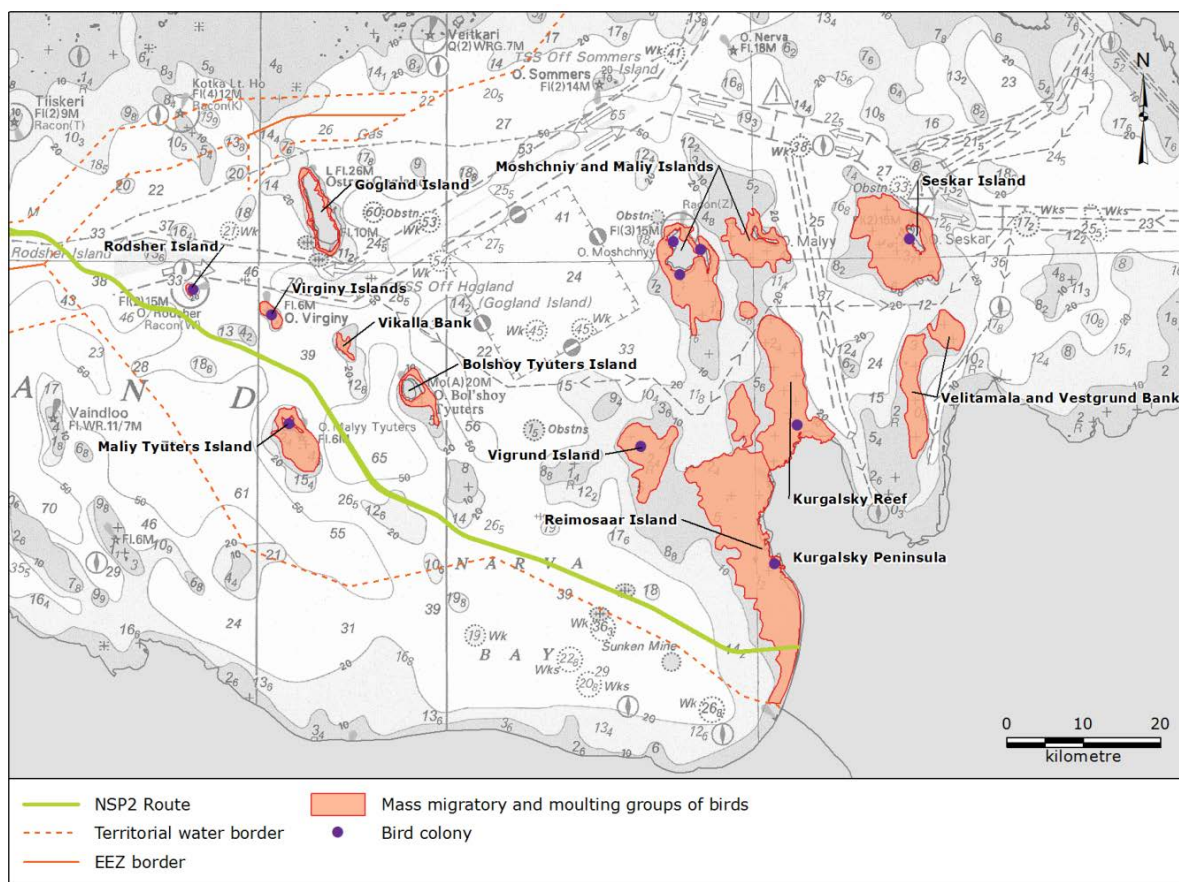
IBA	Species	Season	Distance to planned pipeline route
shallows			
FI099: Öro-Bengtskär	Common eider ( <i>Somateria mollissima</i> )	P	25.0 km (Line A)
FI075: Pernaja outer archipelago	Caspian tern ( <i>Hydroprogne caspia</i> )	B	12.6 km (Line A)
	Razorbill ( <i>Alca torda</i> )	B	
	Black guillemot ( <i>Cepphus grylle</i> )	B	
FI082: Kirkkonummi archipelago	Barnacle goose ( <i>Branta leucopsis</i> )	B	8.2 km (ALT E1)
	Great black-backed gull ( <i>Larus marinus</i> )	B	
FI080: Tammisaari and Inkoo western archipelago	White-tailed eagle ( <i>Haliaeetus albicilla</i> )	B	14.5 km (Line A)
	Common gull ( <i>Larus canus</i> )	B	
	Great black-backed gull ( <i>Larus marinus</i> )	B	
	Caspian tern <i>Hydroprogne caspia</i>	B	
	Black guillemot <i>Uria aalge</i>	B	
FI077: Porvoo outer archipelago	Caspian tern ( <i>Hydroprogne caspia</i> )	B	20.2 (Line A)
	Black guillemot ( <i>Cepphus grylle</i> )	B	
FI081: Hanko western archipelago	Common eider ( <i>Somateria mollissima</i> )	P	21.2 (Line A)
<b>Sweden</b>			
SE065: Hoburgs Bank	Long-tailed duck ( <i>Clangula hyemalis</i> )	W	5 km
	Black guillemot ( <i>Cepphus grylle</i> )	W	
SE067: Northern Midsjö Bank	Long-tailed duck ( <i>Clangula hyemalis</i> )	W	4 km
	Black guillemot <i>Cepphus grylle</i> )	W	
SE066: Southern Midsjö Bank	Black guillemot ( <i>Cepphus grylle</i> )	W	Crossing (by 5.3 km)
SE050: Coastal areas of eastern Gotland Island	Barnacle goose ( <i>Branta leucopsis</i> )	B, P	25 km
	Tundra swan ( <i>Cygnus columbianus</i> )	P	
	Tufted duck ( <i>Aythya fuligula</i> )	W	
	Greater scaup ( <i>Aythya marila</i> )	W	
	Common eider ( <i>Somateria mollissima</i> )	B	
	Long-tailed duck ( <i>Clangula hyemalis</i> )	W	
	Smew ( <i>Mergellus albellus</i> )	W	
	Caspian tern ( <i>Hydroprogne caspia</i> )	B	
	Little tern ( <i>Sternula albifrons</i> )	B	
<b>Denmark</b>			
DK079: Ertholmene east of Bornholm	Guillemot ( <i>Uria aalge</i> )	B, W	13 km
	Razorbill ( <i>Alca torda</i> )	B, W	
DK120: Rønne Banke	Common scoter ( <i>Melanitta nigra</i> )	P	3-12 km for most of the route
	Velvet scoter ( <i>Melanitta fusca</i> )	p	
	Long-tailed duck ( <i>Clangula hyemalis</i> )	P	10 km of the NSP2 route crosses the IBA
	Red-breasted merganser ( <i>Mergus serrator</i> )	P	
	Red-necked grebe ( <i>Podiceps grisegena</i> )	P	
	Great-crested grebe ( <i>Podiceps cristatus</i> )	P	
	Horned grebe ( <i>Podiceps auritus</i> )	P	
	Black guillemot ( <i>Cepphus grylle</i> )	P	
<b>Germany</b>			
DE040: Pomeranian Bay	Common scoter ( <i>Melanitta nigra</i> )	W	Crossing (by 69.4 km)
	Velvet scoter ( <i>Melanitta fusca</i> )	W	
	Long-tailed duck ( <i>Clangula hyemalis</i> )	W	
	Red-breasted merganser ( <i>Mergus serrator</i> )	W	
	Black-throated diver ( <i>Gavia arctica</i> )	W	
	Red-throated diver ( <i>Gavia stellate</i> )	W	

IBA	Species	Season	Distance to planned pipeline route
	Red-necked grebe ( <i>Podiceps grisegena</i> )	W	
	Great-crested grebe ( <i>Podiceps cristatus</i> )	W	
	Horned grebe ( <i>Podiceps auritus</i> )	W	
DE044: Greifswalder Bodden	Tundra swan ( <i>Cygnus columbianus</i> )	W	Crossing (by 21.7 km)
	Mute swan ( <i>Cygnus olor</i> )	W	
	Whooper swan ( <i>Cygnus Cygnus</i> )	W	
	Bean goose ( <i>Anser fabialis</i> )	W	
	Great white-fronted goose ( <i>Anser albifrons</i> )	W	
	Eurasian wigeon ( <i>Anas Penelope</i> )	W	
	Gadwall ( <i>Anas strepera</i> )	W	
	Mallard ( <i>Anas platyrhynchos</i> )	W	
	Tufted duck ( <i>Aythya fuligula</i> )	W	
	Greater scaup ( <i>Aythya marila</i> )	W	
	Long-tailed duck ( <i>Clangula hyemalis</i> )	W	
	Common goldeneye ( <i>Bucephala clangula</i> )	W	
	Red-breasted merganser ( <i>Mergus serrator</i> )	W	
	Goosander ( <i>Mergus merganser</i> )	W	
	Smew ( <i>Mergellus albellus</i> )	W	
	Red-throated diver ( <i>Gavia stellate</i> )	W	
	Black-throated diver ( <i>Gavia arctica</i> )	W	
	Red-necked grebe ( <i>Podiceps grisegena</i> )	W	
	Great-crested grebe ( <i>Podiceps cristatus</i> )	W	
	Horned grebe ( <i>Podiceps auritus</i> )	W	
	Eurasian coot ( <i>Fulica atra</i> )	W	
	Little gull ( <i>Hydrocoloeus minutus</i> )	P	
	Black tern ( <i>Chlidonias niger</i> )	P	

### 9.6.5.2 Species and distribution

#### Russian nearshore area

Due to its geographical location (on the far north-east of the Baltic Sea), the abundance of coastal landscapes and the presence of high-yield shallow waters, the eastern part of the Gulf of Finland plays an important role in the life of seabirds (Figure 9-27). The most valuable habitats for breeding and migratory birds are linked to the uninhabited islands and reefs and the waters around them up to 10 m water depth (Figure 9-27).



**Figure 9-27** Map of the mass migratory and moulting groups and location of seabird and waterbird colonies in the Russian landfall area. For species distribution, please consult Figure 9-28.

During the aerial survey in April-May 2016 (Table 9-1), more than 21,000 birds of 38 species were observed. The dominant species were from the Anatidae family (half of total registered birds), with the most abundant species being tufted duck (*Aythya fuligula*) and greylag goose (*Anser anser*). A third dominating group of species belong to the family Laridae, in particular herring gull (*Larus argentatus*) was observed.

Results of a vessel-based survey along the offshore NSP route and nearby islands identified 56 species of seabirds, 29 of which were observed during the nesting period. The highest diversity of birds was observed at the Reimosaar Island (western coast of Kurgalsky Peninsula, 12 km north of the landfall) and Maliy Tyuters, due to the vast area of shallow water biotopes around these islands /157/. The offshore part of the Gulf of Finland is only used by birds as a migration route, with no stopover sites.

There are no large seabird colonies in the immediate nearshore area. The closest colony is north of the landfall at the Reimosaar Island (Figure 9-27). The main species of the colony are great cormorant, European herring gull, lesser black-backed gull, great black-backed gull, common gull, black-headed gull, Arctic tern, common tern and Caspian tern. However, the area extending 3-7 km from the shoreline is an important stopover site for diving ducks and loons during spring migration.

Forty species of observed birds are prioritised for conservation and/or protection, including 21 of those recorded breeding (Figure 9-28). None of the recorded species are included on the IUCN Red List as critically endangered or endangered, although eight are listed as vulnerable and four as near threatened. Two loons (*Gavia stellate* and *Gavia arctica*) are listed as critically endangered on the HELCOM Red List. Five species are listed as critically endangered or endangered on one or more regional or national Red Lists. All were recorded during migration, with the exception of the ringed plover (*Charadrius hiaticula*), which was also recorded as

breeding. The species is on Russian national Red Lists and is listed as near threatened on the HELCOM Red List.

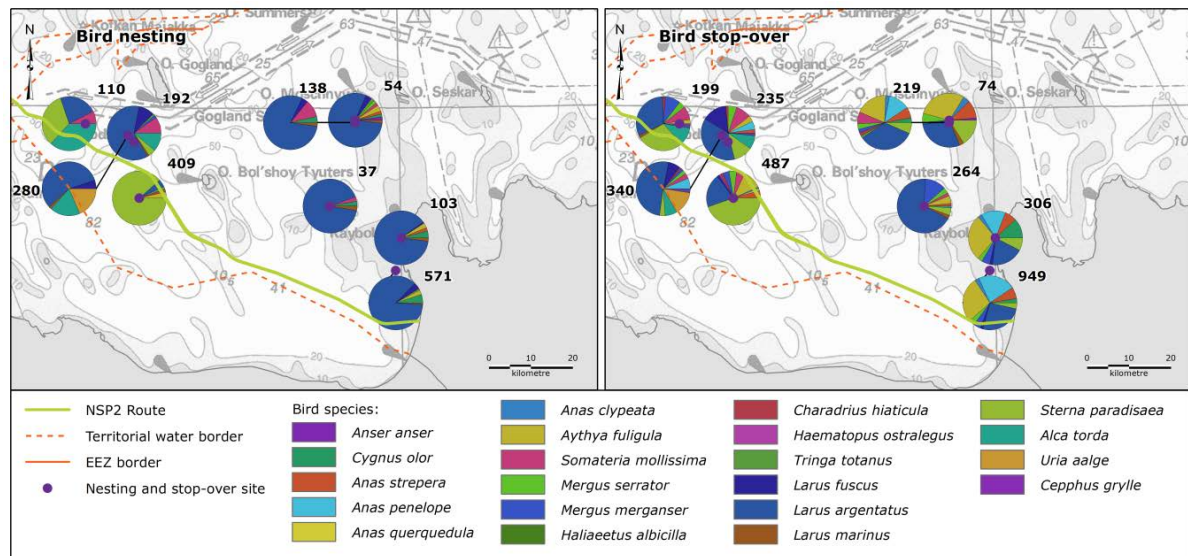


Figure 9-28 Maps of nesting (left) and stopover sites (right) of bird species (spring survey 2016). Numbers represent the abundance of birds observed in the colony during the survey.

### Marine offshore areas

The Baltic Sea is one of the most important sites for wintering and migratory seabirds and waterbirds. In addition, approximately half of all European seabirds breed in the Baltic area (40 of 80 species). The seabirds comprise both pelagic species (e.g. gulls (Laridae) and auks (Alcidae)) and benthic feeders (e.g. dabbling ducks, sea ducks, mergansers (Anatidae) and coots (Rallidae)) /90/. In 2006, the total number of seabirds in the Baltic Sea was 10.2 million, 9.8 million, 3.9 million and 5.8 million during winter, spring, summer and autumn, respectively /167/. Thus, in terms of numbers, the Baltic Sea is relatively important as a wintering and staging area and as a migration route for seabirds, especially for waterfowl, geese and waders that nest in the Arctic tundra. In spring and autumn, the birds use the coastal areas of the Baltic Sea for resting and staging during their migration to and from their nesting grounds. During late summer/early autumn, many of the seabirds congregate for moulting in areas with easy access to optimal feeding grounds. During this moulting period the birds are generally unable to fly.

The majority of wintering birds are associated with relatively shallow water (<30 m), including the lower sublittoral areas, the offshore banks and the lagoons /166/. In Finland and of relevance for NSP2, the highest concentrations of breeding birds are found in the Archipelago Sea and the highest concentrations of wintering birds are found in the Åland region (approximately 40-100 km from NSP2). Furthermore, Hoburgs Bank and the Midsjö Banks comprise some of the largest offshore bank systems in the Baltic, supporting long-tailed duck, black guillemot, common eider and velvet scoter /168/, /169/. Hoburgs Bank in particular is considered an area of global importance for long-tailed duck /168/. Within the Danish EEZ, the most abundant species is long-tailed duck, representing less than 1% of the Baltic population (12,000 registered individuals).

A few birds forage in the more open and deeper parts of the Baltic Sea, where the majority of the pipeline will be situated. These areas are mainly used by pelagic-feeding species such as razorbill, guillemot, herring gull, common gull and great black-backed gull /166/, /168/. It should be emphasised that the abundance of these species is very low in these offshore areas.

Within German waters, the NSP2 route crosses the Pomeranian Bay in Germany, which is designated as an SPA (see Section 9.6.6) and an IBA. This area is one of the most important wintering and staging areas for seabirds and waterbirds, most notably seaducks (long-tailed duck, common and velvet scoters) and Slavonian grebes /166/, /168/. Seaducks and Slavonian grebes depend on benthic prey and are thus mostly concentrated in shallow waters. The NSP2

route runs along the outer margin of the main concentrations of these species. The highest densities of red-throated (in spring) and black-throated divers are also found around the Oderbank, 2 km from the NSP2 route. Divers occur in the entire area at low densities. The only species that occur in high densities around the NSP2 route are the fish-feeding guillemot and razorbill. The total number of each of the above species has been stable or increasing in the Pomeranian Bay since 2006.

Post-construction monitoring for NSP showed no negative impacts on seabirds in the Pomeranian Bay. During 10 vessel-based seabird surveys in the Pomeranian Bay (September 2015-August 2016), which covered most of the NSP2 route in this area of importance for seabirds, the highest estimated numbers in a 6 km wide corridor along the NSP2 route were 9,491 long-tailed ducks, 5,588 common scoters and 8,755 velvet scoters. Detailed aerial surveys of both the NSP and the NSP2 route in 2016 showed large flocks of long-tailed ducks and scoters directly along the existing pipeline, indicating no adverse effects. Further information on the number and distribution of seabirds can be found in the German EIA /54/.

#### **German nearshore area**

In Germany, the landfall area will be near Lubmin in the southern part of Greifswalder Bodden. Greifswalder Bodden is designated as an SPA (see Section 9.6.6) and an IBA. Part of this area includes coastal and terrestrial areas west of Lubmin. Throughout the year, the SPA is highly important for a large number of wintering, staging, moulting and breeding seabirds. The parts of the Greifswalder Bodden that are crossed by the NSP2 route are mostly important for benthic feeding seabirds and seabirds. The Greifswalder Bodden is separated from the Baltic Sea by an underwater ridge, which is crossed by the NSP2 route. This shallow area dominated by hard-bottom substrate is a major staging site for long-tailed duck, common scoter and greater scaup. Greater scaup also feed in large flocks on bivalves inside the Greifswalder Bodden. The open sea on the outer side of this underwater ridge is of limited importance for seabirds due to increasing water depth and ship traffic.

The Greifswalder Bodden itself is also a major spring spawning site for herring. During March and April, large flocks of long-tailed ducks gather to feed on herring spawn. At the same time, fish-eating seabirds gather in the Baltic just outside the Greifswalder Bodden to feed on herring. This is especially the case with red-throated divers during their spring migration. More information on the distribution of seabirds along the NSP2 route is provided in the German EIA /54/. During summer and autumn, the area between Lubmin and the entrance to the Greifswalder Bodden is also a major staging site for little gulls and black terns. Little gulls use this area as a roost while feeding in the Pomeranian Bay off the Usedom coast. Close to the landfall at Lubmin, the NSP2 route passes shallow areas that are important staging sites for seabirds year-round, with at least 50 species being present for some time of the year. The NSP2 route is situated just outside these shallow areas.

#### **9.6.5.3 Importance of birds**

As described earlier, birds contribute to the overall ecosystem dynamic in the Baltic Sea as predators on fish, benthic fauna, plankton (eggs, fish fry), etc. Furthermore, some bird species serve as food source for other bird species.

Many of the bird species in the Baltic Sea area are protected by EU Birds Directive and classified as threatened (endangered or vulnerable) or near threatened on international Red Lists (Table 9-16, see also Appendix 2 for more specifications of protection status and inclusion on national Red Lists) and/or are congregatory or migratory. The level of importance of specific birds and the importance of the areas that support them therefore varies spatially.

**Table 9-16 International protection and conservation status of most common seabirds and waterbirds in the Baltic Sea area. Only critically endangered, endangered and vulnerable and Annex I species are included (see also Appendix 2 for complete list).**

Bird species	Protection/conservation status		
	Birds Directive	IUCN Red List	HELCOM Red List
Arctic tern	Annex I	LC	-
Barnacle goose	Annex I	LC	-
Bean goose	M	LC	EN
Black tern	Annex I	LC	-
Black-throated diver	Annex I	VU	CR
Caspian tern	Annex I	LC	VU
Common eider	M	LC	VU-EN
Common pochard	M	VU	-
Common scoter	M	LC	EN
Common tern	Annex I	LC	-
Great crested grebe	Annex I	LC	-
Greater scaup	M	EN	VU
Horned /Slavonian grebe	Annex I	LC	VU-NT
Lesser black-backed gull	M	LC	VU
Light-bellied brent goose	M	VU	NT
Little gull	Annex I	LC	-
Little tern	Annex I	LC	LC
Long-tailed duck	M	VU	EN
Mediterranean gull	Annex I	LC	EN
Red-breasted merganser	M	LC	VU
Red-necked grebe	M	LC	EN
Red-necked phalarope	Annex I	LC	-
Red-throated diver	Annex I	LC	CR
Ringed plover	Breeding	-	NT
Sandwich tern	Annex I	LC	LC
Smew	Annex I	LC	-
Southern dunlin	Annex I	LC	EN
Steller's eider	Annex I	VU	EN
Tundra swan	Annex I	LC	-
Velvet scoter	M	VU-LC	VU-EN
White-tailed sea-eagle	Annex I	LC	-
Whooper swan	Annex I	LC	-

Only a few bird species of concern use the more open and deeper parts of the Baltic Sea; therefore the importance of these areas for birds is low. The shallow offshore banks of Sweden and Germany (in winter) and the nearshore areas in Germany and Russia hold high numbers of bird species (winter and breeding species/or migratory) some of which are protected and/or on international Red Lists (e.g. common eider and long-tailed duck). Species are often found in very high numbers. The importance of such species and the areas that support them is medium to high, depending on specific species and the nature of use (breeding, resting, etc.).

#### 9.6.6 Natura 2000 sites

The EU Directive on the Conservation of Wild Birds (79/409/EEC) and the EU Directive on the Conservation of Natural Habitats and Wild Flora and Fauna (92/43/EEC) establish the legislative framework for protecting and conserving wildlife and habitats in Europe. The core mechanism outlined for achieving this is the Natura 2000 network for habitats and species, a coherent ecological network of protected areas across the EU. The aim of the network is to ensure



favourable conservation status for species and habitats, which forms the designation basis of the site. As Russia is not a part of the EU, there are no Natura 2000 sites in Russia.

The purpose of the Natura 2000 network is to ensure that habitats and species within the network reach 'favourable conservation status' across their natural range.

The Natura 2000 network comprises three types of sites:

- Special Protection Areas (SPA): sites designated for the protection of rare and vulnerable bird species listed in Annex I of the Birds Directive, as well as of regularly occurring migratory bird species.
- Special Areas of Conservation (SAC)/Site of Community Interest (SCI): designated sites under the Habitats Directive, where the necessary conservation measures are applied for the maintenance or restoration of a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated (a SCI will eventually become an SAC when it has been approved by the European Commission and the Member State has successfully applied the relevant conservation measures).

The conservation status of a natural habitat is 'favourable' when:

- Its natural range and areas it covers within that range are stable or increasing;
- The specific structure and functions necessary for its long-term maintenance exist and are likely to continue for the foreseeable future;
- The current conservation status of its characteristic species is favourable.

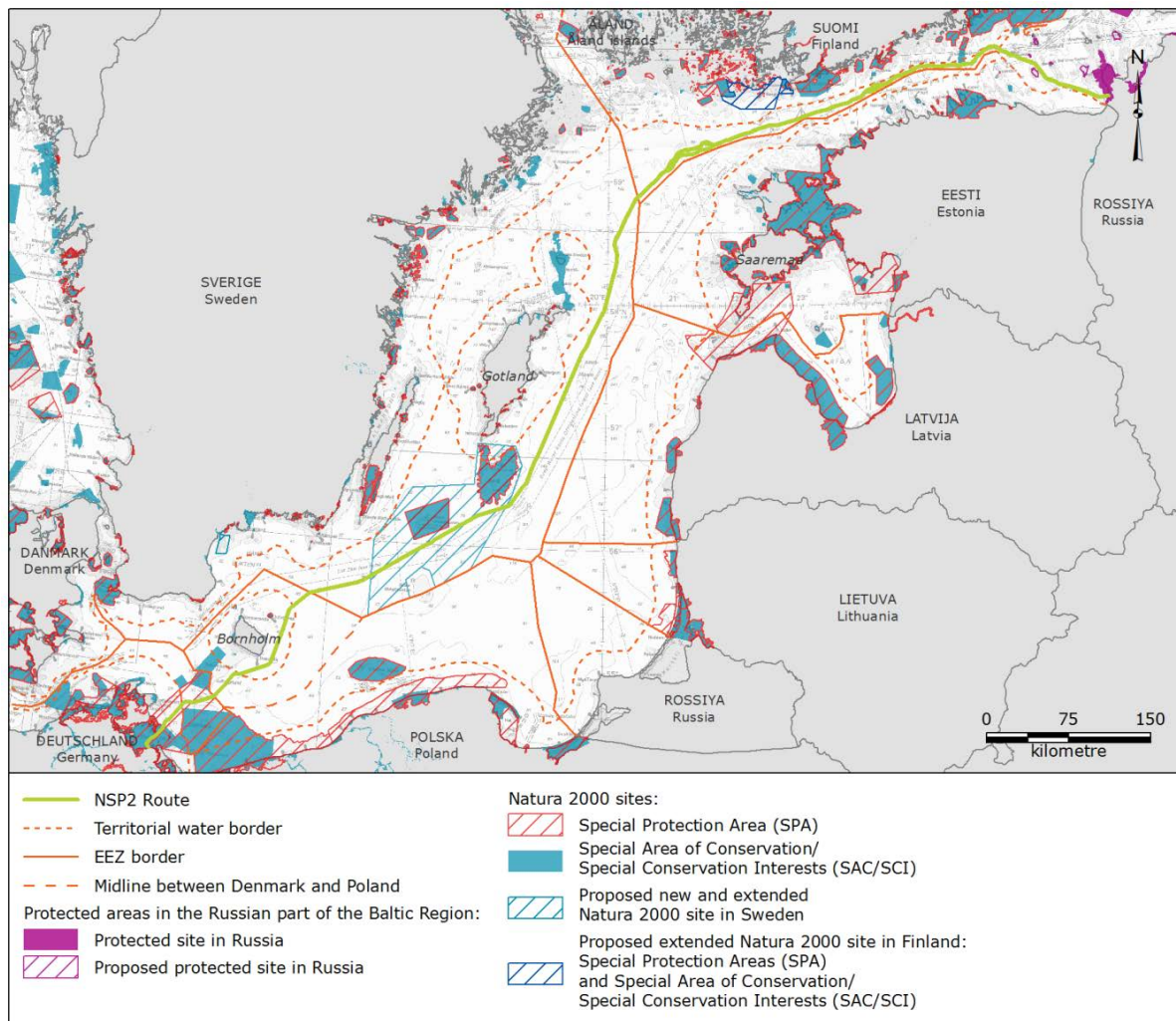
The conservation status of a species is 'favourable' when:

- Population dynamics data indicate that the species is maintaining itself on a long-term basis as a viable component of its natural habitats;
- The natural range of the species is not being reduced nor is it likely to be reduced for the foreseeable future;
- There is, and probably will continue to be, a sufficiently large habitat to maintain its population on a long-term basis.

Natura 2000 sites in the Baltic Sea are shown in Figure 9-29 and in Atlas Maps PA-01-Espoo to PA-03-Espoo. Sites in the vicinity of NSP2 within the PoOs and the APs are listed Table 9-17, together with the main feature for which they were designated and the distance from NSP2.

Strictly terrestrial habitats and species in Natura 2000 sites outside the German landfall area have not been included in the table, as impacts from the project are not likely owing to the distance of the project and/or the likelihood of impacts on receptors from the project (based on modelling results of sediment dispersion).

As a precautionary measure, the two Polish Natura 2000 sites SCI Ostoja na Zatoce pomorskiej (PLH990002) and SPA Zatoka Pomorska (PLB990003) are included for consideration and were addressed during the consultation process.



**Figure 9-29** Marine and adjacent coastal Natura 2000 sites in the Baltic Sea. Sites represent SPAs/SCI's and SACs. See also Atlas Maps PA-01-Espoo to PA-03-Espoo. Protected sites in Russia are also presented (there are no Natura 2000 sites in Russia).

**Table 9-17** Marine Natura 2000 sites relevant to NSP2 presented from east to west. Terrestrial habitats and species are not included in the assessments for Finnish, Danish and Swedish sites, as potential impacts will not extend to coastal areas. Habitats 1610, 1620 and 1650 are included, however, as they can be partially marine. Bird species listed in Annex I are noted with <sup>1</sup>. Only marine Annex I and regularly occurring migrating birds are shown for SPAs related to the marine environment /170/, /171/.

Natura 2000 site SPA/SCI/SAC	Designated species	Designated habitats	Distance to planned pipeline
<b>Finland</b>			
SPA/SAC FI0408001: Itäisen Suomenlahden saaristo ja vedet (Eastern Gulf of Finland archipelago and waters)	Grey seal ( <i>Halichoerus grypus grypus</i> ) Ringed seal* ( <i>Phoca hispida botnica</i> ) Common tern <sup>1</sup> ( <i>Sterna hirundo</i> ) Arctic tern <sup>1</sup> ( <i>Sterna paradisaea</i> ) Caspian tern <sup>1</sup> ( <i>Hydroprogne caspia</i> ) Razorbill ( <i>Alca torda</i> ) Lesser black-backed gull ( <i>Larus fuscus</i> ) Greater scaup ( <i>Aythya marila</i> ) Velvet scoter ( <i>Melanitta fusca</i> )	Sandbanks (1110) Coastal lagoons (1150) Reefs (1170) Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation (1610)	23.5 km (Line A)

Natura 2000 site SPA/SCI/SAC	Designated species	Designated habitats	Distance to planned pipeline
SAC FI0400001: Länsiletto alue (Länsiletto area)	-	Reefs (1170)	26.9 km (Line A)
SAC FI0400002: Luodematalat	-	Reefs (1170)	18.0 km
SPA/SAC FI0100078: Pernajanlahtien ja Pernajan saariston merensuojelualue (Pernaja and Pernaja archipelago)	Grey seal ( <i>H. grypus grypus</i> ) Ringed seal* ( <i>P. hispida botnica</i> ) Caspian tern <sup>1</sup> ( <i>H. caspia</i> ) Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Razorbill ( <i>A. torda</i> ) Velvet scoter ( <i>M. fusca</i> ) Garganey ( <i>Anas querquedula</i> )	Coastal lagoons (1150) Reefs (1170) Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation (1610) Boreal Baltic islets and small islands (1620) Boreal Baltic narrow inlets (1650)	13.1 km (Line A)
SPA/SAC FI0100077: Söderskärin ja Långörenin saaristo (Söderskär and Långören archipelago)	Grey seal ( <i>H. grypus grypus</i> ) Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Caspian tern <sup>1</sup> ( <i>H. caspia</i> )	Sandbanks (1110) Reefs (1170) Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation (1610) Boreal Baltic islets and small islands (1620)	12.5 km (Line A)
SAC FI0100106: Sandkallanin eteläpuolinen merialue (The sea area South of Sandkallan)	-	Reefs (1170)	1.9 km (Line A)
SPA FI0100105: Kirkkonummen saaristo (Kirkkonummi archipelago)	Black/Red-throated diver <sup>1</sup> ( <i>Gavia stellata</i> G. <i>arctica</i> ) Horned grebe <sup>1</sup> ( <i>Podiceps auritus</i> ) Caspian tern <sup>1</sup> ( <i>H. caspia</i> ) Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Razorbill ( <i>A. torda</i> ) Greater scaup ( <i>A. marila</i> ) Black guillemot ( <i>Cephus grylle</i> ) Lesser black-backed gull ( <i>L. fuscus</i> ) Velvet scoter ( <i>M. fusca</i> ) Common scoter ( <i>Melanitta nigra</i> ) Smew ( <i>Mergellus albellus</i> ) Red-necked grebe ( <i>Podiceps grisegena</i> )	-	13.0 km (Line A)

Natura 2000 site SPA/SCI/SAC	Designated species	Designated habitats	Distance to planned pipeline
	Steller's eider ( <i>Polysticta stelleri</i> ) Common shelduck ( <i>Tadorna tadorna</i> )		
SAC FI0100026: Kirkkonummi Saaristo (Kirkkonummi archipelago)	-	Sandbanks (1110) Coastal lagoons (1150) Reefs (1170) Boreal Baltic islets and small islands (1620)	13.0 km (Line A)
SAC FI0100089: Kallbådanin luodot ja vesialue (Kallbådans islets and waters)	Grey seal ( <i>H. grypus grypus</i> )	Boreal Baltic islets and small islands (1620)	8.1 km (ALT E1, Line A) 9.8 km (ALT E2, Line B)
SPA/SAC FI0100017: Inkoo saaristo (Inkoo archipelago)	Caspian tern <sup>1</sup> ( <i>H. caspia</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Velvet scoter ( <i>M. fusca</i> )	Sandbanks (1110) Reefs (1170) Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation (1610) Boreal Baltic islets and small islands (1620)	16.5 km (ALT E1, Line A) 18.8 km (ALT E2, Line B)
SPA/SAC FI0100005: Tammisaaren ja Hangon saariston ja Pohjanpitäjänlahden merensuojelualue (Tammisaari and Hangon archipelago and Pohjanpitäjänlahti MPA)	Grey seal ( <i>H. grypus grypus</i> ) Caspian tern <sup>1</sup> ( <i>H. caspia</i> ) Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Black-throated diver <sup>1</sup> ( <i>G. arctica</i> ) Smew <sup>1</sup> ( <i>M. albellus</i> ) Tundra Swan <sup>1</sup> ( <i>Cygnus columbianus</i> ) Whooper swan <sup>1</sup> ( <i>Cygnus cygnus</i> ) Velvet scoter ( <i>M. fusca</i> )	Sandbanks (1110) Coastal lagoons (1150) Large shallow inlets and bays (1160) Reefs (1170) Boreal Baltic islets and small islands (1620) Boreal Baltic narrow inlets (1650)	17.8 km (Line A)
SAC FI0100107: Hangon itäinen selkä (The Hangon Eastern offshore area)	-	Reefs (1170)	13.7 km (Line A)
SAC FI0200090: Saaristomeri	Grey seal ( <i>H. grypus grypus</i> ) Ringed seal ( <i>P. hispida botnica</i> ) Eurasian otter ( <i>Lutra lutra</i> )	Sandbanks (1110) Coastal lagoons (1150) Reefs (1170) Baltic esker islands with sandy, rocky and shingle beach	27.4 km

Natura 2000 site SPA/SCI/SAC	Designated species	Designated habitats	Distance to planned pipeline
		vegetation and sublittoral vegetation (1610) Boreal Baltic islets and small islands (1620) Boreal Baltic narrow inlets (1650)	
<b>Sweden</b>			
SCI SE0340097: Gotska Sandön-Salvorev	Grey seal ( <i>H. grypus grypus</i> )	Sandbanks (1110)	25 km
SPA/SAC SE0340144: Hoburgs Bank	*Harbour porpoise ( <i>Phocoena phocoena</i> ) Common eider ( <i>Somateria mollissima</i> ) Long-tailed duck ( <i>Clangula hyemalis</i> ) Black guillemot ( <i>C. grylle</i> )	Sandbanks (1110) Reefs (1170)	5 km
SPA/SAC SE0330273: Norra Midsjöbank	**Harbour porpoise ( <i>P. phocoena</i> ) Long-tailed duck ( <i>C. hyemalis</i> ) Black guillemot ( <i>C. grylle</i> )	Sandbanks (1110) Reefs (1170)	4 km
<b>Denmark</b>			
SPA/SAC 007X079: N189 Ertholmene	Grey seal ( <i>H. grypus grypus</i> ) Guillemot ( <i>Uria aalge</i> ) Razorbill ( <i>A. torda</i> )	Reefs (1170)	13 km
SAC DK00VA310: N212 Bakkebrædt og Bakkegrund	-	Sandbanks (1110) Reefs (1170)	17 km
SAC DK00VA261: N252 Adler Grund og Rønne Banke	-	Sandbanks (1110) Reefs (1170)	16 km
<b>Germany</b>			
SCI DE1251301: Adlergrund	Harbour porpoise ( <i>P. phocoena</i> ) Grey seal ( <i>H. grypus grypus</i> )	Sandbanks (1110) Reefs (1170)	6.2 km
SPA DE1552401: Pommersche Bucht	Red/Black-throated diver <sup>1</sup> ( <i>Gavia stellata</i> G. <i>arctica</i> ) Horned grebe <sup>1</sup> ( <i>P. auritus</i> ) Little gull <sup>1</sup> ( <i>Larus minutus</i> ) Razorbill ( <i>A. torda</i> ) Black guillemot ( <i>C. grylle</i> ) Long-tailed duck ( <i>C. hyemalis</i> ) European herring gull ( <i>Larus argentatus</i> ) Common gull ( <i>Larus canus</i> ) Lesser black-backed gull ( <i>L. fuscus</i> ) Great black-backed gull ( <i>Larus marinus</i> ) Black-headed gull ( <i>Larus ridibundus</i> ) Velvet scoter ( <i>M. fusca</i> ) Common scoter ( <i>M. nigra</i> ) Great cormorant ( <i>Phalacrocorax carbo</i> ) Red-necked grebe ( <i>P. grisegena</i> ) Common eider ( <i>S. mollissima</i> )	Sandbanks (1110) Reefs (1170)	Crossing (crossing distance 31.1 km)

Natura 2000 site SPA/SCI/SAC	Designated species	Designated habitats	Distance to planned pipeline
	Guillemot ( <i>U. aalge</i> ) Great crested grebe ( <i>P. cristatus</i> )		
SCI DE1652301: Pommersche Bucht mit Oderbank	Harbour porpoise ( <i>P. phocoena</i> )	Sandbanks (1110)	2 km
SPA DE1649401: Westliche Pommersche Bucht	Red/Black-throated diver <sup>1</sup> ( <i>Gavia stellata</i> / <i>G. arctica</i> ) Horned grebe <sup>1</sup> ( <i>P. auritus</i> ) Little gull <sup>1</sup> ( <i>L. minutus</i> ) Razorbill ( <i>A. torda</i> ) Long-tailed duck <sup>1</sup> ( <i>C. hyemalis</i> ) Velvet scoter ( <i>M. fusca</i> ) Common scoter ( <i>M. nigra</i> ) Red-breasted merganser Great cormorant ( <i>P. carbo</i> ) Great crested grebe ( <i>Podiceps cristatus</i> ) Guillemot ( <i>U. aalge</i> )	-	Crossing (crossing distance 28.5 km)
SCI DE1749302: Greifswalder Boddenrandschwelle und Teile der Pommersche Bucht	Grey seal ( <i>H. grypus grypus</i> ) Harbour porpoise ( <i>P. phocoena</i> ) Harbour seal ( <i>Phoca vitulina</i> ) Sturgeon ( <i>Acipenser sturio</i> ) Twait shad ( <i>Alosa fallax</i> ) European river lamprey ( <i>Lampetra fluviatilis</i> ) Sea lamprey ( <i>Petromyzon marinus</i> )	Sandbanks (1110) Reefs (1170)	Crossing (crossing distance 36.4 km)
SPA DE1747402: Greifswalder Bodden und südlicher Strelasund	Little tern <sup>1</sup> ( <i>Sternula albifrons</i> ) Caspian tern <sup>1</sup> ( <i>H. caspia</i> ) Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Sandwich tern <sup>1</sup> ( <i>Sterna sandvicensis</i> ) Black/Red-throated diver <sup>1</sup> ( <i>Gavia stellata</i> / <i>G. arctica</i> ) Tundra Swan <sup>1</sup> ( <i>C. columbianus</i> ) Horned grebe <sup>1</sup> ( <i>P. auritus</i> ) Whooper swan <sup>1</sup> ( <i>C. cygnus</i> ) Black tern <sup>1</sup> ( <i>Chlidonias niger</i> ) Mediterranean gull <sup>1</sup> ( <i>Larus melanocephalus</i> ) Little gull <sup>1</sup> ( <i>L. minutus</i> ) Red-necked phalarope <sup>1</sup> Barnacle goose <sup>1</sup> ( <i>Branta leucopsis</i> ) White-tailed Sea-eagle <sup>1</sup> ( <i>Haliaeetus albicilla</i> ) (additionally approx. 45 migrating bird species)	-	Crossing (crossing distance 24.6 km)
SCI DE1747301: Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom	Grey seal ( <i>H. grypus grypus</i> ) Harbour seal ( <i>P. vitulina</i> ) Harbour porpoise ( <i>P. phocoena</i> ) Eurasian otter ( <i>L. lutra</i> ) Twait shad ( <i>A. fallax</i> ) European river lamprey ( <i>L. fluviatilis</i> ) Sea lamprey ( <i>P. marinus</i> ) Asp ( <i>Aspius aspius</i> ) Amur ( <i>Ctenopharyngodon idella</i> ) Bitterling ( <i>Rhodeus amarus</i> )	Sandbanks (1110) Estuaries (1130) Mudflats and sandflats not covered by seawater at low tide (1140) Coastal lagoons (1150) Large shallow	Crossing (crossing distance 16.7 km)

Natura 2000 site SPA/SCI/SAC	Designated species	Designated habitats	Distance to planned pipeline
		inlets and bays (1160) Reefs (1170)	
SCI DE1648302: Küstenlandschaft Südostrügen	Grey seal ( <i>H. grypus grypus</i> ) Harbour porpoise ( <i>P. phocoena</i> ) Eurasian otter ( <i>L. lutra</i> )	Coastal lagoons (1150) Large shallow inlets and bays (1160) Reefs (1170)	1.5 km
<b>Estonia</b>			
SAC EE0070128: Struuga	Eurasian otter ( <i>L. lutra</i> ) Salmon ( <i>Salmo salar</i> ) European river lamprey ( <i>L. fluviatilis</i> )	-	19 km
SAC EE0060220: Uhtju	Grey seal ( <i>H. grypus grypus</i> ) Ringed seal ( <i>P. hispida botnica</i> )	Reef (1170)	25 km
SPA EE0060270: Vaindloo	Common tern <sup>1</sup> ( <i>S. hirundo</i> ) Arctic tern <sup>1</sup> ( <i>S. paradisaea</i> ) Black guillemot ( <i>C. grylle</i> ) Lesser black-backed gull ( <i>L. fuscus</i> )	-	18 km
SPA/SAC EE0010171: Kolga lahe	Grey seal ( <i>H. grypus grypus</i> ) Razorbill ( <i>A. torda</i> ) Tufted duck ( <i>A. fuligula</i> ) Lesser black-backed gull ( <i>L. fuscus</i> ) Velvet scoter ( <i>M. fusca</i> ) Common merganser ( <i>Mergus merganser</i> ) Red-breasted merganser ( <i>Mergus serrator</i> ) Great cormorant ( <i>P. carbo</i> ) Common eider ( <i>S. mollissima</i> ) Little tern ( <i>S. albifrons</i> ) Arctic tern ( <i>S. paradisaea</i> )	Sandbanks (1110) Coastal lagoons (1150) Reefs (1170)	30 km
SAC EE0010154: Krassi	Grey seal ( <i>H. grypus grypus</i> )	Reefs (1170)	30.5 km
SAC EE0040002: Väinamere	Grey seal ( <i>H. grypus grypus</i> ) Ringed seal ( <i>P. hispida botnica</i> )	Not relevant	42.5 km
<b>Poland</b>			
SAC PLH990002: Ostoja na Zatoce pomorskiej	Harbour porpoise ( <i>P. phocoena</i> ) Twait shad ( <i>A. fallax</i> )	Sandbanks (1110)	22 km
SPA PLB990003: Zatoka Pomorska	Black guillemot ( <i>C. grylle</i> ) Long-tailed duck ( <i>C. hyemalis</i> ) Red/Black-throated diver ( <i>Gavia stellata</i> / <i>G. arctica</i> ) Velvet scoter ( <i>M. fusca</i> ) Common scoter ( <i>M. nigra</i> ) Smew ( <i>M. albellus</i> ) Red-breasted merganser ( <i>M. serrator</i> ) Horned grebe ( <i>P. auritus</i> ) Red-necked grebe ( <i>P. grisegena</i> )	-	22 km
*Ringed seal – proposed as designation species. **Harbour porpoise – proposed as designated species in August 2015 by governmental decision. ***Harbour porpoise – proposed as designated species in April 2016, referral for consideration.			

In addition to the designated sites listed in the table above, two new Finnish sites and two new sites in Swedish waters are under consideration as potential Natura 2000 sites (Figure 9-29).

In Finland, the new sites would be extensions of two existing SPAs. The new sites are SPA FI0100006 – Tulliniemen linnustonsuojelualue (29 km from NSP2) and SPA FI0200164 – Saaristomeri (27.4 km from NSP2).

In Sweden, one site is an extension of the two sites that are already designated (Hoburgs Bank and Northern Midsjö Bank) /172/, /173/. A referral for proposal regarding an extended Natura 2000 site was sent to the Swedish Government in November 2016 from the Swedish Environmental Protection Agency, based on a suggestion from the County Administrative Boards of Kalmar and Gotland. The extended area consists of the current Natura 2000 sites Hoburgs Bank and Northern Midsjö Bank along with the area towards the IBA at Southern Midsjö Bank. The purpose of this extension is to include important areas for summer breeding harbour porpoises in the Natura 2000 network. The Swedish Government adjusted and forwarded the proposal to the EU Commission in December 2016. The new site number and name is SPA/SCI SE0330380 - Hoburgs Bank och Midsjöbankarna. The designation basis is harbour porpoise, common eider, long-tailed duck, black guillemot, sandbanks and reefs. NSP2 will cross the site along a length of 139.3 km.

The second site in Sweden is Kiviksbredan, which is approximately 78 km north-west of the pipeline. The area has received attention as a result of its potential importance for harbour porpoises based on SAMBAH data/151/. The status of this site is not yet known.

#### **9.6.6.1 Importance of Natura 2000 sites**

As the Natura sites are protected under the EU Habitats Directive, the importance of these sites is evaluated as high.

#### **9.6.7 Other protected and designated areas**

Other areas (in addition to the Natura 2000 sites addressed in the previous section) subject to protection or designation as a conservation priority that are located in marine areas (total or in part) are discussed below. The management measures afforded to such areas vary from strict legal protection, e.g. Natura 2000 designation (as described above) and nationally protected areas, to recommendations for managed conservation, e.g. as Ramsar sites, HELCOM Marine Protected Areas (previously called Baltic Sea Protected Areas), national parks, United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites and UNESCO Biosphere Reserve Areas. In 2004, the Baltic Sea as a whole was classified as a Particularly Sensitive Sea Area (PSSA) by the IMO. All areas have been described in detail in the national EIAs/ES and are discussed below.

##### **9.6.7.1 Ramsar sites**

The Convention on Wetlands of International Importance (the Ramsar Convention) is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation of wetlands. The convention requires contracting parties to formulate and implement their planning so as to promote the conservation of wetlands and as far as possible the wise use of wetlands in their territory /174/.



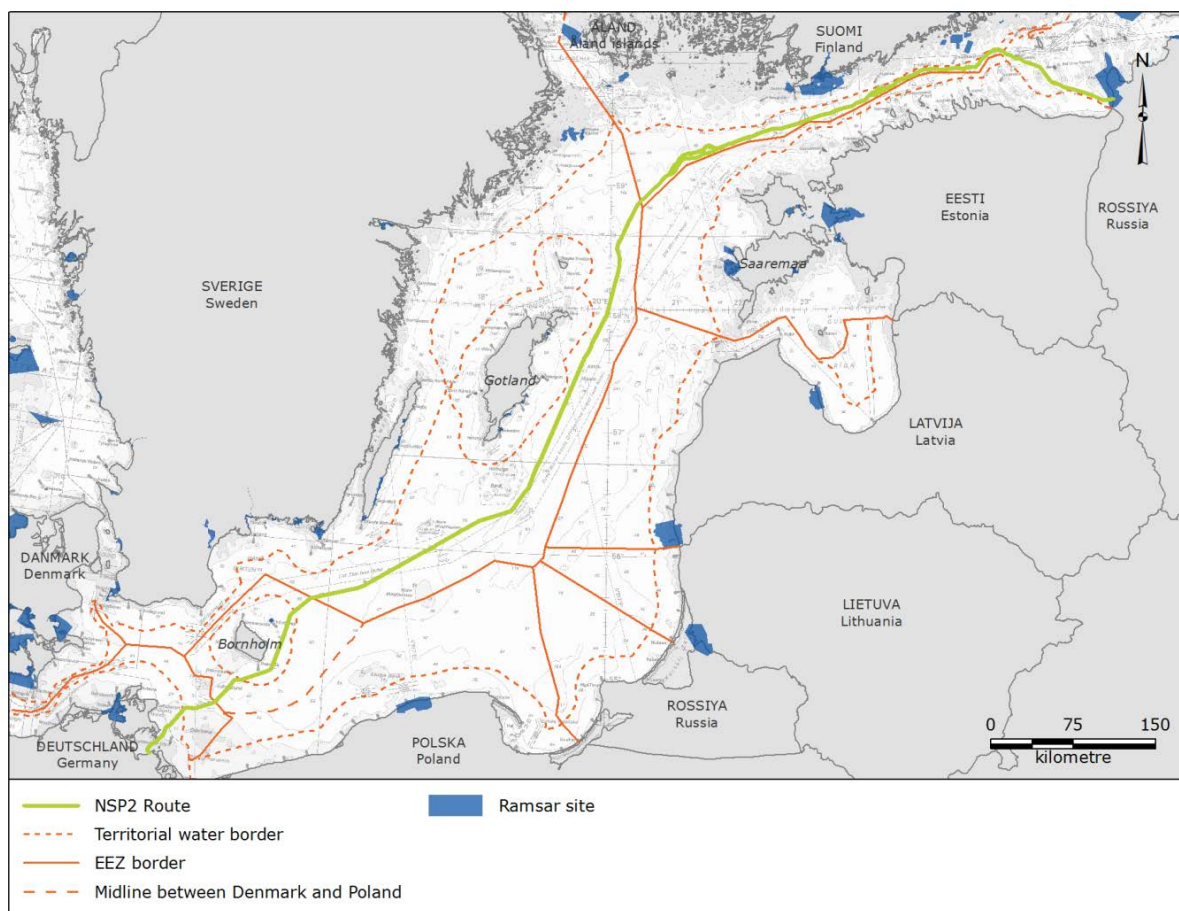


Figure 9-30 Ramsar sites within the Baltic Sea /174/. See also Atlas Map PA-04-Espoo.

Ramsar sites in the Baltic Sea and along the pipeline route are shown in Figure 9-30 and Atlas Map PA-04-Espoo. There are five Ramsar sites within 30 km of NSP2 as listed in Table 9-18.

Table 9-18 Ramsar sites within the vicinity of NSP2 /174/.

Site number	Ramsar site	Distance to planned NSP2
690	Kurgalsky Peninsula (RU)	Crossing (marine: 2,5 km + onshore : 3,8 km)
2	Aspskär Islands (FI)	23.8 km (Line A)
3	Söderskär and Långören archipelago (FI)	12.5 km (Line A)
1506	Bird wetlands of Hanko and Tammisaari (FI)	17.8 km (Line A)
21	Gotland East Coast (SE)	30 km
165	Ertholmene (DK)	13 km

The Ramsar designation is primarily to protect breeding and migrating populations of waterbirds, the wetland coastal landscape of the southern Gulf of Finland, and wetland diversity.

Further information on the biological features of the designated areas within proximity to the landfall site is provided in Section 9.7.

Atlas Maps BI-01-Espoo, PA-01-Espoo, PA-02-Espoo, PA-04-Espoo and PA-05-Espoo show the boundaries of these protected sites in relation to the NSP2 landfall. The proposed route is within the Ramsar and a State Nature reserve border (Section 9.6.7.4), but not within the IBA (Section 9.6.5.1).

### 9.6.7.2 HELCOM Marine Protected Areas

HELCOM works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental cooperation /175/. HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea. In 1994, 62 Baltic Sea Protected Areas (BSPAs) were designated under HELCOM, and today there are 174 sites in the network, which has been renamed the HELCOM Marine Protected Area (MPA) network. The purpose of the designation is "to protect representative ecosystems of the Baltic as well as to guarantee sustainable use of natural resources as an important contribution to ensure ample provident protection of environment and of biodiversity." This is done by designating sites with particular nature values as protected areas, and by managing human activities within those areas /175/. Each site has its unique management plan. Several of the HELCOM MPAs are also subject to other designations (Ramsar sites, Natura 2000 sites, etc.).

The HELCOM MPAs within 30 km of the NSP2 pipeline are shown in Figure 9-31 and in Atlas Map PA-05-Espoo. The HELCOM MPAs are also listed in Table 9-19 /175/.

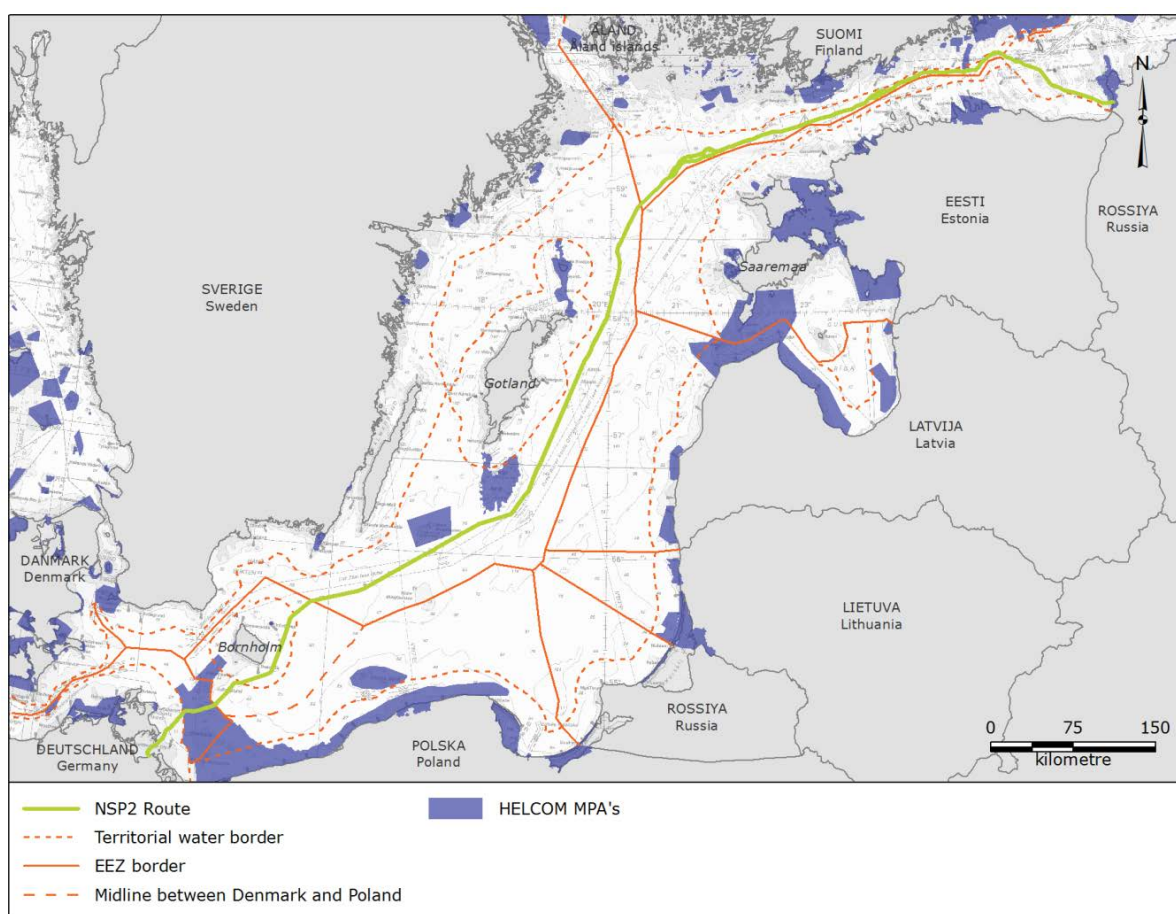


Figure 9-31 HELCOM MPAs within the Baltic Sea /175/.

Table 9-19 HELCOM MPAs in the vicinity of NSP2.

Site number	HELCOM MPA	Distance to planned NSP2
166	Kurgalsky Peninsula (RU)	Crossing (marine 2,5 km + onshore 3,8 km)
145	Eastern Gulf of Finland archipelago and water areas (FI)	23.5 km (Line A)
393	Länsiletto area (FI)	29.8 km (Line A)
394	Luodematalat (FI)	19.7 km (Line A)
161	Pernaja Bay and Pernaja archipelago (FI)	13.1 km (Line A)
372	Sea area south of Sandkallan (FI)	1.9 km (Line A)

159	Söderskär and Långören archipelago (FI)	12.5 km (Line A)
158	Kirkkonummi archipelago (FI)	13.0 km (Line A)
392	Hangon itäinen selkä (Open Sea Area Southeast from Hanko). (FI)	13.7 km (Line A)
144	Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti (FI)	17.8 km (Line A)
109	Kopparstenarna - Gotska Sandön - Salvorev (SE)	25 km
115	Hoburgs Bank (SE)	5 km
116	Northern Midsjö Bank (SE)	4 km
184	Ertholmene (DK)	13 km
245	Bakkebrædt og Bakkegrund (DK)	17 km
275	Adler Grund og Rønne Banke (DK)	16 km
172	Pommersche Bucht – Rønne Bank (GE)	Crossing (crossing distance 34.1 km)
239	Jasmund National Park (GE)	19 km
75	Lahemaa (ES)	20.8 km
72	Pakri (ES)	28 km

Further information on the areas of the Kurgalsky Reserve that are crossed by NSP2 is provided in Section 9.7.

#### 9.6.7.3 UNESCO Biosphere Reserve and UNESCO World Heritage Sites

UNESCO Biosphere Reserves are areas comprising terrestrial and coastal ecosystems that are recognised within the framework of UNESCO's Man and the Biosphere (MAB) Programme. They are internationally recognised, nominated by national governments and under sovereign jurisdiction of the states in which they are located. Each Biosphere Reserve is intended to fulfil three basic functions: a conservation function, a development function and a logistic function.

There are several Biosphere Reserve sites in the Baltic Sea, three of which are located within 30 km of NSP2, see Figure 9-32, Table 9-20 and Atlas Map PA-05-Espoo /176/.

Sites on the UNESCO World Heritage List are cultural, natural or mixed properties recognised by the World Heritage Committee as being of outstanding universal value. There are no marine UNESCO World Heritage sites within 30 km of NSP2, see Figure 9-32 and Atlas Map PA-05-Espoo /177/.

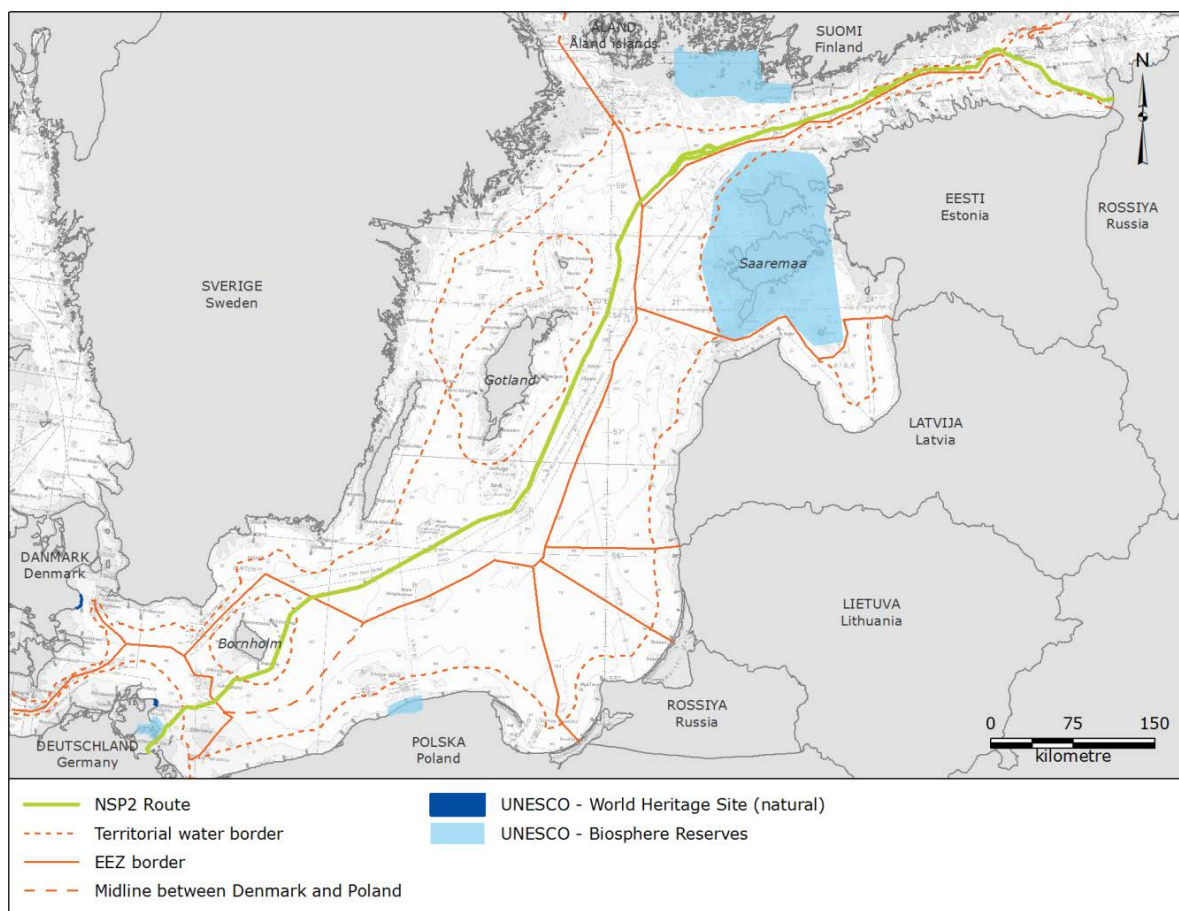


Figure 9-32 UNESCO Biosphere Reserves and World Heritage Sites in the Baltic Sea /176/, /177/. See Atlas Map PA-05-Espoo.

Table 9-20 UNESCO Biosphere Reserves Sites in the Baltic Sea /176/.

UNESCO site - Biosphere Reserve	Distance to planned NSP2
Finnish Archipelago Sea Area (FI)	19.9 km (Line A)
South-East Rügen (GE)	0.25 km
West Estonian Archipelago (ES)	12.5 km

#### 9.6.7.4 National protected areas

The national protected areas have been described in detail in the national EIAs and are listed in Table 9-21. A brief summary of those crossed by NSP2 is also provided below

Table 9-21 National protected or designated areas.

Site number	National site	Description	Distance to planned NSP2
-	Kurgalsky Peninsula (RU)	Nature reserve/sanctuary	Crossing (marine 2,5 km + onshore 3,8 km)
KPU050007	Eastern Gulf of Finland National Park (FI)	National park	23.5 km (Line A)
KPU010001	Tammissaari Archipelago (FI)	National park	18.2 km (Line A)
KPU020002	Archipelago Sea National Park (FI)	National park	26.5 km (Line A)
-	Gotlandskusten (SE)	Nature reserve	30 km
-	Gotska Sandön (SE)	Protection site and seal sanctuary	25 km
	Stärnö-Boön	Nature reserve	By Karlshamn harbour

Site number	National site	Description	Distance to planned NSP2
-	Pommersche Bucht (GE)	Nature reserve	Crossing (crossing distance 31.1 km)
-	Greifswalder Bodden (GE)	Wetlands (Feuchtgebiet Nationaler Bedeutung)	Crossing (crossing distance 24.6 km)
-	South-East Rügen (GE)	Landscape conservation area	0.3 km
-	South-East Rügen (GE)	Biosphere Reserve	0.3 km
-	Peenemünder Haken, Struck and Ruden (GE)	Nature reserve	0.4 km
-	Usedom Island (GE)	Nature park	1.2 km
-	Usedom Island including parts of the continent (GE)	Landscape conservation area	1.3 km
-	Mönchgut (GE)	Nature reserve	1.5 km
-	Greifswalder Oie (GE)	Nature reserve	9.5 km
-	Jasmund (GE)	National park	19 km

### Kurgalsky Peninsula

The Kurgalsky Peninsula exhibits high species diversity of flora and fauna, supporting numerous species of regionally or globally threatened plants, mammals, birds, amphibians and reptiles, as described in Section 9.7.1. The northern tip of the Kurgalsky Peninsula extends 12 km into the Gulf of Finland and continues in the series of rock ridges, islands and shallows that comprise Kurgalsky Reef for a further 16 km north. The Russian proposed nearshore and landfall part of NSP2 (subject to final approval by the Russian Federation authorities) is located in the south-west of the peninsula in an area that is designated as a Ramsar site but also subject to a number of national and regional designations as outlined below:

- Kurgalsky State (Regional) Nature Reserve, established in 2000;
- Kurgalsky Peninsula International Wetland of Importance (Ramsar convention), established in 1994 (Section 9.6.7.1);
- Kurgalsky Peninsula Baltic Sea MPA (HELCOM), established 2009 (Section 9.6.7.2).

An IBA is also present, but it is located north of the proposed project site (Section 9.6.5.1).

The Kurgalsky Nature Reserve covers a total area of 59,950 ha. Most of the area (38,400 ha) includes the water of the Gulf of Finland within the 10 m water depth adjacent to Kurgalsky Peninsula. The Ramsar and IBA designations are primarily to protect breeding and migrating populations of waterbirds, the wetland coastal landscape of the southern Gulf of Finland, and the wetland diversity. Waterbirds are most abundant from April to July. However, the majority of these interest features are located towards the north of the peninsula, where most of the coastal wetland and offshore rocky reefs are found. The proposed project site is therefore located away from the most important features for which these sites are designated. The Regional Nature Reserve and MPA designation are designed to protect the massifs of natural forests; threatened species of animals, plants and fungi; the shallow water areas that are important spawning grounds for commercial fish species (such as the nearshore areas of Narva Bay); and the grey and ringed seal haul-out sites.

Further information on the biological features of the designated areas within proximity to the proposed Russian landfall site is provided in Sections 9.6.4, 9.6.5 and 9.7.1.

### Pommersche Bucht Nature Reserve

The approximately 2,000 km<sup>2</sup> bird protection area “Pomeranian Bay” in the Baltic Sea is an irreplaceable retreat and resting area for seabirds. The sandbanks and reefs occurring here below the water surface with their benthos communities serve as an important feeding habitat for seabirds. In the vicinity of their feeding grounds, seabirds rest and moult in high concentrations. Up to half a million marine ducks as well as hundreds of rare divers and grebes spend the winter here. The most important characteristics of this area are the abundance of food throughout the year and the absence of ice in winter.

### Greifswalder Bodden Landscape Conservation Areas

The objectives of conservation for the conservation area “Greifswalder Bodden” relate to the conservation and improvement of conditions that enable the bird species occurring in significant concentrations to use this area of good conditions for breeding, resting, moulting, hibernation and feeding activities. Bird species taken into consideration are species assigned to article 4 section 1 (connected to the EU directive 79/409/EWG), such as dunlin, Sandwich tern, wood sandpiper, kingfisher, common tern, Eurasian golden plover, ruff, Arctic tern, red-necked phalarope, Slavonian grebe, bar-tailed godwit, black-throated diver, Caspian tern, avocet, Mediterranean gull, sea eagle, whooper swan, red-throated diver, black tern, barnacle goose, smew, little gull, tundra swan and little tern. Furthermore, regularly occurring species according to article 4 section 1 not listed to appendix I, are oystercatcher, greater scaup, greater white-fronted goose, coot, curlew, shelduck, long-tailed duck, goosander, greylag, great crested grebe, mute swan, plover, cormorant, teal, black-headed gull, northern shoveler, red-breasted merganser, wigeon, tufted duck, redshank, bean goose, velvet scooter, common ringed plover, golden eye, gadwall, northern pintail, mallard duck, common scoter and sand martin.

In addition to the sites listed in the table and described above, a number of sites are under consideration for protection/designation.

The proposed Ingermanlandsky Strict Nature Reserve (RU) is located on uninhabited islands (including the shallow waters around them up to 10 m water depth) within the Russian part of the Gulf of Finland. It comprises nine sites: Dolgiy Kamen, Kopytin, Bolshoy Fiskar, Rock Hally, Virginy, Maly Tyuters, Bolshoy Tyuters, Rock Vigrund and Seskar. The four southernmost islands are part of a reef structure stretching from Estonia to Gogland Island and located in relative proximity to the NSP2 (Table 9-22 and Atlas Map PA-02-Espoo). At present, the proposal for the establishment of the Ingermanlandsky nature reserve has received most of the necessary approvals from the federal authorities.

**Table 9-22 Four islands of Ingermanlandsky Strict Nature Reserve that are relevant to NSP2.**

Site	Site name	Area (ha)	Distance to planned NSP2
5	Virginy	248	4 km
6	Malyi Tyuters	2587	3 km
7	Bolshoi Tyuters	184	11 km
8	Rock Vigrund	3799	12.5 km

Klints Bank in Sweden is under consideration as a possible protected area. NSP2 would run approximately 1.6 km from Klints Bank.

Currently, a proposal to place all Natura 2000 areas in the German EEZ (Baltic Sea and North Sea) under national protection has been submitted to the authorities /179/. Within the area of NSP2, this would apply to the nature reserve ‘Pomeranian Bay – Rønnebank’, which includes the nature reserve Pomeranian Bay, and the Natura 2000 sites Western Rønnebank, Adlergrund, Pomeranian Bay with Oderbank and Pomeranian Bay (SPA). Management plans for such sites are not yet available.

The location of the national protected areas within German waters is displayed in Figure 9-33. As indicated in Figure 9-33 and Figure 9-26, the entire Greifswalder Bodden is an IBA. The importance of this area with respect to birds is described in Section 9.6.5.2.

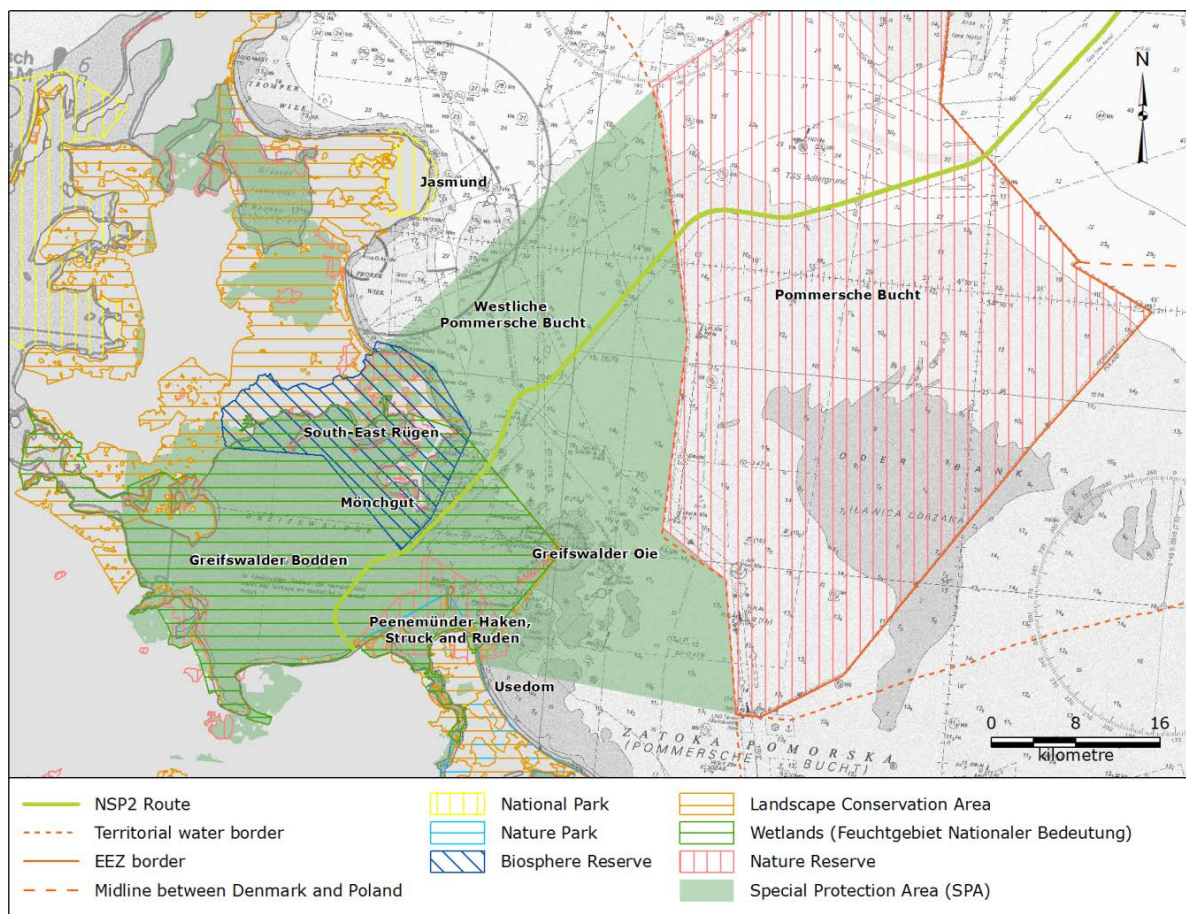


Figure 9-33 National protected areas within German waters. For details on SPAs, see Section 9.6.6.

#### 9.6.7.5 Particularly sensitive sea areas

In 2004, the Baltic Sea as a whole was classified as a PSSA by the IMO. The basis for such a designation is due to its unique ecosystem (see general description in Chapter 9 – Environmental baseline), which exists in an area subject to some of the densest shipping traffic in the world. This classification has resulted in the establishment of shipping routes and avoidance areas. In addition, anti-pollution rules are strictly enforced.

#### 9.6.7.6 Importance of other protected and designated areas

Because protected areas are sites designated under international and national legislation, and because they host numerous important features as habitats and species, the importance of the sites is considered high.

#### 9.6.8 Marine biodiversity

The term biodiversity is a shortening of the words 'biological diversity' and is defined by the Convention on Biological Diversity (CBD) as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" /180/. In a management context, biodiversity is normally referred to as the 'health' of the ecosystem, focusing on the status of the habitats and the species richness within a community, rather than the absolute diversity /181/.

This section provides an overview of the biodiversity of the Baltic Sea, and is presented by discussing its constituent components at the following levels (in accordance with Descriptor 1 of the Marine Strategy Framework Directive (see Chapter 11 – Marine strategic planning):

- Species;
- Habitats and communities;
- Ecosystems.

Such categorisation provides a basis for ensuring the protection of biodiversity and determining the appropriate management measures to control human activities in the marine environment. This section relies upon the information documented in Section 9.6.1-9.6.7 to provide such categorisations.

#### 9.6.8.1 Overview

HELCOM experts assessed the biodiversity of 22 areas in the Baltic Sea in 2009 based on the environmental conditions at three levels: landscape, species and communities. Indicator species used in the assessments include macrophytes, benthic animals and fish, and, in a limited number of cases, birds, phytoplankton and zooplankton.

Areas were categorised as either achieving GES, reflecting an evaluation of 'good' or 'high' condition; or 'impaired status', reflecting an evaluation of 'moderate', 'poor' or 'bad' condition. The overall assessment of an area reflects the worst-performing category /181/.

Along the proposed NSP2 route, the biodiversity has been classified as follows (see Figure 9-34):

- Gulf of Finland (central): bad to moderate;
- Northern Baltic Proper, Eastern Gotland Basin and Bornholm Basin (middle and eastern): bad;
- Bornholm Basin (western) and Arkona Basin (eastern): poor to moderate;
- Arkona Basin (southern): bad to poor.

The classifications reflect a combination of the general eutrophication and chemical status of the Baltic Sea, as well as the biodiversity, which is very low in deep basins due to anoxic or hypoxic conditions.



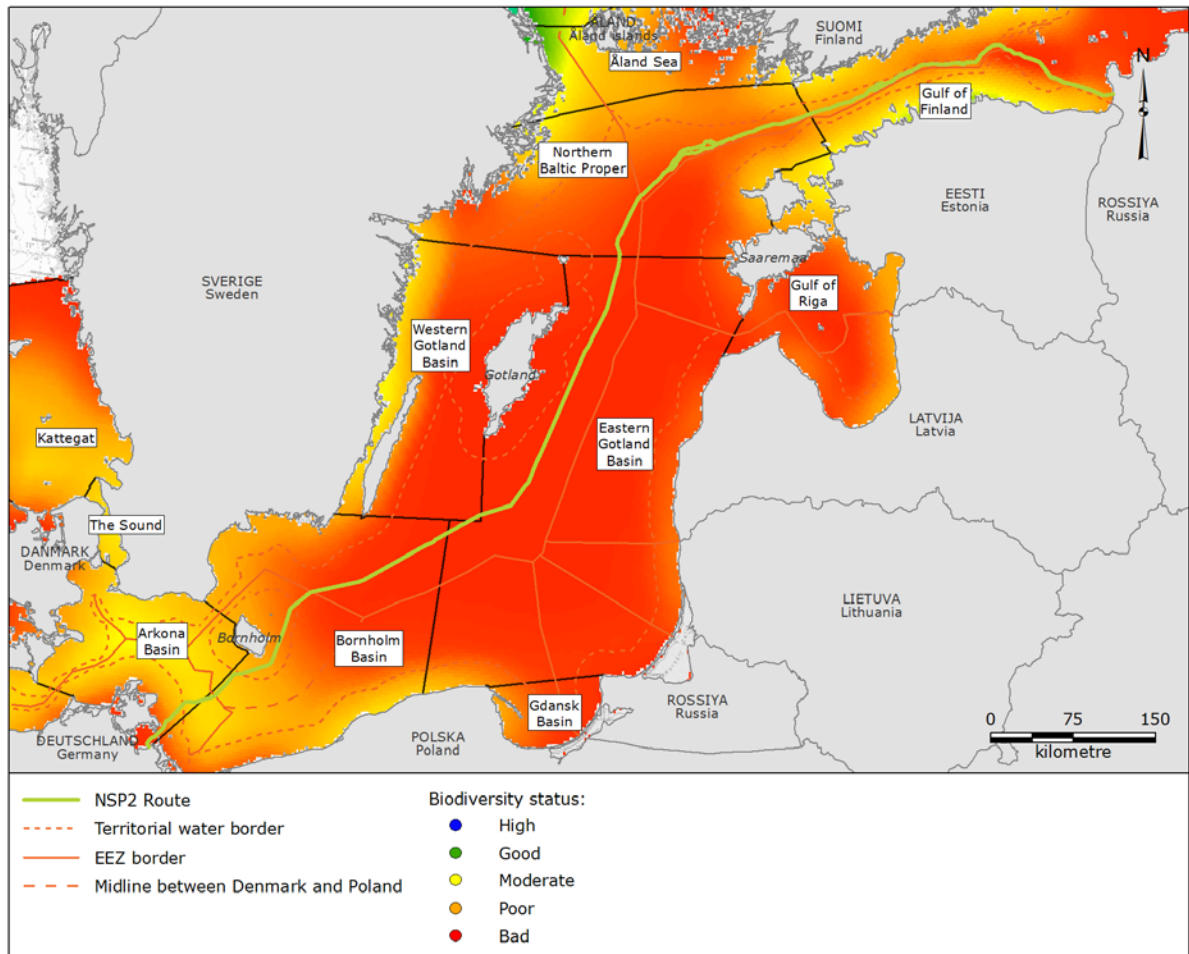


Figure 9-34 Biodiversity status within the Baltic Sea

### 9.6.8.2 Marine ecosystems

Ecosystems can be defined as a mosaic of communities (comprising the habitats and species described below) that interact to form one system. They can function at the local level as well and also form part of a wider ecosystem at the landscape level.

Within an ecosystem, species and habitats interact to deliver fundamental processes. Trophic interactions within the food web influence productivity and stability and thereby also the overall functioning of the ecosystem. The individual species and habitats that form the communities in the Baltic Sea are described in Section 9.6, whilst their interactions are summarised below.

Despite its low diversity, the Baltic Sea ecosystem is considered to have an intrinsic biological value and provides a variety of goods and ecosystem services<sup>14</sup>. Nutrient recycling, climate regulation and production of fish and other food items as well as recreational opportunities are among the ecosystem services provided /182/. As such, protection and improvement of biodiversity in the Baltic Sea is a main focus for the Baltic countries.

An ecosystem with a high natural biodiversity has a higher stability and better regulates and adapts to changing conditions, such as climate change, and thus ensures better resilience against pollution events /96/. The low biodiversity in the Baltic Sea therefore means the function of each species present within the community, and the interactions between them, are particularly important in this context.

<sup>14</sup> Ecosystem services are the benefits people obtain from ecosystems.

### 9.6.8.3 Marine habitats

The landscape and abiotic conditions provide the basis for the biotic conditions of the Baltic Sea. Together these determine the habitats that are present and subsequently the species that inhabit them. A summary of the abiotic conditions is provided in Section 9.2, whilst detailed descriptions of pelagic and benthic habitats can be found in Sections 9.6.1 and 9.6.2 respectively.

#### Abiotic features

A number of background parameters define the abiotic conditions of the Baltic Sea, in particular salinity and temperature, which are influenced by saline and freshwater inflows and can result in the creation of permanent or temporary thermoclines and haloclines. This can prevent vertical mixing of the water column and consequent ventilation of the deeper areas such that hypoxic or anoxic areas can occur. Anoxic conditions in basins can be permanent and prevent the existence of benthic fauna. Salinity of the surface waters also varies geographically, in general decreasing from 30-35 psu in the North Sea to almost 0 psu in the innermost Gulf of Finland.

The abiotic parameters are described in detail in Section 9.2, whilst their influences on biotic features are described below.

#### Biotic features

The highest variation in habitats within the Baltic Sea is observed along the coasts, due to the complex rock structures, sheltered bays and archipelagos. These features provide the most variation in habitat type and therefore support a naturally higher diversity (species richness). In the open waters, a natural lower diversity is found. This is mainly due to the limiting conditions defined by the abiotic parameters, primarily hypoxia/anoxia (see above).

Anoxic conditions are frequent and in some instances (the basins) permanent. Along sections of the NSP2 route, such areas create barriers for distribution (see Section 6.9.4), allowing only hypoxia-tolerant, often short-lived opportunistic species to inhabit the areas. Detritus feeding polychaetes and bivalves form the basis of the biotic features of the habitats of the deeper parts of the sea.

#### Habitat types

In general, the pelagic habitats are defined by the presence or absence of sunlight providing the basis for photosynthesis and hence the primary production. However, other abiotic conditions in the Baltic Sea, primarily salinity, also define the phytoplankton community structure and diversity.

- **Pelagic habitat type 1:** Euphotic zone. The upper level of the water column where the penetration of sunlight allows primary production to take place. The primary production forms the basis for the food web providing food for the higher trophic levels (i.e. zooplankton and zoobenthos (second trophic level), Section 9.6).
- **Pelagic habitat type 2:** Aphotic zone. Section of the water column where the penetration of sunlight is not sufficient to allow primary production to take place. Therefore the basis of the food web is the plankton sinking through the water column (detritus) to finally settle on the seabed and become food for benthic detritus feeders.

Based on the physiochemical properties of the sediment and the water column described in Sections 9.2.1 and 9.2.2, the following benthic habitats can be identified along the proposed NSP2 route:

- **Benthic habitat type 1** (e.g. Gulf of Finland): Coastal zone. Water depth 0-20 m. Hard clay substrate that may be colonised by macroalgae. No limitation of oxygen due to mixing.

- **Benthic habitat type 2** (e.g. Arkona Basin): Coastal zone. Water depth 0-20 m. Sandy substrate with no macroalgae. Presence of flowering plants (e.g. eelgrass). No limitation of oxygen due to mixing.
- **Benthic habitat type 3** (e.g. western part of the Gulf of Finland, the Baltic Proper and the eastern Gotland Basin): Deep basins. Water depth >60 m. Muddy bottom habitat with fine sediment mainly consisting of silt and clay with macrozoobenthos absent or comprised of few opportunistic or hypoxia-tolerant species. Regular or permanent hypoxia/anoxia.
- **Benthic habitat type 4** (e.g. between Bornholm and eastern Gotland Basin, and western Bornholm Basin): Slopes of basins. Water depth 40-60 m. Sandy bottom habitat with relatively diverse benthic community (dominated by *Macoma balthica* and bivalve species). Irregular pycnoclines, resulting in variable conditions of salinity and oxygen.
- **Benthic habitat type 5** (e.g. Bornholm Basin and Arkona Basin): Shallow waters. Water depth 20-40 m. Sandy habitat in direct contact with the mixed surface layer, but below the photic zone. No limitation of oxygen and fairly constant salinity due to regular mixing.

In addition to the general habitat types described above, there are also local variations that influence the overall physiochemical conditions for benthic fauna (see Atlas Map GE-02-Espoo).

#### 9.6.8.4 Species

Due to the geological young age (approximately 8,000 years) of the Baltic Sea, the marine environment is characterised by a small number of functional groups, and low diversity within them. Only a few endemic species have evolved and adapted to the brackish conditions, resulting in the main species composition consisting of true marine or freshwater species living at or near their physiological limits /181/.

On a general level, the ecological receptors of the Baltic Sea can be divided into the following receptor groups:

- Plankton;
- Benthic flora and fauna;
- Fish;
- Marine mammals;
- Birds.

These receptors have been considered in detail in Sections 9.6.1-9.6.5 and therefore are not covered in this section. However, the broad relationship between species and their surrounding habitat as well as their interaction within assemblages are described in the following sections. Genetic variation is not specifically addressed, as most studies focus on a few animal groups of commercial importance and therefore are not representative of the full spectrum of species that are of relevance to NSP2.

Certain benthic species are of particular importance within the Baltic Sea because their community forms a structure that is the habitat for many other species and communities during part or the entire span of their lives. These key 'habitat builders' species include eelgrass (*Zostera marina*), bladder wrack (*Fucus vesiculosus*) and the mussels *M. baltica* and *Mytilus spp.* (see Atlas Map BE-02-Espoo). These species are scarce along the majority of the proposed NSP2 route due to water depth and resulting oxygen and light conditions. However, they are found in coastal zones and benthic habitat types 4 and 5, e.g. *M. baltica*, *M. edulis* (the blue mussel) and various polychaetes (including bristleworms and the invasive species *Marenzelleria viridis*) are abundant.

#### 9.6.8.5 Trophic interactions

The food web in the Baltic Sea is currently influenced by a general reduction in top predator populations (e.g. seabirds, cod and marine mammals) and hence reduced pressure down the

trophic levels from the top predators, such as marine mammals and birds, to the primary producers, such as phytoplankton. Furthermore, the food web is influenced by a general increase in nutrient loading which favours the lower trophic levels, as it encourages primary production. Therefore, the Baltic Sea food web can be categorised as bottom controlled (bottom-up control).

As noted above, due to the hypoxic or anoxic conditions found in the deep basins (i.e. the Gulf of Finland, Baltic Proper, eastern Gotland Basin and parts of the Bornholm Basin), no or a limited number of zoobenthos and demersal fish (intermediate trophic levels) are present along the majority of the proposed NSP2 route. Instead, organic matter from the planktonic primary production accumulates in these basins and decomposition relies upon anaerobic microorganisms, which represent a dead end in the food web. Impacts which occur in the deep basins will therefore not have consequences for higher organisms (fish and marine mammals).

Where the proposed NSP2 route is at shallower water depths, such as on the slope of basins and in coastal zones (i.e. western slope of the Bornholm Basin and close to landfall areas), sufficient oxygen will be available, allowing colonisation by zoobenthos and habitat builders. This will also favour bottom-dwelling fish of small- and medium-size species (i.e. gobies, juvenile cod and flatfish), which subsequently provide food for higher trophic levels (i.e. marine mammals and birds). Hence the trophic interactions in the shallower sections of the proposed NSP2 route comprise all levels of the food web and both benthic and pelagic species.

#### 9.6.8.6 Existing pressures

The predominant pressures on the biodiversity of the Baltic Sea ecosystem comprise:

- Eutrophication;
- Introduction of NIS;
- Other anthropogenic disturbance of important areas.

Eutrophication, as described in detail in Section 9.2.2.5, is the enrichment of nutrients (often as a result of run-off from agricultural land and/or pollution), which can lead to an imbalanced food web due to an increase in primary production (first trophic level of the food web).

The introduction of invasive NIS, often by shipping or aquaculture practices, has the potential to cause a local decline or extinction of local species, alteration of native communities and habitats and/or a change in food web functioning. Invasive species may also hamper the economic use of the sea, i.e. results in financial losses in fishery and expenses for cleaning intake or outflow pipes of industries and structures from fouling. A total of 99 NIS species have been observed in the Baltic Sea /181/, although no new NIS were reported during the NSP2 baseline surveys /190/.

In addition to eutrophication and NIS, other anthropogenic activities taking place in the catchment area, coastal zone and open sea (such as fisheries, maritime traffic, physical damage and disturbance, recreational activities, hunting, noise pollution and climate change) exert pressures on ecosystem interactions and biodiversity, particularly where impacts affect important feeding, resting, spawning or breeding areas for members of different species (receptors).

#### 9.6.8.7 Importance

The biodiversity of the Baltic Sea can be considered to have an inherent value due to the species and habitats it supports (some of which are designated under the EU Habitats Directive) and the ecosystem services it provides (i.e. source for food, nutrient cycling, water and climate regulation as well as production of fish and other food items, etc.). The importance is greatest in shallower sections (e.g. coastal zones and slopes of basins), where higher levels of primary production provide the basis for the rest of the food web. Moreover, areas that form habitats for protected species and protected areas themselves are of higher importance than deep water areas. However, given that much of the NSP2 route is located in deep basins where anoxic conditions

have led to the development of ‘biological deserts’, the biodiversity along the proposed NSP2 route overall can be categorised as being of low importance.

## 9.7 Onshore landfall Narva Bay

### 9.7.1 Overview of habitats and ecosystems

The preferred landfall area in Russia exhibits a high species diversity of flora and fauna and supports regionally or globally threatened plants, mammals, birds, amphibians and reptiles that are protected through a number of national and international designations. Activities within such protected areas or activities that could affect protected areas are thus subject to the relevant legal conditions that apply to such designations.

The majority of the features for which these sites have been designated are located towards the north of the Kurgalsky Peninsula and therefore some distance from the landfall site. The site nonetheless contains several features that play an important role in ensuring the integrity of this area of high conservation value. An overview of the habitats that are present within the area potentially affected by the activities in the landfall and their key ecological functions within this landscape mosaic is summarised in Table 9-23 and shown in Figure 9-35.

**Table 9-23 Identified habitat types and key biological features of the landfall at Narva Bay.**

Location	Habitat type	Biological feature of interest
Marine areas	Brackish water, low level of silt in shallow areas with silty sands and silt in deeper waters	Low benthic diversity and mass (including fish eggs and larvae) close to shore increases in depths between 8-20 m. Important bird habitats, some fish spawning.
	Beach and coastal dune	Part of notified interest of the Kurgalsky Reserve. Supports, among others, three plant species in the Red Book of the Leningrad region and the Red Book of Eastern Fennoscandia, including dark-red helleborine ( <i>Epipactis atrorubens</i> ), which is listed as endangered in the Red Book of Eastern Fennoscandia. Provides habitat for nesting ringed plover ( <i>Charadrius hiaticula</i> ), which is endangered in the Baltic Region Red Data Book; common redshank ( <i>Tringa totanus</i> ), which listed as near threatened in the HELCOM Red List and rare in the Red Book of the Baltic region; and slow worm ( <i>Anguis fragilis</i> ), which is recorded as rare in the Red Data Book of Eastern Fennoscandia.
3+4	Forest	Unmodified and natural forest of high environmental value. Supports a number of breeding birds on regional Red Lists, including the rare white-tailed eagle. No IUCN critically endangered or endangered species were observed.  As shown on Figure 9-19, the area supports great number of flora species in the Red Book of the Russian Federation, including <i>Lobaria pulmonaria</i> (category 2 ‘declining’); 11 species of fungi, one of which, <i>Tyromyces fissilis</i> , is listed in the Red Book of the Leningrad region as rare. Provides habitat for bear, wolf, fox, various amphibians, European roe deer ( <i>Capreolus capreolus</i> ) and Russian flying squirrel ( <i>Pteromys volans</i> ); the latter two are listed as vulnerable in the Red Book of the Leningrad region.
5	Secondary forest	Well established and in good ecological condition, but it has a reduced understory and stands of trees of a similar age, which is thought to be due to historic felling. It has a lower probability of supporting the density and diversity of species present in three forest habitats. The small pasque flower ( <i>Pulsatilla pratensis</i> ) is identified as vulnerable in the Red Book of

		the Leningrad region. Four Red Book species of birds were observed during their nesting period.
6+7	Relict dune	Scarce habitat in the Leningrad region that supports diverse habitats, including Leningrad Red Data Book species. Likely to support Red List species of reptiles and invertebrates. Supports grass snake, which is listed as near threatened in the Red Data Book of Leningrad. European pine vole ( <i>Microtus subterraneus</i> ), which is registered as vulnerable in the Red Book of the Leningrad region, was observed in the area of pine forest recovering from the fire.
8+9	Northern edge of Kader swamp	Kader swamp supports a diverse range of plants, including many plants listed on national or regional Red Lists. Of these, the oblong-leaved sundew ( <i>Drosera intermedia</i> ) is listed as vulnerable in the Red Book of the Leningrad region. Supports breeding bird species including willow grouse ( <i>Lagopus lagopus</i> ), which is listed by IUCN as vulnerable and by the Red Book of the Leningrad region as endangered, and horned grebe ( <i>Podiceps auritus</i> ), which is listed by HELCOM as vulnerable. The most valuable habitats are located in the central part of Kader swamp, south of the proposed NSP2 route.
10+11	Modified habitat affected by fire – recovering birch and pine undergrowth, waterlogged in places	The area is recovering from fires and does not provide a habitat for rare and Red List plant species. A great snipe ( <i>Gallinago media</i> ) nest was observed at the waterlogged meadow surrounded by birch undergrowth. Great snipe is rare for the region and identified in the Red Book of the Leningrad region as vulnerable. Hen harrier ( <i>Circus cyaneus</i> ), which is listed as vulnerable in the Red Book of the Baltic region, was observed above open biotopes (10-13). However, its nesting ground is most likely to be the meadows where the Mertviza and Rosson rivers merge.
12+13	Agricultural land, meadows, meliorative channels	Meadows provide foraging areas for nesting birds that are listed as regionally rare in the Red Book of the Baltic region, including white stork ( <i>Ciconia ciconia</i> ), and regular for the area corn crane ( <i>Crex crex</i> ). Northern lapwing ( <i>Vanellus vanellus</i> ) (IUCN vulnerable) was observed in similar habitat north of the NSP2 proposed working area. This habitat provides feeding and stopover grounds for many migratory birds, including Eurasian curlew ( <i>Numenius arquata</i> ), which is IUCN vulnerable. Otter ( <i>Lutra lutra</i> ), listed as vulnerable in the Red Book of the Leningrad region, was observed at the bank of Mertviza River south of the PTA location. Little tern ( <i>Sterna albifrons</i> ) was observed near Mertviza River; however it nests most likely at the Kurgalsky reef in the northern part of Kurgalsky Peninsula.

In terms of ecosystems, large fauna such as bear, elk, wild boar and wolves play a significant role in maintaining landscapes through the balance between grazing and predator pressure. Terrestrial keystone species for ecosystem functioning are sphagnum mosses, which sequester carbon and are important in the formation and maintenance of bog ecosystems. Within the woodlands, particularly natural woodlands, decomposers such as fungi, bacteria and invertebrates play a major role in carbon cycling and woodland ecosystems, providing an important base for the trophic system.

## 9.7.2 Terrestrial flora and fauna

### 9.7.2.1 Flora

The onshore section of the pipeline crosses ten main plant community types that were identified during a survey in 2016 (Figure 9-35) as being associated with the habitats types identified above.



Figure 9-35 Main plant communities onshore in the Russian landfall area.

Native plant communities (numbers 1, 2, 3, 4, 5 on Figure 9-35) have the greatest environmental value. These are mainly seaside halophilic meadows, natural or near natural pine and pine-spruce forests with some small-leaved species, which stretch in a wide strip along the shore of Narva Bay. These communities are species rich and include species listed on national or regional Red Lists. The 2016 surveys indicated 24 flowering plants, 11 fungi, 14 bryophytes and 2 lichen species that are included in these Red Lists, although none are critically endangered or endangered on the international IUCN Red List. One flowering plant, dark-red Helleborine (*Epipactis atrorubens*), and three bryophytes (*Pohlia prolifera*, *Leskea polycarpa* and *Schistostega pennata*) are listed as category 1 (endangered) in the Red Book of Eastern Fennoscandia. The survey results are shown in Figure 9-36, indicating a cluster of protected

species either located at the central part of the Kader swamp (outside the NSP2 project area) or within the coastal dune and forest habitats. For a full list of protected species, see Appendix 2.

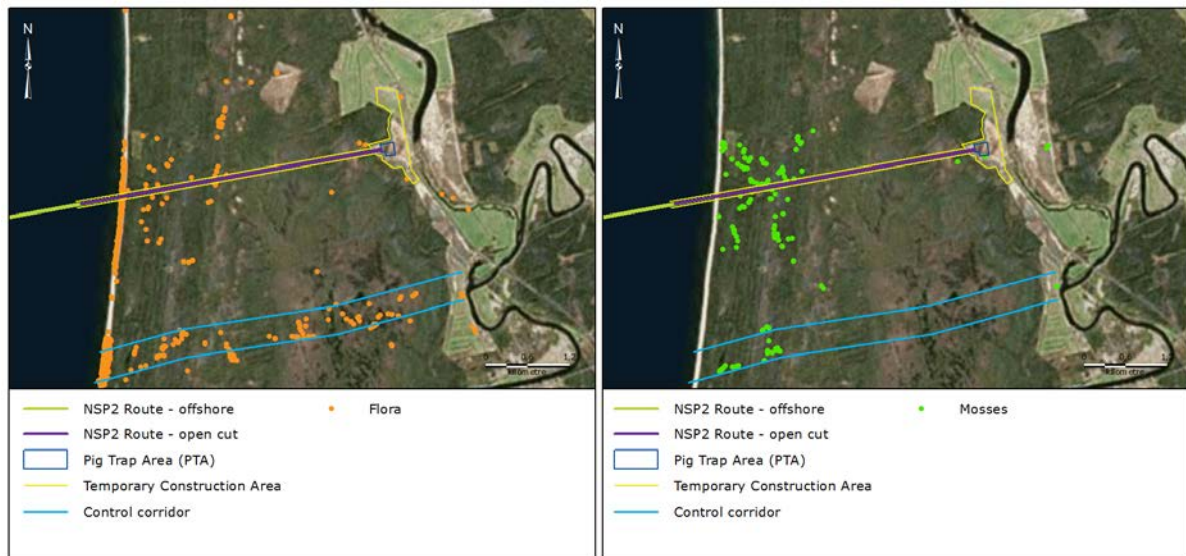


Figure 9-36 Location of species of flora (left) and mosses (right) of conservation importance.

### 9.7.2.2 Fauna

#### Amphibians and reptiles

Of the six species of amphibians and four species of reptiles occurring in the Kurgalsky Reserve, four of the amphibians and all four reptile species were recorded in the vicinity of the landfall facilities, notably the forest habitat, although the relic dunes are also considered to have potential to support such species. Of these, grass snake (*Natrix natrix*) is near threatened in the Red Data Book of the Leningrad Region, with slow worm (*Anguis fragilis*) recorded as rare in the Red Data Book of Eastern Fennoscandinavia. Neither species were recorded within the construction or operational footprint, although slow worm was noted in its vicinity. More information on the other species is provided in the national EIA.

#### Mammals

A number of transects were surveyed in November 2015 and during spring and summer 2016, encompassing the range of habitat types from the PTA towards the shore within a corridor 1 km to either side of the pipeline corridor as well as a control corridor south of pipeline route. Of the 34 species of mammals that were recorded in the Kurgalsky Reserve, 29 were also identified as present in the surveyed areas, based on sightings, field signs or, in the case of the Russian flying squirrel, suitable habitat. The species recorded include charismatic keystone species such as moose, grey wolf and brown bear. They do not include any species listed by IUCN as critically endangered, endangered or vulnerable. However, four species, otter (*Lutra lutra*), european roe deer (*Capreolus capreolus*), European pine vole (*Microtus subterraneus*) and Russian flying squirrel (*Pteromys Volans*), are listed as vulnerable in the Red Data Book of the Leningrad Region. The critically endangered European mink (*Mustela lutreola*) is extinct in the region.

#### Birds

Bird surveys conducted within the vicinity of the landfall site in 2016 recorded 114 species, of which 65 are on regional or national Red Lists. Of these, 42 species were recorded as breeding or potentially breeding. Three species that are listed as endangered on national or regional Red Lists were recorded as breeding (little tern (*Sternula albifrons*)) or potentially breeding (willow ptarmigan (*Lagopus lagopus*) and Eurasian eagle owl (*Bubo bubo*)). One species, Bewick's swan (*Cygnus columbianus*), is IUCN categorised as endangered but was recorded on migration only. Ten other species are noted as either critically endangered or endangered in one or more of the



national or regional Red Lists, with most of the red listed waterfowl being migratory. These were usually associated with the River Mertvitsa, the nearshore area and pine bogs.

The habitats with the highest bird species diversity are associated with the seaward edge of the old growth forest and the complex habitat mosaic between the relict dune crest and the Kader swamp. The nest of a white-tailed eagle (*Haliaeetus albicilla*) (listed as vulnerable in the Red Data Book of Leningrad region and as of least concern in the IUCN Red List) containing one nestling was recorded within the NSP2 footprint. As described above, the most valuable bird habitats are located either within the forest and relic dune system or within the wetland at the central part of the Kader swamp.

Seabirds and waterbirds are addressed in Section 9.6.5.

### **Invertebrates**

Seven species of invertebrate listed in the Red Data Book of the Leningrad Region were recorded within the surveyed area (transects encompassing the range of habitat types identified in the immediate vicinity of the PTA and foreshore, and within a corridor 1 km to either side of the pipeline corridor), with the highest category being two species classified as vulnerable: the southern dune tiger beetle (*Cicindela maritima*) and a robber fly (*Laphria gibbosa*).

An addition, three species were reported as rare but not listed in the Red Data Book of the Leningrad Region.

## **9.7.2.3 Importance of terrestrial flora and fauna and the habitats that support them**

### **Flora**

A total of 51 flora species are listed in regional and national Red Data Books. No species are critically endangered or endangered on the IUCN Red List, but four species are included as endangered in the Red Data Book of Eastern Fennoscandia. The native plant communities have high environmental value, and the constituent flora is considered to be of high importance.

A list of threatened and protected species including their protection status is provided in Appendix 2.

### **Fauna**

Birds provide the most sensitive species in terms of red listing, with one species listed internationally and ten species listed regionally or nationally as critically endangered or endangered. These are mainly migratory species and mainly associated with the nearshore area. Other fauna are of medium importance. The terrestrial fauna are therefore of high importance, primarily based on birds.

A list of threatened and protected species including their protection status is provided in Appendix 2.

### **Habitats and ecosystems**

The proposed landfall is within an area subject to a number of designations, including designation as a Ramsar site and a HELCOM MPA and protection as a Regional Nature Reserve. An IBA is also present to the north of the landfall. The designations and protection status relate to the importance of the site for congregatory waterbirds, the range and quality of habitats present, and the species diversity it supports.

Within the area potentially affected by the landfall, habitats supporting the highest value species are particularly associated with the coastal dune community including natural forest immediately inland, relict dune system and the Kader swamp.

The landfall area therefore qualifies as being of high importance because it is part of an area that is specifically targeted for international conservation internationally and nationally and that supports high value species and significant populations of congregatory species.

### 9.7.3 Natura 2000 sites

As Russia is not a part of the EU, there are no Natura 2000 sites in Russia.

### 9.7.4 Other protected areas

Kurgalsky is a nature reserve and a Ramsar site (Section 9.6.7) that covers both onshore and offshore areas in the vicinity of the proposed landfall. An overview of this reserve is therefore included in the description of such areas provided within the section on protected areas within the marine environment (Section 9.6.7). The key features within the Kurgalsky Reserve that may be affected by NSP2 in terms of its integrity and functioning are outlined in Table 9-23.

## 9.8 Onshore landfall Lubmin 2

### 9.8.1 Terrestrial flora and fauna – German landfall area

The terrestrial flora and fauna in the vicinity of the German landfall, Lubmin 2, were determined through a review of previous studies (biotopes) and a survey programme undertaken in autumn 2015 and spring 2016. Therefore predefined areas of investigation around the PTA were determined. These areas represent the impact areas from a conservative point of view. The results obtained are described in the following sections. Results obtained in the project area are listed separately.

#### 9.8.1.1 Overview of habitats and ecosystems

Eleven major biotope types have been identified in the vicinity of the landfall site within an investigation area of 1,550 m around the PTA: 1) woodlands; 2) copses, avenues, rows of trees; 3) coastal biotopes; 4) running waters; 5) woodless biotopes of riparian areas, eutrophic fens and marshes; 6) dry grasslands, neglected grassland, dwarf shrub heath; 7) grassland and fallow land; 8) shrub margins, ruderal areas and grass; 9) green spaces of settlement areas; 10) settlement and industrial areas and 11) traffic areas (Figure 9-37).

**Table 9-24: Identified biotope types, specifications and key biological features of landfall Lubmin 2.**

Biotope type	Biotope specification and biological feature of interest
Woodland	Woodland is the dominant biotope, comprising young and middle old pine plantations. The middle-aged forests are largely monotone and unnatural developed. The invasive species <i>Prunus serotina</i> is predominant in large sections of the shrub layers in these pine forests. Contrastingly, due to the influence of the coast, the areas facing the Greifswalder Bodden are near-natural. The near-natural forests are part of a forest strip of 150 m width, which is of high touristic importance and protects the Greifswalder Bodden against the B-plan area laying directly behind. Therefore NSP2 will cross this area using a micro-tunnel. A part of the pine forest in the western area is designated as protected biotope (FFH 2180), as it developed on top of coastal dunes. Forests of other tree species can be found on a small-scale at the outer regions of the area of investigation. Pioneer forests of young pine trees are located within the central area of investigation, in the south-east of the PTA. These forests represent an important habitat for bats and breeding birds.
Coastal biotopes	The coastline is highly anthropogenically influenced. In order to protect the coastline, the beach was enlarged and the original dunes were reinforced by building a coastal protection dune of 2 m height that was artificially planted. The beaches and the dunes are subject to intensive touristic use. However, they are colonised by several nationally endangered plant species ( <i>Honckenya peploides</i> , <i>Cakile maritima</i> ).
Copses, avenues, rows of trees	Copses formed by deciduous and coniferous trees as well as shrubs are widely spread within the area of investigation and they are subject to biotope protection according to § 20 NatSchAG M-V. The same holds true for hedges of native species. They are part of the structural diversity of the area and its importance as a habitat for breeding birds and

	reptiles.
Running waters	The only running water within the area of investigation is represented by the former channel located in the north-east of the areas owned by the Energiewerke Nord GmbH. Single trenches are located in the eastern part of the area of interest. No special importance is assigned to the former channel, and the trenches are located outside the impact area of the project.
Woodless biotopes of riparian areas, eutrophic fens and marshes	In areas influenced by water, reeds and meadow fallows inhabited by moisture loving plants developed. These biotopes are protected (according to § 20 NatSchAG M-V) as long as they are not strongly drained. They provide suitable habitats for the partly endangered plant species <i>Iris pseudacorus</i> and <i>Juncus subnodulosus</i> . Furthermore, wetlands are of special importance for breeding birds.
Dry grasslands, neglected grassland, dwarf shrub heath	Dry grasslands, neglected grassland and dwarf shrub heath are small-scale and spread throughout the complete area of investigation. They include plant species that are nationally endangered, such as <i>Helichrysum arenarium</i> . Furthermore, they are protected according to § 20 NatSchAG M-V. They are highly endangered due to the spread of competing grasses and forest.
Grassland and fallow land	Different types of grasslands are located in the outer east of the area of investigation. In addition to the grasslands that are objectives in terms of nature protection (e.g. salt marshes), intensively used grasslands of less importance can be found as well. Neither type will be affected by project impacts.
Shrub margins, ruderal areas and grass	Shrub margins, ruderal areas and grass can be found within the area of investigation at several locations. They are mainly inhabited by ruderal plant species that are widespread. Consequently, they are of no special importance. However, as an additional biotope type they are relevant to the structural diversity of the area and provide important habitat functions for reptiles and breeding birds.
Green spaces of settlement areas + settlement and industrial areas + traffic areas	These three biotope types will be considered together. They represent cultivated and sealed areas. Only the industrial complexes are of certain importance, as they represent important habitats for building inhabiting bat and breeding bird species.

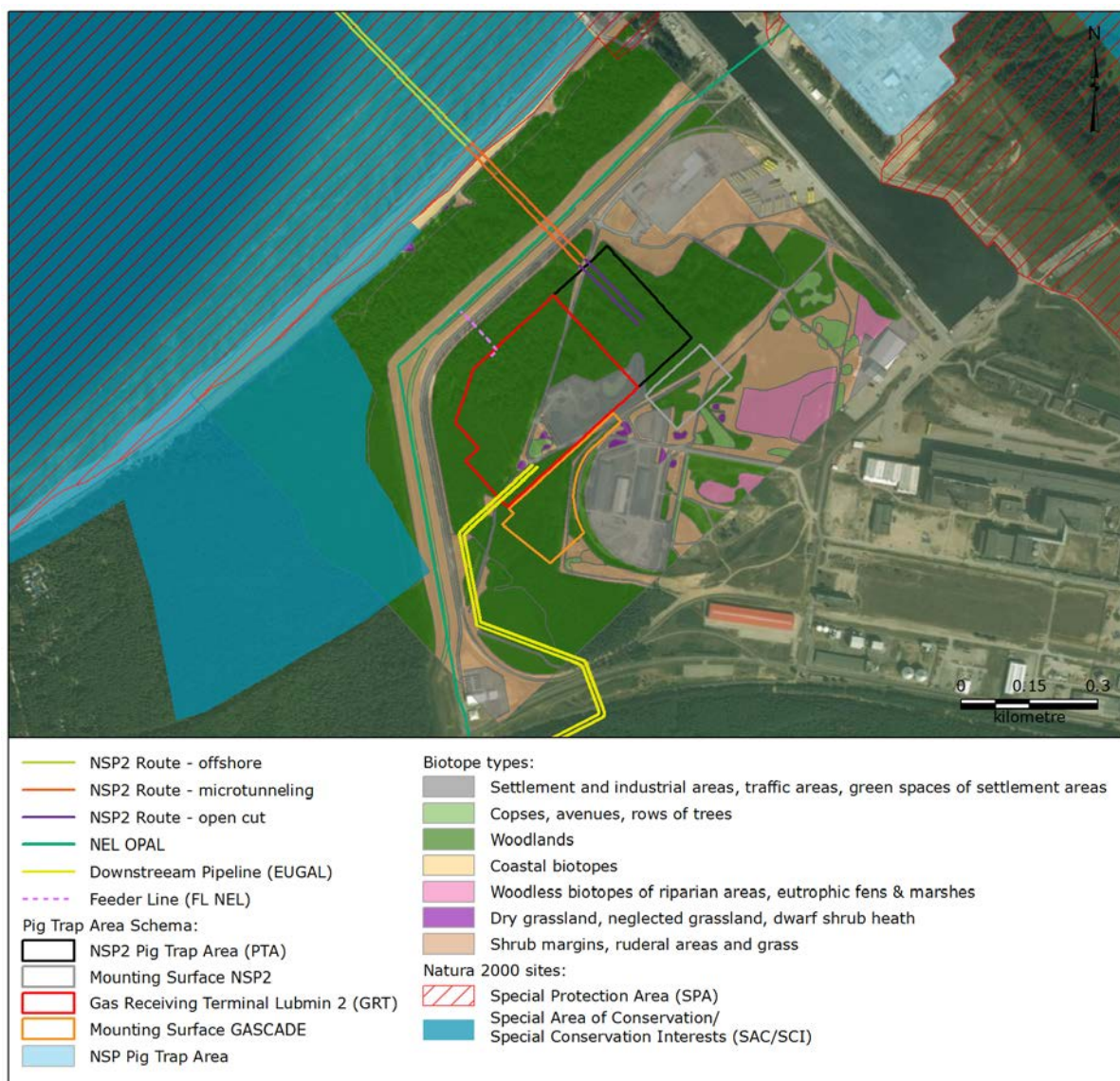


Figure 9-37 Main biotopes mapped onshore at Lubmin 2.

9.8.1.2 Flora

Flora in the area of investigation at the German landfall around the GRS primarily consist of generally widespread and frequently occurring species. Eleven biotope types have been mapped, of which the dry grasslands, the woodless biotopes of riparian areas, eutrophic fens and marshes as well as the coastal biotopes are inhabited by most of the endangered plant species (Table 9-25). Ten regionally protected species are present, comprising 1/183/. However, none of these are assigned to the IUCN Red List (also see Appendix 2). In general, only poorly structured pine forest or ruderal shrub meadows are within the NSP2 footprint, with the other flora identified above generally occurring outside of this area. However, the occurrence of the dwarf ever last (*Helichrysum arenarium*) cannot be excluded, but this species is widespread within the wider area. Table 9-25 lists all protected and endangered plant species and their occurrence within the specific biotopes.

Table 9-25 Identified biotope types, specifications and key biological features of landfall Lubmin 2.

Plant	Biotope class	Regional Red List	National protection
<i>Cakile maritima</i>	Coastal biotopes	VU	
<i>Calluna vulgaris</i>	Woodless biotopes of riparian areas, eutrophic fens and marshes	NT	
<i>Carduus acanthoides</i>	Shrub margins, ruderal areas and grass	NT	
<i>Centaureum erythraea</i>	Woodless biotopes of riparian areas,	VU	x

	eutrophic fens and marshes		
<i>Helichrysum arenarium</i>	Woodless biotopes of riparian areas, eutrophic fens and marshes	NT	x
<i>Honckenya peploides</i>	Coastal biotopes	NT	
<i>Iris pseudacorus</i>	Woodless biotopes of riparian areas, eutrophic fens and marshes		x
<i>Jasione montana</i>	Woodless biotopes of riparian areas, eutrophic fens and marshes	NT	
<i>Juncus conglomeratus</i>	Woodless biotopes of riparian areas, eutrophic fens and marshes	NT	
<i>Juncus subnodulosus</i>	Woodless biotopes of riparian areas, eutrophic fens and marshes	VU	
<p><b>Red List categories</b>  CR: critically endangered; EN: endangered; VU: vulnerable; NT: near threatened; LC: least concern; DD: data deficient; NE: not evaluated; NA: not applicable</p> <p><b>Regional Red ILst:</b> /183/  <b>National protection:</b> Verordnung zum Schutz wild lebender Tier- und Pflanzenarten: Bundesartenschutzverordnung-BArtSchV), Ausfertigungsdatum: 16.02.2005.</p>			

### 9.8.1.3 Fauna

#### Amphibians and reptiles

During the mapping conducted for NSP2, five amphibian and 3 reptile species were identified in the respective area of investigation (landfall Lubmin 2 and a 300 m radius around it): The amphibian species are moor frog (*Rana arvalis*), smooth newt (*Lissotriton vulgaris*), European common frog (*Rana temporaria*), European common toad (*Bufo bufo*) and pool frog (*Phelophylax kl. esculenta*). These species were found at the transition between pine forest and coastal protection dune as well as at two positions on the beach in the north-west of the planned project area (pine forest). They are all assigned to the regional Red List of Mecklenburg-Western Pomerania /184/ and listed as endangered. Furthermore, the moor frog is subject to international protection according to FFH directive 92/43/EWG and listed on the Red List for Germany /185/. As there are no water bodies that potentially serve as breeding waters for amphibians within the area of investigation, the area does not represent an important habitat for the species listed above.

Reptile mapping carried out between 2015 and 2016 at the German landfall Lubmin 2 and a 300 m radius around it confirmed the occurrence of common lizard (*Zootoca vivipara*), grass snake (*Natrix natrix*) and slow worm (*Anguis fragilis*). All of these species are assigned to the regional Red List of Mecklenburg-Western Pomerania /184/. Slow worm and common lizard are listed as endangered, and the grass snake is listed as highly endangered. Furthermore, according to the Red List of Germany /185/ is assigned to the grass snake. The occurrence of reptiles was confirmed in relatively sunny transition areas between different habitats, such as the edges of forests and the limits between bushes and grasslands. In addition, sightings of slow worms and grass snakes on forest roads and on trails within the area of investigation were documented.

#### Ground beetles

During NSP2 surveys, 27 ground beetle species were detected. Coastal biotopes were investigated exclusively. Five of the detected species are listed as endangered (3): (*Amara quenseli silvicola*, *Dyschirius angustatus*, *Harpalus autumnalis*, *Harpalus flavescens*, *Licinus depressus*) /186/. The majority of these species are considered to occur moderately to very frequently in Mecklenburg-Western Pomerania, the federal state in which the project area is located. However, the proportion of rare to very rare species still is very high (approximately 25%). The habitat supporting such species is characterised by sandy conditions (seven species) and exposed, dry areas (nine species). The area of investigation exhibits a quite homogeneous biotope structure, both in the beach and dune areas (parts of the coastal biotope). The number

of species of ground beetles detected here (27) is quite low, but this is typical of extreme habitats such as the one under investigation. The proportion of threatened or highly specialised, sensitive species is very high (see Appendix 2).

## Bats

During surveys in 2015 and 2016, 13 species of bats were recorded within the investigation area: serotine bat (*Eptesicus serotinus*), Brandt's bat (*Myotis brandtii*), pond bat (*Myotis dasycneme*), Daubenton's bat (*Myotis daubentonii*), greater mouse-eared bat (*Myotis myotis*), Natterer's bat (*Myotis nattereri*), common noctule (*Nyctalus noctula*), Leisler's bat (*Nyctalus leisleri*), Nathusius' pipistrelle (*Pipistrellus nathusii*), common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), brown long-eared bat (*Plectococus auritus*) and parti-colored bat (*Vespertilio murinus*). Four species of bats, *P. pipistrellus*, *P. pygmaeus*, *N. noctula*, *P. nathusii*, were detected very frequently, followed by *E. serotinus*, *M. daubentonii* and *M. nattereri*. In contrast, the following six species were detected rarely: *V. murinus*, *M. myotis*, *M. brandtii*, *M. dasycneme*, *P. auritus* and *N. leisleri*. Most bats could be detected during foraging or mating behaviour. Two bat quarters of *N. noctula* were identified in trees. The occurrence of winter quarters within the project area can also be assumed for *N. noctula*. The existence of tree quarters could also be proved for *P. nathusii*, but only within the protected coastal forest. Building-related summer quarters were identified at the eastern border of the Lubmin settlement area, as well as at great halls in the south-eastern region of area of investigation. The summer quarters could be assigned to *P. pipistrellus*, *P. pygmaeus* and *P. nathusii*. Sixteen summer quarters were identified at boathouses in the south-east of the project area. Gaps below the roof sheetings, vertical interstices between the concrete plates and bat boxes mounted at the facades were used.

**Table 9-26 Identified bat species at landfall of Lubmin 2.**

Species	Regional Red List	National Red List	National protection	EG 92/43/EWG Appendix IV
<i>Pipistrellus pipistrellus</i>	NT		x	x
<i>Pipistrellus pygmaeus</i>	NE	DD	x	x
<i>Pipistrellus nathusii</i>	NT		x	x
<i>Eptesicus serotinus</i>	VU	NE	x	x
<i>Vespertilio murinus</i>	CR	DD	x	x
<i>Nyctalus noctula</i>	VU	NT	x	x
<i>Nyctalus leisleri</i>	CR	DD	x	x
<i>Myotis myotis</i>	EN	NT	x	x
<i>Myotis daubentonii</i>	NT		x	x
<i>Myotis dasycneme</i>	DD	DD	x	x
<i>Myotis nattereri</i>	VU		x	x
<i>Myotis brandtii</i>	EN	NT	x	x
<i>Plecotus auritus</i>	NT	NT	x	X
<b>Red list categories</b>				
CR: critically endangered; EN: endangered; VU: vulnerable; NT: near threatened; LC: least concern; DD: data deficient; NE: not evaluated; NA: not applicable.				
<b>Regional Red List: /187/</b>				
<b>National Red List: /187/</b>				

## Other mammals

Within the scope of investigations carried out in line with the management plan for the FFH area „Greifswalder Bodden, Parts of the Strelasundes and Nordspitze Usedom“ /191/, habitats of the European otter (*Lutra lutra*) were detected. Due to its high mobility, occurrence within the area of investigation cannot be excluded. However, as no suitable habitats exist, impacts by the project can be excluded. Previous studies have also identified the occurrence of the root vole

(*Microtus oeconomus*), striped field mouse (*Apodemus agrarius*), Eurasian water shrew (*Neomys fodiens*), European hedgehog (*Erinaceus europaeus*) and European hare (*Lepus euroaeus*) /192/ /193/, /194/. These species are endangered (3) or potentially endangered according to the Red List of Mecklenburg-Western Pomerania. All sightings were documented north of the outflow channel. Therefore they were located outside the area of investigation. Especially for the hedgehog and the striped field mouse, regular occurrence has to be assumed. For the other species mentioned, the habitats available are not very suitable. Therefore extensive usage can be excluded.

### Birds

In the course of the NSP2 onshore mapping, 59 species of breeding birds were identified. Of these, 18 species are on the Red List of breeding birds in Germany /189/ or the Red List of Mecklenburg-Western Pomerania /188/ as category 1-3 species. They are strictly protected species according to §7 ABS: 1 Nr. 14 BNatSchG or to Appendix 1 of the Bird Directive 2009/147/EG. The area of investigation (1,000 m radius around the PTA) contains coastal seams, pine forests, woodlands and semi-open ruderal meadows at different stages of succession, and industrial areas. These different biotope types represent suitable habitats for a species-rich community of breeding birds. The territories of the species of most interest are restricted to the habitats of the ruderal meadows.

The coastal zone with dune lies between the coast of the Greifswalder Bodden and the pine forest. It offers suitable habitats for red-backed shrike and tree pipit. The industrial areas are characterised by intensive anthropogenic activities, industrial buildings, a high amount of areas without any vegetation and high ground compression. These biotopes provide suitable breeding habitats for tree sparrow, house martin, common swift, wheatear, little ringed plover and barn swallow. The woodlands are dominated by pine forests of different age stages. The pine forest provides suitable habitats for the wood warbler, red-backed shrike, starling, Eurasian woodcock and the long-eared owl. At the transition between pine forest and semi-open ruderal meadow, the tree pipit and the woodlark find suitable habitats. The ruderal meadow is characterised by a diverse mosaic of small structures. Breeding occurrences of Whinchat, Wheatear, Red warbler, Red-backed shrike, Little ringed plover, Tree pipit, Grasshopper warbler, Common lark and woodlark depend on the semi-open character of the area. Nobreeding raptors were identified within the area of the PTA.

**Table 9-27 Identified breeding bird species at the landfall Lubmin 2.**

Species	Regional Red List	National Red List	National protection	EU-Vogelschutzrichtlinie 2009/147/EG Appendix I
<i>Alauda arvensis</i>	3	3		
<i>Anthus trivialis</i>	3	3		
<i>Asio otus</i>			x	
<i>Carduelis cannabina</i>	v	3		
<i>Charadrius dubius</i>			x	
<i>Delichon urbica</i>	v	3		
<i>Hirundo rustica</i>	v	3		
<i>Lanius collurio</i>	v			x
<i>Locustella naevia</i>	2	3		
<i>Lullula arborea</i>		v	x	
<i>Oenanthe oenanthe</i>	1	1		
<i>Passer montanus</i>	3	v		

<i>Phylloscopus sibilatrix</i>	3			
<i>Riparia riparia</i>	v	v	x	
<i>Saxicola torquata</i>		v		
<i>Saxicola rubetra</i>	3	2		
<i>Scolopax rusticola</i>	2	v		
<i>Sturnus vulgaris</i>		3		
<i>Sylvia nisoria</i>		3	x	x
<p><b>Red list categories</b>  CR: critically endangered; EN: endangered; VU: vulnerable; NT: near threatened; LC: least concern; DD: data deficient; NE: not evaluated; NA: not applicable.</p> <p><b>National Red List:</b> /189/  <b>Regional Red List:</b> /188/  <b>National protection:</b> Verordnung zum Schutz wild lebender Tier- und Pflanzenarten: Bundesartenschutzverordnung-BArtSchV), Ausfertigungsdatum: 16.02.2005.</p>				

#### 9.8.1.4 Importance of terrestrial flora and fauna – German landfall area

##### Flora

Although 10 species of plant are listed on the IUCN Red List and these species are endangered or on the pre-warning list according to national Red Lists, most of the plants belong to biotopes that are widely distributed and therefore considered to be of low importance. Some small-scale areas are under protection according to national biotope protection § 20 NatSchAG M-V, but they will not be affected by the land use of the NSP2 project.

##### Fauna

Several Red List species of amphibians, reptiles and ground beetles (see sections above) were identified in the German landfall area including ID /184/, /178/, /186/. The area of investigation, including the footprint area, can be defined as of **medium** importance for the species groups mentioned.

All of the encountered bat species are classified as endangered species on the Red List of Mecklenburg-Western Pomerania and in Annex IV of the Habitats Directive and therefore strictly protected and subject to conservation. Furthermore, all bat species are on the IUCN Red List (see Appendix 2). Two of the recorded species, *Myotis myotis* and *Myotis dasycneme*, are also indicated as Annex II species of the FFH directive. The importance of the bat population is classified as high.

Nineteen of the 59 breeding birds identified are listed on the Red List of breeding birds in Germany /188/ or in Mecklenburg Western Pomerania /188/. Furthermore, 16 of these species are listed on the IUCN list of protected species (see Appendix 2). The onshore project area passes through four different bird habitats. The bird habitats pine forest and coastal seam are of medium importance for the existing breeding bird species, whereas the semi-open ruderal meadows and the industrial area are of high importance.

#### 9.8.2 Natura 2000

Natura 2000 sites within the German landfall area include both onshore and offshore areas and are therefore described in the Marine section (Section 9.6.6). The protected onshore areas within the Natura 2000 areas are restricted to the coastal biotopes and one section of the forest. The



latter is protected as pine forest developed on dunes (see above, ecosystem FFH 2180). None of the biotopes within the onshore Natura 2000 areas will be affected by NSP2.

### **9.8.3 Other protected areas**

Other protected areas within the German landfall area include both onshore and offshore areas and are therefore described in the Marine section (Section 9.6.7). None of the onshore areas of the other protected areas will be affected by NSP2.

## Socio-economic environment

The socio-economic baseline documented in this section (marine and terrestrial) considers the receptors and resources identified in the scoping exercise and outlined in Table 8.3 (Chapter 8 – Environmental impact identification). The socio-economic baseline is structured according to the three areas where potential impacts may be experienced (rather than where they originate): marine (offshore and nearshore, as well as islands), onshore landfall areas and onshore ancillary areas.

As outlined in Section 7.5.2 (Chapter 7 – Method adopted for Espoo environmental assessment documentation), socio-economic resources and receptors have been considered in terms of:

- People (primarily the local communities and people from the local areas (projected affected communities, PACs) including residents, workers, visitors, tourists, recreational users and road users in terms of their amenity and safety levels);
- Economic resources (including those associated with tourism, commercial fisheries, marine transport, raw material extraction sites and other commercial uses of land and the marine environment);
- Other services (non-commercial uses of land and marine areas e.g. military practice areas, monitoring stations and public services such as roads, utilities, etc.)
- Cultural heritage (tangible and intangible).

The socio-economic baseline characteristics of the three project areas are listed below.

### Marine areas

- People (local communities, recreational users and those who may derive economic opportunities from NSP2).
- Underwater cultural heritage (UCH) resources (shipwrecks and other associated remains and submerged Stone Age settlements).
- Economic resources:
  - Tourism and recreational activities;
  - Traffic (maritime traffic and navigation);
  - Commercial fisheries;
  - Raw material extraction sites;
  - Existing and planned infrastructure (sub-marine cables, pipelines and offshore wind farms).
- Other services:
  - Military practice areas;
  - International/national monitoring stations.

### Onshore landfall areas

- People (primarily includes local communities, including residents, workers, visitors, tourists, recreational users and road users in terms of their amenity and safety levels);
- Cultural heritage (tangible and intangible resources);
- Economic resources (land used for commercial activities, agriculture, hunting and gathering, land and property values, tourism resources, local labour supply, etc)
- Other services (roads, railway, utilities).

### Onshore ancillary areas

- People (primarily includes local communities and local economic activities, including residents and road users in terms of their amenity and safety levels).

- Economic resources:
  - Tourism and recreational activities.

## 9.9 Marine areas

### 9.9.1 People

This section provides an overview of people in marine areas (offshore, nearshore and islands) that may be affected by NSP2 activities. Such people comprise those who have a permanent residence or regular presence on islands as well as the recreational users of marine waters. The closest receptors fall within 5 km of the NSP2 alignment and are located in island communities (i.e. within the zone of influence of noise, visual and sedimentation impacts, based on noise and sediment modelling results, Appendix III). All other receptors in marine areas (e.g. those in located in the Gulf of Finland, Gotland and Bornholm) are situated between 10-25 km of NSP2 and can partake in recreational activities in open waters and in proximity to NSP2. The following aspects have been considered:

- Island communities within 5 km of the NSP alignment;
- Recreational users of marine areas.

#### 9.9.1.1 Local communities and recreational users

The receptors that may be within the zone of influence of noise and visual impact from NSP2 activities in the marine areas are recreational users of marine waters, located on the coastlines of Rügen Island and Lubmin in Germany, Kurgalsky Peninsula in Russia and in the vicinity of Narva-Jõesuu, Estonia (see Table 9-28). An overview of the island communities/settlements and the main marine areas used for recreation is provided below.

**Table 9-28** Island communities and marine recreational areas within the zone of influence of the NSP2 activities in the marine areas (offshore and nearshore).

Community/ areas	Relevant aspect	Estimated distance from NSP2 alignment
<b>Russia</b>		
Coast of the Kurgalsky Peninsula	Nearshore recreational users	0 km
<b>Estonia</b>		
Narva-Jõesuu <sup>1</sup>	Nearshore recreational users	10 km
<b>Finland</b>		
Islands in the Finnish Archipelago and coastlines south of Finland	Island and mainland community recreational users	25 km
<b>Sweden</b>		
Islands of Gotland, Fårö and Gotska Sandön and the coastal areas of Skåne and Blekinge from Ystad to Karlshamn	Island community recreational users	25 km
<b>Denmark</b>		
Bornholm	Island community and recreational users	10 km
Ertholmene	Island community and recreational users	15 km
<b>Germany</b>		
Lubmin beach	Nearshore recreational users	0 km
<b>Rügen Island</b>		
Südperd (Thiessow )	Island community and nearshore recreational users	2 km, W
Thiessow (Ortslage)	Island community and nearshore recreational users	2 km, W

Community/ areas	Relevant aspect	Estimated distance from NSP2 alignment
Klein Zicker (Ortsslage)	Island community and nearshore recreational users	4 km, W
Nordperd (Göhren)	Island community and nearshore recreational users	4 km, W
Göhren (Ortsslage)	Island community and nearshore recreational users	4.5 km, W
Lobbe (Ortsslage)	Island community and nearshore recreational users	5 km, W
<sup>1</sup> Note: Affected Party that may potentially experience transboundary impacts.		

### Kurgalsky Nature Peninsula

The Narva Bay nearshore area is located to the south of the Kurgalsky Peninsula in Russia). This area will be within the zone of influence of NSP2 nearshore activities off the coast of the Narva Bay landfall area. Residents and visitors use these waters primarily for swimming and fishing. However, levels of use are likely to be low compared with those experienced further north along the peninsula where there are more formal recreational facilities. Onshore recreational activities in the Narva Bay landfall area are discussed in Section 9.10.

### Narva-Jõesuu

The town of Narva-Jõesuu is situated in Ida-Viru County in north-eastern Estonia. Ida-Viru has a population of approximately 146,506 people and shares its borders with Russia. It lies approximately 10 km south of the NSP2 Narva Bay nearshore area and could potentially experience impacts from the NSP2 nearshore activities. Its long coastline makes this town a popular tourist destination (see Section 9.9.3). Recreational activities include sailing and swimming.

### Lubmin beach

Lubmin beach will be within the zone of influence of the NSP2 nearshore activities off the coast of the Lubmin 2 landfall area, in the Mecklenburg-Vorpommern Federal State, Germany (see Table 9-28). The recreational activities include swimming, boating and fishing. Onshore recreational activities related to the onshore Lubmin landfall area are discussed in Section 9.11.

### Rügen Island

Rügen Island is also located in the Mecklenburg-Vorpommern Federal State. It has a population of approximately 70,000 people. The communities within the zone of influence of NSP2 marine areas are approximately 2 km west of the NSP2 alignment, on the southern tip of Rügen Island in the settlements of Südperd and Thiessow. These are also popular tourist areas and include holiday homes (the economic value of such tourism and recreational areas is addressed in Section 9.9.3). Residents and tourists use the nearshore areas for water sports such as swimming, boating, fishing, etc.

All of the above areas generally have high levels of visual amenity with scenic coastlines and landscapes, good air quality and low ambient noise levels (refer to Section 9.4.4).

#### 9.9.1.2 Other local communities and recreational users

There are other local communities and recreational users within 10-25 km of NSP2 that may be impacted by the pipeline. Such receptors are situated along the coastlines in the south of Finland and on the Finnish Archipelago islands, Gotland Island (Sweden), Bornholm Island (Denmark) and Ertholmene Island (Denmark). Recreational users may make use of open waters for recreational fishing, diving and boating/sailing. However, most of these activities undertaken by local communities are limited to the coastline. Recreational activities that do occur in open waters are primarily related to tourism and discussed in Section 9.9.3.

### 9.9.1.3 Importance

As discussed in Chapter 7 – Method adopted for production of Espoo environmental assessment documentation, all “People” are considered to be of equal importance and therefore are not ranked in terms of this parameter. Their vulnerability to potential impacts from the NSP2 in offshore and nearshore areas is discussed Chapter 10 – Assessment of environmental impacts.

## 9.9.2 Cultural heritage

### 9.9.2.1 Shipwrecks and other associated remains

UCH in the Baltic Sea largely comprises historical shipwrecks, remnants and their cargo. Generally, cultural heritage objects (CHOs) are protected under national legislation as well as international conventions, including UNCLOS and the UNESCO Convention on the Protection of Underwater Cultural Heritage, which emphasizes the importance of international collaboration in the protection of UCH in waters extending beyond territorial limits.

The various national historic, archaeological or wreck registers for each country that NSP2 crosses contain records of such CHOs, while further previously undiscovered objects within the vicinity of NSP2 were identified during its planning and implementation. As part of the project preparation, detailed geophysical surveys of potential CHOs on the seabed were undertaken to identify the locations of potential features. Those considered to be CHOs and that could be impacted by the NSP2 marine project components have been or will be subject to visual inspection and, in some cases, evaluation by national experts (as part of the national EIAs/ES) to establish the nature of the object and to determine whether it has cultural heritage value.

The results to date have been analysed and interpreted, and their potential implications have been discussed with the relevant national authorities to determine those features that require specific measures to safeguard them during NSP2 implementation, as well as the nature of such measures. The programme of visual inspections and discussions with agencies has varied between countries (depending in part on specific regulatory requirements) and is ongoing, with some countries being more advanced than others. Any further work that is required is planned to be completed in 2017.

Table 9-29 summarises the number of potential CHOs in the vicinity of the NSP2 route that have been identified to date. These numbers reflect a cautious approach. They are likely to be overestimates of actual figures, as they include features which have not yet been examined through visual inspection (and therefore may not be CHOs) and/or features that national agencies have not yet commented on regarding their value or the buffer zones required around them.

The classification of CHOs that have been identified to date and summarised below takes into account the ongoing nature of the CHO studies as well as the need for some flexibility in the pipeline location and the confidentiality requirements related to the locations of CHOs in certain countries.

A total of 21 potential CHOs have been identified within the immediate vicinity or buffer zone of the pipe-laying corridor and anchor corridor. These features may require avoidance measures (through rerouting of the pipelines) or recovery. Features within a wider corridor may require avoidance when anchoring. Such features are presented in Table 9-30. Atlas Maps CU-01–Espoo to CU-04–Espoo provides an overview of CHOs identified along the NSP2 route.

**Table 9-29** CHOs within the NSP2 corridor and anchor corridor.

Country	Number of potential CHOs		
	Immediate vicinity (0-50 m)	Intermediate vicinity (50-250 m)	Wider corridor (250-1,000 m)

Country	Number of potential CHOs		
	Immediate vicinity (0-50 m)	Intermediate vicinity (50-250 m)	Wider corridor (250-1,000 m)
Russia <sup>1</sup>	8 targets that could potentially be shipwrecks (6) or other objects (2) within 1,500 m of the pipeline survey corridor (the specific pipeline alignments are not yet finalised, as route optimisation is ongoing)		
Finland <sup>2</sup>	1 barrage object	3 wrecks	32 potential targets
Sweden <sup>3</sup>	0 within 50 m	6 possible wrecks	8 possible wrecks
Denmark <sup>2</sup>	0 within 50 m	2 possible features	5 potential wrecks
Germany <sup>1</sup>	Multiple potential wrecks within a 1,500 pipeline survey corridor (ongoing campaign by heritage authorities)		
<sup>1</sup> Note: possible anchor handling. <sup>2</sup> Note: Measured distance from each side of either pipeline. <sup>3</sup> Note: Measured distance from edge of 400 m corridor (200 m corridor on each side of either pipeline).			

**Table 9-30** Details of CHOs within NSP2 corridor that may require adequate management measures (avoidance through pipeline rerouting or recovery).

Wreck ID/name	Description	Distance from NSP2 pipeline/ corridor
<b>Russia<sup>1</sup></b>		
S-R4-0329	Wreck. Possibly iron vessel.	607 m (within survey corridor)
S-R4-0389	Linear object. Possibly a geological feature.	175 m (within survey corridor)
S-R3-1557	Other object. Possibly dangerous.	974 m (within survey corridor)
S-R3-1558	Wreck. Possibly iron vessel.	679 m (within survey corridor)
S-R3-1560	Wreck. Possibly iron vessel.	681 m (within survey corridor)
S-R3-2164	Wreck. Possibly wooden wreck.	289 m (within survey corridor)
S-R4-1105	Wreck. Possibly wooden ship.	1,049 m (within survey corridor)
S-R3-1556	Wreck. Possibly iron vessel.	1,015.5 m (within survey corridor)
<b>Finland</b>		
S-R05-7978	Wreck (wooden barge). Possibly a cannon barge from the late 18 <sup>th</sup> to early 19 <sup>th</sup> century. Significant UCH site.	<sup>2</sup> Distance to Line A: 152 m <sup>2</sup> Distance to Line B: 65 m  <sup>3</sup> Distance to Line A: 147 m (debris) <sup>3</sup> Distance to Line B: 58 m (debris)
S-R09-09806 (SD-ALT1-3372)	Barrage (anti-submarine net). Sections of the "western" and "eastern" parts of the <i>Walross</i> anti-submarine net (barrage) from World War II. Significant World War II historical site.	<sup>2</sup> Distance to Line A: 131 m <sup>2</sup> Distance to Line B: 228 m  <sup>3</sup> Distance to Line A: 0 m <sup>3</sup> Distance to Line B: extends across

Wreck ID/name	Description	Distance from NSP2 pipeline/corridor
		pipeline routes A and B
S-R11-2395 <sup>4</sup>	Wreck (steel, motor vessel). A badly damaged steel-hulled motor vessel. The vessel is of a cargo ship type, possibly a sea-going barge fitted with lifting cranes. Potential World War II historical site.	<sup>3</sup> Distance to Line B: 253 m (debris)
S-R15-02960	Wreck (wooden sailing ship). Wooden merchantman from the 18 <sup>th</sup> century. Age >100 years. Significant UCH site.	<sup>2</sup> Distance to Line A: 233 m <sup>3</sup> Distance to Line A: 220 m (debris)
<b>Sweden</b>		
S-R24-5317	Wreck	92.90 m
S-R28-5046	Wreck. Known since NSP (as S-29-93462)	142.09 m
S-R27-5051	Possible wreck	171.45 m
S-R17-4285	Wreck	203.26 m
S-R27-0640	Possible wreck	232.99 m
S-R19-1026	Wreck	238.43 m
<b>Denmark</b>		
S-R35-0653	Possible wreck	Distance to Line A: 104 m Distance to Line B: 158 m
S-R35-0285	Possible wreck	Distance to Line A: 226 m Distance to Line B: 169 m
No ID	Wreck. <i>Schiffssperre</i> sunk at the entrance to Greifswalder Bodden during the Great Nordic War (1700-1721). Wrecks considered significant to regional and northern European history.	Within 1,500 m of the survey corridor
<p>Note<sup>1</sup>: Distances in Russia relate to an indicative alignment as the route optimisation process is still ongoing.</p> <p>Note<sup>2</sup>: Offset to the centre of the main wreckage/target.</p> <p>Note<sup>3</sup>: Offset to the closest point of target (scattered debris, loose objects, etc.).</p> <p>Note<sup>4</sup>: Target S-R11-2395 is included due to its proximity to line B and thus a cautious approach should be applied to the feature.</p>		

### 9.9.2.2 Submerged Stone Age settlements

Since the last glacial period, the Baltic Sea has gone through major environmental changes that led to rising sea levels and caused submergence of some former land areas and associated human settlements, monuments and landscapes. Most such settlements are located in water depths less than 20 m, although some may be found at water depths down to 40 m. Furthermore, it is unlikely that submerged Stone Age settlements are present at latitudes north of approximately 55.5°-56° N in the Baltic Sea, as these areas were not dry land during the Stone Age /195/. Therefore the possible presence of submerged settlements is linked to relatively shallow waters in the southern part of the Baltic Sea.

A description of the potential for submerged Stone Age settlements along the NSP2 route is provided below.

#### **German nearshore**

Only a limited section of NSP2 is located within areas with water depth less than 20 m, specifically towards the nearshore area in Germany, where a 70 km stretch of NSP2 passes through such water depths. No submerged Stone Age settlements have been identified in the vicinity of the NSP2 alignment in the nearshore areas, and the potential for their presence in these areas is considered highly unlikely.

#### **Midsjö Bank**

The seabed between northern Midsjö Bank and southern Midsjö Bank (located north of the 55.5°-56° N) consists of more recent sediments located in minimum water depths of 38 m (see Figure 9-2, Section 9.2.1). However, it is unlikely that remains of submerged Stone Age settlements are present in this area. An expert from the Swedish Maritime Museum (SMM) confirmed that there is no risk of finding submerged Stone Age settlements in the Swedish EEZ and that no further investigation is required along the NSP2 route.

#### **Bornholm**

According to the local museum (Bornholm Museum), submerged Stone Age settlements and ancient submerged forests may be encountered in waters shallower than approximately 40 m, mainly along the south coast of Bornholm, as identified by the Danish Conservation Agency in 1986 (now known as the Danish Nature Agency). The closest section of NSP2 to the area is approximately 10 km west. Therefore the route will not pass through such areas.

#### **9.9.2.3 Importance**

UCH resources identified along the NSP2 route are protected by international legislation and conventions and therefore considered to be of high importance.

#### **9.9.3 Tourism and recreational activities**

Generally, tourism is an important economic activity and highly seasonal in coastal areas, with high peaks during summer holidays. The communities and recreational activities discussed in Section 9.9.1 are located in coastal areas, within the zone of influence of NSP2 marine activities (nearshore and offshore). Even though most tourism and recreational activities are limited to the coastline, a few recreational activities are undertaken in open waters, including recreational fishing, diving and leisure boating/sailing. Other tourist activities that could be influenced by the offshore section of NSP2 are passenger cruise ships, which are popular all year round (see Section 9.9.4 for further information on maritime traffic). The economic value of such tourism and recreational activities is described below.

##### **9.9.3.1 Kurgalsky Peninsula**

As described in Section 9.9.1, a portion of the coastline of the Kurgalsky Nature Reserve is located within the zone of influence for the NSP2 nearshore activities off the coast of the Narva Bay landfall area. The peninsula is rich in natural and recreational resources, with tourism development potential. However, tourism does not play a significant role in the economy, with informal tourism mainly occurring in the area. Its contribution accounts for less than 2% of the gross regional product.

##### **9.9.3.2 Narva-Jõesuu**

Narva-Jõesuu could potentially experience impacts from the NSP2 nearshore activities (see Section 9.9.1). Ida-Viru County has the third largest city in Estonia (Narva) and a popular resort area, Narva-Jõesuu that is well known for its long coastline. The county accounts for 8% of the national GDP, with the tourism sector as one of the important contributors to the GDP /196/.



### 9.9.3.3 Finnish Archipelago and coastlines south of Finland

The proposed construction of NSP2 will be conducted approximately 25 km south of Finland. Some recreational activities, such as leisure cruises, may occur in proximity to NSP2.

The tourism sector in Finland has been steadily growing in recent years, with the islands in the Finnish Archipelago and coastal areas in the south of Finland being popular tourist attractions. The main recreational activities are related to recreational fishing, sailing and swimming. Tourism in these areas is highly seasonal and concentrated to the summer holiday season. According to the Roadmap of Tourism 2015–2025, tourism development of the Finnish Archipelago will be one of the focus areas in the near future /197/. The majority of leisure boating and other sea-related recreational activities take place closer to the coastline and in the archipelago rather than in the outer sea areas and EEZ, where the construction of NSP2 will take place.

Cruises between Helsinki and Tallinn, which cross the NSP2 route, are popular, with an estimated 8.2 million passengers travelling between Helsinki and Tallinn (2014). Overnight cruises between Finland and Sweden are also popular. According to the Port of Helsinki statistics (2015), nearly 300 cruise ships and up to 420,000 cruise passengers visit Helsinki annually.

### 9.9.3.4 Gotland

The proposed NSP2 route is located approximately 25 km from the east coast of Gotland. The eastern coastal areas of the islands of Gotland, Fårö and Gotska Sandön and the coastal areas of Skåne and Blekinge from Ystad to Karlshamn are the key areas where tourism and recreational activities (such as leisure boating) may be impacted by NSP2 within the Swedish EEZ. Other popular recreational activities include fishing, sailing and diving. However, these activities are limited to the coastline. Therefore leisure boating and cruise ships are further discussed below.

Most of the leisure boating around Gotland occurs between the island and mainland Sweden. There is an annual Round Gotland Race, which is usually held over three days at the beginning of July. It is the most prestigious race in the Baltic Sea, with an average of 300 sailboats participating each year. Passenger ferries from other cities, such as those from Stockholm-Tallinn, Stockholm-Riga, Karlskrona-Gdynia and Ystad-Rønne, Bornholm, cross the NSP2 route as well, of which Stockholm-Riga and Karlskrona-Gdynia are in the Swedish EEZ. Passenger transport has grown by 0.6% between 2007 and 2014 and is estimated to grow by 3.4% annually /198/. The future development of ferries in the region is influenced by a variety of other factors such as transport infrastructure development. However, in general, future ferry passenger numbers and sizes are expected to increase as smaller ferries are replaced with larger, more economically feasible, ships.

In terms of cruise ships, in 2014 over 2 million passengers travelled to and from Gotland by either ferry or plane, which is an increase of 5% over the previous year /199/. Each year, approximately 300,000 people visit Fårö, a popular day-trip destination for many tourists visiting Gotland. The two islands are connected by cable ferries. Passenger ferries to and from Gotland operate only between Visby and mainland Sweden. More than 100 cruise ships call at Visby on the west coast of Gotland every year, mainly during the summer. This number is expected to grow as cruise tourism becomes increasingly popular.

### 9.9.3.5 Denmark

The NSP2 route is situated approximately 10-15 km east of the islands of Bornholm and Ertholmene.

The tourism industry is important for occupational and business-related development on Bornholm and Ertholmene (Christiansø and Frederiksø). Fishing is a popular recreational activity on the coastline of Bornholm. It is performed at least 1 nm (1.85 km) from the coast but most often even further out /200/.

Several diving activities are possible in the waters around Bornholm and Ertholmene, with recreational diving and spearfishing accessible from the coast. Divers often stay close to the coastline of Ertholmene and Bornholm, where sites such as Listed and Hullehavn near Svaneke or Svenskehavn are popular. However, residents and tourists also take diving excursions to visit underwater caves or the many well-preserved shipwrecks further from the coast /201/. It is not uncommon for divers to visit locations 5-10 km or further from the coast, depending on where the wrecks are located /202/.

#### **9.9.3.6 Lubmin beach**

Lubmin beach is within Greifswalder Bodden, a key area for tourism in Germany /203/. According to the Mecklenburg-West Pomerania State, tourism in this area is growing considerably every year /203/. Marine tourism in the Mecklenburg-West Pomerania State contributes to approximately 10% of the national GDP. The recreational activities in Greifswalder Bodden are dominated by leisure boating.

#### **9.9.3.7 Rügen Island**

In addition to Lubmin beach, Rügen Island also forms part of Greifswalder Bodden, making the island a key area for tourism development in Germany /203/. Rügen Island has 22 yacht harbours, with boating being a key coastal activity followed by recreational fishing and beach tourism /203/.

#### **9.9.3.8 Importance**

Several coastal areas in proximity to NSP2 play a key role in tourism and recreational activities. The ranking of importance varies depending on the contribution of the tourism sector to the economy.

The tourism and recreational activities in the Kurgalsky Reserve are of low importance, as they play a minor role in the regional economy. In Germany (Lubmin and Rügen Island), tourism and recreational activities are considered to be of medium importance because the tourism sector is a key contributor at a regional level.

The vulnerability of tourism and recreational activities (including amenity values) to the potential impacts from NSP2 is discussed in Chapter 10 – Assessment of environmental impacts.

### **9.9.4 Traffic**

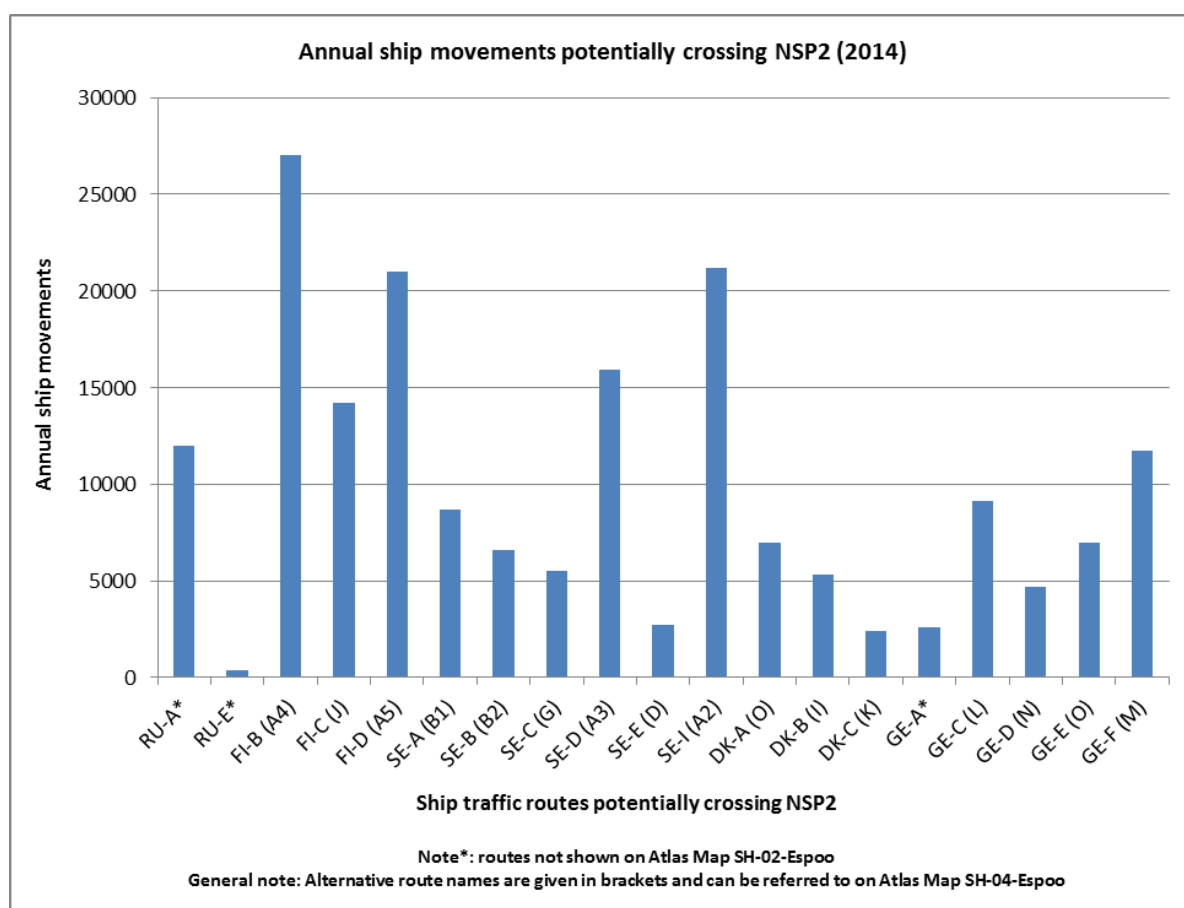
This section provides an overview of maritime traffic and navigation routes crossed by NSP2.

The Baltic Sea is one of the most intensely trafficked seas in the world and accounts for approximately 15% of the world's cargo transportation. The highest traffic movements are in the central Baltic Sea and the west of Gotland, comprising approximately 57,000 vessel passages annually with 20% of this volume made up of tankers over 150 m in length /204/. The majority of the ships follow predesignated routes that are static and approved by existing traffic separation schemes (TSSs). Historical automatic identification system (AIS) data collected by the Danish Maritime Authorities (DMA) from 2007 to 2014 for the entire Baltic Sea have been used to analyse ship traffic around the NSP2 route. Approval to acquire such data from the DMA has been obtained from all HELCOM countries, except Poland. Thus the ship traffic density plots in Atlas Maps SH-01-Espoo to SH-07-Espoo do not include the ship traffic data collected from AIS base stations in Poland.

As shown in Figure 9-38, NSP2 will cross a total of 19 primary ship routes (main ship routes, see Atlas Maps SH-01-Espoo and SH-07-Espoo), of which four primary routes, located in the Finnish and Swedish EEZs (routes FI-B, FI-D, SE-D and SE-I), are considered to have the highest annual ship movements. These routes are mainly used by cargo ships, followed by tankers. Route FI-B accounts for the most ship traffic along NSP2, with approximately 27,000 annual ship movements /204/. The primary ship traffic routes are presented in Atlas Map SH-02-Espoo, and those

crossed by NSP2 are discussed below (see Figure 9-38). It should be noted that the route names presented in the figure are equivalent to those in brackets and can be referred to in Atlas Map SH-02-Espoo. The types of ships potentially crossing NSP2 are presented in Atlas Map SH-04-Espoo.

In German waters, NSP2 is located in an area with the highest intensity of ships, of which 85 km of NSP2 will cross five primary ship routes. These routes are mainly used by cargo ships, passenger ships and ships classified as "other". Within the Swedish EEZ, 512 km of NSP2 will cross six routes, two of which have particularly high volumes of ship movements (routes SE-D and SE-I). In the Finnish EEZ, 378 km of NSP2 will cross three ship routes, of which, as previously mentioned, two routes (FI-B and FI-D) are considered to be routes with high ship traffic. In Danish waters, 139 km of NSP2 will cross three primary ship routes. These routes have less than 15,000 annual ship movements and are used by cargo ships and tankers. In Russian waters, 14 km of NSP2 will cross two ship routes, with route RU-E having the least number of annual ship movements along the NSP2 route. It is predominately used by passenger ships and cargo ships /204/.



**Figure 9-38** Annual ship traffic movements potentially crossing NSP2 /204/ (see Atlas Map SH-02-Espoo).

The annual movements and types of ships on routes of relevance to the NSP2 route in 2014 have been analysed and used as a basis for forecasts for 2025. The forecasts of the annual number of ship movements in 2025 are presented in Atlas Map SH-03-Espoo. All routes are predicted to have an increase in movements per year. In terms of forecasts of the types of ships potentially crossing NSP2, an increase in cargo ships can be expected (see Atlas Map SH-05-Espoo).

Some ship routes that cross the NSP2 route have shallow water depths (specifically in the nearshore areas in Germany and Russia), which may pose restrictions with respect to maritime

safety and navigation where construction activities take place in their vicinity. A description of the shallow areas where NSP2 crosses the primary ship routes is provided in Table 9-31.

**Table 9-31 Water depths along NSP2 route /204/.**

EEZ/ waters	Description
Finnish EEZ	The TSS route off Kalbådagrund has water depths of 26-28 m and just north of the TSS water depths are limited to 15.1 m. Route FI-D is the primary route crossed. TSS Off Porkkala Lighthouse, route FI-C is the main ferry route between Helsinki and Tallin.
Swedish EEZ	In general, the pipeline is routed in water depths greater than 30 m and will only approach shallower waters near Norra Midsjöbanken and Klints Bank (27-29 m). Routes SE-A, SE-B, SE-C and SE-D are the primary routes crossed.
Danish waters	NSP2 is routed in water depths greater than 30 m, with the exception of the pipeline section close to the German EEZ, which passes by shallow areas at Rønne Banke and Adlergrund, with the shallowest point being 27.5 m. route DK-A is the primary route crossed.
German waters	Shallowest area compared with the other routes. The pipeline will enter an area with water depths of approximately 20 m before entering the shallow area in Greifswalder Bodden, where the landfall is located.
Note: See Figure 9-38 for alternative route names equivalent to those in Atlas Map SH-02-Espoo.	

#### 9.9.4.1 Importance

The marine ship traffic industry has a high economic value and is a key contributor to the economy at a national and international level. Therefore a high importance ranking is assigned to ship traffic. The vulnerability of marine ship traffic to the potential impacts of NSP2 is discussed in Chapter 10 – Assessment of environmental impacts.

#### 9.9.5 Commercial fisheries

Commercial fishing in the Baltic Sea is undertaken by all countries in the region, including the five NSP2 PoOs (Russia, Finland, Sweden, Denmark and Germany) as well as the additional four APs (Estonia, Latvia, Lithuania and Poland). The Baltic Sea commercial fishery for each aforementioned country (except Russia) has been characterised on the basis of catch data collected from the national fisheries institutes and ICES data on trawling intensity.

The dominant commercially exploited fish stocks in the Baltic Sea are cod, herring and sprat, which constitute over 95% of the total catch. Other target fish species of economic importance are salmon, plaice, flounder, dab, brill, turbot, pike-perch, pike, perch, vendace, whitefish, turbot, eel and sea trout /205/.

##### 9.9.5.1 Management and fishing techniques

Commercial fisheries in the Baltic Sea are regulated by a range of national and EU legislation and directives. Specifically, the EU Common Fisheries Policy (CFP) regulates fishery by every country mentioned above except Russia. Russia and the EU have agreed to cooperate within the areas of fisheries and marine conservation in the Baltic Sea. The CFP was established in 1983 and has been revised several times, most recently in 2013. The 2013 policy aims to promote environmentally, economically and socially sustainable fishing. An overall catch quota is set for individual species in specific areas of EU waters. The total allowable catch (TAC) of a species is specified by the relevant national authority and divided amongst fishing boats. Fisheries are also regulated through a permit system that specifies the number of days allowed at sea in combination with gear type to be used. Russia is not permitted to fish commercially in EU waters.

Fisheries use different fishing techniques depending on location and fish species. Baltic Sea cod fisheries mainly employ bottom trawls and to a lesser degree gill net and occasionally pelagic trawls. Flounder and other flatfish species (dab, plaice, etc.) are generally caught as by-catch.

Salmon are caught by longlines while feeding in open waters (driftnets are banned in the Baltic Sea). During spawning, salmon are caught along the coasts, mainly in trap nets and fixed gill nets. Where permitted in river mouths, fishermen use gill nets and trap nets. Most of the flatfish fishery is conducted in the western Baltic Sea. Coastal fisheries take place along the entire Baltic coastline.

Pelagic fisheries in the Baltic Sea are dominated by pelagic trawlers catching a mixture of herring and sprat. The relative proportion of each species caught varies by area and season. In addition, a minor fishery predominantly targeting herring is carried out with gill nets and trap nets/pound-nets in most coastal areas of the region as well as with the occasional bottom trawl.

#### 9.9.5.2 Fisheries along NSP2

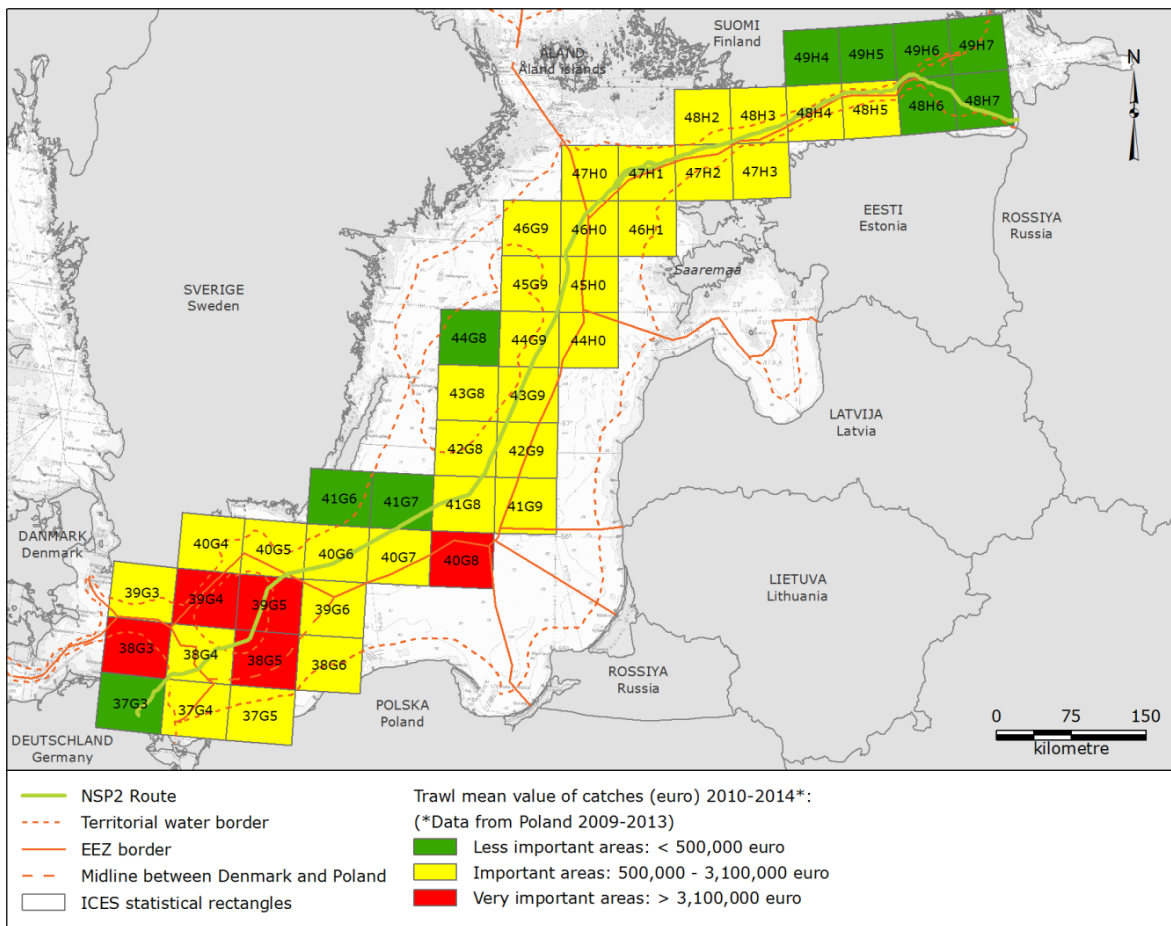
Fishery data in the Baltic Sea are separated according to international fishery statistical areas, or so called ICES rectangles, where national and international fishery regulations, requirements and quotas apply and the majority of the catch data are separated. These ICES rectangles are approximately 30 x 30 nm in size. All fishing vessels  $\geq 8$  m are required to register their catches and equipment used within these ICES rectangles (the so called logbook data). These data give a good overview of the spatial distribution of the catches of various species and the amount (weight) of catches.

The dominant commercially exploited fish stocks in the Baltic Sea are cod, herring and sprat. Of these three species, cod have the highest economic value and yield the highest profit even if sprat has the highest catch weight (see Atlas Maps FC—07-Espoo and FC-08-Espoo). The value of fish is not necessary linked to the catch weight; rather it is more related to the specific species captured.

Figure 9-39 shows the economic value of trawl fishery along the pipeline route identified on the basis of logbook data from 2010-2014 from all of the Baltic countries (except Russia, as Russia does not make inventory of fish catches in ICES sub-squares), based on catch data from 2010-2014<sup>15</sup>.

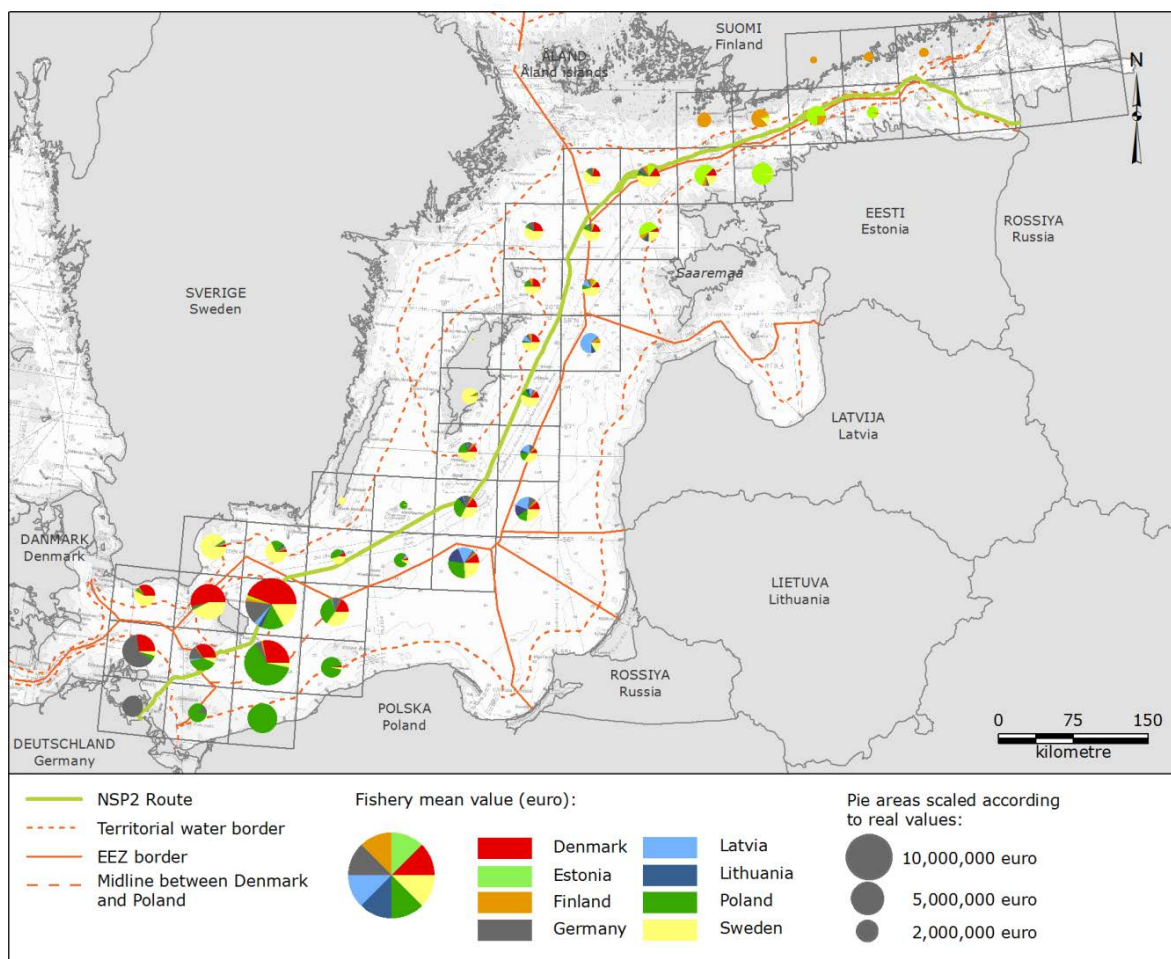
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<sup>15</sup> Data for Poland are from 2009-2013.



**Figure-9-39 Importance of trawl fishery in the ICES rectangles areas along the pipeline route in terms of catch value (in euros) for the period 2010-2014 (\*Poland, 2009-2013) Source: derived from data obtained from fishery authorities in each country.**

As shown in Figure 9-39, some areas are much more important than others in terms of economic value. The most important areas are in the western Baltic Sea around Bornholm, in ICES rectangles 38G5 and 39G5. The spatial distribution of country specific catch value from fishery by Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany along the ICES rectangles that follow or are adjacent to the NSP2 pipeline transect is shown in Figure 9-40. These indicate a substantial amount of cross-border fishing activity. The spatial distribution of country specific catch value within the areas is dominated by Danish fisheries (ICES rectangle 39G5) and Polish fisheries (Figure 9-40).

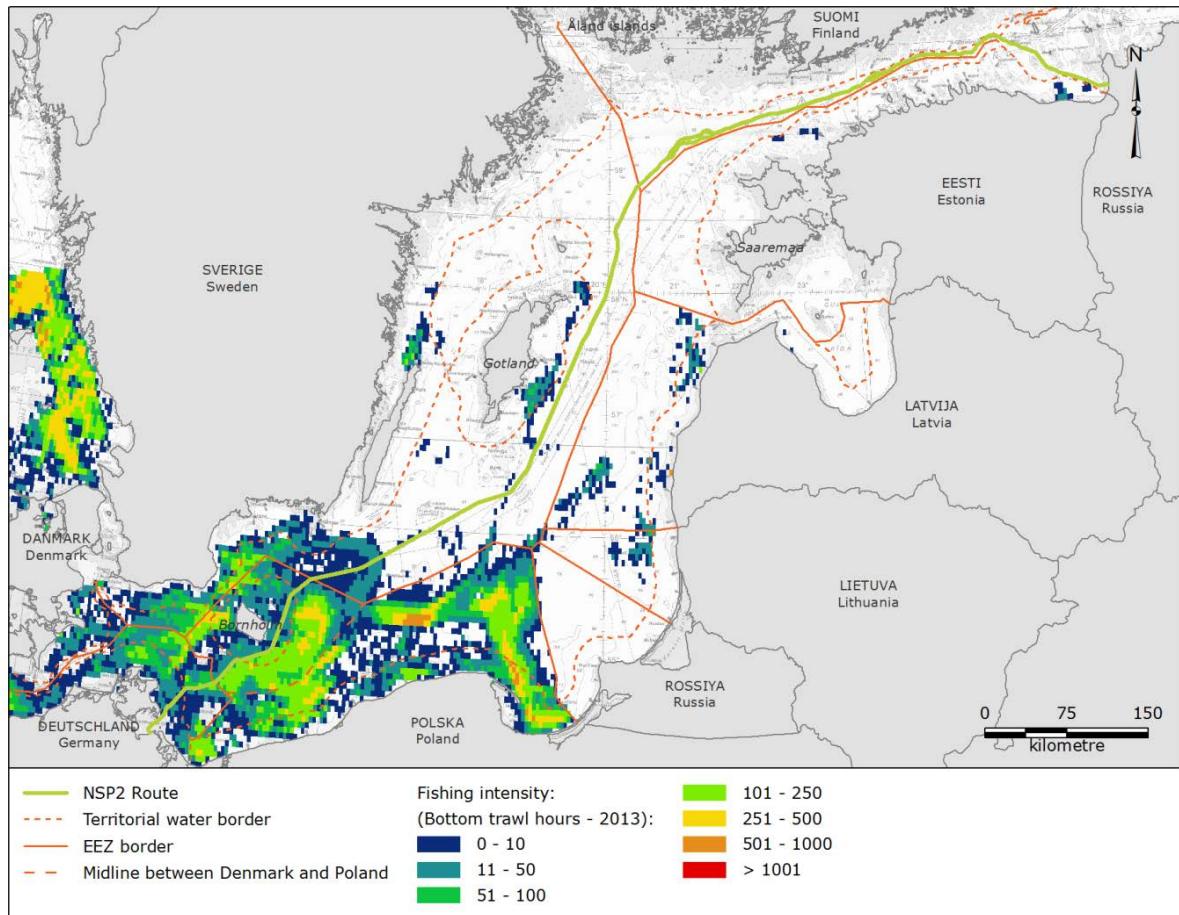


**Figure 9-40** Ratio of the mean annual distribution of the value of fishery by country in the ICES rectangles that follow or are adjacent the NSP2 pipeline transect for the period 2010-2014 (\*Poland 2009-2013). Source: derived from data obtained from fishery authorities in each country.

HELCOM provides data series and maps of the total number of fishing hours in the Baltic Sea. Maps and data for both bottom and midwater trawling are available for every year in the period 2009-2013 /206/. The HELCOM data do not cover the Russian sector. The fisheries that are potentially most impacted by the NSP2 pipeline are bottom trawling activities due to the presence of the pipeline on the seabed. HELCOM data on trawling intensity for bottom trawling is presented in Figure 9-41 and Atlas Map FC-19 (see also Atlas Map FC-20-Espoo (midwater trawling)).

As Figure 9-41 shows, bottom trawling mainly takes place in the western Baltic Sea. High fishing intensity is observed in the waters around Bornholm, in Danish territorial waters and within the Danish and Polish EEZs.

Atlas Maps FC-01-Espoo to FC-20-Espoo shows fish catch (by importance, weight, mean value) in the Baltic Sea by the Baltic Countries. Areas where fishery is prohibited is shown on Atlas Map FC-21-Espoo.



**Figure 9-41 Bottom trawling intensity based on total number of fishing hours in the Baltic Sea in 2013 /206/.**

### 9.9.5.3 Importance

Commercial fisheries within the Baltic Sea, including substantial cross-border activities, are a key contributor to the economy at the national level in many countries around the Baltic. Therefore a ranking of high importance has been given, although some areas are of higher importance than others.

### 9.9.6 Raw material extraction sites

The Baltic Sea coastal and marine areas contain valuable natural resources including marine aggregates and potential oil and gas reserves for extraction. Various locations have been targeted for possible exploitation of such resources. As shown in Atlas Map RM-01-Espoo, NSP2 does not cross such sites. The two closest sites, both of which are located in German waters, are situated approximately 300 m from NSP2. These sites are located in the area of Landtief and Proper Wiek. One is used for commercial gravel and sand extraction and a second is a designated area for the storage of sediments for coastal protection in the Mecklenburg-Western Pomerania State /207/. The status of these extraction sites is “paused” i.e. there is no general operating plans that exist and therefore no impacts to the site operators of the raw material extraction sites is anticipated. Other sites along the NSP2 route are located more than 6 km from the pipeline.

#### 9.9.6.1 Importance

Raw material extraction sites have a high economic value and therefore are key contributors to the economy at the national or international level. A ranking of high importance is assigned to raw material extraction sites.

### 9.9.7 Military practice areas

After 1945, the Baltic Sea served as a border between opposing military blocks and large parts of the TW were restricted areas of military importance. Although international politics have



changed, the Baltic Sea remains a strategic area, with the balance shifting from military interests towards logistic/commercial interests. The Baltic countries, however, maintain various types of military practice areas as shown in Atlas Map MI-01-Espoo.

As indicated on the Atlas Map, the NSP2 route crosses:

- Three firing danger areas in Finnish waters (one of which extends into Estonian waters);
- Two temporary shooting areas;
- Three firing danger areas in German waters.

The military practice areas crossed by NSP2 are described in more detail below.

#### 9.9.7.1 Finnish waters

NSP2 passes through three firing danger areas reserved for the training of the Finnish Defence Forces. Although activities that are dangerous to aircraft may occur, vessel movements in this area are not restricted. The distances crossed by NSP2 in these areas are listed below.

- 18 km section south of Helsinki (this firing danger area extends into the Estonian EEZ);
- 8 km section south of Porkkala;
- 47 km section of Hanko TTS to the west of Hankoniemi Peninsula.

#### 9.9.7.2 Danish waters

A section of the NSP2 route crosses approximately 69.5 km of a temporary shooting area situated to the east of Bornholm that is managed by Denmark and Sweden. Other military practice areas are located approximately 50 m east of NSP2. These include a highly active firing danger area south of Bornholm that is used by the Danish Armed Forces and the Danish Home Guard. It is mainly used for live fire practice from the island, which can occur 24 hours a day, and as a submarine exercise area, which is mainly used for naval shooting exercises by the German army.

#### 9.9.7.3 German waters

The NSP2 route passes through approximately 38 km of military practice areas in the German EEZ. The military practice areas include a target practice area and two artillery firing areas/restricted areas /208/.

#### 9.9.7.4 Importance

Military practice areas crossed by NSP2 provide an important service at the national and international levels and therefore are considered to be of high importance.

### 9.9.8 Existing and planned infrastructure

#### 9.9.8.1 Sub-sea cables

A number of active and inactive telecommunications and power cables traverse the Baltic Sea and are either buried or have been placed on the seabed. There are also proposals to lay further cables to serve future needs. The construction periods of the following currently planned cables that may cross the alignment of NSP2 have the potential to coincide with that of NSP2 (see Atlas Map IN-01-Espoo):

- IP-Only is a planned telecommunications cable running from Finland to Estonia. Details of dates and alignment are currently unknown.
- Linx (East) is a planned cable. Details of the ownership, route, dates and alignment are currently unknown.
- In the German EEZ, 50 Hertz plans to install 6 power cables, which will be crossed 6 times by each of the NSP2 pipelines i.e. a total of 12 crossing points. The cables will provide a connection to the onshore power grid located in Lubmin (north-east of the

Lubmin industrial harbour) from the offshore wind farms known as Arkona Basin South East and Vikings. Three cables are planned to be installed prior to the installation of NSP2. The installation dates of the remaining cables have not been defined. Where the proposed cables will cross NSP2, the section of the pipeline will be buried.

An overview of the status of the planned and existing sub-sea cables that will or may be crossed by both of the NSP2 pipelines is presented in Table 9-32 and in Atlas Map IN-01-Espoo.

**Table 9-32 List of planned, active and inactive cables along the NSP2 route**

Name	Route	Owner	Cable type	Status (active/inactive/planned)	Number of crossings by NSP2 (Line A)	Number of crossings by NSP2 (Line B)
<b>Russia</b>						
DK-RU1	Karlslund (DK) – Kingisepp (RU)	TDC	Telecom	Inactive	2	2
Jollas-Leningrad	Jollas, Helsinki (FI) – St. Petersburg (RU)	Great Northern Telegraph	Telecom	Inactive	1	1
UPT	Kaliningrad (RU) – St. Petersburg (RU)	CJSC Perspective Technologies Agency	Telecom	Active	3	3
<b>Finland</b>						
1 (found in 2005)	Unknown – located in the Finnish EEZ	Unknown	Unknown	Unknown	1	1
48 (found in 2008)	Unknown – located in the Finnish EEZ	Unknown	Unknown	Unknown	1	1
BCS North Segment B2	Helsinki (FI) – Hanko (FI)	Telia Carrier AB	Telecom	Active	2 or 0**	2 or 0**
EE-S1	Tahkuna (Hiiumaa, ES) – Stavsnäs (SE)	Telia Carrier AB	Telecom	Active	1	1
EE-SF2	Kaivopoisto (FI) – Leppneeme (ES)	Telia Carrier AB	Telecom	Inactive	1	1
EE-SF3	Lautasaari (FI) – Meremõisa (ES)	Telia Carrier AB	Telecom	Active	1	1
Estlink 1	Harku (ES) – Espoo (FI)	Fingrid, Elering	Power	Active	1	1
Estlink 2	Püssi (ES) -- Anttila (FI)	Fingrid, Elering	Power	Active	1	1
FEC1	Porkkala (FI)	Elisa	Telecom	Active	1	1

Name	Route	Owner	Cable type	Status (active/inactive/planned)	Number of crossings by NSP2 (Line A)	Number of crossings by NSP2 (Line B)
	– Tallinn, Kakumäe (ES)	Corporation				
FEC 2	Lauttasaari, Helsinki (FI) – Randvere, Tallinn (ES)	Elisa Corporation	Telecom	Active	1	1
FIN-EST out of use 1	FI – ES	Unknown	Unknown	Inactive	1	1
FIN-EST out of use 2	FI – ES	Unknown	Unknown	Inactive	1	1
IP-Only	Helsinki-Hangö (FI) – Tallinn (ES)	IP-Only	Telecom	Planned	2	2
Jollas-Leningrad	Jollas, Helsinki (FI) – St. Petersburg (RU)	Great Northern Telegraph	Telecom	Inactive	1	1
Linx (east)	Unknown	Unknown	Unknown	Planned	1	1
Pangea	Helsinki (FI) – Tallinn (ES) and Hiiumaa (ES) – Sandhamn (SE)	Linx Telecommunications B.V.	Telecom	Active	2	2
S15b_Tallinn-Helsinki KP 230	Tallinn (FI) – Helsinki (FI)	Unknown	Telecom	Inactive	0	1
Sea Lion (C-Lion1)***	Santahamina (FI) – Markgrafenhede (GE)	Cinia Group	Telecom	Active	2	2
UCCBF	St. Petersburg (RU) – Kaliningrad (RU)	Russian Ministry of Defence	Military	Inactive	5	5
UESF1	Helsinki (FI) – Hanko (FI)	Telenor	Telecom	Active	2 or 0**	2 or 0**
UESF2	Helsinki (FI) – Hanko (FI)	Telenor	Telecom	Active	2	2
UNID 3	Unknown – located in the Finnish EEZ	Unknown	Unknown	Unknown	2	2
Unknown R 13 (found in 2015/2016)	Unknown	Unknown	Unknown	Unknown	1	1
Unknown R 15 (found in	Unknown	Unknown	Unknown	Unknown	1	1 or 0

Name	Route	Owner	Cable type	Status (active/inactive/planned)	Number of crossings by NSP2 (Line A)	Number of crossings by NSP2 (Line B)
2015/2016)						
Unknown R 16 (found in 2015/2016)	Unknown	Unknown	Unknown	Unknown	1	1
UPT	Kaliningrad (RU) – St. Petersburg (RU)	CJSC Perspective Technologies Agency	Telecom	Active	4 or 2*	4 or 2*
<b>Sweden</b>						
Baltkom	Ventspils (LA) – Hultung (SE)	Latvia State Radio and Television Centre	Telecom	Active	1	1
BCS EW	Sandviken (SE) – Sventoji (LI)	Telia Carrier AB	Telecom	Active	1	1
LV-S1	S. Jarflotta (SE) – Busnieki (LA)	LatTelecom, Tele 2 Sverige	Telecom	Active	1	1
NordBalt HVDC Link	Nybro (SE) – Klaipeda (LI)	Svenska Kraftnät, Litgrid	Power	Active	1	1
Sea Lion (C-Lion1)***	Santahamina (FI) – Markgrafenhaid (GE)	Cinia Group	Telecom	Active	2	2
SWEPOL (HVDC and MCRC)	Karlshamn (SE) – Slupsk (PL)	Svenska Kraftnät, Polskie Sieci Elektroenergetyczne	Power	Active	2	2
<b>Denmark</b>						
Baltica Seg 1	Dueodde, Bornholm (DK) – Kołobrzeg (PL)	TDC, Telekomunikacja Polska, TeliaSonera International Carrier AB	Telecom	Active	1	1
DK – PL 1	Bornholm (DK) – Poland (PL)	TDC	Telecom	Inactive	1	1
DK - PL 2	Gedebak Odde (DK) – Mielno (PL)	TDC, Telekomunikacja Polska, TeliaSonera International Carrier AB	Telecom	Active	1	1
DK-RU1	Karslunde (DK) -- Kingisepp	TDC	Telecom	Inactive	1	1

Name	Route	Owner	Cable type	Status (active/ inactive/ planned)	Number of crossings by NSP2 (Line A)	Number of crossings by NSP2 (Line B)
	(RU)					
<b>Germany</b>						
50 Hertz	Offshore wind farms to the Lubmin (GE)	50Hertz (Although the wind farms to be connected are owned by EON and Iberdrola, the owner of the corresponding power cables is 50 Hertz)	Power	Planned	9	9****
RU – Russia; FI – Finland; SE – Sweden; DK – Denmark; GE – Germany; ES – Estonia; LA – Latvia; PL – Poland; LI – Lithuania Note*: Only two crossings for Line A and Line B if alternative route is implemented. Note**: No crossing if the alternative route is chosen. Note***: Includes the spur line. Note****: The grid connection consists of six cables that are considered for the permitting process.						

#### 9.9.8.2 Pipelines

Currently, the only two gas pipelines that have been installed in the Baltic Sea and are currently operational are related to those of the NSP project constructed in 2010-2012 (see Atlas Map IN-01-Espoo). The pipelines run from Vyborg (Russia) to Greifswalder Bodden (Germany) and will be crossed by both NSP2 pipelines, four times in Swedish waters and four times in Danish waters.

The Baltic connector is a planned natural gas pipeline connection between Inkoo, Finland, and Paldiski, Estonia. The NSP2 route will cross NSP south of Inkoo, Finland. According to preliminary plans, construction will take place in 2018-2020, and commissioning is expected towards the end of 2020. However, the installation schedule is to be confirmed.

#### 9.9.8.3 Wind farms

A number of wind farms have been constructed in the Baltic Sea. Others are subject to further planning, with permission having been granted for several such developments and areas of interest for the establishment of wind farms in the future also being identified. The closest sites to NSP2 are located more than 10 km away from it, in south of Bornholm (Denmark) and south of Helsinki and Koverhar in the Uusima region of Finland (see Atlas Map IN-02-Espoo). These sites are reserved areas for wind farms. All existing wind farms, areas of interest and wind farm projects that have been granted permission but are not yet developed are also located more than 10 km from NSP2.

#### 9.9.8.4 Importance

Sub-sea cables, pipelines and wind farms are key contributors to the economy at the national or international level. Future infrastructure will also play a key role in the economy. Therefore a ranking of high importance is assigned.

### 9.9.9 International/national monitoring stations

Long-term national and international environmental monitoring stations within the Baltic Sea are managed by several countries as well as by HELCOM. Atlas Map MS-01-Espoo shows monitoring stations in proximity of NSP2.

Stations that provide data related to bottom sediments and water quality may be of particular sensitivity to NSP2 due to the potential for disturbance of sediments from a range of construction activities.

The closest monitoring station is located approximately 800 m from NSP2 in the Finnish EEZ and used for monitoring benthos (see Table 9-33). A further two active stations are located within 1 km of NSP2, in Finland and Germany. An inactive monitoring station is located approximately 0.7 km west of NSP2. These stations are listed in Table 9-33 and presented in Atlas Map MS-01-Espoo.

A further seven environmental monitoring stations, located more than 1 km from the NSP2, may be sensitive to the more intensive seabed intervention works, notably dredging, rock placement and munitions clearance. These are included in Table 9-34 and presented in Atlas Map MS-01-Espoo.

**Table 9-33 Environmental monitoring stations within 1 km of the NSP2 corridor.**

Monitoring station name	Atlas Map ref. no.	Country responsible for monitoring	Parameter monitored	Distance from NSP2 (measured distance from either side of the pipelines)	Monitoring frequency
<b>Finland<sup>1</sup></b>					
LL6A	5	Finland	Benthos	0.8 km from Line A 0.9 km from Line B	Annually in May
LL5	6	Finland	Benthos	1.0 km from Line A	Annually in May
<b>Sweden</b>					
SE-11_old (inactive)	9	Sweden	Sediment contaminants and nutrients	0.7 km from Line A	Inactive station
<b>Germany</b>					
Greifswalder Bodden – GB7 (in the region of Struck)	10	Germany	Water temperature, salinity, oxygen saturation	0.8 km from Line B	5 surveys throughout the year
Note <sup>1</sup> : Only benthos stations have been considered.					

**Table 9-34 Environmental monitoring stations located more than 1 km from NSP2 that may be sensitive to seabed intervention works.**

Monitoring station name	Atlas Map ref. no.	Country responsible for monitoring	Parameter monitored	Distance from NSP2 (Measured distance from either side of the pipelines)	Monitoring frequency
<b>Estonia</b>					
N12	1	Estonia	Water, zoobenthos, zooplankton, phytoplankton, chlorophyll and transparency	2.8 km	Unknown
N8	2	Estonia	Water, zoobenthos, zooplankton, phytoplankton, chlorophyll and transparency (presents a data set on radionuclides in the water for the period 1998-2013)	7.5 km	Unknown
N5	3	Estonia	Radiation		Unknown
Narva jõe suue	4	Estonia	Hazardous substances		Unknown
<b>Finland</b>					
LL11	7	Finland	Water quality and benthos	1.4 km from Line A 1.5 km from Line B	Annually
LL7S	8	Finland	Benthos	1.6 km from Line A 1.4 km from Line B	Annually
<b>Germany</b>					
Greifswalder Bodden – GB19	11	Germany	Water temperature, salinity	4.1 km	5 surveys throughout the year

### 9.9.9.1 Importance

The environmental monitoring stations in proximity to NSP2 provide an important service at the national and international levels. Therefore a ranking of high importance is assigned.

## 9.10 Onshore landfall Narva Bay

### 9.10.1 Overview

The site of the proposed Russian landfall is located in the rural settlement (group of villages) of Kuzemkinskoe in Kingisepp Municipal District, in Leningrad Oblast (region). Further details of the administrative structure are provided in Section 9.10.2.1 below. The landfall facilities will be developed on land belonging to the Kurgalsky Nature Reserve and the Pribrezhnoe agricultural company (see Figure 9-42). The surrounding area is rural and includes forests, agricultural land and small communities.

The two proposed construction traffic routes pass through communities in Kuzemkinsoe as well as several communities in adjoining rural settlements (Figure 9-43).

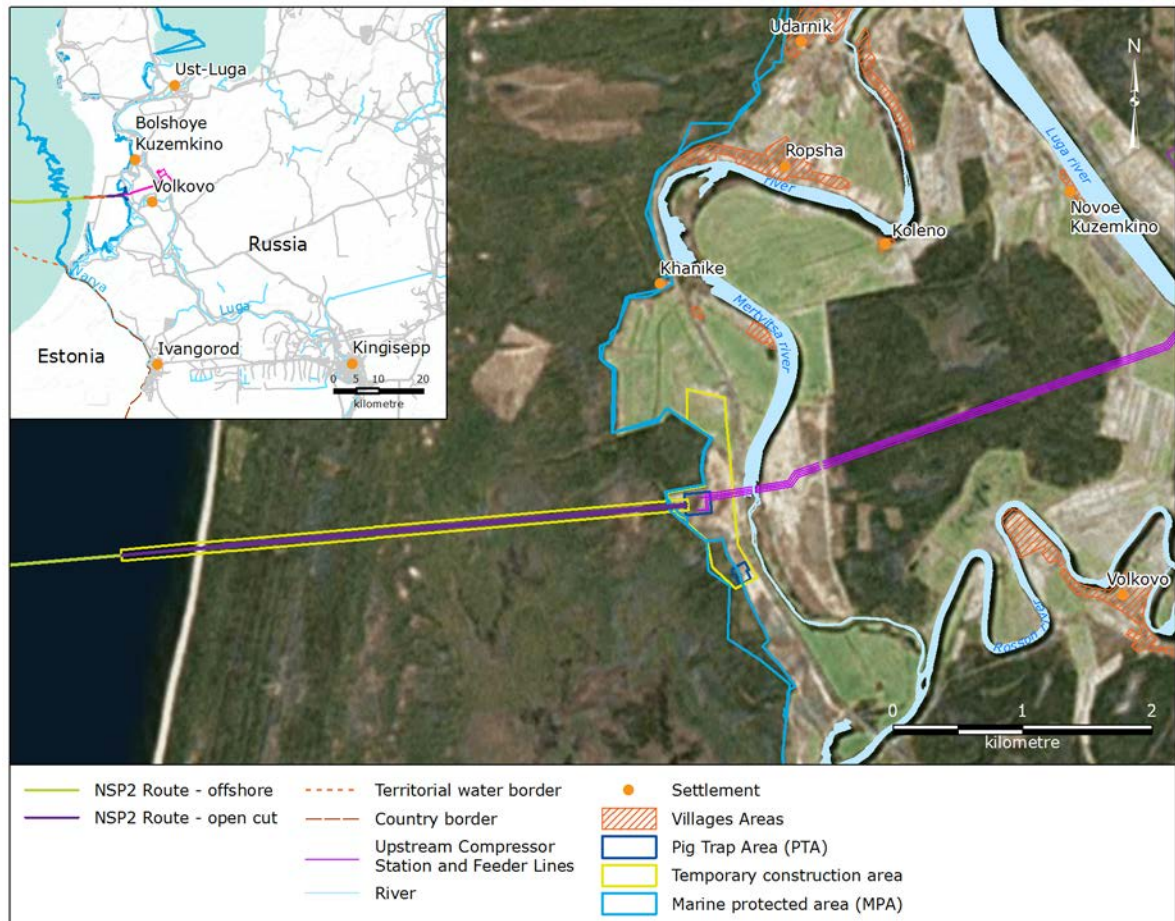


Figure 9-42 NSP2 landfall area in Russia

## 9.10.2 People

The following discussion provides an overview of people and communities that may be impacted by project activities. The primary receptors identified under this category include permanent and temporary residents of PACs, landowners in the project footprint, visitors to the project area and road users in the project area. Information on land and amenity use, community health and the demographical characteristics of these groups is provided below.

### 9.10.2.1 Administrative structure

Kingisepp Municipal District is located in the south-west of Leningrad Oblast and is one its 17 municipal districts. It borders Estonia to the west and the Gulf of Finland to the north and north-west and covers a total area of 201,000 ha, with a population of approximately 79,100 people /209/. The district also includes several islands in the Gulf of Finland /210/. The district comprises 2 urban settlements, 9 rural settlements /211/ and 193 smaller communities /210/. These are shown in Figure 9-43.

The administrative centre of the district is the town of Kingisepp.

### 9.10.2.2 Communities

The communities potentially affected by NSP2 are located within three rural settlements: Kuzemkinskoe, Bol'shelutskoe and Ust-Luzhskoe, all within Kingsepp district. These rural settlements may be affected directly by the construction and operation of the landfall facilities and/or by traffic movement during construction. Locations of these PACs are shown in Figure 9-43, with key characteristics summarised in Table 9-35. Further details are provided below:



- Kuzemkinskoe. Of the 18 communities in this rural settlement, 5 are located within 2.5 km of the landfall site and may potentially be directly affected by construction and operation. The closest community to the landfall area is Khanike, located less 500 m to the north of the boundary of the temporary construction area, and 1.5 km from the permanent PTA. Two other communities, Ropsha and Koleno, are located approximately 1.5 km from the landfall site boundary, while Volkovo and Vanakyulya are located approximately 2 km and 2.5 km from the boundary, respectively. A further 8 communities, as well as Ropsha and Khanike, are located along the construction access route from Ust-Luga port and may thus be affected by traffic movements. The PACs include Bol'shoe Kuzemkino, the administrative centre of Kuzemkinskoe rural settlement.
- Bol'shelutskoe. Of the 22 communities within this rural settlement, 3 (Novopyatnitskoe, Pervoe Maya and Pulkovo) are PACs owing to their proximity to the access route. The administrative centre is Kingisepp.
- Ust-Luzhskoe. Of the 12 communities within this rural settlement, 3 are considered to be PACs: Luzhicy, Ust-Luga and Preobrazhenka. Ust-Luga is the administrative centre of the rural settlement.

**Table 9-35 Potential project affected communities /212/.**

Community	Permanent population (2015)	Proportion of rural settlement population	Approximate distance from temporary work area
<b>Kuzemkinskoe rural settlement</b>			
Strupovo	16	1%	
Maloe Kuzemkino	15	1%	5.5 km
Bol'shoe Kuzemkino	911	67%	3 km
Udarnik	52	4%	1.5 - 2.5 km
Koleno	no data (part of Udarnik community)	-	1.5 km
Ropsha*	82	6%	1.5 km
Khanike*	8	1%	500 m
Volkovo	20	2%	2 km
Vanakyulya	37	3%	2.5 km
Fedorovka	26	2%	6 km
Keykino	91	7%	8.5 km
Dal'nyaya Polyana	1	0.1%	12 km
Izvoz	15	1%	13 km
<b>Bol'shelutskoe rural settlement</b>			
Novopyatnitskoe	260	7%	27 km
Pervoe Maya	113	3%	20 km
Pulkovo	38	1%	16.5 km
<b>Ust-Luzhskoe rural settlement</b>			
Luzhicy	103	4%	15 km
Ust-Luga (7 blocks)	2408	83%	11 km
Preobrazhenka	114	4%	9.5 km
	Communities located within 2.5 km from the PTA.		
*	Communities located within 2.5 km of the PTA and also along a construction access route (Figure 6).		
	Communities located along Route 1 access route that uses the Luga River bridge.		
	Communities located along the Route 2 access route that avoids the Luga River bridge.		

The figures in the table represent the size of the permanent population. As discussed below (Section 9.10.2.4), all of the communities also have temporary residents, a mix of owners of

summer homes and visitors. In Kuzemkinskoe, for example, the numbers of permanent and temporary residents are approximately equal /213/.

### 9.10.2.3 Land use

The landfall areas are characterised by small communities in a predominantly rural landscape.

The footprint of the PTA and the areas required for its construction are comprised of agricultural land currently used for growing hay.<sup>16</sup> The land is owned by a local company, Pribrezhnoe, a joint-stock company and large landholder in Kuzemkinskoe, owning approximately 3,600 ha of land.

The downstream pipeline right of way and associated construction corridor will pass through the Kurgalsky Nature Reserve, which is a state reserve managed by Kingisepp Forestry, Petrovskoe Military Forestry and the Administration of Kingisepp district /215/. As identified in Box 1, the reserve is a site of regional and international significance (it is a Ramsar site) that has been designated to protect the valuable flora and fauna of the Kurgalsky Peninsula and is also used by communities and visitors for a range of recreational activities as well as the collection of wild produce.

The land in the vicinity of the landfall site provides amenity value to local residents, seasonal residents and visitors. The environment and associated amenities are those of an area with few sources of pollution or disturbance and low levels of traffic and urban development. The proximity of the Gulf of Finland and the landscape of the nature reserve have led to this area being favoured for summer homes (“dachas”) by residents of the district and the Oblast.

In addition to the residential uses discussed in Section 9.11.2.2, the following key land uses in the surrounding areas that may be impacted by NSP2 have been identified:

- Nature conservation and recreation within Kurgalsky Nature Reserve;
- Amenity activities undertaken by local residents and residents of Kingisepp district;
- Hay growing by Pribrezhnoe agricultural company;
- Forestry managed by various companies/organisations;
- Hunting activities undertaken by hunting organisations;
- Roads (discussed further in Section 9.11.3).

#### **Box 1: Land uses in the project Area**

##### ***Nature conservation within Kurgalsky Nature Reserve***

The pipeline construction corridor (approximately 85 m wide and approximately 3.8 km in length) will cross the territory of Kurgalsky Nature Reserve. This a state reserve of regional and international importance (it is a Ramsar site) that has been designated to protect the valuable flora and fauna of the Kurgalsky Peninsula.

##### ***Recreational use by local residents and residents of Kingisepp district***

The territory of the Kurgalsky Nature Reserve is widely known as an area for informal recreation by local and district residents and summer visitors. These activities do not contribute significantly to the local economy, but provide a social value to PACs. Formal recreational activities are focused around a campsite and other visitor facilities located in the northern part of the reserve. Informal recreation is not restricted to one portion of the reserve. There are several informal recreation sites on the Gulf of Finland in the southern portion of the reserve that are accessed via unpaved roads accessible only by 4 x 4 vehicles. People use the beach primarily for swimming and hobby fishing. Hobby fishing is allowed within the Kurgalsky Nature Reserve between 1 January and 15 April and 15 July and 31 December /215/. Fishing also takes place in local rivers in the vicinity, including the Luga, Mertvitsa and Rosson rivers.

<sup>16</sup> According to interview with the Chief Engineer of Pribrezhnoye agricultural company on 1 September 2016.

Collection of berries and mushrooms is permitted in the nature reserve /215/. Examples of plants and mushrooms collected include cranberries, red bilberries, blueberries, cloudberries, mushrooms and blooming sally, depending on the season.<sup>17</sup> This activity is popular amongst local residents as well as people from Kingisepp and other communities in the district. Collecting wild plants is also a traditional practice of indigenous peoples residing in the district.<sup>18 19</sup> No priority areas for the collection of wild produce were identified by local stakeholders, who noted that collection activities take place throughout the reserve.

#### ***Hay growing by Pribrezhnoe Agricultural Company***

The PTA and temporary construction facilities and roads will be located on land owned by Pribrezhnoe, a large landowner in Kuzemkinskoe. Pribrezhnoe is a joint-stock company owning approximately 3,600 ha of land and employing only four permanent workers (most of whom are administrative personnel). Pribrezhnoe also leases some land to a local farmer and offers its premises for rent. Currently the company grows hay in the area to be acquired.<sup>20</sup> According to a Pribrezhnoe representative, the company will be able to find alternative land for its activities within that area easily.<sup>21</sup>

#### ***Forestry***

The areas surrounding the landfall include the Kingisepp Regional Forestry Area and the Ust-Luga and Primorskoye Forestry Area. These state properties are leased by two timber companies, CJSC "Kingiseppsky Lespromkhoz" and CJSC "Baltiisky Lessopromyshlenny Holding". These areas are not currently logged for timber but are subject to fire management activities.

#### ***Land used by hunting organisations***

Forested and open areas outside the Kurgalsky Reserve are used for hunting activities. LLC "Ecology-Kurgolovo" manages hunting grounds located to the east of the PTA supporting waterfowl (duck), moose, boar and deer.<sup>22</sup>

A total of 60 hunting licenses were issued in 2016 by LLC "Ecology-Kurgolovo". Hunting is limited to waterfowl. Other types of hunting licenses are not issued, according to a decision of the company's director. The areas used for hunting are located outside the project footprint (see Figure 9-42).

#### **Road use**

Roads in the vicinity of the landfall site tend to have low traffic volume, with the exception of the area near Ust-Luga port. Noise, congestion and air emissions associated with road use are therefore relatively low in the area. In addition to transport, local people also use the roads for commerce, e.g. roadside stands.

The proposed pipeline route will cross one of the access roads into the nature reserve that also provides border police with access to their barracks and connects two villages (Sarkyulia and Korostel) with the main road network.

There is a development project for cycling tourism in Kingisepp district and particularly in the Kurgalsky Nature Reserve and Ivangorod, which would take advantage of the amenity value and low traffic loads in the area. As part of this project, six cycling routes have been developed, including four in the nature reserve. Three out of four of these routes use the potential project access roads (see Figure 9-43 in Section 9.11.3).

Additional detail on roads in the project area is provided in Section 9.11.3.

<sup>17</sup> 'ivan-chai' – rus.

<sup>18</sup> According to interview with representative of 'Shoikula' IP community in September 2016.

<sup>19</sup> This was confirmed during various interviews conducted in August-September 2016, and in particular with Administration of Kingisepp district, administrations of Kuzemkinskoe and Bol'shelutskoe, representative of Indigenous Peoples community 'Shoikula', etc.

<sup>20</sup> According to interview with the Chief Engineer of Pribrezhnoye agricultural company on September 1, 2016.

<sup>21</sup> According to interview with the Chief Engineer of Pribrezhnoye agricultural company on September 1, 2016.

<sup>22</sup> According to information obtained during interview with the gamekeeper of Ecologiya-Kurgolovo hunting company on 2 September 2016.

#### 9.10.2.4 Community health and demographics

##### Community health and safety

Morbidity rates in the Kingisepp district in 2013-2015 exceeded the average rates for Leningrad Oblast. Morbidity rates per 1,000 people (for the district and the Oblast, respectively) were 1.345 and 1.025 in 2013, 1.311 and 1.067 in 2014, and 1.323 and 1.129 in 2015. It should be noted, however, that while morbidity rates have continued to grow steadily in Leningrad Oblast, they showed a downward tendency in Kingisepp district.

Respiratory diseases (27.6 % of morbidity cases), musculoskeletal system and connective tissue diseases (12.7 %) and other diseases (9.8 %) are prevalent in the adult population of Kingisepp district, with respiratory diseases being particularly marked in the morbidity structure of children (57.0% and 66.2% in the 15-17 and under 14 age groups respectively) Overall, respiratory disease is a significant morbidity factor in terms of community health status.

Table 9-36 presents data on road traffic incidents for Kingisepp district in 2014 and 2015. Traffic fatalities remained relatively constant across the two years, while the overall number of accidents and injuries in accidents decreased /216/. The total number of traffic accidents in 2014 and 2015 for the Oblast as a whole were 558 and 570, respectively, and the number of people killed in accidents was 224 and 219, respectively.

**Table 9-36 Road traffic accidents for Kingisepp district /216/.**

Accidents	2014	2015
Total number of road traffic accidents	220	163
Number of people killed in road accidents	22	23
Number of injuries	306	237

##### Medical and emergency services

Emergency and rescue services in the area are controlled by the supervising department of the Ministry of Emergency Situations of Russia in Kingisepp district. This department is located in Kingisepp and controls all emergency response and rescue activities in the area.

The principal hospital in the region is Kingisepp's P. Prokhorov Interdistrict Hospital. There is an ambulance station located in Kingisepp. Hospitals and outpatient clinics in rural settlements are either in poor condition (in case of Bol'shelutskoe or Ust-Luzhskoe rural settlements) or have a limited range of services (in case of Kuzemkino).

##### Demographic trends

While the population of Leningrad Oblast has experienced steady growth, reaching 1.78 million people in 2016 (an increase of 3.5% over the same period), this increase has been based entirely on positive net migration, against a background of a decline in natural population growth /217/.

The trend in natural demographic decline is also shared by Kingisepp district, which since 2011 has been dependent on the rate of positive net migration for population growth. In 2016, the population was approximately 79,100 people. However, 2015 was the only year that showed declines in both natural increase and net migration.<sup>23</sup>

A similar trend is observed in the Kuzemkinskoe, Bol'shelutskoe and Ust-Luzhskoe rural settlements. All of these settlements have experienced a steady natural decline in their permanent population, with population growth over the last five years being dependent on net migration. The general trend in Kuzemkinskoe and Bol'shelutskoe is that young people leave the communities and move to larger cities to study or work. Pensioners, on the contrary, tend to return to the communities. The communities are also constantly expanding because of temporary

<sup>23</sup> Results of Socio-Economic Development of Kingisepp district in 2011, 2012, 2013, 2014 and 2015 years.

residents who are building dachas in these rural areas.<sup>24</sup> This is demonstrated by the fact that in Kuzemkinskoe there is approximately the same number of seasonal or temporary residents /213/, i.e. dacha owners, and permanent residents, amounting to approximately 1,350 in each category.

### **Indigenous peoples**

The Russian landfall site is located in a region formerly inhabited predominantly by Finno-Ugric people, including the ethnic groups known as Votes and Izhorians. Based on a preliminary assessment, it appears that only members of the Izhorian ethnic group occur in the project area. The Izhorians are an officially recognised minor indigenous people of Russia and are included in the Common List of Minor Indigenous Peoples of Russia approved by the government of Russia /214/. Today, representatives of the Izhorian people live mainly in the Lomonosov and Kingisepp districts of Leningrad, and the largest number of Izhorian people live in the village of Vistino (43 people), located approximately 25 km from the project area.

#### **9.10.2.5 Importance and vulnerability of people in the Russian landfall area**

As discussed in Section 9.10.1, all "People" are considered to be of equal importance and it is thus not appropriate to allocate a specific definition of importance ranking. The vulnerability of receptors under this category is discussed in Chapter 10 – Assessment of environmental impacts, as it pertains to resilience to potential impacts.

### **9.10.3 Public services**

#### **9.10.3.1 Traffic and transport**

The area in the vicinity of the proposed landfall is served by federal road A180 "Narva"/E20, which has two and four lane sections and connects Kingisepp to St. Petersburg in the east and to Ivangorod and Estonia across the border, to the west.

Regional road A121 (two lanes) runs from Pervoye Maya, connecting settlements along the coastline on the left bank of the Luga River, including Fedorovka, Bolshoe and Maloye Kuzemkino, etc., to Ust-Luga and then to Vistino before running along the coast to St. Petersburg.

There is also a new A180 "Ust-Luga" double-lane highway, which connects Ust-Luga port to Alekseevka on the federal road A180 "Narva"/E20.

The project will use two road transportation routes from Ust-Luga port to the project area during the construction period. Smaller vehicles can travel via Route 1, which offers a more direct route to the project area along A121, north of Khanike. Due to the weight, width and height restrictions of the bridge over the Luga River near the town of Ust Luga (20 tonnes), oversized and heavy vehicles will travel via Kingisepp along A180 to Alekseevka, the A180/E20 to Pervoye Maya and then along the A121 south of Khanike (Route 2). The two routes are shown in Figure 9-43.

<sup>24</sup> According to information obtained during interviews with the administrations of Bol'shelutskoe RS and Kuzemkinskoe RS in August-September 2016.

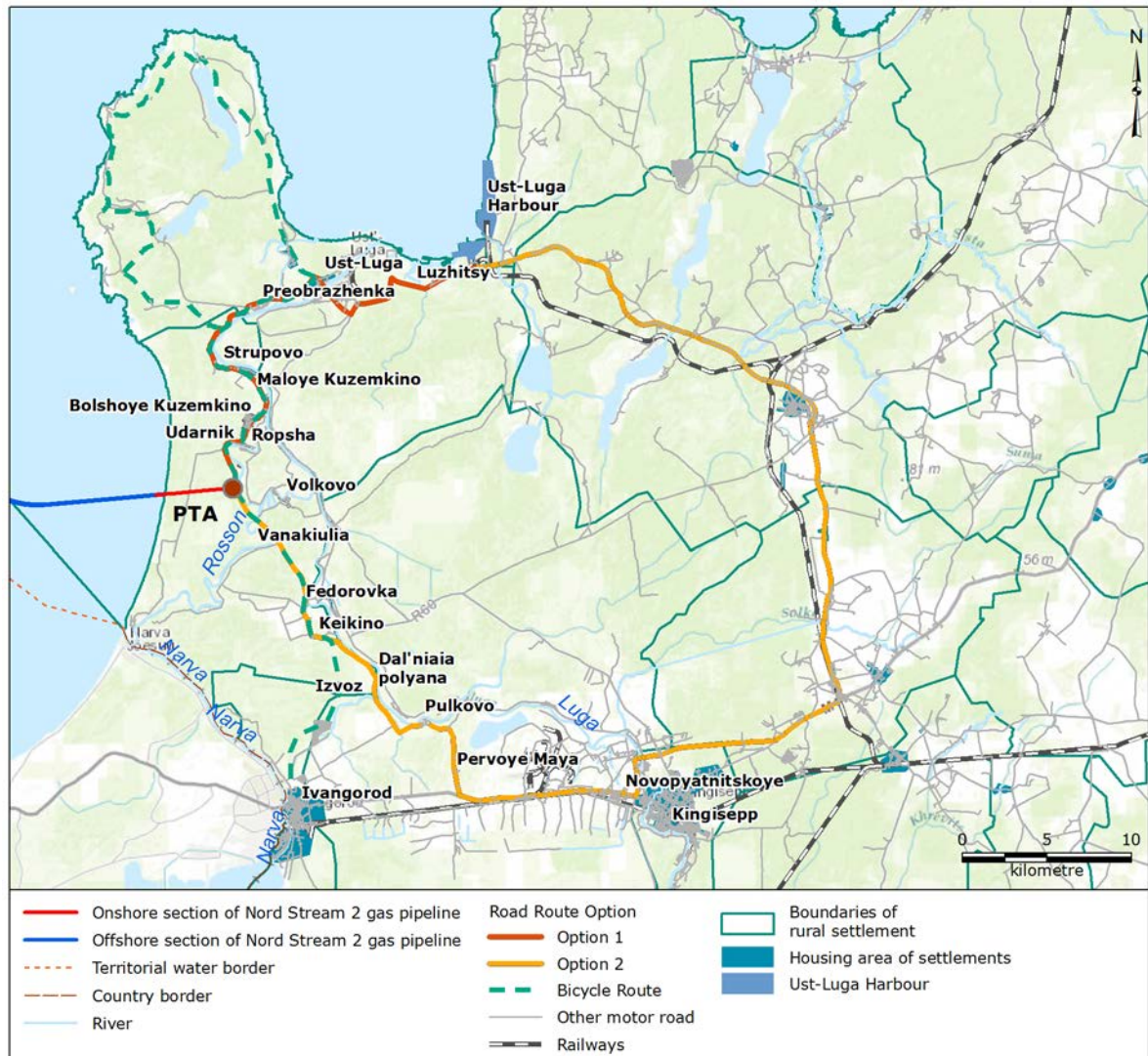


Figure 9-43 Construction traffic access routes

#### Box 2: Proposed construction access routes

##### Route 1:

Most project materials (approximately 95%) will be delivered to the project site along Route 1. The length of Route 1 is approximately 35 km. This route follows the A121 road, which is in good condition overall between Ust Luga and Khanike. It has two lanes and narrow shoulders with no traffic lights, but it does have some tight corners and passes through several villages. Pedestrian sidewalks are present only in Bolshoe Kuzemkino. Ongoing reconstruction works on this road in Bolshoe Kuzemkino were observed during a site visit. In general, roads on this route are not busy, except in the area near Ust-Luga port. There is also evidence of community members using the road for local commerce (i.e. roadside stands, Figure 9-44).

There is a school bus service in operation that takes children from villages in the Kuzemkinskoe rural settlement to a school in Ust-Luga, with most journeys using sections of Route 1. There are two buses operating along this route.

##### Route 2:

The length of Route 2 is approximately 95 km. It uses the A180 and A121 between Pervoye Maya and Khanike. The A180 "Narva" road, especially in the area of the Kingisepp bypass, can be busy with traffic going to Ivangorod and is also used by people from Kingisepp. Most significant junctions are controlled by traffic signals. Reportedly, there is an area with a high density of traffic accidents with pedestrians in Novopiatnitskoe. There is also a children's playground located close to the road.

The school bus service for the Ust-Luga school also utilises some sections of the Route 2 route.



Figure 9-44 Fruit selling along indicative portion of Route 1

There is a public bus transportation network in the Kingisepp district, with the total fleet size estimated at 80 buses. The buses service communities along both construction traffic routes.

There is a proposal to develop cycling tourism in Kingisepp district, in particular in the Kurgalsky Nature Reserve and Ivangorod. As part of this project, six cycling routes have been developed, including four in the nature reserve. Three of these cycling routes use the project access roads, especially the A121 road (Figure 9-43).<sup>25</sup>

#### 9.10.3.2 Schools

The only school in the vicinity of the project is located in Ust-Luga ('Krakol'e school'). It is the only school in the Ust-Luzhskoe and Kuzemkinskoe rural settlements. As described above, school buses transport children from communities in the project area to the school.

#### 9.10.3.3 Utility infrastructure

An underground communications cable and an overhead power line are present along the A121 road but should not be affected by project activities.

#### 9.10.3.4 Importance of public services

Roads are the only public service/infrastructure with the potential to be impacted by project activities. These services are of high importance to local residents, because they are important to local economic and social activity, and there are few alternatives. Both of the construction access routes comprise roads that are used for public transportation (school and public bus routes) as well as by pedestrians, cyclists and private vehicle traffic, particularly in the vicinity of towns and population centres. Sections of Route 2, particularly near the Kingisepp bypass and Novopyatnitskoe, are subject to higher traffic and pedestrian volumes and therefore more susceptible to additional traffic flow disruption and safety concerns.

<sup>25</sup> According to information provided by the administration of Kingisepp District September 2016.

## 9.10.4 Economic resources

### 9.10.4.1 Economy and employment at the regional and district level

Leningrad Oblast is one of the leading economies in north-west Russia. Its GRP grew every year between 2010 and 2014, albeit with a slight decrease in 2013 /218/. In 2014, the Oblast generated 714 billion RUB (11.5 billion EURO). Processing and manufacturing industries (car manufacturing, petrochemicals, etc.) form the basis of the economy, accounting for 27% of the GRP. As an important region for logistics with several large ports, transport and communications comprise the second largest economic sector, generating 16% of the GRP, while agriculture and fisheries account for 8% and 0.1% of the region's GRP respectively /218/, /219/.

At the Kingisepp district level, the economy has traditionally been dominated by processing industries, transport and construction. In 2015, the processing sector accounted for 76% of district level economic activity, and the transport sector accounted for 21% of economic activity /220/. Processing and manufacturing industries include petrochemicals, the glass industry, and the production of spare parts for cars, construction materials and petrochemical products /221/. The majority of the industrial companies of the district are located in the Industrial Area of Phosphorit in Bol'shelutskoe, or in Kingisepp. The key facility in the transport sector of the district is the Ust-Luga marine port (located 11 km from the project area). It is the largest port that operates all year round in Leningrad Oblast and has 12 terminals. The freight turnover of the port was 88 million tonnes in 2015 /222/.

As of 2015, the construction sector accounted for only 1% of the economic activity of the district /220/. The role of agriculture and fisheries in the district economy is also minor (less than 1%) /220/.

As of 2015, the majority of jobs in Kingisepp district are in the processing and manufacturing industries (26%) and transport (19%). Educational and health care institutions are also important employers, providing 12% and 9% of jobs, respectively. Other important sectors in terms of employment include wholesale and retail trade<sup>26</sup> (9%) and construction (8%). Approximately 3% of the district workforce is employed in agriculture /75/.<sup>27</sup> The key employment sectors in the district are not seasonal in terms of labour demand. Seasonal employment in the district tends to be limited to a small number of jobs in the agricultural sector.

The unemployment rate in Leningrad Oblast has been lower than the national level for the past decade. However, it has been growing since 2013, approaching the national rate at 5.1% unemployment /223/. Comparable unemployment figures are not available at the district and rural settlement levels.

### 9.10.4.2 The local economy

The dynamics of the labour market in the project area vary by rural settlement and are linked to the economic activities of local organisations present in each area (e.g. Ust-Luga marine port and industrial companies in Bol'shelutskoe).

Small-scale economic activities in the project area include small shops, roadside vendors along the proposed construction access routes, and the collection of fruits and berries in Kurgalasky Nature Reserve. Although most people pick wild plants for their own consumption, some individuals also collect them for sale.<sup>28</sup>

<sup>26</sup> The full title of the index is 'wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods'.

<sup>27</sup> The full title of the index is 'agriculture, hunting and forestry'.

<sup>28</sup> According to interviews with the Head of Kuzemkinskoe Administration, the Deputy Head of Bol'shelutskoe Administration, with representative of 'Shoikula' IP community in August-September 2016.



**Box 3: Economic and employment trends in the rural settlements****Kuzemkinskoe rural settlement**

Kuzemkinskoe rural settlement does not have any industrial companies. The Pribrezhnoe agricultural company is located in the landfall area within this rural settlement. Due to the decline in collectivised agriculture, this company has large land assets but provides very little in terms of local employment (approximately four permanent jobs and one or two seasonal jobs harvesting hay). There are seven small businesses and eight individual entrepreneurs in the rural settlement. Most of them run small shops.

In 2015, the population of Kuzemkino was mostly employed in construction (35%) and wholesale and retail trade (34%). Approximately 11% of employment was in the educational sector and only 3% of the local workforce (four people) was engaged in 'agricultural activities, hunting and forestry' /224/.

**Bol'shelutskoe rural settlement**

In Bol'shelutskoe, most people are employed in chemical production (46%), 'production of other non-metal products' (13%) and construction (4%). Information on employment in the agricultural sector is lacking. All other sectors account for less than 2% /225/.

**Ust-Luzhskoe rural settlement**

The construction (49%) and transport (33%) sectors are the largest employers in Ust-Luzhskoe /226/. These sectors include people working in the port and construction of residential buildings in the Ust-Luga community. The third most important employment sector is education (12%) /226/. Data on employment in agricultural activities is not available.

**9.10.4.3 Tourism**

Tourism does not play a significant role in the economy of Kingisepp district. Tourism accounts for approximately 1-2% of the GRP, and the sector employs approximately 600 people /220/.

The areas responsible for most of the revenue and employment generation from tourism in the district are not located in the project area. Approximately 10,000 tourists visited Kingisepp district in 2015, and 95% of them visited the urban areas of the district, i.e. Kingisepp and Ivangorod, which are outside the project area. The town of Narva-Jõesuu, located near the landfall location on the Estonian side of the border, is popular with Russian tourists due to its long beach and spas.<sup>29</sup>

The Russian Baltic coastal region, however, is experiencing a steady increase in tourist numbers, and infrastructure investments could lead to further growth in the future. The Kuzemkinskoe area (notably the Kurgalsky Peninsula) is rich in natural and recreational resources and as such has great tourism development potential. There are formal recreational facilities in the northern part of the peninsula. As discussed in Section 9.11.3, a system of cycling routes has been proposed in Kingisepp district, including in the Kurgalsky Nature Reserve and Ivangorod. These were developed with the potential to be part of international cycling routes and may therefore generate additional tourism activity.

Local recreational activities in the landfall area, including within the Kurgalsky Nature Reserve, are discussed under Section 9.11.2.3.

<sup>29</sup> Employed in 'hotels and restaurants' sector.

#### 9.10.4.4 Importance of economic resources: Russian landfall area

The primary economic activities in the project area vary by rural settlement. At a district level, processing and manufacturing industries and transport are the largest contributors to employment and income. These activities are rated medium importance because they play an important role in the local, district and Oblast economy. These sectors rely to some extent on the availability and quality of road transportation.

Tourism activities, including beach tourism and spas, are rated low importance, as they play a small role in the district and oblast economy and generate a relatively small number of jobs in the project area.

#### 9.10.5 Cultural heritage

##### 9.10.5.1 Tangible cultural heritage

Preliminary investigations carried out in 2016 identified two archaeological heritage sites from the Neolithic period within the planned pipeline construction corridor in the Kurgalsky Nature Reserve (Figure 9-45).

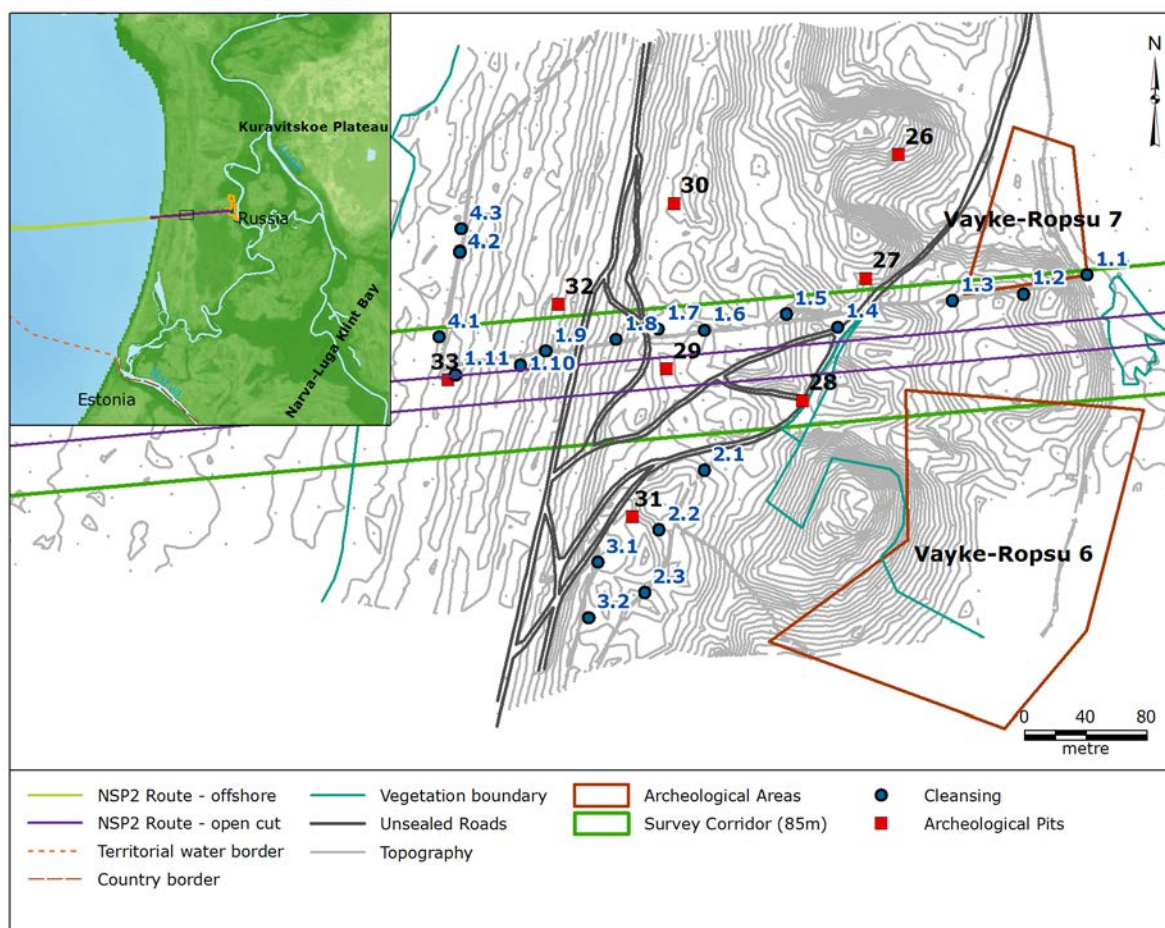


Figure 9-45 Location of identified cultural heritage sites in the Russian landfall area

These sites are associated with a relict dune feature known as the Kudrukulskaya palaeospit. This feature is potentially of both archaeological and palaeogeographical interest. The investigations of the area have found evidence of typical combed and corded ceramics as well as stone tools and bone fragments.

A notification has been sent to the competent authorities who will carry out an expert review of the report of the consulting archaeologist and issue detailed recommendations for further investigation work, if any is deemed to be required.

### 9.10.5.2 Intangible cultural heritage

The PACs have intangible types of cultural heritage associated with their communities. This includes the languages, costumes, folk songs and crafts of the Izhorian and Vod indigenous peoples. The Izhorian and Vod languages are considered to be severely endangered and critically endangered according to UNESCO classification. There are several cultural and intangible natural resources that have been identified by a representative of community Shoikula and Centre of Leningrad Oblast as being of significance in Kurgolovsky peninsula and in Luzhicy. No sites of tangible cultural heritage or intangible heritage of indigenous peoples have been identified within the footprint of or the immediate vicinity of the project landfall site thus far. However, this is the subject of further work by Nord Stream 2 AG.

### 9.10.5.3 Importance of cultural resources: Russian landfall area

As described above, two Neolithic archaeological sites have been identified within the project footprint. The two sites identified during NSP2 surveys are still being reviewed by the national authorities in terms of their significance. A preliminary analysis of the finds has assessed them as having medium importance.

Several sites with intangible cultural heritage, as well as two endangered languages, have been identified in the project area. These are important to local communities, including indigenous peoples. The sites have not been assigned regional or federal significance and are therefore considered to medium importance.

## 9.11 Onshore landfall Lubmin 2

### 9.11.1 Overview

The site of the proposed Lubmin 2 landfall area is situated in the municipality of Lubmin within the rural district Vorpommern-Greifswald in the Mecklenburg-Western Pomerania State, north-east Germany. The permanent landfall facilities (primarily PTA) and associated temporary construction facilities will be accommodated on land reserved for "industrial development with higher space requirements" within the Lubminer Heide industrial and commercial area. The micro-tunnel section onshore will have a length of approximately 385 m. Thereafter, about 120 m of pipeline will pass under the tourist beach. The remainder will pass under a transport and service corridor, ruderal areas and open forest before reaching the PTA (Figure 9-46).

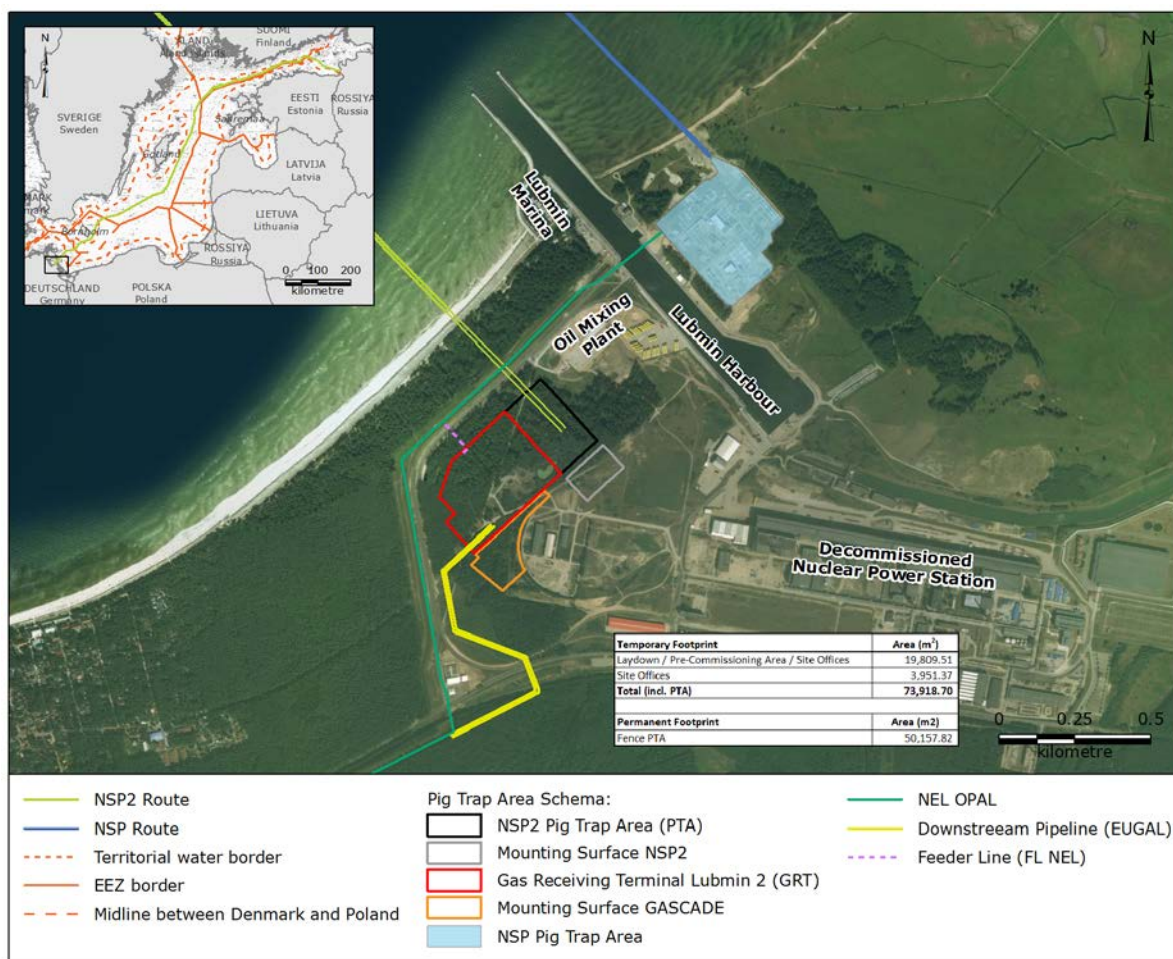


Figure 9-46 Location of German landfall Lubmin 2

### 9.11.2 People

The following sections provide an overview of people and communities with the potential to be impacted by project activities. The receptors identified under this category include permanent and temporary residents of PACs, landowners in the project footprint, recreational users of the surrounding land areas, visitors and road users in the surroundings. Information on land and amenity use, community health and the demographical characteristics of these groups is provided below.

#### 9.11.2.1 Communities/settlements

The only settlement with potential to be directly affected by construction and operation of the landfall facilities is the eastern part of Lubmin town, which is located approximately 800-1,500 m west of the landfall site. Visually, this area is screened from the project area by a pine plantations. Lubmin in general has a population of about 2,100 permanent residents, but as a seaside resort, the area is a touristic hotspot and also includes various facilities for tourism. Guesthouses, shops and restaurants, as well as other pension institutions that can be used by citizens and tourists are located in and around Lubmin, mostly outside of the project area.

#### 9.11.3 Recreational and other land uses

As previously described, the landfall area is situated within the planned "Lubminer Heide" industrial and commercial area, managed by the Energiewerke Nord GmbH (EWN). A legal development plan exists for this area (4<sup>th</sup> amendment of the 19.11.2007, Zweckverband "Lubminer Heide" 2007). In addition, this area is reserved for tourism according to the land use plan /227/ (see Figure 9-16, Section 9.4.2. Lubmin and the adjacent forest areas of the Lubminer Heide area are defined as "important areas for the recreational function of the landscape" /227/.

The beach located about 300 m to the north-west of the PTA and under which the micro-tunnel section of the pipeline will run is a popular recreational area for walks and bathing. The touristic beach of Lubmin and the surrounding forests have a high recreational value for both tourists and residents. The area is also intensively used by citizens of Greifswald, which is the fifth largest city of Mecklenburg-Western Pomerania and located just 20 km away. As Greifswald has no comparable beaches, the large beaches in the close vicinity of Lubmin are frequently used in the summer season (June to end of September). The Lubmin Marina situated next to the industrial harbour and about 500 m north of the PTA has 180 berths and provides ideal access to the Greifswalder Bodden sailing area around Rügen and Usedom. Tourists and residents reportedly use the quay area of Lubmin Harbour to fish.

A kite shop ("Ostsee Kiteschule") in Lubmin Marina that uses the beach and a camping area has been observed in front of the administration building.

Lubmin Marina, which is used by residents and tourists, is connected to the community of Lubmin via two paths running through the dune forests and along the shore.

#### **9.11.4 Public services**

##### **9.11.4.1 Traffic and roads**

The landfall at Lubmin is located within the rural district Vorpommern Greifswald. This area is also called the gate to Scandinavia and Eastern Europe, as many people travel through that region on their way more distant destinations. Consequently, the traffic infrastructure is well developed; there are federal highways running from north to south (B96 and B109) and from east to west (B110 and B111). Furthermore, the well-developed road network contains 200 km of rural roads, and about 20 km of the Baltic highway A20 passes through this area. The German landfall area is directly connected to the roads of long-distance traffic via the main road (L262). The rail network is well developed as well and on the direct connection between Rügen Island and Berlin There are six stops within the rural district. Construction traffic access will be from the L262, which runs in the south of the "Lubminer Heide" industrial and commercial area.

As shown in Fig. 9-47, the route to the construction site (L262) connects to the national road network via federal road B111. The transport infrastructure around the landfall is well developed.

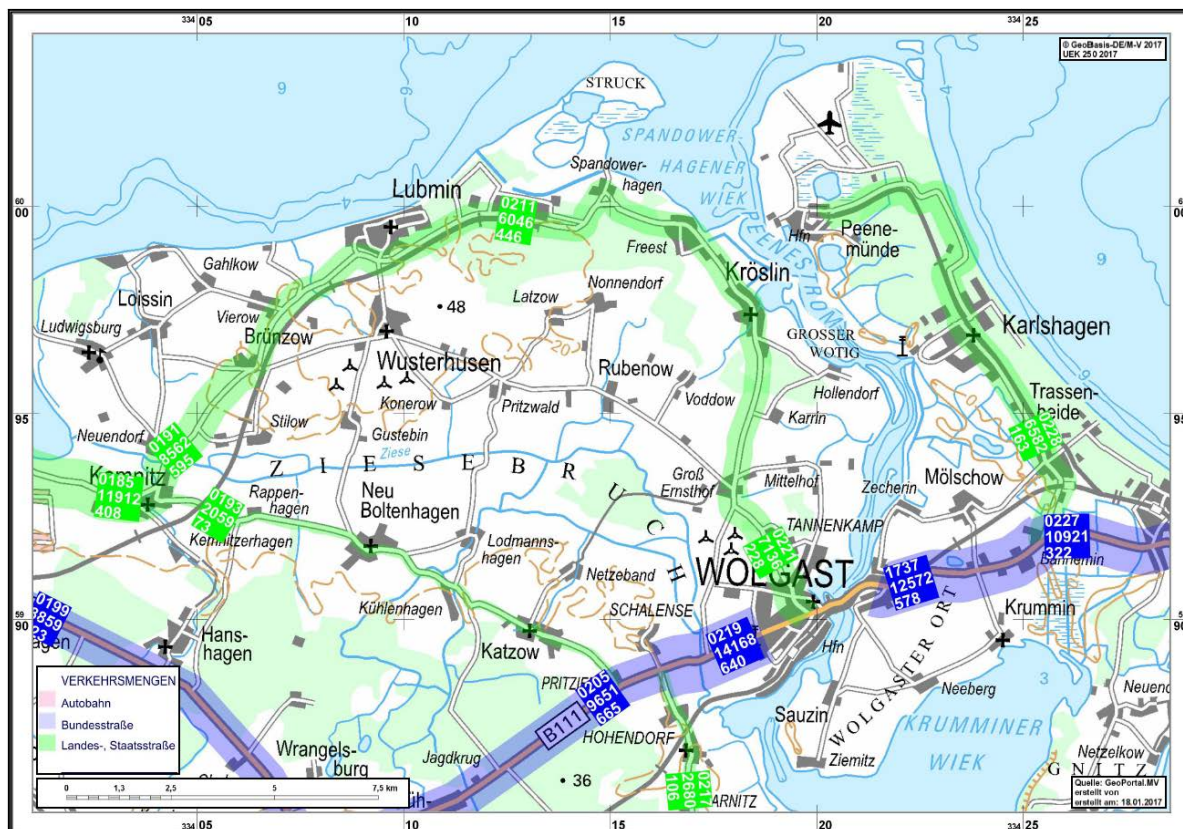


Figure 9-47 Construction traffic access routes at and surrounding the German landfall Lubmin 2

### 9.11.4.2 Existing and planned infrastructure

The onshore section of the Lubmin 2 landfall area will cross underneath a public road, a railway track and other infrastructure comprising a planned gas line, other existing gas lines, wastewater lines and drinking water lines. The infrastructure crossed by NSP2 is provided in Table 9-37.

Table 9-37 Infrastructure within the utility corridor crossed by NSP2 – Lubmin 2 landfall.

Type of infrastructure	Operator/ Description
Road	Freesendorfer road
Railway track	Energiewerke Nord GmbH
Gas (planned)	Concord Power NORDAL GmbH
Gas	NEL Gastransport GmbH
2 fibre optic cables	WINGAS GmbH
Reduction conductor	GASCADE Gastransport GmbH
Gas	OPAL Gastransport GmbH & Co. KG
Wastewater	Zweckverband Wasser / Abwasser Boddenküste
Gas	HanseWerk AG
3 Controlling and communications cables	Energiewerke Nord GmbH
3 medium voltage cables	Energiewerke Nord GmbH
Wastewater	Energiewerke Nord GmbH
Drinking water	Energiewerke Nord GmbH

### 9.11.4.3 Importance

As described above, onshore utility infrastructure will be crossed by NSP2 and is a key contributor to the economy at a regional level. Therefore a ranking of medium importance has been given.

### 9.11.5 Local economic activities and employment

In Mecklenburg-Western Pomerania, the marine industry, engineering, energy and the food industry are of high importance. Furthermore, tourism, the health sector and real estate play an important role.

In Mecklenburg-Western Pomerania, 1,398 companies within the marine tourism represent the supporting pillar for the tourism sector. Fifty-five per cent of these companies work in the area of marine water sports and nautical tourism. Most of the companies consist of three or fewer employees, indicating the major importance of small- and medium-sized companies in Mecklenburg-Western Pomerania. Fifty-eight per cent of the companies are located at the Baltic or in the region of Greifswalder Bodden, and every tenth is located on Rügen Island (MFWAT M-V 2004, 2009). Three thirds of all commercial overnight stays are in coastal areas, more than 20% of which are on Rügen Island. Summer and bathing tourism is the second central topic of tourism in Mecklenburg-Western Pomerania.

Tourism represents the most important economic activity within the close vicinity of the German landfall region. Furthermore, the development of an attractive and innovative industrial location is pushed forward (industrial park "Lubminer Heide").

### 9.11.6 Tourism and recreational areas

As already described in Section 9.11.1.4, Lubmin is a coastal resort and well known for its scenic location. It has well developed tourist infrastructure, making it an important tourism area in the Mecklenburg-Western Pomerania state /227/, /218/. The beaches and forests in proximity of the landfall area are important areas for recreational activities. The closest recreational areas to the landfall area include a marina (approximately 500 m), a beach (300 m) and a pier (approximately 2 km).

#### 9.11.6.1 Importance

Tourism and recreational areas in Lubmin are key contributors to the economy at a regional level. Therefore, tourism and recreational areas are considered to be of medium importance.

### 9.11.7 Cultural heritage

According to the Culture and Preservation of Monuments State Office (Mecklenburg-Western Pomerania State) and the local conservation authority, there are no architectural monuments, areas of architectural monuments or other cultural assets within or around the Lubmin landfall /228/, /229/.

#### 9.11.7.1 Importance

As described above, no cultural heritage features have been identified in the Lubmin landfall area.

## 9.12 Onshore ancillary areas

### 9.12.1 Overview

This section provides an overview of people within 2 km of the rock transportation route and the vicinity of the temporary ancillary facilities. Activities at the ancillary areas include rock transportation in Kotka (Finland) and the operation of temporary ancillary facilities in Kotka (Finland), Hanko (Finland), Karlsham (Sweden) and Mukran (Germany), all of which are located in harbours. The following aspects have been considered:

- Local communities in proximity to the rock transportation route;
- Communities in proximity to ancillary facilities with potential to benefit from economic opportunities from NSP2;
- Roads proposed for rock transportation.

## 9.12.2 People

### 9.12.2.1 Local communities

The receptors that may be within the zone of influence of NSP2 in the onshore ancillary areas are located within 2 km of the rock transportation route, and the nearest communities are located approximately 3 km from the rock transportation route. An overview of the local communities/settlements, local economy and employment are included in the sections below.

**Table 9-38 Communities within the zone of influence of onshore ancillary areas.**

Community/ areas	Closest receptor	Ancillary component	Estimated distance from ancillary activity
<b>Kotka, Finland</b>			
Ristiniemi	Residential area	Coating plant and operations	0.3-0.8 km north
Takakylä	Residential area	Rock transportation route	1 km west of Road 355
Etukylä	Residential area	Rock transportation route	2 km west of Road 355
Hirssarri	Residential area	Rock transportation route	1 km west of Road 355
Hovinsaari	Residential area	Rock transportation route	1 km from Road 15
	Hovinsaari power plant (157 MW)	Rock transportation route	1 km west of Road 15
	Sweetener manufacturing facility of Danisco	Rock transportation route	1 km west of Road 15
	Central Hospital of Kymenlaakso	Rock transportation route	1 km west of Road 15
	Mussalo elementary school	Rock transportation route	1 km from Road 355
	Kindergarten	Rock transportation route	0.3 km from Road 355
	Hospice for disabled youth is located in Etukylä	Rock transportation route	1.2 km from Road 355
Metsola	Residential area	Rock transportation route	1 km west of Road 15
Korela	Residential area	Rock transportation route	1 km west of Road 15
<b>Hanko, Finland</b>			
Lappohja	Village	Pipe storage yard	2.5 km, north-east
<b>Karlshamn, Sweden</b>			
Janneberg	Residential area	Pipe storage yard	2.6 km
Horsaryd	Residential area	Pipe storage yard	2.7 km

#### Kotka, Finland

##### *Local communities*

The city of Kotka is located on the coast of the Gulf of Finland at the river delta of the River Kymijoki, within the Kymenlaakso region in southern Finland. It is located 130 km east of Helsinki and 290 km west of St. Petersburg. The main E18 highway runs through Kotka.

The proposed rock transportation route runs through Highway 7 (E18) via Road 15 (Hyväntuulentie) and Road 355 (Merituulentie) to the Mussalo Harbour (see Section 9.12.2.4). The main rock transportation route, Road 355, is mainly characterised by small-scale industrial areas, with a railway road and residential areas (Takakylä, Etukylä and Hirssarri). The residential areas along Road 355 have a total population of 907 people. The majority of people on the island live in Etukylä. The Mussalo elementary school, kindergartens and a hospice for disabled youth are located approximately 0.2-1.2 km the Road 355. The nearest kindergarten is located 0.3 km from Road 355. Takakylä is another major residential area on the west side of Road 355 (see Table 9-38).



#### *Local economy and employment*

The unemployment rate (recorded in June 2016) in Kotka was high at 21.4%, i.e. 5,275 unemployed people. The average national unemployment rate in Finland was 7.8% /231/.

#### **Hanko, Finland**

##### *Local communities*

Hanko Koverhar is part of the Uusimaa region in southern Finland. The ancillary facilities will be established at the Koverhar Harbour, part of the port of Hanko. The closest residential area to ancillary components is the village Lappohja, located approximately 2.5 km north-east of Hanko Koverhar with a population of 700 people /231/.

##### *Local economy and employment*

The unemployment rate of the registered labour force of the Helsinki-Uusimaa region is higher than the average national unemployment rate /231/. Currently, economic activities in the area of Koverhar are low, as the Koverhar Steel Factory (FN Steel Oy Ab) has been closed since 2012 and the industrial area is mainly administered by the City of Hanko. Lappohja comprises a steel factory (SSAB Europe) and Viskontie comprises a packaging manufacturer for the food industry (ViskoTeepak). At the end of 2016, the unemployment rate in Hanko was at 13.9% i.e. 554 unemployed. The average unemployment rate in Finland is 7.8% /231/.

#### **Karlshamn, Sweden**

##### *Local communities*

The Municipality of Karlshamn is located in the County of Blekinge, with 31,598 residents. Janneberg and Horsaryd are the closest communities to the ancillary facility, located 2.6 km and 2.7 km from the facility, respectively.

##### *Local economy and employment*

Karlshamn port is one of the most important and largest ports in Sweden and plays an important role in the south-eastern Baltic Sea region. The main goods managed in the port include energy, forestry and bulk products /230/. The unemployment rate for the municipality of Karlshamn was 10.2% in 2015 /230/.

#### **Mukran, Germany**

##### *Local communities*

Mukran port is located on the Jasmund Peninsula, Rügen Island, in the Federal State of Mecklenburg Vorpommern. Sassnitz is the closest community to the ancillary facility, located approximately 5 km north-east of the facility.

#### **9.12.2.2 General health**

The general health of communities along the planned rock transportation route has been described due to the nature of the impacts that may arise. A resident survey was conducted in Kotka as a part of the NSP2 Finnish EIA (between April-May 2016), targeting people living within 2 km from the main roads to be used for rock transport. The survey results indicated that most of the residents were satisfied with the current traffic safety in their living environment regardless of the mode of transport. However, the residents also felt that traffic congestion, noise and dust at the Palaslahti industrial area and Mussalo Harbour were mainly caused by heavy traffic to and from Mussalo Harbour /232/.

#### **9.12.2.3 Importance and vulnerability of people**

As discussed in Chapter 7 – Method adopted for Espoo environmental assessment documentation, all “People” are considered to be of equal importance and therefore are not

ranked in terms of this parameter. Their vulnerability to potential impacts from NSP2 is discussed in Chapter 10 - Assessment of environmental impacts.

### 9.12.3 Public services

#### 9.12.3.1 Roads

Rocks will be transported from quarries to Mussalo Harbour over a distance of approximately 16 km, located in Kotka (Finland). The proposed rock transportation routes are shown in Figure 9-48.

Rock placement material for the Finnish and Russian intervention works is planned to be sourced from Finland. The locations of the quarries (and therefore distances and means of transport) are not known at the moment. The assessment is based on the assumption that the sources of rock material are from the same quarries used during NSP.

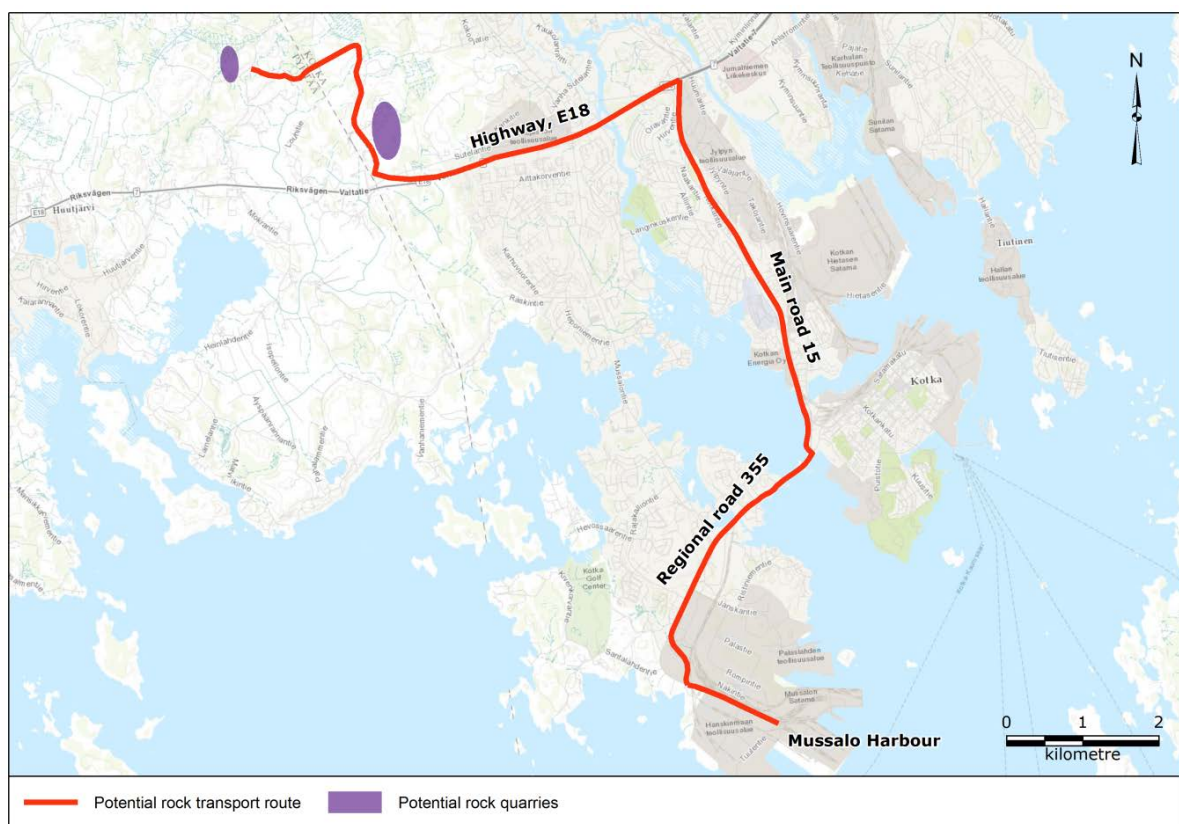


Figure 9-48 Proposed rock transportation route, Kotka, Finland /233/.

As shown in Figure 9-5, the rock transportation route is along Highway 7 (E18), via Road 15 (Hyväntuulentie) and Road 355 (Merituulentie) to Mussalo Harbour, Finland. Heavy vehicles used for the rock transport is estimated to be approximately 110,000 vehicles in total. Rock transport is likely to start one month prior to the commencement of pipeline construction works (hence Q1/2018), and the transport operation will continue for about 18 months. The increase in heavy vehicle traffic to Mussalo Harbour is estimated to be approximately 300 trucks per day.

The conditions of the main rock transport routes are described in Table 9-9. A draft master plan to upgrade Road 355 has been developed by the Centre for Economic Development, Transport and the Environment of south-eastern Finland. The plan aims to remove stops for heavy vehicles as well as to separate freight traffic and local traffic and proposes actions for noise barriers and pedestrian safety improvements. This plan is pending, with construction to commence after 2025.

**Table 9-39** Conditions of proposed rock transportation routes /234/.

Road	Description
Road 15	<ul style="list-style-type: none"> <li>• Single carriageway, four lane road with a speed limit of 70 km/h;</li> <li>• Delays can be expected during peak hours due to queues (especially at the Paimenpoertti junction);</li> <li>• Average daily traffic volume was recorded as 21,100 vehicles (1,500 heavy vehicles per day);</li> <li>• Pedestrians and cyclists have dedicated roads; however there are no railway level crossings with vehicle traffic;</li> <li>• A total of 72 traffic accidents were reported between the Haukkavuori intersection and Highway 7; 12 of these led to personal injuries, with no fatalities recorded.</li> </ul>
Road 355	<ul style="list-style-type: none"> <li>• Single carriageway, two-lane road with a speed limit of 50 km/h, connecting Mussalo Harbour and the nearby industrial areas to Road 15 and also providing a connection from Hirssaari and Etukylä residential areas to Kotka city centre;</li> <li>• Congested during peak hours, with the average daily traffic volume recorded as 6,000-9,500 vehicles (1,300-1,500 heavy vehicles) in 2016;</li> <li>• Pedestrians and cyclists have dedicated roads and have three railway level crossings;</li> <li>• A total of 22 traffic accidents were reported between Haukkavuori intersection and Mussalo Harbour. Six of these led to personal injuries; no fatalities were recorded.</li> </ul>

### Importance of roads

Roads are the only public service/infrastructure with the potential to be impacted by the project components in the ancillary areas. These services are of high importance to local residents. The rock transportation routes will use regional roads that are used for public transportation and by pedestrian and private vehicle traffic. Therefore, roads are considered as being of high importance.

#### 9.12.4 Tourism and recreational areas

Summer cottages are scattered around the harbour area in Kotka. The nearest summer cottage to the rock transportation route in Kotka (Finland) is located about 60 m from Road 355 (see Figure 9-48). Kotka is nationally known for the Kotka Maritime Festival (boat races and cruises) in the last week of July, with about 200,000 visitors annually /235/.

##### 9.12.4.1 Importance

Tourism and recreational activities in Kotka are key contributors to the local economy. Therefore a ranking of low importance has been given.

## Specific topics

This section provides a description of the baseline conditions for topics that are not considered 'environmental receptors' but have been identified during consultations as an issue requiring particular consideration. These topics comprise:

- Conventional munitions,
- Chemical munitions,
- CWAs.

This section aims to document where such features may be present within the areas potentially affected by NSP2 to enable assessment of potential impacts in Chapter 10 – Assessment of environmental impacts.

### 9.13 Conventional munitions

The Baltic Sea has a history of significant strategic naval importance. The Baltic Sea was heavily mined during World War II, and even though known mine areas were swept after the war, thousands of mines still rest on the seabed today.

Databases are available that define the approximate locations of the mine lines. Although the databases are incomplete, they still provide guidance with respect to areas of elevated risk. In addition to mine lines, some areas of the Baltic Sea were used as dumping grounds for conventional munitions in the post-war period and therefore represent areas of elevated risk.

Areas with elevated risk of finding conventional munitions and dumping areas of munitions are shown in Atlas Map MU-01-Espoo and MU-02-Espoo.

Within the Baltic Sea, different types of mines were used, of which contact mines were the most common. Contact mines were built to explode when triggered by contact with an enemy ship or a submarine. There are generally three types of contact mines:

- Moored contact mines,
- Bottom contact mines,
- Drifting contact mines.

Other types of mines, with pressure and magnetic sensors, were also used.

The largest quantity of mines is located in the Gulf of Finland and in the northern and central parts of the Baltic Sea. Other types of ammunition have also been dumped in the Baltic Sea. The most common types comprise:

- Depth charges,
- Torpedoes,
- Submarine combating rockets,
- Grenades.

It is also possible that munitions from military training could be present in the Baltic Sea. Military exercise materials do not contain explosives, but they can contain firing mechanisms. Exercise materials are in general clearly marked with special colours so that they can be identified.

### 9.13.1 Baseline surveys for NSP2

As the exact locations of munitions (UXOs) on the seabed are not known. Geophysical munitions screening surveys of the proposed NSP2 route have been or will be undertaken.

#### 9.13.1.1 Munitions in Russia

Given that a geophysical munitions screening survey has not yet been undertaken in Russia, the presence of munitions has been determined based on the experience of NSP.

In preparation for the construction of the NSP pipelines in the Russian project area, a total of 52 munitions were cleared. Although the NSP2 route differs from the previously surveyed corridors, it has been assumed that a similar ratio of the munitions will need to be cleared in Russia waters. The exact number, types and locations of munitions requiring clearance will be defined following the completion of the munitions screening survey. The munitions screening surveys within the pipeline installation corridor in Russia are planned to commence in April 2017.

#### 9.13.1.2 Munitions in Finland

Given that a geophysical munitions screening survey has not yet been undertaken in Finland, the presence of munitions has been determined based on the experience of NSP.

In preparation for the construction of the NSP pipelines in the Finnish project area, a total of 49 munitions were cleared through detonation and six were relocated. Based on NSP experience and the number of munitions remaining in the Gulf of Finland and the Northern Baltic Proper, it has been assumed that a similar ratio of the munitions will need to be cleared in Finnish waters during NSP2. The exact number, types and locations of munitions requiring clearance will be defined following the completion of the munitions screening survey within the pipeline installation corridor and the visual inspection of items identified within the security corridor.

Atlas Map MU-01-Espoo presents the current knowledge of munitions density in the Gulf of Finland and the Northern Baltic Proper.

#### 9.13.1.3 Munitions in Sweden

Since the NSP2 route has been planned so that it is located far away from known dumping areas of unexploded ordnance, the key risk for encountering munitions within Swedish waters is due to known mine lines. A geophysical munitions screening survey of the NSP2 route corridor was therefore undertaken in the assessed high risk areas (assessment e.g. based on UXO information provided by the Swedish Armed Forces) as reported in the section below. In Atlas map MU-02-Espoo, dumping areas are shown along with mine lines and identified munitions from NSP2 investigations.

In preparation of the construction of the Nord Stream pipelines in the Swedish EEZ 7 munitions were cleared through detonation. The routing, the larger lay corridor that has been applied for and the likely use of a DP vessel for NSP2 significantly reduces the risk that munitions clearance will be necessary. This will be confirmed following the completion of the munitions screening surveys, including visual inspections.

In June 2016, a munition screening survey was undertaken by MMT Sweden AB and N-Sea Offshore Wind B.V, contracted by Nord Stream 2 AG, in four high priority areas along the NSP2 route in the Swedish EEZ. Mainly two 15 m corridors were surveyed centred on pipelines A and B. The visual inspections were performed using a Work class ROV equipped with BlueView and HD camera. There were no relevant findings for the southern parts of the route (high priority areas 3 and 4). Three munition items were identified northeast of Gotland, when surveying the northern parts of the route (high priority areas 1 and 2). Two of the munitions objects were found within the proposed pipeline corridors, one in the corridor for line A and one in the corridor for line B, for which local re-routes are needed. The third object was located well outside both pipeline corridors, hence requiring no further action.

#### 9.13.1.4 Munitions in Denmark

No conventional munitions have been found in Denmark.

#### 9.13.1.5 Munitions in Germany

Nord Stream 2 AG has closely followed the latest development in ordnance detection in recent years in similar projects in the area surrounding the NSP2 route. When selecting the surveying and salvage company, it can thus be ensured that the work for ordnance detection can be carried out according to the current state of the art.

As part of the planning for the construction of the pipeline, Nord Stream 2 AG initially collected and analyzed all available information on areas suspected to be contaminated with explosive ordnance, in particular on minefields and areas for the disposal of conventional and chemical munitions in the Baltic Sea. The results of this research were considered in the optimization of the pipeline route.

### 9.14 Chemical munitions

#### 9.14.1 Overview

Chemical munitions are munitions containing chemical warfare agents (CWA), whose toxic properties were designed to kill, injure or incapacitate humans. Chemical munitions were first used in significant amounts during WWI and proved to be powerful weapons. In 1925, the use of chemical munitions was declared illegal in the Third Geneva Convention. Chemical munitions were not used during WWII, but as well the allied as the German forces stockpiled large quantities of chemical munitions. After the war, the Bornholm Basin (within Danish waters) and the Gotland Deep (within Swedish waters) were selected as dumping sites for chemical munitions, as they are the deepest locations in proximity to the German harbours (Peenemünde and Wolgast) from which the munitions were shipped. HELCOM has concluded that at least 40,000 tonnes of chemical munitions, containing approximately 15,000 tonnes of CWA, were dumped in the Baltic Sea /236/. The dumping areas of chemical munitions are shown in Atlas Map MU-01-Espoo.

As shown in Atlas Map MU-01-Espoo and MU-02-Espoo, there are no chemical munitions dumpsites in Russian, Finnish or German waters (TW and/or EEZ). The dump site identified in Swedish waters is located approximately 9 km from the NSP2 route (Atlas Map MU-02-Espoo). Given this, in combination with the fact that no chemical munitions were found during NSP in Russian, Finnish, Swedish or German waters, the following paragraphs focus on the presence of chemical munitions and associated CWAs in the Danish project area only.

#### 9.14.2 Chemical munitions in Denmark

Chemical munitions transported to the dumping sites were not armed, as the detonators for the explosives were not inserted and were often stored within protective containers. In some cases, warfare materials were loaded onto various types of vessels (ships, barges and hulks), which were sunk at the dumping site. In other cases, munitions or wooden crates with munitions and bulk containers with CWAs were disposed of individually.

The main site used for chemical munitions disposal (within Danish waters) was the southern part of the Bornholm Basin. It is estimated that chemical munitions containing approximately 11,000 tonnes of CWAs were dumped north-east of Bornholm, in a circular 'primary' designated dumpsite with a radius of 3 nm, Figure 9-49. The designated area was marked on sea charts; however, since the navigational equipment at the time of dumping was not very accurate, it is highly possible that dumping vessels may not always have been within the predetermined location when being scuttled or did not remain in one place when overboard dumping was carried out.

Furthermore, there are indications of individual dumping while travelling to and from the designated dumping area. Therefore a wider, and probably more realistic, secondary dumping area is also marked on the sea charts. It is shown on Figure 9-49 as the area where bottom trawling, anchoring and seabed intervention works are discouraged.

In the Bornholm Basin, it is most likely that bombs, some in grenades, bulk containers, spray cans and wooden crates, were dumped. In the area of the 'primary dumpsite', four metallic, heavily damaged shipwrecks deeply immersed in bottom sediments have been identified. However, the origin and contents (chemical or conventional warfare materials or other cargo) of the discovered shipwrecks remain unclear /237/, /239/.

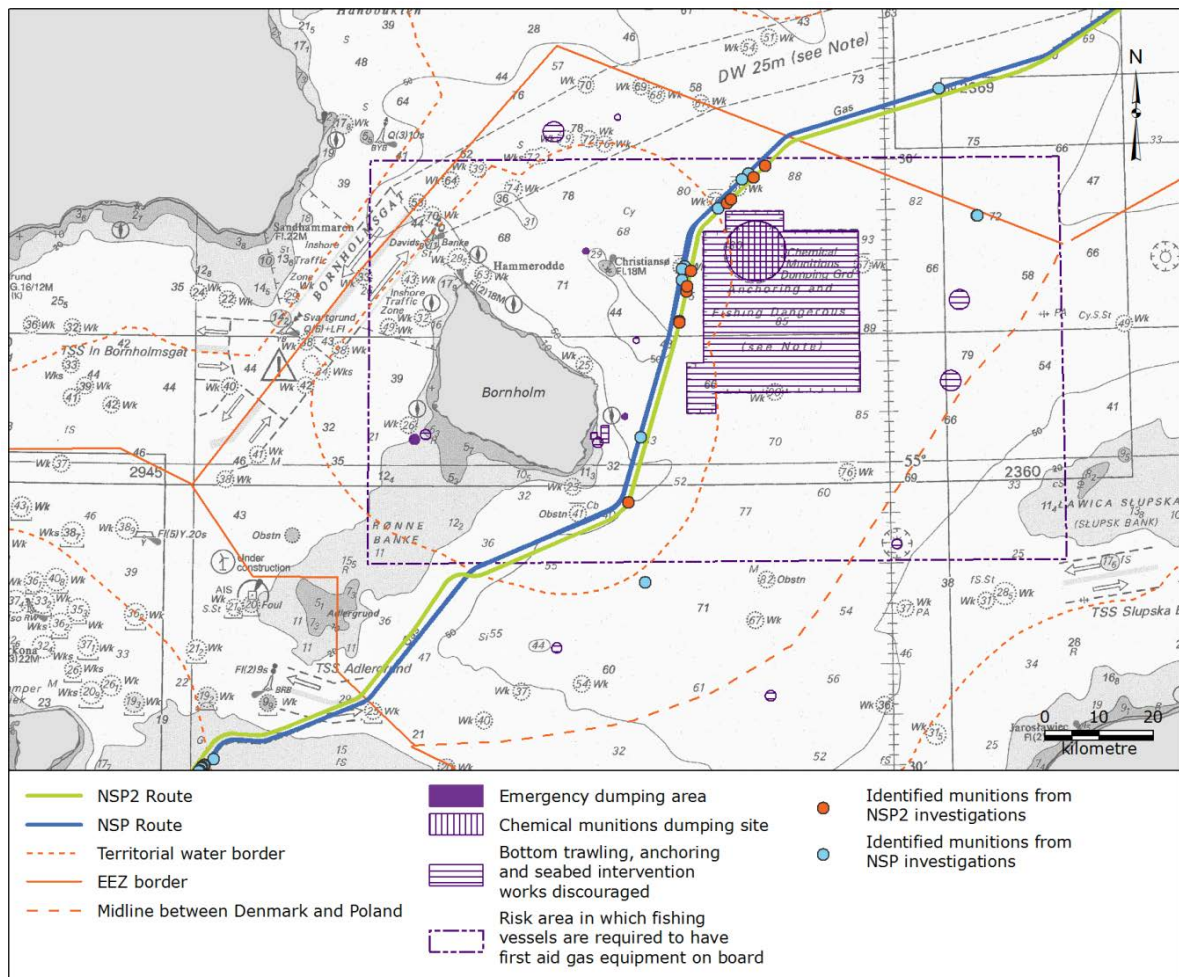


Figure 9-49 Chemical munitions dumping sites and risk areas in Danish waters.

The geophysical reconnaissance survey of the NSP2 route corridor was carried out in the period of November 2015 - January 2016. Seabed features and objects have been interpreted from SSS and MBES data. During interpretation, all sonar contacts were evaluated for the likelihood of them representing munitions. Fifty-two objects were identified as possible munitions. These objects were visually inspected by an ROV, and 12 objects were assessed to be munitions related. All 12 objects were evaluated by a Danish munitions expert to be possible chemical munitions relating to aerial mustard gas bomb type KC 250. Locations of identified chemical munitions are shown on the Atlas Map MU-02-Espoo.

Munitions have been resting on the seabed and in the sediment of the Baltic Sea for more than 65 years. Over time, the metal casing of the munitions as well as the bulk containers have corroded and have been subject to mechanical erosion. Some shells will have leaked their contents, whereas others may still be intact. The ratio between corroded and empty munitions versus intact munitions is not known. It is clear, however, that oxygen is needed for corrosion of

the metal casing of the munitions, and that munitions in anoxic sediments will be better preserved than munitions exposed to oxygen in either sediment or water. Hence, the ratio of corroded and potentially empty munitions versus intact potentially full munitions to a large extent reflects the ratio of the munitions above and below the seabed.

#### 9.14.2.1 Chemical warfare agents

As noted above, shell casings of many chemical munitions have corroded over the time and CWAs have been released into the surrounding marine environment, where they have been accumulating in the seabed sediments.

CWAs break down at varying rates into less toxic, water-soluble substances. Some CWAs, however, have extremely low solubility and degrade slowly (e.g. mustard gas, Clark I and II and Adamsite). Given their low solubility, these compounds cannot occur in higher concentrations in water, and wide-scale threats to the marine environment from dissolved CWAs can be ruled out. However, direct contact with CWAs in sediments is dangerous for many forms of life, most notably humans, other mammals, birds and fish. Knowledge on the interactivity of CWAs with microorganisms is still fragmentary /236/.

The most frequently occurring CWAs in the chemical munitions dumped east of Bornholm and the consequences should humans be exposed to them are shown in Table 9-40.

**Table 9-40** Examples of CWAs contained within chemical munitions dumped in the Bornholm Basin /238/.

Name	Composition	CAS no.	Dumped (tonnes)	Consequences
Sulphur mustard	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> S	505-60-2	6,713	Blisters on exposed skin and lungs
Clark types	Type I: C <sub>12</sub> H <sub>9</sub> AsCl Type II: C <sub>13</sub> H <sub>10</sub> AsN	Type I: 712-48-1 Type II: 23525-22-6	2,033	Nausea, vomiting, headaches
Adamsite	C <sub>12</sub> H <sub>9</sub> AsClN	578-94-9	1,363	Affects the upper respiratory system
α-chloroacetophenone	C <sub>8</sub> H <sub>7</sub> ClO	1341-24-8	515	Tear gas, irritating eyes
Other <sup>1</sup>			74	

<sup>1</sup> Other: hydrogen cyanide ('Zyklon B', chemical waste).

#### 9.14.2.2 Surveys of chemical warfare agents in Denmark

A sampling survey in Danish waters aiming at the evaluation of CWA concentrations in seabed sediments was conducted along the NSP2 route in 2015 and 2016 /241/, /242/.

Quantitative chemical analysis of target CWAs in sediment samples was performed to estimate the presence of CWAs and/or their degradation products. In 2015, a total of 61 sediment samples were analysed at 29 stations along the proposed NSP2 route. In total intact CWAs and/or their degradation products were identified in samples from 18 out of the 29 stations /242/. The results are summarised in Table 9-41 and Appendix 4.

**Table 9-41** Summary of CWAs detected in sediment samples taken in the Bornholm Basin. Concentrations are shown in µg/kg DW (dry weight).

Name	Detected in number samples	Maximum concentration (µg/kg DW)	Description
Sulphur mustard (SM)	1	0.6	Dumped CWA
Adamsite	14	2,000	Dumped CWA
Triphenylarsine (TPA)	8	13	Dumped CWA



$\alpha$ -chloroacetophenone (CN)	1	2.3	Dumped CWA
1,4-Dithiane	2	0.34	Degradation product of SM
1,4,5-Oxadithiepane	5	0.44	Degradation product of SM
1,2,5-Trithiepane	5	1.6	Degradation product of SM
5,10-Dihydrophenarsazin-10-oxide	14	576	Degradation product of Adamsite
Diphenylarsinic acid	11	1764	Degradation product of C1/C2 <sup>1)</sup>
Diphenylpropylthioarsine	9	59	Degradation product of C1/C2
Triphenylarsine oxide	10	234	Degradation product of TPA
Phenylarsonic acid	8	145	Degradation product of PDCA <sup>2)</sup>
Dipropyl Phenylarsonodithionite	9	98	Degradation product of PDCA
Tripropyl arsonotrithioite	1	3.5	Degradation product of TCA <sup>3)</sup>

<sup>1)</sup> CWA: Clark I and Clark II.

<sup>2)</sup> CWA: Phenyldichloroarsine.

<sup>3)</sup> Trichloroarsine, a component in dumped arsine oil.

The highest detection frequencies and the highest maximum concentrations were found along the middle and northern parts of the NSP2 route in Denmark. The southern part of the NSP2 route had a comparatively low degree of contamination associated with CWAs. This correlates with the proximity to the designated dumping ground.

The intact CWA Clark I and II, phenyldichloroarsine, Lewisite I and II, tabun, and trichloroarsine were not detected. Degradation products were found for sulphur mustard, Adamsite and Clark I and II. No traces of degradation products were found for tabun, Lewisite I or Lewisite II.

During 2016, a supplementary survey was undertaken and sediment samples were collected in the areas where trenching was expected to be carried out /241/. Seabed samples at these stations were taken at three depths (seabed surface, 0.5 m and 1 m) to evaluate if CWA concentrations vary with the depth. The samples contained neither intact CWAs nor their degradation products in concentrations higher than the detection limits.

#### 9.14.2.3 Comparison of results from NSP2 with previous results

The frequency of CWA-positive samples was higher during NSP2 surveys (2015) compared with NSP surveys (2008-2012) /238/. However, the findings of NSP2 are similar to the more recent results from the Chemical Munitions Search and Assessment (CHEMSEA) project, where 86% of the samples from the Bornholm Basin contained one or more of the CWAs or their degradation products /237/. Similar to the findings of the 2015 NSP2 survey, CHEMSEA also reports a low frequency of intact mustard gas detections, whereas arsenic-containing compounds are more frequent.

To evaluate differences in the results from the NSP and NSP2 surveys, VERIFIN conducted an evaluation of changes in test methods for chemical analyses of CWAs between 2008-2012 and 2015-2016 and compared four projects in the Baltic Sea where CWAs were analysed /238/, /240/: MERCW<sup>30</sup> (2006-2008), NSP (2008-2012), CHEMSEA (2011-2014) and the current study (NSP2, 2015-2016). The following conclusions were reached:

- The introduction of a new extraction solvent in 2011 has improved the extraction efficiency of several CWA-related compounds, in particular Adamsite, 5,10-dihydrophenarsazin-10-oxid, diphenylarsinic acid and phenylarsonic acid. The lowest limits

<sup>30</sup> MERCW: Modelling of Ecological Risks Related to Sea-Dumped Chemical Weapons

of quantitation (LLOQ) have improved during the period since 2008 due to the introduction of a new GC-MS method.

- In addition, a number of new chemical compounds have been introduced in the analytical methods since 2010 (e.g. cyclic degradation products for sulphur mustard and oxidation product for triphenylarsine).

On the basis of the above, it is likely that the higher frequency of positive samples in comparison with the NSP survey is a result of improved analytical methods, including both a more efficient extraction of CWAs and degradation products and a lowering of the LLOQ.

In addition, it is noted that the distribution of dumped munitions and consequently CWA-related contaminants is inconsistent, patchy and localised. As a result, the results from localised sampling stations, and in some cases even replicas from the same sediment sample, may vary greatly in their content of CWAs and degradation products

## 10. ASSESSMENT OF ENVIRONMENTAL IMPACTS

This chapter presents the results the environmental impact assessment exercise. Section 10.1 provides an overview of the modelling results. This, together with the baseline analysis documented in Chapter 9 – Environmental baseline, has informed the assessment of NSP2 project-wide impacts reported in Sections 10.2-10.5 (Physical and chemical environment), Sections 10.6-10.8 (Biological environment) and Sections 10.9–10.12 (Socio-economic environment). This chapter addresses the environmental impacts of planned activities; accidental events are dealt with in Chapter 13 – Risk assessment.

The project-wide assessment reported within Sections 10.2-10.13:

- Considers for each resource or receptor type identified for consideration in the assessment (Table 7-2) the relevant sources of impact as identified in Tables 8-1-8-3;
- Scopes out any sources of impact from further consideration where, based on the baseline analysis (Chapter 9 – Environmental baseline) and modelling results (Section 10.1), it can be demonstrated without further analysis that no significant impacts may materialise on the relevant resource or receptor from such sources;
- For all the sources of impact that were scoped in for each resource or receptor group, it:
  - Identifies the potential significant impacts that could be experienced, and for each predicts the NSP2 project-wide impact magnitude and ranking based on the methodology provided in Section 7.5, taking into account the assessments in the various national EIAs/ES. The impact ranking also takes into consideration the mitigation measures to which NSP2 has committed, as documented in Chapter 16 – Mitigation measures;
  - Identifies where such impacts may be transboundary in nature, to inform the transboundary assessment documented in Chapter 15 – Transboundary impacts;
  - Where undertaken in the various national EIAs/ES, provides a breakdown of the ranking of these sources of impact for each country, as documented in those national reports.

### 10.1 Overview of numerical modelling and calculation of results

#### 10.1.1 Introduction

Numerical modelling has been carried out in order to predict and assess the potential for significant impacts with respect to:

- Dispersion and re-sedimentation of sediments;
- Dispersion of sediment-associated contaminants;
- Underwater noise propagation;
- Airborne noise propagation;
- Emission of gases and particles;
- Dispersion of spilled oil.

The following section provides a short overview of the modelling undertaken as well as a summary of the key results. Further details are presented in Appendix 3. The findings of the oil spill modelling are presented in Chapter 13 – Risk Assessment.

The modelling approach was determined based on a review of where certain activities take place (see Chapter 6 – Project description), the baseline environment in these areas (see Chapter 9 – Environmental baseline), the requirements from each PoO and experience from NSP.

The NSP2 project is in many ways comparable with the NSP project, both in terms of its routing and construction methods. Therefore, monitoring data collected during construction and

operation of NSP has also been considered when evaluating the results of the modelling for NSP2. A summary of the NSP monitoring data is therefore also provided in Appendix 3.

## 10.1.2 Modelling of dispersion and re-sedimentation of sediments and dispersion of sediment-associated contaminants

### 10.1.2.1 Overview of modelling

Modelling of the dispersion and re-sedimentation of sediments and associated dispersion of sediment-associated contaminants has been undertaken for the specific activities and areas shown in Table 10-1. Justification for the modelling scope is provided in Appendix 3.

**Table 10-1 Activities and areas which have been subject to modelling of dispersion and re-sedimentation of sediments (S) and of sediment-associated contaminants (C).**

NSP2 Activities	RUS	FIN	SWE	DEN	GER
Munitions clearance	S,C	S,C	-	-	-
Rock placement	S,C	S,C	S	S	-
Trenching	-	-	S	S	-
Dredging	S,C	-	-	-	S

A summary of the results of the modelling is shown below for munitions clearance (Table 10-2), rock placement (Table 10-3), trenching (Table 10-4) and dredging (Table 10-5), respectively. Detailed results are presented in Appendix 3. Modelling for Sweden, Denmark and Germany has been conducted for dispersion and re-sedimentation of sediments only.

The modelling results shown are based on the conservative construction scenarios at the time when modelling was carried out. The design is continuously being optimised, and as such, the final design will deviate to some degree from the design which formed the basis of the modelling. For this reason, the input data (e.g. extent of the intervention works) may differ from the most recent technical data shown in the national EIAs. However, the modelled scenarios are considered representative of the scenarios that will ultimately be implemented.

As outlined in Appendix 3, modelling has been carried out for Russia, Finland, Sweden and Denmark for the following hydrographic situations: a summer scenario (June 2010), a normal scenario (April 2010) and a winter scenario (November 2010). The results presented in the tables below show the range of outcomes for the three scenarios. They should therefore cover both the average situation and the "worst case" situation for each parameter.

Sediment dispersion was modelled by taking the specific sediment conditions (grain size distribution) at the locations where seabed intervention works (rock placement, trenching, dredging, munition clearance) are planned, into account.

Moreover, the concentrations have been calculated for the relevant parts of the water column; e.g. it has been assumed that the sediment spill from rock placement will be released 2 m above the seabed and dispersed in the lowermost 10 m of the water column and therefore the SSC is calculated for this part of the water column only. The methods and assumptions for the modelling are outlined in Appendix 3.

The results summarised in the tables represent the total impact from the activities in each PoO across the entire construction period. Therefore, when analysing the results, consideration should be given to the fact that activities in each PoO (and their resulting impacts) will have some geographical and temporal separation (i.e. SSC will be highest in areas where seabed intervention works occur, and not all seabed intervention works within a particular PoO will occur simultaneously).

The below is a summary only – more detailed results are presented in Appendix 3. The results of the modelling are additive in relation to the condition of SSC, etc. already present in the environment.

The tables show the areas which are subject at some point in time during construction to increases in SSCs of 10 and 15 mg/l; justification for these thresholds is presented in Appendix 3. However, it is noted that the impact of these SSCs on receptors/resources will vary depending on the sediment composition. Fine-grained sediments attenuate light more efficiently than coarse-grained sediments (Section 9.2.2.8) and therefore 10 mg/l of coarse-grained sediment will have a smaller impact on turbidity than fine-grained sediment. The ambient levels of SSC are considered, under calm conditions, to be so low (up to a maximum of 5 mg/l, but more regularly 1-2 mg/l, see Section 9.2.1.4) that the incremental change is considered representative of absolute concentrations.

It should be noted that the maximum duration of the SSC increase is not consistent across the total area. Therefore, the maximum durations referenced apply, in most instances, to only a small proportion of the total area.

Modelling of the dispersion of sediment-associated contaminants has also been undertaken for some representative activities in PoOs where contaminants levels were considered to require further investigation. Modelling was undertaken for benzo(a)pyrene, dioxins/furans (based on the calculated toxic equivalents, TEQs, as specified by the WHO) and zinc, which were chosen as representative of the polyaromatic hydrocarbons (PAH), dioxin/furans and metals, respectively. The modelled Predicted Environmental Concentrations (PEC) of these compounds have been compared with the Predicted No Effect Concentrations (PNEC). The PNEC is the concentration of a substance/contaminant below which no adverse effects from exposure in an ecosystem are measured. Further explanation is provided in Appendix 3.

The concentration of contaminants used in the modelling of contaminants dispersion in Russia and Finland are based on chemical analysis of sediment samples from environmental field surveys carried out in 2015 – 2016 along the planned NSP2 pipeline route. As input for the model in Russia and Finland (modelled separately), the 95% percentile concentration (for each contaminant) for all results from Russian and Finnish waters respectively was used.

For the majority of the sections of the NSP2 route, this approach of using the 95% percentile value will be very conservative. As an example of this, the survey results showed very low concentrations of many of the contaminants at the Russian landfall location. This was also the case for some sections along the NSP2 route offshore. As a consequence the results of modelling of dispersion of contaminants at the Russian landfall area shown in atlas maps and figures are very conservative.

The table below shows the differences in concentrations and the 95% percentile of contaminants (zinc, benzo(a)pyrene (B(a)P) and dioxins/furans) for the Russian nearshore (landfall) and offshore section along the NSP2 pipeline route. Based here upon it can be seen that the 95% percentile concentrations is between a factor 1.8 - 18 lower at the landfall location. For dioxins/furans shown on Atlas maps the concentration and the 95% percentile is up to a factor 4.7 and 7.8 lower at the landfall respectively.

This will more or less result in a reduction of the area affected, with the same factor (for dioxins/furans between a factors 4.7 – 7.8).

Concentration of contaminants in sediment inside Russian waters				
Substance		Offshore	Nearshore	Whole section <sup>1</sup>
Zinc Zn (mg/kg DM)	Min-max	12.9 – 168	3.9 – 10.7	
	95% percentile	164	9.1	160
Benzo(a)pyrene B(a)P (mg/kg DM)	Min-max	0.001 – 0.078	0.001 – 0.056	
	95% percentile	0.050	0.027	0.049
Dioxins/Furans WHO(2005)PCDD/F TEQ (ng/kg DM)	Min-max	0 – 32.2	0 – 6.8	
	95% percentile	18.9	2.2	17.1

1: 95% percentile values used as input for modelling.

### 10.1.2.2 Overview of modelling results

In the below tables, a summary of the modelling results is provided. The ranges shown in the tables represent the results of the three hydrographic scenarios as outlined in Section 10.1.2.1 above.

Table 10-2 summarises the results of the modelling of dispersion and re-sedimentation of sediments and sediment-associated contaminants due to munitions clearance (planned only in Finland and Russia). The location and number of munitions modelled were selected based on the predicted density of munitions found along the proposed NSP2 route and the proximity to protected areas (additional assumptions are provided in the notes of Table 10-2).

**Table 10-2 Dispersion and re-sedimentation of seabed sediments and sediment-associated contaminants mobilised by munitions clearance in Finland and Russia (common for both pipelines). The areas are not necessarily limited to the country within which the activity takes place.**

Parameter	Unit	PoO	
		Finland	Russia
Locations and number of munitions	No.	4 locations x 6 munitions <sup>1</sup>	34 munitions <sup>2</sup>
<b>Dispersion and re-sedimentation of sediments:</b>			
Total suspended sediment dispersed	Tonnes	1,030	1,520
Total area where conc. >10 mg/l <sup>3, 4</sup>	km <sup>2</sup>	33-46	13-19
Total area where conc. >15 mg/l <sup>3, 4</sup>	km <sup>2</sup>	16-28	8-11
Max duration of conc. >10 mg/l <sup>3</sup>	Hours	7-13	6-9
Max duration of conc. >15 mg/l <sup>3</sup>	Hours	5-10	6-8
Area where sedimentation >200 g/m <sup>2 4</sup>	km <sup>2</sup>	0.0	0.7-0.9
<b>Dispersal of sediment-associated contaminants:</b>			
Total area where conc. >PNEC <sub>BaP</sub> <sup>4</sup>	km <sup>2</sup>	99-118	34-40
Total area where conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>4</sup>	km <sup>2</sup>	19-21	17-21
Total area where conc. >PNEC <sub>Zn</sub> <sup>4</sup>	km <sup>2</sup>	2-3	1-2
Max duration of conc. >PNEC <sub>BaP</sub>	Hours	12-19	10-17
Max duration of conc. >PNEC <sub>PCDD/F TEQ upper</sub>	Hours	5-7	9-11
Max duration of conc. >PNEC <sub>Zn</sub>	Hours	3	2-5
<p>1: Modelling undertaken based on four locations, each assumed to require clearance of six objects (three medium size (charge size = 30-64 kg TNT) and three large size (charge size= 100-350 kg TNT) objects, releasing 20 m<sup>3</sup> and 42 m<sup>3</sup> seabed sediments, respectively). At each location, it has been assumed that there would be a distance of 1 km between objects, and that clearance would occur over a period of six days (one object/day).</p> <p>2: Modelling undertaken based on an assumed clearance of 34 objects, alternating between an equal amount of medium size (charge size = 30-64 kg TNT) and large-size (charge = 100-350 kg TNT) objects, releasing 20 m<sup>3</sup> and 42 m<sup>2</sup> of seabed sediments, respectively. At four locations, it has been assumed that two objects may require</p>			

Parameter	Unit	PoO	
		Finland	Russia
detonation in the same place and at the same time, i.e. a medium and a large-sized object detonated simultaneously, causing the release of 62 m <sup>3</sup> seabed sediments.			
3: Results show SSCs in the bottom 10 m of the water column (i.e. 10 m closest to the seabed).			
4: Areas refer to the extent where SSC, sedimentation or toxicity exceed the chosen threshold value. The areas are not necessarily limited to the country within which the activity takes place.			
PNEC <sub>B(a)P</sub> : Predicted no effect concentration for Benz(a)pyrene.			
PNEC <sub>PCDD/F TEQ upper</sub> : Predicted no effect concentration for dioxins/furans.			
PNEC <sub>Zn</sub> : Predicted no effect concentration for zinc.			

Table 10-3 summarises the results of the modelling of dispersion and re-sedimentation of sediments and sediment-associated contaminants due to rock placement. The modelling has been carried out based on the rock placement along one of the pipelines (the pipeline with the largest amount of rock placement in each PoO).

**Table 10-3 Dispersion of seabed sediments and sediment-associated contaminants mobilised by rock placement in Denmark, Sweden, Finland and Russia (calculated for one pipeline). The areas are not necessarily limited to the country within which the activity takes place.**

Parameter	Unit	PoO				
		Denmark	Sweden	Finland		Russia
				NSP2, alt. E1E2 <sup>1</sup>	NSP2, alt. W1W2 <sup>2</sup>	
Locations	No.	4	125 + 79 <sup>3</sup>	248 + 46 <sup>3</sup>	248 + 51 <sup>3</sup>	74
Rock volume	m <sup>3</sup>	86,720	518,479	1,102,500	1,211,500	711,304
Duration of rock placement activities	Days	7.4	49	35	38	31
<b>Dispersion and re-sedimentation of sediments:</b>						
Total suspended sediment dispersed	Tonnes	128	1,372	2,593	2,848	804
Total area where conc. >10 mg/l <sup>4</sup>	km <sup>2</sup>	0.00	0.08-0.15	4-6	10	0.1-0.9
Total area where conc. >15 mg/l <sup>4</sup>	km <sup>2</sup>	0.00	<0.02	0.6-1.7	3	0.0-0.3
Max duration of conc. >10 mg/l	Hours	0	0.5-13	7-18	7	1.5-4
Max duration of conc. >15 mg/l	Hours	0	0-0.5	1.5-7.5	1.5	0-0.5
Area where sedimentation >200 g/m <sup>2</sup>	km <sup>2</sup>	0.06-0.11	0.1-1	0-0.05	0.00	0-0.1
<b>Dispersal of sediment-associated contaminants<sup>4</sup>:</b>						
Total area where conc. >PNEC <sub>BaP</sub> <sup>5</sup>	km <sup>2</sup>	-	-	2.9-9.6	-	<0.02
Total area where conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>5</sup>	km <sup>2</sup>	-	-	<0.02	-	<0.02
Total area where conc. >PNEC <sub>Zn</sub> <sup>5</sup>	km <sup>2</sup>	-	-	<0.02	-	<0.02
Max duration of conc. >PNEC <sub>BaP</sub>	Hours	-	-	8-22	-	0
Max duration of conc. >PNEC <sub>PCDD/FTEQupper</sub>	Hours	-	-	0	-	0
Max duration of conc. >PNEC <sub>Zn</sub>	Hours	-	-	0	-	0

Parameter	Unit	PoO				
		Denmark	Sweden	Finland		Russia
				NSP2, alt. E1E2 <sup>1</sup>	NSP2, alt. W1W2 <sup>2</sup>	
<p>1: NSP route, including the alternatives E1 and E2.</p> <p>2: NSP route, including the alternatives W1 and W2 (sediment dispersion only calculated for winter hydrography).</p> <p>3: The second value listed represents the number of spot rock placement locations. The number of locations modelled is a sum of the two values.</p> <p>4: Results show SSCs in the bottom 10 m of the water column (i.e. 10 m closest to the seabed).</p> <p>5: Dispersal of sediment-associated contaminants was not modelled for Denmark, Sweden or the Finnish Alternative (E2+W2). Justification for this approach is provided in Appendix 3.</p> <p>PNEC<sub>B(a)P</sub>: Predicted no effect concentration for Benz(a)pyrene.</p> <p>PNEC<sub>PCDD/F TEQ upper</sub>: Predicted no effect concentration for dioxins/furans.</p> <p>PNEC<sub>Zn</sub>: Predicted no effect concentration for zinc.</p>						

Table 10-4 summarises the results of the modelling of dispersion and re-sedimentation of sediments due to post-lay trenching (planned only in Sweden and Denmark). Dispersal of sediment-associated contaminants was not modelled for post-lay trenching. Justification for this approach is provided in Appendix 3.

**Table 10-4 Dispersion of seabed sediments mobilised by post-lay trenching in Denmark and Sweden (calculated for one pipeline). The areas are not necessarily limited to the country within which the activity takes place.**

Parameter	Unit	PoO	
		Denmark	Sweden
Total length of post-lay trenching/number of sections (total length of pipeline in country)	km	18.7/3 (139)	72.4/6 (510)
Duration of post-laying trenching	Days	2.6	10
<b>Dispersion and re-sedimentation of sediments:</b>			
Volume of sediment handled	m <sup>3</sup>	129,300	448,390
Total suspended sediment dispersed	Tonnes	1,243	6,467
Total area where conc. >10 mg/l <sup>1</sup>	km <sup>2</sup>	11.8-21.7	55-134
Total area where conc. >15 mg/l <sup>1</sup>	km <sup>2</sup>	6.8-7.7	37-85
Max duration of conc. >10 mg/l	Hours	2.5-6.5	11-16
Max duration of conc. >15 mg/l	Hours	2.0-5.5	10-14
Area where sedimentation >200 g/m <sup>1</sup>	km <sup>2</sup>	0.5-0.6	3
1: Results show SSCs in the bottom 10 m of the water column (i.e. 10 m closest to the seabed).			

Table 10-5 summarises the results of the modelling of dispersion and re-sedimentation of sediments and sediment-associated contaminants due to dredging in Russia. The scenario modelled is the so-called micro-tunnel concept as outlined in Chapter 6 – Project description, with results presented for both pipelines.



**Table 10-5 Dispersion of seabed and sediment-associated contaminants mobilised by dredging in Russia (calculated for the micro-tunnel concept, both pipelines). The areas are not necessarily limited to the country within which the activity takes place.**

Parameter	Unit	PoO
		Russia
Length (Section)	km (Kp – Kp)	2.75 (KP 0.50 – KP 3.25)
Duration of dredging	Days	37
Total volume of dredged sediment	m <sup>3</sup>	475,000
<b>Dispersion and re-sedimentation of sediments:</b>		
Total suspended sediment dispersed	Tonnes	39,908
Total area where conc. >10 mg/l <sup>1</sup>	km <sup>2</sup>	121-265
Total area where conc. >15 mg/l <sup>1</sup>	km <sup>2</sup>	101-215
Max duration and area with conc. >10 mg/l the whole period	Hours	340-397
	km <sup>2</sup>	0.17
Max duration and area with conc. >15 mg the whole period	Hours	329-345
	km <sup>2</sup>	0.08
Area <sup>1</sup> where sedimentation >200 g/m <sup>2</sup>	km <sup>2</sup>	11-12
<b>Dispersal of sediment-associated contaminants:</b>		
Total area where conc. >PNEC <sub>BaP</sub> <sup>1</sup>	km <sup>2</sup>	109-172
Total area where conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>1</sup>	km <sup>2</sup>	81-108
Total area where conc. >PNEC <sub>Zn</sub> <sup>1</sup>	km <sup>2</sup>	47-53
Max duration of conc. >PNEC <sub>BaP</sub> <sup>2</sup>	Hours	374-825
Max duration of conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>3</sup>	Hours	349-820
Max duration of conc. >PNEC <sub>Zn</sub> <sup>4</sup>	Hours	256-723
1: Areas refer to the extent where SSC, sedimentation or toxicity are above a certain threshold value. 2: PNEC <sub>B(a)P</sub> : Predicted no effect concentration for Benz(a)pyrene. 3: PNEC <sub>PCDD/F TEQ upper</sub> : Predicted no effect concentration for dioxins/furans. 4: PNEC <sub>Zn</sub> : Predicted no effect concentration for zinc.		

It shall be noted that the analysis of the contaminants along the pipeline route in Russia shows large spatial variations in concentrations. As a conservative measure, the 95%-percentile of the measured concentrations has been adopted for the modelling. This approach was selected in order to cover the high variability in concentrations of contaminants that often is observed for seabed sediments. However, concentrations of the various contaminants are in general significant lower in the nearshore area than in the offshore areas. So the results of the modelling done for the dredging in Russia (near shore) can be considered to be very conservative.

As shown in the table above the total areas where the concentration will be >PNEC value for zinc (Zn), benzo(a)pyrene (B(a)P), dioxins/furans (WHO(2005)PCDD/F TEQ) would, if using the 95% percentile for the modelling of the nearshore area only, be ≤0.06 km<sup>2</sup>, ≤97 km<sup>2</sup>, ≤21 km<sup>2</sup>, respectively (see for comparison of area table above).

Modelling results in Table 10-5 for the Russian landfall are based on the micro-tunnel option rather than the open cut base case scenario as this represents the “worst case” with respect to dredging duration, volumes and maximum sediment concentrations. For the open cut base case scenario, a cofferdam is required due to draft restrictions of the vessel based dredgers, which are unable to work in water depths less than 2.5-3.0 m. The cofferdam will reduce the sediment spreading from dredging activities for the first 300 – 500 m from the shore, as the pipeline route will cross the shoreline via the approximately 300 - 500 m long cofferdam, transitioning into a dredged section that terminates approximately 3.3 km offshore. A total of approximately 23,000 m<sup>3</sup> sediment requires dredging (1,100 m<sup>3</sup>/day for 21 days) from the shoreline to approximately 300 - 500 m offshore. The cofferdam will be constructed within the centre of a causeway. It is anticipated that the material dredged from the cofferdam will be used to build the causeway along with imported material. Within the Russian nearshore area, dredging will remove a total of

approximately of 200,000 m<sup>3</sup> of sandy surface sediments underlain with varying quantities of clay extending from the cofferdam to approximately 3.3 km offshore (to water depths of approximately 11 m below sea level). Modelling for the Espoo Report was based on preliminary conservative engineering design, while the Russian national EIA will present modelling results based on the final engineering solutions as required under Russian EIA legislation.

Where dredging will occur in Germany (Pomeranian Bay and Greifswalder Bodden), the natural seafloor will be removed along a route approximately 50 km in length, covering a total seabed area of approximately 1.4 km<sup>2</sup>. The material will be stored at the marine interim storage and partly refilled after pipe-laying. The excavation will have a total volume of approximately 2.5 million m<sup>3</sup>.

Based on the experience from NSP, the German EIA /54/ has concluded that sedimentation in areas outside the dredging areas will be less than 1 kg/m<sup>2</sup>. Therefore, no measurable changes of the geophysical sediment parameters are expected.

Modelling of sediment spill from the seabed intervention works planned in Germany (dredging, storage and backfill) indicates that plumes with SSCs of approximately 10-30 mg/l will occur within a radius of 500 m around dredgers and barges. Thus, generally SSCs will stay within levels which are naturally observed during rough conditions. Higher concentrations of up to 150 mg/l may occur in the immediate vicinity of the dredging equipment, particularly in areas of silty sediments.

Modelling results for NSP2 mirror the NSP monitoring results. NSP monitoring showed that the German threshold value of 50 mg/l was never exceeded for more than 24 hours at any location /243/. Extensive turbidity plumes can be expected in two small areas along the NSP2 route, where the silt concentration is above 10%. Turbidity plumes of less than 200 m radius are to be expected within the Pomeranian Bay, though the majority of the suspended material will settle within a short distance and timeframe. Very fine substrate may last in the water column for up to 2 days and therefore has a greater potential to drift further away. This is consistent with NSP, where turbidity plumes had an extent of less than 1 km<sup>2</sup> with one exception of 3.43 km<sup>2</sup> /243/.

### 10.1.2.3 Interpretation of the modelling results

The results presented in Tables 10-2 to Table 10-5 have been used as the basis for a number of the assessments presented in Section 10.2 onwards. The modelling results present a worst case scenario in the case of the Russian landfall, where micro-tunnelling has been modelled. The use of a cofferdam to aid installation and connection of the pipeline at the landfall site will have a smaller impact on the marine environment (as discussed below). In particular, the following key conclusions have been used:

#### Dispersion of sediments

- Offshore, post-lay trenching in Sweden and Denmark will result in the greatest area experiencing an increase in SSCs. A maximum total area of approximately 156 km<sup>2</sup> will experience an increase of more than 10 mg/l, which correlates to a maximum dispersion distance of a few km from the source (i.e. the trenching location). However, as noted in Chapter 6 – Project description, the trenching would occur sequentially at discrete locations along the proposed route and therefore specific areas would be affected at different times during the construction phase. The maximum duration of a 10 mg/l increase will be in the order of 16 hours, though this will only apply to a small area close to the source.
- In nearshore and shallow waters, dredging activities at the landfalls will result in the greatest area experiencing an increase in SSCs. Using the micro-tunnelling option, the SSC plume will extend from the Russian dredging site along the western shore of the Kurgalsky Peninsula. As a result of dredging activities in Russia, a total area of up to 265 km<sup>2</sup> will experience an increase of more than 10 mg/l (see Table 10-5). The maximum

duration of the increase will be in the order of 397 hours. However, this maximum duration will only apply to an area much smaller than the total area impacted (approx. 0.17 km<sup>2</sup>), likely close to the source. This is an overestimation of the extent of the sediment plumes, as with the use of a cofferdam at the landfall site, the amount of sediment to be dredged and deposited is reduced from approximately 475,000 m<sup>3</sup> to 200,000 m<sup>3</sup>.

- Higher SSC levels will be exceeded for shorter periods of time and in smaller areas; e.g., the maximum total area within which increases of more than 15 mg/l are predicted (resulting from post-lay trenching in Sweden and Denmark) is approximately 93 km<sup>2</sup>. However, as noted in Chapter 6 – Project description, the trenching would occur sequentially at discrete locations along the proposed route and therefore specific areas would be affected at different times during the construction phase. The maximum duration of the increase will be in the order of 14 hours, though this will only apply to an area much smaller than the total, likely close to the source.

### Sedimentation

- Offshore, post-lay trenching in Sweden and Denmark will result in the greatest area experiencing an increase in sedimentation. A total area of approximately 3.6 km<sup>2</sup> will experience an increase of more than 200 g/m<sup>2</sup>. This corresponds to a layer of approximately 1 mm unconsolidated sediments at the seabed, which will be limited to the near proximity of the proposed NSP2 route. As noted in Chapter 6 – Project description, the trenching would occur sequentially at discrete locations along the proposed route and therefore specific areas would be affected by these levels of sedimentation at different times during the construction phase.
- In nearshore and shallow waters, dredging in Russia and Germany will result in the greatest area experiencing an increase in sedimentation. In Russia, a total area of approximately 12 km<sup>2</sup> will experience an increase of more than 200 g/m<sup>2</sup>. This corresponds to a layer of approximately 1 mm unconsolidated sediments at the seabed. As stated above, this is based on modelling of a greater volume of dredged sediment and therefore represents an overestimation of effects. In Germany, all areas in the vicinity of the NSP2 route with silt content below 5 % (which comprises most of the NSP2 route) will experience an increase in sedimentation of less than 300 g/m<sup>2</sup>. The silty section close to the landfall near Lubmin may experience an increase of up to 3,000 g/m<sup>2</sup> within a range of about 500 m, though this will be quickly dispersed through wave action due to the low water depth (approximately 5 m).

### Dispersion of sediment-associated contaminants

- In offshore waters, munitions clearance in Finland and Russia will result in the greatest area experiencing an exceedance of PNEC values for the three modelled contaminants. A total area of approximately 163, 57.1 and 4.82 km<sup>2</sup> will experience an exceedance of PNEC<sub>BaP</sub>, PNEC<sub>PCDD/F TEQ upper</sub> and PNEC<sub>Zn</sub> values, respectively. The maximum duration of the exceedance will be in the order of 3-19 hours, though this will only apply to an area much smaller than the total, likely close to the source.
- In nearshore and shallow waters, dredging will result in the greatest area experiencing an exceedance of PNEC values for the three modelled contaminants. A total area of approximately 172, 108 and 53 km<sup>2</sup> will experience an exceedance of PNEC<sub>BaP</sub>, PNEC<sub>PCDD/F TEQ upper</sub> and PNEC<sub>Zn</sub> values, respectively. The maximum duration of the exceedance will be in the order of 256-374 hours, though this will only apply to an area much smaller than the total, likely close to the source.

## 10.1.3 Modelling of underwater noise propagation

### 10.1.3.1 Overview of modelling

Modelling of underwater noise propagation has been carried out for specific construction activities and areas, as shown in Table 10-6.

**Table 10-6 Construction activities and areas which have been subject to modelling of underwater noise propagation**

Activities	RUS	FIN	SWE	DEN	GER
Munitions clearance	X	X	-	-	-
Rock placement	X	X	X	X	-
Dredging	X	-	-	-	X
Vibro-piling	X	-	-	-	-
Pipe-lay	-	-	-	-	X
Pipeline operation	X	-	-	-	-

The results of the modelling are shown for munitions clearance (Table 10-7, Table 10-8), rock placement (Table 10-9), dredging, vibro-piling and operation (Table 10-10). These are considered the noisiest activities that have the greatest potential for impact on receptors. Underwater noise propagation depends not only on the noise source, but also on the bathymetry, seabed conditions, water temperature, salinity, etc. Therefore, noise levels are shown for the individual areas. The justification for the threshold values used and the type of noise parameters presented is provided in Section 10.6.4.2 and in Appendix 3.

### 10.1.3.2 Overview of modelling results

Table 10-7 and Table 10-8 show propagation of underwater noise from munitions clearance in Russia and Finland, given as single event Sound Pressure Levels (SEL), shown as average levels and peak levels, respectively, for various impact types.

**Table 10-7 Impact distances for propagation of underwater noise from conventional munitions clearance. Noise values are given as cumulative SEL (one event) dB re 1 $\mu$ Pa<sup>2</sup>s. Average levels.**

Munitions clearance-avg.	Criteria	RUS	FIN
164 dB	Seals/porpoises TTS	13-26 km	15-26 km
179 dB	Seals/porpoises PTS	3-5 km	3.5-5 km
203 dB	Fish injury	0.3 km	0.1-0.4 km
207 dB (229-234 dB peak)	Fish mortality	0.2 km	0.05-0.3 km

**Table 10-8 Impact distances for propagation of underwater noise from conventional munitions clearance. Noise values are given as cumulative SEL (one event) dB re 1 $\mu$ Pa<sup>2</sup>s. Peak levels.**

Munitions clearance-max	Criteria	RUS	FIN
164 dB	Seals/porpoises TTS	55-60 km	15-44 km
179 dB	Seals/porpoises PTS	11-23 km	3.5-15 km
203 dB	Fish injury	1-1.5 km	0.1-1.5 km
207 dB (229-234 dB peak)	Fish mortality	0.4-0.5 km	0.05-0.5 km

Table 10-9 shows propagation of underwater noise for rock placement in Russia, Finland, Sweden and Denmark, given as average 2 hours cumulative Sound Exposure Level (SELcum (2 hour)). This parameter has been selected to best represent the sound generated by rock placement. The threshold values are defined based on the potential impacts on marine mammals and fish.

**Table 10-9 Impact distances for propagation of underwater noise from rock placement. Noise values are given as cumulative SEL (two hours) dB re 1 $\mu$ Pa<sup>2</sup>s. Average levels.**

Rock placement - avg	Criteria	RUS	FIN	SWE	DK
188 dB	Seals/porpoises TTS	80 m	80 m	80 m	80 m
200 dB	Seals PTS	0 m	0 m	0 m	0 m
203 dB	Porpoises PTS, Fish injury	0 m	0 m	0 m	0 m

Rock placement - avg	Criteria	RUS	FIN	SWE	DK
207 dB	Fish mortality	0 m	0 m	0 m	0 m

Table 10-10 shows propagation of underwater noise for dredging, vibro-piling and operation in Russia, given as average 24 hours cumulative Sound Exposure Level (SELcum (24 hour)). This parameter has been selected to best represent the sound generated by activities which can be considered continuous for a longer period. The threshold values are defined based on the potential impacts on marine mammals and fish.

**Table 10-10** Impact distances for propagation of underwater noise from dredging, vibro-piling and operations in Russia. Noise values are given as cumulative SEL (24 hours) dB re 1µPa<sup>2</sup>s. Average levels.

Dredging, piling, operation	Criteria	Dredging	Vibro-piling	Operation
188 dB	Seals/porpoises TTS	50 m	0 m	0 m
200 dB	Seals PTS	0 m	0 m	0 m
203 dB	Porpoises PTS Fish injury	0 m	0 m	0 m
207 dB	Fish mortality	0 m	0 m	0 m

### 10.1.3.3 Interpretation of the modelling results

The results presented in Table 10-7 to Table 10-10 have been used as the basis for a number of the assessments presented in Section 10.2 onwards. In particular, the following key conclusions have been used:

- Underwater noise levels from rock placement and dredging in Russia, Finland, Sweden, Denmark, and Germany may exceed the noise threshold associated with TTS in marine mammals within distances of 50-80 m from the source of the noise.
- Underwater noise levels from conventional munitions clearance in Russia and Finland will exceed the noise threshold associated with TTS in marine mammals within distances of up to 26 km/60 km (average/peak noise levels) from the source of the noise. The threshold associated with PTS in marine mammals is also exceeded within distances of up to 5 km/23 km (average/peak noise levels) from the noise source. The threshold associated with fish mortality will be exceeded within distances of up to 0.2 km/0.5 km (average/peak noise levels) from the noise source; the threshold associated with fish injury will be exceeded within distances of up to 0.3 km/1.5 km (average/peak noise levels) from the noise source.
- Apart from that, marine mammals and fish might show avoidance reactions farther away.

### 10.1.4 Modelling of offshore airborne noise propagation

Airborne noise was calculated for the pipe-lay vessel during offshore pipe-lay activities (considered worst case) during construction for NSP and these calculations are also considered valid for NSP2. The modelling was undertaken based on the characteristics which result in the highest noise level (i.e. downwind and a moderate temperature gradient) /26/. The assumptions made, method used and detailed results are outlined in Appendix 3. A high level summary is provided Table 10-11 and discussed below.

Table 10-11 shows that the calculated noise levels will decrease from approximately 57 dB within 220 m of the noise source (i.e. the activity) to 33 dB at a distance of 4,100 m. Pipe-lay will be conducted on a 24-hour basis, with a speed of approximately 2-3 km per day (see Atlas Map NA-01-Espoo). Therefore, the airborne noise emission will be temporary, with a maximum duration of a couple of days in any given location.

**Table 10-11 Impact distances for propagation of airborne noise from offshore pipe-lay.**

Pipe-lay	57 dB	51 dB	48 dB	45 dB	42 dB	39 dB	36 dB	33 dB
Distance (m)	220	620	860	1,200	1,700	2,300	3,100	4,100

### 10.1.5 Calculation of emission of gases and particles to air

The emission of gases and particles to air during construction and operation of NSP2 has been calculated for the activities and PoOs shown in Table 10-12. The justification for the scope of the calculations as well as assumptions on which the calculations have been made are outlined in Appendix 3.

The air emissions calculations were carried out for a logistics scenario including Slite in Sweden as one of the pipe storage yards. This no longer part of the logistics scenario; however, the overall emissions presented in Table 10-12 are considered to be conservative and remain representative of the likely emissions scenario.

**Table 10-12 Activities and PoOs which have been subject to calculation of emissions of gases and particles to air.**

Emissions to air	RUS	FIN	SWE	DEN	GER
Operation of weight-coating plants	-	X	-	-	X
Onshore transport of rock materials	-	X	-	-	-
Transport and operation at interim stockyards	-	X	X	-	X
Transport and operation at ports (load out of pipes, etc.)	-	X	X	-	X
Transport of coated pipes to interim stockyards	-	X	X	-	X
Onshore/nearshore activities at landfalls	X	-	-	-	X
Offshore pipe-laying activities	X	X	X	X	X
Pre-commissioning	X	-	-	-	X
Operation phase	X	X	X	X	X

The total emissions anticipated to arise from NSP2 during construction and operation are shown in Table 10-13 below.

**Table 10-13 Total air emissions (tonnes) from construction and operation of the NSP2 pipeline. Data from /26/, /244/, /245/, /246/, /247/, /248/, /249/, /250/.**

Total air emissions (tonnes) from construction/operation of NSP2								
	Construction				Operation (50 years)			
	CO <sub>2</sub>	NO <sub>x</sub>	SO <sub>2</sub>	PM	CO <sub>2</sub>	NO <sub>x</sub>	SO <sub>2</sub>	PM
Total marine <sup>3</sup>	1,293,541	27,992	841	785	277,775	5,514	179	161
Total onshore landfall <sup>1</sup>	46,383	115	1	5	163	0.8	0.001	0.030
Total ancillary areas <sup>2</sup>	44,966	208	3	6	0	0	0	0
Total	1,384,890	28,315	845	796	277,938	5,515	179	161
1: Narva Bay (RUS), Lubmin 2 (GER).								
2: Kotka (FIN), Koverhar Hanko (FIN), Karlshamn (SWE), Mukran (GER) and Slite (SWE), though the latter is no longer part of the logistics concept.								
3: "Total marine" – including both "Marine" and "Nearshore" emissions, see Table 10-14								

The construction and operation of NSP2 will result in emissions of GHGs, primarily CO<sub>2</sub>. Table 10-14 below shows CO<sub>2</sub>-emissions for the total project.

**Table 10-14** Calculated CO<sub>2</sub> emissions (tonnes) from construction and operation of the NSP2 pipeline. Data from /251/, /252/, /253/, /254/, /255/, /256/, /257/.

CO <sub>2</sub> emission (tonnes) from construction/operation of NSP2		
Country	Construction	Operation (50 years)
<b>Russia</b>		
-Marine	93,600	15,701
-Nearshore	24,943	-
-Onshore landfall	14,641	163
<b>Finland</b>		
-Marine	326,606	90,074
-Ancillary areas <sup>1</sup>	21,694	-
SWEDEN		
-Marine	438,894	117,201
-Ancillary areas <sup>1</sup>	8,263	-
<b>Denmark</b>		
-Marine	194,362	33,667
<b>Germany</b>		
-Marine	215,136	21,132
-Onshore landfall	31,742	-
-Ancillary areas <sup>1</sup>	15,009*	-
1: Kotka (FIN), Koverhar Hanko (FIN), Karlshamn (SWE), Mukran (GER) and Slite (SWE), though the latter is no longer part of the logistics concept.		
*Cranes, loading equipment, etc. and weight-coating plant based on Finnish emission calculations.		

Marine emissions in Finland, Sweden and Denmark have been estimated both for the use of a DP lay vessel and an anchored lay vessel, since it is uncertain which vessel will be used. The data in Table 10-14 reflects the maximum values found in the estimates.

The construction and operation of NSP2 will result in emissions of NO<sub>x</sub>, SO<sub>2</sub> and PM. Table 10-15 below shows emissions of NO<sub>x</sub>, SO<sub>2</sub> and PM for the total project.

**Table 10-15** Calculated NO<sub>x</sub>, SO<sub>2</sub>, PM emissions (tonnes) from construction/operation of NSP2. Data from /251/, /252/, /253/, /254/, /255/, /256/, /257/.

Air emission (tonnes) from construction/operation of NSP2						
Country	Construction			Operation (50 years)		
	NO <sub>x</sub>	SO <sub>2</sub>	PM	NO <sub>x</sub>	SO <sub>2</sub>	PM
<b>Russia</b>						
-Marine	1,853	60.8	54.2	311.7	10.1	9.1
-Nearshore	495.2	8.0	14.5	-	-	-
-Onshore landfall	83.8	0.8	3.6	0.8	0.001	0.03
<b>Finland</b>						
-Marine	7,090	231	208	1,788	58	52
-Ancillary areas <sup>1</sup>	128.5	2.1	3.3	-	-	-
<b>Sweden</b>						
-Marine	8,707	283	255	2,327	76	68
-Ancillary areas <sup>1</sup>	79.2	1.2	2.2	-	-	-
<b>Denmark</b>						
-Marine	3,853	126	113	668	21.7	19.5
<b>Germany</b>						
-Marine	5,924	132	140	419	13.6	12.3
-Onshore landfall	31.2	-	1.8	-	-	-
-Ancillary areas <sup>1</sup>	30.2*	0.004*	1.0*	-	-	-
1: Kotka (FIN), Koverhar Hanko (FIN), Karlshamn (SWE), Mukran (GER) and Slite (SWE), though the latter is no longer part of the logistics concept.						
*Cranes, loading equipment etc. and weight-coating plant based on Finnish emission calculations.						



# Impacts on the physical and chemical environment

## 10.2 Marine areas

### 10.2.1 Marine geology, bathymetry and sediments

During construction and operation of NSP2, the following four sources of impacts related to marine geology, bathymetry and seabed surface sediments have been identified, assessed and reported below (see Table 8-1):

- Physical changes to seabed features (construction);
- Sedimentation on the seabed (construction);
- Presence of the pipelines (operation);
- Heat exchange between the pipelines and the surrounding environment (operation).

The marine geology, bathymetry and sediments define the boundaries for the marine biological and the socio-economic environment. Therefore, no sources of impacts have been scoped out.

#### 10.2.1.1 Physical changes to seabed features (construction)

Activities with the potential to cause physical changes to seabed features comprise dredging, post-lay trenching, rock placement, munitions clearance, anchor handling and cofferdam construction (see Table 8-1). Dredging, post-lay trenching, munitions clearance and cofferdam construction are the four activities with the highest potential for impact and therefore have been assessed in this section. Other activities, such as anchor handling, will interact with the seabed features to a lesser extent, impacting a smaller area, for a shorter duration (see Appendix 3).

Potential impacts on marine geology, bathymetry and sediments which may arise as a result of physical changes to seabed features comprise:

- Alterations to the seabed profile;
- Alterations to surface sediment composition.

Indirect impacts which may occur as a result of alterations to the seabed morphology (i.e. changes in the local currents) will be assessed in Section 10.2.2.

#### Assessment of potential impacts

The vulnerability of marine geology, bathymetry and sediments is considered to be low – medium due to the fact that these receptors can be restored back to pre-impact status either through human intervention, or naturally over time (through marine processes). The rate at which restoration occurs varies depending on the physical characteristics of a particular area. For example, the seabed in deeper basins, which are less exposed to currents and wave action, would take longer to revert back to pre-impact status than in shallower areas. The overall sensitivity is therefore considered to be low – medium irrespective of the importance, which is considered high as outlined in the baseline section.

The main impacts on marine geology, bathymetry and sediments will occur where dredging is proposed. In Russia, in a worst case, dredging is proposed in the approach channel leading to the Russian landfall in the Gulf of Finland (see Chapter 6 – Project description) which is approximately 2.7 km long and up to 150 m wide. Dredging at this location would result in the temporary removal of approximately 475,000 m<sup>3</sup> of seabed sediments (predominantly sand and silty sand) to allow access for the pipe-lay barges and installation of the pipelines. This would

cause an increase in water depth by up to 5 m in areas where the natural water depth ranges between 3 - 11.5 m (resulting in a new range of approximately 8 – 11.5 m depth). The excavated material displaced by dredging will be left on the seabed immediately adjacent to the pipelines until mechanical backfilling occurs (see below). In the case of the cofferdam construction, approximately 23,000 m<sup>3</sup> of seabed sediments (predominantly sands) will be removed and used to construct the associated causeway. A rock armour will be placed on the outside of the causeway to offer it protection from incoming waves and currents in the nearshore area of the Russian landfall.

Dredging is also proposed near the German landfall (see Chapter 6 – Project description) for the installation of the pipelines. For the preparation of the pipe trenches a volume of approximately 2,500,000 m<sup>3</sup> will have to be excavated with a resulting total trench surface of approximately 1,365,000 m<sup>2</sup>. Depending on various aspects the minimum cover above the pipelines will normally vary between 0.5 m and 1.55 m. Within certain areas (e.g. crossings with shipping lanes) the required pipe cover may increase up to 4.9 m. This would cause an increase of water depth within the confines of the pipe trenches by approximately 2 – 6.4 m in areas where the existing natural water depth ranges from 2 – 17.5 m. It is proposed to temporarily store the dredged material, which is suitable for the backfilling of the trench, at a selected area near the island of Usedom. The natural water depth within the temporary storage area ranges between approximately 10 m and 13 m. The temporarily stored soil may be piled up to a height of up to approximately 4 m above natural seabed. However, a water depth of 7.5 m will remain above the temporarily stored soil. Dredged material, which is unsuitable for the backfilling of the pipe trenches, will be permanently stored onshore.

In Russia, the dredged area will be backfilled to the original bathymetry (with an accuracy of +/- 0.5 m) after the installation of the pipelines. Although the removal and replacement of sediment in Russia has the potential to cause a change in the local seabed composition (marine geology and sediments) due to the mixing of sediment layers, the surface sediments would rapidly equalise with the surrounding seabed and therefore return to pre-impact status. In Germany, due to safety reasons and nature conservation purposes, the minimum cover above the pipelines will normally vary between 0.5 m and 1.55 m. Within certain areas (e.g. crossings with shipping lanes) the required pipe cover may increase up to 4.9 m. Reinstatement of the top layer in Germany will be carried out on a site and sediment specific basis, since all trenches are located within Natura 2000 sites. A top layer of approximately 50 cm will be excavated and stored separately at the interim storage site in order to ensure the reinstatement of the surface sediments to pre-impact status.

Impacts on marine geology, bathymetry and sediments will also occur where post-lay trenching is proposed (in Sweden and Denmark). This would result in the relocation of approximately 1.1 million m<sup>3</sup> of sediments across both countries, with an increase in depth of up to approximately 1.5 m (see Section 6.6.4). The excavated material displaced from the trench will be left on the seabed immediately adjacent to the pipelines, impacting the bathymetry by causing a decrease in depth of up to 1 m. Although no mechanical backfilling is proposed, the seabed profile in shallow areas will rapidly revert back to pre-impact status due to the action of waves and currents. This was documented through monitoring for NSP (see Appendix 3). In deeper waters, the changes in seabed profile may remain for a longer period (due to limited exposure to current and wave action); however, the changes are so localised that the impact on bathymetry is considered limited.

Similar to dredging, this handling of sediment during post-lay trenching has the potential to cause changes in the local seabed composition (marine geology and sediment). However, surface sediments would gradually equalise with the surrounding seabed and thus revert back to pre-impact status, due to the sediment transport processes which tend to level out the grain size distribution in line with the local hydrodynamic forces.

Munitions clearance is anticipated in Russian and Finnish waters (see Table 10-2). This has the potential to create craters in the seabed measuring approximately 0-8 m in diameter (based on NSP monitoring, see Appendix 3), with the associated relocation of up to approximately 50 m<sup>3</sup> of sediment.

Overall, the physical changes to the seabed are anticipated to be similar to those which occurred during the construction of NSP, where monitoring confirmed that no significant impacts were observed (Appendix 3).

On the basis of the above, the impact magnitude is considered to be negligible to low, as although the change is detectable above natural variations, it would not lead to any permanent effect on the ecosystem. The greatest impacts are likely to be observed in Finland, due to a combination of the narrow extent of the Gulf of Finland and the predicted number of munitions clearances which may be required (which have the potential to create craters on the seabed). Notwithstanding this, the overall project impact ranking is assessed to be **negligible**.

#### 10.2.1.2 Sedimentation on the seabed (construction)

Sediments released into the water column will be transported by currents and waves before being re-deposited on the seabed through sedimentation. Therefore, activities with the potential to cause sedimentation on the seabed comprise dredging, post-lay trenching, rock placement, munitions clearance, anchor handling and pipe-lay (see Table 8-1). Dredging, post-lay trenching, rock placement and munitions clearance are the four activities with the highest potential for impact and therefore have been assessed in this section. Other activities, such as pipe-lay and anchor handling, will generate less sedimentation on the seabed, impacting a smaller area, for a shorter duration (see Appendix 3).

Potential impacts on marine geology, bathymetry and sediments which may arise as a result of sedimentation on the seabed comprise:

- Alterations to the seabed profile;
- Alterations to surface sediment composition.

#### Assessment of potential impacts

The vulnerability of marine geology, bathymetry and sediments to sedimentation on the seabed is considered low due to the fact that these receptors can be restored back to pre-impact status naturally over time (through marine processes). The rate at which restoration occurs varies depending on physical characteristics of a particular area; for example, the seabed in deeper basins, which are less exposed to currents and wave action, would take longer to revert back to pre-impact status than in shallower areas. Overall sensitivity is therefore low – medium irrespective of the importance, which is considered high as outlined in the baseline section.

The predicted deposition of seabed sediments mobilised by dredging, post-lay trenching, rock placement and munitions clearance activities in Russia, Finland, Sweden and Denmark is shown in Table 10-2 to Table 10-5 and Appendix 3. These tables show that an area of approximately 20 km<sup>2</sup> distributed along the pipeline route is predicted to be covered by more than 200 g/m<sup>2</sup> of spilled sediments (which corresponds to a layer of approximately 1 mm of fine/loose sediment) (see Appendix 3). The sediment which will re-settle is considered to be of similar composition as the surrounding seabed.

At the Russian landfall, the general counter-clockwise circulation predominantly moves suspended sediments north along the western shore of the Kurgalsky Peninsula. The area affected by additional sedimentation of over 200 g/m<sup>2</sup> was modelled to be a maximum of 12 km<sup>2</sup>.

NSP monitoring in Germany showed that sedimentation amounted to less than 1 kg/m<sup>2</sup> (which corresponds to a layer of up to a few mm thickness). Within 25 m of either side of the pipeline

trench, monitoring also shows some sediment overflow (for sandy trench sections) during refilling of the trenches, which resulted in a 0.2 m layer of sediment immediately adjacent to the trench. This sediment was found to be of similar composition as the overlaid seabed sediments. Surveys did not detect measurable changes in geophysical parameters as a result of the sedimentation /243/. The sedimentation of the seabed caused by NSP2 construction in Germany is expected to be of the same order of magnitude as the sedimentation caused by NSP construction /54/.

It is noted that the predicted levels of sedimentation along the entire route are within the natural annual sedimentation rates in the Baltic Sea, which are in the order of 100-1,000 g/m<sup>2</sup>/yr (see Section 9.2.1.3). Therefore, changes in the seabed profile and seabed composition are considered within the levels of natural variation.

Furthermore, deposited sediments will typically become re-suspended after primary deposition, and subsequently be transported by currents and waves until a natural deposition site is reached (a zone of sedimentation, see Section 9.2.1.3). Therefore, temporary changes in the seabed profile and seabed composition will gradually revert back to pre-impact status due to natural marine sediment transport processes.

On the basis of the above, the impact magnitude is considered to be negligible, as the change is localised, within natural variations, and the seabed will revert to pre-impact status after cessation of the activities. The greatest impacts are likely to be observed in Russia and Germany, due to dredging activities (which will cause increase suspended sediment in the water column, and subsequent sedimentation). Notwithstanding this, the overall project impact ranking is assessed to be **negligible**.

#### 10.2.1.3 Presence of the pipelines (operation)

Potential impacts on bathymetry and sediments which may arise as a result of the presence of the pipelines during the operation phase comprise:

- Introduction of a hard substrate at the seabed surface;
- Alterations to the seabed profile.

Indirect impacts on physical/chemical receptors which may occur as a result of the above are assessed in the relevant sections of this chapter. No impacts are anticipated on marine geology.

#### Assessment of potential impacts

The vulnerability of bathymetry and sediments is considered medium as the receptor is not resilient to the change, but could be actively restored back to pre-impact status. Overall sensitivity is therefore considered medium, irrespective of the importance, which is considered high as outlined in the baseline section.

The pipelines and support structures will occupy an area of the seabed corresponding to the diameter of the pipelines times their lengths plus the area of the support structures. The hard surfaces introduced are different from the surrounding seabed, which mainly consists of loose sedimentary deposits and lag sediments. However, this introduced surface comprises a very small area (approximately 5 km<sup>2</sup> along the pipeline route, depending on the degree of burial in the seabed) compared to the total seabed (both locally in the regions where the pipelines extend and on a Baltic Sea scale). NSP2 therefore has the potential to replace approximately 3-4 km<sup>2</sup> of existing flat seabed with an area of approximately 5 km<sup>2</sup> new, hard cylindrical substrate along the pipeline route.

The alterations to the seabed profile may affect the water currents (see Section 10.2.2), which may subsequently alter local sediment erosion (scouring) and deposition patterns. The impact of the latter (changes to accretion and erosion processes) was modelled during NSP and is considered valid for NSP2. The results indicated that there would be a scour effect at current

speeds above 0.31 m/s perpendicular to the pipelines, and that the extent of the scour on the leeward side of the pipelines (i.e. the side facing away from the water flow) was likely to be up to 10-12 times the pipeline diameter, corresponding to approximately 12-14 m /258/.

However, bottom current speeds only exceed 0.3 m/s during the infrequent major Baltic inflows (see Section 9.2.2.2). Therefore, scour effects caused by NSP2 would be localised and within natural variations, except for during these major events /67/.

On the basis of the discussion above, the impact magnitude is considered to be negligible to low. The greatest impact is likely to be observed in Finland, where the change in seabed surface represents a greater proportion of the total seabed (due to the narrow extent of the Gulf of Finland). Notwithstanding this, the overall project impact ranking is assessed to be **negligible**.

#### 10.2.1.4 Heat exchange between the pipelines and the surrounding environment (operation)

Potential impacts on sediments may arise due to the heat exchange between the pipeline and the surrounding environment. These may comprise:

- Change in the temperature of the sediments.

No impacts are anticipated on marine geology and bathymetry.

##### Assessment of potential impacts

The vulnerability of the sediments is considered low as the receptor is resilient to change and will revert back to pre-impact status. Overall sensitivity is therefore considered low, irrespective of the importance, which is considered high as outlined in the baseline section.

As a result of gas compression, high gas temperatures (40°C) are expected in the pipelines close to the Russian landfall. Conversely, low gas temperatures are expected in the pipelines close to the German landfall, both from cooling of the gas due to the lower temperature of the seawater and cooling by expansion (the 'Joule-Thompson effect'). This will influence the temperature of the pipelines themselves and may result in heat exchange between the pipelines and the surrounding environment.

Such heat exchange has the potential to result in an increase in temperature of the sediments along the upstream part of the pipelines (in particular near the Russian landfall and in the Gulf of Finland) and a decrease in temperature of the sediments (depending on the time of the year) near the German landfall.

The impact on sediments (temperature change) was modelled at the landfall sites in Russia and Germany. The simulations showed that the temperature in the sediment surrounding the trenched pipeline close to the Russian landfall location will be slightly higher than the surrounding sediments in a 10-20 cm wide zone around the pipelines. No detectable temperature difference in the sediment surrounding the trenched pipelines close to the German landfall was predicted. This is in line with what was observed during monitoring of sediment temperature above the covered NSP pipeline in Greifswalder Bodden during the operation phase in 2013 /259/.

On the basis of the discussion above, the impact magnitude is considered to be negligible as the change is highly localised and will not impact the functioning of the ecosystem. As the sensitivity is low, the overall project impact ranking is assessed to be **negligible**, which is not significant.

#### 10.2.1.5 Summary and ranking of potential impacts on marine geology, bathymetry and surface sediments

A summary of the overall project impact rankings for marine geology, bathymetry and surface sediments is provided in Table 10-16, together with the rankings predicted at the country level.

As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

In respect to transboundary impacts, although an increase in sedimentation may extend across national borders into Estonia, it will be of a sufficiently small scale to result in at most a negligible impact. No other potential transboundary impacts have been identified (see Chapter 15 – Transboundary impacts).

**Table 10-16 Overall project assessment and country-specific impact rankings and the potential for transboundary impacts.**

Marine geology, bathymetry and sediments	Project	RU	FI	SE	DK	GE	Trans
Physical changes to seabed features							No
Sedimentation on the seabed							Yes
Change in seabed profile/presence of the pipelines							No
Heat exchange between the pipelines and the surrounding environment				-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

## 10.2.2 Hydrography and seawater quality

During the construction and operation of NSP2, the following five sources of impacts related to hydrography and seawater quality have been identified, assessed and reported below (see Table 8-1):

- Release of sediments to the water column (construction);
- Release of contaminants and nutrients to the water column (construction);
- Presence of the pipelines (operation);
- Heat exchange between the pipelines and the surrounding environment (operation);
- Release of contaminants from pipeline anodes (operation).

The hydrography and seawater quality define the boundaries for the marine biological and the socio-economic environment. Therefore, no sources of impacts have been scoped out.

### 10.2.2.1 Release of sediments to the water column (construction)

Activities with the potential to cause the release of sediments to the water column comprise dredging, post-lay trenching, rock placement, munitions clearance, anchor handling and pipe-lay (see Table 8-1). Dredging, post-lay trenching, munitions clearance and rock placement are the four activities with the highest potential for impact and therefore have been assessed in this section. Other activities, such as pipe-lay and anchor handling, will generate less suspended sediment in the water column, and impact a smaller area, for a shorter duration (see Appendix 3).

Potential impacts on water quality which may arise as a result of release of sediments to the water column comprise:

- Increase in SSC in the water column causing increased turbidity;
- No impacts are anticipated on hydrography.

### Assessment of potential impacts

The vulnerability of water quality to an increase in SSC is considered low as this receptor is regularly exposed to variations in SSC due to the natural sediment dynamics of the Baltic Sea (see Section 9.2.1.4). It is therefore considered to be resilient to change, and will rapidly revert back to pre-impact status. The overall sensitivity is therefore low irrespective of the importance, which is considered high as outlined in the baseline section.

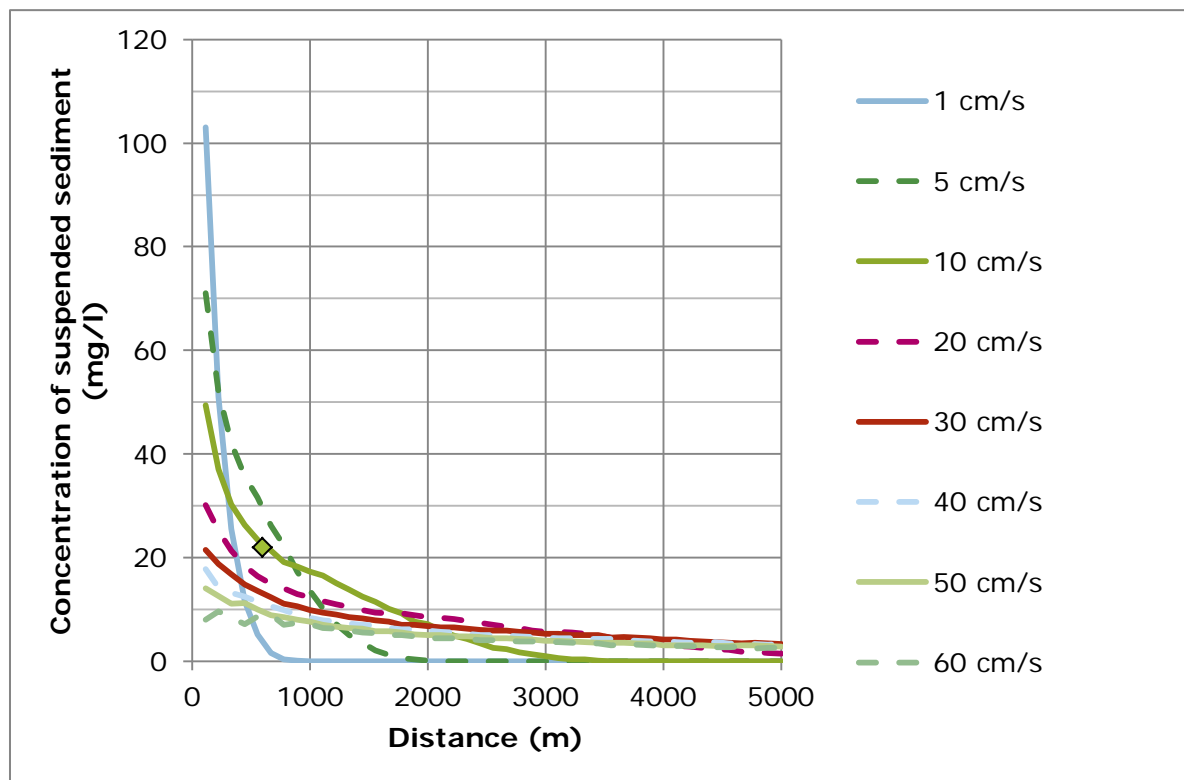
The modelled concentrations of SSC arising from dredging, post-lay trenching, munitions clearance and rock placement are shown for Russia, Finland, Sweden, and Denmark in Section 10.1.2 (Table 10-2 to Table 10-5) and Appendix 3. The modelling shows that an increased SSC of 10 mg/l<sup>31</sup> is anticipated due to the NSP2 activities in an area of approximately:

- 265 km<sup>2</sup> due to dredging in Russia;
- 200 km<sup>2</sup> due to dredging in Germany;
- 160 km<sup>2</sup> due to post-lay trenching in Sweden and Denmark (for the one pipeline with the largest amount of post-lay trenching);
- 65 km<sup>2</sup> due to munitions clearance in Russia and Finland;
- 10 km<sup>2</sup> due to rock placement in Russia, Finland, Sweden and Denmark (for one pipeline, chosen due to it having the largest amount of rock placement).

However, as noted in Section 10.1.2, most of the activities (i.e. post-lay trenching, munitions clearance and rock placement) would occur sequentially at discrete locations along the proposed route and therefore only certain areas (which are smaller than the total) would be affected at any given time during the construction phase. Furthermore, the duration of an increased SSC of 10 mg/l is, in all cases, less than one day after cessation of the activity (Atlas Maps MO-01-Espoo to MO-07-Espoo). This is due to the dispersion and dilution effect as well as natural sedimentation to the seabed. To demonstrate this effect, Figure 10-1 shows the typical decrease in SSC with distance from the spill source (calculated based on a typical grain size distribution where post-lay trenching takes place, i.e. in Sweden and Denmark). The concentration rapidly decreases with distance from the spill source, both due to the dilution effect of the dispersion and to sedimentation on the seabed. The figure shows that at very low current velocities, e.g. 1 cm/s, the SSC reduces to zero approximately 700 m from the spill source, i.e. after a period of approximately 19 hours. At larger current velocities, e.g. 10 cm/s, the SSC is reduced to zero approximately 3,000 m from the spill source, i.e. after a period of 8 hours.

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<sup>31</sup> The results for 10 mg/l have been presented in this section as the threshold concentration above which the majority of potential impacts on biological receptors may be observed; see Appendix 3 for full justification.



**Figure 10-1** Sediment concentrations in the lowermost 10 m of the water column, at various distances from the sediment spill source, and at various current velocities, calibrated in accordance with measurements carried out during trenching for NSP in Danish waters on 13 February 2011 /39/.

Peaks of higher SSC concentrations are likely to be experienced as a result of post-lay trenching, munitions clearance and rock placement in Russia, Finland, Sweden and Denmark, though this would be for an even shorter duration and covering even smaller areas than those described above (see Section 10.1.2).

Where an activity takes place continuously at the same location for a number of days, e.g. dredging, the duration may be longer in localised areas. For example, dispersion modelling studies for the nearshore dredging activities at the Russian landfall area (Atlas Map MO-02) indicate that SSC of over 10 mg/l could persist in an area of 0.17 km<sup>2</sup> for approximately 397 hours (approximately 17 days).

NSP monitoring in Germany has shown that sediments were released to the water column only near dredging vessels. Generally, the concentration of suspended matter near the activities varied between 10-30 mg/l, although peaks of up to 100-150 mg/l were reached in very close proximity to the dredging bucket (depending on the type of dredger). The turbidity plumes reached a radius of less than 500 m in Greifswalder Bodden and less than 200 m in the Pomeranian Bay (the larger plume likely due to sediments containing more than 10% silt). The majority of the released sediments, which comprised fine and medium sand, settled to the seabed within 1 or 2 hours after cessation of the activity. The remainder (5% of the dredged material in Greifswalder Bodden and less than 1% of the dredged material in Pomeranian Bay), which comprised fine grained silt and clay (particle diameter < 20 µm) remained in the water column for up to 1-2 days /243/.

Increasing the SSC, and hence the turbidity, of the water as a consequence of NSP2 activities can reduce the light available, which might impact biological receptors (see Section 10.6), due to the lower transparency of the water. However, it is important to note that, as outlined in Section 9.2.1.3, the natural SSC under calm conditions in the Baltic Sea is typically in the range 0-5 mg/l, whereas the level in high energy conditions (e.g. storms and/or major Baltic inflows) can range between 10 and 100 mg/l. The highest concentrations are usually associated with shallow-



water areas where the seabed is most exposed to the combined action of waves and currents (e.g. in Greifswalder Bodden). Therefore, the majority of the elevated SSC caused by NSP2 would be within the range of natural variation.

On the basis of the discussion above, the impact magnitude is considered to be low, as although some concentrations may be detectable above natural variations (for some activities), the water quality will revert to pre-impact status and there will be no long-term effect on the functioning of the ecosystem. As the sensitivity is low, the overall project impact ranking is assessed to be **minor**, which is not significant.

#### 10.2.2.2 Release of contaminants and nutrients to the water column (construction)

Activities with the potential to cause the release of contaminants and nutrients to the water column are those which would disturb the seabed sediments, and therefore comprise dredging, post-lay trenching, rock placement, munitions clearance, anchor handling and pipe-lay. The greatest impacts are related to release of contaminants from sediments mobilised as a consequence of dredging, post-lay trenching and munitions clearance (see Section 10.1.2). Other activities, such as pipe-lay and anchor handling, will release less suspended sediment (and associated contaminants and nutrients) into the water column, impacting a smaller area, for a shorter duration (see Appendix 3).

Potential impacts on water quality which may arise as a result of the release of contaminants and nutrients to the water column comprise:

- Increased concentration of contaminants in the water column;
- Increased concentration of nitrogen (N) and phosphorus (P) in the water column;
- No impacts are anticipated on hydrography.

#### Assessment of potential impacts

##### *Contaminants*

The vulnerability of water quality to an increase in contaminant levels is considered low due to the rapid decrease in concentrations caused by dispersion and dilution from turbulence in the marine environment. It is therefore considered to be resilient to change, and will rapidly revert back to pre-impact status. The overall sensitivity is therefore low irrespective of the importance, which is considered high as outlined in the baseline section.

The potential for increased concentrations of contaminants is dependent on the amount of sediment released and its corresponding concentration of contaminants, as well as the amount of these contaminants that become bioavailable once in the water column (and can therefore cause a toxicological effect on biological receptors). Desorption (the fraction of a chemical compound bound to the sediment that will desorb during re-suspension) and bioactivity (the fraction of the desorbed chemical compound capable of being taken up by receptors) affect how much of a contaminant becomes bioavailable. Only a minor fraction (in the order of magnitude of 10 % /260/, /261/, /262/) of the contaminants released into the water column can therefore be expected to become bioavailable; the majority will remain bound to the sediment particles and therefore settle to the seabed within similar distances (see above).

Given the variation in contaminant concentrations in the seabed sediments along the proposed NSP2 route (see Section 9.2.1.3), impacts have been discussed on a national basis. The largest concentrations of contaminants in the seabed sediments of the Baltic Sea occur in net sedimentation areas for fine-grained sediments, which have the highest organic content and the largest adsorption capacities.

The results of modelling are presented in Section 10.1 and in Appendix 3. Examples of modelling of the dispersion of contaminants are shown in Atlas Maps MO-04-Espoo and MO-05-Espoo. It is

important to note that most of the activities which cause contaminant release into the water column would occur sequentially at discrete locations along the proposed route and therefore only certain areas (which are smaller than the totals indicated below) would be affected at any given time during the construction phase.

#### Russia

For activities undertaken within Russian waters, modelling of the dispersion of sediment-associated contaminants has taken place for munitions clearance (Table 10-2), rock placement (Table 10-3) and dredging (Table 10-5). The greatest potential for impact is caused by dredging, whereby:

- The PAH PNEC value is exceeded within an area of approximately 172 km<sup>2</sup> for up to 35 days;
- The dioxin/furans PNEC value is exceeded within an area of approximately 108 km<sup>2</sup> for up to 34 days;
- The zinc PNEC value is exceeded within an area of approximately 53 km<sup>2</sup> for up to 30 days.

Sediment disturbance during other seabed works is also likely to release a portion of the bound sediment contaminants into the water column; however, the volumes of sediment and therefore contaminants involved are much smaller and most of these will rapidly re-combine with the suspended fine sediments and be deposited back on the seabed.

As stated in the section 10.1 the analysis of the contaminants along the pipeline route in Russia shows large spatial variations in concentrations due to different sediment types (highest contaminant concentrations are in the deeper muddy sections of the route) and historical aspect (it is well known and documented that significant amount of contaminants including dioxins and furans disperse from the River Kymijoki in Finland into the Gulf of Finland and estimated impacted area may extend across the border to the western part of Russian waters). Concentrations of the various contaminants are therefore significantly lower in the nearshore area than in the offshore areas (see table in Section 10.1.2.1). However, as a conservative measure, the 95%-percentile (over locations and depths) of the measured concentrations has been adopted for the modelling. So the results of the modelling done for the nearshore dredging in Russia can be considered to be very conservative.

#### Finland

For activities undertaken within Finnish waters, modelling of the dispersion of sediment-associated contaminants has taken place for munitions clearance (Table 10-2) and rock placement (Table 10-3). The greatest potential for impact is caused by munitions clearance, whereby:

- The PAH PNEC value is exceeded within an area of approximately 118 km<sup>2</sup> for up to 19 hours;
- The dioxin/furans PNEC value is exceeded within an area of approximately 21 km<sup>2</sup> for up to 7 hours;
- The zinc PNEC value is exceeded within an area of approximately 2.8 km<sup>2</sup> for up to 3 hours.

For the rock placement scenarios, only PAH show concentrations exceeding the PNEC value, and only in an area of up to 9.6 km in total, for up to 22 hours.

#### Sweden

For Sweden, no modelling of the dispersion of sediment-associated contaminants has taken place for NSP2. The concentration and dispersion of four compounds – zinc, copper, arsenic and PAH – released into the water column as a result of rock placement were, however, calculated during

NSP. Calculations were not made for trenching, as the proposed activity was considered to be in erosion areas without any significant degree of contamination /263/.

The following exceedances were calculated for NSP /32/ (and, given the similarity of the construction methods and construction sites between NSP and NSP2, are considered to be representative for NSP2 also):

- The zinc PNEC value was not exceeded at any time;
- The arsenic PNEC was exceeded only within <1 m;
- The copper PNEC value was exceeded within an area of approximately 18 km<sup>2</sup> for more than 24 hours;
- The PAH PNEC value was exceeded within an area of approximately 117 km<sup>2</sup> for, on average, approximately 3 days near the seabed.
- It is noted that the majority of exceedances of the PNEC values occurred only at the major rock placement sites in the deeper parts of the Baltic Sea. The actual concentrations for NSP were expected to be less as the calculations were based on conservative assumptions /32/. Therefore, the exceedances observed during the construction of NSP2 are likely to be less than those indicated above.

#### Denmark

For Denmark, no modelling of the dispersion of sediment-associated contaminants has taken place for NSP2. The concentration and dispersion have therefore been estimated based on the sediment spill rate and the highest measured concentrations of contaminants measured in the sediment along the NSP2 route /26/. The concentrations of the different contaminants corresponding to the increased SSCs have then been compared with the EU criteria for environmental quality standards (EQS) for the water column, or, if such is not available, the PNEC /26/.

None of the metal concentrations in the water column exceed the given EQS/PNEC threshold, though the concentration of lead at 15 mg/l SSC was identical to the EQS. However, as noted in Section 10.1.2.2, an increase of 15 mg/l SSC will only occur in an area of approximately 7-8 km<sup>2</sup>, for a maximum of 2-6 hours /26/.

The potential release of CWA from the sediment is discussed in Section 10.13, though the potential impacts of this release on seawater quality have been taken into consideration within this assessment.

As noted in Section 10.13, seabed interventions, pipe-lay, anchoring operations and use of DP vessels have the potential to cause re-suspension and dispersion of seabed sediments into the overlying water column, which can result in the release of CWA into the water column. However, the types of CWA present in the Baltic Sea are poorly dissolvable in water, and will mainly be present as particulate material that will rapidly resettle on the seabed after getting suspended. Therefore, water quality can be considered resilient. Although water quality is considered an important receptor, the sensitivity of the water quality toward CWAs is judged to be low.

The potential increase in the concentrations of CWAs in the water column as a result of NSP2 has been predicted based on the concentrations of CWAs in seabed sediments along the NSP2 route and modelling the results of sediment redistribution due to intervention works, see Section 10.13. Risk Quotients (RQ), representing the expected CWA concentration in the water column (PEC) divided by the toxicity threshold value (PNEC) were calculated and shown not to exceed 0.0024 at a distance of 200 m from the pipeline. Thus, at a distance of 200 metres from the pipeline route, the concentration of CWA in the water column is expected to remain more than 400 times lower than the level at which a negative impact on biota may occur. Additionally, as noted above, CWA are poorly dissolvable in water and will settle out within a short time span after suspension.

### Germany

The amount of contaminants that will be released from sediment to the water column has been estimated based on the chemical composition of the seabed sediments. The accumulated amount along the proposed NSP2 route is low since the content of organic material is low. Considering the worst case that all heavy metals contained in dredged material will be released, there will still be no measurable increase in the concentrations of heavy metals in the water column. The same holds true for organic contaminants, whose concentrations in sediments were mostly beneath the limit of detection /54/.

Chemical analysis of seabed sediments along the proposed NSP2 route has documented concentrations of heavy metals that correspond to natural levels. The contaminant loads in sediments are very low. The mobilisation of sediments and sediment-associated contaminants are connected to the range of turbidity plumes. In Germany, released substances can potentially reach the Arkona Basin through long-term bedload transport /54/.

After the construction of NSP, increased concentrations of long-chain petroleum-derived hydrocarbons were measured in Greifswalder Bodden for approximately one year. It was not possible to confirm whether those hydrocarbons were as a result of NSP or other sources such as existing ship traffic or third party oil spills. Therefore, it is possible that the input of these substances will temporarily increase during the construction of NSP2 as well /54/.

### Summary

As outlined above, the release of contaminants as a consequence of NSP2 will be very low compared with the overall inventory in the water column and compared with the input from other sources (see Section 9.2.2), so that it will not have any lasting impact on water quality. This is also the case when the possible release of remains of CWA in Danish waters is taken into consideration, due to the negligible impacts from CWA, as outlined in Section 10.13.

- Furthermore, the above assessment is considered to be conservative as most of the activities would occur sequentially at discrete locations along the proposed route and therefore only certain areas (a proportion of the total area affected) would be impacted by elevated concentrations at specific times during the construction phase.

On the basis of the above discussion, the impact magnitude is considered to be low, as although some concentrations may be detectable above natural variations, the water quality will revert to pre-impact status once the activity ceases. Impacts will be greatest in the areas where the activities are of a longer duration in the same location; this is particularly the case for dredging at the landfalls and post-lay trenching in Denmark. As the sensitivity is low, the overall project impact ranking is assessed to be **minor**, which is not significant.

### *Nutrients*

The vulnerability of the water quality to an increase in nutrients is considered low due to the rapid decrease in concentrations from dispersion and dilution. It is therefore considered to be resilient to change, and will rapidly revert back to pre-impact status. The overall sensitivity is therefore low irrespective of the importance, which is considered high as outlined in the baseline section.

As outlined in Section 9.2.2.5, the two main nutrients of interest in the Baltic Sea are nitrogen and phosphorous due to their role in primary production. Adding additional amounts of N and P to the water column in the Baltic Sea has the potential to increase primary production and eventually contribute to the eutrophication of the Baltic Sea. The potential for increased concentrations of nutrients as a result of NSP2 is dependent on the amount of sediment released and its corresponding concentration of nutrients, as well as the amount of these nutrients which become bioavailable once in the water column.

The average concentrations of nitrogen and phosphorous in surface sediments along the proposed NSP2 route indicate a relatively uniform distribution for the offshore section. However, the largest concentrations of nutrients in the seabed sediments of the Baltic Sea occur in zones of sedimentation for fine-grained sediments, which have the highest organic contents and the largest adsorption capacities.

In Russia, the highest measured concentrations in the seabed sediments were 5.4 g P/kg and 10 g N/kg. During a baseline survey in the Finnish EEZ in 2015, the median concentrations of total P and N in the seabed surface (0–30 cm) of the survey corridor were 0.71 g P/kg dry weight and 3.00 g N/kg dry weight, respectively /27/. In Denmark, the highest measured concentrations in the seabed sediments along the proposed NSP2 route were 1.22 g P/kg dry weight and 3.11 g N/kg dry weight, respectively /26/. In Germany, the concentrations of total P and N in the seabed surface (0–30 cm) of the survey corridor ranged between 0.10-0.20 g P/kg dry weight and 0.10-1.00 g N/kg dry weight, respectively /54/.

Assuming a total sediment spill of approximately 2,600 tonnes from munitions clearance (Russia and Finland), 5,200 tonnes from rock placement (Russia, Finland, Sweden and Denmark), 14,200 tonnes from post-lay trenching (Sweden and Denmark) and 40,000 tonnes from dredging in Russia, the overall spill will be in the order of 62,000 tonnes. Assuming concentrations of 0.7 g P/kg dry weight and 3.0 g N/kg dry weight, the total mass of nutrients in the spilled seabed sediments is in the order of 43 tonnes P and 186 tonnes N.

For dredging in Germany, a worst case assessment has shown the release of 15 tonnes of bioavailable P into Greifswalder Bodden and 239 tonnes of bioavailable P into Pomeranian Bay. A comparison with the annual discharge and natural re-mobilisation of P, which amounts to 400 tonnes P in Greifswalder Bodden and more than 5,000 tonnes P in the Pomeranian Bay shows that the additional inputs during the year of construction will be less than 5% of the total for these two areas. For N, it was assessed that, based on an analysis of sediments and pore-water, that dredging will not noticeably contribute to any re-mobilisation of N in Germany /54/.

The overall re-mobilisation of nutrients by NSP2 should be compared with the annual inputs of N and P to the Baltic Sea, which is in the order of 30,000 tonnes of P and 800,000 tonnes of N (see Section 9.2.2.5). Of the above outlined potential releases of nutrients, only a proportion will become bioavailable. N and P incorporated in organic matter is not a direct source of nutrients available for primary production, i.e. the main source of eutrophication. Only after release of the sediment into the water column and mineralisation of the organic matter will the nutrients become available. Nutrients present in coherent lumps of seabed sediments being handled will only cause very limited release of dissolved nutrients to the water column. Bioavailability is further limited by the presence of the pycnocline which will, in deeper areas of the Baltic Sea, prevent transfer of the nutrients into the photic zone. Therefore, only a minor fraction of the nutrients in the seabed sediments spilled as a consequence of NSP2 activities will become available for phytoplankton growth and contribute to eutrophication in the Baltic Sea.

Due to the fact the potential release of nutrients caused by seabed interventions works are so low compared with the yearly influx to the Baltic Sea, no measurable changes in the N and P concentrations are anticipated.

### *Summary*

On the basis of the discussion above, the impact magnitude is considered to be low, as although some concentrations of contaminants and/or N and P may be detectable above natural variations, the water quality will revert to pre-impact status once the activity ceases. The speed at which water quality reverts back is dependent on the duration of the activity, with impacts from dredging likely to remain for a longer period. As the sensitivity is low, the overall project impact ranking is assessed to be **minor**, which is not significant.

### 10.2.2.3 Presence of the pipelines (operation)

Potential impacts on hydrography from NSP2 may arise due to the presence of the pipelines or support structures on the seabed during the operational lifetime of the pipelines. Impacts may comprise:

- Changes in current patterns and inflows.

Impacts on current patterns and inflows also have the potential to cause a change in sediment dynamics (see below).

#### Assessment of potential impacts

The vulnerability of hydrography and seawater quality changes in current patterns is considered low due to the natural variability of the bathymetry. The overall sensitivity is therefore low irrespective of the importance, which is considered high as outlined in the baseline section.

The possible blocking of the inflow of saline water to the Baltic Sea caused by the presence of the NSP2 pipelines is outlined in Appendix 3. The assessment is based on modelling substantiated with hydrographic monitoring for NSP, which have subsequently been updated with modelling for NSP2.

The presence of two new pipelines crossing the dense bottom current in the eastern Bornholm Basin is predicted to double the mixing effect (Appendix 3, Section 2.4.1), resulting in an increased mixing effect of between 0–0.4% for NSP and NSP2 in combination. This is estimated to increase the flow of the bottom current by 0–86 m<sup>3</sup>/s and decrease its salinity by 0–0.008%.

The potential leakage of phosphorus caused by the changes in hydrodynamics from the four pipelines together (NSP and NSP2) in the depth interval 60–80 m has been calculated at between 0 and 26 tonnes P/yr. Given that the natural influx to the Baltic Sea is approximately 30,000 tonnes P/year, the changes predicted by modelling will be below detectable levels if they occur.

In the Gulf of Finland, the nearshore part of NSP2 will be buried and will therefore have no impact on bathymetry or current patterns/profiles. Further offshore, in the Gulf of Finland and Baltic Proper, the seabed current velocities are very low, and any changes to current flow caused by the exposed NSP2 pipelines will be limited to the area in the close vicinity of the pipelines.

In areas where the pipelines are laid on the seabed surface, natural embedment is expected and would reduce impacts on hydrography. Analysis of the embedment of the NSP pipelines shows that five years after installation, the pipelines are embedded at least 50% in most locations.

Near the German landfall, impacts on hydrography may arise during construction from dredging pipe trenches and storing dredged sediments at the seabed near the island of Usedom. Compared to the local water depth, these trenches are sufficiently shallow so that measurable changes are not expected. Furthermore, no measurable changes are anticipated as a result of the temporary 3 m depth reduction at the storage area for a duration of approximately 7 months. Even unmeasurable changes will only be temporary as the affected seabed will be restored to its original state following pipe-lay /54/. Also the construction activities at the Russian landfall might locally and temporarily cause impacts on the hydrography.

On the basis of the discussion above, the impact magnitude is considered to be negligible as the change is localised and within natural variations. As the sensitivity is low, the overall impact ranking is assessed to be **negligible**, which is not significant.

#### 10.2.2.4 Heat exchange between the pipelines and the surrounding environment (operation)

Potential impacts on water quality may arise due to the heat exchange between the pipeline and the surrounding environment during operation. These may comprise:

- Change in the temperature of the surrounding water column.

No impacts are anticipated on hydrography.

##### Assessment of potential impacts

The vulnerability of the water quality is considered low as the receptor is resilient to change because of the hydrodynamic processes encouraging mixing and able to revert back to pre-impact status. The overall sensitivity is therefore considered low, irrespective of the importance, which is considered high as outlined in the baseline section.

As noted in Section 10.2.1.4 above, the gas temperatures within the pipelines vary along the proposed NSP2 route, influencing the temperature of the pipelines themselves, which may result in heat exchange between the pipelines and the surrounding seawater.

The impact on sediments and seawater (temperature change) was modelled at the landfall sites in Russia (Vyborg) and Germany during NSP /264/ (to cover the two extremes) and the results are also considered valid for NSP2.

Where free-laying pipelines close to the NSP landfall site in Vyborg (Russia) were exposed to currents, there was a small temperature increase (maximum 0.5°C) in the water near the seabed and in the water on the downstream side of the pipelines. The temperature change was only detectable at a maximum distance of approximately 0.5-1 m from the pipelines. In the situation with no currents, the temperature change in the surrounding water was also limited, impacting a narrow plume just above the pipelines, with an increase in water temperature of up to 0.1°C, 5 m vertically above the pipeline centre /264/. With currents present, the impacts are even lower due to the rapid dispersion.

Where free-laying pipelines in Pomeranian Bay (Germany) were exposed to currents, there was a small temperature decrease (maximum 0.1°C) in the water near the seabed and in the water on the downstream side of the pipelines. The temperature change was only detectable at a maximum distance of approximately 1 m from the pipelines /264/.

Heat exchange along other parts of the proposed NSP2 route will be less than those indicated above.

On the basis of the discussion above, the impact magnitude is considered to be negligible as the change is highly localised and, although detectable above natural variation, will not impact the functioning of the ecosystem. As the sensitivity is low, the overall impact ranking is assessed to be **negligible**, which is not significant.

#### 10.2.2.5 Release of contaminants from pipeline anodes (operation)

Potential impacts on water quality from NSP2 can arise due to the release of contaminants as a result of the dissolution of sacrificial anodes. Impacts on the environment can result in:

- Increased concentrations of contaminants (aluminium, zinc and associated trace metals) in the water column.

##### Assessment of potential impacts

The vulnerability of water quality to an increase in dissolved metal concentrations is considered low due to the rapid reduction in concentrations caused by dispersion and dilution. It is therefore considered to be resilient to change and able to revert back to pre-impact status. The overall

sensitivity is therefore low irrespective of the importance, which is considered high as outlined in the baseline section.

The release of metals from sacrificial anodes was assessed for NSP and is considered valid for NSP2. The expected concentrations of metal ions in the water column (PEC) immediately around the anodes were calculated and compared with the acceptable levels within the marine environment and background mean concentrations measured from samples. The concentrations of cadmium and lead in the water column around both the aluminium and zinc anodes will be so low that they will fall below the EAC quality criteria and PNEC values (see Appendix 3).

Advection-dispersion calculations showed that elevated zinc concentrations (exceedance of the PNEC value) may be found within 3 m from zinc anodes. This shows that the zinc is quickly dispersed and diluted in the sea. Monitoring for NSP in the Finnish EEZ showed that the concentrations of heavy metals on both sides of the pipeline were low and below the detection limit; concentrations of zinc were not higher in the samples 1-2 m from the anodes as the concentrations measured at the reference stations.

The pH levels in sediment along the proposed NSP2 route range from 7 to 8.5. These conditions will cause the development of insoluble aluminium hydroxide. To date, negative impacts on the marine environment by the present aluminium concentrations are not known /54/.

On the basis of the discussion above, the impact magnitude is considered to be negligible to low, as although some concentrations may be detectable above natural variations, the extent will be very localised (within 1 m from the anodes). The greatest increase in the concentration of contaminants from anodes is expected in Finland, where the greatest amount of zinc anodes (by weight) will be used. As the sensitivity is low, the overall project impact ranking is assessed to be **negligible**, which is not significant.

#### 10.2.2.6 Summary and ranking of potential impacts on hydrography and seawater quality

A summary of the overall project impact rankings for hydrography and seawater quality is shown in Table 10-17, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Although there is some potential for “in-combination” impacts on hydrography and water quality from the various sources of impact, notably from the release of sediment and release of contaminants/nutrients to the water column, the magnitude of the combined impacts is sufficiently low such that the rankings for all sources of impact on this receptor group are likely to be at most minor.

With respect to transboundary impacts, although the release of sediments and contaminants/nutrients to the water column may extend across national borders into Estonia, any resultant increase in SSC will be of a sufficiently small scale to result in at most a negligible impact on water quality. No other potential transboundary impacts have been identified (see Chapter 15 – Transboundary impacts).

**Table 10-17 Overall project assessment and country-specific impact rankings and the potential for transboundary impacts.**

Hydrography and seawater quality	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column							Yes
Release of contaminants and nutrients to the water column							Yes



Change in seabed profile/presence of the pipelines							No				
Heat exchange between the pipelines and the surrounding environment							No				
Release of contaminants from pipeline anodes							No				
Impact ranking:	<table border="1"> <tr> <td>Negligible</td> <td>Minor</td> <td>Moderate</td> <td>Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								

### 10.2.3 Climate and air quality

During construction and operation of NSP2, the following source of impact related to climate and air quality offshore has been identified, assessed and reported below (see Table 8-1):

- Release of air pollutants (NO<sub>x</sub>, SO<sub>2</sub> and PM) and GHGs (CO<sub>2</sub>) from vessels (construction and operation).

#### 10.2.3.1 Release of air pollutants and GHGs from vessels (construction and operation)

Potential impacts on climate and air quality may arise due to the release of air pollutants and GHGs from vessels during construction and operation. These may comprise:

- Increase in GHG/climate gases;
- Reduction in local air quality.

#### Assessment of potential impacts

The vulnerability of air quality is considered low due to natural dilution and dispersion in the atmosphere. It is therefore considered resilient to change, and able to rapidly revert back to pre-impact status. The overall sensitivity is therefore low irrespective of the importance, which is considered high as outlined in the baseline section. Regarding climate, sensitivity towards CO<sub>2</sub> emissions is assessed to be medium.

As shown in Table 10-13, approximately 93% of the CO<sub>2</sub> emissions during the construction phase occur in marine areas. From Table 10-14 it can be seen that the majority of these marine CO<sub>2</sub> emissions occur during the NSP2 construction period (approximately 87%), while the remainder is emitted during the operation period.

The CO<sub>2</sub> emissions from marine activities alone (construction and operation) are shown in Table 10-18 below.

**Table 10-18** Calculated CO<sub>2</sub> emissions (tonnes) in marine areas from construction and operation of the NSP2 pipeline /243/, /251/, /252/, /253/, /254/, /255/, /256/.

CO <sub>2</sub> emission (tonnes) from construction/operation of NSP2, marine areas		
Country	Construction	Operation (50 years)
Russia (incl. nearshore)	118,543	15,701
Finland	326,606	90,074
Sweden	438,894	117,201
Denmark	194,362	33,667
Germany (incl. nearshore)	215,136	21,132
TOTAL	1,293,541	277,775

The total CO<sub>2</sub> emissions from vessels sailing in the Baltic Sea comprised 15,900,000 tonnes in the year 2015 /104/. The construction of the NSP2 pipeline is planned to last approximately two years; therefore, assuming an even distribution of CO<sub>2</sub> emissions during the construction period,

the marine emissions will temporarily increase the total annual emission of CO<sub>2</sub> from vessels in the Baltic Sea by approximately 4%. Although CO<sub>2</sub> emissions in general have an impact on a global scale, the increased emission during the construction period is not anticipated to have a quantifiable impact on global climate.

#### *NO<sub>x</sub>, SO<sub>2</sub> and PM emissions – air quality*

From Table 10-15 and it can be seen that the majority of marine emissions of other compounds (NO<sub>x</sub>, SO<sub>2</sub> and PM) occur during construction of the NSP2 pipeline (approximately 82-84%), while the remainder is emitted during the operation period. Furthermore, Table 10-13 shows that approximately 98% of the NO<sub>x</sub>, SO<sub>2</sub> and PM emissions during the construction phase occur in marine areas.

The emissions of NO<sub>x</sub>, SO<sub>2</sub> and PM from marine activities alone (construction and operation) are shown in Table 10-19.

**Table 10-19** Calculated emissions (tonnes) of NO<sub>x</sub>, SO<sub>2</sub> and PM in marine areas from construction and operation of the NSP2 pipeline. /243/, /251/, /252/, /253/, /254/, /255/, /256/.

Air emission (tonnes) from marine construction/operation of NSP2						
Country	Construction			Operation		
	NO <sub>x</sub>	SO <sub>2</sub>	PM	NO <sub>x</sub>	SO <sub>2</sub>	PM
Russia (incl. nearshore)	2,348	68.8	68.7	312	10.1	9.1
Finland	7,090	231	208	1,788	58	52
Sweden	8,707	283	255	2,327	76	68
Denmark	3,853	126	113	668	21.7	19.5
Germany	5,924	132	140	419	13.6	12.3
TOTAL	27,922	841	785	5,514	179	161

The total emissions of NO<sub>x</sub>, SO<sub>2</sub> and PM from vessels sailing in the Baltic Sea comprised approximately 343,000, 10,000 and 10,500 tonnes, respectively, in the year 2015 /104/. Assuming an even distribution of emissions of these compounds during the construction period, the emissions will temporarily increase the total annual emissions from vessels in the Baltic Sea by approximately 4%.

Marine emissions will lead to a temporary reduction in the air quality nearby NSP2 vessels. However, the majority of vessel activity will take place far offshore, meaning that the emissions will be dispersed and diluted prior to reaching inhabited areas, such that the emissions' impact on air quality in populated areas is not quantifiable. This is supported by dispersion calculations for the offshore operations in the construction phase, conducted in /256/, which indicated that there would be no exceedances of the applicable short-term thresholds, yearly average limit thresholds or hourly average thresholds, as identified in the EU's air quality guidance /103/. The thresholds for SO<sub>2</sub> are 20 µg/m<sup>3</sup> (yearly average to protect vegetation), 350 µg/m<sup>3</sup> (hourly average, 24 permitted exceedances each year) and 125 µg/m<sup>3</sup> (24 hour average, 3 permitted exceedances each year). The thresholds for NO<sub>2</sub> are 40 µg/m<sup>3</sup> (yearly average) and 200 µg/m<sup>3</sup> (hourly average, 18 permitted exceedances each year). The thresholds for PM<sub>10</sub> are 40 µg/m<sup>3</sup> (yearly average) and 50 µg/m<sup>3</sup> (24 hour average). The threshold for PM<sub>2.5</sub> is 25 µg/m<sup>3</sup> (yearly average).

#### *Summary*

On the basis of the discussion above, the impact magnitude is considered to be negligible as the change is temporary and, although detectable above natural variation in close proximity to the activities (for Germany in particular), will not have a quantifiable impact on global climate or local air quality. As the sensitivity is low, the overall project impact ranking is assessed to be **negligible**, which is not significant.

The potential impacts on onshore local air quality and global climate from construction and operation of NSP2 at the Narva Bay landfall, Lubmin 2 landfall and ancillary areas are assessed in Sections 10.3, 10.4 and 10.5, respectively.

In addition to emissions shown in Table 10-19, there will be regular releases of natural gas through vent stacks at the PTAR at Russian landfall (without flaring) provided for by the design. As such, it has been decided to undertake calculations of the predicted emissions of methane (CH<sub>4</sub>). It has been estimated that 873,120 Nm<sup>3</sup> of CH<sub>4</sub> will be emitted during the expected 50 year operation of the PTAR.

### 10.2.3.2 Summary and ranking of potential impacts on climate and air quality

A summary of the overall project impact rankings for climate and air quality is shown in Table 10-20, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Although there is some potential for “in-combination” impacts on climate and air quality from the various sources of impact, the magnitude of the combined impacts is sufficiently low such that the rankings for all sources of impact on this receptor group are likely to be at most minor.

Although some air pollutant and GHG emissions from vessels may eventually extend across national borders, before this takes place, the emissions will be diluted to a degree where they will not be detectable above background levels. Therefore, no potential transboundary impacts have been identified.

**Table 10-20 Overall project assessment and country-specific impact rankings and the potential for transboundary impacts.**

Climate and air quality	Project	RU	FI	SE	DK	GE	Trans
Release of air pollutants and GHGs from vessels							No
Impact ranking:	Negligible		Minor		Moderate		Major

## 10.3 Onshore landfall Narva Bay

### 10.3.1 Geomorphology and topography

During construction and operation of NSP2, one potential source of impact related to geomorphology and topography has been identified, assessed and reported below (see Table 8-1):

- Changes to landform and land cover (construction).

#### 10.3.1.1 Changes to landform and land cover (construction)

Activities with the potential to cause physical changes to landform and land cover comprise the removal of vegetation, stripping and storage of topsoil, trench excavation and construction of the PTA, temporary working areas and access roads.

Potential impacts on geomorphology and topography which may arise as a result of physical changes to landform and land cover comprise:

- Reduction in soil quality, integrity and productivity;
- Increase in soil erosion.

### Assessment of potential impacts

The vulnerability of geomorphology and topography at the landfall area is considered to be medium due to the fact that this receptor will be restored to pre-impact status (except at the permanent PTA structure) through human intervention (trench backfilling and revegetation) after construction is finalised. The rate at which restoration occurs varies depending on factors such as surface slope gradient, hydrological regime and types of soils. With the exception of the open-cut section through the relict dune, the PTA and linear part of pipeline constructed by the open cut is located within the plain with a low slope gradient that is not prone to erosion. The technical reinstatement is therefore expected to be successful through these areas. Acidic soils with a low organic content are, however, characterised by poor drainage properties and require a longer period for vegetation to establish (approximately 5 years), although the species for revegetation will be carefully selected to ensure soil integrity is quickly achieved. The overall sensitivity within the plain with a low slope gradient is therefore assessed to be medium irrespective of the high importance. The area through the relict dune is a more sensitive and important topographical feature, as it was created by geomorphological processes and a sand supply that are no longer available. The relict dune therefore has high sensitivity and high importance.

The main impacts on geomorphology and topography will occur when the vegetation and soil will be removed within the construction area and as a result of trench excavation. The temporary development footprint for the worker camp and laydown area will occupy approximately 42 ha. The conventional open-cut constructed pipeline section within the Kurgalsky Nature Reserve will temporarily occupy an area of approximately 31 ha (3.7 km long and 85 m wide), which represents <0.05% of the overall designated Kurgalsky reserve, and 0.14% of its terrestrial component.

The trenched area will be progressively backfilled and most of the working area will be levelled to the original topography and revegetated after the installation of the pipelines. The impact on topography, for all areas other than through the relict dune, will therefore be at a local scale and short-term; the impact magnitude will be low.

The construction of the pipeline through the relict dune will leave an 85 m wide cut through the dune system, which may not be restored to pre-construction ground levels. This may result in a permanent change in landform. The open cut that remains through the relict dune will require stabilising using hard engineering techniques, such as gabion baskets, to prevent wind and water erosion on the slopes at the edge of the cut area. This is because the slope stability through this dune system is in part derived from the overlying soil and vegetation. The use of hydro-seeding with a relevant seed mix will aid stabilisation of the sand and assist restoration of the topsoil, but the likelihood of full restoration of the soil conditions within this altered landform will take decades. The permanent loss of relict dune topography with the open cut would be approximately 2.5 ha, and given that the topographical feature is already only present over a small area, the impact magnitude on the relict dune is high. However, a dune restoration plan to mitigate permanent impact is under development and with restoration plan in place the impact magnitude is considered medium.

The soil properties across the Russian landfall are acidic with a low organic content and are characterised by poor drainage. Nonetheless, the soils across the whole landfall area underpin the variety of high value habitats across the Kurgalsky reserve, although there are some differences between the soil characteristics to the east of the relict dune and those covered by the primary and secondary forest and within the coastal dunes. The soils between the PTA and the relict dune have been subject to anthropogenic modification and been altered by natural fires and are of low vulnerability, which means the potential for a reduction in quality and soil productivity is limited. However, the soils within the areas covered by primary and secondary forest, including the relict dune covered in pine forest, are of high vulnerability as their quality is intrinsically linked to the overlying vegetation, which has not been modified by anthropogenic activity. These soils are not resilient to change and will take significant time to be restored (much

longer than 20 years), as their recovery is dependent first on the regrowth of the aspen/spruce-fir primary forest. The recovery of these soils will therefore happen in two stages. The first stage of forest regrowth will take 15-20 years. Once the necessary microclimatic conditions have then been created by the tree cover, a further 15-20 years will be required for the recovery of the moss/lichen communities and associated mycorrhizae that influence the forest habitat soil properties. When combined with their high importance, the sensitivity of the soils along the route from the relict dune to the shore is considered high.

The Soil Management Plan will require the topsoil to be stored within the 85 m working width, so that it can be reinstated upon completion of the construction works. The poor drainage properties of the soil affected within the working width between the PTA and the relict dune mean that they only have a local influence on the Kader swamp, and do not contribute to the wider ecosystem function. The impacts on soil quality, integrity and productivity will also be local and temporary and of low intensity; impact magnitude is therefore considered low.

Following mechanical disturbance of the soil within the primary and secondary forest, including the relict dune, re-establishment of the original soils may take much longer (potentially decades). This is because even though the Soil Management Plan will require this soil to be carefully stored prior to reinstatement, it will not be possible to recreate the pre-disturbance conditions soon after reinstatement. Additionally, the damage to soils, mycorrhizae content and existing vegetation mean there is less certainty that original habitats will re-establish. Within the forest habitats there will be no re-growth of deep rooted trees within 7.5 m above each pipeline and the 6 m required for the access road. The creation of these gaps will slow down the re-establishment of the original microclimatic conditions within the understorey beneath the forest canopy and hence the recreation of the pre-construction soil conditions. Given the localised effects on soils from the open-cut sections from the PTA to the east of the relict dune and from west of the relict dune to the coastline, the impact magnitude is medium. For the soil within the relict dune, given the smaller overall area of this landform, the 2.5 ha permanent loss is significant, however with the restoration technique in place the impact magnitude is medium.

Compaction of the soil may occur from the movement of vehicles and machinery along the working width, which may prevent rainfall penetration and thereby increase surface water run-off. The temporary access roads will, however, be constructed with a geotextile membrane beneath a compacted gravel cover, which will prevent long-term impacts on soil integrity and quality and the loss of soil through erosion. Upon completion of construction, temporary access roads will be removed and biological reinstatement will take place, including topsoil cover and seeding and revegetation. The impact from compaction is therefore assessed as having a low magnitude.

The temporary nature of the construction works and their short duration means that the potential for increased surface run-off is limited. The relatively flat topography also means that the opportunity for sediment-laden surface water run-off from excavation stockpiles to reach local surface water features is limited. The most likely destination for run-off from the soil stockpiles will be the excavated trench, which can be dug out and the soil re-stockpiled in the 85 m working width. Impacts arising from an increase in soil erosion during construction are therefore local and temporary and of low intensity. For the relict dune, where erosion can occur, construction within this area requires stabilisation using engineering techniques such as gabion baskets to minimise wind and water erosion.

During operation, no impacts are expected beyond those occurring during construction and no additional mitigation will be required. There will be permanent structures associated with the PTA, but the installation of minimal hardstand areas and the reinstatement of the temporary construction areas will prevent further impacts on soil quality, integrity and productivity.

On the basis of the discussion above, the impact magnitude ranges from low to medium. The impact magnitude on topography will be low for most of the onshore section as although the change is detectable above natural variations, the receptor will revert to the pre-impact status and there will be no long-term effect on the functioning of the ecosystem. The impact magnitude on soils ranges from low to medium: low for the modified habitat, medium for primary forest and the relict dune. When combined with the medium sensitivity, the impact ranking for the modified habitat will be **minor**, which is not significant, whilst when combined with the high sensitivity of soils within the forest and relict dune, the impact ranking ranges is assessed to be **moderate** for the forest and the relict dune.

### 10.3.1.2 Summary and ranking of potential impacts on geomorphology and topography

A summary of the project impacts on geomorphology and topography at the onshore landfall, Narva Bay, is provided in Table 10-21.

Due to the local nature of the impact, no potential transboundary impacts have been identified.

**Table 10-21 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Geomorphology and topography - Russia	Project	RU	FI	SE	DK	GE	Trans				
Changes to landform and land cover	N/A	*	-	-	-	-	No				
Impact ranking:	<table border="1"> <tr> <td>Negligible</td> <td>Minor</td> <td>Moderate</td> <td>Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								
* Minor for modified habitat / Moderate for forest and relict dune. The greatest impact ranking is shown.											

### 10.3.2 Freshwater hydrology

During construction and operation, the following two sources of impact related to freshwater hydrology have been identified, assessed and reported below (see Table 8-1):

- Changes to landform and land cover (construction and operation);
- Releases to land and water (construction).

#### 10.3.2.1 Changes to landform and land use (construction)

Activities with the potential to cause physical changes to landform and land cover comprise the removal of vegetation, stripping and storage of topsoil, trench excavation and construction of the PTA, temporary working areas and access roads.

Potential impacts on freshwater hydrology which may arise as a result of changes to land form and land cover comprise:

- Alterations to drainage patterns and hence both surface hydrology and groundwater regimes;
- Increases in sediment load in surface water run-off, affecting water quality.

#### Assessment of potential impacts

The vulnerability of freshwater hydrology is considered to be medium due to the fact that the receptor will revert naturally back to the pre-impact status over time.

The main hydrological features associated with the pipeline and PTA that influence freshwater hydrology are the Kader swamp, the Mertvitsa River and artificial ditches and channels created for agricultural and fire management purposes. The pipeline and PTA will not cross the Mertvitsa River, so there will be no direct impacts on that receptor. The hydrology within the Kader swamp

and modified habitat underpins the variety of high value habitats across the Kurgalsky reserve, so must be considered to have a high sensitivity.

During construction, removal of vegetation and earthworks may alter the natural drainage patterns both above and below ground, with regard to the location and the intensity of the flows. Water flow may become concentrated due to e.g. the introduction of hard standing areas or the removal of vegetation. This may in turn result in a localised increase in soil erosion and increased sediment load in nearby water bodies.

The open-cut section of the pipeline corridor from the PTA crosses the northern part of the Kader swamp, relict dune, primary forest and coastal dune. Construction of the pipeline and the PTA will require vegetation clearance, topsoil stripping, grading and compaction of the ground and excavation of the trench and associated storage of the excavated material in the working width. These activities have the potential to interfere with the local drainage patterns and hence the local hydrology. The surface hydrology and hydrogeology is, however, mainly recharged from pluvial water sources (rainfall and snowfall), as opposed to groundwater and surface water flow, and the poorly draining podzol soils, along with the flat topography, mean there is limited groundwater flow. The soil for the trench backfilling will have the same filtration properties as underlying soils to ensure the adequate water drainage.

The construction of the open-cut section of the pipeline is therefore unlikely to affect the wider drainage patterns and hence the Kader swamp, relict dune, primary forest and coastal dune as a whole. The impact from the pipeline trench excavation will be of low intensity, on a local scale and short-term, i.e. the environment will return to pre-impact status once the works are complete. Additionally, a requirement of the Water Management Plan is that the technical reinstatement, grading and profiling of the pipeline corridor include the installation of a drainage system under the permanent access road. This will return drainage patterns to pre-construction conditions.

During operation, no impacts are expected beyond those occurring during construction. There will be a permanent system installed at the PTA, which will collect surface water run-off from the permanent access roads and the hardstanding areas. Water will be discharged to the Rosson River; the discharge point is to be approved by the Water Authority.

On the basis of the discussion above, considering the implementation of the Water Management Plan, the impact magnitude during construction is considered to be negligible. Although the water environment forms part of the qualifying features of the protected landscapes and the sensitivity of freshwater hydrology is high, in combination with the negligible impact magnitude, the overall project impact is assessed to be **negligible**.

#### 10.3.2.2 Releases to land and water (construction)

Activities with the potential to cause releases to land and water comprise earthworks, machinery maintenance and pre-commissioning activities.

Potential impacts on freshwater hydrology which may arise as a result of releases to land and water include:

- Increases in sediment load in surface water run-off, affecting water quality;
- Pollution of water.

#### Assessment of potential impacts

The vulnerability of freshwater hydrology is considered to be medium due to the fact that the receptor will revert naturally back to the pre-impact status over time. As discussed previously, the sensitivity of freshwater hydrology is assessed to be high.

Dewatering of the pipeline trench will be required during construction. Water will be pumped from one section of the open trench to another adjacent section without the need to create a new drainage channel at the edge of the right of way. These measures will be specified within the Water Management Plan and will return groundwater back to its source and also prevent sediment-laden water from discharging away from the work areas to surface watercourses. Water run-off management during PTA construction will include installation of a temporary pipeline and settlement tank, which will collect and treat water to fishery standards prior to discharge into the Rosson River.

Parking and refuelling spaces for construction machinery and transport vehicles will be provided in dedicated, bunded hard-standing areas capable of containing any spills to prevent contaminants from reaching water bodies. The impact from water run-off that may affect water quality will be, if any, of low intensity, on a local scale and short-term.

Hydrotesting of the onshore pipeline will be carried out using fresh water brought to the site by road tanker (approximately 2,000 m<sup>3</sup>). After hydrotesting is complete, water will be collected within a pond (or temporary storage tanks) for later disposal off-site. There is no impact expected as a result of pre-commissioning activities.

During operation, no impacts are expected. There will be a permanent system installed at the PTA, which will collect surface water run-off from the permanent access roads and the hardstanding areas. These drainage systems will be designed to ensure that surface water discharges are maintained at greenfield run-off rates. This will prevent the run-off from altering natural drainage patterns and causing soil erosion, and the subsequent increase in sediment load that would affect surface water bodies.

On the basis of the discussion above, considering the implementation of the Water Management Plan, the impact magnitude during construction is considered to be negligible. Although the water environment forms part of the qualifying features of the protected landscapes and the sensitivity of freshwater hydrology is high, in combination with the negligible impact magnitude, the overall project impact is assessed to be **negligible**.

### 10.3.2.3 Summary and ranking of potential impacts on freshwater hydrology

A summary of the impact rankings for freshwater hydrology at the onshore landfall, Narva Bay, is provided in Table 10-22. The impacts are not significant.

Owing to the ranking levels and the different nature of the impacts associated with each of the two sources of impact considered above, there is a limited potential for "in-combination" impacts from these two sources of impact. However, no combined or additive impacts are anticipated.

Due to the local nature of the impacts, no potential transboundary impacts have been identified.

**Table 10-22 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Freshwater hydrology - Russia	Project	RU	FI	SE	DK	GE	Trans
Changes to landform and land cover	N/A		-	-	-	-	No
Releases to land and water	N/A		-	-	-	-	No
Impact ranking:	Negligible		Minor	Moderate	Major		



### 10.3.3 Climate and air quality

#### 10.3.3.1 Climate and GHG emissions (construction and operation)

The impact from GHG emissions caused by the project on the climate is calculated for the whole project in Section 10.2.3. Although detectable above natural variation in close proximity to the activities, emissions of GHGs will not have a quantifiable impact on global climate.

#### 10.3.3.2 Emission of compounds that influence air quality (construction and operation)

The construction and operation of the NSP2 pipeline results in emissions of compounds that will temporarily impact air quality in the onshore landfall at Narva Bay. The total emissions during the onshore construction and 50 years of operation of the NSP2 pipeline are shown in Table 10-23 below.

**Table 10-23** Calculated onshore emissions (tonnes) from construction and operation of the NSP2 pipeline, onshore landfall Narva Bay.

Calculated emissions (tonnes) onshore Narva Bay							
	Activity	Construction			Operation		
		NO <sub>x</sub>	SO <sub>2</sub>	PM	NO <sub>x</sub>	SO <sub>2</sub>	PM
Narva Bay	Construction of PTAR*	1.625	0.176	0.197	-	-	-
	ROW clearance and road construction	0.052	0.005	0.006	-	-	-
	Open cut trench	47.116	0.148	1.945	-	-	-
	Micro-tunnel	31.590	0.044	1.254	-	-	-
	Shore pull	0.252	0.0004	0.009	-	-	-
	On-land transport from Ust-Luga	2.938	0.460	0.216	-	-	-
	Onshore pipeline pre-commissioning	0.210	0.0003	0.007	-	-	-
	Operation phase (PTAR)	-	-	-	0.842	0.001	0.030
	Total	83.8	0.8	3.6	0.8	0.001	0.03

\*Pig Trap Area Russia

There will be regular releases of natural gas through vent stacks at the PTAR (without flaring) provided for by the design. As such, it has been decided to undertake calculations of the predicted emissions of methane (CH<sub>4</sub>). It has been estimated that 873,120 Nm<sup>3</sup> of CH<sub>4</sub> will be emitted during the expected 50 years of operation of the PTAR.

Values for the Russian sector (onshore and nearshore) have been calculated /251/. During construction of the pipeline the air quality onshore will be affected in the vicinity of the construction machines, power equipment and vehicles. The air quality nearshore will be affected in the vicinity of the vessels.

Activities with the potential to cause emissions to air comprise:

- Vehicle transportation of pipe work and equipment from Ust-Luga to the onshore construction site.
- Construction of the micro-tunnel and open-cut trench using machinery and equipment, such as cranes, excavators and winches powered by generators.
- Construction and operation of the PTA.

Potential impacts on air quality that may arise as a result of emissions to air comprise increases in nitrogen oxides (NO, NO<sub>2</sub>, NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), dust and particulate matter (including PM<sub>2.5</sub> and PM<sub>10</sub>) from the combustion of a variety of fuel oils.

The vulnerability of air quality is considered to be low due to the fact that the receptor is resilient to change and will naturally and rapidly revert back to pre-impact status. The sensitivity is therefore assessed to be low irrespective of the importance.

During construction, impacts are predicted to occur primarily at work sites (e.g. from power generation) where active construction works are taking place, and from vehicle movements.

Total emissions were calculated for construction activities based on the duration of work and type of equipment to be used.

The most concentrated work will be done at the PTA location where preparation of the site and installation of equipment will involve operation of various construction machinery and vehicles. The work will last for approximately 470 days. Construction of the open cut section and access road from the PTA to the micro-tunnel entrance as well as micro-tunnel construction and pull-in operation will take approximately 300 days. During construction, the air quality onshore will be affected in the vicinity of the construction machines, power equipment and vehicles. Based on calculated emissions and the nature of work, the impacts on air quality will be on a local scale and temporary.

Impact magnitude is assessed to be low to negligible as the change to the receptor is localised, the environment will revert to pre-impact status once the construction is complete and there will be no long-term effect on the functioning of the ecosystem. As the sensitivity is low, the overall impact ranking is assessed to be **negligible**, which is not significant.

During operation, there will be no continuous emissions to air from the operation of the PTA, and emissions will consist of intermittent releases of natural gas (methane, CH<sub>4</sub>) during inspection, maintenance and repair activities. Given the limited emissions of GHGs during the operation phase, the impact magnitude is considered to be negligible and, therefore, impact ranking is assessed as **negligible**.

### 10.3.3.3 Summary and ranking of potential impacts on climate and air quality

The impact ranking is summarised in Table 10-24 below. Due to the local nature of the impacts, no potential transboundary impacts have been identified.

**Table 10-24 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Air quality	Project	RU	FI	SE	DK	GE	Trans
Emission to air	N/A		-	-	-	-	No
Impact ranking:	Negligible		Minor		Moderate		Major

## 10.4 Onshore landfall Lubmin 2

### 10.4.1 Geomorphology and topography

During construction and operation of NSP2, the potential impacts related to geomorphology and topography at the German landfall are listed below:

- Change to landforms, land use and land cover.

#### 10.4.1.1 Change to landforms, land use and land cover (construction and operation)

Activities with the potential to cause physical changes to landform and land cover comprise the removal of vegetation, stripping and storage of topsoil and construction of the PTA, temporary working areas and access roads.

Potential impacts on geomorphology and topography which may arise as a result of physical changes to landform and land cover comprise:

- Reduction in soil quality, integrity and productivity.
- Loss of soil due to sealing of the ground.
- Changes to the relief.

#### **Assessment of potential impacts**

Due to the construction of a micro-tunnel, the coastal section, including the beach, will not be disrupted. For the construction of the pig trap, parts the forest need to be cleared and soil needs to be excavated. This will lead to a loss of vertical landscape elements (trees) and thus to a degradation of the landscape. Great parts of the coherent forest area, especially west and south of the construction area, and small belts of forest to the north and east of the pig trap will remain. Further, anthropogenic industrial structures exist all around, which must be seen as a pre-existing negative factor.

The preparation of the construction site requires the exchange of naturally occurring soil, which does not have the property to carry the structural load that comes along with the project. Approximately 0.5 m of soil will be exchanged and leveling of the construction site will be carried out in the course of building the PTA Lubmin 2. Concrete foundations that bring terrain level to 7.5 m above sea level will be constructed.

In the northern part of the PTA, a starting pit (approximately 15 x 15 m) will be implemented for each of the planned micro-tunnels by using sheet pile boxes. These starting pits will be refilled after the pipelines are moved in, and all sheet piles and stakes will be removed. Subsequent to these construction works, all surfaces required for the area of the PTA (roads and pathways) will be constructed. Functional impairments of the soil through removal of the topsoil are expected in the complete area of the PTA, including the ring road and the construction, mounting and storage sites. The topsoil will be restored and prepared for re-cultivation and greening. By the repeated crossing of heavy construction machines and the construction work itself, the construction area will be frequently used and impaired by sealing and silting.

Impacts associated with the construction of NSP2 will be greatest in association with the PTA and ring road. Within the footprint of the PTA area, the soil will lose its functionality (habitat loss, regulation function and function in productivity). The totally sealed area will be kept to a minimum. The following areas will be impacted: 41,479 m<sup>2</sup> unsealed areas, 1,111 m<sup>2</sup> partly sealed areas and 13,981 m<sup>2</sup> fully sealed areas. By balancing the relief in the area of the PTA and the mounting areas in the south, as well as the site office, the naturally occurring dune relief will also be lost.

Although these impacts may be considered of a medium magnitude in the immediate vicinity of the route, at a local or regional scale they are considered to be of low magnitude. Where practicable, features would be restored to pre-impact status. In combination with the low to medium sensitivity (given that none of the features are protected or unique in the region), the overall project ranking is assessed to be **minor**, and therefore not significant.

#### **10.4.1.2 Summary and ranking of potential impacts on geomorphology and topography**

The overall impact ranking is summarised in Table 10-25 below.

**Table 10-25 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Geomorphology and topography - Germany	Project	RU	FI	SE	DK	GE	Trans				
Change to landforms, land use and land cover	N/A	-	-	-	-	*	No				
Impact ranking:	<table border="1"> <tr> <td>Negligible</td> <td>Minor</td> <td>Moderate</td> <td>Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								
*for the purposes of the German EIA process, which requires consideration of impacts at the site level, a ranking at such a level is moderate, which may be considered significant.											

#### 10.4.2 Freshwater hydrology

During construction and operation of NSP2, the potential impacts related to freshwater hydrology at the German landfall are likely to arise from the following:

- Change to landforms and land use (construction, operation).

##### 10.4.2.1 Change to landforms and land use (construction)

For construction of the pig trap near Lubmin 2 physical changes of the existing landform may have the potential impact:

- Disturbance of the landscape.

##### Assessment of potential impacts

The starting pit for the micro-tunnel will be approx. 10 m deep; thus, it is below the groundwater level. The groundwater level will be drawn down to 0.5 m below the floor of the pit, which will be kept water-free during the tunnel construction (approx. 9 months). The groundwater recharge rate is high in the surrounding area, so the impact magnitude will be low. The upcoming groundwater predominantly will be discharged into the harbour basin at Lubmin via a receiving water body and a smaller portion of it will seep into the surrounding green space areas. The pumped water masses will be high in the first 42 days (1,717 m<sup>3</sup>/d) and low for the remaining period (88 m<sup>3</sup>/d). The groundwater level will get back to normal shortly after the construction works end.

The tunnel will be flooded with seawater for a period of about two months when it will be opened at the sea side. But since the tunnel material is waterproof, it is very unlikely that saline water will get in contact with the groundwater. The remaining water in the starting pit (approx. 21,220 m<sup>3</sup>) will be discharged into large areas within the forest to the east of the newly built PTA. In conclusion, the measures for the construction of the micro-tunnel are of a local and temporary nature with a low to medium intensity, leading to a low impact magnitude.

Due to the low impact magnitude in combination with the low sensitivity, the impact ranking is assessed to be **minor**, which is not significant.

##### 10.4.2.2 Summary and ranking of potential impacts on freshwater hydrology

The overall impact ranking is summarised in Table 10-26 below. Due to the local nature of the impacts, no potential transboundary impacts have been identified.

**Table 10-26 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Freshwater hydrology - Germany	Project	RU	FI	SE	DK	GE	Trans
Physical changes to landform or land cover	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

### 10.4.3 Climate and air quality

#### 10.4.3.1 Climate and GHG emissions (construction and operation)

The impact from GHG emissions caused by the project on the climate is calculated for the whole project in Section 10.1.5. Although detectable above natural variation in close proximity to the activities, emissions of GHGs will not have a quantifiable impact on global climate.

The construction of NSP2 will result in the partial removal of approximately 36,500 m<sup>2</sup> of forest area associated with the construction of the PTA and ring road.

In line with German EIA requirements, consideration has also been given to potential impacts on the microclimate. . Due to the partial removal of forest areas (36,404 m<sup>2</sup>, equivalent to an area of approximately 190 x 190 m), wind, moisture and temperature conditions will be changed on a small scale. Although this may cause a high magnitude impact on the local microclimate within the immediate vicinity of the PTA, at a local or regional scale, the magnitude of change is considered to be low. The regional climate is considered to have a low sensitivity to localised changes in microclimate i.e. small changes in wind, moisture and temperature conditions. Therefore, the overall project impact ranking is assessed to be **minor**, which is not significant.

#### 10.4.3.2 Emission of compounds that influence air quality (construction and operation)

The onshore construction and operation of the NSP2 pipeline results in emissions of compounds that will temporarily impact air quality at the onshore landfall Lubmin 2. The total emissions during the onshore construction, including the coastal emissions of the offshore works of the NSP2 pipeline, are shown in Table 10-27 below. Emissions during the 50 years of operation are not available from the German EIA.

**Table 10-27 Calculated onshore emissions (tonnes) from construction and operation of the NSP2 pipeline, onshore landfall Lubmin 2.**

Calculated emissions (tonnes) onshore Lubmin 2							
	Activity	Construction			Operation		
		NO <sub>x</sub>	SO <sub>2</sub>	PM	NO <sub>x</sub>	SO <sub>2</sub>	PM
Lubmin 2	NSP2 Pig Trap Area <sup>1</sup>	14	-*	0.8	N/A	N/A	N/A
	Pre-commissioning	14	-*	0.9	N/A	N/A	N/A
	Commissioning	3.2	-*	0.1	N/A	N/A	N/A
	Total	31.2	-*	1.8	N/A	N/A	N/A

<sup>1</sup>Includes construction work, micro-tunnels, building pits, excavation etc. for the area in general  
 \*Sulphur emissions were not considered since sulphur-free fuels will be used for onshore construction works

Values for the German sector were provided by Metcon /256/. The construction of the GASCADE gas receiving station is also stated in this reference, but excluded in the Espoo Report, since approval of the gas receiving station is handled elsewhere.

Dispersion calculations for emissions during the construction phase have been conducted and the results were compared to legal thresholds that are defined in order to protect human health. This analyses revealed that the yearly average limit threshold for NO<sub>2</sub> can be expected to be

exceeded, but only locally in the construction area, where other and higher occupational health and safety thresholds apply. The limit value is far from being reached outside construction sites and particularly in the surrounding residential areas and company premises. Another NO<sub>2</sub> legal threshold (no more than 18 exceedances of an hourly average of 200 µg/m<sup>3</sup>) occurs only in the first and second years of construction and is almost exclusively limited to the area of the land site as well as the above water tie-in area offshore. It is possible that slight exceedances of this short-term value may occur on adjacent roads. In the first year of operation, the short-term limit is no longer reached either at the building site or in the surrounding area. No exceedance has been found for compounds other than NO<sub>2</sub>. The project related impacts on air quality will be of low intensity, medium duration (construction period of 2 years) and on a medium scale. This results in a **minor** impact ranking, which is not significant.

In the course of operational maintenance and repair works, similar impacts are expected compared with those occurring during construction, depending on the technique used. However, maintenance and repair works will be local and temporary and furthermore, of a lower intensity compared with construction works; consequently, the resulting impacts will be even lower. Due to the fact that the pipelines will be installed underground in the landfall area, the expected repair works will be very low, as the pipelines are protected from external influences. Based on the information outlined above, local impacts of low intensity are to be expected for maintenance and repair works at Lubmin 2, resulting in a low impact magnitude. When combined with the low sensitivity of air quality, this results in an overall project ranking of **minor**, which is not significant.

Based on the duration, spatial extent and impact magnitudes listed above, the emissions to air will have a minor impact at Lubmin 2, which is not significant.

#### 10.4.3.3 Summary and ranking of potential impacts on climate and air quality

The overall impact ranking is summarised in Table 10-28 below.

**Table 10-28 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Climate and air quality - Germany	Project	RU	FI	SE	DK	GE	Trans
Emissions to air	N/A	-	-	-	-		No
Changes in the local microclimate	N/A	-	-	-	-	*	No
Impact ranking:	Negligible		Minor		Moderate		Major
* for the purposes of the German EIA process, which requires consideration of impact at the site level, a ranking at such a level is major							

## 10.5 Onshore ancillary areas

### 10.5.1 Climate and air quality

#### 10.5.1.1 Climate and GHG emissions (construction and operation)

The impact from GHG emissions caused by the project on the climate is calculated for the whole project in Section 10.1.5. Although detectable above natural variation in close proximity to the activities, emissions of GHGs will not have a quantifiable impact on global climate.

#### 10.5.1.2 Emission of compounds that influence air quality (construction)

The construction and operation of the NSP2 pipeline results in emissions of compounds that will temporarily impact air quality in the ancillary areas Kotka, Hanko, Karlshamn and Mukran. The total emissions during the offshore construction and 50 years of operation of the NSP2 pipeline

are shown in Table 10-29 below. As noted in Section 10.1.5, the logistics concept has been altered since these calculations were derived (comprising the removal of Slite as a storage yard). However, this change would not materially change the overall emission loads, such that the impact rankings identified below would remain valid.

**Table 10-29 Calculated onshore emissions (tonnes) from construction and operation of the NSP2 pipeline, ancillary areas /243/, /251/, /252/, /253/, /254/, /255/, /256/.**

	Activity	Construction			Operation		
		NO <sub>x</sub>	SO <sub>2</sub>	PM	NO <sub>x</sub>	SO <sub>2</sub>	PM
Karlshamn (SWE)	Supply vessels in harbours	38.0	1.2	1.1	-	-	-
	Cranes and loading equipment in harbours	20.9	0.003	0.7	-	-	-
	Transport at harbours and interim stockyards	20.3	0.006	0.4	-	-	-
Kotka and Hanko (FIN)	Supply vessels in harbours	66.7	2.1	1.9	-	-	-
	Cranes and loading equipment in harbours	35.7	0.005	1.2	-	-	-
	Rock transportation from Highway E18 to Mussalo	12.0	0.004	0.22	-	-	-
	Coating plant operation	14.1	-*	-*	-	-	-
Mukran (GER)**	Cranes and loading equipment in harbours	29.2	0.004	1.0	-	-	-
	Coating plant operation	10.6	-*	-*	-	-	-
*Local emissions due to the use of natural gas; therefore compounds other than NO <sub>x</sub> are excluded from the calculations							
**Estimate is based on Finnish emissions							

Values for the Finnish and Swedish emissions at ancillary areas are based on the national EIAs.

During the operation phase, there are no impacts on air quality from ancillary activities.

### Sweden

The impact on air quality at ancillary areas has been evaluated using a nomogram method. The results show that the activities' addition to the average air pollution values in the nearby areas is very low. The additional temporary contribution will not lead to exceedances of the air quality thresholds. The impact is assessed to be negligible, which is not significant.

### Finland

The sensitivity of the receptors in the Mussalo area is estimated as medium, as there are various emission sources in the harbour and industrial area, including ship traffic and busy road traffic, but also residential areas in the vicinity of the harbour. Air quality has been mostly good or satisfactory in the Kotka region and also in the harbour according to monitoring.

The sensitivity of receptors in quarry areas is estimated as low, as the quarries are located at a distance from residential areas or other sensitive areas. The Rajavuori quarry is located closer to residential areas than Kyytkärr. Other quarries and the Heinsuo waste treatment and landfill facility are located near the Rajavuori quarry. Highway 7 (E18) may also impact the local air quality.

The impact magnitude on air quality in the Mussalo area is estimated to be low as ancillary operations create minor increases in emissions to air in Kotka and the impacts occur for approximately a two year period. However, the slight increase in emissions is not expected to influence the general air quality in the Kotka region or cause exceedances of guideline or limit values. The impact significance is therefore assessed to be minor. The general economy has a significant effect on emissions to air in the Kotka region and therefore also to air quality.

There are existing quarries in Rajavuori and Pyhtää, which are in operation according to existing permits and based on rock demand in the area. If the rock material will be supplied from these quarries, the NSP2 rock supply will increase the rock demand for two years and therefore increase the rock transport traffic as well. The rock supply will cause emissions, although these emissions would also result without NSP2 if the rock was quarried and transported for some other construction project. Emissions from rock transport may have a negative impact on local air quality in the heavily operated traffic areas along the transport route. The impact magnitude of NSP2 rock quarrying is considered to be low, as the impacts from NSP2 rock quarrying occur temporarily and emissions to air are not estimated to have an impact on the general air quality of Kotka or Pyhtää. Therefore the impact is assessed to be minor, which is not significant.

### Germany

The annual values for pollutants that will be emitted due to ancillary activities correspond to 4-11% of the harbour related emissions calculated for the year 2015, compared to 0.2-2% of the environmentally accepted emissions approved for facilities in Mukran in 2015. Air quality will be influenced by emissions of the operating machines and vessels at the interim storage and Mukran harbour, as well as the activities at the concrete casing plant. Furthermore, particle emissions can be generated by traffic and machinery. However, it is not expected that the air pollutants caused by ancillary activities will impair the air quality within the region of Mukran in general, or that legal limits will be exceeded.

The onshore ancillary activities in the area of Mukran will cause a small increase in emissions in the area of Mukran for a period of approximately 2 years. Based on this, a low impact intensity can be assigned to the pollutants. The impact on climate and air quality of the harbour and industrial area of Mukran and the surroundings will be reversible, local and short-term. As a consequence, a low impact magnitude can be assigned. Climate and air quality in the area of Mukran is described as having a low sensitivity.

Based on the impact magnitude and the receptor sensitivity assessed above, the emissions of air pollutants to the harbour and industrial region of Mukran will have a minor impact, which is not significant.

### Conclusion

On the basis of the above, the overall project ranking is considered to be up to a maximum of **minor**.

#### 10.5.1.3 Summary and ranking of potential impacts on climate and air quality

The overall impact ranking of the Espoo impact assessment and country-specific assessments evaluated are summarised in Table 10-30 below.

Due to the local nature of the impacts, no potential transboundary impacts have been identified.

**Table 10-30 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Climate and air quality	Project	RU	FI	SE	DK	GE	Trans				
Emissions to air		-			-		No				
Impact ranking:	<table border="1"> <tr> <td>Negligible</td> <td>Minor</td> <td>Moderate</td> <td>Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								



# Impacts on the biological environment

## 10.6 Marine areas

### 10.6.1 Plankton

Two potential sources of impacts on the pelagic environment are identified in Table 8.2. Of these, one can partially be scoped out from further consideration as outlined in Table 10-31:

**Table 10-31 Potential source of impact scoped out for plankton.**

Potential source of impact	Potential impact	Justification
Release of contaminants to the water column (construction)  (Note that release of nutrients is not scoped out and is considered below)	<ul style="list-style-type: none"> <li>Alteration of growth (decrease/increase)</li> </ul>	As outlined in Section 10.1, the released amounts of contaminants, incl. CWAs, are insignificant compared to the annual amounts entering the Baltic Sea and Baltic Proper. Of the released contaminants, approximately 10% will become bioavailable /260/, /261/, /262/. PNEC values are predicted to be only slightly exceeded for a few contaminants and only for a short duration or over a very small area (Appendix 3), and due to the short turn-over time for plankton, it is therefore not likely that contaminants will have any impact on plankton.

The following two sources of impacts have thus been assessed and reported below:

- Release of sediments to the water column (construction);
- Release of nutrients to the water column (construction).

#### 10.6.1.1 Release of sediments to the water column (construction)

Activities with the potential to release sediments to the water column in areas where plankton may be present comprise dredging, post-lay trenching, rock placement, cofferdam construction, munitions clearance, anchor handling and pipe-laying. Of these, dredging at the landfalls has the highest potential to increase SSC followed by post-lay trenching and rock placement to a substantially lesser extent.

Potential impacts on plankton from the release of sediments comprise:

- Reduced growth of phytoplankton due to reduced light availability;
- Reduced food availability for zooplankton due to reduced primary production;
- Reduced grazing efficiency for zooplankton due to diluted phytoplankton concentration.

#### Assessment of potential impacts

The resilience of plankton to increases in SSCs is very high due to the high turnover rates of both phytoplankton (2-6 days) and zooplankton (ranging from hours for protozoans to one year for large species). Specific threshold values are not found in the scientific literature, but there is evidence that even at very high SSCs, phyto- and zooplankton are generally able to recover to their pre-impact status once the disturbance ceases, if the impact is of a short duration; hence the duration of elevated SSCs is the most important factor /265/. Studies also indicate that the risk of inhibition of phytoplankton growth due to turbidity and reduced light levels during dredging works only generally occurs if the sediments are particularly light-reducing (e.g. comprise forest material) or consist of extremely slowly sinking substances (e.g. very fine mud) /266/, neither of which will be the case for NSP2 /267/. As zooplankton growth is linked to the availability of its primary food source (phytoplankton), it will thus primarily be impacted if that

source is reduced significantly. Overall the vulnerability of plankton to elevated SSC is therefore low, which combined with its medium importance (Section 9.6.1.3) gives it a low sensitivity to releases of sediments.

Offshore (post-lay) trenching will result in the greatest increase in SSC levels. The majority of the increases will be in the bottom 10 m of the water column, which in most offshore areas will be outside the euphotic zone. Modelling indicates that in Swedish waters, a total area of up to 134 km<sup>2</sup> will at some period during construction be subject to increases in SSCs of more than 10 mg/l due to post-lay trenching, while the affected areas in waters of other countries will be smaller (Section 10.1). The area affected by such increases at any single point in time will be much smaller than indicated by modelling, with the degree of increase being highest closest to the point of sediment release and decreasing rapidly once the activity ceases or moves on to another location. The predicted maximum duration of any increase of more than 10 mg/l at a specific location will be on the order of 16 hours (although, for the reasons described above, this maximum duration will only apply to areas close to the source, with durations when such SSC levels are experienced further from it being shorter). Higher SSC levels will be exceeded for shorter periods of time and in smaller areas, e.g. the maximum total area within which increases of more than 15 mg/l are predicted as a result of activities in Sweden is 85 km<sup>2</sup> (Section 10.1, Table 10.4, Appendix 3 and Atlas Maps MO-01-Espoo to MO-07-Espoo).

The degree and spatial and temporal extent of increases SSC from rock placement will be less than from trenching (Table 10-3).

The predictions thus indicate that in the majority of areas where increases in SSCs will occur, the total levels experienced will be within natural variations, as experienced during e.g. storm events (Section 9.2).

Furthermore, the released sediment will typically be restricted to the lower 10 m of the water column; in most parts of the offshore pipeline route (Finland, Denmark and Sweden), any increases in SSC will generally be outside the euphotic zone where plankton is present.

In nearshore and shallow waters, dredging, considered to be the construction activity that gives rise to the highest SSCs, will occur in the Gulf of Finland at the Russian landfall area and in German waters. From the Russian dredging site, in the worst case of a micro-tunnel option, the SSC plume will extend from the dredging site along the western shore of the Kurgalsky Peninsula. Although a total area of up to 265 km<sup>2</sup> (of which a stretch of approximately 12 km is in Estonia, (see Atlas map MO-02-Espoo) may at some time during the entire dredging period experience periods of increase of more than 10 mg/l in SSCs, the actual area affected at any single point in time will, as described above for offshore areas, be much smaller than this, with the levels being highest closest to the dredging activity (see Atlas Map MO-02-Espoo). The predicted maximum duration of any increase of more than 10 mg/l at any specific location will be approximately 400 hours (Table 10-3) over the entire dredging period of approximately 37 days<sup>32</sup>, but will be limited to an area of 0.17 km<sup>2</sup> close to the dredging site. Higher concentrations will be more limited both in terms of spatial and temporal extents. The predicted maximum total duration of any exceedance in Estonia is 50 hours over the entire dredging period (see Atlas map MO-02-Espoo).

This is a worst case scenario, as with the use of a cofferdam at the landfall site (base case option), a reduction in sediment to be dredged and deposited is reduced from approximately 475,000 m<sup>3</sup> to 200,000 m<sup>3</sup>.

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<sup>32</sup> The dredging modelling scenario is assumed to be carried out during an 18 hour work day. Based on a worst case scenario, dredging is likely to last 37 days over a 60 day period.

In Germany, the SSCs are expected to be as monitored during dredging associated with the construction of NSP, which indicated that the German threshold value of 50 mg/l was never exceeded for more than 24 hours at any location /243/. Although the maximum SSCs did at limited times reach 100-150 mg/l in the immediate vicinity of the dredgers, beyond 500 m from the dredging activity, they never exceeded the natural variation of SSC of up to 60 mg/l, as experienced during rough weather (Section 9.2.1.4). Levels more typically varied from 10-30 mg/l close to the dredging activity and 10-20 mg/l in the wider surroundings.

#### *Phytoplankton*

As any increases in SSCs offshore will be restricted to the water depths outside the euphotic zone, there will generally be no impact on phytoplankton. Furthermore, due to the short duration of any increase in SSC that might occur in the limited locations where released sediment does reach the euphotic zone, light will not be a limiting factor for the growth of phytoplankton. The impact magnitude is hence negligible and when combined with the low sensitivity gives a **negligible** impact ranking which is therefore not significant.

In nearshore and shallow areas though, due to dredging, the intensity and duration of impacts will be larger than in deeper waters. The impacted areas will be small compared to the coverage of plankton communities both locally and in the entire Baltic Sea and are not likely to influence other trophic levels. Consequently, the magnitude of the impact will at most be low. This is particularly the case for activities occurring close to the Russian landfall where dredging is planned during the spring bloom, when shading effects are likely to occur. In Germany, construction works have been planned from mid-May, which is expected to be after the bloom. Although plankton may therefore be impacted, their low sensitivity to such impact (largely due to the adaptation of local phytoplankton to natural regular periods of high SSCs, and the fast regeneration times described above) results in an overall project impact ranking which is at most **minor** and therefore not significant.

This assessment is supported by the monitoring of plankton during NSP construction in Russia, which demonstrated no measurable impacts on the plankton communities.

Due to the at most negligible impact magnitude on any plankton that may be present in Estonian waters, the transboundary impact ranking in such areas would at most be **negligible** and not significant.

#### *Zooplankton*

Impacts on zooplankton resulting from reduced food availability (due to impacts on phytoplankton and the dilution of available food) are unlikely due to the short durations of increased SSCs and the negligible impact on phytoplankton. Impact magnitudes for zooplankton are thus considered negligible, which when combined with the low sensitivity to increased SSC gives an overall project impact ranking which is **negligible** and therefore not significant. As identified above such predictions are supported by monitoring of plankton during NSP construction, undertaken in Russia, which showed no measurable impacts on the plankton communities.

The overall impact ranking for plankton (phytoplankton and zooplankton) is thus assessed as **negligible** to **minor**.

### **10.6.1.2 Release of nutrients to the water column (construction)**

Potential impacts on the plankton from the release of nutrients comprise:

- Stimulated growth of phytoplankton from elevated nutrient concentrations (increased eutrophication) with a subsequent increase in zooplankton growth.

### Assessment of potential impacts

As phytoplankton growth is dependent on available light and nutrients and zooplankton are dependent on phytoplankton, the release of sediment-associated nutrients could potentially increase such growth. The vulnerability to release of nutrients is high due to the fast response to nutrients (increased growth if nutrients and light are available) which, when combined with the medium importance, results in a medium sensitivity of both phytoplankton and zooplankton to the release of nutrients.

Based on the measured nutrient levels in sediments along the NSP route, a calculation of the amounts of nutrients (N and P) that would be released from such sediments during construction activities was undertaken for NSP and was similarly applied to NSP2 /268/. This calculation showed that the contributions of nutrients from NSP2 construction will be extremely low and insignificant compared to the annual amount (Section 9.2.2.5), which enters the Baltic Sea and Baltic Proper. Furthermore, any releases will be spatially and temporally distributed along the pipeline route as work progresses and in many cases outside the euphotic zone, making the change in nutrient levels at any given location very small. Owing to the small scale of any change in nutrients available to plankton the magnitude of impact is considered at most to be negligible, which when combined with the medium sensitivity, results in an overall project impact ranking for both phytoplankton and zooplankton that is **negligible** and therefore not significant.

#### 10.6.1.3 Summary and ranking of potential impacts on plankton environment

A summary of the overall project impact rankings for plankton arising from the potential sources of impact scoped into the assessment is provided in Table 10-32, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Owing to the ranking levels and the different nature of the impacts associated with each of the two sources of impact considered above, there is a limited potential for “in-combination” impacts on plankton from these two sources of impact. As such, the ranking of the impact on this receptor group resulting from all sources of impact is likely to most be minor, largely due to generation of elevated SSCs close to the dredging site in Russia.

The release of sediments to the water column may extend across national borders into Estonia. The potential for such impacts is considered in Chapter 15 – Transboundary impacts.

**Table 10-32 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Plankton	Project	RU	FI	SE	DK	GE	Trans				
Release of sediments to the water column							Yes				
Release of nutrients to the water column							Yes				
Impact ranking:	<table border="1"> <tr> <td>Negligible</td> <td>Minor</td> <td>Moderate</td> <td>Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								

### 10.6.2 Benthic flora and fauna

Seven potential sources of impacts on the benthic flora and fauna are identified in Table 8.2. Of these, three can be scoped out from further consideration for reasons outlined in Table 10-33 and are thus not considered further:

**Table 10-33 Potential sources of impact scoped out for benthic flora and fauna.**

	Potential impact	Justification
Release of contaminants and/or nutrients to the water column (construction)	<ul style="list-style-type: none"> <li>Alteration of growth due to increased nutrient levels (increase in phytoplankton and subsequent changes in light availability etc.);</li> <li>Bioaccumulation of contaminants.</li> </ul>	As outlined in Section 10.1, the released amounts of contaminants, incl. CWA, are insignificant compared to the annual amounts entering the Baltic Sea and Baltic Proper. In addition, the nutrient contribution is also insignificant compared to the annual nutrient load (see Section 10.1 and Section 9.2.2.5). Of the released contaminants, only approximately 10% will become bioavailable /260/, /261/, /262/. PNEC values are predicted to be only slightly exceeded for a few contaminants and only for a short duration or over a very small area (Appendix 3). As benthic communities are living in and on the seabed, from which the released contaminants originate, there will not be an additional risk of contaminant exposure for the benthic communities. As shown in Table 10-31, impacts are not likely to occur on plankton (the main food source for many benthic invertebrates). Therefore any impact from contaminants on benthic flora and fauna is not likely to occur.
Heat exchange between the pipelines and the surrounding environment (operation)	<ul style="list-style-type: none"> <li>Changes in benthic community patterns around the pipeline due to local temperature increase.</li> </ul>	Simulations of temperature increase around NSP /263/ showed that there was no significant temperature difference between the surface of the pipelines and the marine environment. The temperature of the water at the surface of an unburied section of the pipelines was at most -0.5 °C (Germany) to +0.5 °C (Russia) different from the temperature of the surrounding water. The temperature difference is not likely to have any significant impact on benthic communities.
Release of metals from anodes (operation)	<ul style="list-style-type: none"> <li>Changes in growth and bioaccumulation of Al and Zn.</li> </ul>	Al is not considered eco-toxicologically problematic for marine life. Zn is potentially toxic, but modelling undertaken for NSP showed that Zn concentrations will only be elevated ( $PEC_{Zn} > PNEC_{Zn}$ ) 1.8-3.8 m from the pipeline (Sections 8.3.6 and 10.2.2). In addition, a large part of the pipeline will be buried and the majority of Zn will be bound to the sediment. Impacts on the benthic flora and fauna communities are therefore not likely to occur.

The following four sources of impacts have thus been assessed and are reported below:

- Physical changes to seabed features (construction);
- Release of sediments to the water column (construction);
- Sedimentation on the seabed (construction);
- Presence of pipeline structures (operation).

### 10.6.2.1 Physical changes to seabed features (construction)

Activities with the potential to physically change seabed features in areas where benthic species may be present comprise intervention works, (dredging, post-lay trenching and rock placement) and pipe-laying, anchor handling and munitions clearance.

Potential impacts on the benthic flora and fauna communities associated with changes to seabed features comprise:

- Potential total or partial destruction of species and habitats by munitions clearance and seabed intervention works;
- Local disturbance of species and habitats due to pipe-lay and anchor handling.

#### Assessment of potential impacts

The vulnerability of *benthic flora* to changes to seabed features is highly linked to the time required to recover from the above impacts and depends on the type of floral communities. Benthic flora are only present along the NSP2 route in German waters (Section 9.6.2.1) and for the large part comprise red algae, which are expected to have a recoverability of 1-2 years. A few stands of beaked tasselweed occur near the Lubmin 2 landfall, with the recoverability of this Vulnerable (German Red List, Appendix 2) species being 2-3 years. This degree of recoverability combined with their medium importance (due to their ecosystem functions and the presence of tasselweed) gives benthic flora a medium sensitivity to changes to seabed features. Since flowering plants in shallow nearshore waters will not be affected physically due to the installation of a micro-tunnel for shore crossing down to 2 m water depth, no impact is expected near the Lubmin 2 landfall.

The vulnerability of *benthic fauna* to changes to seabed features also depends on the recovery time and the recolonization processes, which occur through migration of organisms from the surrounding seabed and through settlement of planktonic larvae from the water column, at the destroyed area. The timeframe depends on the benthic community structure and may take from a few to several years. Opportunistic species recover fast, whereas long lived species recover more slowly. This, combined with the medium importance of benthic fauna (due to their ecosystem functions and the presence of Vulnerable species (German Red List, Section 9.6.2.3, Appendix 2) gives them a medium sensitivity to changes to seabed features in German nearshore areas. Due to shorter period of recovery for species in Russian waters (few and more opportunistic species), low abundance in deep water areas and lack of species of conservation interest, benthic fauna in Russian waters are allocated a low sensitivity to changes to seabed features. Offshore the sensitivity is considered as low.

Munitions clearance will completely destroy the benthic species in the impact crater, with the scale of the change influenced by the crater size, typically 0- 8 m in diameter (Section 10.2.1.1) and will be limited to the Gulf of Finland where such clearance will be undertaken. The change to the seabed is therefore highly localised and with a limited total spatial extent.

Seabed intervention works will similarly totally destroy the benthic communities that might be present in their footprints. Compared to the overall area of the Baltic Sea and the areas of benthic habitats within it, the total affected area is small.

In contrast to munitions clearance and intervention works, pipe-laying activities and anchor handling will generally only disturb rather destroy the benthic communities and be confined to very local areas around the footprint of such activities.

#### *Benthic flora*

As munitions clearance will only take place in Finnish and Russian waters where benthic flora is largely not present (Section 9.6.2.1), this activity will not impact the benthic flora.

Seabed interventions in Germany will remove the benthic flora (primarily red algae) from reefs and other hard substrates in the area of the Greifswalder Bodden marginal swell and in the Pomeranian Bay. In Germany, stones and reef structures will be re-established, as the dredged trenches will be backfilled with stored sediment material (Section 6.7), and natural recolonization and re-establishment of floral communities is expected soon thereafter. In addition, the subsequent presence of the pipeline will also function as an artificial reef for recolonization of flora, which is assessed in Section 10.6.2.4. The magnitude of the impacts on benthic flora is therefore predicted to be low, which when combined with their medium sensitivity results in **minor** impact ranking in such areas.

This ranking is supported by monitoring of similar measures after construction of NSP, which showed that the rebuilt natural reefs in German shallow waters were covered with macrophytes after one year, with regeneration complete by three years. As there will be no cofferdam in German waters, the impact from NSP2 intervention works will be much smaller.

Due to the low potential for the presence of benthic flora outside of Greifswalder Bodden, impacts from intervention works would be at most **negligible** in other all PoOs.

Pipe-lay and anchor handling, which will occur in Germany (Chapter 6 – Project description), may disturb (rather than totally destroy) benthic flora. This together with the very localised nature of the disturbance means that the impact magnitude on benthic flora is negligible. When combined with their medium sensitivity, this gives a **negligible** ranking.

#### *Benthic fauna*

The impact on the benthic fauna communities due to munitions clearance and offshore seabed intervention works is regarded as reversible due to the sedimentation and colonization processes, although the timeframe depends on the community structure and can range from a few to several years. Opportunistic species recover fast, whereas long lived species recover more slowly. The majority of munitions clearance takes place in deep water regions (deeper than 40 m) with a low abundance or absence of benthic fauna (see Section 9.6.2.2) while the extent of changes to seabed features, both from munitions clearance and seabed interventions, will be highly localised. The size of the benthic community habitat area impacted will thus be small in comparison with the overall benthic community habitats found in the Baltic Sea. Based on these considerations, the magnitude of the impacts occurring in the offshore areas of Finland, Sweden and in Denmark is considered to be negligible, resulting in a **negligible** impact ranking.

In Russian waters, due the low sensitivity of benthic fauna to physical changes, when combined with medium impact magnitude, the impact ranking is **minor**.

In German shallow waters, although the areas affected are small, the intensity is high. The resulting impact magnitude is assessed as low as no structural and functional changes are expected to be significant. This combined with the medium sensitivity of these areas due to the importance of the ecosystem functions and the presence of Vulnerable (German Red List) species, results in an impact ranking for the benthic fauna communities in German waters that is overall **minor** (though for small areas within the German EEZ outside Greifswalder Bodden it may be **moderate**), and hence not significant.

This is supported by the results of NSP monitoring in German waters, which demonstrated that in Greifswalder Bodden and the Pomeranian Bay three years after the end of construction, all native invertebrate species had re-inhabited the backfilled trench in abundances similar to those prior to construction activities /269/. Since then, the benthic fauna of re-instated trench habitats have developed in a similar manner to those in undisturbed sediments /270/.

Although anchor handling and pipe-laying cause direct mechanical disturbance of the seabed and the benthic fauna communities, the impact will occur over a very localised area and recovery is

expected to be fast. The impact magnitude is thus assessed as negligible for such activities in all locations along the NSP2 route, which when combined with the low-medium sensitivities results in an overall impact ranking for all places where anchor handling occurs that is **negligible** and hence not significant.

The overall physical changes to the seabed will only have impacts on *benthic flora* in Germany, where the overall impact ranking will be **minor**. For the *benthic fauna* the impact is generally at most **minor**. Impacts are therefore generally not significant.

#### 10.6.2.2 Release of sediments to the water column (construction)

Activities with the potential to release sediment to the water column in areas where benthic communities may be present are the same as those identified in Section 10.6.1.1. They may impact such communities through:

- Reduced growth of benthic flora due to reduced light availability;
- Reduced food availability due to dilution of plankton and clogging of respiratory organs or feeding apparatus for filtering organisms.

#### Assessment of potential impacts

The vulnerability of *benthic flora* (microalgae and flowering plants, e.g. eelgrass) to increased SSCs is linked to the reduced availability of light to support growth. Coastal species of flora are, however, adapted to short periods with high SSCs, and hence their vulnerability to sediment releases is low. This combined with their medium importance gives them a medium sensitivity to releases of sediment to the water column.

The vulnerability of *benthic fauna* to increased SSCs is linked to the food availability (dilution of food) and the risk of clogging of the filtering apparatus. In general most filtering species can survive for at least one week without food, as may result from continuous exposure to elevated SSCs (which results in e.g. closed bivalves for protection of the filtering apparatus) /263/, /275/ although the growth rates of individuals may be affected. As filtrators (suspension feeders) generally have a high growth rate, the biomass will be restored quickly after the impact has stopped. Their vulnerability to sediment releases is therefore low. This combined with their medium importance (see Section 10.6.1.1) gives them a medium sensitivity to releases of sediment to the water column in German waters and low sensitivity in the waters of the other PoOs.

The impact from increased SSCs will be highest in shallow areas near the two landfall areas, as this is in the euphotic zone where benthic flora are present (Section 9.6.2) and where dredging will occur. As described in Section 10.6.1.1, although detectable changes in SSCs are predicted due to dredging close to both the Russian and German landfall sites, these will be of both short duration and limited spatial extent (with the highest concentrations being restricted to the immediate vicinity of the activities giving rise to the sediment releases) and the total SSCs generally remaining within natural variations as experienced during storm events (Section 9.2.1.4).

Offshore there will similarly be detectable changes in SSCs notably in the vicinity of post-lay trenching and rock placement activities and to a lesser extent in the vicinity of munitions clearance, anchor handling and pipe-laying. Due to the greater water depth, the natural variations in SSCs may not be as large as in nearshore, shallower locations. However, the levels of sediment released by these construction activities are considerably lower than those generated by dredging (Table 10-4). Consequently, the predicted increases in SSCs and duration and spatial extent over which these occur, as summarised within Section 10.6.1, are also lower than predicted for dredging and within the natural variations for such areas, which typically vary from 0-5 mg/l but can at times reach levels of up to 60 mg/l (Table 9-1).



*Benthic flora*

Offshore and in Russian nearshore areas, there will not be an impact on benthic flora, as flora are not present.

Although the benthic flora (primarily red algae species) present in the shallow German waters, notably those in the Greifswalder Bodden marginal swell, will be subject to a measurable increase in SSCs, the levels experienced and the duration over which they happen will be within natural variations. This together with the limited spatial extent over which such changes may occur will not affect the functioning or viability of the benthic communities. Consequently, the impact magnitude is assessed as at most low. This combined with the medium sensitivity of benthic flora to such impacts results in an impact ranking which is **minor** and hence not significant.

*Benthic fauna*

Similarly, the duration of changes in SSCs will generally be too short to affect food availability for *benthic fauna*, so the impact magnitude on such species will be negligible to low. As the receptor sensitivity is low to medium, the impact ranking will be **negligible to minor**.

The overall ranking for benthic flora and fauna due to releases of sediments to the water column is thus assessed to be **minor**.

**10.6.2.3 Sedimentation on the seabed (construction)**

Suspended sediment will re-settle on the seabed with the following potential effects on benthic flora and fauna:

- Reduced viability due to smothering of flora and fauna;
- Prevention of mussel larval settlement.

The impact magnitude is closely linked to the amount of sediment to settle at a given location, the water depth and the timing of the sedimentation event.

**Assessment of potential impacts**

The vulnerability of the *benthic flora* communities to sedimentation depends on the species and the existing environment in which these species are adapted to live. Small filamentous macroalgae with fragile structures with no ability to store resources, such as red algae of the genus *Ceramium* (which is one of the dominant red algae species in the German area, see Section 9.6.2.1) can be affected by minor sedimentation events. However, it is generally assumed that sedimentation events of less than 2 mm will not affect macroalgae species and events of less than 1 cm will not affect flowering plants (e.g. eelgrass and tasselweed) /273/. The vulnerability of benthic flora to sedimentation (at sedimentation layers relevant for NSP2) is therefore low, which when combined with their medium importance gives them a low the sensitivity to such occurrences.

The vulnerability of *benthic fauna* to sedimentation also depends on the species and the community types. Sessile epifaunal filtering species are more sensitive than species inhabiting regions where re-suspension and sedimentation are naturally high. In the scientific literature there are not many relevant references on the impact of sedimentation on benthic fauna. However, benthic fauna are considered generally able to cope with low levels of sedimentation, remaining unaffected due to their abilities to burrow/escape and to selectively reject particles when feeding on e.g. pelagic phytoplankton /274/, /276/, /277/. Their vulnerability to sedimentation (at sedimentation layers relevant for NSP2) is therefore low which, when combined with their medium importance, gives them a low sensitivity to such changes.

Modelling of sediment spill from NSP2 trenching activities indicates that the total areas subject to sediment deposition > 200 g/m<sup>2</sup> (the typical deposition density resulting in an increase in sediment layer of 1 mm) are on the order of 3 km<sup>2</sup> and 0.6 km<sup>2</sup> for such activities taking place in

Swedish and Danish waters, respectively (Table 10-4) and will be limited to areas up to a few hundred meters of the pipeline where such activities are undertaken. Rock placement will result in even smaller areas with sedimentation above 1 mm.

Owing to dredging activities in Russian and German waters, the areas predicted to be affected by sediment deposition above 200 g/m<sup>2</sup> extend further from the pipeline alignment. Dredging in Russian waters results in sediment deposition of 200 g/m<sup>2</sup> over an area of approximately 12 km<sup>2</sup> (Table 10-5) and 2,000 g/m<sup>2</sup> (corresponding to roughly a 1 cm sediment layer, under a very conservative estimate) over less than 2 km<sup>2</sup> (Section 10.1 and Appendix 3). During normal hydrographical events, there will not be any sedimentation above 200 g/m<sup>2</sup> in Estonian waters, while during storm events, less than 2 km<sup>2</sup> would be impacted by sedimentation above 200 g/m<sup>2</sup> if dredging were to take place at such times. Similarly, the extent of any sedimentation greater than 1 mm will also be limited to within the immediate vicinity of the German landfall.

#### *Benthic flora and fauna*

In offshore areas, the affected areas will be very local to the pipeline and extremely small in spatial extent so that despite the low sensitivity of benthic species to sedimentation, the impact ranking will be at most **negligible**.

Although in Russian and German nearshore areas, a larger area may be affected by sedimentation of more than 1 mm and hence may also potentially result in a measurable change in conditions of benthic communities, this will only affect a small proportion of the population with no long-term consequence on species functioning. In addition, it should be mentioned that annual sedimentation rates vary largely within the Baltic Sea (Section 9.2.1.3). The impact magnitude will therefore be low. The benthic communities in these areas are well adapted to re-suspension and sedimentation, giving them a low sensitivity to such changes. This together with the low magnitude of impact results in a **minor** impact ranking which is therefore not significant.

#### **10.6.2.4 Presence of pipeline structures (operation)**

Pipeline structures with the potential to affect benthic communities comprise the pipelines themselves as well as supporting structures. These may result in the following impacts on benthic communities:

- Loss of infaunal seabed habitat from the project footprint;
- Introduction of a new hard substrate ("artificial reef") resulting in new habitat for epiflora and –fauna communities.

#### **Assessment of potential impacts**

The presence of the pipeline structures, including supporting structures such as rocks etc., will completely eliminate the benthic habitat within the footprint area. The seabed comprises soft sands, so impacts will be primarily linked to infauna, which currently inhabit these areas. Infauna will not be able to re-establish as the soft seabed is lost and replaced by the hard substrate created by the pipeline and supporting structures. In addition, some areas of hard substrate will be removed, but the extent of such losses will be negligible. As infauna, which comprise most of the species present, cannot recover, the vulnerability of benthic communities to the loss of seabed habitat is therefore high, although when combined with their low importance as a result of their limited conservation status, their sensitivity to the presence of pipeline is overall low. However, in Germany, where Vulnerable Red List species of both benthic flora and fauna are present, due to their higher levels of importance, the sensitivity to seabed loss due to presence of the pipeline and other structures is medium.

The presence of the pipeline will on the other hand introduce a hard substrate, on which epiflora and fauna can establish. Their ability to become established is linked to the water depth (light and oxygen availability) and species settlement success. A reef effect is only likely in shallow areas with sufficient available oxygen and where the pipeline is not buried. The total area

covered by such new artificial reef structures will thus be limited to the shallow areas of Russia and Germany, and some (albeit very limited) shallow areas in Danish and Swedish waters, where epiflora and fauna can establish (depending on available light and oxygen). In deep water areas, the pipelines will be covered in sediment such that settlement of epifauna species will not occur.

#### *Benthic flora*

Loss of habitat is not evaluated for benthic flora, as the flora is associated with hard substrates and can thus re-establish on the new substrate created by the pipeline and supporting structures in the areas where flora potentially can grow (see Atlas Map BE-01-Espoo).

Potential *gain* of habitat for flora may occur through the pipeline and rock placement, creating an artificial hard substrate where benthic macroalgae can grow. However, due to the water depth, benthic flora are not expected to grow along the pipeline route outside Greifswalder Bodden in Germany (see Section 9.6.2.1). Red algae grow at depths between 0 and approximately 20 m, beyond which growth will be sporadic and the size of the algae will be very small. Thus, although a degree of colonisation of the new structures by red algae species may occur and potentially contribute to an overall increase in epiflora diversity, resulting in a potentially **positive** impact, the area affected will be limited by water depth.

#### *Benthic fauna*

While loss of the soft seabed will result in loss of benthic infauna species that may be present, the affected areas are very small, compared to both the local and overall areas of benthic infauna habitats in the Baltic Sea, so that the impact magnitude is regarded as negligible to low. When combined with the low (general) to medium (Germany) sensitivity of benthic fauna to loss of habitat due to presence of the pipeline, the impact ranking ranges from **negligible to moderate** (negligible in Finland, where benthic fauna are mostly absent and moderate in Germany due to the introduction of a high biomass of sessile hard-bottom fauna into an extensive soft-bottom environment).

Succession of epifaunal species on the new introduced habitat, which is expected especially in German and Russian waters, can potentially increase the biodiversity and productivity in some regions along the route. In regions where benthic fauna is absent due to anoxic seabed conditions, e.g. some areas in Finland and Sweden, no change is anticipated. In Russia and Germany, a degree of colonisation of the new structures by epifauna species is anticipated, which can potentially contribute to an overall increase in biodiversity, resulting in a potentially **positive** impact, although the area over which this will occur will be limited.

The overall conclusion is that impacts from the loss of the soft seabed due to presence of the pipeline structures is assessed as **negligible to moderate**, although the introduced artificial reefs will change the existing habitats with the potential for a degree of positive impact at selected locations.

The above assessment is supported by the monitoring of the reef effect of NSP in Sweden, Denmark and Germany (more shallow water depths).

- In Swedish waters, no sessile epifauna were observed at water depths more than 25 m, most likely due to the observed sedimentation layer on the pipeline /271/.
- In some Danish waters, two to three years after pipe-lay, blue mussels (*Mytilus edulis*) were observed to have colonised the surface of the pipelines in some areas at water depths of up to 68 m, although only a few individuals of blue mussels, hydroids and/or bryozoans were recorded /272/, with the cover increasing with decreasing water depth.
- In German waters, epifauna were recorded on the pipeline structures at water depths of less than 30 m. The dominant species was the mussel *Mytilus edulis*. On the surrounding soft bottom habitat, accumulations of blue mussel aggregates were frequently observed. The monitoring of the soft sediment communities also showed a higher abundance of

*M. edulis* and its associated fauna at a distance of approx. 10 m from the pipeline. A succession pattern of different communities on the pipeline was observed during the monitoring period (2011-2014), ending with full coverage of the pipeline with mussels /271/, /272/. It is assumed that a similar succession pattern will occur on the NSP2 pipeline.

#### 10.6.2.5 Summary and ranking of potential impacts on benthic flora and fauna

A summary of the overall project impact rankings for benthic flora and fauna arising from the potential sources of impact scoped into the assessment is provided in Table 10-32, together with the rankings predicted in the country level EIAs. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level, although a moderate impact ranking and hence a potentially significant impact is expected in German waters for the presence of pipeline structures. As a new artificial reef is created by the pipeline structures, positive impacts on biodiversity can potentially occur.

Although there is some potential for “in-combination” impacts on benthic flora and fauna, the magnitude of the combined impacts is sufficiently low, so that the impact ranking on benthic flora and fauna resulting from all sources of impact in general will be at most minor, and moderate in Germany due to the presence of species of conservation interest in the impacted area.

Impacts from the release of sediment to the water column and sedimentation on the seabed may extend across national borders into Estonia. The potential for such impacts is considered in Chapter 15 – Transboundary impacts.

**Table 10-34 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Benthic flora and fauna	Project	RU	FI	SE	DK	GE	Trans
Physical changes to seabed features				-			No
Release of sediments to the water column							Yes
Sedimentation on the seabed							Yes
Presence of pipeline structures						*	No
Impact ranking:	Negligible		Minor		Moderate		Major
*Assessed as minor for benthic flora							

#### 10.6.3 Fish

A number of potential sources of impact on fish are identified in Table 8-2. Based on the nature of the source of impact (Section 10.1) and the characterisation of fish sensitivity (Chapter 9 – Environmental baseline), one can be scoped out from further consideration, as outlined in Table 10-35:

Table 10-35 Potential source of impact scoped out for fish.

Potential source of impact	Potential impact	Justification
Release of metals from anodes (operation)	<ul style="list-style-type: none"> <li>Alteration of growth due to toxicological effects</li> </ul>	The released amounts of contaminants from anodes are insignificant compared to the annual levels entering the Baltic Sea. The dispersion has also been shown to be locally limited and the impact and risk of bioaccumulation are deemed unlikely.

The following sources of impacts have thus been assessed and reported below:

- Physical changes to seabed features (construction);
- Release of sediments to the water column (construction);
- Release of contaminants and nutrients to the water column (construction);
- Sedimentation on the seabed (construction);
- Generation of underwater noise (construction);
- Presence of vessels (construction and operation);
- Presence of pipeline structures (operation).

#### 10.6.3.1 Physical changes to seabed features (construction)

Various seabed works, as mentioned in Section 10.6.2.1, may cause physical disturbance of the seabed and may also create new features on the seabed, e.g. spoil heaps and rock piles below and around the pipelines, which can result in:

- Disturbance and change of habitats (spawning, nursery areas).

#### Assessment of potential impacts

The vulnerability to physical changes to seabed features can vary between different life stages in fish and is linked to the duration and impact magnitude. Benthic fish eggs (e.g. herring eggs) are more vulnerable when it comes to physical changes to seabed features compared to pelagic eggs (e.g. cod eggs), as they are laid on the ground. Adult fish are, however, resilient to changes and will rapidly return to pre-impact status once the activities cease. The overall vulnerability of fish is low, which combined with its medium importance (Section 9.6.3) gives it a low sensitivity to physical changes to seabed features.

Since the size of the construction area is very small compared with the overall fish habitat areas, any impact will be limited. The maximum distance on each side of the pipeline where direct seabed disturbance may occur will be 100 m for trenching, 100 m for rock placement and 1,000 m for anchor handling. Munitions clearance will create an impact crater, typically 0 to 8 m in diameter and is limited to the Gulf of Finland where such clearance will be undertaken (see Section 10.2 and Appendix 3). The change to the seabed is therefore highly localised with a limited spatial extent.

No important benthic spawning areas will be impacted in offshore areas; however, herring is known to spawn in some coastal areas. NSP2 crosses a spawning area in the coastal area of Narva Bay. Hence herring may lose habitat related functions i.e. spawning grounds. In Narva Bay, a baseline survey showed an absence of correct substrate in the shallow waters within the project area which means that only a small number of herring select the area for spawning. The main spawning grounds are located toward the northern part of Kurgalsky peninsula and also around offshore islands and the impact is therefore regarded as minor.

In the territorial waters of Germany, there are no herring spawning grounds along the route except in Greifswalder Bodden and therefore, the impact is assessed as minor. Furthermore, no construction works will be undertaken in Greifswalder Bodden during the main part of the herring spawning season in early spring. Furthermore, no offshore construction activities will be

undertaken during the herring spawning season and therefore, the impact is assessed as **negligible to minor**.

Impacts on fish habitats affected by the construction work are assessed as negligible to minor. The different assessments correlate to the varying sensitivity of the habitats and where they are located. In benthic offshore areas, the impacts are reversible, temporary and local as the habitats are physically uniform in comparison to the vast area surrounding the construction sites and fish species are mobile and have the ability to return to an area after the disturbance has ceased. The intensity of the impact is low to high (depending on the nature of the type of construction activity).

Monitoring of fish in relation to NSP showed no impacts on fish populations were observed due to seabed intervention works.

On the basis of previous experience and the conclusions presented above, the impact magnitude is regarded as negligible to low and the sensitivity is regarded as low. The impact ranking is therefore assessed to be **negligible to minor**, and therefore not significant.

#### 10.6.3.2 Release of sediments to the water column (construction)

Seabed intervention works related to construction works, as mentioned in Section 10.6.1.1, will cause sediments to be suspended in the water column (Section 10.1). The potential impacts on fish can be:

- Avoidance behaviour;
- Injuries and clogging of gills;
- Reduced viability of pelagic fish eggs.

#### Assessment of potential impacts

The vulnerability of fish to suspended sediment varies highly between species and their life stages and on the duration, concentration and composition of the impact /278/. High concentrations of SSC for a short period of time are of less concern than a lower level that persists longer. Impacts vary from behavioural effects, to sub-lethal and even lethal effects. In general demersal fish species are more adapted to periods with elevated concentrations of SSC and is less sensitive than pelagic species /279/. Taking into consideration the importance of several fish species and the presence of important areas (e.g. cod spawning area), the sensitivity of fish to sediments in the water column is assessed to be high.

Coarse particles may lead to skin injuries and fine sediments may clog gills and cause suffocation in adult fish. However, high concentrations in the magnitude of 3,000 – 250,000 mg/l of suspended material are required in the water column in order to harm adult fish and are well above concentrations released from NSP2. For adult fish, releases of sediment to the water column will most likely lead to avoidance behaviour in the immediate vicinity of the construction site; such behaviour has been reported to occur from concentrations of approx. 10 mg/l /280/. These avoidance behaviours are temporary and will have no long-term impact on fish or fish stock.

Fish larvae may be impacted, with reduced growth rates and breeding success as possible effects. Furthermore, SSC may adhere to pelagic eggs, such as cod or sprat eggs, causing them to sink to depths with oxygen deficiency. Generally, high concentrations of SSC can cause lethal impacts. The most crucial sediment concentration reported in the literature is 5 mg/l for cod eggs, in which cod eggs started to sink after 96 hours in stagnant water /281/. The NSP2 route goes through a cod spawning area in Bornholm Deep. However, since cod spawning occurs pelagically above the halocline, well below elevated SSC, there will be no impact on cod eggs or fry.

In Russia, modelling studies showed that the SSC plume will extend along the western shore of the Kurgalsky Peninsula. Although a total area of up to 265 km<sup>2</sup> may, at some time during the entire dredging period, experience periods of more than 10 mg/l SSCs (of which a stretch of approximately 12 km is in Estonia) and will mainly occur over a time frame of less than 50 hours; (see Atlas map MO-02-Espoo), the actual area affected at any single point in time will be much smaller than this with the levels being highest closest to the dredging activity (see Atlas Map MO-02-Espoo). The predicted maximum duration of any increase of more than 10 mg/l at any specific location will be approximately 16.5 days (Table 10.3) over the entire dredging period of approximately 3 weeks, but will be limited to an area of 0.17 km<sup>2</sup> close to the dredging site /282/. Higher concentrations will be more limited both in terms of spatial and temporal extents. In Narva Bay, a baseline survey showed that the main spawning grounds for herring are located towards the northern part of Kurgalsky peninsula and also around the offshore islands of Gogland, Malyi and Bolshoy Tyuters while the eastern part of Narva Bay where the route is situated, is a less significant spawning ground for herring. In that sense, the most important grounds will not be affected by the high concentrations and the long duration, but a minor impact is nevertheless foreseen.

The dredging volumes required for access and to create the cofferdam will be less than half of the volumes assumed for the modelling studies, meaning that the effects described above are an overestimate of the likely effects.

In Germany, as outlined in (Section 10.2.1), the maximum SSC within the Pomeranian Bay and Greifswalder Bodden will be in the range 100-150 mg/l in the immediate vicinity of the dredgers. The German threshold value of 50 mg/l is never exceeded for more than 24 hours at any location /54/. SSC in the close vicinity of dredging activities will vary within the range 10-30 mg/l, and SSC within turbidity plumes in the wider surroundings will be about 10-20 mg/l. At 500 m from the dredging activity, the SSCs never reach the natural SSC in the area during rough weather. However, due to the fact that the spawning time is not fully covered by the period of the construction ban, the impacts from release of sediment to the water column are assessed as **minor**.

In offshore areas where only rock placement and trenching will take place, smaller SSCs in the water column are expected. In important spawning areas in the offshore banks (i.e. Hoburgs Bank and the Northern and Southern Midsjö Banks) within Swedish waters, impacts on fish from sediment spreading have been assessed as **negligible** since concentrations will be below 5mg/l for most scenarios and never exceed 10 mg/l, which is within natural variations.

Monitoring of fish in relation to NSP showed that no impacts were observed on fish populations due to seabed intervention works and SSC.

Since the impact is assessed is reversible, temporary and local, the impact magnitude for fish is considered negligible. Impacts are generally assessed to be highest nearshore at the landfall areas (Russia and Germany), where minor impacts are assessed to take place. The overall project impact ranking is **negligible**.

### 10.6.3.3 Release of contaminants to the water column (construction)

The Baltic Sea is intensely industrialized. Pollutants enter the sea from the surrounding land and via atmospheric pollution. Various seabed works, as mentioned in Section 10.6.2.1, can cause a simultaneous release of contaminants bound to sediments, in addition to the dispersion of sediment.

In addition to contaminants from the landfall area, CWA used during World War I and stockpiled during World War II can occur on the seabed. Bornholm, especially the eastern part including the Bornholm Basin, presents a higher risk of encountering chemical munitions that were dumped in the sea after World War II.

The release of contaminants from sediment deposition can potentially impact fish by:

- Bioaccumulation of contaminants in tissue, which can prevent egg hatching, reproduction and growth.

### Assessment of potential impacts

In general, fish are considered the most sensitive trophic level compared to phytoplankton and higher aquatic plants, but the vulnerability of and impacts on fish depend on:

- The concentration and bioavailability of the contaminants in the water environment;
- The bioaccumulation potential for a specific contaminant;
- The duration in which the fish species is exposed to contaminants.

Overall, the vulnerability to the release of contaminants to the water column can be low to high depending on the above factors. The sensitivity, when combined with the medium importance (Section 9.6.3), can therefore be high.

Concentrations of contaminants bound to sediment are highest in the deeper, muddier parts of the Baltic Sea, in areas with low dissolved oxygen concentrations which do not provide suitable conditions for fish, see Section 10.1.2.1. However, in places where munitions clearance and dredging will take place, a wider extent of contamination spread will occur. Dredging will take place outside the Russian landfall and numerical modelling (worst case scenario) shows that the PNEC values are exceeded for all modelled contaminants (PAH, dioxin and zinc) and that the PNEC for PAH (benzo(a)pyrene) is exceeded the most, covering an area of 172 km<sup>2</sup>. The area where the PNEC value is exceeded is mainly to the north of the pipeline, but some impact south of the pipeline and in Estonian waters is also seen. The maximum accumulated duration of the exceedance of PNEC for PAH is 34 days due to the relatively long working period /282/.

Munitions clearance will take place in the Gulf of Finland in both Russian TW and within the Finnish EEZ. Numerical modelling, as for dredging, shows that the PNEC values are exceeded for all three contaminants (PAH, dioxin and zinc) during munitions clearance. For PAH (benzo(a)pyrene), the PNEC value is exceeded the most, covering areas of 40 km<sup>2</sup> and approx. 100 km<sup>2</sup> in the Russian and Finnish EEZs, respectively. The duration times are, however, generally short and mainly close to the pipeline corridor. The maximum accumulated duration of the exceedance of PNEC for PAH is less than one day within the Russian EEZ /282/ and 4-5 hours in 90% of the impacted area within the Finnish EEZ, with a maximum duration calculated to 19 hours (worst case scenarios) /283/.

Within the Swedish EEZ (where trenching and rock placement are planned to take place), results from monitoring during NSP showed that the PNEC for Cu and PAHs was exceeded in a few locations connected to the deeper parts of the Baltic Sea. The maximum accumulated duration of the exceedance of PNEC for these substances is assessed to be from one to few days. For Zn, the PNEC value was not exceeded at any time, while for arsenic it was shown that the exceedance of the PNEC value will be restricted to a distance of less than 1,000 m from the construction site. Based on the average duration and area affected, the effects and bioaccumulation of contaminants by fish species are evaluated to be insignificant. As seen in Section 10.2.2, the impact on the water quality is assessed as negligible (as PNEC values will not be exceeded or only be temporarily exceeded). In addition, released contaminants will most likely be restricted to bottom waters. It is therefore assessed that there will be negligible impact on fish.

An assessment of the potential toxicological effects from CWA has been done in the Danish EIA, where seabed sediments were sampled at stations along the route within the Bornholm area /284/ and the PNEC of the different types of CWA for fish species were calculated. The results showed that concentrations of the different CWAs and their degradation products are far below



the levels at which a negative impact on the environment would be expected. In conclusion, no negative impacts related to CWAs in the seabed are expected during NSP2, which are in line with monitoring results obtained during NSP /285/.

Although the sensitivity to toxicological effects can be high for fish, the impact magnitude depends on the concentration and duration of contaminants present. Based on the low levels of contaminants, the short duration and area affected, the impact magnitude of bioaccumulation of contaminants by fish species is negligible.

In summary, due to the negligible impact magnitude, the impact ranking is assessed as **negligible** and therefore the impact is not significant.

#### 10.6.3.4 Sedimentation on the seabed (construction)

Various seabed works, as mentioned in Section 10.6.2.1, will cause sediments to be suspended in the water column, which will then resettle. Impacts on fish due to sedimentation can include:

- Burial of demersal fish species;
- Smothering of larvae and eggs.

##### Assessment of potential impacts

Sedimentation of suspended sediment resulting from intervention works and pipe-lay may affect sediment quality and/or deposit an additional sediment layer. This has the potential to bury fish species which are demersal or rely upon the seabed for spawning. No impacts on pelagic fish species or spawners from sedimentation are anticipated.

Whereas demersal fish species are resilient to the impact caused by sedimentation because their mobility allows escape behaviour, demersal eggs and larvae have a lower resilience due to their inability to escape. Thus, the eggs and larvae of bottom-spawning species, including e.g. the important herring and turbot, may be impacted by a rapid pulse of sediment deposition (smothering). Additionally, increased sedimentation may bury benthic fauna, thus limiting fish food sources.

Overall, the vulnerability to sedimentation is low. Taking into consideration the importance of benthic laying egg species (e.g. herring and turbot), the sensitivity of fish to sedimentation is assessed to be medium.

In offshore waters, impacts from sedimentation on fish habitats, including nursery areas, will be of minor importance since no important spawning grounds are expected to be impacted. Any impacts would be restricted to the very close vicinity of the pipelines. The thickness of the sedimentation layer of  $>200 \text{ g/m}^2$  caused by NSP2 trenching/rock placement activities covers only a few  $\text{km}^2$  ( $0.01 \text{ km}^2$  in Russia,  $3 \text{ km}^2$  in Sweden,  $0.6 \text{ km}^2$  in Denmark and  $0 \text{ km}^2$  in Finland). A sedimentation layer of  $>200 \text{ g/m}^2$  corresponds to a fine sand sediment layer of less than 1 mm, which is within the range of natural sedimentation. It is assessed that such a degree of sedimentation will not impact demersal fish and no smothering of fish eggs and larvae is envisaged. The system will quickly revert to its natural state after the termination of the project activities. In addition, large parts of the pipeline route will be situated in areas with hypoxia in the bottom waters (Atlas Map WA-02-Espoo), where no fish larvae or eggs are present.

In coastal areas (where dredging is planned) the intensity of the impact can be low to high (depending on the distance from the construction activity). The impact magnitudes are local, of short duration and of high intensity. In the dredging area outside the Russian landfall, an area of  $12 \text{ km}^2$  will be affected by sediment deposition of  $>200 \text{ g/m}^2$ /282/. Although investigations have shown that herring spawning grounds in Narva Bay are located toward the northern part of Kurgalsky peninsula and around the offshore islands, and that the eastern part of Narva Bay,

where the route is situated, is a less significant spawning ground for herring, a minor impact is foreseen. Greifswalder Bodden (German coast) is an important spawning ground for the western Baltic herring. Benthic eggs of substrate associated fish species such as herring have a high sensitivity to sedimentation rates. To minimise the overall impacts caused by dredging, Nord Stream 2 AG will restrict its offshore construction time in Germany so that there will be no working activities during the herring spawning season in spring. Furthermore, there are no significant spawning grounds located close to the pipeline route. Hence, the impacts from sedimentation are assessed as minor.

For munitions clearance, which is planned in the Gulf of Finland, sedimentation is distributed over a large area and therefore, no high sedimentation values are found /282/.

The impacts are local and temporary but with a high intensity in the close vicinity of dredging activities. Since the impact is assessed as reversible, temporary and local, the impact magnitude on fish species, demersal eggs and larvae is assessed as low, which is supported by monitoring of fish in relation to NSP.

In summary, because of the low impact magnitude and the medium sensitivity, it is assessed that the impact ranking is **minor**. Therefore, the impact is not significant.

#### 10.6.3.5 Generation of underwater noise (construction)

Underwater noise, which arises from seabed preparation activities (munitions clearance in Russia and Finland) and various seabed works, as mentioned in Section 10.6.2.1, can impact fish by:

- Injury/mortal injury;
- Avoidance behaviour.

#### Assessment of potential impacts

Elevated underwater noise levels and/or vibrations can affect fish by causing mortal injuries, tissue damage (including damage to hearing apparatus) and changes in behaviour (including avoidance and attraction). There are relatively few studies that deal with noise-related impacts on fish and moreover, the studies often show varying results. The nature and magnitude of the impacts of noise also vary greatly between species due to their differing hearing abilities and resultant sensitivity to noise.

Tissue damage (injury) or mortal injuries are likely to occur when fish are in the immediate vicinity of very loud impulse noises and pressure waves caused by e.g. the explosion of munitions. The vulnerability to noise is dependent on the fish species (receptor), noise source and distance from it. In combination with the medium importance (Section 9.6.3), the sensitivity is regarded as medium when it comes to munitions clearance and negligible when it comes to other construction activities.

Fish have two principal sensory organs for the detection of underwater noise and vibrations: the lateral line system and the inner ear. Physical damages to the hearing apparatus rarely lead to permanent changes in the detection threshold, as the sensory epithelium will regenerate in time; however, temporary hearing loss (TTS) may occur **Error! Reference source not found.** The impact is regarded as negligible for fish in NSP2 context. Underwater noise modelling has been made for the NSP2 project (see Section 10.1 and Appendix 3). Thresholds have been based on Popper et al. 2014 /390/. Model results (worst case) are presented in Table 10-36.

**Table 10-36 Thresholds and impacts on fish from noise from rock placement, dredging, vibro-piling and munitions clearance.**

Intervention work	Threshold levels (dB)	RUS	FIN	SWE	DEN	GER
Rock placement – avg.	Fish injury (203 dB)*	0 m	0 m	0 m	0 m	-
	Fish mortality (207 dB)*	0 m	0 m	0 m	0 m	-
Dredging	Fish injury (203 dB)*	0 m	-	-	-	0 m
	Fish mortality (207 dB)*	0 m	-	-	-	0 m
Vibro-piling	Fish injury (203 dB)*	0 m	-	-	-	-
	Fish mortality (207 dB)*	0 m	-	-	-	-
Munitions clearance	Fish injury (203 dB)**	1-1.5 km	0.1-1.5 km	-	-	-
	Fish mortality (207 dB)** (229-234 dB peak)	0.4 -0.5 km	0.05-0.5 km	-	-	-

\*Cumulative SEL (two-hour rock placement); \*\* Cumulative SEL (1 event)

The modelling results show that no mortal injury or injury will occur as a consequence of rock placement, dredging or vibro-piling. The impact magnitudes are therefore assessed as negligible.

In Russia and Finland, munitions clearance will take place. Modelling results show that the risk of mortality is assessed to be local (50-500 m), temporary and with a high intensity of impact. Fish injury or hearing loss may occur within 100-1,500 m of the clearance site. The impact magnitude depends on the area and season, but is assessed as low because whole populations will not be impacted. The old minefields identified along the route in the Gulf of Finland are not in the close vicinity of any important spawning or nursery areas for fish.

Experience from NSP showed that minor impacts were observed in connection with munitions clearance in Finland, and the only species observed to be impacted was herring. In Sweden, a small number of fish (<20 individuals/location) were collected from the sea surface from five of the seven clearance sites and no fish shoals were detected during clearance activities.

In summary, avoidance behaviour among almost all fish species will most likely occur in close proximity to construction activities (rock placement, dredging and vibro-piling) but the fish will return a short time after the cessation of activities. Due to the negligible impact magnitude and low sensitivity, it is assessed that the impact ranking is **negligible**, and therefore is not significant. For munitions clearance, because of the low impact magnitude and the medium sensitivity in the nearshore areas, it is assessed that the impact ranking is **minor**, and therefore not significant. Offshore, the impact ranking on fish stock levels is assessed as negligible.

#### 10.6.3.6 Presence of vessels (construction and operation)

Impacts on fish caused by the presence of construction vessels, and thus visual disturbance and illumination, can result in:

- Avoidance or attraction behaviour;
- Visual disturbance.

#### Assessment of potential impacts

Avoidance behaviour due to noise from vessels is likely to occur among almost all fish species in close proximity to construction activities and vessels. Light from vessels may, however, attract some species (positive phototaxis), such as herring, which might affect them during migration to and from spawning sites in coastal areas. However, due to its local and temporal duration, this impact is assessed as negligible. The overall vulnerability of fish is low, which, combined with its medium importance (Section 9.6), gives it a low sensitivity to the presence of vessels.

Difficulties in investigating the responsiveness to noise in fish have consequences for deriving appropriate threshold values for avoidance behaviour. However, it has been proposed that fish show avoidance behaviour to vessels when the radiated noise levels exceed their threshold of hearing by 30 dB re 1µPa or more (typically around 160-180 dB re 1µPa). The range of reaction varies from 100 - 200 m for many typical vessels but is as high as 400 m for relatively noisy vessels /286/.

The lay vessel and the accompanying supply vessels move approximately 2-3 km per day. The pipe-lay itself is not expected to emit noise louder than a vessel. Visual disturbance caused by illumination from construction related vessels (e.g. guard vessels, dredging vessels, placement barges etc.) will be restricted to the construction site. The potential impacts are assessed to stay within normal maritime levels and will not have any effect at the population level. These predictions are in line with monitoring of fish that was made during NSP. Results showed that no impacts were observed on fish populations during construction.

On the basis of previous experience and the conclusions above, it is assessed that the impact magnitude is negligible and the sensitivity is low. The impact ranking is therefore **negligible** and the impact is assessed as not significant.

#### 10.6.3.7 Presence of pipeline structures (operation)

New pipeline structures such as rocks and the pipeline itself will not impact fish directly but can create new habitats. The colonisation of epifauna will attract other organisms such as mobile crustaceans and fish looking for food and/or shelter. The pipeline structures can bring:

- Destruction of seabed habitats;
- New habitat ("artificial reef") and increased biodiversity as a consequence.

#### Assessment of potential impacts

The vulnerability of fish to changes in the seabed profile and presence of pipeline structures is low. The size of the area of the seabed occupied by the pipeline will be negligible compared to the overall fish habitat area in the Baltic Sea. The negative impact on the fish related to the presence of pipeline structures is considered to be insignificant as fish are mobile species, and can move to adjacent habitats. The vulnerability in combination with its medium importance (Section 9.6) gives it a low sensitivity to physical changes to seabed features.

The introduction of new habitats and the potential increase in biodiversity will in some regions of the pipeline be insignificant as the water depth is too deep for establishment of epifauna and associated fish species. In other regions, epifauna will establish (based on experience from NSP, see Section 10.6.4) and it is expected that with time, pelagic fish species will enter the new habitat. As the total area of introduced hard substrate is limited, the overall impact, which will be positive, will be local, long-term and of a low intensity. The magnitude of the impact will be insignificant as the ecological conditions in the region must not be overestimated. Its contribution to the overall productivity in the region is very limited and it will therefore have limited significance for the abundance of the marine life.

Offshore, no important demersal spawning grounds are affected. The Bornholm Basin is an important spawning area for cod, sprat and flounder; however, these eggs are pelagic and will not be affected by a pipeline along the bottom. In the coastal waters of Russia and Germany, herring spawn. However, in Narva Bay, a baseline survey showed that the main spawning grounds are located towards the northern part of Kurgalsky peninsula and also around the offshore islands of Gogland, Malyi and Bolshoy Tyuters, while the eastern part of Narva Bay, where the route is situated, is a less significant spawning ground for herring. In the German EEZ, the pipeline laid on top of seabed may lead to habitat loss for established stationary fish species such as sand eels. In contrast, new habitats will be created for reef species. It is expected that this effect will lead to an attraction of such fish species in areas with homogenous

sand habitats. Overall, the impact magnitude is local, permanent and with a low intensity, and is therefore assessed as negligible. The sensitivity of the fish species is low and the impact will lead to displacement of fish individuals to similar habitats in adjacent areas.

Monitoring of the reef effect of NSP was conducted in Germany, Sweden and Denmark post-construction. After three years of monitoring, a clear reef effect of NSP could be confirmed in Germany for sea scorpion, eelpout as well as some other fish species /288/. Benthic communities have in some areas been established on the surface of the pipeline and rocks (epifauna) and in sediments (infauna) /271/.

As the impact magnitude is negligible and the sensitivity is low, the impact ranking is **negligible**, and therefore the impact is not significant.

#### 10.6.3.8 Summary and ranking of potential impacts on fish

A summary of the overall project impact rankings for fish arising from the potential sources of impact scoped into the assessment is provided in Table 10-37, together with the rankings predicted at the country level. As indicated in the table, all impacts are considered to be insignificant at the overall project level and are assessed as negligible to minor for the most part in the national assessments. As a new artificial reef is created, positive impacts on biodiversity and the creation of habitat for fish can potentially occur.

Owing to the ranking levels and different nature of the impacts associated with each of the seven sources of impact considered above, there is a limited potential for “in-combination” impacts on fish from these sources of impact.

The release of sediments to the water column, sediment associated contaminants and sedimentation on the seabed may extend across national borders into Estonia. Transboundary impacts on fish from underwater noise, based on underwater noise modelling for munitions clearance (Russia and Finland), show that the threshold for impacts (injury) on fish in the worst case is exceeded up to 1.5 km from the munitions detonation site. The potential for such impacts is considered in Chapter 15 – Transboundary impacts.

**Table 10-37 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Fish	Project	RU	FI	SE	DK	GE	Trans
Physical changes to seabed features				-			No
Release of sediments to the water column							Yes
Release of contaminants to the water column							Yes
Sedimentation on the seabed							Yes
Generation of underwater noise							Yes
Presence of vessels		-		-	-		No
Presence of pipeline structures							No
Impact ranking:	Negligible		Minor		Moderate		Major

#### 10.6.4 Marine mammals

Six potential sources of impacts on the marine mammals are identified in Table 8-2. Of these, four can be scoped out from further consideration, as outlined in Table 10-38:

**Table 10-38 Potential sources of impact scoped out for marine mammals.**

Potential source of impact	Potential impact	Justification
Release of contaminants and nutrients to the water column (construction)	<ul style="list-style-type: none"> <li>Accumulation of contaminants caused by mobilisation of contaminant from the sediment into the food chain (secondary impact)</li> </ul>	As outlined in Section 10.1, the released amounts of contaminants, incl. CWA, are insignificant compared to the annual amounts entering the Baltic Sea and Baltic Proper. In addition, the nutrient contribution is also insignificant compared to the annual nutrient load (see Sections 9.2.2.5 and 10.1). Of the released contaminants, only a small percentage, approximately 10%, will become bioavailable /260/, /261/, /262/. The PNEC values are only slightly exceeded for a few contaminants and only for a short duration. Additionally, no significant impacts are expected on the food source (fish). An impact from contaminants on marine mammals is therefore not likely to occur.
Presence of vessels (construction)	<ul style="list-style-type: none"> <li>Behavioural changes</li> </ul>	Any physical disturbance caused by NSP2 activities above water, e.g. the visual presence of vessels, is negligible compared to the underwater noise emitted from vessels. Therefore only underwater noise is assessed.
Presence of vessels (operation)	<ul style="list-style-type: none"> <li>Behavioural changes</li> </ul>	As above
Presence of pipeline (operation)	<ul style="list-style-type: none"> <li>New habitat</li> </ul>	As assessed in Sections 10.6.2 and 10.6.3, change of habitat due to the presence of the pipelines will not contribute to changes in the diversity or abundance of benthic and/or fish species and thus will not result in an increase of food sources of marine mammals.

The following sources of impacts have thus been assessed and reported below:

- Release sediments to the water column (construction);
- Generation of underwater noise (construction).

##### 10.6.4.1 Release of sediments to the water column (construction)

Activities with the potential to release sediment to the water column in areas where mammals may be present are the same as those identified in Section 10.6.1.1 and may impact such communities through:

- Visual impairment;
- Avoidance behaviour.

##### Assessment of potential impacts

Since harbour porpoises primarily use echolocation for orientation in the environment as well as for prey localisation, any visual impairment caused by increased SSCs is unlikely to affect their functioning. Seals do not use echolocation, but like porpoises are often found in dark and turbid waters where prey congregates. While avoidance behaviour may affect the long-term survival and reproductive success of individuals, and thereby ultimately the population status, this will only materialise when such behaviour occurs over an extended period of time, well above that

anticipated from avoidance of suspended sediment during NSP2 construction. Consequently, the vulnerability and sensitivity of both harbour porpoises and seals to the release of sediment are low (irrespective of their importance level resulting from their conservation status (Section 9.6.4.1)).

As shown in Section 9.6.4, harbour porpoises and seals are present in areas where the range of activities that release sediment may occur; this includes waters close to the landfalls where, as a result of dredging, the most marked increases in SSCs will occur. However, as described in Section 10.6.1.1, although detectable changes in SSCs are predicted due to dredging close to both the Russian and German landfall sites, these will be of both short duration and limited spatial extent (with the highest concentrations being restricted to the immediate vicinity of the activities giving rise to the sediment releases) and the total SSCs will generally remain within the natural variations experienced during storm events.

Offshore, there will similarly be detectable changes in SSCs, notably in the vicinity of post-lay trenching and rock placement activities; but again, as summarised in Section 10.6.1, these SSCs will remain within the natural variations for such areas.

Although the above-described SSCs might result in some avoidance behaviour, they are likely to be similar to those that occur e.g. during storm events. The duration of any behavioural change that does occur will be substantially shorter than that which could affect the viability or functioning of any marine mammal populations. The impact magnitudes for all species are therefore considered low, which, irrespective of the sensitivity levels, result in at most **minor** impact rankings for all species and **negligible** in the offshore areas of Finland, Sweden and Denmark; hence, the impact is not significant.

#### 10.6.4.2 Generation of underwater noise (construction)

Underwater noise can potentially arise from a range of NSP2 construction activities, notably munitions clearance (by far the loudest activity) followed by rock placement. The noise levels associated with trenching, pipe-lay, anchor handling, construction vessel movements and other construction activities will, beyond the immediate vicinity of the noise-generating activity, be generally indistinguishable from background noise levels in the Baltic Sea where there are already large volumes of ship traffic. The noise generated by munitions clearance and rock placement may, however, result in the following impacts on marine mammals:

- Physical injury (incl. blast injury and PTS);
- Temporary hearing loss (TTS);
- Avoidance behaviour;
- Masking of other sounds;
- Behavioural response (other than avoidance).

#### Assessment of potential impacts

At close range, the shock wave from an explosion or other very loud activities can tear apart and damage animal tissue as a result of differential acceleration of tissues with different density, leading to anything from insignificant small bleedings to death.

For marine mammals, it is generally accepted that the auditory system is the most sensitive organ to acoustic injury, meaning that injury to the auditory system will occur at lower noise pressure levels than injuries to other tissues (see e.g. /289/). Noise induced threshold shifts, which are the temporary or permanent reductions in hearing sensitivity following exposure to loud noise (commonly experienced by humans as reduced hearing following rock concerts etc.) are also generally used as precautionary proxies for more widespread injuries to the auditory system. TTS disappears with time, depending on the intensity and duration of exposure to the noise, with small amounts of TTS disappearing in a matter of minutes but very high levels of TTS taking hours or even days.

At high levels of noise exposure, hearing does not recover fully, but results PTS due to damage to the sensory cells in the inner ear. There are no standard thresholds for TTS and PTS, but there are two key factors that determine their values; the frequency spectrum of the noise and the the number of repetitions, with the duration of exposure and the duty cycle (proportion of time that the sound is generated during intermittent activities, such as pile driving) having a large influence on the degree of TTS/PTS induced. There is, however, no simple model available that can predict this relationship (see Appendix 3).

In order to determine the noise levels at which harbor porpoises and seals may be vulnerable to TTS and PTS from NSP2 activities, values for these thresholds associated with single explosions from munitions clearance and continuous noise from rock placement (Table 10-39) have been determined for these species /145/, /289/, /290/ based on scientific data and literature (method described in /145/, /290/) and summarised in Table 10-39.

**Table 10-39 Estimated thresholds for inducing PTS and TTS from single explosions (munitions clearance) and continuous noise from rock placement.**

Species	Munitions clearance		Rock placement	
	PTS	TTS	PTS	TTS
Harbour porpoise	179 dB SEL	164 dB SEL	203 dB SEL	188 dB SEL
Seals	179 dB SEL	164 dB SEL	200 dB SEL	188 dB SEL

Although not affecting hearing, noise levels below the TTS threshold may nonetheless alter the behaviour of animals. This can have implications for the long-term survival and reproductive success of individuals, and thereby ultimately the population status, if a sufficiently high proportion of the population is affected /291/. Seals are generally considered less sensitive to displacement by noise than harbour porpoises /292/.

The sensitivity of a species to behavioural changes in response to noise levels also depends on the time within its life cycle when the noise generation occurs. Seals are most vulnerable during the moulting, breeding and lactation periods and for harbour porpoises, adults are most vulnerable during the breeding period and calves are for at least ten months after birth (see Table 10-40 and Table 10-41).

**Table 10-40 Seasonal sensitivities of marine mammals in German, Danish and Swedish waters during the year /145/. The sensitivity includes abundance considerations.**

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise	High	High	High	Med	High	High	High	High	High	High	High	High
Harbour seal	Med	Med	Med	Med	High	High	High	High	Med	Med	Med	Med
Grey seal	Med	High	High	Med	High	High	Med	Med	Med	Med	Med	Med

**Table 10-41 Seasonal sensitivities of marine mammals in Russian, Finnish and Estonian waters during the year /290/. The sensitivity includes abundance considerations.**

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise	High	High	High	High	High	High	High	High	High	High	High	High
Grey seal	Med	High	High	High	High	High	Med	Med	Med	Med	Med	Med
Ringed seal	Med	High	High	High	High	Med	Med	Med	Med	Med	Med	Med

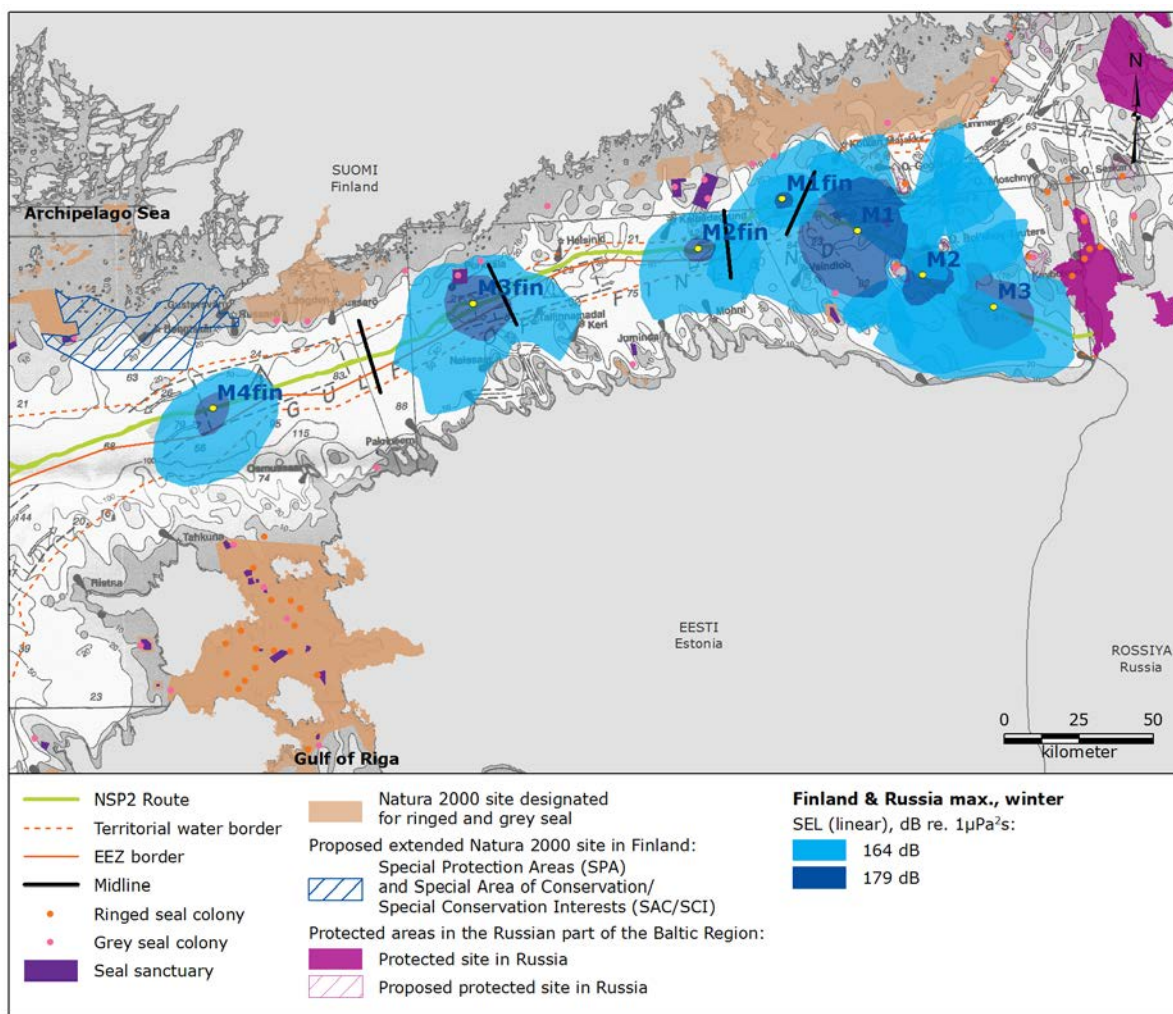


*Physical injury (incl. blast injury and PTS)*

The extent of noise propagation, and hence areas over which noise related impacts may be experienced by harbour porpoises and seals, depends on several hydrographical parameters, including water depth and sediment conditions, as well as the size of the charge.

The areas over which the threshold for PTS (and TTS, discussed in the next section) associated with munition detonation would be exceeded for harbour porpoises and seals have been calculated for each species in several areas within the Gulf of Finland (M1-M4 in Finland and M1-M3 in Russia), which provides a range of scenarios that represent the situations likely to apply to NSP2. The models considered detonation of a suite of different munitions at each site, and predicted both average (based on average size of munition in the suite) and maximum (based on largest munition in the suite) areas over which the relevant thresholds would be exceeded from each single detonation event. The results are shown in Figure 10-2, Section 10.1 and Appendix 3.

The noise from rock placement is insufficient to cause injury or exceed the threshold for PTS for any marine mammals present in the vicinity.



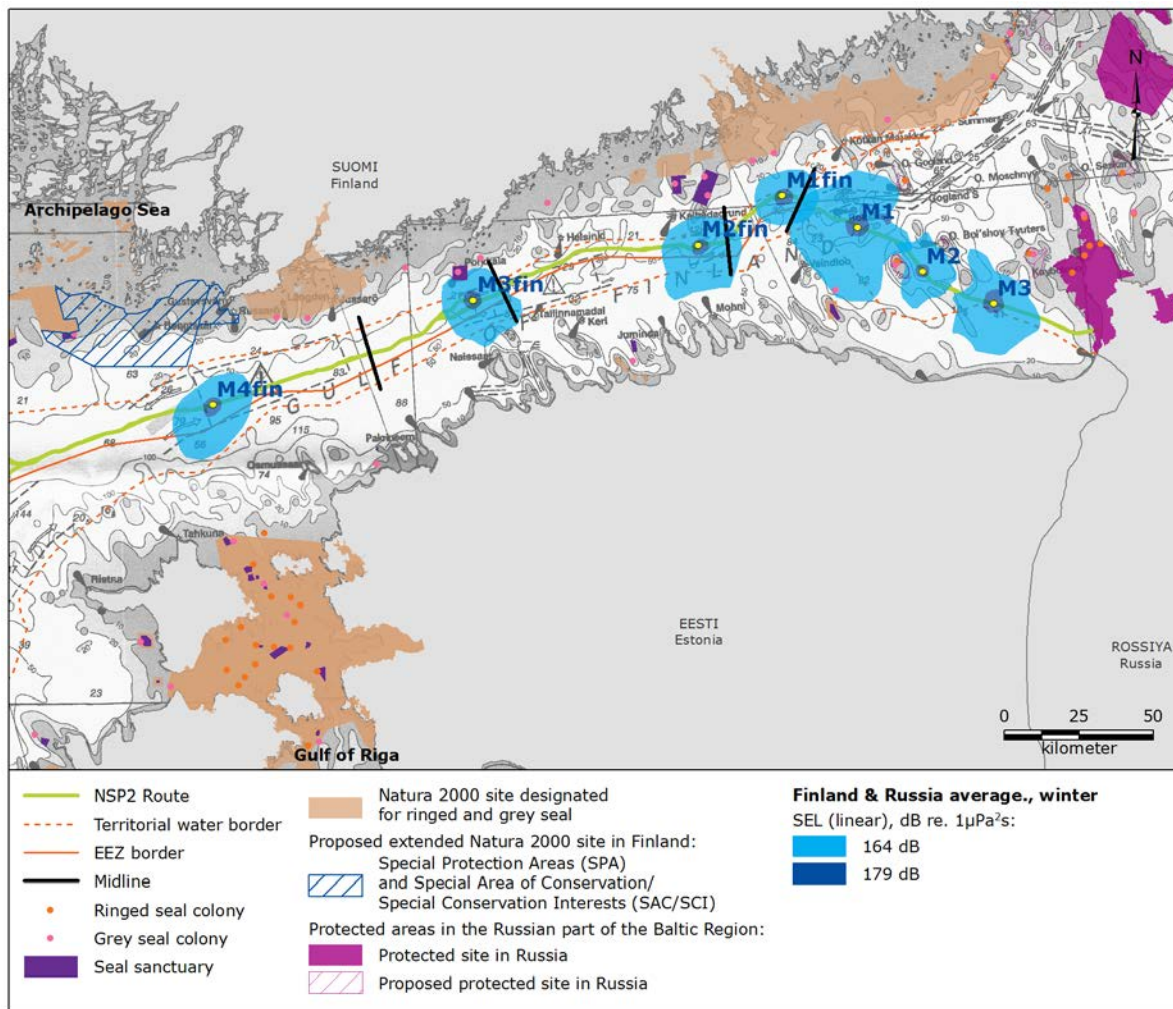


Figure 10-2 Maximum (top) and average (bottom) noise propagation from munitions clearance in Finnish and Russian waters, with indication of munitions area (M1-M4). For more details, see Appendix 3 and Atlas Maps UN-01-Espoo to UN-04-Espoo.

There are only minor differences between summer (Atlas Map UN-01-Espoo and UN-03-Espoo) and winter (Figure 10-2 and Atlas Map UN-02-Espoo and UN-04-Espoo) impact ranges, so the assessment has therefore not differentiated between the seasons of clearance.

Threshold distances for PTS can be seen in Figure 10-2 and are also summarised in Table 10-42 below.

Table 10-42 The maximum and average extents of PTS and TTS zones for munitions clearance at the seven munitions sites in Russia (M1-M3) and Finland (M1- M4).

Thres hold	Threshold distances (km) – munitions clearance													
	Finland								Russia					
	M1 max	M1 ave	M2 max	M2 ave	M3 max	M3 ave	M4 max	M4 ave	M1 max	M1 ave	M2 max	M2 ave	M3 max	M3 ave
PTS	3.5	3.5	8	3.5	15	3.5	9	3.5	23	5	11	3	18	5
TTS	15	15	38	26	44	19	32	22	56	26	55	13	60	20

Notes:

Max = distance at which threshold would be exceeded for the largest size of munition

Ave = distance at which threshold would be exceeded for an average size of munition

It needs to be noted that transmission of noise from explosives is effectively reduced in shallow waters due to the poor propagation of low frequencies in shallow water /290/. Based on this

knowledge and available survey data, it is not expected that the sound from underwater explosions will reach seal haul-out sites in the northern part of Kurgalsky peninsula (known as Kurgalsky reef), should any munitions clearance to be performed in the shallow waters at the Russian landfall.

#### *Assessment of impacts per species*

As identified above, since blast injury and PTS will only be experienced from munitions clearance, impacts on harbour seals are not likely as this species is not present in the Gulf of Finland, where such activities will occur.

Owing to slight differences between the assessment methods applied in the Espoo Report and Finnish EIA (notably, the consideration of the proportion of a specific marine mammal population affected by an impact as part of the impact magnitude score in the former, but as part of the receptor sensitivity score in the latter) there may be some differences in the scores assigned to impact magnitude and receptor sensitivity in each document. Such differences do not, however, influence the impact rankings, which are the same in both documents for all impacts arising from activities in Finnish waters.

In recognition of the high levels of public concern regarding certain marine mammals, the assessment described below has therefore considered impacts at two levels:

- Whether and to what extent NSP2 may affect the functioning of a species *population*, notably in relation to its distribution and abundance;
- Whether *individuals* of a species may experience injury, death or other impacts as a result of NSP2, irrespective of whether this results in changes to the functioning of the population.

#### Harbour porpoise

The Belt Sea populations of harbour porpoise are not present on the Gulf of Finland so are not considered in the assessment. The vulnerability of the Baltic subsea population of harbour porpoise to blast injury and PTS is considered to be high due to the risk of fatal injuries. This combined with their conservation status (Vulnerable in IUCN Red List, Critically Endangered in HELCOM Red List and EU Habitats Directive, Annex IV) gives them a high sensitivity to such impacts both at the individual and population levels.

The areas adjacent to NSP2 in Finnish, Russian and Estonian waters hold very low densities of harbour porpoises (Figure 9-6 and Figure 9-7), so the likelihood of an individual harbour porpoise being present during a detonation event is extremely low. Any blast injury or permanent hearing loss that does occur will therefore in general not be sufficient to affect the functioning or viability of populations of this species. The magnitude of impact is thus considered to be low both at *individual* and *population* levels.

Although this species has a high sensitivity ranking, due to the fact that munition detonation will occur is at the border of its distribution, the numbers affected would be so low that the impact ranking is assessed as **minor** for both blast injury and PTS.

An exception to this ranking may apply in the vicinity of the Finnish M3-area, where a larger number of mines is likely to be encountered (42 detonations were required during the previous NSP construction). As identified above, the number of repetitions of a noise-generating event in a single area can have a large influence on the degree of damage caused. In addition, the extended period over which the Finnish M3 area (compared to other detonation areas) may be exposed to such an event will also increase the likelihood of an individual being present when it occurs. Without detailed knowledge about the movement of harbour porpoises, their responses to such multiple events is not known. As a precautionary approach, the impact magnitude for this location is considered to be medium, resulting in a **moderate** ranking for blast injury, which is

therefore considered to be significant and **minor** for PTS at the individual level. At the population level, the impact ranking is **minor** for both blast injury and PTS.

#### Grey seal

The vulnerability of grey seals to blast injury and PTS is considered to be high due to the risk of fatal injuries. This combined with their low importance, based on their conservation status (Least Concern), gives them a low to medium sensitivity ranking.

There is a high likelihood of grey seals being present in Russian and Finnish waters, with multiple colonies, and there are both sanctuaries and protected areas within the Gulf of Finland, including a grey seal protection area in Estonia (Table 9-12 and Figure 9-25).

At the *individual level* there is thus a risk that, without mitigation, a considerable number of grey seals could be subject to blast injury. This results in a high impact magnitude which, when combined with the medium sensitivity ranking of this species, gives a **major** impact ranking for *blast injury*. The impact magnitude for *PTS* is assessed as medium, giving an impact ranking of **moderate** for *PTS*; thus the impact may be considered to be significant.

At the *population level*, due to the number of individuals affected, there may be a short-term decline in a portion of the population over one generation. The population as a whole is, however, increasing and has good environmental status, so that such an event is highly unlikely to affect the long-term viability or functioning. While the areas over which the thresholds for blast injury and PTS may be exceeded is considerable, this will not, for an *average* detonation scenario, extend into any seal sanctuaries, sites protected for seals or waters around seal colonies. Several such areas could, however potentially be affected in the event that a *larger* munition be detonated their vicinity. Sites that might be affected in such an event include the sanctuaries Sandkallen, Stora Kölhällan and Kalbadan and the Natura 2000 site SAC FI0100089: Kallbådanin luodot ja vesialue (Kalbådans Islets and Waters) in Finland, which have grey seal as a conservation objective. In addition, the proposed Ingermanlandsky Nature Reserve in Russia, protected for (among other species) grey seal. The impact magnitude for blast injury is therefore considered to be medium, which results in a moderate impact ranking, which may therefore be considered significant at the population level. The impact magnitude for *PTS* is assessed as medium, giving an impact ranking of **minor** at the population level.

Additive impacts from multiple explosions in the Finnish M3-area are not expected to increase the impact on grey seal due to the favourable population status of the species.

Impacts on designated areas including those, which have seals as a conservation objective are addressed in Sections 10.6.6 and 10.6.7.

#### Ringed seal

The vulnerability of ringed seals to blast injury and PTS is considered to be high due to the risk of fatal injuries. This combined with their low to medium importance based on conservation status (HELCOM Red List, Vulnerable) gives them a medium sensitivity ranking.

Ringed seals can be found all over the Gulf of Finland, with multiple colonies, three sanctuaries (Figure 10-2) and protected areas designated for their seal population within this region (Figure 10-2, and Table 9-14) ^, with the densities in general being higher close to the colonies.

At the *individual level*, there is thus a risk that, without mitigation, a considerable number of ringed seals could be subject to *blast injury*. This results in a high impact magnitude which, when combined with the medium sensitivity ranking for this species, gives a **major** impact ranking, and is thus considered to be significant. For *PTS*, the impact magnitude is medium and the impact ranking is thus assessed to be **moderate**.

The determination of impact magnitude, and hence overall impact ranking at the population level, has accounted for the proportion of the population affected. Where the abundance of a population is low and/or the status is poor, the impact ranking will thus be similar to that allocated at the individual level since, in this case, the impact on an individual could affect the population viability and functioning. Where the abundance of a population is high and impacts at an individual level will not affect population functioning, a lower magnitude and ranking have been applied than at the individual level. The determination of impact magnitude at the *population level* has adopted a precautionary approach in which the three ringed seal breeding areas (Gulf of Finland, Archipelago Sea and Gulf of Riga) are considered to be reproductively isolated.

- **M1-M3-area in Russia and M1-M2-area in Finland (inner Gulf of Finland population).** The magnitude of impact is assessed to be high as the abundance of the population in the inner Gulf of Finland is very low (100-300 individuals) and any detonation site in these areas would be located close to the colonies (except for the Kurgalsky reef colony), where the species density (and hence the potential for impact) will be higher compared to other locations. Although there is no telemetry data from individuals tagged at the haul-out sites closest to the M1-M2-area in Finland, it is unlikely that more than a few individuals will be present within the blast injury zone at the time of each munitions clearance. However, if these individuals are e.g. 2-3 mature females, the impact on the population may be high, while male individuals are less important in this respect. The impact magnitude is thus assessed as high and the overall impact ranking as **major** for blast injury, and is thus significant. As the impact magnitude is medium for PTS, the impact ranking is **moderate**, and is thus significant.
- **M3-area in Finland (inner Gulf of Finland, Archipelago Sea populations and Gulf of Riga).** The magnitude is assessed to be major for blast injury and medium for PTS as although fewer animals may be present compared to the M4- and the M1-M2-areas, the presence of the inner Gulf of Finland population is likely. Nevertheless, low numbers of transient individuals from all three breeding areas, including the threatened Gulf of Finland seals, may potentially be present within the PTS or blast injury zone at the time of munitions clearance. The impact ranking is therefore **major** for blast injury and **moderate** for PTS and hence significant for both.
- **M4-area in Finland (inner Gulf of Finland, Archipelago Sea and the Gulf of Riga population).** The magnitude of impact is assessed to be low for PTS and medium for blast injury due to the higher abundance (relative to the Gulf of Finland area) of the population in this area with its core range positioned at a greater distance from the pipeline. Although there is no available telemetry data for the animals at the closest haul-out sites to any of the breeding areas for the three populations, it is likely that some individuals will be present within the PTS or blast injury zone at the time of munitions clearance. The overall impact ranking is **moderate** for blast injury and **minor** for PTS on a population level, giving a potentially significant impact.

Additive impacts from multiple explosions in the Finnish M3-area are not expected to increase the impact on grey seal due to the favourable population status.

There are no Natura 2000 sites designated for ringed seals which are likely to be impacted by blast injury or PTS. The proposed Ingermanlandsky Nature Reserve in Russia, protected for (among other) ringed seal, is situated in the M1-M3 sites in Russia; hence the impact ranking is major as assessed above.

Additive impacts from multiple explosions are not expected to increase the impact on ringed seals.

#### *Temporary threshold shift and avoidance behaviour*

Vulnerability to TTS and avoidance behaviour is considered to be low, as although there will be measurable changes to hearing and behaviour from underwater noise, hearing will revert to pre-impact levels once the impact ceases. The sensitivity is therefore, irrespective of the receptor importance, considered to be low for all species of marine mammals.

Threshold distances for TTS (also considered to be a proxy for avoidance behaviour) due to munitions clearance and rock placement are provided in Table 10-39. These distances vary per munition site but are the same for all species. The results indicate that:

- For *munitions clearance*, an exceedance of the underwater noise level that could induce TTS could, in the case of large munitions detonation (the “maximum” scenario) extend up to 60 km from the detonation site (Table 10-42), including into Estonian waters.
- For *rock placement*, an exceedance of the underwater noise level that could induce TTS is restricted to areas within 80 m from the rock placement sites (Table 10-9).

For *munitions clearance*, although the number of species affected will vary according to location, as the impact will be short-term and not affect species functioning at the individual or population level, the impact magnitude is low for all species. When combined with the low sensitivity, the impact ranking is **minor**, and hence not significant, both at the *individual level* and *population level* for all species.

The predictions indicate that seals associated with seal sanctuaries and Natura 2000 sites may potentially be affected by TTS and behavioural responses. These include the Kallbådan sanctuary and the Natura 2000 sites SPA/SAC FI0100078: Pernajanlahtien ja Pernajan saariston merensuojelualue (Pernaja and Pernaja Archipelago), SPA/SAC FI0100077: Söderskärin ja Långörenin saaristo (Söderskär and Långören Archipelago) and SPA/SAC FI0100005: Tammisaaren ja Hangon saariston ja Pohjanpitäjänlahden merensuojelualue (Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area).

Impacts on these designated areas are addressed in Sections 10.6.5, 10.6.6 and 10.6.7.

The short-term nature of any impact on TTS and behaviour from *rock placement*, which occurs in the waters of all PoOs, will similarly not affect species functioning at the *individual or population level*. This combined with the very local nature of the impact results in a low impact magnitude. As the sensitivity is low, the impact ranking is assessed as **minor** both at the *individual level* and *population level* for all species.

#### *Behavioural response*

Behavioural responses to underwater noise from rock placement, trenching, dredging, pipe-lay, the presence of vessels and other construction activities around the pipeline are expected to occur only in the vicinity of the vessels and remain only for the time when the vessels are present.

Modelling of noise from rock placement was used as a proxy for wider construction related noise and from vessels in general, as (except for munitions clearance, which will create avoidance behaviour and is addressed above) rock placement is considered one of the noisiest activities arising from the project.

Most underwater noise, other than from munitions clearance (which is only required in the Gulf of Finland), will come from vessel traffic. The overall expected sound levels will in general be low and are likely to be of a similar magnitude as those from passing merchant vessels, which are very abundant along the pipeline corridor. Any increase is unlikely to be discernible above such background noise levels and thus insufficient to disturb mammals. The assessment is confirmed

by mammal monitoring activities during NSP, which did not record any measurable disturbance during offshore construction works.

In Germany, where no munitions clearance will take place, there are two haul-out sites for grey seals near the pipeline. Rock placement may be applied locally to stabilize Above-Water Tie-Ins (AWTIs). The AWTIs considered in Germany are located in shallow waters and rock dumping will be carried out by comparatively small ships. Noise emissions from rock dumping will be in the range of noise emissions from dredging activities. Most noise from construction works in German waters is assumed to come from vessel traffic and dredging, and expected source levels will be low, as close to the landfall site (Lubmin 2) the construction is planned with a micro-tunnel. Measurements of sound levels during the construction of NSP showed no exceedance of the threshold value of 160 dB re 1  $\mu\text{Pa}^2\text{s}$  (SEL) specified by the federal environmental agency of Germany /293/, which is below TTS threshold. The impact magnitude from underwater vessel noise in German waters is assessed as low. Therefore the impact ranking is **minor** for marine mammals.

Owing to the short duration, limited spatial extent and the fact that TTS thresholds (and hence also thresholds for behavioural response) will not be exceeded, the magnitude from vessel noise, including dredging and micro-tunnelling, is therefore assessed as low, which when combined with the receptor sensitivity will result in an impact ranking which is at most **minor** for all marine mammal species.

#### *Masking of other sounds*

Masking is the phenomenon whereby noise can negatively affect the ability of a species to detect and identify other sounds, e.g. from prey and inter-communication between individuals within a species. In order to produce a masking effect, the noise must be audible, roughly coincide with the masked sound levels, and have energy in roughly the same frequency band as the masked sound.

Vulnerability to masking is considered to be low as although there may be short-term interruption in the ability of a species to detect other sounds, this will cease once the noise stops. The sensitivity is, irrespective of the receptor importance, considered to be low for all species of marine mammals.

However, given the limited current level of knowledge about the conditions wherein masking occurs outside strictly experimental settings and how masking affects the short-term and long-term survival of individuals, it is not possible to assess masking.

#### **Mitigation measures and assessment of residual impacts**

As identified above, there is the potential for significant impacts on marine mammals as a result of underwater noise generation, notably in association with munitions clearance. Specific mitigation measures have therefore been developed and incorporated as project commitments (Chapter 16 – Mitigation measures) to ensure that these impacts can be avoided or reduced to acceptable (non-significant) levels.

Acoustic deterrent devices (ADDs), also known as seal scarers, including “pingers” will be deployed either individually or as required in arrays prior to munitions detonation to drive seals and harbour porpoises animals away from the detonation zone (Chapter 16 – Mitigation measures). Additionally, marine mammal observers (MMOs) will be stationed on munitions clearance vessels to check for the presence of marine mammals (as well as diving seabirds, such as sea-ducks and auks) and detonation will be delayed if they are observed in the area.

*Harbour porpoises* are known to react strongly to seal scarers by evasion (see references in /290/). Deterrence ranges differ between studies, but appear to be at least 350 m for total deterrence and somewhere between 1 and 2 km for almost complete deterrence, although effects

up to 8 km have been observed in a single study. The most effective seal scarer appears to be the Lofitech, the same model proposed for used for NSP2. Using the planned setup for mitigation, harbour porpoises would be scared away at least 1,300 to 2,300 m from the explosion site and possibly more.

When used as a mitigation device for loud underwater noise, several studies support that seals are deterred from the vicinity of seal scarers. The Lofitech device is considered effective in deterring grey seals out to a distance of at least some hundred meters (see references in /290/). At further distances, out to around 1 km, seals may not be deterred, but will change their behaviour and spend more time at the surface (see references in /290/), hence reducing the impact from underwater noise. Using the planned setup for mitigation, seals would be scared away from the nearest few hundred metres of the seal scarer, which corresponds to an area with a radius of at least 500 m from the blast site (four scarers in use), and would alter their behaviour to be more surface active up to around 1,300 m from the blast site.

Mitigation measures, more specifically seal scarers, can therefore substantially reduce the risk that marine mammals are very close when an explosion occurs, and hence also the risk that they suffer significant blast injury or death due to exposure to the shock wave from the explosion /290/. The likely effects of such measures on harbour porpoises and seals are discussed below together with an evaluation of the level of impact that is anticipated should they be adopted.

### *Blast injuries*

#### Harbour porpoises

For large explosions (300 kg TNT-equivalent, the largest size of munition anticipated to be encountered during construction of NSP2 and hence the “maximum” scenario modelled), threshold distances for “moderately severe blast injuries” /294/ are less than 1 km and about 2.5 km respectively for harbour porpoises at the surface and bottom (40 m) of the sea. The category “moderately severe blast injuries” covers nontrivial, but survivable injuries, where animals are considered able to recover on their own. Since the seal scarers, as described above, are very effective in deterring porpoises out to distances of at least 1-2 km, it is unlikely that any porpoises will be within this range at the time of the detonation. For large explosions, the safe distance where no blast injury from a similar sized explosion is expected, is about 2.5 km and 10 km for animals in the surface and at the bottom, respectively. It thus is assessed that use of scarers will reduce the risk of fatal injuries and reduce, but not eliminate, the risk that harbour porpoises will be present within some kilometres from the blast site and at risk of suffering non-lethal blast injuries. The impact magnitude is therefore low, and hence the impact ranking is reduced from moderate without mitigation to **minor** for blast injury for the M3-site, both at the individual and population levels. At other sites, the impact ranking remains as without mitigation, i.e. **minor**.

#### Seal

Although the same thresholds for blast injury apply to both harbour porpoises and seals, the displacement range for seals in response to seal scarers is smaller, typically on the order of a few hundred meters from the seal scarer. This distance can, however, be increased by using several scarers each about 300 m from the detonation site, thus increasing the displacement area to at least 500 m.

Since, as identified above, the threshold distance for “moderately severe injuries” for the 300 kg TNT explosion is about 1 km for animals at the surface, the likelihood that seals will be killed by an explosion is reduced substantially with the use of scarers. As the likelihood of killing or permanently disabling seals due to blast injuries is small, the impact magnitude for blast injury is hence medium.

At the *individual* level the impact ranking is thus **moderate** for both species of seal.



At the *population level* the impact ranking is **moderate** for the Gulf of Finland ringed seal populations and **minor** for grey seals and the Gulf of Riga ringed seal population.

#### *Permanent Threshold Shift*

Deterrence of seals and harbour porpoises prior to munitions clearance will have some influence on the number of animals likely to suffer onset of PTS, but only in a relatively small area compared to both the average and maximum extent of the PTS zones. However, due to the exponential (on average) decrease in sound pressure level with distance from the blast site, the exclusion of seals from the innermost area around the blast site will reduce the number of animals which would experience onset of severe PTS. On the other hand, as far more animals are likely to be exposed at larger distances, the overall number of animals subject to onset of a degree of PTS will not be reduced very much by the seal scarers. Consequently, the use of seal scarers is considered not to alter the assessed impact ranking.

At the *individual level* the ranking thus remains **moderate** for seals and **minor** for harbour porpoises. At the *population level* it is also **moderate** for ringed seals and **minor** for harbour porpoises, grey seals and for the ringed seal populations found at M4.

#### *Temporary Threshold Shift*

TTS can occur at a considerable distance from the blast site, i.e. well beyond the reach of the seal scarers. This means that the risk of inflicting TTS on marine mammals is largely unaffected by the use of seal scarers as a mitigation measure and thus the impact ranking remains as **minor** for all marine mammal species at both the individual and population levels.

#### *NSP monitoring*

Monitoring of marine mammals during the construction of NSP only recorded a few marine mammals as present along the pipeline route, so it was not possible to draw firm conclusions on the impact of its construction. However, no measurable disturbance was observed within the individuals that were monitored. In Finland and Sweden, where seal scarers were applied prior to each munitions detonation event, MMOs were utilised and passive acoustic monitoring applied to minimise the potential for marine mammals being present, no adverse impacts on marine mammals were reported.

### **10.6.4.3 Summary and ranking of potential impacts on marine mammals**

A summary of the overall project impact rankings for marine mammals arising from the potential sources of impact scoped into the assessment, with the proposed mitigation in place, is provided in Table 10-43, Table 10-44 and Table 10-45, together with the rankings predicted at the country level. As indicated in the tables, most of the impacts are considered not to be significant at either the national or overall project level, although the potential for some moderate impacts, which may therefore be considered significant, are predicted to arise from activities in Russian and Finnish waters associated with underwater noise generation from munitions clearance.

Owing to the ranking levels and different nature of the impacts associated with each of the two sources of impact considered above, there is a limited potential for "in-combination" impacts on marine mammals. The overall impact ranking on this receptor group, arising from all sources of impacts, will be dominated by that associated with noise generation arising from munitions clearance, and hence will be moderate.

The release of sediment from seabed intervention and the generation of underwater noise from munitions clearance may extend across national borders into Estonia (from activities in both Finland and Russia) as well as from Finland into Russia, and vice versa. The potential for such impacts is considered in Chapter 15 – Transboundary impacts.

**Table 10-43 Overall project assessment and country-specific impact ranking and potential for transboundary impacts for harbour porpoises (sources of impacts represented with '-' have not been assessed). Assessments have been undertaken at the population level with mitigation in place.**

Harbour porpoise	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column							Yes
Generation of underwater noise due to munitions clearance – Blast injury				-	-	-	Yes
Generation of underwater noise due to munitions clearance – PTS				-	-	-	Yes
Generation of underwater noise due to munitions clearance – TTS/Avoidance reactions				-	-	-	Yes
Generation of underwater noise due to munitions clearance – Masking				-	-	-	Yes
Generation of underwater noise due to munitions clearance – Behavioural response				-	-	-	Yes
Generation of underwater noise due to rock placement and other construction related activities including presence of vessels – TTS/Avoidance reactions							Yes
Impact ranking:	Negligible		Minor	Moderate	Major		

**Table 10-44 Overall project assessment and country-specific impact ranking and potential for transboundary impacts for grey seal (sources of impacts represented with '-' have not been assessed). Assessments have been undertaken at the population level with mitigation in place.**

Grey seal	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column							Yes
Generation of underwater noise due to munitions clearance – Blast injury)		*	*	-	-	-	Yes
Generation of underwater noise due to munitions clearance – PTS				-	-	-	Yes
Generation of underwater noise due to munitions clearance – TTS/Avoidance reactions				-	-	-	Yes
Generation of underwater noise due to munitions clearance – Masking				-	-	-	Yes
Generation of underwater				-	-	-	Yes

noise due to munitions clearance – Behavioural response							
Generation of underwater noise due to rock placement and other construction related activities including presence of vessels – TTS/Avoidance reactions							Yes
Impact ranking:	Negligible		Minor		Moderate		Major
* moderate at individual level.							

**Table 10-45 Overall project assessment and country-specific impact ranking and potential for transboundary impacts for ringed seal (sources of impacts represented with '-' have not been assessed. Assessments have been undertaken at the population level *with* mitigation in place. Ringed seal populations are not present in SE, DK and GE within project area.**

Ringed seal	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column				-	-	-	Yes
Generation of underwater noise due to munitions clearance – Blast injury			*	-	-	-	Yes
Generation of underwater noise due to munitions clearance – PTS			*	-	-	-	Yes
Generation of underwater noise due to munitions clearance – TTS/Avoidance reactions				-	-	-	Yes
Generation of underwater noise due to munitions clearance – Masking				-	-	-	Yes
Generation of underwater noise due to munitions clearance – Behavioural response				-	-	-	Yes
Generation of underwater noise due to rock placement and other construction related activities including presence of vessels – TTS/Avoidance reactions				-	-	-	Yes
Impact ranking:	Negligible		Minor		Moderate		Major
*minor at M4-Finland.							

#### 10.6.4.4 Annex IV species

The harbour porpoise is listed on Annex IV of the Habitats Directive. The impact assessment therefore needs to determine whether any of the pressures resulting from NSP2 may lead to a violation of the objectives of Article 12 of the Directive, notably through the deliberate capture or

killing of specimens (including injury) of this species or through their deliberate disturbance or deterioration of their breeding sites.

NSP2 activities during seabed preparation, construction and operation will not intentionally cause impacts on harbour porpoises. During munitions clearance, impacts on the hearing of few individuals may occur in the M3-area in Finland (Figure 10-2), but this will not have an influence on the ecological functionality of the species, as the key areas where this species occurs are outside the M3-area in Finland (see Section 9.6.4). In addition, mitigation measures will be applied which reduce the risk of harbour porpoise injury.

In conclusion, NSP2 will not be in conflict with the Habitats Directive, Article 12.

### 10.6.5 Birds

Five potential sources of impacts on birds are identified in Table 8-2. Of these, two can be scoped out from further consideration, as outlined in Table 10-46.

**Table 10-46 Potential sources of impact scoped out for birds.**

Potential source of impact	Potential impact	Justification
Release of contaminants and nutrients to the water column (construction)	<ul style="list-style-type: none"> <li>Accumulation of contaminants caused by the mobilisation of contaminants from the sediment into the food chain (secondary impact)</li> </ul>	As outlined in Section 10.1, the released amounts of contaminants, incl. CWAs, are insignificant compared to the annual amounts entering the Baltic Sea and Baltic Proper. In addition, the nutrient contribution is also insignificant compared to the annual nutrient load (Sections 9.2.2.5 and 10.1). Of the released contaminants, approximately 10% will become bioavailable /260/, /261/, /262/ and the PNEC values are predicted to be only slightly exceeded for a few contaminants and only for a short duration or over a very small area (Appendix 3). Additionally, no significant impacts are expected on the food sources (benthic communities and fish). An impact from contaminants on birds is therefore not likely to occur.
Presence of pipeline structures (operation)	<ul style="list-style-type: none"> <li>Reduced food availability due to the loss of a food source in footprint area;</li> <li>Additional food resources on the pipeline</li> </ul>	Impacts would indirectly result from those on food source on which birds forage. As impacts on benthic communities (food source) will be not significant in most areas, though moderate impact ranking will occur very locally in German waters (Section 10.6.2.4).

The following sources of impacts have thus been assessed and are reported below:

- Release of sediment to the water column (construction);
- Generation of underwater noise (construction);
- Presence of vessels (construction).

#### 10.6.5.1 Release of sediment to the water column (construction)

Activities with the potential to release sediment to the water column in areas where birds may be present are the same as those identified in Section 10.6.1.1. They may impact birds by:

- Reducing feeding efficiency by decreasing water transparency;
- Reducing food availability due to prey avoidance.

### Assessment of potential impacts

The optical properties of the water are crucial for the foraging efficiency of visually hunting aquatic animals, including sea- and waterbirds. Thus, decreased visibility may negatively affect the foraging conditions for sea- and waterbirds. The vulnerability to such releases of sediment will depend on the species and their foraging strategy. Surface feeders such as gulls are not very vulnerable to decreased water transparency as they do not pursue diving behaviour. On the other hand plunge divers (terns), pursuit divers (divers, grebes, mergansers, cormorants and auks), bottom feeders (sea ducks, diving ducks) and herbivorous species (species associated with terrestrial habitats such as swans, geese, dabbling ducks and coots) are more vulnerable as they use visibility more as they forage by diving. The overall vulnerability is considered medium. SSCs below 15 mg/l are regarded as having no effect on diving seabirds such as common scoter, long-tailed duck, razorbill and guillemots /243/. An exceedance of this level is unlikely to result from NSP2 activities except in highly localised areas for short durations. Hence the overall sensitivity of birds to releases of sediment to the water column by NSP2 is considered medium irrespective of the importance of the species.

In addition to direct impacts on birds from increased SSCs described above, such increases may also indirectly impact birds by affecting prey species availability, notably by clogging their respiratory or feeding apparatuses or by resulting in the avoidance of areas by mobile bird prey species such as fish due to increased turbidity. When suspended sediments re-settle, burial of food resources (in- and epifauna species) may result, also affecting the availability of prey species to birds. The assessment of the impact on the benthic fauna and fish (Sections 10.6.2 and 10.6.3, respectively), however, assessed that such species will not be affected by increases in SSCs, so that indirect impacts on birds due reduced benthic and prey availability will not occur.

Offshore, changes in SSCs, notably in the vicinity of post-lay trenching and rock placement activities, may temporarily change water transparency. The modelled increases in SSCs and the duration and spatial extent over which these increases will occur are summarised in Table 10.5 and Section 2.1.1 in Appendix 3. This indicates that increases in SSCs will generally be restricted to the areas near the pipeline and that the maximum duration for which increases of more than 15 mg/l will be experienced at any location will be 14 hours.

The increases in SSCs will be higher and last longer in shallow waters near the two landfall areas where dredging will occur and where the density of birds is higher. As described in Section 10.6.1.1, although detectable changes in SSCs are predicted, these will be of both short duration and limited spatial extent (with the highest concentrations being restricted to the immediate vicinity of the activities giving rise to the sediment releases) and the total SSCs will generally remain within natural variations, as experienced during e.g. storm events.

The modelling results for the Russian landfall, which are summarised in Table 10.5 and Figure 2-14 in Appendix 3, indicate that a total area of up to 215 km<sup>2</sup> may at some point in time during the entire dredging period experience increases of more than 15 mg/l SSCs. However, the area affected at any single point in time will be much smaller. The predicted maximum duration of any increase of more than 15 mg/l at a single location will be 345 hours over the entire dredging period of approximately 37 days, and will be limited to an area of 0.08 km<sup>2</sup>. Exceedances outside this area will be of much shorter duration (Appendix 3), with the majority of the areas with concentrations above 15 mg/l experiencing this for less than 72 hours. Modelling results indicate that any increases in SSCs above 15 mg/l in Estonia, should they occur, will only be in very small areas very close to shore and for less than 72 hours (this may even be a model artefact).

In Germany, as outlined in Section 10.6.1.1, SSCs are expected to be as monitored during dredging associated with construction of NSP, which indicated that levels above the German threshold value of 50 mg/l were never exceeded for more than 24 hours at any location. Although the maximum SSCs did at limited times reach 100-150 mg/l in the immediate vicinity of the dredgers, beyond 500 m from the dredging activity they never reached the natural variation

of SSC of 60 mg/l experienced during rough weather (Section 9.2.1). In close proximity to dredging activity, they more typically varied from 10-30 mg/l, while those in the wider surroundings were typically 10-20 mg/l. In addition, in German nearshore areas, dredging and backfilling will take place outside the wintering and main staging season of most sea- and waterbirds. The potential impacts on great cormorant and terns are minor.

Due to the limited spatial extent, short duration and timing of the activities, any increases in SSC above 15 mg/l that might occur will be of negligible impact magnitude where there are generally few birds to low impact magnitude where there are higher concentrations of birds, including those associated with several IBAs, and hence the likelihood of exposure to increased sediment is therefore greater. When combined with the medium sensitivity to the release of sediments, this results in a **negligible to minor** impact ranking, which is therefore not significant.

These predictions are supported by the experience gained by monitoring of birds in Russian and German waters during the construction and operation of NSP, which included areas of importance for wintering and migrating birds and showed no overall negative impact on waterbirds in these areas.

Owing to the short duration and limited spatial extent of any exceedances of 15 mg/l SSCs that could occur in Estonian waters, the magnitude and hence impact ranking of any transboundary impact on birds in such areas is negligible and therefore not significant.

#### 10.6.5.2 Generation of underwater noise (construction)

As identified in Sections 10.1 and 10.6.4.2, underwater noise can arise from a range of NSP2 construction activities, with munitions clearance being by far the loudest such activity and the only one with the potential to affect birds. This can potentially have an impact on diving water birds through:

- Injury or death.

As munitions clearance will only take place in the Gulf of Finland, the potential for such impacts will only apply to birds in this area.

#### Assessment of potential impacts

Knowledge of underwater hearing in diving birds is sparse and in general, birds are not considered sensitive to noise due to their mobile nature and ability to relocate from areas subject to changes in noise levels. In addition, they are able to regenerate cells in the inner ear so potential impacts on their hearing are considered temporary. Previous studies indicate no physical damage or behavioural response in birds foraging close to seismic activities, which generate very high levels of underwater noise /295/ and that the threshold for low probability of trivial lung injuries and no eardrum rupture is 187 SEL, dB re. 1  $\mu\text{Pa}^2\text{s}$  and for mortality it is 198 SEL, dB re. 1  $\mu\text{Pa}^2\text{s}$  /294/.

The vulnerability of birds that might be present in the areas where munitions detonation will occur is high due to the risk of injury or death. The sensitivity to impact will thus range from low for offshore species (which generally have a low importance) and medium for species in nearshore areas (due their higher conservation status (Section 9.6.5.3)).

Underwater noise modelling of munitions detonation scenarios did not specifically predict site specific distances at which noise thresholds for impacts on birds would occur (as was undertaken for fish (Section 10.6.3) and marine mammals (Section 10.6.4)). However, a generic calculation of noise propagation for a representative scenario of munitions detonation at 10 m depth (the typical diving depths at which sea- and waterbirds primarily dominate and forage) indicates that the distance from the detonation point within which noise levels may exceed the threshold for

bird mortality is approximately 150 m and for physical injury is 2 km (maximum, corresponding to a large munitions size) and 400–500 m (average munitions size).

The magnitude of the impact is linked to the concentration of birds within the areas where thresholds may be exceeded in the Gulf of Finland and in Russian offshore waters where munitions clearance for NSP2 will take place. In offshore waters deeper than 20 m, the concentration of birds is low; hence, any exceedance of the threshold is only likely to affect a few individuals.

In Russia within more shallow areas, the concentrations of birds are significantly higher, resulting in an increased risk of impacting birds, many of which are recognised as of conservation importance (Section 9.6.5.3).

The minimum distance from any of the munitions clearance sites to IBA sites in the Gulf of Finland is 7.3 km (Kurgalsky Peninsula, Section 9.6.5.2), so no impacts are anticipated on species associated with such sites. The Malayi Tyuters Island in Russia, which supports nesting birds and stop-over sites (Section 9.6.5.2) is situated 3-4 km from the NSP2 route. It is thus possible that, depending on the specific locations of the munitions to be cleared, underwater noise from their detonation may potentially impact diving birds in these areas.

The incorporation of mitigation measures to be applied during munitions clearance, including the use of observers to check for the presence of marine diving seabirds (such as sea-ducks and auks) and delaying detonation if they are observed in the area (Chapter 16 – Mitigation measures) will ensure that only a few, if any, individuals will be subject to noise related impacts at any location. The magnitude of the impact will thus be low, which when combined with the sensitivities of diving bird species results in an impact ranking that is **negligible** in open waters and **minor** in shallow waters close to the Russian landfall.

This assessment is supported by the results of monitoring of NSP munitions clearance, during which no seabird injuries or mortalities were observed.

There are no identified IBAs or bird colonies in Estonian waters close to pipeline within the Gulf of Finland (Figure 9-10), and the closest point of NSP2 to the Estonian border is 1.5 km from any potential detonation site, i.e. within the distance at which some underwater noise disturbance on birds may occur. There are, however, no IBAs within this area. No transboundary impacts on birds in Estonia from underwater noise are therefore predicted.

Should detonation of munitions be required in the western part of Russian waters within 2 km of the border with Finland, exceedances of the noise level thresholds for impact on birds could be experienced across the border into Finland. A similar situation would arise should detonation be required in the eastern part of Finnish waters, with thresholds being exceeded in Russian waters. As there are no IBA sites in these areas and, as identified above, in offshore waters deeper than 20 m the concentration of birds is low, any exceedance of thresholds that would occur is only likely to affect a few individuals. This combined with the low likelihood for munitions to be present in such a limited area and the use of observers to check for the presence of birds prior to detonation mean that the magnitude of any transboundary impact would at most be **negligible**.

### 10.6.5.3 Presence of vessels (construction)

Movement, noise and light generation from vessels undertaking a range of construction activities including seabed preparation, seabed intervention works (dredging, trenching, rock placement) and pipe-laying have potential to impact birds through:

- Disturbance of nesting birds;
- Avoidance behaviour by seabirds due to disturbance.

### Assessment of potential impacts

Disturbance at sea is especially relevant with regards to the visual presence of moving vessels which, in combination with light and noise emissions, may disturb birds and cause them to move from their resting and/or foraging area, impacting the birds by causing energy loss. Studies have shown that faster moving vessels cause a larger disturbance and a shorter flush distance than slower moving vessels /295/, /296/. The specific flush distance (the distance at which a species begins to react in the face of approaching danger) differs greatly between species. Flush distances have been published for a number of bird species relevant to the project area, which give an indication of the spatial impact zone:

- Long-tailed duck: flush distance from ships up to 400 m away /295/, /296/;
- Velvet scoter: flush distance up to 1,000 m /296/;
- Common scoter: flush/effect distance up to 3,000 m away /295/, /296/;
- Common guillemot: flush distance from ships up to hundreds of meters away /297/, /298/;
- Black guillemot: flush distance from ships up to hundreds of meters away /297/, /298/;
- Razorbill: flush distance from ships up to hundreds of meters away /298/;
- Red- and black-throated diver: flush distance up to 1,000 m away /295/, /296/, /299/;
- Common goldeneye: flush distance from ships between 500 – 1,000 m away /299/.

The vulnerability to disturbance depends on the species and their response to disturbance as described above, as well as the seasonality and the timing of the activity giving rise to the impact (notably if the impact occurs in areas where birds are breeding, moulting, or resting). In general, areas with moulting birds are highly sensitive, with most moulting seabirds unable to fly during the period of July to September.

The vulnerability to disturbance is in general considered high, but as only a few bird species use the more open and deeper parts of the Baltic Sea and their abundance is very low, when combined with the high vulnerability, this results in a negligible impact magnitude for disturbance from vessel presence in these offshore areas. The impact ranking is therefore assessed as **negligible**.

In sharp contrast to this, the shallow offshore banks of Sweden and Germany (in the winter period) and in the landfall areas in Germany and Russia hold high numbers of bird species (wintering and breeding species), some of which are protected under the EU Birds Directive and/or are on international or regional Red Lists. Notably, NSP2 will pass through three important bird areas (IBA areas - see Section 9.6.5.1 and Atlas Map BI 01-Espoo): Southern Midsjö Bank (Sweden), Pomeranian Bay and Greifswalder Bodden (Germany), and close to Hoburgs Bank and Northern Midsjö Bank (Sweden) and Rønne Bank (Denmark). In addition, Kurgalsky Peninsula IBA is situated approximately seven km from NSP2.

The vulnerability of birds in nearshore areas and IBAs therefore ranges from medium to high, which, when combined with their range of conservation importance, results in a sensitivity to disturbance from vessels that also ranges from medium to high depending on the species.

Based on their flush distances and sensitivity, it is concluded that impacts on birds associated with disturbances from the presence of vessels will in general be limited to a 1-2 km radius around the working area. The impact magnitude will especially depend on the season.

#### *Russian landfall*

The only moulting area identified in proximity to the NSP2 route is within the Kurgalsky Peninsula IBA. However, surveys conducted for NSP2 indicate that the parts of this reserve close the nearshore Russian landfall area do not support important numbers of seabirds, with the main concentrations occurring to the north of the landfall. At the Russian landfall, the pipeline route will thus avoid the main breeding, migration and moulting areas within the Kurgalsky Peninsula.



Vessels will be present in the nearshore area of the landfall for a longer period than elsewhere on the route, as dredging will take a maximum of 37<sup>33</sup> days. Assuming that disturbance of birds occurs within 1-2 km of project vessels and there is no habituation by birds to vessels, this will potentially exclude birds from an area (based on the distance of the dredging area) of 314 – 628 ha over the course of the dredging programme. This represents approximately 1-2% of the marine area of the Ramsar site (Section 10.6.7) but does not include any of the IBA or the main areas used for moulting. Disturbance from the presence of vessels on birds will thus be limited in extent and unlikely to affect the functioning of populations. The impact is therefore considered to be of negligible to low magnitude. When combined with the medium to high sensitivity ranking, this results in a **minor** impact ranking (moderate is not likely to occur).

As all Estonian IBAs are more than 2 km away, transboundary impacts on Estonia are not likely to occur from the presence of vessels.

#### *Sweden*

Long-tailed duck and black guillemot, which are the main species in the Midsjö Bank IBAs in Sweden, do not moult at that site /300/. However, as the flush distance is up to a maximum of 1 km for these species, foraging and resting birds might be disturbed. An international shipping lane with high traffic intensity runs east of Hoburgs Bank and between Northern and Southern Midsjö Bank. The levels of noise and visual disturbance from pipe-laying will be similar to those associated with ships using these channels such that the birds in these areas are therefore likely to be adapted to the presence of vessels, resulting in a low sensitivity to impact from NSP2. Further, since offshore construction activities have a short duration at any location (typically progressing at 2-3 km day), disturbance at any particular location will generally be less than 24 hours, so that the magnitude of the impact is predicted to be negligible, resulting in a **negligible** impact ranking.

Monitoring during NSP construction in these areas confirms the predictions that birds at such locations are not likely to be significantly disturbed by pipe-laying activities.

#### *German shallow water and landfall*

Within the Pomeranian Bay, pipe-laying is planned to take place in the period from September to December, which is outside the main staging and wintering periods of sea- and waterbirds. Furthermore, the NSP2 routing will avoid the core habitats present within the Natura 2000 sites for sea ducks and grebes, i.e. the Oderbank and Adlergrund (areas within Pomeranian Bay). It will, however, pass close to an important moulting area for the common scoter, but as the timing of the construction is planned to begin at the end of the moulting period, this will limit the impact on such species during this sensitive period.

In the Greifswalder Bodden Natura 2000 site, due to dredging activities, construction will last longer than in offshore areas and will thus overlap in late autumn with the presence of various sea- and waterbirds, but will not take place during the wintering and spring staging period, when the area holds the highest bird densities and is most sensitive to disturbance. It will locally and temporarily reduce the densities of birds. Altogether, the impact magnitude will therefore be low.

The locations for pipe-laying as well as the transport routes for pipes from Mukran to the pipe-laying vessel and for sediment to and from the sediment storage sites are all currently subject to regular shipping activities and supply ships will navigate predominantly inside these existing, intensively used shipping routes. For this reason, the number of birds actually displaced will be limited.

This assessment is supported by the monitoring results from NSP in German waters, which showed that in general there was no impact on sea- and waterbirds caused by disturbance from

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<sup>33</sup> The dredging modelling scenario is assumed to be carried out during an 18 hour work day. Based on a worst case scenario, dredging is likely to last 37 days over a 60 day period.

the presence of vessels. Some disturbance was, however, recorded on resting birds in the Pomeranian Bay, although the levels were low compared those associated with commercial ship traffic.

Based on the above analysis, the overall project impact on birds from vessel disturbance is assessed to have a **minor** impact ranking largely due to the potential for some impacts on species of conservation importance at the landfall areas.

#### 10.6.5.4 Summary and ranking of potential impacts on birds

A summary of the overall project impact rankings for birds arising from the potential sources of impact scoped into the assessment is provided in Table 10-47, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Owing to the ranking levels and different nature of the impacts associated with each of the sources of impact considered above, there is limited potential for “in-combination” impacts on birds from them. The ranking of impact on this receptor group resulting from all sources of impact is therefore likely to be minor, largely due to generation of noise in the Gulf of Finland and short-term increases in SSCs close to the dredging sites in Germany and Russia.

Although the release of sediment to the water column may extend across national borders, any resultant increase in SSC is insufficient to affect birds and hence no significant transboundary impacts are anticipated from this source. Although noise levels in exceedance of the threshold that disturbs birds may extend into a very limited part of Estonia, this affected area does not overlap with areas of importance to birds. No transboundary impacts are predicted.

**Table 10-47 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with ‘-’ have not been assessed).**

Birds	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column							No
Generation of underwater noise				-	-	-	No
Presence of vessels							No
Impact ranking:	Negligible		Minor		Moderate		Major

#### 10.6.6 Natura 2000 sites

The potential for NSP2 to impact Natura 2000 sites has been addressed in the national EIAs/ES through consideration of the likelihood for changes to occur on designated habitats and species within these areas and whether these could potentially result in significant impacts. The results have been recorded either through a general assessment within the EIAs/ES or as a separate Natura 2000 Screening Report. An initial review identified that 32 existing sites and a further four proposed sites required such consideration.

The NSP2 route crosses five marine Natura 2000 sites and passes within 6 km of a further three within German territorial waters, as well as within 1.9 km of one such site in Finnish waters. These are (Table 9-9):

- SAC FI0100106: Sandkallanin eteläpuolinen merialue (Finland)/301/;
- SCI DE1652301: Pommersche Bucht mit Oderbank (Germany) /302/;
- SCI DE1251301: Adlergrund (Germany) /303/;
- SPA DE1552401: Pommersche Bucht (Germany) /304/;

- SCI DE1747301: Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom (Germany) /305/;
- SCI DE1749302: Greifswalder Boddenrandschwelle und Teile der Pommersche Bucht (Germany) /306/;
- SCI DE1648302: Küstenlandschaft Südostrügen (Germany)/307/;
- SPA DE1649401: Westliche Pommersche Bucht (Germany)/308/;
- SPA DE1747402: Greifswalder Bodden und südlicher Strelasund (Germany)/309/;
- SAC EE0070128: Struuga (Estonia)/310/;
- SAC EE0060220: Uhtju (Estonia)/310/;
- SPA EE0060270: Vaindloo (Estonia)/310/;
- SAC PLH990002: Ostoja na Zatoce pomorskiej (Poland)/311/;
- SPA PLB990003: Zatoka Pomorska (Poland)/311/.

In order to comply with the relevant national requirements, separate Natura 2000 Screening Reports were prepared for these based on the methodology given in the Habitats Directive (which requires a determination, supported by evidence, of whether or not there may be the potential for significant impacts on such sites as a result of the construction and operation of NSP2). The other 24 *existing* Natura 2000 sites were subject to similar assessments, reported within the national EIAs/ES. A summary of the conclusions from both the general assessments reported in the national EIAs/ES and the separate Natura 2000 Screening Reports is provided in Table 10-48.

These studies concluded that for the existing Natura 2000 sites, the only sites where there may be potential for significantly impact from NSP2 are those which have marine mammals as the designation basis (see Table 10-48) and which could be affected by underwater noise from munitions clearance (i.e. restricted to those in the Gulf of Finland).

Underwater noise modelling for munitions clearance showed that marine mammals occurring in the impact area may experience either temporary (TTS) or permanent (PTS) hearing loss if munitions clearance would be carried out without additional mitigation measures. Additionally, in the worst case scenario (maximum underwater sound exposure levels, Section 10.6.4.2), the modelling shows that there is a risk that the PTS and TTS areas would reach protected areas with seals as a protection objective.

The only Natura 2000 site which can be impacted by PTS zones is the “Kallbådan Islets and Waters” site (8.1 km from the nearest point of the pipeline), which is designated for grey seal and includes the Kallbådan seal sanctuary (6.8 km) in Finland. For precautionary reasons, it is assessed that the impact on Natura 2000 sites with seals as designated species corresponds to the risk that any individual of seal species would experience PTS. At the population level, the sensitivity of grey seals is assessed to be low, because the population abundance is increasing and population has good environmental status (Section 10.6.4.2). Based on this approach (as documented in Section 10.6.4.2), a moderate impact ranking due to onset of permanent hearing loss in this species cannot currently be ruled out at this Natura 2000 site. In writing this Espoo Report (and the Finnish EIA), detailed information about the location and features of munitions on the seabed was not available. The Natura 2000 Appropriate Assessment for the “Kallbådan Islets and Waters” Natura site will be carried out in accordance with the requirements of the Habitats Directive /312/ after receiving the detailed information on observed munitions (location, characteristics) to be cleared.

Based on the results of underwater noise modelling, five other Natura 2000 sites with seals as a conservation objective could be reached by the TTS zone (Section 10.6.4.2). Natura sites potentially reached by TTS in the worst case scenario (maximum underwater sound exposure levels) include Söderskär and Långören Archipelago (12.5 km from the NSP2 route), Pernaja Bay and Pernaja Archipelago (13.1 km) and Tammisaari and Hanko Archipelago, Pohjanpitäjänlahti MPA (17.8 km) and Itäisen Suomenlahden saaristo ja vedet (23.5 km) Natura sites in Finnish waters and Uhtju (25 km) in Estonian waters. The overall impact ranking for TTS in seals has

been assessed to be **minor** (Section 10.6.4.2), therefore the underwater noise impact significance for the above-mentioned sites is assessed not to be significant.

Screening of the potential for significant impacts on proposed Natura 2000 sites in Sweden (Kiviksbredan (no number), Section 9.6.6) concluded that there is no potential for significant impacts on proposed sites from NSP2.

The Swedish site SPA/SCI SE0330380: Hoburgs Bank and Midsjöbankarna was proposed for designation (due to the presence of harbour porpoises, birds and habitats) by the Swedish authorities in December 2016 /313/. The area is crossed by NSP2 and has been subject to a supplementary assessment, which identified that there would be no significant impact on the site. The report documenting the assessment was submitted as part of the application supplement to the Swedish authorities in February 2017 **Error! Reference source not found.**

As Natura 2000 is a network of protected sites, it is important to address whether the project will have an impact on the overall functioning of the Natura 2000 network, with potentially transboundary implications. Based on the screening assessment undertaken to date, it is considered that there is a limited potential for such an occurrence. However, following the Appropriate Assessment that will be undertaken for the one site identified above, the results of that assessments will be reviewed to evaluate whether any potential for significant effects described in it could also affect the wider network functioning. Should this have any transboundary implications, these will be specifically highlighted.

**Table 10-48 Summary of impacts on marine Natura 2000 sites within the vicinity of NSP2 presented from east to west. Summaries are based on the national EIAs/ES and separate Natura 2000 screenings (where undertaken). For details on the main features/reason for designation see Table 9-17.**

Natura 2000 site SPA/SCI/SAC	Di-stance (km)	Reason for designation	Potential for significant impact	Rationale for evaluation of potential for significant impact cause
<b>Finland</b>				
SPA/SAC FI0408001: Itäisen Suomenlahden saaristo ja vedet (Eastern Gulf of Finland archipelago and waters)	23.5	Grey seal, ringed seal, birds and habitats	No significant impacts	Risk of TTS from munitions clearance in Russia. Activities are not likely to have significant impacts on seals (maximum munitions model scenario) (Section 10.1, Section 10.6.4.2, Appendix 3).
SAC FI0400001: Länsiletto alue (Länsiletto area)	26.9	Habitats <sup>34</sup>	No significant impacts	There will be no impacts on habitats due to the distance of NSP2 to the site (Section 10.1 and Appendix 3).
SAC FI0400002: Luodematalat	18.0	Habitats	No significant impacts	There will be no impacts on habitats due to the distance of NSP2 to the site (Section 10.1 and Appendix 3).
SPA/SAC FI0100078: Pernajanlahtien ja Pernajan saariston	13.1	Grey seal, ringed seal, birds and habitats	No significant impacts	Risk of TTS from munitions clearance in Finland. Activities are not likely to have significant impacts on seals (maximum

<sup>34</sup> Habitats refer to the designated habitats from Annex 1, such as Reefs, Sandbanks, Coastal lagoons etc.

Natura 2000 site SPA/SCI/SAC	Di-stance (km)	Reason for designation	Potential for significant impact	Rationale for evaluation of potential for significant impact cause
merensuojelualue (Pernaja and Pernaja archipelago)				munitions model scenario) (Section 10.1, Section 10.6.4.2 and Appendix 3).
SPA/SAC FI0100077: Söderskärin ja Långörenin saaristo (Söderskär and Långören archipelago)	12.5	Grey seal, birds and habitats	No significant impacts	Risk of TTS from munitions clearance in Finland. Activities are not likely to have significant impacts on seals (maximum munitions model scenario) (Section 10.1, Section 10.6.4.2, Appendix 3).
SAC FI0100106: Sandkallanin eteläpuolinen merialue (The sea area South of Sandkallan)	1.9	Habitats	No significant impacts	Sediment modelling shows that sediment spill is not likely to have a significant impact on habitats (Sections 10.1, Section 10.2.1 and Appendix 3).
SPA FI0100105: Kirkkonummen saaristo (Kirkkonummi archipelago)	13.0	Birds	No significant impacts	There will be no impacts on birds due to the distance of NSP2 to the site (Section 10.1, Section 10.6.5 and Appendix 3).
SAC FI0100026: Kirkkonummi saaristo (Kirkkonummi archipelago)	13.0	Habitats	No significant impacts	There will be no impacts on habitats due to the distance of NSP2 to the site (Section 10.1 and Appendix 3).
SAC FI0100089: Kallbådanin luodot ja vesialue (Kalbådans islets and waters)	8.1-9.8	Grey seal	Significant impacts cannot be ruled out	Risk of PTS from munitions clearance- in Finland (maximum scenario without mitigation) (Section 10.1, Section 10.6.4.2 and Appendix 3).
SPA/SAC FI0100017: Inkoo saaristo (Inkoo archipelago)	16.5 -18.8	Birds and habitats	No significant impacts	There will be no impacts on birds or habitats due to the distance of NSP2 to the site (Sections 10.1, Section 10.6.5 and Appendix 3).
SPA/SAC FI0100005: Tammisaaren ja Hangon saariston ja Pohjanpitäjänlahden merensuojelualue (Tammisaari and Hanko archipelago and Pohjanpitäjänlahti MPA)	17.8	Grey seal, birds and habitats	No significant impacts	Risk of TTS from munitions clearance in Finland. Activities are not likely to have significant impacts on seals (maximum munitions model scenario) (Section 10.1, Section 10.6.4.2 and Appendix 3).
SAC FI0100107: Hangon itäinen selkä (The Hanko Eastern offshore area)	13.7	Habitats	No significant impacts	There will be no impacts on habitats due to the distance of NSP2 to the site (Section 10.1 and Appendix 3).
SAC FI0200090:	27.4	Grey seal,	No significant	There will be no impact on species

Natura 2000 site SPA/SCI/SAC	Di-stance (km)	Reason for designation	Potential for significant impact	Rationale for evaluation of potential for significant impact cause
Saaristomeri		ringed seal, habitats and Eurasian otter	impacts	or habitats due to the distance from NSP2 (Sections 10.1, Section 10.6.4 and Appendix 3).
<b>Sweden</b>				
SAC SE0340097: Gotska Sandön-Salvoren	25	Grey seal and habitats	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Sections 10.1, Section 10.6.4 and Appendix 3).
SPA/SAC SE0340144: Hoburgs Bank	5	Harbour porpoise, birds and habitats	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Sections 10.1, 10.6.4, and 10.6.5 and Appendix 3).
SPA/SAC SE0330273: Norra Midsjöbank (Northern Midsjö Bank)	4	Harbour porpoise, birds and habitats	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Section 10.6.4, Section 10.6.5 Section 10.1 and Appendix 3).
<b>Denmark</b>				
SPA/SAC 007X079: Ertholmene	13	Grey seal, birds and habitats	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Sections 10.1, 10.6.4 and 10.6.5 and Appendix 3).
SAC DK00VA310: Bakkebrædt og Bakkegrund	17	Habitats	No significant impacts	There will be no impacts on habitats due to the distance from NSP2 to site (Section 10.1 and Appendix 3).
SCI DK00VA261: Adler Grund og Rønne Banke	16	Habitats	No significant impacts	There will be no impacts on habitats due to the distance from NSP2 to site (Section 10.1 and Appendix 3).
<b>Germany</b>				
SCI DE1251301: Adlergrund	6.2	Harbour porpoise, grey seal and habitats	No significant impacts	No significant impacts on marine mammals anticipated outside the Gulf of Finland (Section 10.1, Section 10.6.4 and Appendix 3). Significant impacts on habitats have been assessed as not significant (Sections 10.1 and 10.2.1 and Appendix 3).
SPA DE1552401: Pommersche Bucht	Crossing (by 31.1)	Birds and habitats	No significant impacts	Impacts on birds and their habitat have been assessed as not significant (Section 10.6.5). Impacts on habitats have been assessed as not significant (Sections 10.1 and 10.2.1 and Appendix 3).
SCI DE1652301: Pommersche Bucht mit Oderbank	2	Harbour porpoise and habitats	No significant impacts	No significant impacts on marine mammals anticipated outside the Gulf of Finland (Section 10.6.4). Impacts on habitats have been assessed as not significant

Natura 2000 site SPA/SCI/SAC	Di-stance (km)	Reason for designation	Potential for significant impact	Rationale for evaluation of potential for significant impact cause
				(Sections 10.1 and 10.2.1 and Appendix 3).
SPA DE1649401: Westliche Pommersche Bucht	Crossing (by 28.5)	Birds	No significant impacts	Impacts on birds and their habitats have been assessed as not significant (Section 10.6.5).
SCI DE1749302: Greifswalder Boddenrandschwelle und Teile der Pommersche Bucht	Crossing (by 36.4)	Harbour porpoise, grey seal, harbour seal, birds and habitats	No significant impacts	No significant impacts on marine mammals anticipated outside the Gulf of Finland (Section 10.6.4). Impacts on birds and their habitats have been assessed as not significant (Section 10.6.5). Impacts on habitats have been assessed as not significant (Sections 10.1 and 10.2.1 and Appendix 3).
SPA DE1747402: Greifswalder Bodden und südlicher Strelasund	Crossing (by 24.6)	Birds	No significant impacts	Impacts on birds and their habitats have been assessed as not significant (Section 10.6.5).
SCI DE1747301: Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom	Crossing (by 16.7)	Harbour porpoise, grey seal, harbour seal, Eurasian otter, fish and habitats	No significant impacts	No significant impacts on marine mammals anticipated outside the Gulf of Finland (Section 10.6.4), including for otters, which potentially could use marine areas. Impacts on fish have been assessed as not significant (Section 10.6.3). Impacts on birds and their habitats have been assessed as not significant. Impacts on habitats have been assessed as not significant (Sections 10.1 and 10.2.1 and Appendix 3).
SCI DE1648302: Küstenlandschaft Südostrügen	1.5	Harbour porpoise, grey seal, Eurasian otter and habitats	No significant impacts	No significant impacts on marine mammals anticipated outside the Gulf of Finland (Section 10.6.4), including for otters, which potentially could use marine areas. Impacts on birds and their habitats have been assessed as not significant (Section 10.6.5). Impacts on habitats have been assessed as not significant (Sections 10.1 and 10.2.1 and Appendix 3).
<b>Estonia</b>				
SAC EE0070128: Struuga	19	Eurasian otter and fish	No significant impacts	Although this site extends to the Narva River, immediately south of the Narva Bay landfall site, seawater cannot enter against the flow direction, so the river habitat

Natura 2000 site SPA/SCI/SAC	Di-stance (km)	Reason for designation	Potential for significant impact	Rationale for evaluation of potential for significant impact cause
				and species cannot be affected by any change in seawater quality that may result from dredging at the landfall site. There will be no impact on species or habitats due to NSP2 (Section 10.1 and Appendix 3).
SAC EE0060220: Uhtju	25	Grey seal, ringed seal and habitats	No significant impacts	Risk of TTS from munitions clearance in Estonia. Impacts are not likely to have significant impacts on seals (maximum munitions model scenario) (Sections 10.1 and 10.6.4 and Appendix 3).
SPA EE0060270: Vaindloo	18	Birds	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Sections 10.1 and 10.6.5 and Appendix 3).
<b>Poland</b>				
SAC PLH990002: Ostoja na Zatoce pomorskiej	22	Harbour porpoise, fish and habitats	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Sections 10.1, 10.6.3 and 10.6.4 and Appendix 3).
SPA PLB990003: Zatoka Pomorska	22	Birds and habitats	No significant impacts	There will be no impact on species or habitats due to the distance from NSP2 (Sections 10.1, 10.6.4 and 10.6.5 and Appendix 3).

### 10.6.7 Other protected areas

The potential for NSP2 to impact protected areas (in addition to the Natura 2000 sites, reported in Section 10.6.6) has been assessed in the various national EIAs/ES. While the approach adopted has varied slightly between countries, all assessments have considered how the various sources of impact identified in Chapter 8 – Environmental impact identification could affect the features for which the sites were designated and/or their integrity. The sites considered were identified based on the features present (species, habitat type, etc.) and the spatial extents of the potential sources of impacts that could affect such features, adopting a precautionary approach. Many of these sites overlap with Natura 2000 sites and, where this is the case, the assessment has also been informed by the relevant screening process reported in Section 10.6.6, taking account as appropriate of the fact that features for which the designations have been made may in some instances be different.

A summary of the findings of the various national assessments is provided in Table 10-49. Where the impacts score a significance ranking higher than negligible, the impacts are described below and in Section 10.7.3 for the Kurgalsky protected area.

Underwater noise modelling of munitions clearance in Finnish waters has shown that eight protected areas could fall within the TTS zone for marine mammals. As the TTS zone falls outside the functioning of mitigation measures, such as seal scarers, the assessments will be identical with and without mitigation measures /290/. It should be noted that the Finnish sites are identical to or included within the Natura sites, which will be included in the Natura assessment screening. Stora Kölhällen (17.0 km) and Sandkallan (12.4 km) seal sanctuaries, Söderskär and



Långören Archipelago Ramsar site (12.5 km) and Söderskär and Långören Archipelago HELCOM MPA (12.5 km) are included in Söderskär and Långören Archipelago Natura site. The Pernaja and Pernaja Archipelago HELCOM MPA (13.1 km) is identical to the Pernaja Bay and Pernaja Archipelago Natura site. The Bird Wetlands of Hanko and Tammisaari Ramsar site (17.8 km) is identical to the Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area Natura site, but it also includes the Tulliniemi Bird Protection Area. The Tammisaari Archipelago National Park (18.2 km) is included in Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area Natura site. The Open Sea Area Southeast from Hanko HELCOM MPA (13.7 km) is an offshore marine area adjacent to Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti MPA Natura site. For all these eight areas, only grey seal is listed as a designated species or species relating to the international importance of the site. For the reasons described above, it is assessed that the underwater noise impact ranking for these areas will be **minor**.

In addition to the potential for NSP2 to impact the existing protected areas listed in Table 10-49, it may also impact the proposed Ingermanlandsky Nature Reserve, comprising nine sites of uninhabited islands (including the shallow waters up to 10 m water depth around them) within the Russian part of the Gulf of Finland (Atlas Map PA-02-Espoo, Section 9.6.7). This designation is intended to protect the landscape of the islands, nesting and migrating birds and populations of ringed and grey seals. As the site is in the Gulf Finland, munitions clearance may, with the application of mitigation measures, such as seal scarers (Section 10.6.4.2), have a **minor** and **moderate** impact ranking for grey and ringed seal populations, respectively, in this area (Section 10.6.4.2).

A summary of the predicted impact ranking for each of the existing marine protected areas is shown in Table 10-49.

**Table 10-49 Summary of impact rankings for marine protected areas within the vicinity of NSP2, presented from east to west.**

Site number	Protected area	Impact ranking
<b>Ramsar site</b>		
690	Kurgalsky Peninsula (RU)	Minor
2	Aspskär Islands (FI)	Negligible
3	Söderskär and Långören archipelago (FI)	Negligible
1506	Bird wetlands of Hanko and Tammisaari (FI)	Negligible
21	Gotland East Coast (SE)	Negligible
165	Ertholmene (DK)	No impact
<b>HELCOM MPA</b>		
166	Kurgalsky Peninsula (RU)	Minor
145	Eastern Gulf of Finland archipelago and water areas (FI)	Negligible
393	Länsiletto area (FI)	Negligible
394	Luodematalat (FI)	Negligible
161	Pernaja Bay and Pernaja archipelago (FI)	Minor - due to risk of TTS on marine mammals
372	The sea area south of Sandkallan (FI)	Negligible
159	Söderskär and Långören archipelago (FI)	Minor - due to risk of TTS on marine mammals
158	Kirkkonummi archipelago (FI)	Negligible
392	Hangon itäinen selkä (Open Sea Area Southeast from Hanko) (FI)	Minor - due to risk of TTS on marine mammals

Site number	Protected area	Impact ranking
144	Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti (FI)	Negligible
109	Kopparstenarna - Gotska Sandön - Salvorev (SE)	Negligible
115	Hoburgs Bank (SE)	Negligible
116	Northern Midsjö Bank (SE)	Negligible
184	Ertholmene (DK)	No impact
245	Bakkebrædt og Bakkegrund (DK)	No impact
275	Adler Grund og Rønne Banke (DK)	No impact
172	Pommersche Bucht – Rønne Bank (GE)	Negligible
239	Jasmund National Park (GE)	Negligible
75	Lahemaa (ES)	Negligible
72	Pakri (ES)	Negligible
<b>UNESCO site - Biosphere reserve</b>		
-	Finnish Archipelago Sea Area (FI)	Negligible
-	Südost-Rügen (GE)	Negligible
-	West Estonian Archipelago (ES)	Negligible
<b>National protection</b>		
-	Kurgalsky Peninsula (RU)	Minor
KPU050007	Eastern Gulf of Finland National Park (FI)	Negligible
KPU010001	Tammisaari Archipelago (FI)	Minor - due to risk of TTS on marine mammals
KPU020002	Archipelago Sea National Park (FI)	Negligible
YSA200556	Lehmäsaari (FI)	Negligible
YSA051521	Sarvenniemenkari (FI)	Negligible
-	Gotlandskusten (SE)	Negligible
-	Gotska Sandön (SE)	Negligible
-	Pommersche Bucht (GE)	Negligible
-	Greifswalder Bodden(GE)	Negligible
-	Usedom Island (GE)	Negligible
-	Biosphere reserve South-east Rügen (GE)	Negligible
-	Peenemünder Haken, Struck and Ruden (GE)	Negligible
-	Usedom island including parts of the continent (GE)	Negligible
-	Mönchgut (GE)	Negligible
-	Greifswalder Oi (GE)	Negligible
-	Jasmund (GE)	Negligible
-	South-east Rügen (GE)	Negligible

### 10.6.8 Marine biodiversity

The potential impacts on species and habitats have been assessed in Sections 10.6.1-10.6.7 and are therefore not represented here. The focus in the present section is on impacts on functional groups rather than on individual species because of the groups' function within the ecosystem and the resulting potential for sustaining the ecosystem and the associated biodiversity, in line with MSFD requirements. With due consideration to the aforementioned assessments, this section provides an assessment of the potential for "in-combination" impacts (on species and habitats) to result in impacts on marine biodiversity.

For the purpose of this assessment, the sources of impact (pressures) which may have the potential to impact the biodiversity of the Baltic Sea have been identified on the basis of HELCOM's matrix of linkages across human activities and pressures. Due to the linear shape of

NSP2, the project is comparable to the HELCOM activity 'Cables', although the impacts are of a larger scale.

For completeness, consideration has also been given to the potential for the release of nutrients into the water column (as a potential contributor to eutrophication) and the introduction of NIS.

An initial scoping process has been undertaken to determine which sources of impact assessed in Sections 10.1.2-10.1.4 and 10.6.1-10.6.7 have the potential to impact biodiversity. Those sources of impacts that have been scoped out are presented in Table 10-50 along with a justification.

**Table 10-50 Potential sources of impact scoped out for biodiversity.**

Potential source of impact	Potential impact on biodiversity	Justification
Heat exchange between the pipelines and the surrounding environment	<ul style="list-style-type: none"> <li>Alteration of the environment, favouring other species composition and therefore disrupting the natural species distribution</li> </ul>	Temperature changes are of a maximum of 0.5°C in a zone of a maximum of 1 m to the sides of the pipelines in a zone of less than 5 m above the pipelines. Such a temperature difference is too small for any of the components of the Baltic Sea ecosystem to be affected, and the impact is of a scale that would not impact biodiversity.
Release of contaminants to the water column	<ul style="list-style-type: none"> <li>Release to the environment with detrimental impacts on species and habitats</li> </ul>	Remobilisation and redistribution of contaminants is local and is not anticipated to alter the contamination levels of the surrounding seabed environment, and the impact is of a scale that would not impact biodiversity. The concentrations of the different contaminants and their degradation products due to release to the water column are far below the level at which a negative impact on the environment would be expected, and the impact is therefore of a scale that would not impact biodiversity.
Release of contaminants from pipeline anodes	<ul style="list-style-type: none"> <li>Release to the environment with detrimental impacts on species and habitats</li> </ul>	The release of contaminants from pipeline anodes is far below the level at which a negative impact on the environment would be expected and the impact is therefore of a scale that would not impact biodiversity.

The following eight sources of impacts have thus been assessed and are reported below:

- Physical changes to seabed features (construction);
- Release of sediments to the water column (construction);
- Release of contaminants and nutrients to the water column (construction);
- Sedimentation on the seabed (construction);
- Generation of underwater noise (construction);
- Presence of vessels (construction and operation);
- Presence of pipeline structures (operation);
- Introduction of NIS (construction)

#### 10.6.8.1 Physical changes to seabed features (construction)

Potential impacts on biodiversity comprise:

- Loss of important habitats or flora and fauna species key to sustaining the existing ecosystem and therefore the biodiversity due to munitions clearance and seabed intervention works.

### Assessment of potential impacts

It is assessed in 10.6.2 that the impact on benthic flora (habitat builder and the first trophic level of the food web) due to changes in seabed features is negligible, primarily due to the abundance of the flora and recovery rates.

In Section 10.6.2, the overall impact on benthic fauna due to loss of habitats is not significant for the majority of the NSP2 route, primarily due to the ability of the fauna to recover and due to the general abundance of fauna. Therefore, there will be no significant impact on habitat builders or the second trophic level of the food web, which would impact the functioning of the ecosystem. Based on this, changes in habitats due to physical changes to seabed features are assessed to be of negligible impact on biodiversity.

The impact of physical changes to seabed features on benthic species and communities is also assessed not to be significant, primarily due to the abundance of the fauna along the NSP2 route, the spatial extent of the impact and the anticipation of no structural or functional changes. As no significant impacts on key species or functional groups in the food web are anticipated for the majority of the NSP2 route, it is assessed that the changes in benthic fauna along the majority of the NSP2 route during the construction phase represents a negligible impact on the overall biodiversity.

No impacts on benthic flora and fauna during operation are anticipated.

In Section 10.6.3, the overall impact on fish (the third trophic level of the food web) due to loss of habitats, primarily with a focus on spawning grounds for herring in Greifswalder Bodden and the Bornholm Basin waters, is assessed not to be significant during the construction phase. This is partly due to a restriction regarding the construction period that safeguards spawning season and partly due to the vast habitat surrounding the construction area. With no significant impacts on the third trophic level of the food web, no impacts on biodiversity are anticipated during the construction phase.

No impacts on fish are anticipated during the operation phase. See Section 10.6.3.7 for the assessment of impacts due to the presence of pipeline structures on biodiversity during the operation phase.

As no significant impacts on any of the functional groups (first, second and third level of the food web) associated with the seabed are anticipated, it is assessed that the impact of physical changes to the seabed is **negligible** for the overall biodiversity, both locally in Greifswalder Bodden and along the rest of the NSP2 route.

There are **no** impacts on biodiversity due to physical changes of the seabed during the operation phase.

#### 10.6.8.2 Release of sediments to the water column (construction)

Potential impacts on biodiversity comprise:

- Loss of functional groups/key flora or fauna species due to the increased concentration of suspended sediments.

### **Assessment of potential impacts**

The impact of the release of sediments to the water column is assessed not to be significant in respect to phytoplankton, partly due to the fact that the majority of the sediment will be released in the aphotic zone and partly because of the relative proportion of the impacted photic zone and the coverage of the plankton community combined with the overall productivity of the primary producers (see Section 10.6.1.1). Benthic flora are only present in shallow German waters, but the impact of the increased concentration of suspended sediment is assessed not to be significant in Section 10.6.2.2.

As there are no significant impacts on either of the functional groups in the first trophic level of the food web, no impacts on biodiversity due to changes in phytoplankton and benthic flora communities are anticipated.

No impact on the first level of the food web due to the release of sediments to the water column is anticipated during the operation phase.

The impact on zooplankton due to the release of sediments is assessed not to be significant due to the short duration of the increase in SSC and the limited impacts on the first trophic level on which the zooplankton graze (see Section 10.6.1.1). Similarly for benthic fauna, the impact of suspended sediment is assessed not to be significant due to the temporary nature of the impact (see Section 10.6.2.2). As there are no impacts on either of the functional groups on the second trophic level, no impacts due to changes in zooplankton and benthic fauna communities are anticipated.

No impact on the second level of the food web due to the release of sediments to the water column is anticipated during the operation phase.

The impact on adult and juvenile fish due to the release of sediments is assessed not to be significant for the majority of the NSP2 route, due to the localised areas of increased SSCs and to the temporary nature of the impact. The impact on fish eggs and larvae is also assessed not to be significant, primarily due to stratification that prevents the suspended sediment from interfering with egg and larval development (See Section 10.6.3.2)

The impact on fish in German waters, however, is assessed to be minor because the construction period is seasonally restricted in order to prevent harmful impacts during the herring spawning period. As there are no impacts on the third trophic level of the food web, no impacts due to changes in fish communities are anticipated.

No impact on fish (the third level of the food web) due to the release of sediments to the water column is anticipated during the operation phase.

The impact on marine mammals is assessed not to be significant due to the low sensitivity to increased turbidity and the spatial and temporal extent of the suspension events during the construction phase (see Section 10.6.4.1). Impacts on birds due to the release of sediment to the water column are generally assessed to be negligible during the construction phase due to the low intensity and the local and spatial extent of the suspension events. In the nearshore area of Russia, the impact is, however, assessed to be minor due to the intensity of the event during munitions clearance. This impact is local and temporary in a biodiversity context. Based on the above, no impact on the top trophic level in the food web is anticipated.

No impact on predators (top level of the food web) due to the release of sediments to the water column is anticipated during the operation phase.

No significant impacts on any of the functional groups in the food web are anticipated during the construction phase due to release of nutrients. Based on this, the impact on biodiversity is

assessed to be **negligible** during the construction phase. There are **no** impacts on biodiversity due to release of sediments to the water column during the operation phase.

#### 10.6.8.3 Release of contaminants and nutrients to the water column (construction)

Potential impacts on biodiversity comprise:

- Bioaccumulation of contaminants in fish, which may have toxic effects on the third and fourth trophic level of the food web;
- Bloom in phytoplankton and cyanobacteria changing the composition of the first trophic level of the food web.

##### Assessment of potential impacts

The impact on phytoplankton and cyanobacteria due to the release of nutrients during the construction phase is assessed not to be significant, primarily due to the amount released and the bioavailability of the released nutrients (see Section 10.6.1.2). With no significant impacts on the lowest trophic level of the food web, no impacts are anticipated for the biodiversity.

No impact on phytoplankton and cyanobacteria due to the release of nutrients to the water column is anticipated during the operation phase.

The impact on fish due to the release of contaminants during the construction phase is assessed not to be significant, partly due to the low concentration of contaminants and partly due to the spatial and temporal extent of the events releasing the contaminant. With no significant impacts on the third trophic level of the food web, no impacts are anticipated on biodiversity.

No impact on fish due to the release of contaminants to the water column is anticipated during the operation phase.

No significant impacts on any of the functional groups in the food web are anticipated during the construction phase due to the release of contaminants. Based on this, the impact on biodiversity is assessed to be **negligible** during the construction phase. There are **no** impacts on biodiversity due to release of contaminants during the operation phase.

#### 10.6.8.4 Sedimentation on the seabed (construction)

Potential impacts on biodiversity comprise:

- Loss of key species/functional groups in the food web due to smothering.

##### Assessment of potential impacts

The impact on benthic communities due to sedimentation during the construction phase is assessed to be negligible in offshore areas, primarily due to the abundance of benthic flora and fauna species along the majority of the NSP2 route. In the nearshore areas in Russian and German waters, the impact of sedimentation is assessed to be minor due to importance of the species present. (See Section 10.6.2.3). These impacts are local and temporary in a biodiversity context. Based on the above, no significant impacts on the lowest (first and second) trophic levels in the food web are anticipated.

No impact on benthic communities due to sedimentation on the seabed is anticipated during the operation phase.

The impact on fish due to sedimentation during the construction phase is assessed to be negligible for the majority of the NSP2 route (see Section 10.6.3.4). This is primarily due to the NSP2 route crossing through areas with in hypoxic or anoxic conditions and no or limited abundance of demersal fish species. The impact on important fish spawning areas in the nearshore areas in German waters is assessed to be minor, as national regulation of construction

activities prevents disturbances during the spawning season except for two weeks in the end of May. Both nearshore areas are re-established after the construction period. Based on this, the impact is considered local and temporary in a biodiversity context. It is concluded that no impacts on the third trophic level in the food web are anticipated and hence it is assessed that there are no significant impacts on biodiversity due to sedimentation during the construction phase.

No impact on fish due to sedimentation on the seabed is anticipated during the operation phase.

No significant impacts on any of the functional groups in the food web are anticipated during the construction phase due to sedimentation on the seabed. Based on this, the impact on biodiversity is assessed to be **negligible** during the construction phase. There are **no** impacts on biodiversity due to release of contaminants during the operation phase.

#### 10.6.8.5 Generation of underwater noise (construction)

Potential impacts on biodiversity comprise:

- Loss of key species/functional groups in the food web due to underwater noise.

##### Assessment of potential impacts

The impact on fish due to underwater noise during the construction phase is assessed to be negligible for the majority of the NSP2 route due to the limited spatial and temporal extent of the underwater noise events combined with the use of mitigation measures (see Section 10.6.3.5). In German waters, the impact on fish is assessed to be minor, primarily due to disturbance of fish during the spawning period. As national regulation of construction activities prevents disturbances during the spawning season except for two weeks in the end of May, the disturbance of spawning is assessed to be temporary. Based on this, the impact is considered local and temporary in a biodiversity context. It is concluded that no impact on the third trophic level in the food web is anticipated.

The impact on marine mammals due to underwater noise during the construction phase is generally assessed to be minor for the project due to the medium sensitivity to noise levels associated with the general construction activities and seabed intervention works. However, impacts on marine mammals due to underwater noise associated with munitions clearance (Finland and Russia) are assessed to be moderate, primarily due to the high sound level and abundance of different marine mammals. Although this has the potential to impact individuals which are top predators within the food web, the remaining links within the food web would not experience any significant impacts. Furthermore, the impact is reversible and the abundance of marine mammals will revert over time, depending on breeding success. Based on this, the impact of underwater noise on marine mammals potentially results in a negligible impact on biodiversity.

Based on the limited impacts on key functional groups in the food web due to underwater noise during the construction phase along the rest of the NSP2 route, the impact on the biodiversity is assessed to be **negligible** and therefore not significant. There are **no** impacts on biodiversity due to the generation of underwater noise during the operation phase.

#### 10.6.8.6 Presence of vessels (construction and operation)

Potential impacts on biodiversity comprise:

- Temporary and local disturbance of key species/functional groups in the food web due to the presence of vessels.

##### Assessment of potential impacts

The impact of the presence of vessels during both the construction and operation phases on fish is assessed not to be significant (see Section 10.6.3.6). This is primarily due to the spatial and

temporal extent of the presence. As the impact on the third trophic level of the food web is not significant, no impacts are anticipated for biodiversity due to disturbance of fish.

The impact of the presence of vessels during both the construction and operation phases on birds is assessed not to be significant for the majority of the NSP2 route (see Section 10.6.5.3). This is primarily due to the spatial and temporal extent of the presence. As the impact on the top trophic level of the food web is not significant, impacts on biodiversity are assessed to be negligible.

The presence of vessels during the operation phase would be considerably smaller and therefore the impact on birds is also negligible. Hence the impact on the biodiversity due to changes in abundance of top predators (birds) is also negligible.

As no significant impacts on key species or functional groups in the food web are anticipated during the construction and operation phases due to the presence of vessels, the impact on biodiversity during construction and operation is assessed to be **negligible**, which is not significant.

#### 10.6.8.7 Presence of pipeline structures (operation)

Potential impacts on biodiversity comprise:

- Loss of habitats for key species/functional groups in the food web due to changes in the seabed profile/presence of pipeline structures;
- Introduction of a new habitat, increasing the biodiversity.

##### Assessment of potential impacts

Assessment of impacts is not relevant for the construction phase.

Impacts on benthic flora due to changes in the seabed profile/presence of pipeline structures during the operation phase are assessed to be minor (see Section 10.6.2.4). This is primarily due to the local spatial extent of the pipeline. A minor impact on benthic flora is local in a biodiversity context. Based on the above, no significant impact on the first trophic level of the food web is anticipated.

The impact on benthic fauna due to loss of habitats during the operation phase is assessed to be minor for most of the NSP2 route, primarily due to the local spatial extent and the general abundance of benthic fauna along most of the route.

The impact on fish due to the presence of pipeline structures during the operation phase is assessed to be negligible for NSP2 (Section 10.6.3.7). This is primarily due to the spatial extent of the structure and the general abundance of fish on the seabed along the NSP2 route. Based on this, no impacts on the third trophic level of the food web are anticipated.

Impacts on marine mammals due to the presence of pipeline structures during the operation phase are assessed to be negligible. Based on this, no significant impacts on the top trophic level (predators) of the food web are anticipated.

With no significant impacts on any of the trophic levels of the food web due to the change in seabed features/presence of pipeline structures during the operation phase, potential impacts on biodiversity are assessed to be **negligible** during both construction and operation.

#### 10.6.8.8 Introduction of non-indigenous species (construction)

Potential impacts on biodiversity comprise:

- Pressure on endemic species due to the release of NIS in ballast water or from hull fouling.



### Assessment of potential impacts

The potential to introduce NIS species is the only source of impact specific to biodiversity during the construction phase. In order to minimise the risk of introducing NIS into the Baltic Sea, construction vessels will conduct ballast water exchange outside of the Baltic Sea. Furthermore, Nord Stream 2 AG will prepare Ballast Water Management Plans which will include measures to ensure adherence to OSPAR/HELCOM General Guidance on the Voluntary Interim Application of the D1 Ballast Water Exchange Standard in the North East Atlantic. Ballast tanks will also be cleaned regularly and washing water delivered to reception facilities ashore in line with IFC EHS Guidelines on shipping and the International Convention for the Control and Management of Ships' Ballast Water and Sediments.

As vessel activity during the operation phase is connected to maintenance activities where ballast water is rather taken in from the Baltic Sea than released there, or surveying activities where no release exchange of ballast water is anticipated, no impacts are expected. During this phase, hard-bottom species may use the NSP2 pipelines as an area of artificial reef, and therefore bridge otherwise non-contiguous hard-bottom areas. This has the potential to encourage the spread of NIS due to migration along the NSP2 pipelines. However, the abiotic conditions within the deep basins (i.e. low light and hypoxic/anoxic) will function as a barrier which will prevent migration of species along the NSP2 pipelines.

Based on the above mitigation measures, the risk of introducing NIS during the construction of NSP2 is considered to be very low. Regardless, applying a conservative approach, the impact is considered to be local to regional, long-term and of low intensity, with an impact magnitude of negligible. Based on this, the impacts on biodiversity are assessed to be **negligible**, which is not significant. **No** impacts on biodiversity are anticipated during operation.

#### 10.6.8.9 Summary and overall ranking of potential impacts on biodiversity

A summary of the overall project impact ranking for biodiversity arising from the potential sources of impact scoped into the assessment is provided in Table 10-51 together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Owing to the ranking levels and different nature of the impacts associated with each of the sources of impact considered above, there is a limited potential for "in-combination" impacts on biodiversity, so the impact ranking on this receptor resulting from all sources of impact is likely to be at most negligible.

Although the potential sources of impact may be transboundary, impacts on biodiversity would be no more than negligible. Details are provided in Chapter 15 – Transboundary impacts.

**Table 10-51 Overall project assessment and country-specific impact ranking and potential for transboundary impacts.**

Biodiversity	Project	RU	FI	SE	DK	DE	Trans
Physical changes to seabed features							No
Release of sediments to the water column							No
Release of contaminants and nutrients to the water column							No

Sedimentation on the seabed							No				
Generation of underwater noise							No				
Presence of vessels							No				
Presence of pipelines on the seabed							No				
Introduction of NIS							No				
Impact ranking:	<table border="1" style="width: 100%; text-align: center;"> <tr> <td style="background-color: #cccccc;">Negligible</td> <td style="background-color: #ffff00;">Minor</td> <td style="background-color: #ffcc00;">Moderate</td> <td style="background-color: #ff0000;">Major</td> </tr> </table>						Negligible	Minor	Moderate	Major	
Negligible	Minor	Moderate	Major								

## 10.7 Onshore landfall Narva Bay

### 10.7.1 Terrestrial flora

During construction and operation of NSP2, three potential sources of impact on terrestrial flora are identified in Table 8.2. Of these, one can be scoped out and one can be partially scoped out from further consideration for the reasons outlined in the Table 10-52, and are thus not considered further:

**Table 10-52 Potential sources of impact scoped out for terrestrial flora.**

Potential source of impact	Potential impact	Justification
Releases to land and water (construction and operation)	<ul style="list-style-type: none"> <li>Pollution of soil and water</li> <li>Alteration of growth due to increased pollution level</li> <li>Change in flora species</li> </ul>	As assessed in Section 10.3.2.2, the releases of water during construction and operation will be done through the Water Management Plan. Other measures will include organized parking and refueling spaces. Dewatering after hydro-test of the onshore section will be done in settling pond, after which the water will be taken away in a tank. No impacts are predicted.
Emissions to air (operation)	<ul style="list-style-type: none"> <li>Changes in botanical species composition due to chemical changes in air</li> <li>Blocking of stigma affecting reproduction and deposition on leaves affecting photosynthesis</li> </ul>	During operation, there will be no continuous emissions to air from the operation of the PTA. Emissions will consist of intermittent releases of natural gas (methane, CH <sub>4</sub> ) during inspection, maintenance and repair activities. No potential impacts in terms of species composition or plant health are predicted.

The following two sources of impacts have been assessed and reported below:

- Physical changes to landform and land cover (construction and operation);
- Emissions to air (construction).

#### 10.7.1.1 Physical changes to landform or land cover (construction and operation)

Activities with the potential to cause changes to landform and land cover comprise the removal of vegetation, the stripping and storage of topsoil, trench excavation and dewatering, and construction of the PTA, temporary working areas and access roads.

Potential impacts on terrestrial flora comprise:

- Disturbance and/or destruction of habitats due to vegetation clearance;
- Fragmentation/severance of habitat and edge effect in forest areas;
- Loss of soil integrity, production and soil erosion, limiting the ability for regeneration of vegetation;
- Alteration to the drainage and groundwater regime, leading to habitat and species composition change;
- Introduction of invasive species associated with ground disturbance.

### **Assessment of potential impacts**

The vulnerability and overall sensitivity of terrestrial flora are assessed to be medium to high depending on biotope type and location.

The areas covered by primary and secondary forest, including relict dunes covered in pine forest, are of high vulnerability as they are not resilient to change and restoration is likely to take decades to achieve. When combined with the high importance (Section 9.7), the sensitivity of vegetation along the part of the route from the relict dune to the shore is considered to be high.

The eastern part of the route (from the PTA to relict dune) crosses modified habitat affected by fire and agricultural land, and also crosses the northern edge of the Kader swamp. The survey data (Section 9.7.2) shows that vegetation along this part of the route comprises mostly birch and pine undergrowth, waterlogged in places, natural meadows and former agricultural land. The vulnerability is assessed to be medium, as flora will be restored as part of the reinstatement process (excluding deep-rooted vegetation above the Right of Way) and is expected to revert to pre-impact status within approximately 5-15 years. The overall sensitivity is considered to be medium irrespective of the high importance.

### *Construction*

The main impacts on terrestrial flora will occur when the vegetation and soil will be removed within the construction area.

The temporary development footprint for the worker camp and laydown area will occupy approximately 42 ha and will be located on fallow agricultural land outside the Kurgalsky Nature Reserve. The conventional open-cut constructed pipeline section within the Kurgalsky Nature Reserve will temporarily occupy an area of approximately 31 ha (3.7 km long and 85 m wide), which represents 0.05% of the overall designated Kurgalsky Nature Reserve, and 0.14% of its terrestrial component.

Prior to construction, all Red Book species of flora identified within the construction corridor will be re-planted in accordance with Russian legislation. After the construction is finalised, the working area will be levelled to the original topography and revegetated. The Soil Management Plan will require that following vegetation clearance, the topsoil is stored within the 85 m working width, so that it can be reinstated progressively during construction works.

There is reasonable certainty that recovery of the vegetation to pre-impact status, once the works are complete, could occur within 5 to 15 years depending on the soil and vegetation type (e.g. modified habitat and northern part of Kader swamp). The use of good soil storage techniques, rapid restoration of the infilled pipeline corridor and controls on invasive species will also increase the certainty of vegetation recovery taking place. The impact magnitude for this section of pipeline is assessed to be low, as the difference from the baseline conditions will affect a small proportion of species and will be of a short duration.

For primary forest and relict dune habitat within an 85 m wide working area, re-establishment of the original habitats may take much longer (potentially decades) due to the damage to soils, changes in the groundwater regime, mycorrhizae content and existing vegetation, and there is less certainty that original habitats will re-establish at all. In addition to the very long-term and uncertain recovery of these sensitive habitats, there will also be a small permanent loss of forest cover as re-growth of deep rooted trees will be prevented within 7.5 m above each pipeline and within 6 m of access road.

The relict dune in particular is a small and discrete habitat area of high sensitivity. Open cut construction may result in a permanent change in landform (see Section 6.7). In addition, the conditions that created the relict dune no longer exist and therefore the likelihood of full restoration of the flora within an 85 m wide working area and ecological functioning within this altered landform is very low, and effects on flora are likely to be permanent. The impact will be local but of high intensity and without appropriate mitigation in place, the impact magnitude will be high. Construction within this area is likely to require stabilisation and the use of specialised engineering techniques such as gabion baskets to minimise wind and water erosion. The use of hydro-seeding with a relevant seed mix will aid the stabilisation of sand and assist restoration of some flora to a limited extent, bringing the impact magnitude to medium.

Whilst overall impacts on flora vary, the impacts on old growth forests with complex moss based flora and on the relict dune, are of high intensity and are long-lasting but localised. Given the localised effects, the impact magnitude from disturbance and/or destruction of habitat on flora is medium.

Compaction of the soil may occur from the movement of vehicles and machinery along the working width, which may prevent rainfall penetration and thereby increase surface water runoff and soil erosion. The temporary access roads will, however, be constructed with a geotextile membrane beneath a compacted gravel cover, which will prevent long-term impacts on soil integrity and quality as well as the loss of soil through erosion. Upon completion of construction, temporary access roads will be removed and biological reinstatement will take place, including topsoil cover, seeding and re-vegetation. This will allow flora to return to pre-impact status once the works are complete. The impact from compaction is therefore assessed as having a negligible magnitude.

Where land is disturbed, there is the possibility of invasive non-native species establishing in the cleared and disturbed areas. Nord Stream 2 AG has an overarching policy on the control of invasive species and this embedded mitigation will prevent invasive species becoming established.

Trenching will create a need to dewater the trenches, and this may affect flora by drawing down the water table. These activities have the potential to interfere with the local drainage patterns and hence the local hydrology. The water table is, however, mainly recharged from rainwater, and the poorly draining podzol soils, along with the flat topography, mean there is limited groundwater flow. Water table draw down is, therefore, likely to be very localised. In addition, a Water Management plan will ensure that water removal activities are temporary and most likely will include the water being pumped back into the pipeline trench where the pipeline has already been installed. The construction of the open-cut section of the pipeline is therefore unlikely to affect the wider drainage patterns and hence the flora of Kader swamp as a whole. The impact will be of low intensity, short-term and local scale and the local hydrology will return to pre-impact status once the works are complete. The impact from dewatering the pipeline trench is therefore assessed as having a negligible magnitude.

For sensitive habitats such as the old growth forest and relict dune, the impact of dewatering is secondary to the cutting, clearing and bulldozing of the soil in terms of impacts on flora. However, dewatering of trenches within the forest section may temporarily reduce the local water

table leading to increased stress on flora adjacent to the trench and small scale waterlogging and alluvial fanning of sediment near discharge points. As pipe-laying will be a continuous process and any dewatering water will be pumped back into the trenched area, such effects will be minor, short-term and localised. Thus, the impact magnitude will be low.

On the basis of the discussion above, the impact magnitude ranges from negligible to medium. A medium impact magnitude was assessed in terms of impacts on flora within the forested area due to vegetation clearance and therefore habitat disturbance and/or destruction. For high sensitivity habitats such as the old growth forest and relict dune, the overall impact ranking is considered to be **moderate**. For less sensitive habitats (modified habitat and northern part of Kader swamp) and where restoration of habitat has a high certainty of success (and impact magnitude is assessed to be low), the overall impact ranking is considered to be **minor**.

#### *Operation*

During operation, no impacts are expected beyond those occurring during construction and no additional mitigation will be required above and beyond control of weeds, undergrowth and erosion. There will be permanent structures associated with the PTA and access roads where vegetation will be absent.

There will be a small permanent loss of forest cover as re-growth of deep rooted trees will be prevented above the pipelines, producing two parallel 7.5 metre gaps plus a 6 m access road in the area of forest cover. The need to maintain these areas free of deep rooted trees will result in a long-term change in habitat from moss-rich, old growth forest to grassland and shrub.

The impact will be at local scale, affecting a small area and small proportion of species, but will be long-term. The impact ranking is assessed to be the same as for the construction phase – **minor** for less sensitive habitats (modified habitat and northern part of Kader swamp) and **moderate** for the forest and relict dune.

#### **10.7.1.2 Emissions to air (construction)**

Activities with the potential to cause emissions to air comprise:

- Construction of the linear part of the pipeline and PTA, resulting in chemical pollutant emissions (CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, particulate matter);
- Earthworks and vehicle movements resulting in dust generation;
- Vegetation clearance resulting in wind-blown dust.

Emissions to air from project activities will result in chemical and dust deposition that may impact terrestrial flora through:

- Changes in botanical species composition;
- Blocking of stigma, affecting reproduction, and deposition on leaves, affecting photosynthesis.

#### **Assessment of potential impacts**

The vulnerability of terrestrial flora is considered to be medium to high, as the receptor in general is expected to revert to its pre-impact state naturally over a certain time (within 5-15 years); however, some species (such as those in old growth forest and relict dune communities) may not be able to tolerate impacts that may result in very long-term changes (> 15 years). Lichens and mosses have a low resilience to polluted air and are especially very sensitive to sulphur dioxide pollution in the air (this being the reason why lichens are used as environmental indicators of air quality). During baseline surveys, species of lichens and mosses, including those listed in the Red Books of the Russian Federation and Leningrad region, were observed in the primary forest. However, most damage to lichen communities is done by long-term exposure associated with thermal power plants and an annual mean of 10-20 µg/m<sup>3</sup> would be required to produce

measurable effects. Even if such effects were to occur as a result of construction traffic, it is generally accepted that effects from traffic are confined to within 200 m of the traffic source. For the PTA and the linear part from the PTA to the eastern part of the dune, the vulnerability of flora is assessed to be medium as the receptor can recover to pre-impact status once the construction works are completed. The overall sensitivity is considered to be medium irrespective of high importance.

#### *Dust generation*

Stripping and storage of topsoil and the movement of construction vehicles along unmade roads are the activities with the highest potential contribution to dust generation. Topsoil and excavated material will be stored within the working width, and wind action on these stockpiles may cause dust particles to become airborne and then settle out on the surrounding vegetation and surface water features. Construction vehicles will cause re-suspension of dust particles through the action of vehicle wheels pulverising the particles comprising the road and projecting these particles into the air. The turbulent vehicle wake adds to the upward momentum of the particles.

The areas subject to dust deposition depend on particulate size. In dry arid areas with light friable clay soils, dust deposition can be significant and large infrastructure projects have assumed potential dust impacts out to 50 m. However, in a wet site such as Kurgalsky, where soils are dominated by peat and poorly draining podzols or coarse grained sands, and where rain can be expected year round, the likelihood of dust production is low. The impact from dust emissions will be localised, i.e. around the temporary working area and right of way (RoW). It will also be limited to the construction phase and therefore of short duration and low intensity.

The implementation of mitigation further reduces the likelihood of dust impacts as does the often closely vegetated nature of the surrounding area, which reduces wind speed and wind dispersion. In addition, in accordance with Nord Stream 2 AG's committed mitigation measures (Chapter 16 – Mitigation measures), a geotextile membrane will be used beneath a compacted gravel cover on all unpaved roads and reinstatement of such roads will include replacement of topsoil cover, seeding and re-vegetation. The Soil Management Plan will also contain measures to manage dust generation from exposed soils and excavated material stockpiles. Such measures will include minimising the duration of stockpiling activities and requiring technical reinstatement, grading and profiling of RoW as soon as possible following completion of pipeline installation. The magnitude of impact will thus be negligible as the change to the conditions may occur, but is generally undetectable. When combined with the medium sensitivity of receptor, this results in a **negligible** impact ranking.

#### *Chemical pollution*

Air pollution may lead not only to the occurrence of occasional local damage to terrestrial flora, but also to changes in plant species composition in the adjacent areas. This can be associated with the loss of species that are characterised by high and average sensitivity to air pollution. In a polluted air environment, some forest species become eliminated with the increased role of meadow and ruderal plant species. Such an effect can only be observed when the level of pollution is very high, i.e. in the areas located within the impact zones of large industrial enterprises.

There is no impact predicted due to elevated levels of chemical pollutants in the air during construction activities. These predictions are supported by air quality monitoring carried out for NSP in Russia (2010-2012) which demonstrated that concentrations of nitrogen dioxide, carbon monoxide, particulates and hydrocarbons were below the Maximum Allowable Concentrations (MAC) indicating good air quality. The levels of atmospheric emissions predicted to arise during the construction of the pipeline and PTA are unlikely to result in acid deposition and nitrification.

### 10.7.1.3 Summary and ranking of potential impacts on terrestrial flora – Russian landfall area

The overall project assessment on terrestrial flora is summed up in Table 10-53.

**Table 10-53 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Terrestrial flora - Russia	Project	RU	FI	SE	DK	GE	Trans
Physical changes to landform and land cover	-		-	-	-	-	No
Emissions to air			-	-	-	-	No
Impact ranking:	Negligible		Minor	Moderate	Major		

### 10.7.2 Terrestrial fauna

During construction and operation of NSP2, five potential sources of impacts on terrestrial fauna have been identified in Table 8-2. Two sources can be scoped out from further consideration for reasons outlined in Table 10-54 and thus are not considered further:

**Table 10-54 Potential sources of impact scoped out for terrestrial fauna.**

Potential source of impact	Potential impact	Justification
Releases to land and water	<ul style="list-style-type: none"> <li>Pollution of water sources</li> </ul>	As assessed in Section 10.3.2.2, the releases of water during the construction and operation phases will be done through the Water Management Plan. Other measures will include organized parking and refueling spaces. No impacts are predicted.
Emissions to air	<ul style="list-style-type: none"> <li>Loss of certain species through change in vegetation cover and therefore loss of suitable habitat</li> </ul>	As assessed in Section 10.7.1, there is no impact predicted due to elevated levels of chemical pollutants in the air during construction of NSP2. The impact magnitude of dust generation will be negligible as the change to fauna is generally undetectable.

The following three sources of impacts have been assessed and reported below:

- Physical changes to landform and land cover (construction and operation);
- Light (construction and operation);
- Airborne noise (construction and operation).

#### 10.7.2.1 Physical changes to landform or land cover (construction and operation)

Activities with the potential to cause changes to landform and land cover comprise the removal of vegetation, the stripping and storage of topsoil, trench excavation, and construction of the PTA, temporary working areas and access roads.

Potential impacts on terrestrial fauna comprise:

- Disturbance and/or destruction of habitats due to vegetation clearance;
- Loss of animals due to traffic and construction activity.

#### Assessment of potential impacts

The vulnerability and overall sensitivity of terrestrial fauna are assessed to be medium to high depending on habitats, taxonomic groups, species and season.

Forested areas (primary forest, coastal and relict dunes) provide secure habitats for a variety of species. The relict dune is a scarce habitat in the Leningrad region which contains protected invertebrate and reptile species and is considered to be of high sensitivity. Woodland species can be vulnerable to direct habitat destruction and a break in the connectivity between habitats (fragmentation). The overall sensitivity for all species inhabiting forest areas is considered to be high.

For the “open” and undergrowth habitats, vulnerability varies. The most vulnerable fauna are slow moving species such as invertebrates or those that are at a seasonally vulnerable stage of their lifecycle, such as eggs or nestlings of birds, torpid bats roosting in trees or reptiles undergoing hibernation or aestivation. Animals with small territories such as small mammals, nesting birds, reptiles, amphibians and particularly invertebrates are vulnerable to reduction of habitat. Birds, particularly large species such as raptors or grouse or ground nesting species such as waders are most vulnerable to disturbance.

The overall species vulnerability will be the highest for groups such as invertebrates, small mammals and some reptiles and amphibians with limited powers of dispersion that are most likely to be affected by direct habitat loss, and the overall sensitivity of fauna to physical changes to landform ranges from medium to high.

#### *Construction*

The temporary development footprint for the worker camp and laydown area will occupy approximately 42 ha and will be located on fallow agricultural land outside the Kurgalsky Nature Reserve. The conventional open cut construction will remove a total of approximately 31 ha of terrestrial habitat. This includes the Kader swamp (8.2 ha), modified habitats (8.4 ha), relict dune (2.5 ha), secondary forest (1.7 ha), old growth forest (8.9 ha) and coastal dune (1.2 ha) which represents <0.1% of the designated Kurgalsky Nature Reserve.

Vegetation clearance will lead to direct habitat destruction and, for less mobile species, may lead to direct loss. The use of open trenching creates a potential wildlife trap for reptiles, amphibians and small mammals, whilst the working width creates a temporary break in connectivity. In habitats such as the modified habitats and the Kadar swamp habitat restoration techniques (see flora section) are well known and the reversibility of damage can be achieved within 5 -15 years.

Other habitats within the 85 m wide working area, such as old growth and secondary growth forest and relict dune systems are likely to take decades to recover and there is uncertainty over whether these areas can ever be restored to full ecological functionality. There will be small areas where deep rooted plants are not allowed to establish that will be permanently changed and some species will be affected by the loss of connectivity. These can include bats, flying squirrels (if present) and small mammals, reptiles, amphibians and invertebrates. However, as part of reinstatement process, trees will be re-planted between the two pipelines (7.5 m above the pipelines will be left without trees) and between the access road and pipeline. The effects of habitat fragmentation and loss of connectivity will diminish as trees establish and canopy cover increase. On this basis, the impact magnitude is assessed as medium.

Construction related traffic, especially during RoW preparation, may lead to the direct loss of single fauna individuals; it particularly relates to small mammals, amphibians and reptiles. In order to avoid or minimise the potential impact, detailed planning of the construction work schedule and identification of particularly sensitive areas for fauna species will be required. As an example, measures in advance of construction may be required to avoid birds establishing nests within the future construction corridor.

The use of open trenching creates a potential wildlife trap for reptiles, amphibians and small mammals. However, as a mitigation measure (see Chapter 16 – Mitigation measures), excavated



areas and active work sites will be fenced. Therefore, no impact is predicted in a base case scenario.

The development of the construction camp will increase the potential for disturbance within the wider area through worker recreation, hunting and fishing. The Russian EIA also notes the likelihood that stray dogs may appear near the construction camps and shelters, which could potentially lead to a 2-2.5 times reduction in the numbers of ground nesting birds (grouse, certain ducks, waders) and small mammals. This impact should be avoided by implementation of necessary measures (Chapter 16 – Mitigation measures), such as ban on bringing any types of animal hunting gear into the area and a strict prohibition on keeping dogs.

On the basis of the discussion above, it is concluded that the impacts on terrestrial fauna arising from vegetation clearance will be of low intensity, short-term and local scale for some habitats. However, for primary and secondary growth forest and relict dune systems, these effects are likely to be longer term and some areas may not return to pre-baseline conditions.

For fauna, there will be temporary disturbance over two breeding seasons and the loss of supporting habitat within an 85 m wide working area, which for relict dune and old growth forest will take decades to re-establish and may never reach full ecological functionality. Loss of connectivity will affect a number of high value species and it is likely to be 5-15 years before tree growth is sufficient to restore connectivity.

The overall impact magnitude is considered to be medium, as although the area affected is small, impacts are likely to be long-term and the effects are compounded by the loss of connectivity within a previously intact forest in particular. The sensitivity of the receptor, which can potentially experience adverse impacts during construction, is high as it may contain Red Book species. The overall impact ranking is assessed to be **moderate**.

#### *Operation*

During operation, no impacts are expected beyond those occurring during construction and no additional mitigation will be required. There will be a permanent (50 years of operation) loss of habitats where structures associated with the PTA and access roads will be located. There will be a change of habitat within 15 m (2 x 7.5 m wide strips above the pipelines) where establishment of deep-rooted vegetation will be prevented. The impact will be at a local scale, affecting a small area and a small proportion of species, but long-term. The impact magnitude is therefore assessed to be low. As the sensitivity of fauna to changes to landform ranges from medium to high, the overall impact ranking is considered to be **minor to moderate**.

#### **10.7.2.2 Light (construction and operation)**

During construction, lighting along the route and at the PTA will be associated with working areas, compounds and traffic movements, as well as lighting associated with nearshore works. Operational lighting impacts are associated with the permanent facility at the PTA.

The potential impact on terrestrial fauna comprises:

- Disturbance to fauna.

#### **Assessment of potential impacts**

The vulnerability of terrestrial fauna is considered to be medium to high depending on the taxonomic group.

For invertebrates, it is estimated that up to one-third of flying insects attracted to artificial light subsequently die as a result of the encounter. Lighting may also disrupt daily and seasonal rhythm /314/. Invertebrates listed in the red data book of the Leningrad region are known to be

present within the surveyed area (although none are critically endangered or endangered) and as such the vulnerability of invertebrates is regarded as medium.

Light from the construction site can disturb terrestrial mammals and result in avoidance behaviour, and this could affect species such as the regionally listed flying squirrel and IUCN near threatened otter. The mammals most sensitive to lighting are bats. Slower flying bats, particularly *Myotis* species and horseshoe bats, are known to actively avoid illuminated areas. Construction lighting could therefore disturb foraging, commuting and roosting of regionally and IUCN listed species. Mammals are therefore regarded as having medium vulnerability.

Birds show mixed responses to lighting, with some evidence of earlier egg laying, longer singing and improved foraging /316/ whilst other species such as owls may be deterred from breeding and foraging and may be attracted to lights whilst on migration. Given this mixed response and the presence of regionally listed species, birds are assessed as having medium vulnerability.

In combination with its importance, the overall sensitivity of fauna to light is assessed as medium.

#### *Construction*

During construction, lighting along the pipeline route and PTA will be associated with working sites, compounds and vehicle movements. The total duration of onshore work is expected to last 24 months. Light spill outside of working areas will be controlled using directional lighting.

Lighting from vehicle headlights is likely to spill out from the worksites and access roads, but there will be dedicated access routes within the allocated RoW and work areas that will restrict the vehicle movements. As a base case, all construction activities at the PTA and along the open cut section will take place during daylight hours.

The impact of lighting will be localised to the working areas, of a low intensity and short-term. The impact magnitude is assessed to be low as there will be a slight change to condition expected over a limited area, will affect small proportion of species and for a short duration.

The construction of the cofferdam will require lighting during the 21 days of construction. This effect will be short-term and reversible. Impacts on terrestrial fauna are expected to be negligible.

On the basis of the discussion above, it is concluded that the impacts on terrestrial fauna from artificial lighting will be localised, temporary and generally of low intensity. Only small numbers of regionally red listed species are likely to be affected and impacts will not affect the viability of populations. The impact magnitude is assessed to be low. The receptor sensitivity is medium; therefore the overall impact ranking is considered to be **minor**.

#### *Operation*

During operation, there will be no permanent lighting provided along the pipeline corridor. The PTA will have a maintenance light which will normally be off except for when a maintenance engineer is on site during low light conditions approximately 4 times a month. It is a possibility, based on similar projects, that the PTA will need constant illumination for security reasons. In this case, the illuminated area will cover approximately 3.5 ha.

The impact will be long-term, but very localised and of low intensity. The impact magnitude is assessed to be low as the change to conditions is expected over a limited area and affecting a small proportion of particular species. When combined with the medium sensitivity of the receptor, this results in a **minor** impact ranking, which is not significant.

### 10.7.2.3 Airborne noise (construction and operation)

Activities with the potential to cause airborne noise comprise RoW clearance and road construction, onshore pipe-lay, construction of the PTA, nearshore dredging, cofferdam installation and pre-commissioning. For the operation phase, there will be only occasional (once a year) release of gas at the PTA.

The key impact on fauna arising from airborne noise comprises:

- Disturbance to fauna.

#### Assessment of potential impacts

During baseline surveys, a white-tailed eagle's nest with one nestling (listed as Vulnerable in the Red Data Book of the Leningrad region, and as of Least Concern on the IUCN Red list) was recorded within the primary natural forest. For species such as birds of prey and grouse, construction noise may cause disturbance at up to 1 km from the noise source /317/. Noise modelling has identified that the noise levels during the construction period in the forest area will reach the guideline value of 65 dBA (German guidelines for bird protection area during daytime) up to 300 m from the noise source. The maximum modelled noise value is 75 dBA at the source. The modelling was presented for the worst case scenario, with all construction activities taking place simultaneously. The impact will be temporary (approximately 2 years), localised (up to 300 m from construction corridor) and of medium intensity (the work will be spread out within the linear part and some detectable changes to the receptor will not affect its basic function).

For the section from the PTA to the relict dune, members of grouse family can be disturbed by noise emissions during vegetation clearance and onshore pipe-laying. Noise can have the highest impact during the breeding season when disturbance may affect the reproductive success of individuals or groups of animals. Nesting grounds of the willow grouse were observed south of pipeline working corridor, in the central part of Kader swamp. No impact is expected to occur at this distance. However, there are nearby nesting grounds for other grouse species, such as black and wood grouse. Also, some regionally Red Listed birds were observed during the breeding period, including tufted duck (*Aythya fuligula*), common greenshank (*Tringa nebularia*) and whimbrel (*Numenius phaeopus*). IUCN vulnerable species Eurasian curlew (*Numenius arquata*) was observed only during migration. For the species within or at a very close proximity to the pipeline construction corridor, noise will be a disturbing factor and will drive these species away from the construction site. The impact will be temporary (approximately 2 years), localised (within the construction corridor) and of low intensity (the work will be spread out within the linear part and not be concentrated in one location).

The open cut section from the PTA to the relict dune supports a breeding habitat for amphibians. During baseline surveys, two breeding sites were observed, one of which is slightly south of construction corridor. Construction noise could mask the mating calls of single amphibian individuals during the mating season and can also be a disturbing factor. The impact will only affect a small number of individuals, will be concentrated within the construction corridor and will be temporary.

Modelling results showed that the guideline values for night-time of 50 dBA will be achieved at approximately 100 m from the noise source and the guideline value for daytime of 65 dBA will not be exceeded at all. The impact will be localised, temporary and of low intensity.

In terms of the wider protected area, the effects are local and temporary (no single area is likely to be affected for more than 18 months), and once works are completed, the impacts will be reversible.

Timing of works to minimise effects during the breeding season and the use of best available technology to reduce noise can significantly reduce these impacts.

Based on the discussion above, disturbance of terrestrial fauna by noise generated from NSP2 activities will be localised, temporary and of low to medium intensity. The impact magnitude is assessed to be low as the impact is of a short duration and will not affect the viability or functioning of the receptor. As the overall sensitivity is assessed as medium, the overall impact ranking is considered to be **minor**, which is not significant. For particular species with a high sensitivity, the impact ranking can be considered **moderate**, and will require detailed planning of the construction work schedule and the use of best available technology to minimise the disturbance factor for these species.

#### Operation

For the operation phase there will be only occasional releases of gas at the PTA through vent stacks. This activity normally takes place once a year during the daytime for the maximum duration of 2 hours.

For assessing impacts on fauna, criteria applied in Germany for the bird protection area were adopted, as Russian norms only regulate acceptable noise levels for human receptors. Airborne noise modelling results /251/ showed that noise levels will reach the guideline value for night time of 50 dBA at approximately 200 m from the noise source and the guideline value for daytime of 65 dBA at less than 100 m. The impact will be localised, of low intensity and occasional. The impact magnitude is assessed to be negligible. In combination with the medium and high sensitivity, the overall impact ranking is considered **negligible**, which is not significant.

#### 10.7.2.4 Summary and ranking of potential impacts on terrestrial fauna – Russian landfall area

The overall project assessment on terrestrial fauna is summed up in Table 10-55.

**Table 10-55 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Terrestrial fauna - Russia	Project	RU	FI	SE	DK	GE	Trans
Physical changes to landform and land cover	N/A		-	-	-	-	No
Light	N/A		-	-	-	-	No
Airborne noise - construction	N/A	*	-	-	-	-	No
Airborne noise - operation	N/A		-	-	-	-	No
Impact ranking:		Negligible	Minor	Moderate	Major		
* moderate for certain species groups and for fauna inhabiting forest areas							

#### 10.7.3 Other protected areas

The proposed landfall is within an area subject to a number of designations including listing as a Ramsar site, a HELCOM Marine Protected Area, and protection as a Regional Nature Reserve. An Important Bird Area is also present to the north of the landfall. The designations and protection relate to the importance of the site for congregatory waterbirds, the range and quality of habitats present, and the species diversity it supports. Five potential sources of impacts on other protected areas were identified in Table 8-2.

Based on the nature of the source of impact (Section 10.1) and the characterisation of the terrestrial flora and fauna sensitivity (Section 9.3), none of the potential impacts have been scoped out from further consideration.

During construction of NSP2, the potential impacts related to other protected areas are listed below:

- Physical changes to landform and land cover;
- Light;
- Airborne noise generation;
- Emissions to air;
- Discharges to land and water.

### **Assessment of potential impacts**

The proposed landfall is located within an area of high importance by virtue of it being part of an area specifically targeted for conservation, both internationally and nationally, and that supports high value species and significant populations of congregatory birds (Section 9.7.3).

The assessments carried out within Sections 10.7.1 and 10.7.2 have demonstrated that changes to landform through vegetation clearance will have up to a maximum of a moderate impact. For other sources of impacts, the impact ranking is either minor or negligible. The assessments have identified that the impacts will vary depending on habitat and that in habitats with the highest sensitivity, there will be long-term impacts, but these will be local in scale (less than 0.1% of the reserve). Nord Stream 2 AG is working on the development of Biodiversity Action Plan, which will include a concept and methodology for site restoration after construction to reinstate biodiversity values. There will be no impediment to maintaining the reasons and features for the original designation, and therefore the overall impact ranking for the overall ecosystem function and integrity of Kurgalsky Nature Reserve is assessed to be **minor**, which is not significant.

In addition to the five potential sources of impact described above, the following was identified in Table 8-2:

- Land acquisition and use.

#### **10.7.3.1 Land acquisition and use (construction)**

NSP2 will require the temporary occupation of land (including the establishment of a worker camp and laydown areas) during the construction phase and the permanent occupation of land for the PTA and offices. The permanent development footprint of 6.1 ha for the PTA and offices is located outside of the protected area, so there will be no direct impact on the Kurgalsky Nature Reserve.

Within the Kurgalsky Nature Reserve, there will be a permanent access road along the pipeline and two lines each 7.5 m wide above the pipelines, which need to be kept free of deep-rooted vegetation. The road will occupy approximately 2.2 ha (6 m wide by approximately 3.7 km long) and the pipelines will occupy approximately 5.5 ha (15 m wide by 3.7 km long), which represents 0.03 % of the overall onshore part of the designated Kurgalsky Nature Reserve.

The planned area of permanent occupation is very small in relation to the total area of the Kurgalsky Nature Reserve and is located in less sensitive and partially modified habitats; however, 1.7 km will be located within highly sensitive habitats such as primary forest and relict dune. The impact magnitude in terms of the overall protected area is assessed to be negligible and the receptor sensitivity ranges from medium to high. The impact ranking is therefore assessed to be **negligible**.

## **10.8 Onshore landfall Lubmin 2**

### **10.8.1 Terrestrial biotopes**

The following potential sources of impacts on the terrestrial biotopes in Germany were assessed:

- Physical changes to landform or land cover (natural or man-made); land acquisition/use (construction and operation);

- Emissions to air (construction and operation);
- Changes to landform/use (construction and operation).

#### **10.8.1.1 Physical changes to landform or land cover (natural or man-made) and land acquisition/use (construction and operation)**

During the construction of NSP2, the soil conditions will be changed due to soil excavation, soil loss, the compression of soil and the backfilling of soil. Prior to that, vegetation and biotope structures have to be removed. Woodlands, more specifically pine forests, ruderal areas as well as traffic and industrial areas will be affected by the physical changes. Furthermore, the construction and operation of the PTA leads to a construction/operation related land use and the terrestrial flora will consequently be potentially impacted by the loss of biotopes.

##### **Assessment of potential impacts**

The loss of biotopes in the area of the PTA as well as in adjacent areas is of high intensity, as it results in the total loss of the structures and functionality. It is a permanent, but small-scale impact, as the areas will not be re-cultivated after the construction of NSP2. Due to the irreversibility of the intervention, it results in a medium to high impact magnitude. The sensitivity and the importance of the biotope stock affected can be assessed as low (ruderal areas) up to higher order woodlands that are assessed as more important, due to their long regeneration time.

Based on the medium sensitivity and the high impact magnitude assessed above, the physical changes to landform or land cover during the construction phase have a significant impact on the terrestrial biotopes.

#### **10.8.1.2 Emissions to air (construction)**

Airborne emissions relevant for the terrestrial biotopes affected by NSP2 include particulate matter and nitrogen. According to BMUB /318/ a threshold of 30 µg/m<sup>3</sup> for nitrogen must be taken into account, which is only relevant for the starting pit of the micro-tunnel. During pre-commissioning, elevated values will be reached at mounting and storage areas in the south of the area, which will also be relevant for adjacent areas. The emission of particulate matter will only be relevant for the construction areas. The emissions described here can potentially impact the terrestrial flora by impairing the functionality of the biotopes.

##### **Assessment of potential impacts**

The impairment of biotopes by airborne emissions during the construction phase is of low intensity, short duration, local and reversible. Based on this, the impact magnitude is low. As the affected biotopes have primarily developed in eutrophic and ruderal locations, their sensitivity to airborne emissions is assessed as low.

Based on the low sensitivity and the low impact magnitude assessed above, the airborne emissions that will occur during the construction of NSP2 are assessed not to have a significant impact on the terrestrial biotopes.

#### **10.8.1.3 Summary and ranking of potential impacts on terrestrial flora/biotopes – German landfall area**

Physical changes to landform and land use during the construction and operation of NSP2 have a significant impact on the loss of terrestrial biotopes. The airborne emissions during the construction phase have a non-significant impact. The overall project assessment on terrestrial biotopes is summed up in Table 10-56.

**Table 10-56 Overall project assessment and country-specific impact ranking and anticipated transboundary impacts.**

Terrestrial biotopes	Project	RU	FI	SE	DK	GE	Trans
Physical changes to landform or land cover (natural or man-made), land acquisition/use	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Change to landfall/use	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

## 10.8.2 Terrestrial fauna

The following potential sources of impacts on terrestrial fauna at the German landfall were assessed:

- Land acquisition/use (construction and operation);
- Traffic and construction activity (construction);
- Noise generation (construction and operation);
- Light (construction and operation);
- Emissions to air (construction);
- Interruption of exchanges between sub-habitats (construction and operation).

### 10.8.2.1 Land acquisition/use (construction and operation)

Land acquisition and the loss of habitat structures by the removal of vegetation and soil in the area of the planned gas receiving terminal and in the area of temporarily used surfaces can potentially impact breeding birds, amphibians, reptiles, ground beetles, bats and other mammals during NSP2 construction works. Additionally, land acquisition can influence the exchange relations between partial habitats by keeping the premises clear. Furthermore, maintenance and repair works can potentially impact the terrestrial fauna while NSP2 is in operation.

#### Assessment of potential impacts

The impacts on breeding birds can be described as disturbing individuals during breeding activities and loss of breeding habitats of medium and high importance. Land acquisition and the loss of habitat structures have to be considered during all phases of NSP2. During construction, the loss of habitats of medium and high importance can be of short or permanent duration, due to the different regeneration times of forest and surface habitats. It therefore must be assessed as a medium impact magnitude, even though the spatial extent is small. Related to the facilities of NSP2, the loss of parts of the pine forest as bird habitat of medium importance is permanent but on a small scale. It is assessed as a medium impact magnitude. Losing one starling and one woodcock habitat after the NSP2 facilities are built will be permanent but on a small scale. As just two bird species are affected, this impact magnitude is assessed as low. During operation of NSP2, short-term and small-scale impacts of low intensity on bird habitats will occur while maintaining and repairing the system. The resulting impacts are assessed as low. Due to the differing regeneration times of forests and open space habitats, as well as the varying permanent or temporary land use, a short-term up to permanent and local loss of important to medium-important bird habitats must be expected.

In the course of the project, land acquisition and land use in connection with construction and operation will require removal of vegetation and potential amphibian habitats will be destroyed in the area of the German landfall Lubmin 2. However, the project area is of minor importance for amphibians, as no potential spawning waters occur in the close surroundings. Furthermore, just a small number of individuals were identified in the course of field surveys prior to the project. Nevertheless, the loss of potential amphibian habitats in the area of the PTA and adjacent areas

is of high intensity, as even though the impact ranges on a small scale, the structures will be permanently lost. Re-cultivation is not planned and the intervention is irreversible. On this basis, the impact magnitude is assessed as medium to high, whereas the sensitivity and importance of the amphibian habitats affected is assessed as low.

In this context of land acquisition and use, potential reptile habitats will be destroyed. In the course of operation, solid and partial filling occurs together with the development of open spaces and greening. The German landfall area is of medium importance for reptiles, as various suitable habitats that vary on a small-scale between forests and shrub habitats as well as dry and open soil areas represent favourable habitats for reptiles. Therefore, and due to the irreversibility of the impact, the loss of habitats in the area of the PTA is of high intensity. The impact is permanent, but on a small-scale and no re-cultivation is planned in that area. Accordingly, the impact magnitude is assessed as medium to high and the sensitivity of the locally occurring reptile population is assessed as moderate.

Areas used for project related activities can also generally lead to the loss of ground beetle habitats. However, the ground beetles in the beach habitats will not be affected, as no beach habitats of ground beetles will be destroyed during construction or operation of NSP2. Therefore, the impact magnitude is assessed as negligible and their sensitivity can be assessed as low.

Due to construction-related tree felling in order to clear the construction field for the PTA and the building site facilities, the permanent removal of potential roosts of tree-dwelling bats and other terrestrial mammals is possible. For the affected woodlands, a permanent modification of the habitat structures and functions is predicted. This will be prevented by specific measures, which include the installation of alternative bat quarters (for more detailed information, see the German application document AFB /319/). The pile driving work for the permanent installation of the micro-tunnels is considered to have no significant impacts on the habitats of terrestrial mammals. In the German landfall area Lubmin 2, impairments of terrestrial mammals through land acquisition and loss of habitat structures altogether are assumed to be of high intensity. However, due to the application of specific measures, intensity can be reduced to medium. Therefore the impact magnitude on the highly sensitive local terrestrial mammal populations is predicted as medium.

According to the impact magnitudes and receptor sensitivities listed above, the impact of construction and project related land acquisition is assessed for terrestrial fauna as **negligible** (ground beetles), **minor** (amphibians) and **moderate** (reptiles, bats and other mammals, breeding birds).

#### 10.8.2.2 Traffic and construction activity (construction)

Construction activities and traffic related to constructional works can cause the loss of individuals by road casualties or collisions in general.

##### Assessment of potential impacts

Because the area around the PTA only contains less suitable and rarely used amphibian habitats, the occurrence of amphibians will be low even in the worst-case scenario. Construction related traffic that may cause the loss of single individuals will be of high intensity (as it might cause the death of single individuals), but on a small-scale and of short duration. As the possible intervention will have no lasting consequences to the local amphibian population, it is judged as reversible and results in a low impact magnitude on an amphibian population of minor importance and sensitivity.

Due to the permanent construction activities in the area of interest, general avoidance behaviour by reptiles can be expected. As the potential loss of single individuals is irreversible, the intensity is high. However, the overall impact magnitude is assessed as low, as it is reversible in relation



to the local reptile population, which is assessed as of medium sensitivity and medium importance for the area of interest.

The ground beetles in the beach habitats are not affected; therefore the impact magnitude is assessed as negligible and their sensitivity can be assessed as low.

Excavations on the operational area of the PTA can lead to the burial of underground living small mammals. Threats to the species inventory are unlikely due to high reproductive rates of small mammals. Excavations have no significance as animal traps for bats or other terrestrial mammals, because these species are able to visually detect pits and avoid them. Construction-related impacts are assessed as local, short-term and with a low impact magnitude on terrestrial mammal populations.

According to the impact magnitudes and receptor sensitivities listed above, the impact of individual animal losses due to construction activities and traffic are assessed for terrestrial fauna as **negligible** (ground beetles, bats and mammals) and **minor** (amphibians, reptiles).

### 10.8.2.3 Noise generation (construction and operation)

Noise emitted during the onshore construction works, e.g. due to ramming for the micro-tunnel or compressor operation during pre-commissioning, as well as during operation of NSP2, e.g. when blowing out gas, can potentially impact breeding birds, amphibians, reptiles, bats and other mammals.

#### Assessment of potential impacts

Constructional and operational acoustic disturbances to medium sensitive breeding bird species will be restricted to the near surroundings of the PTA, the ring road of the construction sites, the micro-tunnel and the compressor stations, including the mounting surfaces. The duration will be short-term, of low intensity will be low and small spatial extent. The noise emissions resulting from gas blow outs will be of high intensity, medium duration and small spatial extent. The impact magnitude is assessed as low. Generally, the impacts of noise generated during construction and operation of NSP2 are assessed minor.

The impact of construction and operation related noise on amphibians during migration and the reproduction season can be widely excluded due to missing mating waters in the near surrounding of the German landfall area Lubmin 2. In general, the emission of noise has only minor impacts on amphibians. The construction and operation-related noise only has a short-term and local impact which are reversible and with an impact magnitude that is assessed as negligible, and the local amphibian population is assessed as of minor importance and low sensitivity.

Construction related acoustic disturbances to terrestrial mammals will be restricted to the near surroundings of the construction sites. Noise generation is expected to have a displacement effect on terrestrial mammals. Especially the summer roosts of bats as well as flight routes and foraging areas can be affected. The greatest disturbance of the roosting sites and foraging grounds of bats is expected by the operation of the compressors during pre-commissioning. This disturbance will be reduced by the application of specific mitigation measures. Consequently, impacts on bats can be excluded. The duration of noise generation will be of medium-term, the intensity will be medium and the spatial extent will be small. Disturbances caused by ramming activity, compressor operation and other construction-related noises altogether are assessed as of medium impact magnitude.

Based on the impact magnitudes and receptor sensitivities listed above, the impact of noise generated during the construction and operation of NSP2 is assessed for terrestrial fauna as **negligible** (amphibians) and **moderate** (breeding birds, bats and other mammals).

#### 10.8.2.4 Light (construction and operation)

Light emitted during onshore construction works, e.g. due to construction site illumination (construction) or traffic from or towards the premises (operation), can potentially impact breeding birds, amphibians, reptiles, ground beetles, bats and other mammals.

##### Assessment of potential impacts

The illumination of the construction site will be restricted to the PTA, the micro-tunnel and the compressor station (including mounting surfaces). It therefore can be considered as small-scale impact with a low intensity and medium duration. In contrast to that, the traffic from and towards the premises will be permanent, but also restricted to the PTA and the adjacent areas. This spatial expansion can be assessed as small-scale and the impact intensity as low.

Light emissions could attract ground beetles and therefore cause the loss of individuals, e.g. by collision after being attracted. The ground beetles in the beach habitats are not affected; therefore, the impact magnitude is assessed as negligible and their sensitivity can be assessed as low.

Light emissions on the construction site and the surrounding environment can have a repelling effect on terrestrial mammals. In particular, the light sources in the close vicinity of the summer roosts of bats as well as the flight routes and foraging areas of sensitive bat species can lead to impairment. Light emissions will be widely reduced due to the application of specific mitigation measures and professional planning. Disturbances caused by light emissions are considered to be of medium duration and on a medium scale. The extent of the impairment of terrestrial mammals is expected to be of low intensity.

The impact of light of terrestrial fauna based on intensity, duration and spatial extent as outlined above is assessed as **negligible** (ground beetles) and **minor** (breeding birds, bats and other mammals).

#### 10.8.2.5 Emissions to air (construction)

The introduction of air pollutants during the onshore NSP2 construction works can potentially impact breeding birds, amphibians, reptiles, ground beetles, bats and other mammals. When assessing the potential impact of air emissions, only emissions related to construction works have to be considered. The emissions will be restricted to the area in the close vicinity of the PTA, and will therefore be of a small spatial extent. The intensity will be low and the duration will be medium-term. In general, the release of airborne pollutants can cause impairment to animals.

##### Assessment of potential impacts

The impairment of amphibians or their habitat structures in the German landfall area and the near surroundings can be excluded. With regard to amphibians, pollutants have a medium impact intensity. The release of airborne pollutants will be of a short duration and on a small scale, thus not inducing irreversible impairments. The impact magnitude is assessed as low on amphibians, which are assessed as of minor importance and of low sensitivity with regard to the release of airborne pollutants.

The impairment of reptiles linked to pollutants released during the construction of NSP2 (mainly nitrogen and particulate matter) cannot be excluded. In contrast, pollution induced impairment of reptile habitats or habitat functions within the construction area can be excluded. As emissions to air will be short-term and local, they do not have irreversible effects and the impact magnitude is assessed as low. The local reptile population and habitats are assessed as to be of medium sensitivity and medium importance.

Emissions to air that can be expected in the area of the starting pit of the micro-tunnel and the mounting and storage areas in the south of the construction site can potentially affect the habitats of ground beetles and cause the loss of individuals. The ground beetles in the beach

habitats in the German landfall areas will not be affected. Therefore, the impact magnitude is assessed as negligible and their sensitivity can be assessed as low.

In general, the release of airborne pollutants can cause an impairment of animals. The emissions will be restricted to the area in close vicinity of the construction site. This area can be affected by time-related limit value exceedances for fine dusts and nitrogen dioxide. Significant impacts on terrestrial mammals are not expected due to the temporal limitation of pollutant emissions and the small spatial extent of emissions.

The impact of airborne pollutants on local populations of terrestrial fauna based on the intensity, duration and spatial extent as outlined above is assessed as **negligible** (ground beetles) and **minor** (bats and other mammals, breeding birds, amphibians, reptiles).

#### 10.8.2.6 Interruption of exchanges between sub-habitats (construction and operation)

Construction and project-related facilities as well as storage areas associated with construction interrupts the possibility for terrestrial species to move between sub-habitats and affects local populations. The clearing of the construction field for the PTA and other building site facilities will lead to a permanent and irreversible fragmentation of forest areas.

##### Assessment of potential impacts

For amphibians in the German landfall area Lubmin 2, this interruption is of medium intensity, local and permanent. Furthermore, the interruption is irreversible, as the facilities will be present throughout the whole period of pipeline operation, resulting in a low to medium impact magnitude on the local amphibian population, which is of minor importance and low sensitivity.

Adverse impacts for reptiles are expected at the German landfall area due to the clearing of areas for the construction of NSP2 related facilities. The area constitutes a permanent barrier between sub-habitats in the near surroundings. Grass snakes and slow worms are very sensitive to the bi-sectioning of habitats /320/ and the interruption of possible exchanges is of medium intensity, local and permanent. Furthermore, the interruption is irreversible, as the project-related facilities will be present throughout the complete operational life of the pipeline. The general impact magnitude for the interruption is assessed as low to medium on the reptile population, which is of medium sensitivity and medium importance.

The construction and project-related facilities as well as the need to keep areas free for mounting or other construction related activities inhibit the free exchange between different ground beetle sub-habitats and can therefore affect the local ground beetle population. The ground beetles in the beach habitats in the German landfall areas are not affected. Therefore, the impact magnitude is assessed as negligible and their sensitivity is assessed as low.

Exchanges between populations, foraging grounds and flight routes of forest-dwelling mammals can also be interrupted. In the German landfall area Lubmin 2, this interruption is of medium intensity, local and permanent. Therefore, the impact magnitude on local terrestrial mammal populations is predicted as minor.

The impact of the interruption of exchange between sub-habitats on terrestrial species, based on intensity, duration and spatial extent as outlined above, is assessed as **negligible** (ground beetles) and **minor** (bats and other mammals, breeding birds, amphibians, reptiles).

#### 10.8.2.7 Summary and ranking of potential impacts on terrestrial fauna – German landfall area

None of the project-related impact sources assessed above have a significant impact on the local amphibian population (Table 10-57).

The assessments for breeding birds in the German landfall area reveal that the construction and operation-related noise generation and land acquisition have a moderate impact ranking,

whereas all other potential impact sources assessed above have no significant impact (Table 10-58).

The assessments for reptiles in the German landfall area reveal that the construction and operation-related land acquisition and land use have a moderate impact ranking, whereas all other potential impact sources assessed above have no significant impact (Table 10-59).

None of the project related impacts have a significant impact on the ground beetles in the beach habitats of the German landfall area Lubmin 2 (Table 10-60).

The impact on bats altogether is assessed as moderate, since moderate structural and functional changes can be predicted for the local bat population. None of the impact sources assessed above have significant impacts on other local terrestrial mammals, and the overall significance is therefore assessed as negligible. Therefore, only the assessment for bats is further illustrated in the table below (Table 10-61).

**Table 10-57 Overall project assessment and country-specific impact ranking and potential transboundary impacts on amphibians.**

Amphibians	Project	RU	FI	SE	DK	GE	Trans
Land acquisition/use	N/A	-	-	-	-		No
Traffic and construction activity	N/A	-	-	-	-		No
Noise generation	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Interruption of exchanges between sub-habitats	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

**Table 10-58 Overall project assessment and country-specific impact ranking and potential transboundary impacts on breeding birds.**

Breeding birds	Project	RU	FI	SE	DK	GE	Trans
Land acquisition/use	N/A	-	-	-	-		No
Light	N/A	-	-	-	-		No
Noise generation	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

**Table 10-59 Overall project assessment and country-specific impact ranking and potential transboundary impacts on reptiles.**

Reptiles	Project	RU	FI	SE	DK	GE	Trans
Land acquisition/use	N/A	-	-	-	-		No
Traffic and construction activity	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Interruption of exchanges between sub-habitats	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

**Table 10-60 Overall project assessment and country-specific impact ranking and potential transboundary impacts on ground beetles.**

Ground beetles	Project	RU	FI	SE	DK	GE	Trans
Traffic and construction activity	N/A	-	-	-	-		No
Land acquisition/use	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Interruption of exchanges between sub-habitats	N/A	-	-	-	-		No
Light	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

**Table 10-61 Overall project assessment and country-specific impact ranking and potential transboundary impacts on bats and other mammals.**

Bats and other mammals	Project	RU	FI	SE	DK	GE	Trans
Land acquisition and habitat loss	N/A	-	-	-	-		No
Interruption of exchanges between sub-habitats	N/A	-	-	-	-		No
Traffic and construction activity	N/A	-	-	-	-		No
Light	N/A	-	-	-	-		No
Noise generation	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

# Impacts on the socio-economic environment

## 10.9 Marine areas

This section considers the potential for the sources of impacts identified in Chapter 8 – Environmental impact identification to result in impacts on the following receptors and resources in the marine areas (offshore, nearshore areas and islands), as identified in the socio-economic baseline:

- People (local communities, recreational users and those who may derive economic opportunities from NSP2);
- Underwater cultural heritage resources (shipwrecks and associated remains and submerged Stone Age settlements).
- Economic resources:
  - Tourism and recreational activities;
  - Commercial fisheries;
  - Traffic (maritime traffic and navigation);
  - Raw material extraction sites;
  - Existing and planned infrastructure (sub-marine cables, pipelines and offshore windfarms).
- Other services:
  - Military practice areas;
  - International/national monitoring stations.

### 10.9.1 People

Nine potential sources of impacts on people are identified in Table 8-3. Of these, seven can be scoped out of the assessment, as outlined in Table 10-62.

**Table 10-62 Potential sources of impacts scoped out for people – marine areas.**

Source of impact	Potential impact	Justification
Release of contaminants and/or nutrients to the water column (e.g. sediment associated contaminants and nutrients) (construction)	<ul style="list-style-type: none"> <li>• Deterioration of health due to the exposure to such contaminants in swimming areas and indirect impacts from consumption of fish caught in areas exposed to such contaminants.<sup>35</sup></li> </ul>	<p>This issue of risks to human health from the consumption of fish that could be exposed to contaminants mobilised by NSP2 activities was raised as a specific concern by stakeholders. The assessment of the potential for bioaccumulation of contaminants and nutrients in fish (Section 10.6.3) identified no significant impacts. There will thus also be no significant impacts on humans from consumption of such fish.</p> <p>In relation to exposure of water users to contaminants in swimming areas, the water quality assessment demonstrated the levels of contaminants as a consequence of NSP2 will be very low (Section 10.2.2.2). Furthermore, due to the imposition of safety zones around</p>

<sup>35</sup> Bioaccumulation of contaminants in fish, should it occur, could potentially affect a much wider group of people (those that undertake recreational fishing in marine areas). However, the potential for impacts on such wider groups can be scoped out for similar reasons as those provided in Table 10-62.

Source of impact	Potential impact	Justification
		construction vessels, any recreational activities will be outside areas where any detectible increase in contaminant levels will occur.
Release of air pollutants and GHGs from vessels (construction)	<ul style="list-style-type: none"> <li>Increase in respiratory diseases due to the deterioration of local air quality from emissions (SO<sub>2</sub>, NO<sub>x</sub> and particulates) from the movement of vessels.</li> </ul>	Due to the imposition of safety zones around construction vessels, any marine based recreational activities will be outside areas where any increase in air pollutant is detectible.
Release of air pollutants and GHGs from vessels (operation)		Vessels are sufficiently far from island communities to avoid impacts on local air quality experienced by people in such locations.
Presence of vessels (airborne noise, visual including light, vessel movement) (construction)	<ul style="list-style-type: none"> <li>Reduction of general amenity due to an increase in ambient noise levels and visual intrusion due to artificial light and vessel movements.</li> </ul>	During construction, the NSP2 vessels will be in proximity to the coastline of Rügen Island (located approximately 2 km from NSP2) and Usedom Island (located approximately 7 km from NSP2), located in German waters, which already have a high density of ship movements, such that any incremental increase in noise or visual intrusion from presence of NSP2 vessels (includes dredging operations) is unlikely to be noticeable to island communities during either construction or operation.
Presence of vessels (airborne noise, visual including light, vessel movement) (operation)		<p>Dredging in the nearshore areas in proximity to Kurgalsky peninsula and Lubmin beach will be performed approximately 500 m from the shore of the landfall areas, so it is unlikely that recreational users will experience any noise or visual impacts.</p> <p>Other island and mainland communities are situated between 10-25 km from NSP2 (south coast of Finland, Gotland and Bornholm) and NSP2 vessels will be sufficiently far from these communities that increases in noise levels or any visual impacts are not expected.</p> <p>Generally, most recreational users are limited to the coastlines. However, safety zones (up to a radius of 3 km) will be implemented around NSP2 vessels during construction, which will exclude the potential presence of any marine recreational users within areas subject to increases in noise levels or visual intrusion.</p> <p>During operation, smaller safety zones of 500 m will be applied around vessels, which will also minimise potential impacts. The limited occasions when this may apply in areas used</p>

Source of impact	Potential impact	Justification
		for marine recreation means that significant impacts are highly unlikely to occur.
<ul style="list-style-type: none"> <li>Safety zones around inspection/maintenance vessels (operation)</li> </ul>	<ul style="list-style-type: none"> <li>Restriction of recreational activities.</li> </ul>	During operation, temporary safety zones up to 500 m will be placed around the maintenance vessels. However, these are anticipated to be required very rarely, for very short periods of time and in limited locations.
<ul style="list-style-type: none"> <li>Release of contaminants from pipeline anodes (operation)</li> </ul>	<ul style="list-style-type: none"> <li>Deterioration of health due to direct exposure to such contaminants (aluminium, zinc and associated trace metals) in swimming areas and indirect impacts from the consumption of contaminated fish exposed to such contaminants (especially Zn, Cd).</li> </ul>	<p>As determined in Sections 10.2.2 and 10.6.3, no significant impacts associated with release of contaminants from pipeline anodes and their bioaccumulation in fish are predicted due to the dispersion of contaminants being limited to the immediate vicinity of the pipeline.</p> <p>In addition, no impacts on recreational users in proximity to NSP2 are predicted, as recreational fishing is generally limited to the coastline and in shallow areas (nearshore areas) and the pipelines will be trenched into the seabed.</p>

The following two sources of impacts have thus been assessed and reported below:

- Release of sediments to the water column (construction);
- Safety zones around vessels (construction).

#### 10.9.1.1 Release of sediments to the water column (construction)

Activities with the potential to release sediments to the water column where people (recreational users) may be present comprise: dredging, cofferdam construction and pipe-lay. Of these, dredging has the highest potential to increase SSC, followed by pipe-lay, but to a substantially lower extent.

The potential impact on people from the release of sediments to the water column comprises:

- Reduction of general amenity in swimming areas (coastlines of islands and nearshore areas) due to an increase in SSC, resulting in an increase in turbidity (reduction in water transparency).

#### Assessment of potential impacts

The bathing waters in recreational areas along the NSP2 route are generally classified as “good water quality”/321/. Therefore, the vulnerability of people to an increase in SSC and turbidity is high as a temporary change in water transparency could potentially have an impact on the general amenity of recreational users. Based on this, the sensitivity of recreational users is high in relation to the release of sediments.

In nearshore and shallow waters, dredging activities will give rise to the highest SSCs. Recreational users present in the immediate vicinity of nearshore areas in Narva Bay and Lubmin beach mainly use these areas for fishing and swimming, with boating associated with Lubmin



beach. An increase in SSCs and turbidity will reduce the transparency of waters used for recreational activities and subsequently impact the general amenity values of recreational users. However, in general, water with SSCs less than 30-40 mg/l tends to be clear, with cloudiness only becoming apparent above these levels.

In Narva Bay, dredging will lead to an increase in SSCs. The dredging modelling results for the Narva Bay nearshore area (Section 10.1.2 and Appendix 3) indicate that the highest amount of sedimentation will be close to the dredging site. Safety zones of up to 3 km will be placed around the NSP2 construction vessels (including those used for dredging operations) (see Chapter 16 – Mitigation measures). Therefore, the impact magnitude will be negligible.

In Germany, dredging operations and offshore interim sediment storage activities will be performed in proximity to Rügen Island, Lubmin beach and Usedom Island. SSCs are expected to be monitored as during dredging associated with construction of NSP, which indicated that beyond 500 m from the dredging operations, SSCs did not exceed the natural variation of up to 60 mg/l experienced during rough weather conditions (Section 10.2.2.1). Turbidity modelling (see Appendix 3) indicates that an increase in SSC in the nearshore area will be less than 1 mg/l, below natural background SSC in Pomeranian Bay of 2-5 mg/l /322/. Based on this, an increase in SSC is expected to be low and confined to the dredging vessels and, as previously mentioned, safety zones will be placed around the NSP2 vessels to prevent any non-project related activities from occurring within the areas. Therefore the magnitude will be negligible.

In the marine areas, NSP2 seabed intervention works will occur 10-25 km off the coastlines of the south of Finland, Gotland and Bornholm. Even though most recreational users in these areas are limited to the coastlines, there may be those that partake in recreational activities in open water, such as diving, and seabed intervention works such as pipe-lay may reduce the transparency of water. In Gotland, although divers normally stay close to the shore, when visiting interesting locations such as wrecks, diving trips can be conducted much further from the coast. In areas around Bornholm, recreational diving is usually associated with visiting interesting locations such as wrecks or other CHOs and is therefore not limited to any specific location; multiple areas within Danish waters are used. Pipe-lay activities in these areas may increase SSCs. Modelling results indicated that increased SSCs will occur in close proximity to pipe-lay activities, and water quality will not be affected beyond a few hundred meters from the pipeline route. Due to safety zones placed around the NSP2 vessels (see Chapter 16 – Mitigation measures) and the buffer zones placed around shipwrecks (diving areas of interest), the impact magnitude will be negligible.

Based on the negligible impact magnitude in both the nearshore and offshore areas, the impact ranking is **negligible**.

#### **10.9.1.2 Safety zones around vessels (construction)**

Activities with the potential to impact people due to imposition of safety zones around vessels during construction comprise: dredging, pipe-lay, post-lay trenching, munitions clearance and rock placement. The resulting potential impact comprises:

- Restriction of recreational activities.

#### **Assessment of potential impacts**

The vulnerability of people to the imposition of safety zones is high because recreational users are dependent on high amenity values and these impositions may temporarily restrict recreational activities.

During construction, temporary safety zones will be established around the NSP2 construction vessels up to a radius of 3 km, and vessels (fishing vessels, passenger/sailing boats) and activities such as diving not related to the project will be restricted within the safety zone. The

safety zones may overlap with recreational activities close to the coastlines of Rügen Island and those in the nearshore areas of Narva Bay and Lubmin, especially during the summer when the number of recreational users generally increases. Recreational activities in open waters include fishing, diving, leisure boating and passenger cruise ships, and the imposition of safety zones will prevent access to any areas of interest within these zones as well as the passage of boats. However, construction activities will be temporary (typically progressing at 2-3 km per day in offshore areas of the route) and disturbance at any particular location will generally be for less than 24 hours (with peak durations at the landfalls). Based on this, the magnitude will be negligible.

The high sensitivity and negligible impact magnitude result in a **negligible** overall project ranking for people in both the offshore and nearshore areas, which is not significant.

### 10.9.1.3 Summary and ranking of potential impacts on people

A summary of the overall project impact rankings for people arising from the potential sources of impacts scoped into the assessment is provided in Table 10-63, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

As impacts will be determined primarily by the imposition of the safety zone, which will prevent the presence of people within areas subject to increased SSCs, there is a limited potential for “in-combination” impacts on people from these two sources of impacts.

The increase in SSCs and imposition of safety zones are insufficient to affect recreational users of neighbouring marine waters, and thus no potential for transboundary impacts has been identified.

**Table 10-63 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

People	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column							No
Safety zones around vessels							No
Impact ranking:	Negligible		Minor		Moderate		Major

### 10.9.2 Cultural heritage

Three potential sources of impact on underwater cultural heritage objects (CHOs) are identified in Table 8-3. Of these, two have been scoped out of the assessment from further consideration, as outlined in Table 10-64.

**Table 10-64 Potential sources of impact scoped out for underwater cultural heritage.**

Source of impact	Potential impact	Justification
Sedimentation on the seabed (construction)	<ul style="list-style-type: none"> <li>Sedimentation and erosion may cause damage to CHOs.</li> </ul>	As assessed in Section 10.2.1.3, sedimentation resulting from deposition of particles suspended during construction will be confined to the immediate vicinity of NSP2 and in general be limited to less than 1 mm depth. Monitoring performed during the implementation of NSP indicated that no changes in the conditions of CHOs resulted from the low levels of sediment deposition arising from construction activities, nor from erosion in the vicinity of the pipelines.
Presence of pipeline structures (operation)		

The following source of impact has thus been assessed:

- Physical changes to seabed features (construction).

#### 10.9.2.1 Physical changes to seabed features (construction)

Activities with the potential to cause physical changes to seabed features where CHOs may be present comprise: dredging, pipe-lay, post-lay trenching, rock placement and munitions clearance. These may cause impacts on CHOs through:

- Damage or destruction to CHOs (known or as yet to be discovered);
- Enhanced knowledge and scientific research potential due to recording, and potentially recovery, of previously unknown features.

#### Assessment of potential impacts

The vulnerability of CHOs to physical changes to seabed features is high because CHOs are fragile and irreplaceable and often cannot be moved without a degree of loss of their value. When combined with their high importance (Section 9.9.2.3), CHOs are considered to have a high sensitivity to physical changes to seabed features.

As identified in Section 9.9.2, the potential for submerged Stone Age settlements to be present in the vicinity of NSP2 is extremely low and as such, they have therefore not been considered further in the assessment.

Munitions clearance will take place in Russian and Finnish waters and has potential to damage any CHO typically within a radius of 0-8 m (Section 10.2.1.1), while pipe-lay and seabed intervention activities could similarly affect any feature within the footprint of the pipeline. An anchor-positioning system will be used in Russian (over a 14 km stretch)<sup>36</sup> and German waters (and over a small stretch in Danish waters) consisting of up to 12 anchors. During pipe-lay and dredging, such impacts could be experienced within a wider corridor both from the placement of the anchors but also from the associated catenaries (curves) and sweep of the anchor wires.

Geophysical and visual surveys have been used from an early stage of project development to identify potential CHOs and the alignment of NSP2 has wherever possible been modified to avoid such features and minimise the number that remain within its potential impact area.

As outlined in Section 9.9.2.1 (Table 9-25), to date, a total of 21 potential CHOs have been detected within the immediate vicinity of NSP2 that could be affected by construction activities and could therefore require management measures (as indicated in Section 9.9.2.1) to ensure that any important features are adequately safeguarded. Of these, three within Finland have, due to their distance from the route, been excluded from being subject to management measures during construction, although their condition will be monitored prior to and following construction.

As discussed in Section 9.9.2.1, it is likely that, following further visual inspection of the other 18 CHOs listed in Table 9-26, subsequent analysis and discussion with the relevant authorities to clarify their nature, the number of these features requiring measures ahead of, during or after construction will be substantially lower. It is nonetheless anticipated that based on the visual surveys, analyses and consultations undertaken to date that the following features will warrant such attention (ongoing surveys such as those in German waters, will confirm other features requiring measures):

- WWII historical site S-R09-09806, a WWII barrage that extends across the NSP2 route and for which a procedure has been already agreed with the authorities.

<sup>36</sup> An anchored pipe-lay vessel will be used for part of the route (over a 14 km stretch) and a DP vessel will be used for the rest of the route.

- A wreck in Germany considered significant to regional and northern European history.

Following completion of the outstanding surveys and analyses, the measures required to safeguard CHOs prior to and during construction, as well as to monitor their condition post-construction, will be agreed with the authorities in each country and implemented as required. Such measures are anticipated to include the following, as outlined in Chapter 16 – Mitigation measures:

- Local diversion of the NSP2 route to avoid identified CHOs;
- Site-specific placement and use of pipe-lay vessel anchors that ensure that wires and chains are used in a manner that avoids impacts on identified CHOs;
- Controlled lay procedure that ensures adherence to a specified safety distance between a given CHO and the NSP2 route.

These measures will, however, be modified as required to incorporate any additional requirements emerging from consultations with the authorities.

In addition, the potential for NSP2 to damage CHOs which may not be identified ahead of construction will be addressed through the following:

- Pre-lay geophysical surveys to identify both CHOs and undetonated munitions within the final NSP2 corridor;
- Chance Finds Procedure to specify and manage actions in the event of chance finds of objects that could potentially be CHOs. This will include, among other, notification instructions to inform the national cultural heritage agencies of the finds, contractor roles, management actions, responsibilities and lines of communication;
- In the event that non-detonated munitions are identified near CHOs, there will be a case by case assessment made by a marine archaeologist, in consultation with the relevant authorities.

The application of the above measures will in general ensure avoidance of damage to CHOs, resulting in a negligible impact. However, in the event of NSP2 causing a degree of intrusion on, or requiring recovery of a CHO, an impact of negligible to low magnitude may result due to alteration of, or removal of the CHO from, its current setting. When combined with the high sensitivity of CHOs to physical changes in the seabed, this results in impact which is at most **minor**, which is not significant.

The surveys and analyses of CHOs undertaken to inform the country level assessments and Espoo Report will provide a valuable resource regarding such underwater features in the Baltic Sea that will be available for future research activities. As such, it results in a degree of **positive** impact on such cultural heritage research resources.

#### 10.9.2.2 Summary and ranking of potential impacts on underwater cultural heritage

A summary of the overall project impact ranking for underwater cultural heritage arising from the potential source of impact scoped into the assessment is provided in Table 10-65, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

As there is only one source of impact on cultural heritage during construction, no “in-combination” impacts are anticipated.

They may be some wrecks of varying national origin present in the jurisdiction of other countries, which may result in another country claiming an interest in the feature. However, all potential CHOs are protected under UNCLOS and UNESCO and buffer zones will be applied to prevent any

damage to such features and therefore, no potential for transboundary impacts has been identified.

**Table 10-65 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Cultural heritage	Project	RU	FI	SE	DK	GE	Trans
Physical changes to seabed features (natural and man-made features)			*				No
Impact ranking:	Negligible		Minor	Moderate	Major		
*Minor impact due to a peak of sensitivity for one site (CHO S-R09-09806).							

### 10.9.3 Tourism and recreational activities

The following potential source of impact on tourism and recreational activities has been identified in Table 8-3, as listed below, and has thus been assessed:

- Employment generation (construction).

#### 10.9.3.1 Employment generation (construction)

Activities with the potential to generate employment and/or impact tourism and recreational activities comprise: dredging, pipe-lay, post-lay trenching, munitions clearance and rock placement. During operation, the safety zones in the vicinity of inspection/maintenance vessels may also affect tourism and recreational activities. Of these, dredging has the highest potential to reduce the general amenity, followed by imposition of safety zones and pipe-lay. The resulting potential impact comprises:

- Reduced tourism business revenues caused by reduction of general amenity.

#### Assessment of potential impacts

The vulnerability of tourism and recreational activities in relation to employment generation (tourism-related) is typically medium-high because the NSP2 route is in the proximity of areas where the tourism sector is dependent on high amenity values (or, in some areas, not dependent on high amenity values) in terms of tourism-related business revenues. Given the high importance (as discussed in Section 9.9.3.1), a medium-high sensitivity is given to tourism-related employment generation. An exception is made for Narva Bay, where the vulnerability of tourism and recreational activities to tourism-related employment generation is low because tourism activities play a small role in the economy of the district and region. When combined with the low importance (as discussed in Section 9.10.3.1), a low sensitivity is given to employment generation in Narva Bay.

As discussed in Section 9.9.3, tourism and recreational activities have been identified along the NSP2 route, with the closest activities mainly occurring on Rügen Island. As discussed in Section 9.9.3, even though most tourism and recreational activities are limited to the coastline, a few are undertaken in open waters, such as recreational fishing, diving and leisure boating/ sailing activities and passenger cruise ships, which are popular year round.

During construction, dredging operations in the nearshore areas may lead to an increase in noise increment levels, visual impacts and sedimentation, which may impact tourism-related business revenues. As discussed in Section 10.10.1, no impacts from dredging operations are anticipated on recreational users due to the imposition of safety zones, and therefore, dredging operations will not discourage tourists/recreational users from visiting recreational areas. As such, dredging operations will not lead to reduced tourism business revenue. Thus, the intensity will be low, resulting in a negligible impact magnitude. Furthermore, no transboundary impacts are

anticipated in Estonia as a result of sedimentation from dredging operations in the Narva Bay landfall; hence no impacts on tourism are expected.

Pipe-lay activities will occur in areas used for diving and fishing. Modelling results, as indicated in Section 10.1.1, may lead to increased SSCs; however, this was shown to occur in close proximity to seabed intervention works, and thus water quality will not be affected beyond a few hundred meters from the pipeline route. Furthermore, due to safety zones placed around the NSP2 vessels (see below) and buffer zones placed around shipwrecks (diving interests) (see Section 10.10.2), recreational users partaking in diving and fishing will not be impacted. Subsequently the intensity will be low, resulting in a negligible impact magnitude on employment generation for tourism-related business revenues.

The imposition of safety zones around construction vessels will restrict non-project related activities and vessels from entering these zones. However, as determined in Section 10.1, offshore construction activities will be temporary (typically progressing at 2-3 km per day) and disturbance at any particular location will generally be for less than 24 hours. Therefore, it is not expected that tourism-related business will be impacted. Therefore, the intensity will be low, resulting in a negligible impact magnitude. During operation, temporary safety zones with a radius of up to 500 m will be placed around the maintenance vessels. However, these are anticipated to be required very rarely, for very short periods of time and in limited locations.

The medium-high sensitivity of tourism and recreational areas (low sensitivity in Narva Bay) and negligible impact magnitude in both areas gives an overall project ranking for tourism and recreational areas as **negligible**, therefore resulting in an impact that is not significant.

#### 10.9.3.2 Summary and ranking of potential impacts on tourism and recreational activities

A summary of the overall project impact rankings for tourism and recreational activities arising from the potential sources of impact scoped into the assessment is provided in Table 10-66, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

As there is only one source of impact on tourism and recreational activities during construction, no "in-combination" impacts are anticipated.

The increase in SSC is insufficient to reduce tourism business revenues and hence no potential transboundary impacts have been identified.

**Table 10-66 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Tourism and recreational areas	Project	RU	FI	SE	DK	GE	Trans
Employment generation			-	-	-		No
Impact ranking:	Negligible		Minor		Moderate		Major

#### 10.9.4 Commercial fisheries

Six potential sources of impacts on commercial fisheries have been identified in Table 8-3; of these, two have been scoped out of the assessment, as outlined in Table 10-67.

**Table 10-67 Potential source of impact scoped out for commercial fisheries.**

Source of impact	Potential impact	Justification
Release of sediment to the water column (construction)	<ul style="list-style-type: none"> <li>Reduction in income generation potential due to avoidance behaviour in fish during construction works.</li> </ul>	Fish will return to the impacted area shortly after the disturbance has ceased.
Generation of underwater noise (construction)	<ul style="list-style-type: none"> <li>Reduction in income generation potential due to avoidance behaviour in fish during construction works.</li> </ul>	Fish will return to the impacted area shortly after the disturbance has ceased.

The following sources of impacts have thus been assessed and are reported below:

- Presence of vessels (conflict of marine space uses) (construction and operation);
- Safety zones around construction vessels (construction);
- Safety zones around and inspection/maintenance vessels (operation);
- Presence of pipeline structures (operation).

##### 10.9.4.1 Presence of vessels (construction and operation)

Activities that require the use of vessels where commercial fishing activities may be present comprise: dredging, post-lay trenching, rock placement, munitions clearance, anchor handling, pipe-laying and inspection/maintenance.

The potential impacts on commercial fisheries due to the presence of vessels comprise:

- Propeller damage to long-lines and gill nets;
- Conflict of space with other marine users such as trawlers and other fishing vessels.

##### Assessment of potential impacts

In general, the vulnerability of fisheries to the presence of vessels is low since the Baltic Sea has intense ship traffic and the fishermen are adapted to a high amount of ship traffic/vessel movements. The perception of vulnerability may, however, be different for fishermen since the project area is of local significance to the livelihoods of some of them. However, many fishermen fish in multiple ICES squares and are therefore thought to have a lower vulnerability to localised impacts, as they can fish in other areas. In addition, although commercial fisheries are of high economic importance (see Section 9.9.5.3), a low sensitivity of commercial fisheries is given in relation to the presence of vessels.

Vessels associated with the construction of NSP2 may impact the longline and gill net fisheries by cutting the fishing gear with their propellers, resulting in the loss of the fishing gear. The longlines and gill nets are in some cases up to several kilometres long (equipped with hooks every 1-3 m). This method is, however, generally used in shallow waters and in water conditions where reefs do not allow trawling. The impact is assessed to be very limited, as only relatively few fishermen use longlines. In addition, the duration of a fishing restriction will be limited to a few days for each of the specific areas. NSP2 will avoid any such impact and as mentioned in Chapter 16 – Mitigation measures, the fishermen will be informed about the locations of construction vessels and their associated safety exclusion zones to increase awareness of the vessel traffic associated with the project. Impacts on gill nets in German coastal waters will be avoided by the exclusion of the herring spawning season from the offshore

construction timeframe as well as by definition of certain route corridors for dredgers and barges in shallow, nearshore waters. In terms of other fishing activities, due to the short presence of vessels at any location, conflicts with such other marine uses will be limited to several days. Moreover, since most fish are assessed to avoid the site during construction (see Section 10.6.3), the presence of vessels is unlikely to impact the chance of finding fish in that particular area.

During operation, inspection/maintenance surveys of the pipelines are expected to be carried out on a regular basis; one or two year intervals at the beginning of the operation phase. Later in the operation phase, there will be longer intervals between these surveys. Similar impacts are anticipated as during construction phase, but with a smaller magnitude.

Although fisheries are considered to be of high importance (see Section 9.9.5.3), owing to their low vulnerability, the sensitivity is assessed as low. This combined with the local extent and the temporary impact, the impact magnitude on commercial fisheries from presence of vessels is assessed to be negligible.

Due to the negligible impact magnitude and low sensitivity, it is assessed that the impact ranking is **negligible**, and therefore the impact is assessed as not significant.

#### **10.9.4.2 Safety zones around construction vessels and inspection/maintenance vessels (construction and operation)**

Activities that require the use of safety vessels where commercial fishing activities may be present are similar to those identified in the assessment in Section 10.9.4.1, and comprise: dredging, post-lay trenching, rock placement, munitions clearance, anchor handling, pipe-laying and inspection/maintenance. Safety zones will be established around the pipe-lay vessel during pipe-lay in order to avoid collision. Unauthorised ship traffic, including fishing vessels, will not be permitted to enter this safety area. There will also be additional traffic and safety zones around other vessels during rock placement, munitions clearance and the construction of the hyperbaric tie-in, for example. The safety zones around those vessels will be 500 m or agreed with the relevant shipping authorities in advance of the construction commencement (see Section 10.9.5).

The potential impacts on commercial fisheries from the safety zones around vessels comprise:

- Hindrance of the passage of trawlers and other fishing vessels conducting fishery activities.

#### **Assessment of potential impacts**

The vulnerability of fisheries in relation to safety zones is considered to be low since many fishermen fish in multiple ICES squares and therefore have a lower vulnerability to localised impacts as they can fish in other areas. Combined with the high importance of fishery (see Section 9.9.5.3), a low sensitivity is given to the presence of vessels.

During construction, the pipe-lay vessel will move forward with a speed of approximately 2-3 km a day, and so the duration of the fishing restriction will be very limited at any given location. The duration of the impact is hence temporary and of a local nature and the intensity of the impact is regarded as low. Moreover, since most fish are assessed to avoid the site during construction, the presence of vessels and their safety zones are not expected to affect the opportunities of finding fish in that particular area. Owing to the low vulnerability, the sensitivity is assessed as low. The impact magnitude is therefore assessed as negligible.

During operation, similar impacts are anticipated as during the construction phase, but with a smaller magnitude, as pipeline maintenance surveys are expected to be carried out on once or twice per year.

Due to the negligible impact magnitude and low sensitivity, it is assessed that the impact ranking is **negligible**, and therefore the impact is assessed as not significant.



#### 10.9.4.3 Presence of pipeline structures (operation)

The presence of pipeline structures may interfere with commercial fisheries.

The impact on commercial fisheries due to pipeline structures can be:

- Loss of fishing area;
- Reduction in catch;
- Loss or obstruction of fishing gear.

#### Assessment of potential impacts

The vulnerability of fisheries from the presence of pipeline structures is assessed to be low. Only a very small area of the seabed will be occupied by the pipeline system, and therefore not available for fisheries. This area is <1% compared to the overall fishing area (ICES rectangles) within the Baltic Sea and it is important to note that the lost area is not equated with a direct loss to fishermen, but merely a loss of opportunity. Even though fisheries have a high economic importance (see Section 9.9.5.3), a low sensitivity is given in relation to the presence of pipeline structures.

There will be no restrictions on fishery due to the presence of the pipelines. However, where the pipelines are placed on top of the seabed, there may be a certain impact where bottom trawling is practiced. Scale model tests have shown that there could be a risk of gear getting stuck in areas where the pipeline is lying flat on the seabed, especially if the approach angle to the pipeline is small (less than 15 degrees). In areas where the pipeline does not naturally embed itself into the seabed, the fishermen have to cross the pipeline at as steep of an angle as possible – preferably 90 degrees – to reduce the risk of the trawl boards getting stuck. So the pipeline will to some extent reduce the ability for fishermen to fish where they want, as they must adapt their trawl patterns to some extent. This impact is limited to areas where bottom trawling is practiced. Pelagic trawlers will be able to avoid the pipelines by allowing sufficient distance between the pipelines and the towed net.

In the eastern part of the Gulf of Finland, there will be significant areas of freespan along the pipeline. In these areas, there is a potential risk for the trawl equipment to become snagged on the pipelines, which makes them worth avoiding for safety reasons. However, the prevailing trawling method in these areas is mid-water trawling, which significantly reduces any possible impact due to the freespan sections.

Monitoring of fisheries conducted in Finland during NSP (2007-2014) showed that the construction and operation of NSP has not been a major problem for pelagic trawling in the Gulf of Finland. According to the some fishermen, the pipelines have caused some hindrance, but the majority of them have not experienced this. Offshore fishing in the Gulf of Finland has diminished during this time period, but according to VMS data, the proportion of fishing conducted in the vicinity of the pipeline corridor has not changed /323/. In Sweden, changes in bottom trawling patterns and net fishery patterns were not observed during the monitoring period (2010-2014) and the patterns were the same as those observed during the baseline survey in 2004-2009. No changes to fishery patterns were observed as a result of the presence of the pipeline system /324/.

Experience from NSP has shown that fishermen can co-exist with the pipeline. To date, no gear has been reported lost or damaged. Natural embedment (and post-lay trenching) of the pipeline has in most locations - depending on the seabed conditions – significantly reduced the risk and hassle for bottom trawling activities. Analysis of the embedment of NSP shows that five years after installation, the pipeline is embedded >50% in most locations. A significant impact is therefore not anticipated on fish stocks (Section 9.4.5).

Based on the above, the impacts of the pipeline on the seabed are long-term but of local spatial extent. The impact intensity is assessed as low, as the presence of the pipelines on the seabed will have a very limited effect on commercial fisheries. It will only affect bottom trawling to a minor extent in areas where the pipelines do not embed into the seabed, and it can have an impact on pelagic trawling in areas with extensive freespan sections, such as in the eastern part of the Finnish EEZ. However, the fishermen have no direct loss, as they may choose to fish somewhere else. The impact magnitude on commercial fisheries is therefore assessed to be low.

Overall, because of the low impact magnitude and the low sensitivity, it is assessed that the impact ranking is **minor**, and therefore the impact is assessed as not significant.

#### 10.9.4.4 Summary and ranking of potential impacts on commercial fisheries

A summary of the overall project impact rankings of commercial fisheries arising from the potential sources of impact scoped into the assessment is provided in Table 10-68, together with the rankings predicted at the country level.

Owing to the nature of the impacts associated with each of the sources of impacts considered above, there is a limited potential for “in-combination” impacts on fisheries. The presence of vessels along with their safety zones have similar impacts on fisheries and will not cause an in-combination impact with the presence of the pipelines on the seabed. Therefore, the ranking of impacts on this receptor group resulting from all sources of impact is likely to be at most negligible.

Fisheries in the Baltic Sea originate from various countries other than where the source of impact occurs and thus there is a potential for transboundary impacts on all the PoO and AP countries. This potential transboundary impact on fishermen is discussed in Chapter 15 – Transboundary impacts.

**Table 10-68 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Commercial fisheries	Project	RU	FI	SE	DK	GE	Trans
Presence of vessels							Yes
Safety zones around construction vessels							Yes
Safety zones around inspection/maintenance vessels							Yes
Presence of pipeline structures							Yes
Impact ranking:	Negligible		Minor		Moderate		Major

#### 10.9.5 Traffic

Three potential sources of impacts on ship traffic have been identified in Table 8-3, as listed below, and have thus been assessed:

- Safety zones around construction vessels (construction);
- Safety zones around inspection/maintenance vessels (operation);
- Presence of pipeline structures on the seabed (operation).

##### 10.9.5.1 Safety zones around construction vessels and inspection/maintenance vessels (construction and operation)

Activities with the potential to impact maritime traffic movement due to the imposition of safety zones around vessels during construction comprise: dredging, pipe-lay, post-lay trenching,

munitions clearance and rock placement. During operation, the safety zones in the vicinity of inspection/maintenance vessels may also affect maritime movements. The resulting potential impact comprises:

- Restrictions to commercial ship movements.

### Assessment of potential impacts

The vulnerability of ship traffic movements and those that are reliant on them to the imposition of safety zones around vessels is typically low as the operators generally have a high ability to navigate around these zones. However, NSP2 does cross several shipping routes in shallower waters (see Table 9-27 in Section 9.9.4), notably in Russian waters (where there are two shipping routes, all with relatively lower volumes of traffic); small areas in Finnish waters (one route with higher traffic volumes, FI-D); Swedish waters (three routes with lower volumes and one route with higher traffic volume routes, SE-D); Danish waters (one route with lower traffic volumes, two which are close to the German boundary (DK-A and DK-B) and German waters (where there are five shipping routes, all with relatively lower volumes of traffic)). There may be less ability to navigate around such zones resulting in a medium vulnerability at these locations. When combined with the high importance (Section 9.9.4.1) of ship traffic, a low (deep water) to medium sensitivity (shallow water) is given to ship traffic in relation to the imposition of safety zones around vessels.

During construction, safety zones will be imposed around construction vessels in the order of 3 km for the anchor lay barge, 2 km for the DP pipe-lay vessel, and 500 m for other vessels. Only vessels involved in the construction of NSP2 will be allowed inside the safety zone and all non-project related vessels will be required to plan their journey around the safety zones. As identified in Section 9.9.4, NSP2 vessels will cross a total of 19 primary ship routes (Figure 9-38), of which four are considered as intense ship traffic routes, located in the Finnish and Swedish EEZ (routes FI-B, FI-D, SE-D and SE-I), while two of these (SE-D and FI-D) are located in shallow water. The presence of NSP2 construction vessels may therefore cause a degree of restriction to ship movements, particularly those that use the two shipping lanes in shallow waters.

As discussed above, in deep waters, the duration of such restrictions associated with the presence of pipe-lay, post-lay trenching and rock placement vessels will be very short, due the speed of movement /short presence of such vessels at any specific site. Similarly, the duration of any vessels undertaking munitions clearance is on the order of hours. Hence, impacts in deep water will be of a short duration and of limited spatial extent at any specific location. In shallower waters, the rate of pipe-lay will be slower, notably in German waters, where the rate may be on the order of 500 m per day. Although the duration of the impact may be longer than in deep waters, it is unlikely to persist for more than several days. As part of their commitment (Section 16.2) to manage vessel traffic that may generally move within the safety zones, Nord Stream 2 AG, in conjunction with relevant construction contractors and the Maritime Authority, will give prior notification of the planned locations of their construction vessels and the size of the requested Safety Exclusion Zones through Notices to Mariners to ensure there is appropriate awareness of the vessel traffic associated with NSP2 and to minimise disruption to maritime traffic. Specifically, in relation to lanes FI-B and FI-D, consultations will be undertaken with the pipe-lay contractor and relevant authorities to reduce the safety zone around the pipe-lay vessel from a radius of 1.0 to a radius of 0.5 nm in the TSS Off Kalbådagrund and TSS Off Porkkala Lighthouse.

The impact magnitude during construction is thus generally negligible (low volume traffic lanes) to low (high volume traffic lanes), although due to its very high volumes of traffic, the impact on FI-B may have medium magnitude. When combined with the low sensitivity (deep waters) and medium sensitivity (shallow waters) of maritime traffic to the imposition of safety zones, this results in a **minor** impact ranking for maritime traffic in shipping lanes FI-D, FI-B, SE-B and SE-I. The ranking for impacts on all other maritime traffic is **negligible**.

During operation, there may be some presence of vessels associated with pipeline inspection or maintenance, but these are anticipated to be required very rarely, for very short periods of time and in limited locations. Similar mitigation measures will apply as during construction, resulting in an at most **negligible** impact ranking. Impacts due to the imposition of safety zones are transboundary in nature due to ships originating from various countries that use the shipping routes along NSP2, and transboundary impacts may be experienced by all PoO and AP countries. See Chapter 15 – Transboundary impacts.

#### **10.9.5.2 Presence of pipeline structures on the seabed (operation)**

If the pipelines are installed on the seabed in shipping lanes in shallow waters, notably in Germany, this could constrain ship traffic due to reduced under-keel clearance for vessels traffick these shipping lanes. The impact on ship traffic due to pipeline structures on the seabed could therefore be:

- Restrictions to ship movements.

#### **Assessment of potential impacts**

NSP2 crosses shipping lanes in shallow areas (less than 20 m water depth) only in German waters (refer to Table 9-31) where NSP2 crosses the Northern (Shipping Lane 20) and the Western Approaches of the Polish harbours of Szczecin and Świnoujście.

A risk assessment conducted for NSP2 established that the pipelines can be placed on top of the seabed at a water depth of 17.0 m and deeper without any additional protection.

In the area of the Northern Approach, water depths range from 18.0 m to 18.1 m, and here the pipelines are placed on top of the seabed. With an outside diameter of the pipelines of less than 1.5 m, this leaves a water column of at least 16.5 m above the pipelines. An analysis of AIS data of vessels navigating the Northern Approach of the harbours of Szczecin and Świnoujście identified a maximum draught of 12.9 m.

In the area of the Western Approach, water depths range from 15 m to 16 m. AIS data shows that ships with a maximum draught of 13.5 m navigate in the Western Approach. In this area, the risk assessment stipulates a burial depth flush-to-seabed. The NSP2 trenching design provides for a burial depth of 0.5 m in this section. As a consequence, water depths remain unchanged.

It can therefore be concluded that there will be no impact on ship traffic due to the presence of the pipeline structures on the seabed.

#### **10.9.5.3 Summary and ranking of potential impacts on ship traffic**

A summary of the overall project impact rankings for ship traffic arising from the potential sources of impact scoped into the assessment is provided in Table 10-69, together with the rankings predicted at the country level. As indicated in the table, in general, none of the impacts are considered to be significant at either the national or overall project level.


Owing to the different nature of the impacts associated with each of the three sources of impacts considered above and the different receptors experiencing them, there is a limited potential for “in-combination” impacts on ship traffic from these three sources of impacts. Therefore, the ranking of impacts on this receptor group resulting from all sources of impact is likely to be at most negligible.

Ship operators that may use ship routes that cross NSP2 originate from various countries other than where the source of impact occurs and thus there is the potential for transboundary impacts

due to the imposition of safety zones during construction and operation on ship traffic, which may be experienced by all the PoO and AP countries (see Chapter 15 – Transboundary Impacts).

**Table 10-69 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Traffic	Project	RU	FI	SE	DK	GE	Trans
Safety zones around construction vessels	*		**				Yes
Safety zones around and inspection/ maintenance vessels							Yes
Presence of pipeline structures on the seabed	N/A	-	-	-	-	No impact	No

Impact ranking: 

\*Minor impact due to a peak of sensitivity rank for routes FI-B, FI-D, SE-D and SE-I; impacts on all other routes are negligible.

\*\* Minor impact due to a peak of sensitivity rank for the TSS off Kalbådagrund and TSS off Porkkala Lighthouse; impacts on all other routes are negligible.

#### 10.9.6 Raw material extraction sites

Two potential sources of impacts on raw material extraction sites have been identified in Table 8-3. Both can be scoped out of the assessment, as outlined in Table 10-70.

**Table 10-70 Potential sources of impact scoped out for raw material extraction sites.**

Source of impact	Potential impact	Justification
Safety zones around construction vessels (construction)	<ul style="list-style-type: none"> <li>Restriction of access to raw material extraction sites.</li> </ul>	Even though NSP2 does not cross any raw material extraction sites, the safety zones around the construction vessels (ranging from 500 m - 3 km) and inspection/maintenance vessels (up to 500 m) may overlap with the sites at Landtief and Proper Wiek (German waters), situated approximately 300 from the proposed NSP2 route. However, the status of these extraction sites is "paused", i.e. there are no general operating plans that exist and therefore no impacts on the site operators of the raw material extraction sites are anticipated /325/.
Safety zones around inspection/maintenance vessels (operation)		

#### 10.9.7 Military practice areas

Two potential sources of impacts on raw material extraction sites have been identified in Table 8-3. Of these, one can be scoped out of the assessment, as outlined in Table 10-71.

**Table 10-71 Potential source of impact scoped out for military practice areas.**

Source of impact	Potential impact	Justification
Safety zones around inspection/maintenance vessels (operation)	<ul style="list-style-type: none"> <li>Disruption of military practice operations.</li> </ul>	During operation, there may be some presence of vessels associated with inspection or maintenance of NSP2, but these are anticipated to be required very rarely, for very short periods of time and in limited locations, and therefore, impacts during the operation phase on military practice areas is not expected.

The following source of impact has thus been assessed:

- Safety zones around construction vessels (construction).

### 10.9.7.1 Safety zones around construction vessels (construction)

Activities that will result in the presence of vessels in the vicinity of military practice areas comprise: dredging, pipe-lay, munitions clearance, post-lay trenching and rock placement, which may impact these areas through:

- Disruption of military practice operations.

#### Assessment of potential impacts

The vulnerability of military practice areas to the presence of vessels is high as military operations will not be able to occur when vessels are present in their vicinity. When combined with the high importance assigned to these areas (Section 9.9.7.4), a high sensitivity is given to military practice areas in connection with the presence of vessels.

As described in Section 9.9.7, during construction, military practice areas will be crossed by NSP2 in the waters of Finland, Denmark and Germany. The imposition of safety zones around the construction vessels (ranging from 500 m - 3 km) would therefore constrain military activities in these areas due to the presence of construction vessels. As previously discussed (Section 10.9.5 and 10.9.6), the duration of such constraints associated with the presence of vessels for pipe-lay, post-lay trenching and rock placement will be very short due to the speed of movement and the short presence of such vessels at any specific site. Similarly, the duration of any vessels undertaking munitions clearance is of the order of hours. In Germany, where dredging will take place, the duration of the impact may be longer where the NSP2 vessels will move at a speed of 500 m per day.

Any disruption of military activities will therefore be of short duration. For the military practice areas crossed by NSP2 in Finland, the Finnish Defence Forces confirmed during the national EIA process that the construction or operation of the pipelines will not have any impacts on the use of the military areas of the Finnish Defence Forces in the Gulf of Finland or the Archipelago Sea.

Furthermore, in accordance with the mitigation commitments (Section 16.3) Nord Stream 2 AG will plan, communicate and coordinate their activities in conjunction with the appropriate authorities to ensure that there will be no conflict between military activities and the timing of NSP2 activities in the vicinity of such military areas.

The impact magnitude during construction is thus negligible, which when combined with the high sensitivity to the presence of vessels, results in an overall project impact ranking which is **negligible** and hence not significant.

### 10.9.7.2 Summary of ranking of potential impacts on military practice areas

A summary of the overall project impact rankings for military practice areas arising from the potential source of impact scoped into the assessment is provided in Table 10-72, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

As there is only one source of impact on military practice areas during construction and operation, no "in-combination" impacts are anticipated.

No potential for transboundary impacts on military practice areas has been identified.

**Table 10-72 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Military practice areas	Project	RU	FI	SE	DK	GE	Trans
Safety zones around construction vessels		No impact	No impact	No impact		-	No
Impact ranking:	Negligible		Minor		Moderate		Major

### 10.9.8 Existing and planned infrastructure

Four potential sources of impacts on existing and planned infrastructure have been identified in Table 8-3. Of these, two sources of impact can be scoped out of the assessment, as outlined in Table 10-73.

**Table 10-73 Potential sources of impact scoped out for existing and planned infrastructure.**

Source of impact	Potential impact	Justification
Safety zones around construction vessels (construction)	<ul style="list-style-type: none"> <li>Restrictions on construction of planned offshore developments that may be planned for construction simultaneously with construction of NSP2.</li> <li>Restrictions on maintenance activities for existing offshore developments that may be required simultaneously with inspection or maintenance of NSP2.</li> </ul>	<p>The duration of safety zones associated with the presence of pipe-lay, post-lay trenching and rock placement vessels will be very short, due the speed of movement of such vessels at any specific site. Similarly, the duration of imposition of safety zones associated with munitions clearance is on the order of hours. Therefore, the restriction of activities of the pipeline and cable operators who may require access to existing infrastructure or areas to construct planned pipelines and cables, which might occur simultaneously with the construction/operation of NSP2 in the same locations, is not expected.</p>
Safety zones around inspection/maintenance vessels (operation)		

The following sources of impact have thus been assessed:

- Physical changes to seabed features (construction);
- Presence of pipeline structures (operation).

#### 10.9.8.1 Physical changes to seabed features (natural and man-made features) (construction)

Activities with the potential to cause physical changes to seabed features where existing and planned infrastructure may be present comprise: dredging, pipe-lay, post-lay trenching, rock placement and munitions clearance. These may affect existing and planned infrastructure through:

- Damage to existing seabed cables and pipelines, which may interrupt supplies with economic implications to the owners of the infrastructure and their customers.

#### Assessment of potential impacts

The vulnerability of existing and planned infrastructure and those dependent on it, due to physical changes to seabed features, is high due to the lack of alternatives available to the owners and their customers to maintain continuity of supplies. When combined with the high importance assigned to such supplies (Section 9.9.8.4), a high sensitivity is given to existing and planned infrastructure, in relation to physical changes to seabed features.

As determined in the baseline analysis (Section 9.9.9), no existing or reserved areas for windfarms or any other developments are located in proximity to NSP2. Therefore, potential impacts on sub-sea cables and pipelines are assessed below.

As described in Section 9.9.8, NSP2 will cross 42 existing pipelines and cables, of which three are currently planned. Without appropriate planning, the activities on the seabed during construction could therefore damage such infrastructure. A key element of the project planning has therefore been to identify where all such existing and planned infrastructure is located and for each of these, in accordance with the mitigation commitments (Section 16.3), Nord Stream 2 AG will develop and adhere to crossing and/or proximity agreements between NSP2 and the relevant sub-sea cable and pipeline owners. In these agreements, the crossing methods and precautionary measures required during construction will be agreed on a case by case basis.

The impact magnitude during construction is thus negligible to low, which when combined with the high sensitivity to the presence of vessels results in an overall project impact ranking which is **negligible** and hence not significant. This is supported by experience from NSP for which no damage to third-party infrastructure was reported during its construction.

Impacts due to physical changes to seabed features are transboundary in nature as the owners of sub-sea infrastructure are located in countries other than where the source of impact occurs and transboundary impacts may be experienced by all PoO and AP countries; see Chapter 15 – Transboundary impacts.

#### 10.9.8.2 Presence of pipeline structures (operation)

Pipeline structures with the potential to affect other existing or planned infrastructure comprise the pipelines as well as supporting structures, which may result in the following impacts:

- Restriction on the ability of the infrastructure to be repaired in crossing areas, with similar consequences for owners and customers;
- Constraints on the construction of future infrastructure on the seabed.

#### Assessment of potential impacts

The vulnerability of existing and planned infrastructure due to the presence of pipeline structures is low as third-party owners of sub-sea cables and pipelines will be able to adapt to changes brought about by NSP2 due to the implementation of agreed crossing methods. When combined with the high importance assigned to such supplies (as discussed in Section 9.9.8.4), a low sensitivity is given to existing and planned infrastructure in relation to the presence of pipeline structures.

The NSP2 pipelines will occupy a corridor of approximately 1,200 km, which will restrict the ability of the infrastructure to be repaired in crossing areas, with similar consequences for owners and customers, as well as limit construction of future infrastructure. However, each crossing will be designed to take into consideration the crossing angle and the burial depth of the cable or pipeline (e.g., specific survey results detailing the state of burial of an installed cable) so that negative impacts on the cables and pipelines will be minimised during both construction and operation. As previously mentioned in Section 10.9.8.1, Nord Stream 2 AG will develop and adhere to crossing and/or proximity agreements between NSP2 and the relevant sub-sea cable and pipeline owners. In these agreements, the crossing methods and precautionary measures required during construction will be agreed on a case by case basis. Therefore, impacts on existing and planned infrastructure from the presence of pipelines and structures will be local, long-term and of low intensity. The impact magnitude is therefore considered to be negligible.

Based on this, the low sensitivity results in an overall project impact ranking which is **negligible** and therefore not significant. Impacts due to the presence of pipeline structures are transboundary in nature as the owners of sub-sea infrastructure are located in countries other



than where the source of impact occurs and transboundary impacts may be experienced by all PoO and AP countries; see Chapter 15 – Transboundary impacts.

### 10.9.8.3 Summary and ranking of potential impacts on existing and planned infrastructure

A summary of the overall project impact rankings for existing and planned infrastructure arising from the potential sources of impact scoped into the assessment is provided in Table 10-74, together with the rankings predicted at the country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Owing to the different nature of the impacts associated with each of the two sources of impact considered above and the receptors experiencing them, there is a limited potential for “in-combination” impacts on existing and planned infrastructure from these two sources of impacts. Therefore, the impact rankings on this receptor group resulting from all sources of impact are likely to be at most negligible in relation to physical changes to the seabed and the presence of pipeline structures.

Several of the owners of, and customers for, the services provided by the subsea cables and pipelines potentially impacted by NSP2 activities are located in countries other than where the activity that may cause an impact occurs. Therefore, impacts on such cables or pipelines have the potential to be transboundary in nature.

**Table 10-74 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Existing and planned infrastructure	Project	RU	FI	SE	DK	GE	Trans
Physical changes to seabed features (natural and man-made features)							Yes
Presence of pipeline structures							Yes
Impact ranking:	Negligible		Minor		Moderate		Major

### 10.9.9 International/national monitoring stations

Four potential sources of impacts on international / national monitoring stations have been identified in Table 8-3. Of these, two sources of impact can be scoped out of the assessment, as outlined in Table 10-75.

**Table 10-75 Potential sources of impact scoped out for international/national monitoring stations.**

Source of impact	Potential impact	Justification
Safety zones around construction vessels (construction)	<ul style="list-style-type: none"> <li>Restriction of the planned measurement/sampling programme activities of monitoring stations.</li> </ul>	Safety zones placed around NSP2 vessels will range between 2 and 3 km for construction vessels and 500 m for inspection and maintenance vessels, and the activities will be conducted over a short period and with the implementation of mitigation measures (see Section 10.9.9.1). Furthermore, based on NSP experience, NSP2 will not coincide with monitoring campaigns. During operation, inspection or maintenance, vessels will be required very rarely, for very short periods of time and in limited locations and therefore, impacts during the operation phase on environmental monitoring stations are also not
Safety zones around inspection/maintenance vessels (operation)		

Source of impact	Potential impact	Justification
		expected.

The following sources of impact have thus been assessed:

- Release of sediments to the water column (construction);
- Release of contaminants and/or nutrients to the water column (construction).

#### 10.9.9.1 Release of sediments to the water column (construction)

Activities with the potential to cause the release of sediments to the water column in areas where environmental monitoring stations (Finland and Germany) may be present comprise: dredging, cofferdam construction, pipe-lay, post-lay trenching, rock placement and munitions clearance. Of these, dredging has the highest potential to increase SSCs in the nearshore areas (Russia and Germany).

The potential impacts on environmental monitoring stations from the release of sediments to the water column comprise:

- Disturbance of the scientific representativeness of environmental monitoring data.

#### Assessment of potential impacts

The vulnerability of environmental monitoring stations to the release of sediments to the water column is high because an increase in SSC has the potential to affect the data collected from the stations. When combined with the high importance assigned (as discussed in Section 9.9.9.1), a high sensitivity is given to environmental monitoring stations in relation to the release of sediments to the water column.

A summary of the type of environmental stations that may be sensitive to seabed intervention works is provided in Table 10-76.

**Table 10-76 Summary of environmental stations located in the vicinity of NSP2 seabed intervention works.**

Environmental station name	Type of station	Country	Type of seabed intervention works	Distance from NSP2
LL6A	Benthos	Finland	<ul style="list-style-type: none"> <li>• Munitions clearance;</li> <li>• Pipe-lay;</li> <li>• Post-lay trenching;</li> <li>• Rock placement.</li> </ul>	0.8 km from Line A 0.9 km from Line B
LL5	Benthos	Finland	<ul style="list-style-type: none"> <li>• Munitions clearance;</li> <li>• Pipe-lay;</li> <li>• Post-lay trenching;</li> <li>• Rock placement.</li> </ul>	1.0 km from Line A
LL11	Benthos	Finland	<ul style="list-style-type: none"> <li>• Munitions clearance;</li> <li>• Pipe-lay;</li> <li>• Post-lay trenching;</li> <li>• Rock placement.</li> </ul>	1.4 km from Line A 1.5 km from Line B

LL7S	Benthos	Finland	<ul style="list-style-type: none"> <li>• Munitions clearance;</li> <li>• Pipe-lay;</li> <li>• Post-lay trenching;</li> <li>• Rock placement.</li> </ul>	1.6 km from Line A 1.4 km from Line B
GB7	Water quality	Germany	<ul style="list-style-type: none"> <li>• Dredging;</li> <li>• Pipe-lay (with anchor-handling).</li> </ul>	0.8 km from Line B

As seen in Table 10-76, stations LL6A and GB7 are the closest to NSP2. Increased sedimentation during construction may cause a short-term disruption of the historical sediment quality, benthos and water quality data collected from the environmental monitoring stations. This was the case during the NSP project, where one of the HELCOM/SGU sediment monitoring stations (SE-11) located in the Swedish EEZ 0.7 km from the NSP pipelines was relocated to another position (SE-11 new) approximately 10 km from the NSP pipelines, due to sedimentation potentially impacting the monitoring station (see Atlas Map MS-01).

Seabed intervention works, notably dredging and the construction of a cofferdam in the nearshore area of Narva Bay, could increase sedimentation which could potentially disturb the scientific representativeness of the environmental monitoring stations located in Estonia (stations N8, N5 and Narva jõe suue). As listed in Table 9-34 (Section 9.9.9), stations N12 and N8 monitor water quality and radiation and hazardous substances are monitored at stations N5 and Narva jõe suue, respectively. Based on the sediment modelling results for dredging (see Section 10.1.2.1), SSC will extend along the western shore of the Narva Bay nearshore area with the highest SSC close to the dredging site; however, the plume of increased SSC exceeding 15 mg/l will only occur very close to the coastline, for less than 72 hours and in very small areas, as discussed in Section 10.9.1.1. The construction of a cofferdam will have a smaller impact (see Section 10.1.2).

The water quality monitoring stations located in Estonia south of the nearshore dredging area may be sensitive to an increase in SSC. The stations are located approximately 288 m - 1 km from the Estonian coastline. Potential transboundary impacts on these monitoring stations from dredging activities in Narva Bay on Estonia are addressed in Chapter 15 – Transboundary impacts.

Dredging in Germany may impact stations GB7 and GB19, at which water quality is monitored. These stations are located 0.8 km and 4.1 km, respectively, from NSP2. Monitoring for dredging carried out in the German nearshore during NSP indicated that SSC above 50 mg/l was confined to the immediate vicinity of the dredging vessel, with the majority of sediments re-settling after one or two hours, resulting in a small and short-term increase above typical background levels. However, SSC levels were within the natural reported variations of up to 10- 50 mg/l. Based on this, an increase in SSC at the Lubmin 2 landfall is expected to be confined to the dredging vessels and will not exceed the natural variations in the Greifswalder Bodden. There will be no cofferdam in German waters. The intensity will be low, resulting in a negligible impact magnitude for the monitoring stations in connection with the release of sediments to the water column.

The sediment modelling results for offshore pipe-lay (see Section 10.1.2.1 and Appendix 3) indicate that the impact of an increase in SSC caused by NSP2 offshore activities on the water quality will be limited to areas close to the NSP2 route, with a duration of up to a few hours to a few days for all locations along the route. This is relevant for the monitoring stations where pipe-lay will be performed. Moreover, monitoring campaigns will be conducted over a short duration and, as previously mentioned, mitigation measures will be implemented should NSP2 coincide with monitoring campaigns. Therefore, the intensity will be low. Based on this, the impact magnitude is considered to be negligible.

Sedimentation modelling was performed for dredging, rock placement, munitions clearance and pipe-lay and the results are summarised below where environmental monitoring stations may be present.

The modelling results for rock placement that will be conducted in Finland and for munitions clearance (should munitions be detonated in Russia and Finland) indicated that the concentration of 10 mg/l is exceeded in an area of 65 km<sup>2</sup> for less than one day after cessation of the activity. This is due to the dispersion and dilution effect in the water column as well as natural sedimentation to the seabed (see the water quality assessment in Section 10.2.2.1 and Appendix 3). Results from environmental monitoring during NSP indicated that pipelines on the seabed in the vicinity of the HELCOM long-term benthos stations did not compromise the representativeness of the stations. Therefore, the intensity will be low with a negligible impact magnitude on stations LL6A, LL5, LL11 and LL7S.

The above assessments can be confirmed with experience from NSP, which indicated that during construction in the Swedish EEZ, Nord Stream AG and its construction vessels followed the communications and reporting procedures that were agreed upon with Swedish authorities and organisations to avoid any interference with monitoring periods/campaigns. Nord Stream AG provided the relevant authorities with notifications four weeks prior to commencement of new construction activities and with daily updates from the construction vessels as well as weekly and monthly forecasts. The same procedures will be implemented for NSP2, which include that Nord Stream 2 AG will consult with relevant authorities to minimise interference with monitoring campaigns should construction works be scheduled to be performed in the vicinity of long-term monitoring stations, at a similar time to the planned measurement/sampling programme. More specifically, for the environmental monitoring stations used to monitor benthos in Finland, Nord Stream 2 AG will coordinate with the Finnish Environmental Institute (SYKE) so that seabed intervention work would not coincide simultaneously with or just before (approximately one week) the yearly benthos monitoring campaign, scheduled in May, near the monitoring stations, within a distance of 1 km. Discussions, if needed, will be held with SMHI and SYKE to mitigate any problems with conflicting times for measurements and construction works (see Section 16.3).

Given the high sensitivity of the environmental stations, the implementation of mitigation measures and the negligible impact magnitude, the impact is ranked as **negligible**, resulting in an impact that is not significant.

#### **10.9.9.2 Release of contaminants and/or nutrients to the water column (construction)**

Activities with the potential to cause the release of contaminants and/or nutrients to the water column are the same as those described above.

The potential impacts on environmental monitoring stations from the release of contaminants and/or nutrients to the water column comprise:

- Disturbance of the scientific representativeness of environmental monitoring stations.

#### **Assessment of potential impacts**

The vulnerability of environmental monitoring stations to the release of contaminants and/or nutrients to the water column is high because an increase in SSC has the potential to affect the historical data collected, and when combined with the high importance assigned (as discussed in Section 9.9.9.1), a high sensitivity is given to environmental monitoring stations in relation to the release of contaminants and/or nutrients to the water column. Mitigation measures outlined in Section 10.9.9.1 will be applied to avoid or minimise potential impacts on the environmental monitoring stations in proximity to NSP2.

As discussed in Section 10.9.9.1, the release of contaminants as a consequence of seabed intervention works will be very low and will not have any lasting impact on the water quality. The possible impacts will be limited to the seabed intervention works, with an increase in SSC associated with dredging occurring very close to the coastline for less than 72 hours in very small areas; however, sensitive stations in Estonia could potentially be impacted. Transboundary impacts on these monitoring stations are addressed in Chapter 15 – Transboundary impacts. The intensity will be low and it is considered unlikely that the planned monitoring campaigns at any of the environmental monitoring stations would coincide with NSP2 activities at that particular location due to the implementation of mitigation measures. Therefore, the impact magnitude is negligible, considering the application of mitigation measures. The negligible impact magnitude can be confirmed with NSP monitoring experience during the construction and operation phases (see Section 10.9.9.1).

Given the high sensitivity and negligible impact magnitude based on the application of mitigation measures and NSP experience, the impact is ranked as **negligible**, resulting in an impact that is not significant.

### 10.9.9.3 Summary and ranking of potential impacts on international/national monitoring stations

A summary of the overall project impact rankings for international/national monitoring stations arising from the potential source of impact scoped into the assessment is provided in Table 10-77, together with the rankings predicted at country level. As indicated in the table, none of the impacts are considered to be significant at either the national or overall project level.

Owing to the different nature of the impacts associated with each of the two sources of impact considered above and the receptors experiencing the impacts, there is a limited potential for “in-combination” impacts on environmental monitoring stations from these two sources of impacts. Therefore, the impact rankings on this receptor group resulting from all sources of impact are likely to be at most negligible in relation to the release of sediments to the water column and the release of contaminant and/or nutrients to the water column.

Impacts due to the release of sediments to the water column and the release of contaminants and/or nutrients to the water column during construction from the Narva Bay nearshore area (Russia) have the potential to extend into Estonian waters and may cause transboundary impacts on Estonian monitoring stations. This increase will occur close to the coastline, for less than 72 hours and in very small areas. Transboundary impacts on the monitoring stations are assessed in Chapter 15 – Transboundary impacts.

The rankings of potential impacts on environmental monitoring stations are summarised in Table 10-77.

**Table 10-77 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed in the national EIAs/ES).**

International/national monitoring stations	Project	RU	FI	SE	DK	GE	Trans
Release of sediments to the water column							Yes

International/national monitoring stations	Project	RU	FI	SE	DK	GE	Trans
Release of contaminants and/or nutrients to the water column							Yes
Impact ranking:	Negligible		Minor		Moderate		Major

## 10.10 Onshore landfall Narva Bay

### 10.10.1 People

Fifteen potential sources of impact on people are identified in Table 8-3. Of these, six can be scoped out from further consideration, as outlined in Table 10-78:

**Table 10-78 Potential sources of impact scoped out for people.**

Potential source of impact	Potential impact	Justification
Land acquisition and use (operation)	Temporary loss of access to areas for recreational use, to local communities, or to the military barracks.	During operation, all access restrictions associated with construction works will have been reversed. People will be able to cross the pipeline route and the only remaining areas of restriction will be around the PTA and permanent office buildings, an area of 6.5 ha. This area is entirely on the land of the Pribrezhnoe agricultural company and so will not pose any impacts on other receptors. As Pribrezhnoe will receive lease payments for its land, there are no significant impacts associated with this land use.
Noise generation (operation)	Disturbance, such as on sleep patterns, affecting the ability of people to work or concentrate. Also, subsequent impacts on health and quality of life.	There are no significant sources of noise during the operation of NSP2 and therefore no significant impacts are predicted.
Emissions to air (construction)	Impacts on agricultural livelihoods.	<p>The primary pollutant of concern for construction activities in relation to potential impacts on agriculture is dust/PM<sub>10</sub>/PM<sub>2.5</sub>. Dust can coat agricultural crops, blocking stomata function in some cases, or providing a source of perceived impact.</p> <p>The only agricultural activities within close proximity of the construction sites are those of the Pribrezhnoe agricultural company. It is planned that their agricultural production (solely hay) within and around the project site will be moved to other land areas owned by the company; there is sufficient time to move this production in advance of construction activities. As such, it is not expected that the impacts of dust on agricultural land will be a significant impact. Potential impacts on agriculture from all other pollutants are also assumed to be negligible on the basis of short-term and low emission levels.</p>
Emissions to air (operation)	Soiling of property from dust generation and	The only air emissions from NSP2 during operation will be some gas released once a year from each line via vent

Potential source of impact	Potential impact	Justification
	increased respiratory disease from emissions.	stacks (cold stacks) located near the PTA. The pig launcher will be used as necessary to remove condensate and impurities accumulated in the pipeline. A Sanitary Protection Zone (SPZ) shall be set around the PTAR during its operation, extending approximately 300 m. Concentrations of pollutants at the boundary of the SPZ will not exceed national legislative requirements and as such no significant impacts are predicted.
Employment generation (operation)	Conflict between local residents and the non-local workforce.	The workforce on site during operation will be small, totalling about 20 people visiting the site on the daily basis. No significant impacts are therefore predicted.
Transport to the site (operation)	Disruption and risks to health and safety associated with project traffic.	There will not be any significant project-related traffic during the operation phase. There are expected to be two to four light vehicles travelling to and from the project site each day with project personnel, and approximately 10 trucks per month for maintenance or deliveries (this volume will vary from month to month). There will therefore be no significant change to pre-project baseline traffic levels and therefore no significant impacts are predicted.

The following sources of potentially significant impacts on people have been assessed:

- Land acquisition and use (construction);
- Physical changes to landform or land cover (natural or man-made) (construction and operation);
- Light from working areas (construction and operation);
- Noise generation (construction);
- Emissions to air (construction);
- Employment generation (construction);
- Transport movements to site (construction).

#### 10.10.1.1 Land acquisition and use (construction)

The building of the PTA, pipeline, offices and facilities, access road and working areas required during construction, will require a mix of temporary and permanent<sup>37</sup> land acquisition. This will result in some restricted access to land within the project footprint; including potential severance of a road crossed by the pipeline corridor that services two village and a military barracks. Potential impacts on people as a result of this land acquisition and use include:

- Temporary loss of access to areas for recreational use;
- Temporary loss of access to local communities and military barracks from severance of the road that crosses the pipeline corridor.

Impacts on tourism, agricultural and livelihood activities and land/property values as a result of land acquisition and use are discussed under Section 10.10.3.

<sup>37</sup> For the purposes of this assessment 'permanent' refers to the operational period of NSP2 (50 years).

### Assessment of potential impacts

During construction, which will extend over 18-24 months, the following facilities and their construction will require acquisition or temporary use of land:

- **PTA and temporary working areas:** 42 ha of land will be acquired to accommodate the PTA, office facilities and temporary working area (which will extend beyond to the north and south of the PTA). Upon completion of construction, all of this area except approximately 6.5 ha required to accommodate the PTA, office and access road for the PTA will be reinstated and returned to its former use.
- **Onshore pipeline (conventional open cut construction):** An 85 m wide RoW working corridor, running approximately 3.7 km from the PTA to the shore, will be temporarily acquired (31.8 ha in total). During construction, the RoW will be fenced and access by non-workers prohibited. While the temporary working area is likely to be fenced for the entire construction period, works will be phased and so restrictions may vary along the route during this period. It is expected that crossing points will be maintained throughout construction. Upon completion of construction, much of the area within the 85 m RoW will be reinstated. Within the forest area, trees will be re-planted; the exceptions to this being a 7.5 m area over each pipeline and a 6 m wide access road where deep-rooted vegetation will be prevented.

As described in Section 9.10.1.3, the PTA and the temporary works area (totalling 42 ha) are located on the land of Pribrezhnoe agricultural company. This company used to be a large milk-processing company with facilities and land plots throughout the rural settlement. However, the agricultural activities of this company are now limited to producing a small amount of hay. The land to be acquired by NSP2 is a mixture of fallow land and land used for hay production, the latter of which will be transferred to other vacant land owned by the company. Pribrezhnoe will receive payments for the land leased by the project during the construction and operation of NSP2.

Land within the Kurgalsky Nature Reserve will also be used by NSP2 during construction. It will total approximately 31.7 ha and be used for the pipeline and associated RoW. The Kurgalsky Nature Reserve is a popular location for recreational activities. People travel there from across the district to walk, picnic, swim, fish, relax and collect berries, mushrooms and herbs. The proposed pipeline route will cross one of the access roads into the nature reserve which also provides border police with access to their barracks, and connects two villages (Sarkyulia and Korostel) with the main road network.

Consultation undertaken with stakeholders<sup>39</sup> suggests that recreational users of the nature reserve will be able to utilise alternative areas while access restrictions are in place. It is also understood that the collection of natural products from the reserve is largely for household consumption, although some do sell products from roadside stalls. Stakeholder consultation suggests that these gathering activities do not play a significant role in sustaining the livelihoods of local residents.<sup>39</sup> Considering this information, local people who use the nature reserve for gathering natural products are considered to have a medium to high ability to adapt to changes brought about by the project, meaning their sensitivity/vulnerability is assessed as low to medium.

Tourists and visitors to the reserve are likely to be less sensitive to access restrictions, as the reserve area is large and there are alternative, similar areas that can be easily accessed. Based on this, the sensitivity/vulnerability of tourists and visitors is assessed as low, as they have a high ability to adapt to change brought about by the project.

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<sup>39</sup> Information obtained during an interview with the Head of Kuzemkinskoe RS on September 1, 2016.



Residents of Sarkyulia and Korostel and the users of the military barracks do not have alternative routes available and so have limited ability to adapt to any changes made to this access routes by NSP2. As such, their sensitivity/vulnerability to any project impacts on this infrastructure is high.

#### *Impacts during construction*

During construction, the RoW will be fenced and access by non-workers prohibited. While the temporary working area is likely to be fenced for the entire construction period, works will be phased and so restrictions may vary along the route during this period. It is expected that crossing points will be maintained throughout construction. All access restrictions within the Kurgalsky Nature Reserve will be short-term, for the construction period of 18-24 months, and reversed after construction. As such, they are not expected to pose significant disruption to users of the reserve (both visitors and local residents). The impact is localised, of short duration and affects a relatively small number of receptors. It is therefore considered to be of low magnitude. When combined with low to medium sensitivity/vulnerability, this results in a **minor** impact ranking for local residents, tourists and visitors. For residents of Sarkyulia and Korostel, as well as users of the military barracks, which are high sensitivity receptors, the impact ranking is assessed to be moderate. To mitigate potential impacts on residents of Sarkyulia and Korostel and users of the military barracks, Nord Stream 2 AG will ensure that alternative access for these areas is maintained (specific design details of this access are yet to be finalised). With this mitigation measure in place, the magnitude of this impact is reduced to **negligible**.

#### **10.10.1.2 Physical changes to landform or land cover (construction and operation)**

During construction, changes to landform and land cover that may affect people, including vegetation removal, earthworks, the presence of the construction plant and the existence of temporary and permanent structures<sup>40</sup>. The permanent features, such as PTA components, office buildings and the access route along the pipeline easement (Figure 6-20), will become visible during construction and will remain on site as permanent elements in the landscape during operation. Potential impacts on people as a result of these physical changes to landform or land cover include:

- Changes in visual amenity resulting from the introduction or removal of features that contribute to landscape character, or alter views.

Potential impacts on the tourism sector and house prices as a result of changes in visual amenity are considered in Section 10.10.3.

#### **Assessment of potential impacts**

The land in and around the project footprint is mostly flat. The area is renowned for its rural character and natural beauty; this is one of the key reasons for the development of dacha communities in this area. These communities are therefore likely to be quite sensitive to any changes in their landscape and visual amenity; it is an important feature for their lifestyle, which is not easily replaced. These receptors are therefore assessed as having medium sensitivity/vulnerability.

#### *Impacts during construction*

During construction, which will extend over 18-24 months, the following project components and construction activities will have the potential to result in changes to visual amenity:

- **Construction of the PTA and establishment temporary working area:** 42 ha of fallow grassland<sup>41</sup> will be cleared for the PTA and a temporary working area, which will accommodate the worker camp, laydown areas and several low-profile buildings

<sup>40</sup> These will include the PTA and office buildings.

<sup>41</sup> The social survey work being undertaken in 2017 will confirm whether all the land to be used is fallow grassland.

(workshops and office facilities). These buildings will be up to 5 m in height. Once constructed, the PTA will include elements up to 5 m high and extend over an area of approximately 6.5 ha.

- **Construction of the onshore pipeline (conventional open cut construction):** Preparatory works will require clearance of an 85 m wide RoW running for approximately 3.7 km across wetlands, fallow grassland, forest and dunes. The construction plant (including Caterpillar Side Booms required to lay pipeline in the excavated ditches) and vehicles will be visible; but the only project component built above ground will be the permanent access road along the pipeline easement.
- **Nearshore construction activities:** Construction of the cofferdam, causeway, nearshore dredging, pull-in operation and pipeline installation will take approximately 5 months. Sources of visual impacts will include the presence of large vessels and equipment in the nearshore area. The activities will be located immediately at the shore and will therefore be visible to any users of the nature reserve in the vicinity.

The communities of Khanike, Ropsha, Volkovo and parts of Udarnik, are all located within 2 km of the project footprint. During construction, changes to the landscape may be particularly prominent within 500 m of the site boundary. The exact number of receptors still needs to be confirmed, but it has been estimated that there are approximately 10 – 12 dachas located within this area.<sup>42</sup> The northern part of the temporary working area will be clearly visible to these receptors, but the PTA is expected to be largely screened from Koleno by intervening vegetation.

For receptors located beyond 500 m of the project footprint, construction activities will comprise a small element of any views, which together with their temporary duration will result in a negligible impact magnitude. When combined with the medium sensitivity/vulnerability of receptors, this results in a **negligible** impact ranking. For receptors within 500 m of the project footprint the magnitude of the impacts on views will be greater, but due to their temporary duration and restricted extent, will generally remain low, resulting in a **minor** impact ranking.

The exception to the above may be one residence (dacha – summer house) located within 50 m of the project footprint. All landscape changes will be highly visible to this receptor. Further assessment is being undertaken with regards to this property due to its close proximity to construction activities. Without further mitigation, there is the potential for this impact to have a **moderate** impact ranking for this receptor.

Recreational users of the nature reserve are not expected to experience any significant impacts on visual amenity, as a result of the project, during construction. There are no known popular tourist sites near the project footprint and considering the size of the reserve, visitors will have the ability to adapt and utilise other areas, away from the project.

#### *Impacts during operation*

During operation, the PTA, offices and permanent access route along the pipeline easement, will be the only visible changes to the landscape. The maximum height of project elements (pipework within the PTA) during operation will be 5 m, which is unlikely to be seen beyond a distance of 2km<sup>43</sup> and only in locations where there is no screening by vegetation.

Along the pipeline corridor, approximately 76% of the cleared RoW will be replanted with trees. The remaining areas will consist of a gravelled access road approximately 6 m wide and two cleared areas 7.5 m wide over the pipeline re-planted with grass (deep-rooted vegetation will be prevented). Because the planted areas are on the exterior of the RoW, this acts as embedded mitigation for visual impacts from the cleared areas. The low level of this access road is not expected to impact on the views of any social receptors.

<sup>42</sup> They are located within Koleno (part of the Udarnik community).

<sup>43</sup> This is to be confirmed during the next social survey in 2017.

The magnitude of impacts on visual amenity will remain negligible to low, which when combined with a medium vulnerability/sensitivity, results in an impact ranking of **minor** for those living within 500 m of the PTA. For those beyond 500 m, impact magnitude is assessed as negligible, resulting in a **negligible** impact ranking.

The exception may again be the one residence located with 50 m of the project footprint. The exact distance to any permanent infrastructure (the closest being the PTA) needs to be confirmed, but it is expected that it will be sufficiently far away that impacts on visual amenity will be of low magnitude, which when combined with a medium sensitivity, results in a **minor** impact ranking.

There are not expected to be any significant impacts on recreational users of the nature reserve during operation, for the same reasons as described for construction.

### 10.10.1.3 Light (construction and operation)

During construction, artificial lighting will be required at night, for security. No floodlights will be required as all works are expected to be undertaken during daylight hours. During operation, lighting will be limited to the site of the PTA and offices. Potential impacts on people as a result of light from working areas include:

- Changes in visual amenity as a result of artificial lighting.

#### Assessment of potential impacts

The project site is located in a relatively rural area, with low population and limited traffic. As such, there are no significant sources of light in the area and no light pollution at night<sup>44</sup>. As was described previously, it is the rural character and natural beauty of the area that tends to attract visitors and home-owners so they will be sensitive to any change to these amenities. However, as light impacts from the project will only occur at night, when most people are inside their accommodation, their sensitivity/vulnerability is considered to be low.

#### Impacts during construction

There are generally no set levels prescribed for light to be considered a nuisance. An assessment considers whether it interferes with the use of a property or affects health, amongst other things. project-related light impacts will only occur at night, will be associated with directional security lighting, not floodlights and of short duration i.e. limited to the construction period. The project will ensure that lighting used during construction is appropriately designed; this will include a focus on siting, directional light and other measures so that light does not affect people in their houses at night. The magnitude of this impact is thus assessed as negligible to low. When combined with the low sensitivity/vulnerability of receptors, this impact is assessed to have a **negligible to minor** impact ranking.

#### Impacts during operation

During operation, lighting will be confined to the PTA and office areas. The same design measures will be in place as described for construction and the areas to be lit will be much smaller in extent. Lighting will still be required on site at night, for security, but it will continue to be directional, to minimise impacts outside the operation site. Whilst the number of receptors potentially affected by light impacts during operation will be less, any change will be long-term. The impact magnitude is therefore considered to be medium, which when combined with the low sensitivity/vulnerability of receptors to light impacts results in a **minor** impact ranking.

<sup>44</sup> This will be confirmed during the upcoming social survey in 2017.

#### 10.10.1.4 Noise generation (construction)

Activities that may generate noise include site preparation works, trench dredging, road construction, the movement of vehicles generator operations and staff activities. Key locations from which noise impacts will be generated will be the site of the PTA, along the pipeline route, workshops and the worker camp. No night time working is anticipated during construction. Potential impacts on people as a result of noise generation include:

- Disturbance that can affect the ability of people to work or concentrate. This can have subsequent impacts on health and quality of life.

#### Assessment of potential impacts

Receptors in the vicinity of the project construction areas (landfall, pipeline RoW and PTA) are particularly vulnerable to impacts, because many have chosen to live in, or visit, the area for its tranquil environment. Many residents have chosen to live in river settings or close to the nature reserve; areas that are pleasant for relaxed living and recreation. Disturbance caused by noise may severely affect both visitors' recreational enjoyment of the reserve and residents' quality of life and as such the sensitivity/vulnerability of these receptors is assessed as medium. One identified residential receptor that would likely be considered as high sensitivity is the residence located with 50 m of the project footprint.

Receptors located along the public roads that will be used by the project do not have the same degree of sensitivity as isolated settlements or visitors to the nature reserve, as they already experience a higher level of background noise. Their sensitivity/vulnerability to noise impacts is assessed as medium.

#### *Impacts during construction*

Noise thresholds for residential receptors (established by Law SN 2.2.4/2.1.8.562-96 '*Noise at Workplaces, in Residential and Public Places, and in Area of Residential Development*') are 55 dB during the daytime, and 45 dB at night. The noise assessment for the project has determined that these levels will be achieved at the boundary of the nearest residential area from the project footprint, which is Khanike.

As detailed in Chapter 16 – Mitigation measures, Nord Stream 2 AG will ensure that all equipment is selected with consideration of noise emissions and will be well maintained. A Traffic Management Plan (TMP) will also be implemented to manage noise impacts related to project traffic. Noise levels will be monitored to ensure required thresholds are being achieved. The Grievance Mechanism will also be regularly reviewed for any grievances related to noise, with additional mitigation measures implemented should they be necessary.

Following implementation of the mitigation measures committed to by the project, the magnitude of noise impacts on people living around the temporary construction area (including PTA) and pipeline is in general assessed as low. Although there will be a perceptible difference from baseline conditions, the areas affected will be small, and the impact is short-term, lasting the duration of the construction period and the noise levels will be within accepted standards. This combined with the medium sensitivity/vulnerability of these receptors result in an impact with a **minor** impact ranking. The exception to this may be the one residence located with 50 m of the project footprint, who potentially can have a moderate impact during construction period if no mitigation in place. However, further assessment is required to determine the noise impacts on this property.

Traffic noise along the access routes will peak during the first and last few months of construction, which will be a noticeable change in baseline conditions for those living along the side of the roads. Following implementation of the mitigation measures committed to by the project, the magnitude of noise impacts on people near the road will be low on the basis that

they will be short-term and localised. This combined with the medium sensitivity/vulnerability for people near existing roads results in impact rankings of **minor**.

#### 10.10.1.5 Emissions to air (construction)

During construction of the landfall and onshore facilities in Russia, air emissions will occur in the vicinity of work sites including the pipeline route, PTA, temporary construction area (which includes the worker camp), and along access routes. Emissions of dust will arise from a range of construction activities, including earth moving, stockpiling of material and the movement of vehicles over open ground. Potential impacts on people as a result of these emissions to air include:

- Acute and chronic human health issues associated with reduced air quality.

#### Assessment of potential impacts

Dust (including PM<sub>10</sub> and PM<sub>2.5</sub>), NO<sub>x</sub> and SO<sub>2</sub>, which will be emitted by construction equipment and vehicles, have the potential to adversely affect human health, including contributing to increases in acute and chronic respiratory illnesses. Baseline studies for this assessment ascertained that respiratory illnesses are prevalent in the morbidity structure of Kingisepp district's population.<sup>45</sup> Such prevalence makes receptors more vulnerable to air quality impacts, with them designated as medium sensitivity/vulnerability.

#### *Impacts during construction*

Exposure to air quality emissions are likely to occur intermittently throughout the construction period. According to the air quality assessment undertaken for the project, the magnitude of air quality impacts associated with the temporary construction area (including the PTA), pipeline construction, RoW clearance and road construction, will be low. This has been based on the fact that the distance from these components to the nearest inhabited areas is such that air emissions will be dispersed and diluted before reaching social receptors; all emissions from the project components are also predicted to be within the maximum permissible levels specified in national regulatory requirements. When combined with the medium vulnerability/sensitivity of receptors, this results in a **minor** impact ranking.

This also applies to the access roads; it has been predicted that higher levels of pollutants along these roads will be short-lived and quickly dispersed. As such, the air quality assessment for the project has determined that impact magnitude will be low, which when combined with the medium sensitivity/vulnerability of receptors, results in an impact ranking of **minor**.

#### 10.10.1.6 Employment generation (construction)

Nord Stream 2 AG will require a temporary workforce of approximately 350 to 400<sup>46</sup> people during construction of the landfall and onshore facilities in Russia. Potential impacts on people as a result of this employment generation include:

- Change in social dynamics within local communities and potential conflict between communities and the migrant workforce;
- Exposure to communicable diseases;
- Tension due to the presence of security services.

Potential impacts on local jobs as a result of employment generation are covered in Section 10.10.3.

<sup>45</sup> With a prevalence rate of approximately 28% for adults, 57% for adolescents and 56% for children under 14 years of age.

<sup>46</sup> Workforce numbers are still to be confirmed.

### Assessment of potential impacts

The population has a relatively high number of retired people, as well as families with children, who may be particularly sensitive to the influx of a large male, non-local workforce. Local residents living close to the site are thus considered to be of medium sensitivity/vulnerability to the presence of an external workforce.

#### *Impacts during construction*

The worker camp will be constructed within the temporary works area for the project. The number of workers living at the camp will far exceed the number of local residents. The influx of such a large non-local workforce could, without appropriate management, lead to conflict. It is likely that the majority of construction workers will be male. The presence of large populations of men, many away from their families and with limited ties to the local community, could result in a change in social dynamics within the surrounding neighbourhoods. This could include increased occurrences of prostitution and related health impacts (e.g. transmission of sexually transmitted diseases [STDs] and other communicable diseases), concerns about community safety or increased crime levels, harassment of residents if workers do not behave appropriately and potential conflict between workers and existing residents.

If the project has private security at the construction camp, there is the risk of conflict and tension due to the presence of security services, particularly in cases where personnel are unfamiliar with local conventions and customary modes of behaviour.

As detailed in Chapter 16 – Mitigation measures, the layout of the worker camp within the temporary construction area will be carefully considered so that impacts on residential receptors are minimised. This will be particularly important for the residence situated 50 m from the boundary of the temporary works area. The Nord Stream 2 AG will also implement a Worker Code of Conduct and Security Plan to govern the behaviour of workers and security personnel. The duration of these impacts is short-term (for the duration of the construction period), localised and affects a small proportion of receptors. With the effective implementation of the prescribed mitigation measures, any such impacts should be rare and so the magnitude is predicted to be low. When combined with the medium vulnerability of the receptors, this impact is assessed as having a ranking of **minor**.

#### 10.10.1.7 Transport to the site (construction)

During construction, the project will utilise two proposed access routes, along existing roads, to transport materials from the port in Ust'-Luga to the construction sites. Potential impacts on people as a result of transport to the site include:

- Increased road congestion;
- Increased risk of traffic-related accidents.

Traffic-related air quality and noise impacts are described in Sections 10.10.1.5 and 10.10.1.6.

### Assessment of potential impacts

#### *Increased road congestion*

As described in Section 9.10.2, there are two routes proposed to be used for construction traffic. For the purposes of the impact assessments they have been called 'Route 1' and 'Route 2' (see Figure 9-43 in Section 9.10.2.1). Whilst both routes will be utilised, it is expected that 90% of construction traffic will use Route 1. This route is characterised by a lower traffic load, with approximately five vehicle movements observed in an hour.<sup>47</sup> Route 2 is of larger capacity and much busier, especially in the area of the Kingisepp bypass, with vehicles travelling to Ivangorod, Kingisepp and the Phosphorit industrial area. However, the section of the road between Pervoye

<sup>47</sup> ERM Social Baseline Survey, August to September 2016.

Maya and construction site is, as Route 1, characterised by a low traffic load and in addition goes through the centre of the villages.

There are eight settlements<sup>48</sup> along Route 1. Residents of these communities, as well as other road users, will be potential receptors for increased road congestion. However, local residents will have limited opportunity to find alternative routes and so are identified to be of medium sensitivity/vulnerability. Other road users are assessed as being of low to medium sensitivity/vulnerability, depending on their ability to avoid Route 1 during the construction period.

There are seven settlements<sup>49</sup> along Route 2. Residents of these communities, as well as other road users, will also be potential receptors for increased road congestion. The sensitivity of the villages residents is the same as per route 1 for the reasons discussed above. Local residents and other road users are assessed as being of medium sensitivity/vulnerability to project-related traffic impacts.

#### *Impacts during construction*

During the first and last three months of construction, it is expected that project-related traffic will peak, with approximately 120 per day. At other times during construction there will be an average of approximately 55 per day.

The traffic increases resulting from the project will be much more prevalent on Route 1 as the roads to be utilized currently have very low traffic levels. However, it is anticipated that the route has sufficient capacity to accommodate this volume of traffic and that the movement of vehicles will be carefully planned by the project. Although there will be a considerable and marked change in traffic volumes on Route 1 during the construction periods, this will not substantially disrupt traffic movements. In addition described in Chapter 16 – Mitigation measures, Nord Stream 2 AG will implement a TMP which will reflect Good International Industry Practice (GIIP), including appropriate scheduling of traffic to avoid any peak times on local roads (for example, to avoid school bus movements). Daily visual inspections will also be used to monitor any increases in road congestion and/or travel times, with amendments made to mitigation and management measures, as necessary. The magnitude of traffic congestion impacts during construction are therefore assessed as low. When combined with the medium sensitivity/vulnerability of receptors using this route the impact rating is predicted to be **minor**.

Road users utilising Route 2 are not expected to see a significant increase in traffic from pre-project baseline levels, as only 10% of construction traffic will take this route and their contribution to total volumes will be low (since baseline traffic volumes are significantly higher than on Route 1). However, existing levels of congestion need to be understood in order to refine the assessment and determine whether the additional movement from the project could aggravate and congestion hotspots<sup>50</sup>. Assuming that Route 2 has sufficient capacity to accommodate the additional project traffic, the magnitude of the impact is assessed to be low. There will be some minor disruption associated with increased traffic, but it will be short-term (mainly during the first and last three months of construction) and reversed at the end of the construction period. When combined with the medium sensitivity of receptors along this route, the impact ranking is predicted to be **minor**.

#### Increased risk of traffic-related accidents

As previously described, both 'Route 1' and 'Route 2' will be utilised by construction traffic, with 90% of project vehicles utilising Route 1. The sections of both routes that cross residential areas have limited base flow of traffic under normal conditions. There are known to be limited

<sup>48</sup> Ust'\_Luga, Preobrazhenka, Strupovo, Male Kuzemkino, Bolshoe Kuzemkino, Udarnik, Ropsha and Khanike.

<sup>49</sup> Fedorovka, Keykino, Dal'naya Polyana, Izvoz, Novopyatnitskoe, Pervoe Maya and Pulkovo.

<sup>50</sup> Additional baseline traffic data is to be collected during the upcoming social survey in 2017.

pavements and lighting along these sections and receptors include children travelling to school, families vacationing in the area and cyclists (these roads are part of a national cycle route). Local residents and other road users in these sections are therefore identified of high sensitivity/vulnerability to substantial changes to traffic brought about by NSP2.

Increased traffic will generate a risk of accidents that could lead to injuries or fatalities. The risk of traffic accidents is further amplified by the fact that there are no sidewalks for pedestrians along much of the roads and street lighting is limited. Nord Stream 2 AG will implement a robust TMP, Stakeholder Engagement Plan (SEP) and Emergency Preparedness and Response Plan (EPRP) to manage traffic-related impacts. It will also run an awareness raising campaign to inform stakeholders (particularly those most vulnerable, such as children) about potential project-related impacts.

The magnitude of potential impacts in the absence of suitable risk management measures is medium - the duration of the impact is equivalent to the construction period and so does not present a long-term risk but the potential severity of an event is high. Considering the high sensitivity/vulnerability of receptors, the potential impact ranking is therefore assessed as moderate. Nord Stream 2 AG has stringent safety objectives and all activities associated with NSP2 will be designed and managed to achieve a zero fatality target and negligible incident risk. Therefore, following effective implementation of the project's mitigation and management plans, the magnitude of project-related traffic injuries or fatalities, during construction is assessed as low. This, combined with the high sensitivity of receptors, results in a **minor** impact ranking.

#### 10.10.1.8 Summary and ranking of potential impacts on people

A summary of the rankings of impacts on people at the Russian landfall site arising from the potential sources of impact scoped into the assessment is provided in Table 10-79. None of the impacts are considered to be significant.

It is possible for people to be impacted by more than one of these sources of impact concurrently. The degree to which these combined sources impact social receptors is largely based on their distance to the project footprint (during construction) and project site (operation). This will be carefully considered in Nord Stream 2 AG's mitigation and management measures. However, considering the different nature of the impact sources, it is not expected that their combination will result in any "in-combination" impact rankings higher than minor.

The impacts arising from all the identified potential sources of impact will be highly localised and not extend over national borders. As such, no potential for transboundary impacts on people has been identified at the Russian landfall site.

**Table 10-79 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

People - Russia	Project	RU	FI	SE	DK	GE	Trans
Land acquisition and use	N/A		-	-	-	-	No
Physical changes to landform or land cover	N/A		-	-	-	-	No
Light from working areas *	N/A		-	-	-	-	No
Noise generation *	N/A		-	-	-	-	No
Emissions to air	N/A		-	-	-	-	No
Employment generation	N/A		-	-	-	-	No
Transport movements to site	N/A		-	-	-	-	No
Impact ranking:		Negligible	Minor	Moderate	Major		

\* The residence located 50 m from the project footprint is not currently included, as more assessment is



required.

### 10.10.2 Economic resources

Four potential sources of impact on economic resources are identified in Table 8-3. Of these, two have been scoped out in part (for the specified potential impacts) and one in full for the reasons outlined in Table 10-80 and are thus not considered further.

**Table 10-80 Potential source of impact scoped out for economic resources**

Potential source of impact	Potential impact	Justification
Land acquisition/use (construction)  Scoped out in part	Impacts on agricultural livelihoods.	The only agricultural lands within the project footprint are those of the Pribrezhnoe agricultural company. This company runs a low level operation, growing hay. Much of the land owned by Pribrezhnoe is fallow and so any hay production in the area of the project footprint will be moved to these areas. Pribrezhnoe will receive lease payments for the land used by NSP2. As such, there are not expected to be any significant impacts on agricultural livelihoods as a result of land acquisition by the project.
Land acquisition/use (operation)  Scoped out in part	Impacts on hunting and gathering livelihoods due to temporary or permanent loss of access to land. Impacts on agricultural livelihoods.	The land required by NSP2 during operation does not significantly impact the areas currently used for hunting and collection of berries, mushrooms, etc. Additionally, these areas are large in extent and so alternative areas are available for use. No significant impacts are therefore anticipated.
Employment generation (operation)	Generation of employment and economic opportunities for local residents.	The number of direct and indirect jobs generated by the project during the operation phase is not expected to be significant.

The following sources of potentially significant impacts on economic resources have been assessed:

- Land acquisition/use (construction and operation);
- Employment generation (construction).

#### 10.10.2.1 Land acquisition/use (construction and operation)

The building of the PTA, pipeline, offices, access road and facilities and working areas required during construction will require a mix of temporary and permanent land acquisition. This will result in some restricted access to land within the project footprint. Potential impacts on economic resources as a result of land acquisition and use include:

- Impacts on hunting and gathering livelihoods due to temporary or permanent loss of access to land;
- Reduction in tourism income;
- Impacts on land and property values.

#### Assessment of potential impacts

As described in Section 10.10.1.1, the PTA and the temporary works area are to be located on the land of the Pribrezhnoe agricultural company, whilst the pipeline and its associated RoW are located on land within the Kurgalsky Nature Reserve.

#### *Impacts during construction*

### Impacts on hunting and gathering livelihoods

The nature reserve is widely known as an area for picking berries, mushrooms and herbs. People travel from across the Kingisepp district to gather these natural resources for their own consumption. Collecting wild plants is one of the traditional activities of the indigenous (Izhorian) people, living within the district. No particular areas are known as central for these activities, but the wetlands<sup>51</sup> are understood to be one of the best places for berry picking. Hunting within the reserve is illegal, although understood to still occur.

There is currently a limited amount of information about the importance of these livelihood activities to households<sup>52</sup>, but feedback during consultation was that they do not contribute much to household incomes, or indeed play a significant role in sustaining the livelihoods of local residents.<sup>53</sup> Importantly, the area of the nature reserve is large (totalling 20,702 ha onshore) and it is expected that social receptors will have a high ability to adapt, utilising other areas in and around the reserve. Therefore, the importance of these livelihoods as an economic resource is assessed as low.

During construction, the project will (as described in Section 10.10.1.2) result in temporary access restrictions within the Kurgalsky Nature Reserve due to the presence of the 85 m wide RoW running approximately 3.7 km from the PTA to the shore. Considering the extent of the access restrictions in comparison to the area of land used for hunting and gathering, the magnitude of this impact is assessed as low. The impact is localised, of short duration and affects a relatively small number of receptors. When combined with the low sensitivity/vulnerability of the receptor, the impact ranking is **minor**.

### Reduction in tourism income

As described in Section 10.10.1.2, the nature reserve and its surrounds are a known location for visitors and tourists. Whilst the tourism sector is not known to be a significant source of income or employment in the local area, there is still revenue generated from the renting and selling of dachas and the provision of goods and services to visitors. However, considering the small-scale nature of the tourism sector (along with its contributions to the economy) the importance of this tourism income as an economic resource is assessed as low.

The area to be used by NSP2 is a small proportion of that utilised by tourists and there are no specific formal tourist attractions within the vicinity of the site although even such informal visitors may contribute modest amount of tourism related income to the local economy. Visitors who have come to the area for its tranquil setting will be impacted by construction activities within the project footprint, which may have subsequent impacts on such tourism income if visitor numbers are reduced. As described in Chapter 16 – Mitigation Measures and the project's SEP, Nord Stream 2 AG will ensure that there is timely and appropriate information disclosed to stakeholders about the construction schedule for NSP2. With sufficient information about the location and scheduling of works, tourists will be able to plan their visits to the area so as to avoid any disruption associated with construction activities. With this mitigation in place, the magnitude of the impacts on tourism income is assessed as negligible to low. The impact is small-scale, localised and of short duration. When combined with the low importance of tourism income as an economic resource, this impact is ranked **negligible to minor**.

### Impacts on land and property values

The project footprint is within the Kuzemkinskoe Rural Settlement (RS), which consists of permanent residents and dacha (holiday home) owners. Most houses are located along local rivers, in the vicinity of the nature reserve, or in other quiet, rural settings. It is assumed that

<sup>51</sup> The location of these wetlands is to be established during the upcoming social survey in 2017.

<sup>52</sup> Further information will be collected during the upcoming social survey in 2017.

<sup>53</sup> According to the Kuzemkinskoe administration consulted during the ERM Social Survey, August to September 2016.

these favourable living conditions are reflected in the price of housing in the area. As such, land and property values are assessed to be of medium importance as an economic resource.

The land taken and used by NSP2 may therefore serve to reduce the value of property in the area as the project's presence impacts on the natural setting of the location. This is particularly the case for those communities in closest proximity to the project site: Khanike, Ropsha, Koleno (part of Udarnik) and Volkovo (potentially also Udarnik and Vanakyulya).

For the majority of local residences, impacts on land and property prices will be temporary (during the 18 to 24 months of construction), if at all, and so the magnitude of the impact is assessed as negligible to low. When combined with the medium importance of land and property values, this impact is ranked as **minor**.

#### *Impacts during operation*

##### Reduction in tourism income

During operation, land use restrictions will only apply to the PTA. There may be some very localised impacts on tourism income for the owners of properties close to the PTA. Despite there being no direct noise, air quality or visual impacts (although some properties may have sight of the PTA), visitors may not choose to vacation close to a pipeline. However, such impacts are expected to be very localised and therefore of negligible to low magnitude. When combined with the low importance of tourism income as an economic resource, this impact is ranked as **negligible to minor**.

#### **10.10.2.2 Employment generation (construction)**

NSP2 will require a temporary workforce of approximately 350 to 400<sup>54</sup> people during construction of the landfall and onshore facilities in Russia. Nord Stream 2 AG and its contractors will also need to procure a range of goods and services to support project activities. Potential impacts on economic resources as a result of employment generation include:

- Direct and indirect job opportunities, locally and more broadly in the region.

##### **Assessment of potential impacts**

Due to the technical nature of the construction it is expected that specialist skills will mostly be required on site, but there may be some job opportunities for local people. Employment levels in the local communities and the broader Kingisepp region are reasonably healthy (see Chapter 9 – Environmental baseline for more details). Additionally, a large proportion of the local population comprises retirees or vacationing visitors. As such, the level of importance of employment generation during construction is assessed as low.

#### *Impacts during construction*

The need for specialist skills during construction will minimize opportunities for local residents, but at certain points during construction, unskilled jobs will likely make up around 20-30% of the workforce. Nord Stream 2 AG and its contractors will also need to procure goods and services, such as catering, cleaning, waste disposal, logistics and other services, all of which may lead to job opportunities. Whilst there are unlikely to be many local suppliers (within the local communities) with capacity to supply the project, it is expected that in the broader Kingisepp district there will be suitable companies. The district's marine port in Ust'-Luga will be used for shipping materials and equipment for NSP2, generating work and revenues at the port. Additional indirect jobs may also be created by companies securing contracts with Nord Stream 2 AG. The presence of a construction workforce in the area will also likely boost revenue for other local businesses, such as shops and eateries. Employment levels are reasonable in the Kingisepp

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<sup>54</sup> Workforce numbers are to be confirmed.

region and so the importance of these short-term jobs during construction is assessed as low to medium.

As detailed in Chapter 16 – Mitigation measures, Nord Stream 2 AG and its contractors will endeavour to procure products and services locally where feasible. The SEP for the project will also include appropriate engagement with local stakeholders so that expectations regarding direct and indirect job opportunities with the project are well managed.

Any direct or indirect employment associated with NSP2 will be temporary in nature, but would result in a **positive** economic impact.

### 10.10.2.3 Summary and ranking of potential impacts on economic resources

A summary of the rankings of impacts on economic resources at the Russian Landfall site arising from the potential sources of impact scoped into the assessment is provided in Table 10-81. As indicated in the table, none of the impacts are considered to be significant.

Due to the different nature of the impacts associated with each of these two sources of impact, it is not expected that a combination of these sources will result in any changes to the impact rankings.

The impacts arising from all the identified potential sources of impact will be highly localised and not extend over national borders. As such, no transboundary impacts on economic resources are anticipated as a result of NSP2 activities at the Russian landfall site.

**Table 10-81 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Economic resources – Russia	Project	RU	FI	SE	DK	GE	Trans
Land acquisition and use	N/A	Negligible to Minor	-	-	-	-	No
Employment generation	N/A	Positive	-	-	-	-	No
Impact ranking:							

### 10.10.3 Public services

The potential for project activities to impact public services has not yet been fully assessed. The project's usage of local utilities needs to be confirmed so that any impacts on public services are fully known. Such impacts could include reductions in electricity supply or water quality for local communities.

It is anticipated that there is a sufficient supply of energy and that the NSP2 power supply will not impact social receptors. As such, this is not expected to result in a significant impact; this will be confirmed.

Local communities are not connected to the piped water network<sup>[1]</sup>, with household water obtained from wells. It will thus be imperative that groundwater quality is not affected by the project, but this will be safeguarded through the measures laid out in Nord Stream 2 AG's Environmental Management Plans. As such, this is not expected to result in a significant impact.

Nord Stream 2 AG has a Grievance Mechanism in place for the project (as described in Chapter 16 – Mitigation measures). Any grievances raised regarding impacts on public services as a result of project activities will be carefully assessed and mitigation and management measures implemented, as necessary.

<sup>[1]</sup> To be confirmed during the upcoming social survey in 2017.

#### 10.10.4 Cultural heritage

One potential source of impact on cultural heritage was identified in Table 8-3. Of these, the aspects detailed in Table 10-82 have been scoped from further consideration.

**Table 10-82 Potential source of impact scoped out for cultural heritage**

Potential source of impact	Potential impact	Justification
Physical changes to landform or land cover (construction and operation)	Permanent or temporary changes to the setting of buildings or features of cultural heritage importance	There are no registered cultural heritage sites within 2 km of the landfall area or the project footprint.
Physical changes to landform or land cover (operation)	Damage to archaeological remains	Following the completion of the construction works, there will be no ground disturbance and therefore no risk of impacts on archaeological remains.
Physical changes to landform or land cover (construction and operation)	Impacts on intangible cultural heritage, such as traditional activities or indigenous languages.	Collection of wild plants is a traditional activity of indigenous groups in the district. Access to such resources will not be significantly impacted by the project because of the limited extent of the project footprint and the extensive areas available for collecting plants, berries and mushrooms. Additionally, there are not expected to be any other significant impacts on intangible cultural heritage as a result of the project.

The following sources of potentially significant impacts on cultural heritage have been assessed:

- Physical changes to landform or land cover (tangible cultural heritage in construction phase).

##### 10.10.4.1 Physical changes to landform or land cover (construction)

During construction, changes to landform and land cover that may affect cultural heritage features comprise soil stripping, earthworks, notably those associated trenching, and excavation associated with the construction of buildings and other structures and civil works. Such activities and the changes in landform or land cover may result in the following impacts on cultural heritage:

- Damage or destruction of archaeological remains as a result of physical disturbance associated with earthworks.

##### Assessment of potential impacts

Two Neolithic archaeological sites were identified during baseline surveys in the Russian landfall area (see Figure 9-45 in Section 9.10.5). Based on a preliminary assessment, the importance of the two sites located in the project area is assessed to be medium. The archaeological finds are still being assessed by the national authorities, following which their level of importance will be further refined.

The area where the two Neolithic sites were identified, is recognised as being of '*significance for the paleogeography and archaeological study of the area*' (see Chapter 9 – Environmental baseline). Therefore, in addition to the discovered sites, there is the possibility of additional sites within the project footprint.

As detailed in Chapter 16 – Mitigation measures, Nord Stream 2 AG has committed to implementing a Chance Finds Procedure so that any cultural resources encountered during construction are appropriately identified and managed in line with national and international good practice procedures. With the implementation of this mitigation, this impact magnitude is assessed to be low and the discovery of any chance finds would potentially enhance knowledge regarding previously unknown cultural heritage in the area. This, in combination with a medium level of importance, results in a **minor** impact ranking.

#### 10.10.5 Summary and ranking of potential impacts on cultural heritage

A summary of the rankings of impacts on cultural heritage at the Russian landfall site arising from the potential sources of impact scoped into the assessment is provided in Table 10-83. None of the impacts are considered to be significant.

Only one source of impact was assessed for cultural heritage, and so there are no “in-combination” impacts to consider.

The impacts arising from the identified potential sources of impact will be highly localised and not extend over national borders. As such, no potential for transboundary impacts on cultural heritage has been identified at the Russian landfall site.

**Table 10-83 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Cultural heritage - Russia	Project	RU	FI	SE	DK	GE	Trans
Physical changes to landform and land cover	N/A		-	-	-	-	No
Impact ranking:	Negligible		Minor		Moderate		Major

#### 10.11 Onshore landfall Lubmin 2

The sources of impacts identified in Chapter 6 – Project description have been used to assess the potential impacts on the following receptors and resources in the Lubmin 2 landfall area as identified in the socio-economic baseline:

- People (primarily includes local communities, including residents, workers, visitors, tourists, recreational users and road users in terms of their general amenity and safety levels);
- Cultural heritage (tangible and intangible resources);
- Tourism and recreational areas (economic resources);
- Existing and planned infrastructure (other services, including utility infrastructure).

##### 10.11.1 People

Eleven potential sources of impacts on people are identified in Table 8-3; of these, four have been scoped out of the assessment from further consideration, as outlined in Table 10-84.

**Table 10-84 Potential sources of impacts scoped out for people – Lubmin 2 landfall area.**

Source of impact	Potential impact	Justification
Land acquisition/use (construction)	<ul style="list-style-type: none"> <li>• Temporary loss of access to land used for recreation.</li> </ul>	The project area is located in an area planned for industrial and commercial purposes. Additionally, there are no established facilities within this area.

Source of impact	Potential impact	Justification
Traffic disruption and safety (construction)	<ul style="list-style-type: none"> <li>Increased road congestion;</li> <li>Increased risk of traffic-related accidents.</li> <li></li> </ul>	Newly constructed roads for transportation of equipment and machinery will be limited to the landfall area. No regional roads will be used. Most of the material will be transported via the rail network into the industrial area of Lubmin.
Noise generation (operation)	<ul style="list-style-type: none"> <li>Disturbance, such as on sleep patterns, which can affect the ability of people to work or concentrate. This can have subsequent impacts on health and quality of life.</li> </ul>	Noise generated during operation will be less than noise generated during construction and will be limited to the PTA, which will not involve any significant equipment and machinery.
Emissions to air (operation)	<ul style="list-style-type: none"> <li>Increase in respiratory disease from emissions (SO<sub>2</sub>, NO<sub>x</sub>, particulate matter).</li> </ul>	No communities are located within the project area. Air emissions will be significantly reduced during operation and are not expected to exceed the national air quality guidelines.

The following six sources of impacts have thus been assessed and are reported below:

- Physical changes to landform or land cover (natural or man-made) (construction);
- Light (from working areas) (construction);
- Noise generation (plant, traffic, power generation, release of pressure test gas, etc.) (construction);
- Emissions to air (chemical pollutants, GHGs and dust from earthworks plant, traffic, power generation, etc.) (construction);
- Employment generation (construction);
- Change to landform/use (operation);
- Light (from buildings) (operation).

#### 10.11.1.1 Physical changes to landform or land cover (natural or man-made) (construction)

Activities with the potential to cause physical changes to landform or land cover where people may be present comprise: land acquisition, site preparation (pipe installation and PTA), earthworks and dewatering, building of structures, pipe-lay, site restoration, construction of temporary roads, work camp and pre-commissioning activities.

The potential impact on people from physical changes to landform or land cover comprises:

- Changes in visual amenity from the introduction or removal of features that contribute to landscape character, or alter views.

#### Assessment of potential impacts

The vulnerability of people from physical changes to landform or land cover is high, because people are dependent on high amenity values. Due to the recreational uses of the surrounding area, the sensitivity of people is medium.

The construction works will result in a change of the landscape and the activities may be visible by recreational users, resulting in changes in visual amenity from the introduction or removal of features that contribute to landscape character, or alter views. During the operation phase, the above ground installations will result in a permanent change of landscape due to the permanent occupation of above ground structures. The main potential impacts will arise from the construction phase and will be limited to the landfall area.

As described in the baseline, the Lubmin 2 landfall is located in an industrial area, predominately surrounded by forests. The closest residential area is located approximately 1,300 m of the landfall area, with the adjacent forest areas and beach being used for limited recreational activities. The scale of the impact at the landfall area is local and construction activities will be confined to the landfall area. The construction activities will be temporary, as they will occur during the construction phase. The site will be re-instated after construction. Therefore, the intensity will be low.

Even though the construction period will be short-term, the change of landform will be permanent, resulting in a low impact magnitude. Combined with the medium sensitivity of the receptor, a **minor** overall project impact is given, which is assessed as not significant.

#### 10.11.1.2 Light (construction and operation)

As described in Section 10.11.1.1, similar activities with the potential to cause light impacts where people may be present will be conducted, which comprise: land acquisition (temporary and permanent), site preparation (pipe installation and PTA), earthworks and dewatering, building of structures, pipe-lay, site restoration, construction of temporary roads, work camp and pre-commissioning activities.

The potential impact on people from light from working areas comprises:

- Changes in visual amenity as a result of artificial lighting.

##### Assessment of potential impacts

The vulnerability of people from light from construction areas is high, because people are dependent upon high amenity values. The closest residential area is located approximately 1,300 m away from the landfall area. While recreational areas are located closer to the landfall sites, recreational activities are unlikely to happen at night. Based on their vulnerability, the sensitivity of people is medium.

During construction, some construction activities will require the use of temporary artificial light to provide adequate lighting. Modelling results performed for light indicated that the illumination at night (later than 10 pm) would not exceed the very conservative orientation. During the operation phase, permanent lighting installations will be used. Therefore, the intensity of the impact is considered to be low as the nearest community is located approximately 1,300 m away.

Based on the above, the impact magnitude is negligible, which when combined with the medium sensitivity, gives an overall **negligible** project impact ranking, therefore resulting in an impact that is not significant.

#### 10.11.1.3 Noise generation (construction)

As described in Section 10.11.1.1, similar activities with the potential to generate noise where people may be present will be conducted, which comprise: land acquisition (temporary), site preparation (pipe installation and PTA), earthworks and dewatering, building of structures, pipe-lay, site restoration, transportation to site, work camp and pre-commissioning activities.

The potential impact on people from noise generation comprises:

- Disturbance, such as on sleep patterns, which can affect the ability of people to work or concentrate. This can have subsequent impacts on health and quality of life.

##### Assessment of potential impacts

The vulnerability of people from noise generation from construction areas is high due to the recreational uses which rely on amenity. The impact of noise on settlement areas depends on: the type of use of the respective area, the impact intensity (level of noise), the distance to the



respective areas as well as the duration and the timespan of the impact, such as whether activities will be conducted during the night time.

To enable Affected Communities to raise any issues/concerns about the project, a grievance mechanism will be established to receive and facilitate resolution of concerns and grievances about the project's environmental and social performance. Exceedances of the applicable guide values for noise emissions will be avoided at all times in the coastal area off Mecklenburg Vorpommern through the selection of equipment that ensures compliance with the guide values. Detailed mitigation measures are provided in Chapter 16 – Mitigation measures.

During construction, airborne noise at the landfall area will be generated from the use of heavy machinery and equipment involved in earthworks and site preparation for the establishment of micro-tunnels and pipe-installation etc., movement of heavy vehicles and those used by site personnel. These activities could cause disturbance, such as to sleep patterns, which can affect the ability of people to work or concentrate. This can have subsequent impacts on health and quality of life and reduce the general amenity of the area.

The settlement Lubmin is located approximately 1,300 m from the PTA. According to German national guidelines on noise for residential areas, noise cannot exceed 50 dB during the day and 35 dB during the night time. Noise modelling conducted for activities at the PTA indicates that dredging and pipe-lay operations should be performed at an optimal distance of 4.6 km from the Lubmin settlement during the night time operations (20:00 - 07:00) and 350 m during the day (07:00 - 20:00) to remain below the noise threshold and to meet the noise guidelines. As seen from the modelling results, noise will not exceed noise guidelines during the day time. The intensity will be low because the impact does not lead to any permanent change.

Mitigation measures previously highlighted will be implemented to ensure compliance with the noise guidelines. The noise generated from the activities will be conducted over a short period and confined to the industrial area and therefore, noise generation is not expected to exceed any guidelines. It should be noted that the Lubminer Heide development plan (Bauplan, B-plan), which the landfall lies within, includes a noise barrier to the north and west of the area and this should reduce noise levels. Therefore, the impact magnitude is low because there may be a perceptible difference to the amenity due to noise generation, which affects a small proportion of households, communities or recreational users.

During the construction of NSP in Germany, airborne noise generated was monitored in the vicinity of the nearby residential areas, Lubmin and Rügen Island (Thiessow), as well as in the Marina of Lubmin industrial harbour. A survey performed in the settlements confirmed that the stochastic and temporary nocturnal noise exposure was not considered a relevant issue by the residents. The airborne noise monitoring performed during the construction works and commissioning activities further indicated that the noise levels that exceeded allowable levels for residential areas appeared to be episodic in nature and did not exert a considerable noise impact on adjacent residential areas.

According to the impacts outlined above and combined with the medium sensitivity of the receptor, the construction related noise emissions have a **minor** impact ranking and can therefore be assessed as not significant for the people in the vicinity of the NSP2 project area.

#### 10.11.1.4 Emissions to air (construction)

As described in Section 10.11.1.1, similar activities with the potential to cause emissions to air where people may be present will be conducted, which comprise: land acquisition (temporary), site preparation (pipe installation and PTA), earthworks and dewatering, building of structures, pipe-lay, site restoration, transportation to site, work camp and pre-commissioning activities.

The potential impact on people from air emissions:

- Increase in respiratory disease from emissions (SO<sub>2</sub>, NO<sub>x</sub>, particulates).

- 

#### **Assessment of potential impacts**

The vulnerability of people from emissions to air from construction areas is high, because people are dependent upon high amenity values. However, the closest residential area is located approximately 1,300 m away from the landfall area. Based on their vulnerability, the sensitivity of people is medium, because people have an ability to adapt to changes brought about by the project, though there may be some areas of vulnerability.

To enable Affected Communities to raise any issues/concerns about the project, a grievance mechanism will be established to receive and facilitate resolution of concerns and grievances about the project's environmental and social performance (further details are provided in Chapter 16 – Mitigation measures).

An increase of air emissions of gases such as increased CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> and fugitive dust is anticipated. Additionally, fugitive dust will result from site clearance and the movement of vehicles in the landfall. The modelling results for air quality (Appendix 3) showed that a significant impact on the businesses and industrial areas, as well as areas including settlements and recreational areas (health risk of employees and inhabitants) during the construction of NSP2 is not expected. Due to the type of project, the distance to settlements and recreational areas and the good aeration of the area, impacts are expected to be low. Furthermore, the impact of the construction-related intake of pollutants and dust will be over a short period and of low intensity.

Therefore, the impact magnitude is negligible, which when combined with the high sensitivity, gives an overall **negligible** project impact ranking, therefore resulting in an impact that is not significant. This is further confirmed by air quality monitoring performed during NSP.

#### **10.11.1.5 Employment generation (construction)**

The potential impact on people from employment generation comprises:

- Direct and indirect economic benefits due to presence of workforce.

#### **Assessment of potential impacts**

The vulnerability of people from employment generation is high as the construction activities will provide opportunities to people and local businesses. Therefore, their sensitivity in terms of vulnerability is considered as high due to employment generation.

The main impacts on employment opportunities (direct and indirect) will occur during the construction phase, which is expected to last 18-24 months. For direct employment, NSP2 will create approximately 320 jobs at the Lubmin 2 landfall, comprised of skilled and unskilled labour. The majority of these jobs will be over a short period.

Indirect employment will be generated through the procurement of goods and services from local businesses, which may result in employment generation. A potential may arise for workers to spend on local accommodation, goods and services.

In conclusion, impacts on people due to indirect employment generation have been assessed as **positive**.

#### **10.11.1.6 Summary and ranking of potential impacts on people**

A summary of the overall project impact rankings for people arising from the potential sources of impacts scoped into the assessment is provided in Table 10-85, together with the rankings

predicted at the country level. As indicated in the table, none of the impacts are considered to be significant.

No potential for transboundary impacts has been identified, as the sources of impact are confined to the landfall area.

**Table 10-85 Overall project assessment and country-specific impact ranking and anticipated transboundary impacts (sources of impacts represented with '-' have not been assessed).**

People	Project	RU	FI	SE	DK	GE	Trans
Physical changes to landform or land cover (natural or man-made)	N/A	-	-	-	-		No
Light	N/A	-	-	-	-		No
Noise generation	N/A	-	-	-	-		No
Emissions to air	N/A	-	-	-	-		No
Employment generation	N/A	-	-	-	-	Positive	No
Impact ranking:	Negligible		Minor		Moderate		Major

### 10.11.2 Cultural heritage

One potential source of impact on cultural heritage has been identified in Table 8-3 and has been scoped out of the assessment, as outlined in Table 10-86.

**Table 10-86 Potential source of impact scoped out for cultural heritage – Lubmin 2 landfall area.**

Source of impact	Potential impact	Justification
Physical changes to landform or land cover (natural or man-made) (construction)	<ul style="list-style-type: none"> <li>• Damage or destruction of archaeological remains (known or as yet undiscovered);</li> <li>• Damage or destruction of cultural heritage sites;</li> <li>• Enhanced knowledge due to recording and reporting of previously unknown features;</li> <li>• Permanent or temporary changes to the setting of buildings or features of cultural heritage importance.</li> </ul>	As highlighted in the baseline description (Section 9.11.6), no cultural heritage features have been identified. However, a Chance Finds Procedure will be applied (See Chapter 16 – Mitigation measures) for any features that are encountered and the cultural heritage resources will be handled in accordance with national legislation.

### 10.11.3 Tourism and recreational activities

Nine potential sources of impacts on tourism and recreational areas have been identified in Table 8-3, of which all have been scoped out of the assessment, as outlined in Table 10-87.

**Table 10-87 Potential sources of impacts scoped out for tourism and recreational areas – Lubmin 2 landfall area.**

Source of impact	Potential impact	Justification
Physical changes to landform or land cover (natural or man-made) (construction)	<ul style="list-style-type: none"> <li>• Changes in visual amenity resulting from the introduction or removal of features that contribute to landscape character, or alter views, which may</li> </ul>	The project area is located in an area planned for industrial and commercial purposes and located approximately 300 m from recreational areas/facilities.

Source of impact	Potential impact	Justification
	<p>lead to reduced tourism business revenue.</p>	
<p>Light (from working areas) (construction)</p>	<ul style="list-style-type: none"> <li>Changes in visual amenity as a result of artificial lighting, which may lead to reduced tourism business revenue.</li> </ul>	<p>The project area is located in an area planned for industrial and commercial purposes and located approximately 300 m from recreational areas/facilities.</p>
<p>Noise generation (plant, traffic, power generation, release of pressure test gas, etc.) (construction)</p>	<ul style="list-style-type: none"> <li>Changes in general amenity, which may lead to reduced tourism business revenue.</li> </ul>	<p>The project area is located in an area planned for industrial and commercial purposes and located approximately 300 m from recreational areas/facilities.</p>
<p>Emissions to air (chemical pollutants, GHGs and dust from earthworks plant, traffic, power generation, etc.) (construction)</p>	<ul style="list-style-type: none"> <li>Changes in general amenity due to dust, etc., which may lead to reduced tourism business revenue.</li> </ul>	<p>Air emissions from construction activities will not exceed the guideline values outside the project area and therefore, will not impact tourism revenue.</p>
<p>Land acquisition/ use (construction)</p>	<ul style="list-style-type: none"> <li>Temporary loss of access to areas for recreational use, which may lead to reduced tourism business revenue;</li> <li>Temporary loss of access to local communities, which may lead to reduced tourism business revenue.</li> </ul>	<p>The project area is located in an area planned for industrial and commercial purposes and there are no established facilities within this area.</p>
<p>Change to landform/use (operation)</p>	<ul style="list-style-type: none"> <li>Permanent loss of access to areas for recreational use, which may lead to reduced tourism business revenue.</li> <li>Permanent loss of access to local communities, which may lead to reduced tourism business revenue.</li> </ul>	<p>The project area is located in an area planned for industrial and commercial purposes and there are no established facilities within this area.</p>
<p>Light (from buildings) (operation)</p>	<ul style="list-style-type: none"> <li>Changes in visual amenity as a result of artificial lighting, which may lead to reduced tourism business revenue.</li> </ul>	<p>There are no established tourism facilities in the project area, with the closest facilities located approximately 300 m away. Therefore, no impacts are anticipated.</p>
<p>Noise generation (operation)</p>	<ul style="list-style-type: none"> <li>Disturbance, such as on sleep patterns, which can affect the ability of people to work or concentrate,</li> </ul>	<p>There are no established tourism facilities in the project area, with the closest facilities located approximately 300 m away. Therefore, no impacts are anticipated.</p>

Source of impact	Potential impact	Justification
	which may lead to reduced tourism business revenue.	
Emissions to air (operation)	<ul style="list-style-type: none"> <li>Increase in respiratory disease from emissions (SO<sub>2</sub>, NO<sub>x</sub>, particulate matter), which may lead to reduced tourism business revenue</li> </ul>	As previously mentioned, there are no established tourism facilities in the project area, with the closest facilities located approximately 300 m away. Therefore, no impacts are anticipated.

#### 10.11.4 Existing and planned infrastructure

One potential source of impact on existing and planned infrastructure has been identified in Table 8-3, as listed below, and will be assessed and reported below:

- Land acquisition/use (construction).

##### 10.11.4.1 Land acquisition/use (construction)

Activities with the potential to result in land use impacts where existing and planned infrastructure may be present comprise: site preparation (pipe installation and PTA), earthworks and pipe-lay. As pipe-lay will be conducted via micro-tunnels at the German landfall, potential impacts from this activity can be scoped out for Germany.

The potential impact on people from land use comprises:

- Damage to third-party infrastructure.

##### Assessment of potential impacts

The vulnerability of existing and planned infrastructure as a result of land use is high because third-party owners of infrastructure will be unable to adapt to changes brought about by the impacts from construction activities, and when combined with the high importance (as discussed in Section 9.11), a high sensitivity is given to existing and planned infrastructure in relation to land use.

- During excavation and pipeline installation, buried cables and pipelines may be damaged, and as identified in the baseline, most of the buried infrastructure is utilised by Energiewerke Nord GmbH. Should NSP2 damage the infrastructure, the scale of the impact will range between regional and transboundary, will be long-term and with a low intensity because the impact does not lead to any permanent change, or in this case, permanent changes will be mitigated. Therefore, considering the design methods that will be implemented to prevent damage to infrastructure, the magnitude of the impact will be negligible.

Taking into account the negligible impact magnitude and high sensitivity of existing and planned infrastructure, the impact is ranked as **negligible**, resulting in an impact that is not significant.

##### 10.11.4.2 Summary and ranking of potential impacts on existing and planned infrastructure

No potential for transboundary impacts has been identified as the sources of impact will be limited to the landfall site in Germany.

The overall significance of the project assessment carried out for existing and planned infrastructure is summarised in Table 10-88.

**Table 10-88 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Existing and planned infrastructure	Project	RU	FI	SE	DK	GE	Trans				
Land acquisition/use	N/A	-	-	-	-		No				
Impact ranking:	<table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 25%; background-color: #cccccc;">Negligible</td> <td style="width: 25%; background-color: #ffff00;">Minor</td> <td style="width: 25%; background-color: #ffcc00;">Moderate</td> <td style="width: 25%; background-color: #ff0000;">Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								

## 10.12 Onshore ancillary areas

The sources of impacts identified in Chapter 6 – Project description have been used to assess the potential impacts on the following receptors and resources in the onshore ancillary areas, as identified in the socio-economic baseline:

- People (primarily includes local communities and local economic activities, including residents and road users in terms of their amenity and safety levels);
- Economic resources:
  - Tourism and recreational activities.

### 10.12.1 People

Seven potential sources of impacts on people are identified in Table 8-3; of these, three have been completely scoped out and a further two have been partially scoped out of the assessment, as outlined in Table 10-89.

**Table 10-89 Potential source of impact scoped out for people – onshore ancillary areas.**

Source of impact	Potential impact	Justification
Physical changes to landform or land cover (natural or man-made) (construction)	<ul style="list-style-type: none"> <li>• Changes in visual amenity resulting from the introduction or removal of features that contribute to landscape character, or alter views.</li> </ul>	The ancillary components will be temporarily established in existing industrial or harbour areas and will not cause conflicts with current land uses. Furthermore, as per the project description, the ancillary facilities will be temporary and will be constructed and operated by third parties, which have been assessed within separate permitting processes.
Light (from working areas) (construction)	<ul style="list-style-type: none"> <li>• Changes in visual amenity as a result of artificial lighting.</li> </ul>	
Noise generation (work machines, traffic, power generation, etc.) (construction)  (Note: Noise generation (traffic) is not scoped out and is considered in the assessment)	<ul style="list-style-type: none"> <li>• Disturbance, such as on sleep patterns, which can affect the ability of people to work or concentrate. This can have subsequent impacts on health and quality of life.</li> </ul>	
Emissions to air (chemical pollutants, GHGs and dust from the earthworks plant, traffic, power generation, etc.) (construction)  (Note: Emissions to air (traffic) is not scoped out and is considered in the assessment)	<ul style="list-style-type: none"> <li>• Soiling of property from dust generation associated with pipe-coating and storage; and</li> <li>• Increase in respiratory disease from emissions (SO<sub>2</sub>, NO<sub>x</sub>, particulates) during construction and operation.</li> </ul>	

Source of impact	Potential impact	Justification
Land acquisition/ use (construction)	<ul style="list-style-type: none"> <li>Conflict on present and planned land use and infrastructure or conflict on the development of the area.</li> </ul>	

The following four sources of impacts have thus been assessed and reported below:

- Noise generation (traffic) (construction);
- Emissions to air (traffic) (construction);
- Employment generation (construction);
- Traffic disruption and safety (construction).

#### 10.12.1.1 Noise generation (construction)

The activity with the potential to generate noise where people may be present comprises transportation of rocks over land.

The potential impact on people from noise generation by traffic comprises:

- Noise disturbances due to an increase in ambient noise levels from the movement of rock transportation trucks.

It is assumed in the below that the rock will come from the same locations used during NSP.

#### Assessment of potential impacts

As discussed in Chapter 7 – Method adopted for production of Espoo environmental assessment documentation, 'people' are considered to be of equal importance and therefore their importance has not been ranked. The vulnerability of people to an increase in noise levels is medium as they could have the ability, at least in part, to adapt to changes brought about by the project, though there may be some areas along the rock transportation route where the receptors are located along roads or in proximity to industrial areas. Based on this, the sensitivity of people in terms of their vulnerability is medium to noise generation from traffic.

Noise will be generated from the use of trucks for rock transportation during the construction phase, and will be primarily sourced from engines at low driving speed, exhaust pipes during acceleration and tyres. A few residential areas are located along the rock transportation route (see Table 9-14, Section 9.12.2.1) and people may be sensitive to an increase in noise levels along the route.

Noise modelling performed for rock transportation was conducted from Highway 7 (E18), the Kotka intersection and to the Mussalo Harbour, covering an area of about 0.5–0.7 km on both sides of the rock transport route in Finland. Night-time noise was assessed as irrelevant, as rock transportation is planned to take place during the day-time (16 hours per day). The modelling results showed that rock transportation will increase noise levels by up to 2 dB on Road 255 compared to the normal conditions of the noise levels at residential areas. On Road 15, noise levels will contribute to an increase in ambient noise levels of less than 1 dB. It was determined that an increase of 1 to 2 dB in noise can hardly be heard by humans; however, an increase of more than 3 dB can be detected in the residential areas.

Therefore, taking into account the noise modelling results, the impact will be limited and the duration will be temporary as the activity will only occur during the construction phase and will be limited to daylight hours, with a low intensity. It has been assessed that the impact of increased noise is estimated to have a low impact magnitude along Road 355 as the noise levels will increase up to 2 dB and negligible along Highway 7 and Road 15 (increase of less than 1 dB).

Based on this, the impact is ranked differently for the rock transportation routes. A **minor** ranking has been given to Road 355 and a **negligible** ranking to Highway 7 and Road 15. Therefore, the overall project impact on all roads proposed for rock transportation is determined as not significant.

The noise generated by storage yard operation is considered to be **negligible** compared to the nearby existing operations and negligible in the nearest residential areas located at a distance of 2-2.5 km.

#### 10.12.1.2 Emissions to air (construction)

The activities with the potential to generate air emissions from traffic comprise land transportation of rocks (Kotka) and transport and storage of weight-coated pipes (Hanko).

The potential impact on people from emissions to air from traffic comprises:

- Increase in respiratory disease from emissions (SO<sub>2</sub>, NO<sub>x</sub>, particulates) from rock transportation.

#### Assessment of potential impacts

The vulnerability of people to an increase in air emissions is high as they are unable to adapt to changes brought about by the project as the receptors are located along roads or in proximity to industrial areas.

Rock transportation could potentially increase air emissions and, as described in Section 10.12.1.1, a few residential areas are scattered along the rock transportation route, which could increase respiratory disease from emissions (SO<sub>2</sub>, NO<sub>x</sub>, particulates).

Air quality modelling was conducted on Highway 7 to the Mussalo Harbour. The results indicated that the annual rock transportation emissions result in an increase of 0.4–1.6% of the traffic emissions of the City of Kotka. It was determined that the rock transportation route to the harbour is an asphalt paved, high-quality road; thus dust emissions during rock transport are considered to be minor. Generally direct and indirect (street dust) emissions from road traffic are considered to have quite a significant impact on the regional air quality of Kotka.

Based on the air quality modelling results for rock transportation, the transportation of rocks will be limited over a short period. The intensity will be medium as rock transportation could increase air emissions, though the slight increase in emissions is not expected to influence the general air quality in the Kotka region or cause exceedances of guideline or limit values.

Given the slight increase in air emissions over a short period, the magnitude of the impact on people will be low; however, a slight increase in emissions is not expected to influence the general air quality in Kotka or cause exceedances of guideline or limit values. Therefore, the impact is ranked as **minor**, resulting in an overall project impact that is not significant.

Activities in Koverhar, Hanko, include the storage yard for pipes. The pipes are transported to and from Koverhar by ship and use the existing Koverhar Harbour. The planned operations in Hanko take place during construction in 2018–2019.

Total emissions (NO<sub>x</sub>, SO<sub>2</sub>, PM) from ancillary operations in Hanko over the entire construction period are only 0.5–9% of the total annual emissions of the Port of Hanko. Annual emissions from ancillary operations in Hanko are 0.2–4% of the annual emissions of the Port in 2012. The impact on air quality from NSP2 in Hanko is **negligible** and cannot be distinguished from other operations in the Hanko region.



### 10.12.1.3 Employment generation (construction)

The activities with the potential to cause employment generation comprise operation of a CWC plant, rock transportation, pipe coating and pipe storage.

The potential impact on people from employment generation comprises:

- Employment opportunities (direct and indirect) that will lead to an increase in the local economy and influx of non-local workers.

#### Assessment of potential impacts

The vulnerability of people from employment generation will be high as local communities could benefit from the project. The ancillary facilities are located in areas with high unemployment rates and businesses and people could benefit from the NSP2 project. Based on their vulnerability, the sensitivity of people is high due to employment generation.

During construction, the project will generate local economic opportunities. Similar to NSP, NSP2 will generate job opportunities in all direct or indirect project-involved economic sectors. The various ancillary areas are assessed according to their locations below.

#### *Kotka (Finland)*

The ancillary project components in Hanko include the operation of a CWC plant and temporary pipe storage facilities at Mussalo Harbour and rock transportation from quarries to Mussalo Harbour.

A social survey was conducted in Kotka in 2016 regarding the proposed NSP2 project and in terms of employment, it is anticipated that job opportunities in Kotka would be created. In Kotka, the project and associated activities are expected to create 300 direct jobs and 100 indirect jobs during the construction phase. During NSP, the majority of the employees (labourers) were local. Therefore, the impact on employment is assessed to be **positive**.

#### *Hanko (Finland)*

The ancillary project component in Hanko includes temporary pipe storage facilities at Hanko Koverhar (see Chapter 6 – Project description).

A few small businesses are located in Hanko Koverhar; however, the temporary pipe storage yard will not have a significant impact on the existing small businesses. Only a few people will be employed at the storage yards. The impact on employment is assessed to be **positive**.

#### *Karlshamn (Sweden)*

The ancillary project components in Karlshamn include temporary pipe storage facilities (see Chapter 6 – Project description).

It is possible that contractors will have businesses related to maintenance work, transportation, supplies, etc. which could contribute to the local economy through direct and indirect employment. Therefore the impact on employment is assessed to be **positive**.

#### *Mukran (Germany)*

The ancillary project components in Mukran include construction and operation of CWC plant at Mukran and marshalling/storage yards (see Chapter 6 – Project description).

At least 150 jobs will be generated during construction by the Wasco Coating Europe BV, the company that will operate the CWC plant, at the harbour and industrial location in Mukran. The logistics of NSP2 construction will lead to general economic development and a sustainable structural improvement of the region surrounding the ancillary facilities. The generation of jobs and investments at the facilities will have a positive influence on the regional development. As

most of the impacts on the people assessed in this section are connected and dependent on each other, they will be cumulatively assessed.

Depending on the phase of the project, the impacts can be temporary (up to 2 years), or longer-term (overall development of the region). Regardless, the impact on employment is assessed to be **positive**.

#### 10.12.1.4 Traffic disruption and safety (construction)

The activity with the potential to cause traffic disruptions and safety risks comprises transportation of rocks over land.

The potential impact on people from traffic disruption and safety comprises:

- Road use disruption and risks to safety of people and vulnerable groups from increased traffic movements and reduction of general amenity.

#### Assessment of potential impacts

The vulnerability of people to traffic disruption and safety is high, as the receptors are frequent, high-volume, regular road users and sensitive receptors (e.g. children and non-motorised road users) that may be particularly vulnerable to increases in traffic movements, including risks to safety, are present in certain areas. Therefore, the sensitivity of people in terms of their vulnerability is high due to traffic disruption and safety.

Rock transportation will lead to increased vehicle traffic to the Mussalo Harbour in Kotka, which could impact the functionality of traffic and road safety, leading to congested roads and traffic-related accidents, thereby potentially reducing general amenity. As described in the baseline (Section 9.12.2), vulnerable groups have been identified along the rock transportation route. It is assumed that, in Highway 7, the effects of rock transportation are insignificant considering the total highway traffic of and are therefore not included in this assessment. Therefore, the impacts of rock transportation will be assessed along Road 15 and Road 355.

Road 15 will have a 3% increase in total traffic and a 42% increase in heavy traffic. Road 355 will have a 10% increase and a 40% increase in heavy traffic. This may lead to an increase in safety risks.

The scale of the impact will be to a local extent as the quarries are located approximately 17 km from Mussalo Harbour, and will be limited to the construction phase. Due to the increase of traffic on the roads, the intensity of the impact is medium on Road 15 and high in Road 355. It is estimated that rock transport will increase the average daily traffic by approximately 600 heavy vehicles. However, the impact magnitude will be low, as traffic will return to normal average volumes after the construction phase. Therefore, considering the low impact magnitude and high sensitivity, the overall project impact is ranked as **moderate** and therefore the impact is not significant.

#### 10.12.1.5 Summary and ranking of potential impacts on people

A summary of the overall project impact rankings for people arising from the potential source of impact scoped into the assessment is provided in Table 10-90, together with the rankings predicted at the country level.

No potential for transboundary impacts has been identified as the source of impact will be limited to the ancillary areas.

The overall impacts on people (applicable for Finland, Sweden and Germany) are summarised in Table 10-90.

**Table 10-90 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

People	Project	RU	FI	SE	DK	GE	Trans				
Noise generation (traffic)		-		-	-	-	No				
Emissions to air (traffic)		-		-	-	-	No				
Employment generation	Positive	-	Positive	Positive	-	Positive	No				
Traffic disruption and safety		-		-	-	-	No				
Impact ranking:	<table border="1"> <tr> <td style="background-color: #cccccc;">Negligible</td> <td style="background-color: #ffff00;">Minor</td> <td style="background-color: #ffcc00;">Moderate</td> <td style="background-color: #ff0000;">Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								

### 10.12.2 Tourism and recreational activities

The potential source of impact on tourism and recreation areas has been identified in Table 8-3 (Chapter 8 – Environmental impact identification) as listed below, and will be assessed and reported below:

- Traffic disruption and safety.

#### 10.12.2.1 Traffic disruption and safety (construction)

The activity with the potential to cause traffic disruption and safety comprises:

- Reduction of general amenity due to rock transportation which could lead to reduced tourism business revenue.

#### Assessment of potential impacts

The vulnerability of tourism and recreational areas to traffic disruption and safety is low as the tourism industry is able to adapt to changes brought about by NSP2, which will occur over a short duration and tourism is seasonal, which when combined with the low importance, as described in Section 9.12.3.1, a low sensitivity is given to traffic disruption and safety in relation to tourism and recreational activities.

A few recreational parks and summer cottages have been identified close to Kotka, which are seasonally used by tourists to access recreational facilities. It has been determined that traffic to and from the Mussalo Harbour in Kotka (Finland) will cause only small changes in relation to recreational areas. Therefore, the impact will be local and temporary (during the construction phase). The intensity will be low and the magnitude will be negligible as the recreational areas will remain unchanged and rock transportation will be temporary and will not lead to reduced tourism business revenue. Therefore, the impact has been ranked as **negligible** and therefore the impact is not significant.

#### 10.12.2.2 Summary and ranking of potential impacts on tourism and recreational areas

A summary of the overall project impact rankings for people arising from the potential source of impact scoped into the assessment is provided in Table 10-91, together with the rankings predicted at the country level.

No potential for transboundary impacts has been identified as the source of impact will be limited to the ancillary areas.

The overall impacts on tourism and recreational areas (applicable to Finland) are summarised in Table 10-91.

**Table 10-91 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Tourism and recreational areas	Project	RU	FI	SE	DK	GE	Trans
Traffic disruption and safety		-		-	-	-	No
Impact ranking:	Negligible		Minor		Moderate		Major

## Specific topics

Chemical munitions and associated chemical warfare agents (CWA) were identified during Espoo consultations as an issue requiring particular consideration as a potential source of impacts.

This section discusses the potential impacts from NSP2 on relevant receptors and provides an impact ranking which is then incorporated into the overall assessment of relevant receptors (seabed sediments and water quality) presented in Sections 10.2.1 and 10.2.2 (in order to provide an “in-combination” assessment).

### 10.13 Chemical munitions and CWAs

As described in Section 9.14, there are two main dumping sites for chemical munitions within the Baltic Sea: one located to the north-east of Bornholm in Danish waters (comprising a main site and a secondary site) and one located to the south-east of Hoburgs Bank in Swedish, Latvian, Lithuanian and Russian waters (comprising only a main site), see Atlas Map MU-02-Espoo. The proposed NSP2 route is located <1 km – 4.5 km (secondary/main) and >5 km from the dumping sites, respectively, but crosses the precautionary risk area (where fishing vessels are required to have first aid gas equipment on board) for both sites.

Given the distance from the dumping site in Sweden, in combination with the fact that no chemical munitions or CWAs have been found within the Swedish EEZ during NSP and NSP2 surveys, no impacts are predicted. Therefore, no further consideration has been given to the dumping site located within Swedish, Latvian, Lithuanian and Russian waters within this chapter. This section therefore focuses on the dumping site in Danish waters, due to the proximity of the secondary site and the results of NSP and NSP2 surveys (see below). It is noted that the HELCOM guidelines for chemical munitions will be followed during project activities which involve interaction with the seabed within either of the precautionary areas.

Along the NSP2 route in Denmark, 12 potential chemical munitions/munition-related objects were identified during the munitions screening survey. The findings were confirmed by the Danish ADF expert and identified as the remains of mustard gas type KC250 bombs.

A sampling survey was conducted in Danish waters to map the presence of CWAs in the seabed sediments along the NSP2 route. Quantitative chemical analysis of target CWA was performed to quantify the concentration of CWA and/or their degradation products in sediment samples. The highest detection frequencies and the highest maximum concentrations were found along the middle and northern parts of the NSP2 route in Denmark.

The potential sources of impacts associated with chemical munitions and CWAs during the construction phase comprise:

- Physical changes to seabed features;
- Release of contaminants (CWAs) to the water column;

No impacts associated with chemical munitions and CWAs are expected during operation;

Consideration has been given to the potential risk of chemical munition or CWA contact with pipelines, vessels and/or the public in Chapter 17 – Environmental management (as an unplanned event).

### 10.13.1 Physical changes to seabed features

Construction activities which disturb the seabed have the potential to mobilize CWA due to redistribution and break down lumps of CWA on the seabed. Potential impacts are associated with seabed sediments and comprise:

- Changes in concentrations of CWA in seabed sediments.

#### 10.13.1.1 Assessment of potential impact

Project activities such as rock placement, trenching, pipe-lay and anchor handling have the greatest potential to cause physical changes to seabed features and mobilize CWA. Remobilization and redistribution of CWA is expected only in the close vicinity of the disturbed area. CWA that is remobilized and redistributed by construction activities has the potential to increase concentrations of CWA in the surrounding seabed sediments, which has the potential to exert toxic effects on the biological environment. The receptor sensitivity is assessed to be high.

The mobility of CWA lumps would increase only if broken into smaller pieces. To evaluate whether the lumps would be moved by currents and waves, a desktop analysis has been performed /326/, /327/. This has concluded that the relocation of chemical munitions would primarily be due to fishing activities (bottom trawling) and that relocation by currents is only a minor factor. This is in line with the conclusion of the HELCOM Working Group on Dumped Chemical Munitions regarding the mobility of the chemical munitions and CWA /328/.

Furthermore, it can be concluded that the weathering and natural degradation of viscous mustard gas is more rapid for very small lumps than for large lumps /327/. Therefore, it must be expected that the very small fragments with a diameter of 10 mm would not be preserved on the seabed as long as the large lumps that can be found in the Baltic Sea. Monitoring of seabed sediments during NSP construction in 2010-2012 showed that intervention works did not lead to changes in concentrations of CWA in the seabed sediments, and it was concluded that the CWA-associated risks for the marine environment were not significant.

Taking into account that the seabed intervention works within Danish waters (trenching and rock placement) will be at distinct locations along the route (see Atlas Map MO-01-Espoo) and will last for only a few days at any given location, it is evaluated that construction activities will have a local and short-term effect on CWA spreading. The level of sedimentation is also not considered sufficient to alter the contamination levels of the surrounding seabed environment.

Based on the negligible impact magnitude, the impact of physical disturbance of the seabed on sediment quality resulting from CWA redistribution is assessed to be negligible in Denmark.

This conclusion is incorporated into the overall assessment of impacts on seabed sediments presented in Section 10.2.1.

### 10.13.2 Release of contaminants (CWAs) into the water column (construction)

Construction activities that disturb the seabed have the potential to release CWAs into the water column. Potential impacts are associated with water quality and comprise:

- Increased concentration of CWAs in the water column.

#### 10.13.2.1 Assessment of potential impacts

Initially, chemical analysis of the sediment samples along the proposed NSP2 route was performed to determine the concentrations of CWA that might be released into the water column as a result of construction and operation activities for NSP2. The evaluation of CWA toxicity and impacts on the marine environment are based on the concentrations of CWA in seabed sediments and modelling results of sediment redistribution due to intervention works /284/.

In order for chemicals to be incorporated into organisms, such as fish, and exert toxicity, they generally need to be in solution. The measured CWA concentrations in the sediments were used to calculate pore water CWA concentrations based on adapted equilibrium partitioning as described in /284/. The pore water concentration of each compound can then be considered a conservative estimate of the concentration of the compound in the bottom water above the seabed. The calculated pore water concentrations of the detected CWA and degradation products (PEC) are presented in column 2 in Table 10-92.

In addition to the inherent bottom water concentration of CWA and degradation products, there will be a contribution of CWA-related chemicals from suspended sediment due the activities undertaken in relation to the NSP2 construction. The volume of sediment that may be dispersed from the pipeline due to trenching and rock placement, which are considered to be the activities which contribute the most to the disturbance of sediment, were modelled for NSP2 as described in /329/. The concentration of CWA brought into suspension as a result of these construction activities, was estimated based on sediment dispersion modelling and measurements of CWA concentrations in sediment along the proposed NSP2 route. The highest predicted concentration of suspended sediment at a distance of 200 m from the pipeline during trenching and rock placement was considered. The results of this calculation are listed in the third column of Table 10-92.

**Table 10-92** PEC in pore water/bottom water and potential added bottom water concentrations caused by sediment dispersion at the distance of 200 m from the pipeline during intervention works /284/.

CWA	Calculated mean inherent pore water (bulk water) concentration (PEC)	Calculated mean added bulk water concentration
	µg/l	µg/l
Sulphur mustard	0.031	0.000094
1,4-dithiane	0.566	0.000029
1,4,5-oxadithiepane	0.098	0.000030
1,2,5-trithiepane	0.044	0.000089
Adamsite	0.360	0.0169
5,10-dihydroxyphenarsazin-10-ol 10-oxide	0.0023	0.0080
Diphenylarsinic acid	0.0021	0.0122
Diphenylpropylthioarsine	0.0046	0.0015
Triphenylarsine	0.0002	0.00057
Triphenylarsine oxide	0.0006	0.0022
Phenylarsonic acid	0.307	0.0033
Dipropyl phenylarsonodithionite	0.073	0.0015
α-chloroacetophenone	0.283	0.00022
Tributyl arsenotrithionite	0.0094	0.00055

#### Calculation of predicted no effect concentration

The toxicologically acceptable exposure concentrations associated with fish communities was used as a measure for PNEC. As a measure of these exposure concentrations, the fish community extrapolated HC5 value was used. HC5 (hazard concentration 5%) represents the concentration where the acute LC50 (lethal concentration causing death of 50% of population) is not exceeded for 95% of the fish species in the community. For cyclic degradation products of sulphur mustard, PNEC for daphnia were used.

For simplicity, the various intact CWAs and the degradation compounds that were detected in the sediment were distributed into 5 classes (sulphur mustard, organoarsenic CWA, thiodiglycol, cyclic sulphur mustard products, and α-chloroacetophenone) and HC5 was derived for each class as described below /284/.

*Sulphur mustard.* Based on the available literature, the chronic EC50 (i.e. the concentration that induces a response halfway between the baseline and maximum) for sulphur mustard is identified

as 2 mg/l. This value was used to derive a species sensitivity distribution for 14 different fish species using the USEPA extrapolation tool WEB ICE<sup>55</sup> with the most sensitive species, bluegill sunfish, as the surrogate species. This resulted in a fish community HC5 of 0.69 mg/l.

*Organoarsenic CWAs.* In the absence of high quality environmental toxicity data for the multitude of arsenic compounds, the known most toxic compound is used (inorganic AsIII). The toxicity of AsIII was derived from the US National Library of Medicine Hazardous Substances Data Base (HSDB). The data were used to derive a species sensitivity distribution for 12 fish species (adult and juvenile). This resulted in a fish community HC5 of 0.29 mg/l.

*Thiodiglycol.* The HC5 for thiodiglycol was set to 1,000 mg/l based on experimental results using bluegill sunfish /330/.

*Cyclic sulphur mustard products.* For the detected cyclic products of mustard gas (1,4-dithiane, 1,4-oxathiane, 1,4,5-oxadithiepane, 1,2,5-trithiepane), the new OECD standardized GLP tests with algae (*Raphidocelis subcapitata*), crustacean (*Daphnia magna*), and marine bacteria (*Allivibrio fischeri*) were conducted in Microtox™. During initial screening, 1,4,5-oxadithiepane was shown to be one of the most toxic of the compounds, and it was chosen as a representative for the cyclic mustard gas dissipation products in subsequent tests. An assessment factor of 500 was applied to the derived no observed effect concentrations (NOECs, i.e. the concentration at which no effects are observed on the test species) from the tests in accordance with EU guidelines. At a concentration of 0.825 mg/l, no effect was observed with *Daphnia magna*. In the case of *Raphidocelis subcapitata*, the test results showed no effect at concentrations at or below 8.41 mg/l. The corresponding PNECs for the two groups were thus  $0.825/500$  mg/l = 0.00165 mg/l and  $8.41/500 = 0.0168$  mg/l.

*α-chloroacetophenone.* The acute fish community HC5 value for α-chloroacetophenone was set to 0.5 mg/l based on available literature.

The PNEC results are summarised in Table 10-93.

**Table 10-93 PNEC values for detected CWAs (mg/l) /284/.**

CWA	PNEC
Sulphur mustard	0.69
Organoarsenic CWAs	0.29
Thiodiglycol	1,000
Cyclic mustard gas products	$0.0168^1/0.00165^2$
α-chloroacetophenone	0.5

<sup>1</sup>Raphidocelis subcapitata; <sup>2</sup>Daphnia Magna

### Predicted environmental risk

The assessment of the potential for the CWA to impact the environment is expressed through a risk quotient. The risk quotient (RQ) for a hazardous compound can be calculated as the PEC divided by the PNEC. A value above 1 indicates that the compound will be present in a concentration that is high enough to affect the environment negatively whereas a value below 1 indicates that no negative effects are anticipated.

In Table 10-94 the average RQs (average based on all stations along the route) corresponding to an undisturbed scenario are listed in column 2, and the average added RQs caused by sediment dispersion at a distance of 200 m from the NSP2 route are presented in column 3. The RQ during construction is the sum of the RQs in the undisturbed scenario (average RQ during undisturbed scenario) and the added CWA resulting from sediment dispersion due to intervention works (average added RQ).

<sup>55</sup> <https://www3.epa.gov/ceampubl/fchain/webice/index.html>



**Table 10-94** Calculated mean RQ during undisturbed scenario and the mean added RQ during worst case scenario /284/.

CWA	Average RQ during undisturbed scenario	Average added RQ
Sulphur mustard	0.00005	<0.00001
1,4-dithiane	0.34	0.00002
1,4,5-oxadithiepane	0.059	0.00002
1,2,5-trithiepane	0.027	0.00005
Adamsite	0.0012	0.00006
5,10-dihydrophenarsazin-10-ol 10-oxide	<0.00001	0.00003
Diphenylarsinic acid	<0.00001	0.00004
Diphenylpropylthioarsine	0.00002	<0.00001
Triphenylarsine	<0.00001	<0.00001
Triphenylarsine oxide	<0.00001	<0.00001
Phenylarsonic acid	0.0011	0.00001
Dipropyl-phenylarsonodithionite	0.0003	<0.00001
$\alpha$ -Chloroacetophenone	0.0006	<0.00001
Tripropyl arsenotrithionite	0.00003	<0.00001

Table 10-95 shows the maximum RQ calculated at the stations along the pipeline route for the same two scenarios.

**Table 10-95** Calculated maximum RQ during undisturbed scenario and the maximum added RQ /284/.

CWA	Maximum RQ during undisturbed scenario	Maximum added RQ
Sulphur mustard	0.00005	<0.00001
1,4-dithiane	0.39	0.00002
1,4,5-oxadithiepane	0.083	0.00003
1,2,5-trithiepane	0.046	0.00009
Adamsite	0.020	0.0011
5,10-dihydrophenarsazin-10-ol 10-oxide	0.00008	0.0003
Diphenylarsinic acid	0.0002	0.0010
Diphenylpropylthioarsine	0.00009	0.00003
Triphenylarsine	<0.00001	<0.00001
Triphenylarsine oxide	0.00002	0.00008
Phenylarsonic acid	0.0066	0.00008
Dipropyl-phenylarsonodithionite	0.0022	0.00005
$\alpha$ -Chloroacetophenone	0.0006	<0.00001
Tripropyl arsenotrithionite	0.00003	<0.00001

Based on the maximum added RQ for single compounds, the sum of the maximum added RQ values for all compounds is 0.00278. This value represents the maximum RQ during NSP2 construction.

In general, the RQs listed in Table 10-95 are much lower than 1, i.e. the concentrations of the different CWAs and their degradation products are far below the level at which a negative impact on the environment would be expected. This is the case both in the undisturbed scenario and during seabed intervention. In conclusion, no negative impacts on the water column related to CWAs in the seabed are expected in connection with NSP2.

In summary, the mean and maximum added RQs from pipeline installation for the sum of chemicals are far below one (<0.003), indicating no or negligible risk.

The predictions are supported by monitoring surveys conducted in 2010-2012 during NSP construction. The overall objective was to enable assessments of impacts on changes in the risk of CWAs in the seabed as a result of the construction activities. The monitoring was focused on the impacts from trenching, as this is the activity assessed to have the greatest impact on the seabed environment and thereby the greatest potential for disturbing buried CWA residues.

Results of the monitoring have shown that construction activities did not affect concentrations of CWA-related products present in the seabed sediments and CWA-associated risks for the marine environment were insignificant /285/.

Based on the above, it is evaluated that the release of CWAs into the water column as a result of NSP2 construction activities will be local and short-term, resulting in a negligible magnitude of impact. Given this magnitude, the impact from the release of CWAs into the water column on water quality is assessed to be negligible in Denmark.

This conclusion is incorporated into the overall assessment of impacts on seabed sediments presented in Section 10.2.2.

### 10.13.3 Summary of potential impacts from chemical munitions and CWAs

Table 10-96 provides the impact rankings of the Denmark specific assessment relating to chemical munitions and CWAs. These have been incorporated into the overall assessment of relevant receptors (seabed sediments and water quality) presented in Sections 10.2.1 and 10.2.2 (in order to provide an “in-combination” assessment).

**Table 10-96 Overall project assessments and country-specific impact ranking and anticipated transboundary impacts.**

CWA	Project	RU	FI	SE	DK	GE	Trans
Physical changes to seabed features		-	-	-		-	No
Release of contaminants (CWAs) into the water column		-	-	-		-	No
Impact ranking:	Negligible		Minor		Moderate		Major

## 10.14 Wet pre-commissioning

The base case is a dry pre-commissioning concept as described in Chapter 6 – Project description. There is no water discharge in the case of a dry pre-commissioning concept. The alternative wet pre-commissioning concept would mean that after the installation of the pipelines is complete, pre-commissioning activities would prepare the pipelines for commercial operation. Pre-commissioning includes the following main activities: flooding, cleaning and gauging of the pipeline interior followed by hydrotesting, dewatering and drying and hyperbaric tie-ins of the pipelines. The specific sources of impacts are related to the activities specified in Table 10-97.

**Table 10-97 Main activities during wet pre-commissioning.**

Activities	RU	FI	SWE	DK	GER
Intake of filtered untreated water for pre-commissioning	-	X	X	-	-
Discharge of minor amounts of untreated water	-	X	X	-	-
Discharge of treated anaerobe water (including surplus of NaHSO <sub>3</sub> )	X	-	-	-	-
Rock placement for underwater hyperbaric underwater tie-in (HWTI)	-	X	X	-	-
-: No action					

### 10.14.1 Assessment of potential impacts

#### 10.14.1.1 Russia

The offshore pipelines will be flooded with water taken from the sea. Traditionally, additives will be added to the flooding water in the closed pipeline system. Typical additives would be an oxygen scavenger (Natrium bisulphite (NAHSO<sub>3</sub>)) to prevent internal corrosion of the pipe. After

flooding, a pressure test will be carried out in order to verify the integrity of the system. After completion of the pressure test, the water will be discharged back into the sea outside the Russian landfall at KP 3, where the test water will be diluted by the ambient seawater.

Modelling of the discharge and dispersion of treated pressure test water (1,300,000 m<sup>3</sup>/pipeline) has been carried out in /241/. In /241/, modelling has been undertaken for the following three scenarios:

- Calm conditions (summer) representing calm current conditions;
- Rough conditions (winter) representing relatively strong current conditions;
- Normal conditions, representing average current conditions.

Based on the results from/241/, it is concluded that differences in temperature, salinity and oxygen conditions between the discharged water and the water at the discharge location will be equalized by a dilution of the discharged water of approximately 10 times. As shown in /241/, a 10 times dilution will be experienced approximately <5 km from the discharge point. Overall it is assessed that the wet pre-commissioning has a **minor** impact in Russia.

#### 10.14.1.2 Finland and Sweden

Inside Finnish EEZ at approximately KP 300, and inside Swedish EEZ at approximately KP 675, there will be intake of filtered seawater at a water depth of 5 – 15 m for the pre-commissioning operation. Furthermore - during pre-commissioning, a limited discharge of untreated water from the pipelines is expected at the two locations/hyperbaric tie-in locations.

At least two sub-surface hyperbaric weld tie-ins (HWTI) are required on each pipeline (used to connect two pipe sections that have previously been laid down).

At both locations, as described in Chapter 6 – Project description, gravel berms will be installed on the seabed to provide stability for the tie-in operations.

The impacts at these two locations will be restricted to the presence of vessels during the period of water intake for the pre-commissioning operation, during the period when the sub-surface hyperbaric tie in is carried out, and from the establishment of gravel berms at the seabed.

Overall it is assessed that the wet pre-commissioning has **negligible** impact ranking in Finland and Sweden as it is local and temporary.

#### 10.14.1.3 Germany

The impacts from activities to be undertaken at the German landfall during wet pre-commissioning has been assessed in the German EIA not to be beyond what has been assessed for the dry pre-commissioning concept that is assessed in Chapter 10 – Assessment of environmental impacts /54/ .

#### 10.14.2 Summary and ranking of potential impacts from wet pre-commissioning

On the basis of the discussion above, the magnitude of the impacts from wet pre-commissioning is considered to be negligible. As the sensitivity is low, the overall project impact ranking is assessed to be **negligible**.

The overall impact ranking of country-specific assessments carried out for wet pre-commissioning are summarised in Table 10-98.

Based on Table 10-98, it has been assessed that there will be no risk of transboundary impacts from the activities of wet pre-commissioning undertaken in Russia, Finland, Sweden and Germany to PoOs/AP countries.

**Table 10-98 Overall project assessment and country-specific impact ranking and potential for transboundary impacts (sources of impacts represented with '-' have not been assessed).**

Wet pre-commissioning	Project	RU	FI	SE	DK	GE	Trans				
Wet pre-commissioning					-		No				
Impact ranking:	<table border="1"> <tr> <td>Negligible</td> <td>Minor</td> <td>Moderate</td> <td>Major</td> </tr> </table>							Negligible	Minor	Moderate	Major
Negligible	Minor	Moderate	Major								

## 11. MARINE STRATEGIC PLANNING

In addition to analysing potential impacts on specific receptors in accordance with the EU EIA Directive, it is also important to consider the impacts of NSP2 in the context of other relevant EU legislation and recommendations designed to protect the marine environment and create a framework for the sustainable use of marine waters in the Baltic Sea.

The objectives of this section are therefore to:

- Supplement the information provided in Chapter 3 – Regulatory context on key EU Directives comprising the Marine Strategy Framework Directive (MSFD) and Water Framework Directive (WFD) as well as the Baltic Sea Action Plan (BSAP);
- Assess the degree of compliance of NSP2 with the objectives of these legislative tools (as they have been transposed into national legislation), and management plans based on the potential impacts of NSP2 during construction and operation.

### 11.1 Legislative context

The legislation described in this section includes the MSFD and the WFD, which are closely interlinked. Moreover this section presents the BSAP, upon which the environmental targets in the legislation are based. Together, they aim to improve the quality of European waters as set out in the Marine Spatial Planning Directive, which was adopted by the European Parliament in July 2014, creating a common framework for maritime spatial planning in Europe.

In particular, there are synergies between the MSFD and WFD, which have comparable objectives for Good Environmental Status (GES) of marine waters and Good Ecological/Good Chemical Status of surface waters, respectively. Significant levels of overlap include chemical quality, eutrophication and other aspects of ecological quality, and hydromorphological quality. The MSFD applies to the entirety of each EEZ (up to 200 nm). Where geographical overlap occurs (in coastal waters up to 12 nm), see Figure 11-1, the MSFD is generally being applied to those aspects which are not already covered by WFD (e.g. noise etc.).

Both the MSFD and WFD are also inter-related to the Habitats and Birds Directives. However, the scope of the MSFD is far broader than all three directives in that it aims to achieve and maintain GES, which includes all marine biodiversity (and therefore requires an ecosystem approach), whilst the Habitats and Birds Directives focus on the conservation of particular habitats and species, and the WFD assesses the quality of each ecosystem component separately. In this regard, the impact of NSP2 in the context of the Habitats and Birds Directives has been addressed in Sections 10.6.4-10.6.6.

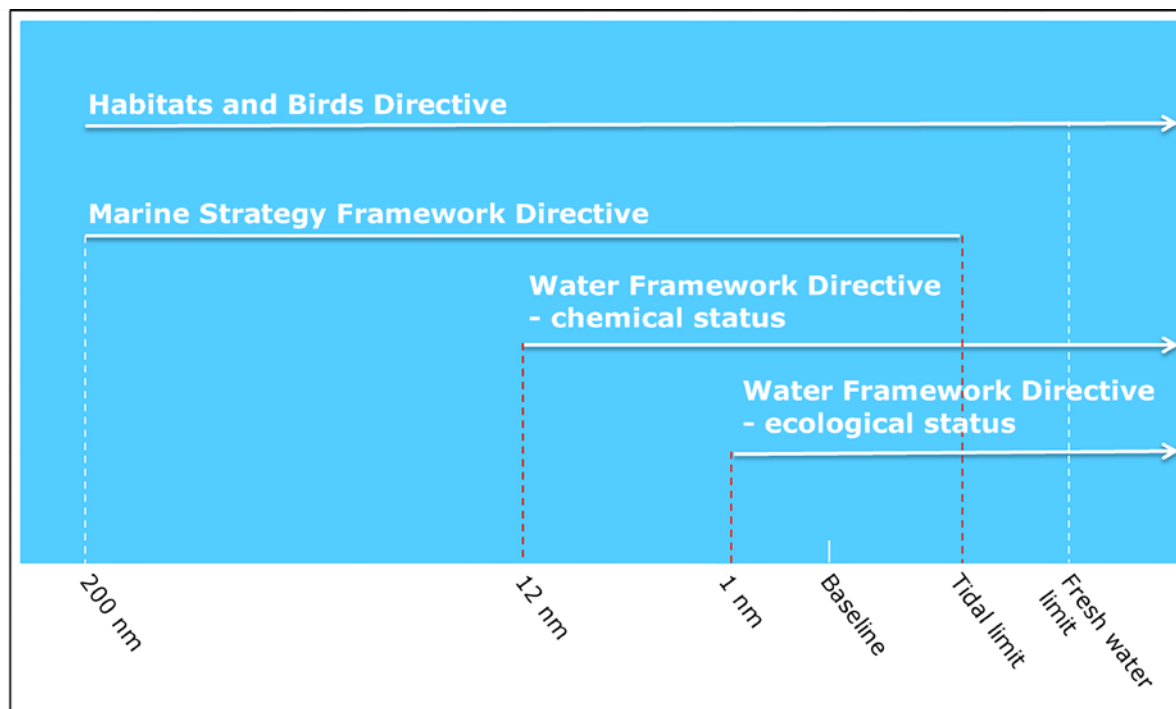


Figure 11-1 Marine areas covered by EU marine legislation.

The MSFD requires that, in developing their marine strategies, Member States use existing regional co-operation structures to co-ordinate their actions with those of other countries in the same region or sub-region. The HELCOM Baltic Sea Action Plan is such a regional plan and thus is considered relevant to the Marine Strategies of the Baltic Sea States and forms the basis for the countries' national strategies for reaching GES.

It is noted that, as Russia is not bound by EU Directives, neither the MSFD nor the WFD is applicable within its EEZ. Therefore, impacts on Russian waters from NSP2 have been assessed for compliance with the BSAP only.

## 11.2 Implementation status and data from national marine strategies

### 11.2.1 Marine Strategy Framework Directive

The MSFD (Directive 2008/56/EC) is the first encompassing piece of EU legislation specifically aimed at protecting the marine environment and natural resources and encouraging the sustainable use of marine waters. It establishes a framework within which each Member State must take the necessary measures to achieve or maintain GES of the marine environment by the year 2020 at the latest (Article 1).

The MSFD outlines 11 high-level descriptors, see Table 11-1, used to assess the GES of the marine environment and provides a list of associated anthropogenic pressures (Annex III). As these descriptors cover a broad range of topics, the EU Commission has produced a set of detailed criteria and methodological standards for GES to help Member States measure progress of the status /332/. Descriptors have been categorised as either 'state descriptors', which characterise marine biodiversity (D1, D4 and D6), or 'pressure descriptors', which relate to human-induced pressures (D2, D5, D7 – D11). Descriptor D3 is considered both a state and pressure descriptor (see Table 11-1).

The national authorities of the PoOs which are EU member states in the Baltic Sea region (all countries except Russia) have prepared marine strategies in which they have sought to establish GES (Article 9), provide an overview of the current environmental status (see Table 11-2) (Article 8) as well as identify associated targets and condition criteria (Article 10) for each descriptor. The data presented within each PoO national marine strategy is not consistent and is considered inadequate for many descriptors /333/. Therefore, for the purpose of this chapter, where information in the PoO national marine strategies was considered insufficient to determine the current environmental status, reference has been made to information provided by HELCOM (Table 11-2) /334/.

Given the disparity in the data available for each PoO, and the fact that there are multiple targets for each descriptor (within each PoO national marine strategy), it is considered appropriate to assess the impacts of NSP2 against the relevant condition criteria. Indicators are specific attributes of each condition criteria that can either be qualitatively described or quantitatively assessed to determine whether it meets GES, or to ascertain how far each criterion departs from GES. Although consideration has been given to indicators when preparing the assessment, specific reference has not been made to them.

The classification scheme for current ecological and chemical status includes five categories: "high", "good", "moderate", "poor" and "bad". In order to achieve "GES" both ecological and chemical statuses must be at least good. If either ecological or chemical status is classified as "moderate", "poor" or "bad", this would result in a status where "GES is not reached".

Overall, the current environmental status of the Baltic Sea ranges from "poor" to "bad" with the most significant anthropogenic pressures related to eutrophication, fishery and pollutants (e.g. metals) according to national river basin management plans /335/, /336/, /337/.

**Table 11-1 Overview of the MSFD high level descriptors.**

Descriptor	Description of GES	Relevant Criteria	Condition	Relevant pressures	Where in the Espoo Report further baseline information can be found
D1 Biodiversity	Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species reflect the prevailing physiographic, geographic and climatic relationship	Species distribution Population size Population condition Habitat distribution Habitat extent Habitat condition Ecosystem structure		All pressures	Sections 9.6.1-9.6.8
D2 Non-indigenous species*	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem	Abundance and state characterisation of NIS in particular invasive species Environmental impact of invasive NIS		P8	Section 9.6.8
D3 Commercial fish and shellfish*	Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative	Level of pressure of the fishing activity Reproductive capacity of the stock Population age and size distribution		P1 P2 P3 P8	Sections 9.6.2-9.6.3

Descriptor	Description of GES	Relevant Criteria	Condition	Relevant pressures	Where in the Espoo Report further baseline information can be found
	of a healthy stock				
D4 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.	Productivity of key species or trophic groups Proportion of selected species at the top of food webs Abundance/distribution of key trophic groups/species		All pressures	Sections 9.6.1-9.6.8
D5 Eutrophication *	Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.	Nutrients levels Direct effects of nutrient enrichment Indirect effects of nutrient enrichment		P7	Sections 9.2.1-9.2.2
D6 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.	Physical damage to substrate characteristics Condition of benthic communities		P1 P2	Sections 9.2.1, 9.3.2 and 9.6.2
D7 Hydrographical conditions*	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.	Spatial characterisation of permanent alterations Impact of hydrographical changes		P4	Section 9.2.2
D8 Contaminants *	Concentrations of contaminants are at levels not giving rise to pollution effects.	Concentration of contaminants Effect of contaminants		P5	Sections 9.2.1-9.2.2
D9 Contaminants in seafood*	Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.	Levels, numbers and frequency of contaminants		P5	Sections 9.2.1-9.2.2 (precursors)
D10 Marine litter*	Properties and quantities of marine litter do not cause harm to the coastal and marine environment.	Characteristics of litter in the marine and coastal environment Impacts of litter on marine life		P3 P6	Chapter 6 – Project description



Descriptor	Description of GES	Relevant Criteria	Condition	Relevant pressures	Where in the Espoo Report further baseline information can be found
D11 Energy, Underwater noise*	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.	Distribution in time and place of loud, low and mid frequency impulsive sounds Continuous low frequency sound		P3	Sections 9.6.3-9.6.5
<b>Pressures</b>		<b>Impacts associated with the pressures in MSFD annex III) (NSP2 relevancy is <u>underscored</u>)</b>			
P1 Physical loss		<u>Smothering, sealing</u>			
P2 Physical damage		<u>Siltation, Abrasion</u> , Extraction			
P3 Other physical disturbance		<u>Underwater noise, Litter</u>			
P4 Interference with hydrological processes		Significant changes to thermal or salinity regimes			
P5 Contamination by hazardous substances		Synthetic compounds, <u>Non-synthetic compounds</u> , radio nuclides			
P6 Release of substances		Other substances			
P7 Nutrient and organic matter enrichment		Fertilizers, <u>Other N- or P-rich substances</u> , <u>Organic matter</u>			
P8 Biological disturbance		Introduction of microbial pathogens, <u>NIS</u> , Extraction of species			
*: These descriptors are considered 'pressure descriptors', which relate to human pressures. In respect to D3, this is both a state and pressure descriptor.					

Table 11-2 Current environmental status of 11 MSFD descriptors.

Descriptor	Germany	Denmark	Sweden	Finland
D1: Biodiversity	GES Not reached <sup>2</sup>	GES Not reached <sup>2</sup>	GES Not reached <sup>1</sup>	GES Not reached <sup>1</sup>
D2: Non-indigenous species	Status not known <sup>3</sup>	Status not known <sup>3</sup>	Status not known <sup>3</sup>	GES reached <sup>1</sup>
D3: Commercial fish and shellfish	GES Not reached <sup>2</sup>	GES Not reached <sup>1</sup>	GES Not reached <sup>2</sup>	Status not known <sup>3</sup>
D4: Food webs	Status not known <sup>3</sup>	GES Not reached <sup>2</sup>	GES Not reached <sup>2</sup>	GES Not reached <sup>1</sup>
D5: Eutrophication	GES Not reached	GES Not reached <sup>1</sup>	GES Not reached <sup>1</sup>	GES Not reached <sup>1</sup>
D6: Sea-floor integrity	Status not known <sup>3</sup>	GES reached <sup>2</sup>	GES reached <sup>2</sup>	GES reached <sup>1</sup>
D7: Hydrographical conditions	GES reached <sup>2</sup>	Status not known <sup>3</sup>	Status not known <sup>3</sup>	GES reached <sup>1</sup>
D8: Contaminants	Status not known <sup>3</sup>	GES Not reached <sup>1</sup>	GES Not reached <sup>1</sup>	GES Not reached <sup>1</sup>

Descriptor	Germany	Denmark	Sweden	Finland
D9: Contaminants in seafood	GES Not reached <sup>2</sup>	GES Not reached <sup>1</sup>	GES Not reached <sup>2</sup>	GES Not reached <sup>1</sup>
D10: Marine litter	Status not known <sup>3</sup>	Status not known <sup>3</sup>	Status not known <sup>3</sup>	Status not known <sup>3</sup>
D11: Energy, Underwater noise	Status not known <sup>3</sup>	Status not known <sup>3</sup>	Status not known <sup>3</sup>	Status not known <sup>3</sup>
1: Information from National Marine Strategies /335/, /336/, /337/. 2: Information from HELCOM /334/ 3: No information available from either the national marine strategies or HELCOM. Therefore it has not been possible to derive a current environmental status				

### 11.2.2 The Water Framework Directive

The WFD /20/ is a key initiative aimed at improving water quality throughout the EU to achieve a good status of both groundwater and surface waters. In this regard, the WFD has a number of objectives, such as preventing and reducing pollution, promoting sustainable water usage, environmental protection and improving aquatic ecosystems. As noted above, whilst the main focus is fresh water, the Directive also covers transitional and coastal waters up to one nautical mile (nm) off the coast for ecological status and 12 nm for chemical status. The objective of the WFD was to achieve 'good ecological and chemical status' for all EU waters by 2015 (though there was an acknowledgement that the objective could be delayed until 2021). The classification scheme used to describe the status for the purpose of the WFD is the same as that used for MSFD (see Section 11.1.1 above).

The NSP2 route crosses both the 1 nm and 12 nm zones in Germany, and the 12 nm zone in Finland and Denmark. It does not cross within 12 nm of the coast in Sweden and as such does not directly interact with any Swedish waters under WFD. The ecological and chemical status (as appropriate) of these 'zones' relevant to the WFD are listed in Table 11-3 below.

**Table 11-3 Current status (according to WFD) for the transitional (1nm) and coastal (12nm) waters.**

	Germany <sup>3</sup>	Denmark <sup>2</sup>	Sweden	Finland <sup>1</sup>
Ecological status (1 nm)	Moderate	Not relevant*	Not relevant*	Not relevant*
Chemical status (12 nm)	Not Good	Good	Not relevant*	Good
1: Data from 'Suomen merenhoitosuunnitelman toimenpideohjelman 2016–2021' /336/ 2: Data from 'Vandområdeplan 2015-2021 for Vandområdedistrikt Bornholm' /337/ 3: Data from 'Die Wasserrahmenrichtlinie. Deutschlands Gewässer 2015 /335/ *: NSP2 is outside the 1 nm or the 12 nm limit				

River Basin Management plans for the Gulf of Finland, waters around Bornholm and off the Greifswalder Bodden indicate that the main anthropogenic pressures to achieving GES (ecological and chemical) comprise eutrophication, commercial fishery, and contamination. It is noted that NSP2 is specifically mentioned in the Kymijoki-Suomenlahti River Basin Management Plan /342/ as a project that potentially has impacts on the outer archipelago zone in the Gulf of Finland (relevant to Finland only).

### 11.2.3 HELCOM Baltic Sea Action Plan

The 1992 Helsinki Convention entered into force on 17 January 2000 and the Baltic Marine Environment Protection Commission (Helsinki Commission/HELCOM) was established. In 2007, the HELCOM's BSAP was adopted; the contracting parties are Denmark, Germany, Finland, Estonia, Latvia, Lithuania, Poland, Sweden, the Russian Federation and the European Union.

The BSAP is a programme that aims to restore the good ecological status of the Baltic marine environment by 2021 /338/. Although the BSAP was originally adopted by all of the Baltic coastal

states and the EU in 2007 (see above), a HELCOM ministerial meeting was held in October 2013 during which the Baltic Sea countries reconfirmed their commitment to the BSAP.

The main goals of the BSAP are to achieve a Baltic Sea which:

- is unaffected by eutrophication;
- is undisturbed by hazardous substances;
- has a favourable biodiversity conservation status
- has maritime activities carried out in an environmentally friendly way.

The BSAP adopts an ecosystem approach, based on the integrated management of human activities impacting the marine environment and the marine ecosystem, thus supporting sustainable use of ecosystem goods and services. Under the BSAP, a number of recommendations are presented to support the four goals identified above. Included in the BSAP is also a document listing indicators and targets for monitoring and evaluation of the goals /338/.

All PoOs are signatories of the Helsinki Convention and are therefore bound to implement the measures relating to the BSAP.

### 11.3 Compliance assessment

In the following sections, a semi-quantitative assessment of the compliance of NSP2 in the context of the above legislation is provided, supported by the assessments undertaken in chapter 10. The assessments have been undertaken assuming implementation of identified mitigation measures (see Chapter – 16 Mitigation measures) and assuming compliance with relevant national legislation as well as best practice. Where quantitative data is not available, a qualitative assessment has been undertaken.

Where there is potential for transboundary impacts to affect compliance with the legislation (considered to be those with an impact ranking of minor or above), this is stated in the discussion below. Where there is no or negligible potential for transboundary impacts, this is considered insufficient to impact compliance and has not been assessed in this chapter.

#### 11.3.1 The Marine Strategy Framework Directive

The following sections discuss the potential for the construction and operation of NSP2 to prevent achievement of targets or the long-term goal for GES for each descriptor set out in the MSFD. Firstly, the pressure descriptors (which relate to human induced pressures i.e. D2, D3, D5, D8, D9, D10 and D11) are discussed with a focus on whether NSP2 activities will result in an increase in intensity of relevant pressures (see Table 11-1). Thereafter, the potential for NSP2 to impact state descriptors is discussed.

##### 11.3.1.1 Pressure descriptors

###### **Non-indigenous species (D2)**

Non-indigenous species is considered a 'pressure descriptor' which has the potential to threaten native species by competition for food and space. The target in the MSFD is therefore to keep introduction of new species to the Baltic Sea at a level that does not adversely alter the ecosystem. This section discusses the potential for NSP2 to increase the intensity of relevant pressures associated with D2 (P8 Biological disturbance), and concludes on the potential for impact based on relevant condition criteria.

NSP2 has the potential to introduce non-indigenous species through vessel movements (construction and operation) as well as colonisation along the pipelines (operation). However, as discussed in Chapter 17 – Environmental management, Nord Stream 2 AG will prepare Ballast Water Management Plans which will include measures to ensure adherence to OSPAR/HELCOM General Guidance on the Voluntary Interim Application of the D1 Ballast Water Exchange

Standard in the North East Atlantic. Implementation of these measures will reduce the risk of introducing NIS via vessel movements to a very low level. In respect to operation, the NSP2 pipelines will introduce a hard substrate where there has previously been soft bottom, creating a new habitat type. This impact would be highly localised to the proposed NSP2 route and the spread of NIS along the pipelines would be limited by changes in abiotic conditions (i.e. reduced light conditions, low oxygen conditions).

In summary, and as described in Section 10.6.8.8, impacts during construction and operation (individually or in combination) will not result in significant impacts on abundance or state characterisation of NIS or cause significant impacts on the marine environment due to introduction of NIS (condition criteria of D2).

On that basis, it can be concluded that NSP2 will not prevent the achievement of targets or the long-term goal for GES for Descriptor D2 for any of the Baltic countries.

### **Commercial fish and shellfish (D3)**

Commercial fish and shellfish can be considered a 'state descriptor' and 'pressure descriptor'. The target in the MSFD for commercially exploitable fish is to keep commercially exploited fish and shellfish within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. This section discusses the potential for NSP2 to increase the intensity of relevant pressures associated with D3 (P1 Physical loss, P2 Physical damage, P3 Other physical disturbance and P5 Contamination with hazardous substances), and concludes on the potential for impact based on relevant condition criteria. P8 Biological disturbance (Introduction of NIS) is discussed separately above in 11.3.1.1 and is not included below.

NSP2 has the potential to impact fish (including reproductive capacity and stock characteristics) in numerous ways, including through physical disturbance to habitats or individuals (P1 and P2), reduced viability of eggs or larvae (due to increase in SSC or sedimentation, P2), physical injury and/or avoidance behavior (due to underwater noise, P3), toxic effects (due to increased concentration of contaminants in the water column, P5). Impacts will be greatest in areas of dredging (due to the extent of seabed disturbance) and in Finland and Russia where munitions clearance is proposed. Impacts on fish and shellfish from pressures related to P1, P2, P3 and P5 are assessed to be negligible to minor and therefore not significant (see Sections 10.6.2.1 - 10.6.2.3 and 10.6.3.1 - 10.6.3.5). Moreover, as discussed in Sections 10.6.3.1, 10.6.3.2 and 10.6.8.4, there will be no significant impacts on important spawning areas and impacts on individuals are expected to be of short duration and localised.

Some commercial fishery activities may be locally and temporarily redistributed due to the safety zones around NSP2 vessels during the construction phase, resulting in a negligible impact. During operation, similar impacts from safety zones are anticipated, but with a smaller magnitude given the infrequent nature (once or twice per year) of maintenance/inspection surveys. Also during operation, in areas where the pipelines do not naturally embed themselves into the seabed, fishermen will have to cross the pipelines at as steep an angle as possible to reduce the risk of the trawl boards getting stuck. Therefore, in these areas, the NSP2 pipelines will result in fishermen having to adapt their trawl patterns and minor impacts are anticipated for the project as a whole (see Section 10.9.4). Experiences from the NSP pipelines, however, show that fishermen can coexist with the pipeline system and thus far no gear has been reported lost or damaged.

In summary and on the basis of the above, impacts during construction and operation (individually or in combination) will not result in significant impacts on the level of fishing or cause changes in the reproductive capacity or age and size distribution of the stock (condition criteria of D3).

On that basis it can be concluded that NSP2 will not prevent the achievement of the targets or the long-term goal for GES for Descriptor D3 for any of the Baltic countries.

### **Eutrophication (D5)**

Eutrophication is a 'pressure descriptor' which has the potential to enhance primary production (potentially causing toxic algal blooms) and could disrupt the balance of the food web and ecosystem of the Baltic Sea. The target in the MSFD is to minimize human induced eutrophication, especially the adverse effects thereof. This section discusses the potential for NSP2 to increase the intensity of relevant pressures on D5 (P7 Nutrient and organic matter enrichment), and concludes on the potential for impacts based on relevant condition criteria.

Nutrients will be released from the sediment pool as a result of disturbances of the seabed by interventions, pipe-lay and/or anchor handling during construction phase. However, the amount of nutrients transferred from the sediment into the water column are considerably below the annual inputs, such that they would not cause a measurable change in nutrient availability or levels of eutrophication. In this regard, it is noted that along a majority of the NSP2 route resuspension levels are likely to be lower than those caused by natural sediment disturbance due to wave impact. Furthermore, it is noted that where intervention works are planned along sections of the NSP2 route which are beneath the halocline, the natural stratification will reduce the upwards transport of nutrients. Therefore, any increases in nutrient availability will be contained within the lower section of the water column where phytoplankton are not present and as such no algal blooms, including those of toxic algae, are expected. Impacts on pelagic communities are therefore considered to be negligible (see Section 10.6.1.2 ). No release of nutrients is anticipated during the operation phase.

In summary and on the basis of the above, construction and operation activities (individually or in combination) will not result in significant impacts on nutrient levels in the water column or cause direct or indirect impacts on the environment due to nutrient enrichment (condition criteria of D5).

On that basis it can be concluded that NSP2 will not prevent the achievement of the target or the long-term goal for GES for Descriptor D5 for any of the Baltic countries.

### **Contaminants (D8) and contaminants in seafood (D9)**

Both D8 (contaminants) and D9 (contaminants in seafood) are considered 'pressure descriptors'. The descriptors are grouped as they are closely interlinked and targets overlap. The targets in the MSFD are to keep the concentration at levels not giving rise to pollution effects, and below the maximum level set for human consumption. This section discusses the potential for NSP2 to increase the intensity of relevant pressures on D8 and D9 (P5 contamination by hazardous substances), and concludes on the potential for impacts based on relevant condition criteria.

Hazardous substances (P5) will be released from NSP2 activities in both construction and operation phases due to release from sediments (construction phase) and anti-corrosion measures (operation phase). Management plans, compliant with international requirements (e.g. MARPOL) will be prepared for all vessel activity to ensure that impacts on water quality as a result of discharges from vessels will be negligible.

As assessed in Sections 10.2.2 and 10.6.2, NSP2 would result in negligible change in the concentrations of contaminants in the water column or sediments (as a result of sediment relocation). Furthermore, a majority of PNEC exceedances are in areas where no benthos exists due to anoxic conditions, so only a very limited number of benthic or pelagic organisms will be exposed to critical levels of contaminants in the water column due to release from suspended sediments (see Sections 10.6.1 and 10.6.2). CWA-associated risks on benthic organisms and fish, which are relevant for Danish waters only, were also assessed to be negligible (see Section 10.13.2).

During operation, the release of metals from zinc or aluminium anodes will result in elevated concentrations in these metals in the water column; however, this is measurable only within a few meters from NSP2 and is assessed to be negligible (see Section 10.2.2.6).

In summary and on the basis of the above, impacts during construction and operation (individually or in combination) will not result in significant impacts on the concentration in sediment or water column (condition criteria of D8) and subsequently will not cause changes in levels, numbers and/or frequency of contaminants (condition criteria of D9).

On this basis it is concluded that NSP2 will not prevent the achievement of the targets or the long-term goal for GES for Descriptors D8 and D9.

### **Marine litter (D10)**

Marine litter is defined as a 'pressure descriptor' which has the potential to mechanically disturb marina fauna in both movement and feeding. The target in the MSFD is to prevent marine litter from impacting the coastal and marine environment. This section discusses the potential for NSP2 to increase the intensity of relevant pressures on D10 (P3 Other physical disturbance and P6 Release of substances), and concludes on the potential for impacts based on relevant condition criteria.

In summary and on the basis of Section 6.6 and Chapter 17 – Environmental management, it is assessed that for both construction and operation phases there will be no physical disturbances of the sea, seabed or coastlines as a result of marine litter (P6). Hence, NSP2 would not impact the amount of litter in the water column, in by-catches or on beaches (condition criteria of D10).

On this basis it is concluded that NSP2 will not prevent the achievement of the target or the long-term goal for GES for Descriptor D10 for any of the Baltic countries.

### **Energy, underwater noise (D11)**

Underwater noise is a 'pressure descriptor'. Elevation of underwater sound levels may mask sounds from the marine fauna or cause avoidance behaviour, whilst sound pulses have the potential to cause temporary or permanent damage to hearing apparatus. The target in the MSFD is to ensure that introduction of energy (underwater noise) is at levels that do not adversely affect the marine environment. This section discusses the potential for NSP2 to increase the intensity of relevant pressures on D11, and concludes on the potential for impacts based on relevant condition criteria.

Underwater noise (P3) from seabed interventions during the construction phase and vessel activity during both the construction and operation phases will temporarily elevate background sound levels. Rock placement<sup>56</sup> activities were modelled and the results indicate that there is potential for TTS for fish and marine mammals within 100 and 80 m from the activity, respectively. The increase in underwater noise may also cause temporary and local avoidance reactions in both fish and marine mammals, which are considered to be minor. No permanent impacts are expected from this activity.

Munitions clearance is expected to take place in Finnish and Russian waters during the construction phase, and will cause impulsive noise. This has the potential to result in blast injuries or PTS with moderate impact on marine mammals (grey seal and ringed seal) in Finland

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<sup>56</sup> In sections of the route where munitions clearance is not planned, e.g. Sweden and Denmark, rock placement is considered to be the NSP2 activity which generates the greatest noise, and therefore has the highest potential for impact in respect to underwater noise generation. Therefore rock placement has been used for the modelling in such sections (see Section 10.1.2).

and Russia<sup>57</sup>. Based on the areas which will likely require munitions clearance, there is also the potential for the impulsive noise from munitions clearance in Finland and Russia to propagate into Estonian waters, as well as from Russia into Finnish waters. Should this occur, it would have the potential to result in TTS, blast injuries or PTS with minor - moderate impacts on marine mammals (grey seal and ringed seal) (See Chapter – 15 Transboundary impacts for specification of transboundary impacts in the Gulf of Finland). Notwithstanding the above, it is considered that the generation of impulsive noise would be temporary with short-term peaks in noise during the construction phase (the total duration of munitions clearance activities is estimated at two months), and would not result in any significant impacts on the ecosystem (see Section 10.6.8).

In summary and on the basis of the above, impacts during construction phase (individually or in combination) will not result in long-term significant impacts on the distribution of impulsive sounds and continuous sounds in the water column (condition criteria of D11).

On this basis it is concluded that NSP2 will not prevent the achievement of the targets or the long-term goal for GES for Descriptor D11 in any of the Baltic countries.

### 11.3.1.2 State descriptors

#### **Biodiversity (D1), food webs (D4) and sea-floor integrity (D6)**

The descriptors associated with biodiversity (D1), food webs (D4) and seafloor integrity (D6) are closely linked and in some instances overlap; therefore they have been discussed together below.

The targets for D1, D4 and D6 in the MSFD are to maintain biodiversity and normal abundance and diversity of all elements of the food web and to safeguard the structure and function of ecosystems and prevent changes to the sea-floor that adversely affect the ecosystem. Therefore, this section discusses the potential for NSP2 to increase the intensity of relevant pressures on all three state descriptors, and concludes (on the basis of assessments presented in Sections 10.6.1 – 10.6.8) on the potential for impacts based on relevant condition criteria.

The pipelines and in particular seabed interventions, such as pipe-lay, munitions clearance in Russia and Finland, seabed intervention works and/or anchor handling (if required), will cause physical losses (P1), due to smothering and sealing, and physical damages (P2), due to abrasion and siltation, during the construction phase. These pressures are of particular relevance to benthic communities which may experience burial or clogging of respiratory and filtration apparatus. However, physical loss will be limited to the footprint of the pipelines (and support structures), whilst physical damage from sedimentation will be limited to an area of less than 20 km<sup>2</sup> where >200 g/m<sup>2</sup> is anticipated (see Section 10.1.2 for modelling results). It is noted that this level of sedimentation (approximately 1 mm) is within the natural annual sedimentation rate of the Baltic Sea (0.5-1.5 mm/year). The physical losses (P1) and the physical damage (P2) on the seabed introduce a change in substrate on soft bottom sections of the NSP2 route, as well as a negligible change in bathymetry. However, NSP2 will not function as a barrier for marine flora and fauna (condition criteria for D6) due to the nature of their reproductive and spreading strategies.

Given the highly localised nature of these impacts, in combination with the fact that a proportion of the affected area is not colonised by benthic communities (due to abiotic conditions) and no threatened species are affected, impacts on biodiversity (D1), food webs (D4) and sea-floor integrity (D6) from physical loss and/or physical damage have been assessed to be negligible (see Section 10.6.2). Negligible impacts associated with physical loss or damage are also predicted for individual species and habitats along the NSP2 route (see Sections 10.6.1-10.6.8).

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<sup>57</sup> It is noted that MSFD is not relevant for Russia, and therefore although mentioned here, impacts on Russia in respect to MSFD compliance have not been assessed.

Increased suspended sediment in the water column (P3) as a result of construction activities may reduce light penetration into the water column (resulting in reduced primary production), reduce visibility (resulting in a behavioural response in mobile species (i.e. fish, marine mammals)) and/or reduce viability of eggs (fish). Concentrations of suspended sediment in the water column exceeding 10 mg/l will be limited to an area of approximately 233 km<sup>2</sup> and will persist for a maximum of less than 20 hours, excluding sediment suspension at the Russian landfall, which is not covered by the MSFD. Given its localised extent and temporary nature, impacts from increased suspended sediment on primary production (phytoplankton) and other species (benthos, fish, mammals and birds) are assessed to be negligible to minor (see Sections 10.6.1.1 and 10.6.2.2) and are assessed in Section 10.6.8.2 to not represent any impact on biodiversity (D1) and food webs (D4).

The NSP2 construction activities also have the potential to cause the release of contaminants (P5 and P6) and nutrients (P7) currently trapped in the sediment into the water column. However, concentrations of contaminants are not expected to exceed thresholds for EQS and PNEC, with the exception of two organic compounds. The particular organic compounds will be released in anoxic sections of the route, and will therefore only represent a negligible impact on biodiversity (D1) and food webs (D4) (see Section 10.6.8). The release of nutrients in oxygenated sections will result in oxygen consumption but oxygen levels are assessed to return to pre-impact status within days (See Section 10.2.2). On this basis, the potential impacts on biological receptors and biodiversity due to water quality is assessed to be negligible (see Sections 10.6.1-10.6.5 and 10.6.8). This is further discussed in Sections 11.3.1.3 (D5 Eutrophication) and 11.3.1.4 (D8/D9 Contaminants).

The generation of underwater noise (P3) by construction activities has the potential to trigger a behavioural response or cause injury to fish, marine mammals and/or birds. The noise generated by the noisiest NSP2 activities was modelled (see Sections 11.3.1.6 (D11 Energy, underwater noise) above and 10.1.3), and it was concluded that impacts would be negligible to minor on all receptors, with peaks of moderate on the Gulf of Finland ringed seal population in areas where munitions clearance is planned. Although this has the potential to impact individuals which represent top predators within the food web, the remaining links within the food web would not experience any significant impacts (see Sections 10.6.3-10.6.5 and 10.6.8). Therefore the impacts on the food web are considered overall to be negligible and reversible, whilst impacts on marine biodiversity are considered to be negligible at worst (see Section 10.6.8).

The construction of NSP2 will result in negligible impacts on the abiotic conditions (including hydrological processes, P4), with the exception of minor impacts on water quality. Potential impacts on specific species and habitats are discussed in Sections 10.6.1-10.6.8 and have been assessed not to be significant.

During construction, vessel movements have the potential to introduce non-indigenous species into the Baltic Sea (P8). However, subject to the implementation of standard mitigation measures (see Chapter 16 – Mitigation measures), the risk of introducing NIS is considered to be low. However, the potential impacts from NIS during construction and operation are conservatively assessed to be negligible. This is further discussed for the Non-indigenous species descriptor in Section 0 (P2 Non-Indigenous species).

The same conclusions can be reached for the operation phase, where impacts (if applicable) would be of a lower magnitude than those during the construction phase.

In summary and as described in Section 10.6.8, impacts at species or habitat level would not combine to result in impacts which would be sufficient to cause a change in biodiversity nor ecosystem functioning and structure. Therefore it can be concluded that impacts during construction or operation (as relevant), either individually or in combination will not result in significant impacts on:



- species distribution, population size or condition (condition criteria of D1);
- habitat distribution, extent and condition or ecosystem structure (condition criteria of D1);
- the productivity of key species, proportion of top predators or abundance of key trophic groups (condition criteria of D4);
- the substrate characteristics and the condition of benthic communities (condition criteria of D6).

On the basis of the above, it can be concluded that the construction and/or operation of NSP2 will not prevent the achievement of targets or the long-term goal for GES for Descriptors D1, D4 and D6.

### **Hydrographical conditions (D7)**

Hydrographical conditions are 'state descriptors' which describe the physical parameters of seawater such as temperature, salinity, depth, currents, waves, turbulence and turbidity. The target in the MSFD is to prevent alterations from adversely affecting marine ecosystems and, in general, only localised permanent changes to hydrography can be allowed. Therefore, this section discusses the potential for NSP2 to increase the intensity of relevant pressures on D7, and concludes on the potential for impacts based on relevant condition criteria.

The physical presence of the pipelines (and support structures) during the operation phase has the potential to cause a limited interference with local hydrological processes (P4) by introducing a small change in bathymetry. A review of the hydrographic impacts on the Baltic Proper for NSP /388/, /389/, which is considered to remain valid for NSP2, concluded that there would be no impacts on bulk flow or sediment accretion/erosion. Therefore, the impact on hydrographical conditions is assessed to be negligible (see Section 10.2.2).

In summary and on the basis of the above, impacts during construction and operation (individually or in combination) will not result in permanent alterations of hydrographical conditions (condition criteria of D3).

On that basis it can be concluded that NSP2 will not prevent the achievement of the targets or the long-term goal for GES for Descriptor D7.

### **11.3.2 Compliance with objectives of the Marine Strategy Framework Directive**

Based on the above, NSP2 will not significantly impact condition criteria or targets (where applicable) for any of the descriptors. Therefore, it is concluded that the impacts of NSP2 will not delay or prevent the achievement of the long-term goal for GES for descriptors D1 – D11.

### **11.3.3 The Water Framework Directive**

The following sections discuss the potential for the construction and operation of NSP2 to prevent achievement of good chemical status for the 12 nm limit (in Finland, Denmark and Germany), focusing on the release of nutrients and contaminants, and good ecological status for the 1 nm limit in Germany. Countries which are not covered by WFD (see Section 11.2.2 above) have not been assessed in this section.

Firstly, it is important to note that all project vessels will be compliant with the requirements of the Helsinki Convention (Convention on the Protection of the Marine Environment of the Baltic Sea Area) and the prescriptions for the Baltic Sea Area as a MARPOL 73/78 Special Area /339/. Therefore, impacts from discharges from project vessels (e.g. sewage) on water quality are therefore assessed to be negligible. As such, no further consideration has been given to this source of impact in this section.

### 11.3.3.1 Impacts on chemical status within 12 nm zone (Finland, Denmark and Germany)

Construction activities associated with NSP2 such as pipe-lay, seabed intervention works and anchor-handling (if required) will result in disturbance of the seabed. This has the potential to release sediment and contaminants (including nutrients) into the water column, which may then become bio-available and potentially transferrable up through the food web. Of these activities, post-lay trenching, rock placement and dredging are considered to be the activities with the highest potential for impact, and therefore have been discussed in this section.

The concentrations of suspended sediment (which contributes to turbidity) and the resulting sedimentation have been modelled for post-lay trenching in Denmark and rock placement for both Denmark and Finland<sup>58</sup> (see Section 10.1.2). Results indicate that the SSC in the water column due to these activities will exceed 10 mg/l within a distance of no more than a few kilometres from the NSP2 route and for less than 24 hours, and the area where sedimentation would exceed 200 g/m<sup>2</sup>, corresponding to a 1 mm layer, would be within the immediate vicinity of the pipelines (i.e. a few meters away) and cover less than 15 km<sup>2</sup> (in the worst case scenario). All impacts are therefore assessed to be localised and temporary (returning to near baseline conditions within 24 hours), as are any associated impacts (i.e. resuspension of contaminants) (See Section 10.1.2). No impacts are expected in the Finnish 12nm zone designated under WFD and impacts due to post-lay trenching and rock placement activities in the Danish 12 nm areas will be negligible.

Turbidity and sedimentation have also been modelled for dredging in Germany. Results show that during the dredging operations, the SSC in the immediate vicinity of the dredgers may increase up to several hundred mg/l /337/. At approximately 500 m from the operations, modelling indicates that the SSC in surface waters will have decreased to approximately 30 mg/l. The increase will be temporary, with SSCs likely to return to near baseline conditions within a few days, and generally within natural variations (in rough conditions). Sediment deposition shows different patterns in the open waters compared to in the Greifswalder Bodden. In the open waters, the deposition will generally not exceed 25 g/m<sup>2</sup> except for in the immediate vicinity of the trench. In Greifswalder Bodden where the currents are weaker, the deposition will be more concentrated in an area immediately adjacent to the trench, generally up to approximately 3,000 g/m<sup>2</sup>. The dredged sediment will be temporarily stored at the Usedom site. Modelling has shown that high SSCs during the handling of sediment will have a short duration and decrease quickly after completion of the activity (as the sediment settles to the seabed) (see Section 10.2.2.3). Both impacts are assessed to be temporary (returning to near baseline conditions within hours/days, or a month in the case of the interim storage), therefore any associated impacts (i.e. resuspension of contaminants) on water quality are assessed to be temporary and local. Impacts due to dredging and disposal operations in within the 12 nm area designated under the WFD in Germany will be negligible.

Turbidity and sedimentation have also been modelled for munitions clearance (see Section 10.1.2.2). The results show that the concentration of suspended sediments in the water column (turbidity) due to this activity will exceed 10 mg/l in an area of 65 km<sup>2</sup>. An area of less than 1 km<sup>2</sup> will be impacted by sedimentation levels of >200 g/m<sup>2</sup> due to munitions clearance. Both turbidity and sedimentation are assessed to be temporary (returning to near baseline conditions within hours/days) and comparable to conditions during storm events, therefore any associated impacts (i.e. resuspension of contaminants) on water quality are also assessed to be temporary and local (See Section 10.2.2). Therefore impacts due to munitions clearance activities within the 12 nm area designated under WFD are assessed to be negligible.

During operation the metals aluminium and zinc will be released from the anodes. The impact from the release of metals is low and local and will only be measurable in the water column a few

<sup>58</sup> It is noted that modelling was also carried out for Sweden, but is not reported here as NSP2 does not cross any Swedish waters covered under the WFD.

metres from NSP2. The release of metals is assessed to have a negligible impact on water quality.

### 11.3.3.2 Impacts on ecological status within 1 nm zone (Germany)

#### Biological quality elements

Modelling has indicated short-term and localised increases in SSC, which have the potential to impact phytoplankton due to changes in light penetration through the water column. However, given the natural variations in turbidity, such as those caused by strong wind events, the phytoplankton is adapted to such temporary changes in light conditions. According to sediment-chemical investigations, the release of bio-available nutrients from the sediment was assessed to be low and the atmospheric deposition of nitrogen emitted during construction was assessed to be negligible. An increase in phytoplankton biomass is therefore not expected.

Although macro-algae and angiosperms may be damaged or destroyed along the footprint of the NSP2 route as a direct result of trenching activities, the impacted area is small compared to the whole water body. Populations in close proximity of the trenches may also be impacted by increases in turbidity and sedimentation. However, according to modelling results, turbidity and sedimentation will return to near baseline conditions within hours/days, such that the resulting impacts on macro-algae and angiosperms can be assessed as negligible. Furthermore, the release of nutrients and contaminants will be very low and no impact is anticipated. Upon completion of the construction works, all habitats will be restored to near natural conditions. On the basis of the NSP monitoring results, the regeneration of aquatic marine flora is expected within three years; therefore it can be concluded that NSP2 will have no permanent impacts on the composition or abundance of species.

Similar to flora, the benthic fauna along the footprint of the NSP2 route will also be damaged or destroyed as a direct result of trenching activities. Those outside the footprint, but still close to the trench, will be influenced by increases in turbidity and sedimentation. Given the natural variations in SSC within coastal waters, it is considered that the benthic fauna will be resilient and able to cope with the increased sedimentation and the short-term occurrence of turbidity plumes, such that no impacts are anticipated. On the basis of the NSP monitoring results, it can be expected that the composition and abundance of benthic fauna will normalize within a period of three years after restoring the benthic habitats.

During the operation phase, the habitat conditions which support the aquatic flora and fauna will be similar to those prior to construction. Due to the local and temporary nature of impacts from NSP2, no significant impacts on biological elements are to be expected.

#### Hydromorphological quality elements

Dredging of the trenches over a length of 26.5 km within the 1 nm limit in German waters will influence the hydromorphology. As noted in Section 10.2.1.1, the depth of the trenches will vary between 1.7 and 3.4 m, but will be backfilled to the original bathymetry (with a pipe cover of +0.2 m). Depending on the intake of energy, e.g. due to increased swell, natural sediment dynamics are expected to smooth out differences in seabed level in the area immediately surrounding the backfilled trenches, therefore reverting to pre-impact conditions. Sediment may be released into the water column during this process, though the resulting sedimentation impacts (see turbidity modelling mentioned above) on the structure and substrate of the seabed will be negligible. Due to repeated handling of the sediment, silt and organic matter will be released, resulting in a temporary change in sediment parameters after refilling the trenches. However, NSP investigations have shown that, as a result of bedload transport, the organic and silt content of the sediment returned to pre-impact levels within three years of the completion of construction works /340/. Consequently, changes in structure and substrate of the seabed will be limited and do not result in significant impacts on the biological quality elements. The structure of the intertidal zone has no relevance for the area affected by NSP2.

In the course of the project, no construction and operation related impacts on the tide regime (wave exposure, direction of dominant currents) can be expected. Therefore, no deterioration of the condition of the hydromorphological quality elements can be expected.

#### **Physical-chemical quality elements**

As noted above, modelling has indicated that NSP2 will result in increases in SSC, thus the turbidity (or transparency) of the water column will be temporarily affected. Impacts will be short-term and localised, with a return to baseline conditions within a few hours.

It has been assessed that NSP2 will not result in any significant impact on the following:

- thermal conditions /341/;
- oxygen conditions within the water column or sediment; or
- salinity.

Impacts on the nutrient conditions will result from dredging and nitrogen emissions within the 1 nm zone. During dredging, nutrients will be released from the excavation material; however, results from a sediment-chemical expert opinion indicate that the nutrient resolution from the sediment disturbance will be low and within inter-annual variations in nitrogen and phosphorus concentrations in the water column. Emitted nitrogen can also reach the water body by deposition. Referring to an expert opinion, it is indicated that the deposition of in-air nitrogen due to NSP2 construction related activities will reach a maximum of 0.4 kg/(ha/a) /256/. This reflects approximately 5 % of the atmospheric intake which already exists.

During construction, contaminants can be released from the disturbed sediments, or restored together with the material. The concentrations in the sampled sediments in the excavation area in combination with the sediment properties means that the overall release of contaminants from dredging in Greifswalder Bodden will be low. Based on the sediment analysis results it has been assessed that the handling of dredged materials can take place without restrictions. During operation, aluminium and zinc will be released from the anodes; however, the impact from the release of metals will be low and only be measurable in the water column a few meters away from NSP2. Therefore, no deterioration of the condition of the physical-chemical quality elements can be expected.

#### **Summary**

In summary, it can be concluded that the project will not affect the ecological or chemical conditions within the 1 nm zone in German waters, nor interfere with a possible improvement of the ecological and chemical conditions. Overall it is concluded that NSP2 will not increase the pressures on the environment and therefore NSP2 will not be contrary to the objectives and initiatives set out in the WFD.

#### **11.3.4 HELCOM Baltic Sea Action Plan**

The HELCOM Sea Action Plan sets out four key focus topics in order to achieve the goal of the Baltic Sea attaining GES before 2021. The BSAP has formed the basis for the targets of both the MSFD and WFD and consequently the focus topics of the BSAP overlap with the goals of both the MSFD and the WFD. The topics comprise:

- Eutrophication;
- Hazardous substances (e.g. contaminants);
- Biodiversity and Nature conservation;
- Maritime activities

For each topic, HELCOM has set indicators and targets. Where these are considered relevant to NSP2, specific reference has been made in the following sections.

#### 11.3.4.1 Eutrophication

As noted above, disturbances of the seabed by munitions clearance, interventions or pipe-lay and anchor handling will cause resuspension of sediment and associated release of nutrients from the sediment pool. However, the amount of nutrients transferred from the sediment into the water column are considerably below the annual inputs, such that they would not cause a measurable change in nutrient availability or levels of eutrophication. In this regard, it is noted that along a majority of the NSP2 route resuspension levels are likely to be lower than those caused by natural sediment disturbance due to wave impact.

Furthermore, it is noted that where intervention works are planned along sections of the NSP2 route which are beneath the halocline, the natural stratification will reduce the upwards transport of nutrients. Therefore, any increases in nutrient availability will be contained within the lower section of the water column where phytoplankton are not present and as such no algal blooms, including those of toxic algae, are expected (see Sections 10.2.2 and 10.6.1). No release of nutrients is anticipated during the operation phase.

Based on these assessments it is concluded that NSP2 will not impact the clarity of the water and it is concluded that NSP2 would not prevent member states from reaching the target in the BSAP for eutrophication.

#### 11.3.4.2 Hazardous substances

During the construction phase, seabed intervention works and munitions clearance may cause hazardous substances (i.e. contaminants previously trapped in the sediment) to be released to the water column. During the operation phase, metals are released from anodes on the pipeline (anti-corrosion measures). However, the impact on the concentration of hazardous substances in the Baltic Sea is assessed to be minor (see Sections 10.1.2 and 10.2.2.5) for both the construction and operation phases.

Based on the assessments it is concluded that NSP2 will have negligible impacts on the biological environment from the release of contaminants from the seabed (see Sections 10.6.3.3 and 10.6.8). In respect to specific BSAP indicators, NSP2 will have negligible impacts on the trends in concentrations of TBT, nonylphenol (NP) or metals. Based on this it is concluded that NSP2 will not prevent member states from reaching the targets in the BSAP for hazardous substances.

#### 11.3.4.3 Biodiversity and Nature conservation

The identified impacts are primarily connected to disturbance of the seabed with resulting resuspension of sediments and associated eutrophication, loss of habitats and underwater noise. Siltation and abrasion may bury benthic habitats and seabed interventions will release nutrients from the seabed. The resuspension of sediments will be restricted to the lower parts of the water column where photosynthesis does not occur and the impact is temporary and spatially limited. The impacts are therefore assessed to be negligible (see Sections 10.6.1 and 10.6.2).

Underwater noise from trenching and rock placement may cause temporary avoidance reactions by some key predators within a limited area from the activity. The impact is assessed to be minor (see Sections 10.6.3 and 10.6.4). As the impact on the predators is temporary and no impacts are expected regarding primary production, it is assessed that NSP2 would result in negligible impact on trends in trophic structures and the diversity of species.

Impulsive noise from munitions clearance is expected to occur in Finnish and Russian waters during the construction phase. This has the potential to result in TTS, blast injuries or PTS with minor - moderate impact on marine mammals (in particular for the grey and ringed seal) in Finland and Russia. Notwithstanding the above, it is considered that the generation of impulsive noise would be temporary with short-term peaks in noise during the construction phase (the total

duration of munitions clearance activities is estimated at two months), and would not result in any significant impacts on the biodiversity (see Section 10.6.8).

On the habitats level, NSP2 would result in negligible impact on habitat forming species. NSP2 would result in negligible impact on abundance and distribution of rare or threatened habitats and negligible impact on trends in numbers or detection of NIS. The overall assessment for the entire project is therefore that NSP2 will not impact indicators set for biodiversity with respect to habitats (See Section 10.6.8).

The seafloor integrity will not be impacted and no impacts on targets regarding spatial distribution, abundance and quality of habitat forming species are anticipated. NSP2 will also not impact threatened or declining habitats and there will be no impact on the conservation status of species included in the HELCOM lists of threatened/declining species/habitats. NSP2 will not impact the abundance or diversity of any element of the marine food web and the project will have no impacts on the number or biomass of NIS (see Section 10.6.8). NSP2 will not impact marine and coastal landscapes and none of the indicators for 'Biodiversity and Nature conservation' are impacted by NSP2.

Based on this it is concluded that NSP2 will not prevent member states from reaching the targets in the BSAP for biodiversity and nature conservation.

#### **11.3.4.4 Maritime activities**

Lay barges and vessels emit greenhouse gases (CO<sub>2</sub>) as well as other air pollutants (i.e. NO<sub>x</sub> and SO<sub>x</sub>) and their presence increases the risk of accidents and unplanned events, e.g., oil spills. Furthermore, NSP2 vessel activities have the potential to introduce NIS through ballast water and hull fouling (see Chapter 13 – Risk assessment and Section 10.6.8). Assessments of the socioeconomic aspects of the marine areas are dealt with in Section 10.9.

However, NSP2 will have a negligible impact on climate change and air pollution (see Section 10.5.1) and on the introduction of NIS (see Section 10.6.8). With respect to risk, there will be a temporary increased risk of oil spills. The theoretical increase in the annual oil spill frequency as a result of the NSP2 project is assessed to be 0.1%, which is a very low risk (see Section 13.2.3.2). Based on this it is concluded that NSP2 will not prevent member states from reaching the targets in the BSAP for maritime activities.

#### **11.3.5 Compliance with objectives and initiatives in the Baltic Sea Action Plan**

Based on the above, it is assessed that NSP2 will have no significant impacts on relevant indicators or targets identified by HELCOM. Therefore, NSP2 will not be contrary to the objectives and initiatives set out in the BSAP.

## 12. DECOMMISSIONING

As described in Chapter 6 – Project description, NSP2 is designed to operate for at least 50 years. The proposed decommissioning programme will be developed during the operation phase of NSP2 to allow consideration to be given to any new or updated legislation and guidance available at the time, as well as to utilise good international industry practice (GIIP) and technical knowledge gained over the lifetime of NSP2. It is considered highly likely that statutory requirements, technological options and preferred methods for decommissioning will have changed in 50 years' time.

The condition of NSP2 infrastructure may also influence the preferred decommissioning method and relevant mitigation measures.

This chapter highlights the legislation and policy context related to decommissioning, the potential options for decommissioning NSP2 and the associated potential impacts.

### 12.1 Offshore decommissioning

#### 12.1.1 Overview of legal requirements

The decommissioning process for offshore structures is regulated by a framework of international conventions which aim to influence national legislative requirements. The primary international conventions specifically related to decommissioning are defined in Chapter 3 – Regulatory context and include:

- UNCLOS (Article 60 (3) – which states that *“Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States”*. The competent organisation for the decommissioning of offshore installations or structures is the IMO, which in 1989 adopted the IMO Guidelines and Standards setting out the minimum international standards for the removal of offshore installations. The guidelines state that *“the decision to allow an offshore installation, structure, or parts thereof, to remain on the sea-bed should be based, in particular, on a case-by-case evaluation, by the coastal State with jurisdiction over the installation or structure”*.
- London (Dumping) Convention – which promotes effective control of all sources of marine pollution and taking all practicable steps to prevent pollution of the sea resulting from dumping of wastes and other matter;
- International Convention for the Prevention of Pollution from Ships (MARPOL) - sets the standards and guidelines for the removal of offshore installations worldwide.

Although consideration will be given to the international conventions listed above, none of the PoOs or APs have specific legislation or policies for the decommissioning of offshore installations or pipelines at this point in time. Given this limited legislative framework, a review of other guidance has been undertaken to provide additional context, see below.

#### 12.1.2 Overview of decommissioning guidelines

Although there is no international guidance on the decommissioning of pipelines or specific guidance developed by the PoOs, Norway and the United Kingdom have enforced guidelines within this field. Those of particular relevance to NSP2 include:

- DNV recommended practice document *“Marine Operations during removal of offshore installations”*, which provides guidance on technical feasibility and overcoming technical challenges related to the removal of offshore installations /343/.

- Norwegian Parliament white paper “Decommissioning of redundant pipelines and cables on the Norwegian continental shelf”, which briefly addresses the options for the decommissioning of pipelines and cables and highlights the need for decommissioning programmes to be developed with due consideration given to potential environmental, socio-economic and marine spatial planning impacts as well as overall cost /344/.
- UK Oil and Gas guidance note “Decommissioning of offshore installations and pipelines”, which provides a framework for decommissioning of offshore installations and pipelines and provides guidance for the safe decommissioning of pipelines /345/.
- Oil & Gas UK “Decommissioning of pipelines in the North Sea region”, which provides an overview of pipeline infrastructure in the North Sea and achievements in decommissioning parts of that infrastructure. It also highlights the technical capabilities and limitations that impact the decommissioning options available to owners of pipeline systems /346/.

In the absence of specific guidance for the Baltic Sea, the general principles contained within these documents are considered broadly applicable to the development of the decommissioning programme for NSP2.

These general principles can be summarised as follows:

- The potential for reuse should be considered before decommissioning. If reuse is considered viable, suitable and sufficient maintenance of the pipeline should be detailed.
- All feasible decommissioning options should be considered and a comparative assessment undertaken in respect of technical, environmental and socio-economic criteria (including those relevant to marine spatial planning and other sea users). Assessment of decommissioning options should be based on scientific evidence, with consideration given to the following topic areas as a minimum:
  - Water quality;
  - Geology;
  - Hydrography;
  - Biodiversity (including threatened species and habitats);
  - Commercial fishery;
  - Contamination and pollution.
- The condition of the pipelines should be considered in respect to deterioration, exposure and/or burial (both in terms of potential implications for decommissioning method and possible future impacts on the environment).
- The decision should be undertaken in light of individual circumstances.

According to the UK Oil and Gas guidance note /345/, the following pipelines may be candidates for *in situ* decommissioning:

- Pipelines which are adequately buried or trenched and which are not subject to development of freespans and are expected to remain so;
- Pipelines which were not buried or trenched at installation but which are expected to self-bury over a sufficient length within a reasonable time and remain so buried;
- Pipelines where burial or trenching of the exposed sections is undertaken to a sufficient depth and is expected to be permanent;
- Pipelines which are not trenched or buried but which, nevertheless, are candidates for leaving in place if the comparative assessment shows that to be the preferred option (e.g. trunk lines);
- Pipelines where exceptional and unforeseen circumstances due to structural damage or deterioration or other causes mean they cannot be recovered safely and efficiently.

The guidance note also states that where rock placement has been used to protect a pipeline, the removal of the pipeline (or pipeline section) is unlikely to be practicable. It is therefore assumed



that rock placement will remain in place, unless there are special circumstances that would warrant consideration of removal. Should the rock be associated with a pipeline that is removed, a minimum disturbance of the rock placement material to allow safe removal of the pipeline and any seabed obstructions would be expected.

Although the above guidelines serve as an illustration of the general principles to be applied in decision making processes concerning decommissioning, it is anticipated that additional international or national guidelines will be developed before the end of the operational life of NSP2. Should such documents become available, these will be taken into consideration when preparing the decommissioning programme for NSP2.

### 12.1.3 Decommissioning practices

The comparative assessments of the majority of decommissioning cases in the United Kingdom have demonstrated that the preferred decommissioning option for large diameter pipelines is to leave them *in situ*, either on the seabed or buried. This approach is often complemented by remedial actions to reduce risks to other sea users, for example the cutting and removal of exposed pipeline ends to minimise snagging risk /346/ and is in accordance with the guidelines highlighted in Section 12.1.1.

### 12.1.4 Decommissioning options for NSP2 and potential impacts

#### 12.1.4.1 Potential decommissioning options

As noted above, at present there is no certainty as to which decommissioning method will be applied to the offshore structures of NSP2. Therefore, a detailed impact assessment for the decommissioning phase has not been carried out within this report.

The decommissioning plan for the offshore structures of NSP2 will be developed during the latter years of the operation phase. The identification of the preferred option will likely be based on the following criteria:

- Technical feasibility;
- Health and safety;
- Environmental impacts;
- Socio-economic impacts.

Notwithstanding this, two decommissioning scenarios (a base case and theoretical alternative) for NSP2 have been considered during the EIA phase. The options considered (based on the guidelines outlined in Section 12.1.1) are as follows:

- Based on precedent and industry best practice guidelines for large diameter pipelines, the base case is to leave the pipeline on the seabed (in situ):
  - Following the gas inventory removal and pipe cleaning operations, the pipeline will then be flooded in a controlled manner with seawater. After the pipeline is filled with water, the ends would be capped and buried. The pipeline and rock berms will then remain in situ, until they slowly degrade according to natural processes in the marine environment.
- Based on a review of other potential options, the theoretical alternative is pipeline removal by reverse lay recovery or by sectional recovery, followed by waste management:
  - Reverse-lay recovery would be carried out by pulling the pipelines up and cutting out the pipes using a pipe-laying barge. The pipeline, when recovered to the pipe-lay barge, would then be cut into convenient sections (12-24 m) and taken by pipe-carrier vessels to the shore for disposal. Whilst technically feasible, such reverse lay would require a significant engineering assessment of the condition of the pipelines and of the pipeline seabed configuration. Apart from the risks

associated with the structural strength of the pipeline, the resistance during reverse pipe-lay may also be unpredictable dependant on the degree of natural embedment of the pipelines. Should there be sudden changes in resistance during break-out of the seabed, the reverse-lay operations would be difficult to control, and there would be associated risks to the vessel, equipment and personnel.

- Sectional recovery would comprise cutting the pipelines into sections (12-24 m) on the seabed and the recovery of the sections to a pipe-carrier piece-by-piece. This method can be performed with the use of a ROV and a diamond cutter or a high-powered water jetting system.
- When onshore the pipeline materials would either be further processed for material recovery or disposed of. Regardless, temporary storage areas (i.e. storage yards for removed pipe sections) and processing would be required. Permanent areas for disposal may also be necessary.

It should also be noted that hybrid options (comprising a combination of the above) may also be considered. However, given that the pipelines will, over their operational lifetime, become an integrated part of the seabed (due to embedding and colonisation by marine life), leaving the pipelines *in situ* (base case) is likely to remain the optimal solution.

#### 12.1.4.2 Potential impacts

A qualitative review of potential sources of impact which may arise from the above decommissioning options has been undertaken based on the conclusions of the impact assessment outlined in Chapter 10 – Assessment of environmental impacts, the decommissioning report developed for NSP /347/ and professional experience. These are summarised below.

It is noted that the identification of potential impacts associated with pipeline removal is theoretical and has relied heavily upon professional experience. This is due to lack of empirical data as, based on existing knowledge, no similar large-diameter pipelines have been decommissioned by removal. Should a hybrid option be chosen, the potential impacts would be a combination of those identified below, though the magnitude of each type of impact would likely be reduced compared to the removal option.

##### **Leave *in situ* option**

For the leave *in situ* option, it is anticipated that many of the potential sources of impacts will be a continuation of impacts likely to be encountered due to the presence of the pipelines during the operation phase (therefore of a lower magnitude than the pipeline removal option). Other impacts related to the operation of the pipelines (e.g. local temperature difference, impacts associated with inspections/survey) will not be relevant after decommissioning.

The potential sources of impacts from the leave *in situ* option comprise:

- Continued presence of the pipeline on the seabed, which has the potential to impact commercial fisheries and further habitat creation;
- Continued release of contaminants from pipeline anodes which has the potential to reduce water quality (through increased metal concentrations).

##### **Pipeline removal option**

For the pipeline removal option, it is anticipated that the potential sources of impacts will be similar in nature, temporary and of a similar or greater order of magnitude to those encountered during the construction phase (and therefore of a higher magnitude than the leave *in situ* option). Recovery would require a significant spread of vessels, operating along the route and to and from ports, and is unlikely to be carried out with the same speed as pipe-lay (therefore requiring greater resource/energy use).

Following recovery to shore, the pipeline materials could either be further processed for material recovery or disposed of. In any case, temporary areas for storage (i.e. storage yards for removed pipe sections) and processing would be required. Permanent areas for disposal may also be necessary.

The potential sources of impacts from the pipeline removal option comprise:

- Physical changes to seabed features (natural and man-made), which have the potential to impact benthic habitats in areas where the pipelines have acted as an artificial reef;
- Release of sediments into the water column, which has the potential to impact water quality due to the spreading of sediments, with secondary impacts on marine fauna and flora;
- Release of contaminants and/or nutrients into the water column (e.g. sediment-associated contaminants), which has the potential to impact water quality with secondary impacts on marine fauna;
- Sedimentation on the seabed, which has the potential to impact sediment quality, benthic flora and fauna and fish;
- Generation of underwater noise and/or vibrations, which has the potential to impact fish and marine mammals;
- Above water disturbance (noise, visual including light, vessel movement, etc.), which has the potential to impact marine mammals, birds and people;
- Safety zones around vessels, which has the potential to impact commercial fisheries and maritime traffic (shipping);
- Release of air pollutants and GHGs from vessels, which has the potential to impact the climate and local air quality with secondary impacts on people;
- Employment generation.

## 12.2 Onshore decommissioning

As noted above, at present there is no certainty as to which decommissioning method will be applied to the onshore structures of NSP2. Therefore, a detailed impact assessment for the decommissioning phase has not been carried out within this report.

The decommissioning plan for the onshore structures of NSP2 will be developed during the last years of the operation phase. The identification of the preferred option will likely be based on the following criteria:

- Technical feasibility;
- Health and safety;
- Environmental impacts;
- Socio-economic impacts.

Decommissioning will be carried out in compliance with the applicable legal requirements (if any) at the time when decommissioning will be conducted, and in agreement with the relevant authorities.

### 12.2.1 Decommissioning options for NSP2 and potential impacts

Assuming reuse is not possible, the onshore decommissioning phase will likely include removal of the onshore landfall facilities such as above ground installations (e.g. PTAs and buildings), restoration of access roads and site rehabilitation.

The following section focuses only on the decommissioning options for the onshore sections of the pipelines.

Similar to the offshore sections of the pipelines, two decommissioning scenarios (a base case and theoretical alternative) have been considered for the onshore sections of the pipelines. The options considered are leave *in situ* (base case) and removal (theoretical alternative).

#### 12.2.1.1 Leave *in situ* option

For the leave *in situ* option, it is anticipated that many of the potential sources of impacts will be a continuation of impacts likely to be encountered due to the presence of the pipelines during the operation phase (and therefore of a lower magnitude than the pipeline removal option). Other impacts related to the operation activities (e.g. emissions to air from inspection activities) will not be relevant after decommissioning.

The potential sources of impacts from the leave *in situ* option comprise:

- Continued presence of the pipeline which may constrain further development of the land.

#### 12.2.1.2 Pipeline removal option

For the pipeline removal option, it is anticipated that the potential sources of impact will be of a similar nature and of a similar or greater order of magnitude as those encountered during the construction phase (and therefore of a higher magnitude than the leave *in situ* option).

Following recovery, the waste materials could either be further processed for material recovery or disposed of. In any case, temporary areas for storage (i.e. storage yards for removed pipe sections) and processing would be required. Permanent areas for disposal may also be necessary.

The potential sources of impacts from the pipeline removal option comprise:

- Physical changes to landforms or land cover, which has the potential to impact terrestrial geomorphology and topography;
- Light (from working areas), which has the potential to impact terrestrial fauna, birds and people;
- Noise generation (traffic, power generation, etc.), which has the potential to impact terrestrial fauna, birds and people;
- Release of air pollutants and GHGs (from earthworks plant and traffic, etc.), which has the potential to impact the climate and local air quality with secondary impacts on terrestrial fauna and people;
- Employment generation;
- Traffic disruption and safety, which has the potential to impact people;
- Rehabilitation/site restoration.

### 12.3 Concluding remarks

Based on the guidelines and conclusions for the cases of the decommissioning programmes in the United Kingdom, leaving *in situ* is likely to be the preferred option for both onshore and offshore structures of NSP2. Management and mitigation measures for decommissioning of NSP2 will be developed:

- in agreement with the relevant national authorities (PoOs);
- in accordance with the legislative requirements at the time of decommissioning;
- with due consideration of the technology available at the time of decommissioning;
- with due consideration of the knowledge gained over the lifetime of NSP2 and the condition of the infrastructure.

Therefore, for the marine areas (offshore and nearshore), the potential impacts resulting from leaving the pipelines *in situ* would likely be related to the gradual dissolution of materials over time and continued obstruction on the seabed. The potential impacts from pipeline recovery would comprise seabed disturbance, vessel operations, and the use of energy and land areas for

material separation, recycling and/or disposal. The potential impacts on the marine environment from pipelines left *in situ* are generally considered to be lower than the impacts from recovery.

For the onshore landfall areas, the potential impacts from leaving the pipelines *in situ* would be limited to constraints on other land uses due to the presence of the pipelines. The potential impacts from pipeline recovery would comprise physical disturbance to landforms, light and noise generation and emissions to air etc. Therefore, similar to the marine areas, the potential impacts on the environment from pipelines left *in situ* are generally considered to be lower than the impacts from recovery.

Although this chapter has sought to provide an overview of the potential options for decommissioning of NSP2 and their associated potential impacts, a decommissioning programme will be developed during the latter years of the operation phase. This will allow regulations, technical knowledge gained over the lifetime of NSP2 and prevailing pipeline decommissioning practices at the time to be taken into account /346/.

## 13. RISK ASSESSMENT

### 13.1 Risk assessment methodology

The risk assessments follow the classic risk assessment framework as illustrated in Figure 13-1. The initial step of the risk assessment is the identification of hazards followed by an assessment of the associated risks (frequency and consequences). The risk summation stage determines the risk levels and calculates the individual and societal risks which can be compared against the risk tolerability criteria. The risks are then assessed with respect to the risk acceptance criteria, and decisions are made in order to reduce the risks to a level that is as low as reasonably practicable (ALARP). This includes applying mitigation measures where relevant to avoid or minimise the risk.

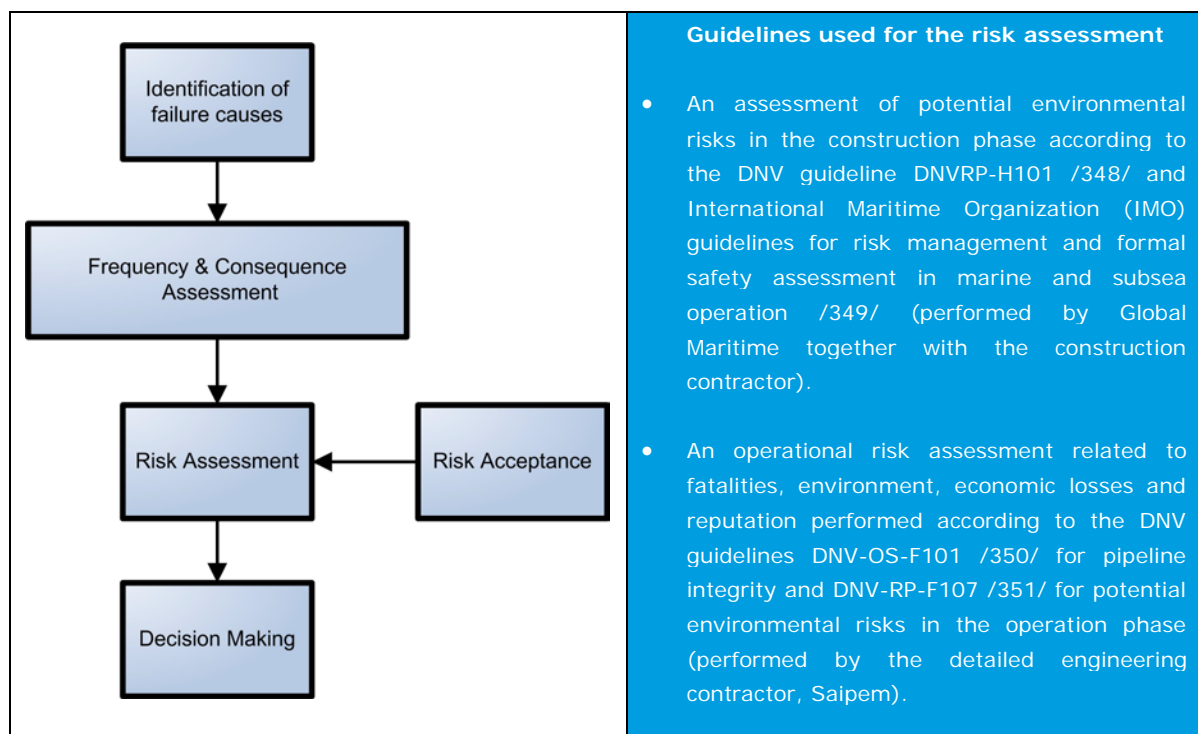


Figure 13-1 Risk assessment methodology and guidelines used for the risk assessment.

The ALARP principle is illustrated in Figure 13-2. Risks in the upper, generally intolerable region cannot be justified on any grounds. Risk reduction measures will be implemented to bring the risk down, to below the intolerable risk level boundary. The middle region is called the ALARP region, or the tolerable region. This is the region where efforts should be made to reduce the risk, and where it need to be justified that possible risk-reducing measures are grossly disproportionate to the achieved reduction in risk. In the lower region, the risk is negligible. Further risk reduction measures are in general not required.

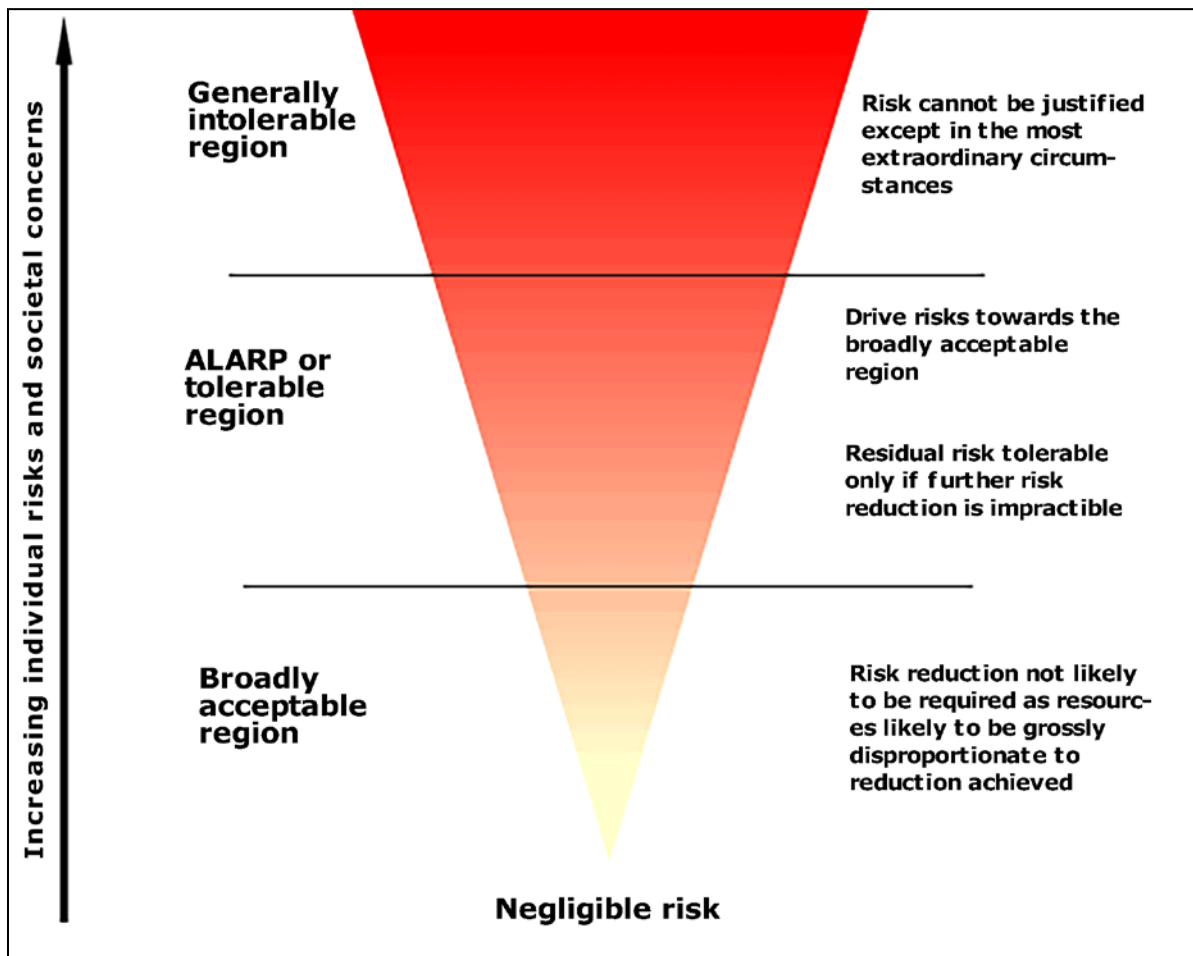


Figure 13-2 The ALARP triangle: the upper region is the intolerable region, where the risk is not acceptable compared to risk acceptance criteria and authority requirements.

## 13.2 Environmental risks during the construction phase

Environmental risks linked to the construction phase cover the following activities:

- Preparation of the landfall areas (only relevant for Germany and Russia);
- Pre-lay intervention works/rock placement including vessel loading operations;
- Pipe-laying including the pipe load-out activities and transportation;
- Post-lay intervention works/rock placement including vessel loading operations;
- Pre-commissioning operations.

It should be noted that during the construction phase the assessment of risks to the environment is limited to oil spills, which previous experience has shown is the main risk for the environment during the construction phase.

In addition to the activities which can lead to the release of hazardous substances, the risk of encountering non-mapped munitions in connection with the construction phase is also present. This topic is assessed in Section 13.2.4.

### 13.2.1 Environmental hazards

A general risk assessment for the construction phase has been performed to evaluate the risks of the project. The assessment has been performed by Global Maritime and in this context will supplement an overall environmental impact assessment of the unplanned event.

The assessed hazards related to the NSP2 activities which can lead to breaking containment and the release of hazardous substances to the environment are:

- Spill of fuel oil from construction activities onshore or at landfall areas;
- Passing vessel collision;
- Construction vessel collision;
- Vessel fire;
- Vessel grounding;
- Vessel sinking;
- Oil spill – bunkering.

In the event of a collision, the cargo and/or fuel of the involved ships can be spilled into the environment. The fuel types are provided in Table 13-1.

**Table 13-1 Liquids that potentially can be spilled from the NSP2 vessels and third-party vessels.**

Type of vessel	Fuel type	Cargo
NSP2 vessel	Fuel oil/diesel	-
Third-party vessel	Diesel, bunker, etc.	Oil products or crude oil

### 13.2.2 Construction risk assessment

A dedicated set of documents<sup>59</sup> has been prepared for NSP2 which considers the risks that may arise in each of the countries, taking into consideration the country-specific characteristics of the pipeline section. These documents are part of the independent third-party verification of the engineering work performed by DNV. Subsequently, DNV will provide final certification of compliance for the overall pipeline system.

In connection with the risk assessment, the probability has been calculated for each of the environmental hazards described in Section 13.2.1. The identified environmental hazards related to the construction phase are shown in Table 13-2, together with the calculated probability and the volume of the potential spill.

**Table 13-2 Risk categories and findings of the environmental quantitative risk assessment for NSP2 /352/.**

Category	Hazards	Probability of oil spill (per year)	Potential spill quantities (t)
<b>Passing vessel collision</b>			
a	Third-party vessel collision 1-10 t spill	$2.1 \cdot 10^{-5}$	1 – 10
b	Third-party vessel collision 10-100 t spill	$4.2 \cdot 10^{-5}$	10 – 100
c	Third-party vessel collision 100-1000 t spill	$6.1 \cdot 10^{-5}$	100 – 1.000
d	Third-party vessel collision 1000-10,000 t spill	$2.9 \cdot 10^{-5}$	1,000 – 10,000
e	Third-party vessel collision >10,000 t spill	$8.0 \cdot 10^{-6}$	> 10,000
<b>Construction vessel collision</b>			
f	Pipe-laying vessels	$2.6 \cdot 10^{-5}$	750 – 1,250
g	Diving support vessel (DSV)/ trench support vessel	$3.0 \cdot 10^{-5}$	500 – 850
h	Rock placement vessel	$1.5 \cdot 10^{-5}$	500 – 850
i	Pipe carrier and supply vessel	$8.0 \cdot 10^{-5}$	300 – 500
j	Anchor-handling tug (AHT)	$3.5 \cdot 10^{-5}$	300 – 500
k	Shallow water lay	$6.7 \cdot 10^{-6}$	300 – 500
<b>Vessel fire</b>			

<sup>59</sup>

- The construction risk assessment has been reported in the "Pipeline Construction Risk Assessment" /352/.
- The documents related to the operation phase are part of the technical description included in the national permit applications.
- The operation phase risk assessment has been reported in the following documents:
  - Offshore Pipeline Frequency of Interaction – Russia /353/, Finland /354/, Sweden /355/, Denmark /356/, and Germany /357/;
  - Offshore Pipeline Damage Assessment – Russia /358/, Finland /359/, Sweden /360/, Denmark /361/, and Germany /362/;
  - Offshore Pipeline Risk Assessment – Russia /363/, Finland /364/, Sweden /365/, Denmark /366/, and Germany /367/.



Category	Hazards	Probability of oil spill (per year)	Potential spill quantities (t)
l	Pipe carrier/AHT/supply vessel	$1.0 \cdot 10^{-4}$	100
m	Rock placement vessel	$5.6 \cdot 10^{-5}$	170
n	Pipe-laying vessels	$1.0 \cdot 10^{-4}$	250
o	DSV/trench support	$1.9 \cdot 10^{-5}$	250
p	Shallow water lay	$2.8 \cdot 10^{-5}$	100
<b>Vessel grounding</b>			
q	Pipe carrier	$1.4 \cdot 10^{-4}$	300 – 500
r	Rock placement vessel	$1.5 \cdot 10^{-5}$	500 – 850
s	Supply vessel	$5.8 \cdot 10^{-5}$	300 – 500
<b>Vessel sinking</b>			
t	DSV/trench support vessel	$5.3 \cdot 10^{-7}$	750 – 1,250
u	Pipe carrier/AHT/supply	$3.0 \cdot 10^{-6}$	300 – 500
v	Pipe-laying vessels	$3.0 \cdot 10^{-6}$	750 – 1,250
w	Rock placement vessel	$1.6 \cdot 10^{-6}$	500 – 850
x	Shallow water lay	$7.9 \cdot 10^{-7}$	300 – 500
<b>Oil spill – bunkering</b>			
y	AHT	$2.0 \cdot 10^{-3}$	0 – 10
z	Pipe-laying vessel	$5.0 \cdot 10^{-2}$	0 – 10
aa	Shallow water lay	$1.2 \cdot 10^{-2}$	0 – 10

The oil spill frequencies and their consequences have been plotted in an environmental risk matrix in Figure 13-3.

Consequences		Probability (increasing probability → )			
Descriptive	Environment	Remote ( $< 1.0 \times 10^{-5}/y$ )	Unlikely ( $1.0 \times 10^{-5} - 1.0 \times 10^{-3}/y$ )	Likely ( $1.0 \times 10^{-3} - 1.0 \times 10^{-2}/y$ )	Frequent ( $1.0 \times 10^{-2} - 1.0 \times 10^{-1}/y$ )
<b>1</b> <b>Extensive</b>	Global or national effect. Restoration time > 10 yr				
<b>2</b> <b>Severe</b>	Restoration time > 1 yr. Restoration cost > USD 1 mil.	t, u, v,	d, e, f		
<b>3</b> <b>Moderate</b>	Restoration time > 1 month. Restoration cost > USD 1 K	k, w, x	c, g, h, i, j, m, n, o, q, r, s		
<b>4</b> <b>Minor</b>	Restoration time < 1 month. Restoration cost < USD 1 K		a, b, l, p,	y, z, aa	
<b>HIGH</b>	The risk is considered intolerable so that safeguards (to reduce the expected occurrence frequency and/or the consequences severity) must be implemented to achieve an acceptable level of risk; the project should not be considered feasible without successful implementation of safeguards				
<b>MEDIUM</b>	The risk should be reduced if possible, unless the cost of implementation is disproportionate to the effect of the possible safeguards				
<b>LOW</b>	The risk is considered tolerable and no further actions are required				

Figure 13-3 Classification of environmental hazards according to the construction risk assessment for NSP2, based on the oil spill frequencies and consequences as shown in Table 13-2 /352/.

As shown in Figure 13-3, the overall risk assessment shows that there are no events classified as 'high risk' hazards. Risks related to passing vessel collision and the DP pipe-laying vessel have been classified as 'medium risk', corresponding to the ALARP or tolerable region in Figure 13-2.

The passing vessel collision scenario relates to third-party vessel collisions which may result in a 1,000-10,000 t spill (d) and >10,000 t spill (e) (see Table 13-2). This risk is related to passing vessel collisions, and a reduction of collision risks is required to minimise the potential for environmental damage. The necessary management and mitigation measures to reduce the risk are outlined in Section 13.5.

The DP pipe-laying vessel scenario relates to construction vessel collision with the DP pipe-laying vessel which may result in a 750-1,250 t spill (f) (see Table 13-2). The necessary management and mitigation measures to reduce the risk are outlined in Section 13.5.

### 13.2.3 Risk of oil spill during construction

The existing spill frequencies (releases/year) for the EEZs along the NSP2 route are indicated in Table 13-3 below.

Table 13-3 Spill frequency (releases/year) for the EEZs along the NSP2 route /352/.

Spill frequency (releases/year) along the NSP2 route					
Country	1-10 t	10-100 t	100-1,000 t	1,000-10,000 t	>10,000 t
Russia	$4.0 \cdot 10^{-7}$	$8.0 \cdot 10^{-7}$	$1.2 \cdot 10^{-6}$	$5.5 \cdot 10^{-7}$	$1.5 \cdot 10^{-7}$
Finland	$2.5 \cdot 10^{-6}$	$5.0 \cdot 10^{-6}$	$7.4 \cdot 10^{-6}$	$3.5 \cdot 10^{-6}$	$9.7 \cdot 10^{-7}$
Sweden	$1.3 \cdot 10^{-5}$	$2.6 \cdot 10^{-5}$	$3.8 \cdot 10^{-5}$	$1.8 \cdot 10^{-5}$	$5.0 \cdot 10^{-6}$
Denmark	$6.6 \cdot 10^{-7}$	$1.3 \cdot 10^{-6}$	$1.9 \cdot 10^{-6}$	$9.2 \cdot 10^{-7}$	$2.6 \cdot 10^{-7}$
Germany	$4.2 \cdot 10^{-6}$	$8.5 \cdot 10^{-6}$	$1.2 \cdot 10^{-5}$	$5.9 \cdot 10^{-6}$	$1.6 \cdot 10^{-6}$
Total	$2.1 \cdot 10^{-5}$	$4.2 \cdot 10^{-5}$	$6.1 \cdot 10^{-5}$	$2.9 \cdot 10^{-5}$	$8.0 \cdot 10^{-6}$

As indicated in Table 13-3, the total annual frequency of oil spills resulting from the NSP2 construction activities is estimated to  $1.6 \cdot 10^{-4}$  oil spills per year (>1 tonnes), corresponding to a return period of 6,200 years. Statistically, the number of oil spill accidents in the Baltic Sea has been estimated to be 2.9 per year /368/. The increased risk of accidental spills introduced by the activities related to the NSP2 construction is hence in the order of magnitude of 0.01%, compared with the situation without construction activities. The introduction of mitigation measures will further decrease the risk of spills.

#### 13.2.3.1 Dispersion of oil and environmental vulnerability

Environmental vulnerability mapping and ranking has been carried out as a part of the project "Sub-regional risk of spill of oil and hazardous substances in the Baltic Sea (BRISK)"/370/. Maps covering environmental vulnerability in relation to oil spills, which have been determined for the four seasons (spring, summer, autumn, winter), are shown in Figure 13-4. Areas at the western/northern coasts of Gotland and on the Finnish coast in the Gulf of Finland are highly vulnerable, especially during summer and spring. Hoburgs Bank and northern Midsjö Bank are ranked as medium-low to medium-high vulnerable.

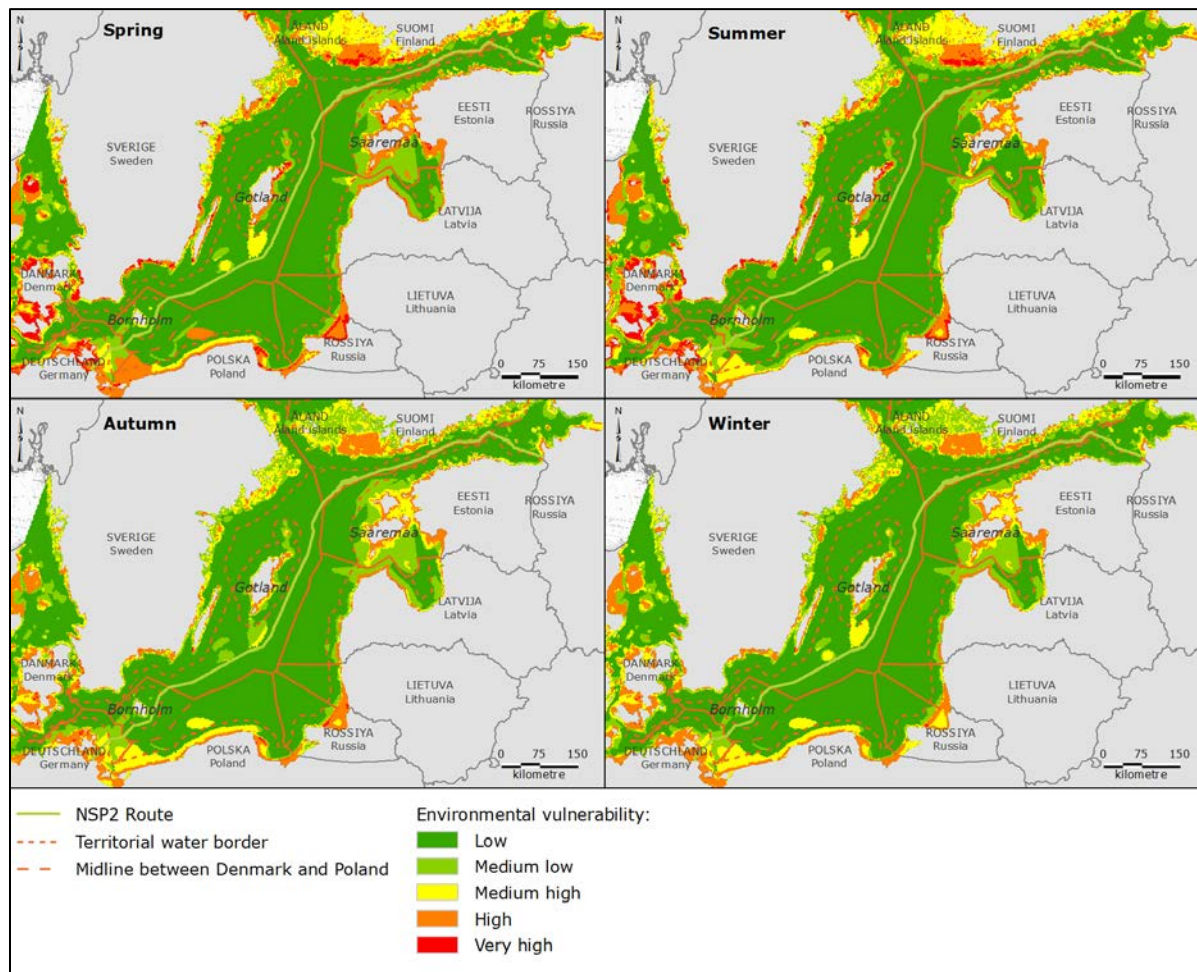


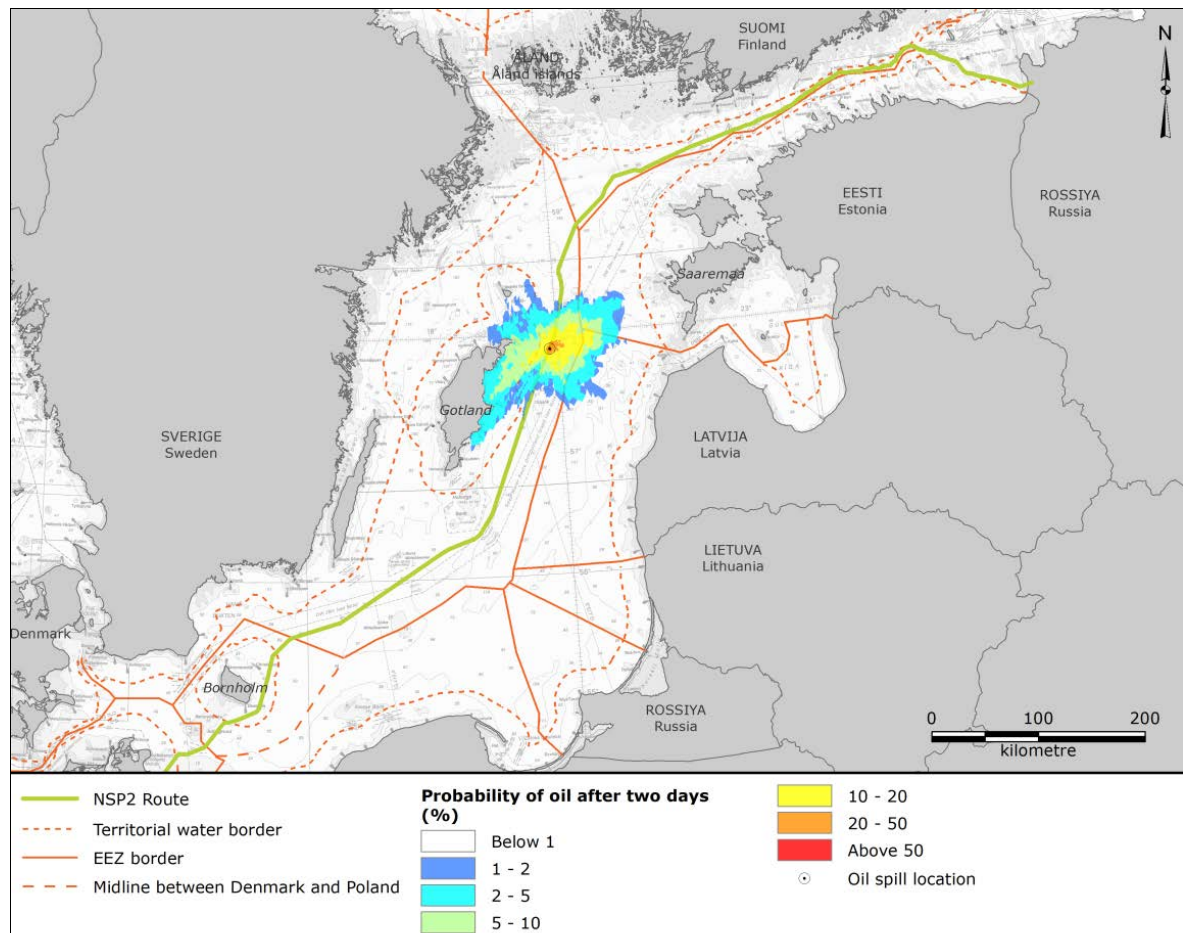
Figure 13-4 Vulnerability ranking due to an oil spill /370/.

Modelling of the fate of oil spills has been carried out at representative spill locations along the NSP2 route. Drift simulations were carried out to determine the likelihood of an area being contaminated by spilled oil. The likelihood is based on an ensemble of 120 oil spill simulations comprising one simulation every third day throughout the hydrodynamic year 2010 /369/.

The HELCOM countries have adopted a recommendation on the development of national ability to respond to accidental spills of oil spills and other harmful substances. The recommendation specifies response times for combatting oil spills. Within six hours the spill location shall be reached in the response region of the respective country. An adequate and substantial on-site response action must be implemented within 12 hours, and countermeasures against a spill of oil or hazardous substances should be initiated within two days.

An example of the modelled dispersion of spilled oil is shown in Figure 13-5. The example is from the Swedish EEZ, which has the highest likelihood of a major oil spill (see Table 13-3), at a position in a shipping lane close to the vulnerable coast of Gotland (see Figure 13-4). The figure shows the probability of detecting oil (>0 mg/l) within one of the 120 simulations for each of the four oil spill positions after two days. The outcome of the oil drift modelling is reported in detail in the oil spill modelling report /369/.

The modelling shows that there is a 5-10% probability that the spilled oil will reach the Swedish coastline of Gotland after two days /369/.



**Figure 13-5** Simulation of the probability of oil after two days with a spill location in a shipping lane close to the island of Gotland in Sweden /369/.

### 13.2.3.2 Assessment of environmental impacts – oil spill

The potential impacts of an accidental oil spill on the receiving environment during the construction phase are:

- Hydrography and seawater quality;
- Pelagic environment (plankton);
- Benthic marine flora and fauna;
- Fish;
- Marine mammals;
- Birds;
- Tourism and recreational areas.

When oil is spilled, it goes through physical processes such as evaporation, spreading, dispersion in the water column and sedimentation to the sea floor. Eventually, the oil will be eliminated from the marine environment through biodegradation. The effects of oil spills at sea depend on numerous factors, such as:

- Amount of oil spilled;
- Properties, toxicity and stability of the oil;
- Rate of spread of the oil slick;
- Size and location of the oil spill;
- Time or season of the oil spill;
- Species biodiversity at the site of the oil spill;
- Environmental sensitivity, i.e., proximity of bird habitat;

- Biological processes occurring at the spill site, such as evaporation, dissolution, dispersion, emulsification, photo-oxidation and biodegradation.

Oil spills pose a danger to the marine environment and cause damage to sea and shore ecosystems. In addition to the mechanical impacts (smothering of fur and feathers), many of the petroleum-related chemicals that are spilled are toxic or can be bioaccumulated in the tissues of marine organisms. Such chemicals may then be biomagnified up the marine food chain from phytoplankton to fish, birds and marine mammals /375/. Furthermore, an oil spill located close to coastal areas will be more severe than a spill in offshore areas (Figure 13-4).

Consequences from an oil spill for fish, birds and marine mammals, which will be the main receptors, are described below.

#### **Marine mammals, birds, fish and protected areas**

Fish may be exposed to spilled oil in different ways. The water column may contain toxic and volatile components of oil that may be absorbed by fish at different stages of development. Toxic compounds can be consumed together with contaminated food sources. Direct contact with oil causes blockage of the gills. Fish exposed to oil may suffer from changes in heart and respiratory rates, enlarged livers, reduced growth, fin erosion, as well as a variety of biochemical and cellular changes, and reproductive and behavioural responses /375/.

Often the most visible victims of an oil spill are seabirds, which spend significant amounts of time on the water surface or along the shoreline. The primary effect of oil contamination on birds is the smothering of feathers, which causes loss of the body insulation that is provided by the feathers. The cold water reaches the skin, leading to hypothermia and death. Furthermore, large amounts of oil cause feathers to stick together, impairing flight and buoyancy. Birds may ingest and/or inhale oil while trying to preen or eat contaminated food. Consequently, they suffer rapid, short-term or long-term effects, such as damage to the lungs, kidneys and liver, and gastrointestinal disorders /375/.

A major oil spill may impact marine mammals which come into contact with the spill. Impacts are related to direct contact with the oil, where smothering of seals may occur leading to inflammation, infection, suffocation, hypothermia and reduced buoyancy. Seals can also lose their shoreline habitat if oil washes up on their haul-out sites /375/.

The increase in shipping traffic during the construction of the NSP2 project will last for a short duration. There will be a temporary increased risk of oil spill. The theoretical increase in the annual oil spill frequency as a result of the NSP2 project is assessed to be very low, in particular with respect to large spills (Table 13-2). The amount of traffic caused by the activities related to NSP2 will occur within a limited time.

Impacts on animals and habitats, e.g. in coastal areas, can subsequently impact protected areas and biodiversity.

#### **Tourism and recreational areas**

If the oil spill reaches the coastal areas, impacts can occur, e.g. on bathing water quality. As the probability and time of a potential oil spill is low, the risk is of impacts on bathing water is low.

### **13.2.4 Risk from conventional and chemical munitions**

#### **13.2.4.1 Risk from conventional munitions**

As outlined in Section 9.13.4, a large number of unexploded ordnance (UXO) objects are present on the seabed of the Baltic Sea. Based on the findings of the munitions screening survey, it is highly unlikely that any interaction with non-detected UXO would occur during the construction activities or during operation of NSP2.

To supplement the munitions screening survey, a detailed anchor corridor survey will be performed prior to construction in the event that an anchored lay vessel is used for pipe-laying activities.

Route planning will take the presence of conventional UXOs on the seabed into account and where possible, the pipeline will be routed around UXOs to avoid the impacts associated with clearance. If consistent with safe practice and in agreement with the relevant authorities, conventional munitions that cannot be avoided through pipeline rerouting will be either recovered for onshore disposal or relocated away from the pipeline corridor. Conventional munitions that are identified as chance finds during construction and over the operating life of the pipeline will be managed through the chance finds procedure of NSP2.

#### **13.2.4.2 Risk from chemical munitions**

As outlined in Section 9.13.5, the remains of chemical warfare agents (CWAs) are present in the seabed surface sediments in parts of the route through Danish waters. Potential impacts from chemical munitions during the construction and operation phase relate to the risk of contact with pipelines/vessels and the public. When chemical munitions are left undisturbed they should not represent any risk to the pipelines or the marine environment.

Contact with identified chemical munitions will be avoided by marking the positions of the munitions in the navigation database as “areas to avoid”. The anchor touchdown points and anchor wire sweep will then be planned to circumvent the positions of the identified chemical munitions. Chemical munitions that are identified as chance finds during construction and over the operating life of the pipeline will be managed through the chance finds procedure of NSP2.

In areas with potential risk of chemical munitions, precautionary measures to prevent human contact with chemical agents will be undertaken. This includes adequate training of staff and the provision of equipment in accordance with the HELCOM guidelines for preventive measures and first aid.

### **13.3 Environmental risks during the operation phase**

The risks during the operation phase are related to damage to the pipeline, and the potential for gas release and ignition, that may be caused by interaction with vessels in the Baltic Sea. Potential interaction includes dropped objects (e.g. containers from cargo vessels), dropped anchors, dragged anchors, sinking ships and grounding ships (close to the landfall areas) and impact by dragged munitions. There is also a risk of fishing gear becoming snagged on the pipeline and, in extreme cases of incorrect handling, the loss of a fishing vessel.

#### **13.3.1 Environmental hazards**

The possible causes of failure leading to unplanned releases of gas are identified on the basis of literature data on offshore gas pipeline incidents /371/ and the hazard identification (HAZID) report /372/.

The following causes of failure that may threaten the integrity of the pipeline which may lead to the release of gas have been included in the risk assessment:

- Corrosion (internal and external);
- Mechanical defects;
- Natural hazards (storm, scouring, seismic activity and geotechnical stability);
- Other/unknown (sabotage, accidentally transported mines, etc.);
- Interaction with third-party activities (commercial ship traffic).

Other causes of failure that may threaten the integrity of the pipeline will be managed adequately through the application of relevant DNV standards<sup>60</sup> (not described further in the risk assessment).

The risk of unexploded munitions is addressed with adequate UXO surveys of the NSP2 pipeline corridor during the design phase. The risk due to munitions dumping is addressed during the design phase with adequate surveys performed along the offshore section and criteria to avoid such areas in NSP2 pipeline routing activities. During the operation phase, the requirements for external inspections of the pipeline and monitoring of the pipeline corridor will be developed as part of the inspection and monitoring plan. As per the recommendation included in the HAZID report /372/, the crossing of military exercise areas will be addressed with specific risk assessment and clearance requirements verified with the relevant authorities.

### 13.3.2 Operations risk assessment

The release frequencies for the following failure causes are estimated based on the Pipeline and Riser Loss of Containment (PARLOC) 2001 database /371/ and the PARLOC 2012 database /373/

The PARLOC database contains incidents and related loss of containment from offshore pipelines operated in the North Sea. The database has been used because no specific data are available for the Baltic Sea. In the PARLOC database, incidents are grouped according to the following pipeline leak size categories:

- Pinhole: 20 mm (hole size diameter < 20 mm);
- Hole: 80 mm (hole size diameter of 20-80 mm);
- Full bore rupture: internal pipeline diameter (hole size diameter >80 mm).

The risk of gas release caused by corrosion, mechanical defects and natural hazards is considered *negligible* due to the design of the pipeline and due to the foreseen inspection and maintenance programme. Other/unknown causes include all of the incidents for which no specific causes have been identified. This includes sabotage, military exercises and/or accidentally transported mines; geotechnical instability; seismic activity and emergency anchoring areas near Hoburgs Bank and northern Midsjö Bank in terms of drifting vessels. Other interference related to surveys and construction of nearby/crossing installations foreseen to be installed once NSP2 is in operation are considered to be *negligible*, as they will be addressed with dedicated interfaces between project teams at the design stage.

### 13.3.3 Risk of gas release during operation

#### 13.3.3.1 Frequency of gas release

For offshore pipelines, interaction with third-party activities is related to commercial ship traffic. The following initiating events have been identified:

- Sinking ships;
- Dropped objects;
- Dropped anchors;
- Dragged anchors.

Release frequencies due to interaction with third-party activities related to commercial ship traffic are evaluated by means of mathematical modelling in the frequency of interaction assessment

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<sup>60</sup>

- Natural hazards due to current and wave action – addressed in the guideline DNV RP-F109;  
 - Pipeline free spanning sections – addressed in the guideline DNV RP-F105;  
 - External interference with fishing activities – addressed in the guideline DNF RP-F111; and  
 - Operating temperature and pressure conditions – addressed in the guideline DNV RP-F110.



/353/, /354/, /355/, /356/, /357/ and the pipeline damage assessment /358/, /359/, /360/, /361/, /362/.

Initially a number of sensitive pipeline sections have been identified. The sensitive pipeline sections are those where the frequency of ships crossing the pipeline exceeds a criterion value of 250 ships/km/year. The criterion value corresponds to less than one ship/km/day. For each identified section where ship activity is at this level or higher, the interaction frequency is estimated.

The results are calculated and presented separately for each of the countries through which the pipeline runs, namely: Russia, Finland, Sweden, Denmark and Germany. The gas release frequency calculated for each of the sensitive pipeline sections as defined above is discussed below. The calculations are based on the calculated failure frequency based on potential impacts from dropped objects, dropped anchors, dragged anchors and sinking ships for each of the identified sensitive pipeline sections.

It should be noted that not all pipeline failures lead to a gas release; i.e. gas release frequency is only a subset of the pipeline failure frequency.

The interaction scenario frequency for Russia, Finland, Sweden, Denmark and Germany is reported in /363/, /364/, /365/, /366/, /367/. The gas release frequency due to failure of the pipeline distributed according to pinhole, hole, rupture and total for the investigated pipeline sections is shown in Table 13-4 below<sup>61</sup>.

**Table 13-4 Highest gas release frequency per year for pinhole, hole, full-bore rupture scenarios, and total, for the pipeline sections investigated for Russia, Finland, Sweden, Denmark and Germany in /363/, /364/, /365/, /366/, /367/.**

Country	Pinhole	Hole	Rupture	Total
	(highest occurrence/year)			
Russia	$3.6 \times 10^{-8}$	$3.6 \times 10^{-8}$	$2.5 \times 10^{-5}$	$2.5 \times 10^{-5}$
Finland	$1.7 \times 10^{-8}$	$1.7 \times 10^{-8}$	$1.1 \times 10^{-5}$	$1.1 \times 10^{-5}$
Sweden	$1.3 \times 10^{-9}$	$1.3 \times 10^{-9}$	$1.1 \times 10^{-6}$	$1.1 \times 10^{-6}$
Denmark	$1.4 \times 10^{-9}$	$1.4 \times 10^{-8}$	$2.3 \times 10^{-7}$	$2.4 \times 10^{-7}$
Germany	$2.9 \times 10^{-7}$	$2.9 \times 10^{-7}$	$6.0 \times 10^{-6}$	$6.6 \times 10^{-6}$
Total	$3.5 \times 10^{-7}$	$3.6 \times 10^{-7}$	$4.3 \times 10^{-5}$	$4.4 \times 10^{-5}$

### 13.3.3.2 Gas release scenarios

Each of the pipelines will carry 27.5 bcm of dry, sweet natural gas each year from Russia to Germany. In the unlikely event of a full-bore pipeline rupture, the pipeline inlet valve would be closed, and as much gas as possible would be removed from the pipeline via the outlet valve. However, a typical worst-case estimate of the amount of gas released can be made assuming simultaneous closure of both the intake and offtake valves, after which the settle out pressure in the pipeline will be approximately 165 bar (as shown in Figure 13-6).

<sup>61</sup>

- Pipeline failure with a gas release due to a dragged anchor scenario is 30% of the pipeline failure frequency. Conservatively, it is associated with a full-bore rupture.
- Pipeline failure with a gas release due to a sinking ship scenario is equal to 100% of the pipeline failure frequency. It is distributed as: 5% pinhole, 5% hole and 90% full-bore rupture.
- No gas release is expected in case of dropped object and dropped anchor interaction, as stated in the offshore pipeline risk assessment reports in /363/, /364/, /365/, /366/, /367/.

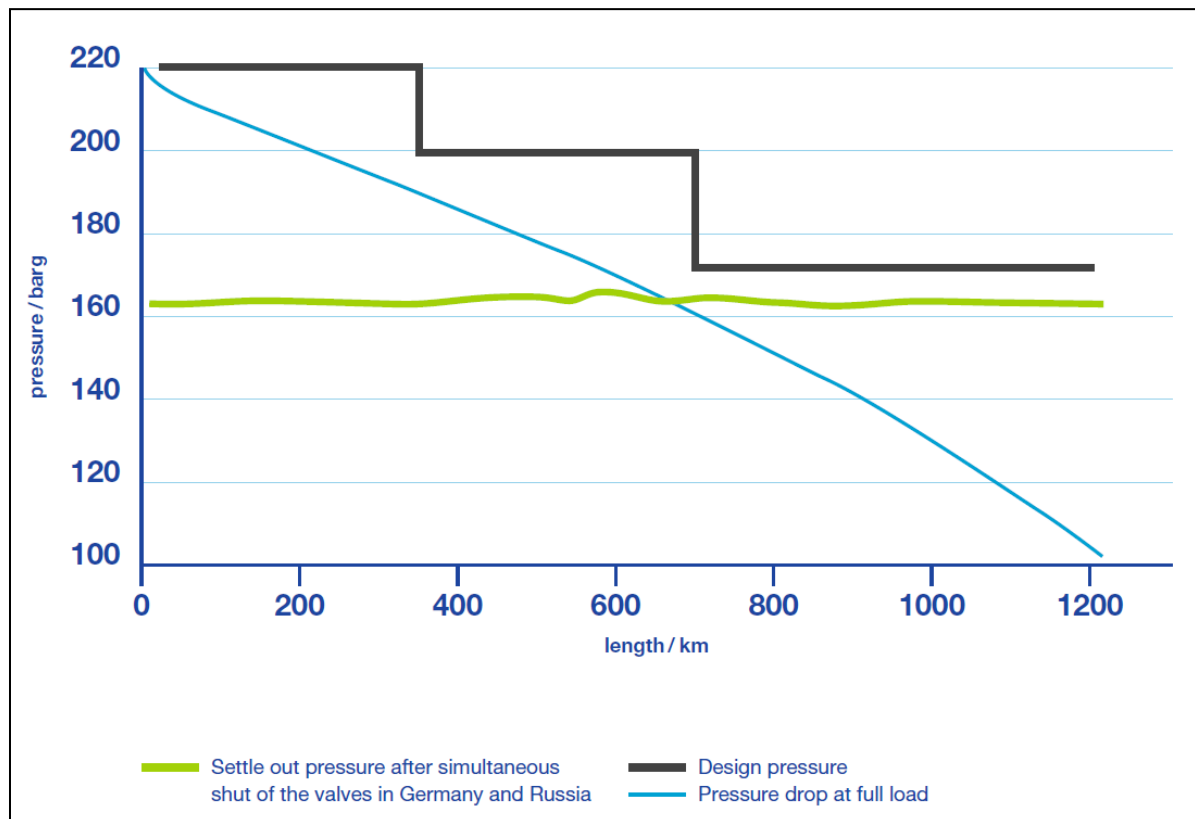


Figure 13-6 Methane pressure in the NSP2 pipelines.

From the pipeline dimensions given in the project description (internal diameter 1,153 mm, length 1,222 km), the volume of the pipeline can be calculated as 1.27 million cubic metres (mcm). At the settle out pressure of 165 bar, there will be the equivalent (at atmospheric pressure) of 210 mcm of gas in the enclosed pipeline. The density of methane also varies with temperature; at one atmospheric pressure, methane has a density of 0.688 kg/m<sup>3</sup> at 20°C and 0.717 kg/m<sup>3</sup> at 0°C. The temperature at the bottom of the Baltic varies between 4°C and 6°C; at 5°C the density of methane is 0.705 kg/m<sup>3</sup>. Therefore, the mass of gas in the pipeline (at 165 bar and 5°C) is approximately 148,000 tonnes.

The consequence assessment of subsea gas releases involves several steps, from depressurisation calculations, underwater release, through the effects at the sea surface and the atmospheric modelling of gas dispersion, to the assessment of the physical effects of the final outcome scenario in /363/, /364/, /365/, /366/, /367/. The physical effects are related to exposure to the thermal effects in case of ignition of the released fluid.

The subsea dispersion is modelled in order to provide parameters such as plume width, gas volume fraction and mean velocities at the sea surface. These parameters constitute the input to the atmospheric dispersion model. Subsea dispersion calculations have been performed by means of the computer program POLPLUME.

On reaching the surface, the gas will begin to disperse within the atmosphere. The nature of the dispersion depends upon the molecular weight and on the source conditions at the surface. In general, the resulting source has a large diameter but the gas has a very low velocity (see Figure 13-7).

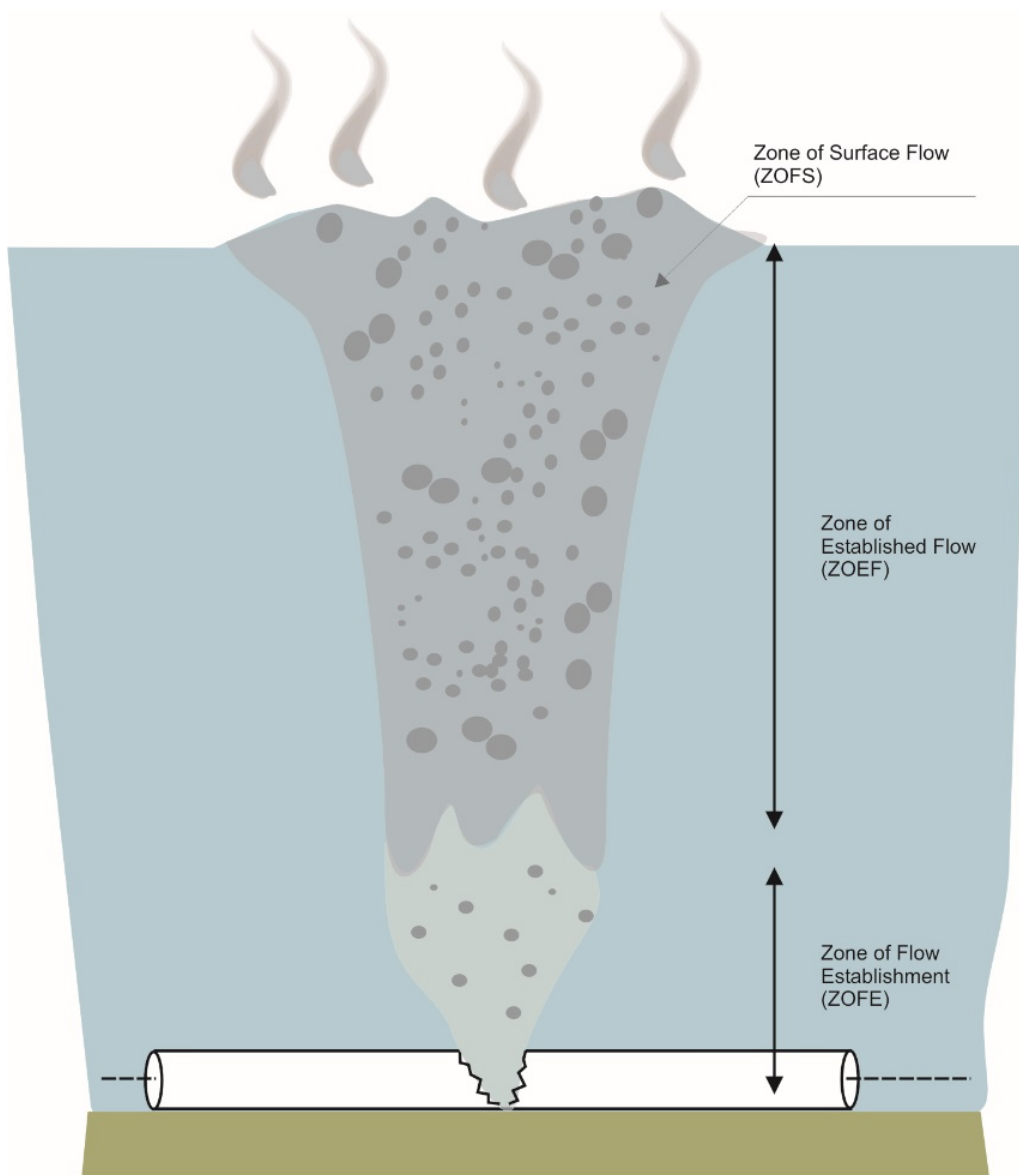


Figure 13-7 Schematic drawing of the release of gas from an offshore pipeline.

The radii of the zone of surface flow (central boil region) for the three scenarios (pinhole, hole and full-bore rupture of the pipeline) through which the pipeline runs are summarised in Table 13-5 below.

Table 13-5 Results of underwater gas dispersion calculations /363/, /364/, /365/, /366/, /367/.

Leakage	Water depth (m)	Radius at surface (m)
<b>Russia</b>		
Pinhole	63.6	6.8
Hole		7.8
Rupture		18.2
<b>Finland</b>		
Pinhole	69.7	7.35
Hole		8.2
Rupture		17.4
<b>Sweden</b>		
Pinhole	37.8	4.4
Hole		5.6
Rupture		16.9

Leakage	Water depth (m)	Radius at surface (m)
<b>Denmark</b>		
Pinhole	58.9	6.2
Hole		7.5
Rupture		18.0
<b>Germany</b>		
Pinhole	15.7	2.2
Hole		3.4
Rupture		11.0

### 13.3.3.3 Consequences of the gas release scenarios

Following a loss of containment event from the subsea pipelines, the possible outcome scenarios are:

- Atmospheric dispersion;
- Flash fire.

Since the gas is not toxic, atmospheric dispersion has no impact on the risk of fatalities.

The effects of the outcome scenarios are assessed using the software DNV PHAST 6.7. The results of the dispersion calculations, given the extension of the gas cloud to lower flammable limit<sup>62</sup> (LFL), are shown in Table 13-6 below.

**Table 13-6** Extent of hazardous gas cloud dispersion in the countries through which the pipeline runs /363/, /364/, /365/, /366/, /367/.

Hole size	Distance of flammable limits at 10 m height above the sea	
	LFL (m)	LFL/2 (m)
<b>Russia</b>		
Pinhole	Not reached	Not reached
Hole	60	89
Rupture	63	81
<b>Finland</b>		
Pinhole	Not reached	Not reached
Hole	60	89
Rupture	59	78
<b>Sweden</b>		
Pinhole	Not reached	Not reached
Hole	60	90.8
Rupture	62.5	81.6
<b>Denmark</b>		
Pinhole	Not reached	Not reached
Hole	60	92
Rupture	65	84
<b>Germany</b>		
Pinhole	Not reached	Not reached
Hole	59	92
Rupture	64	93

A flash fire occurs when a flammable cloud engulfs an ignition source before it is diluted below its flammable limits (delayed ignition). Flash fires generally have a short duration and therefore do

<sup>62</sup> LFL is the lower end of the concentration range over which a flammable mixture of gas or vapor in air can be ignited.

less damage to equipment and structures than to personnel on a ship directly exposed to a flash fire. It is conservatively assumed that anyone directly exposed to the flash fire will suffer fatal injuries. To determine the area covered by the flash fire, and therefore the effect on people, flammable gas dispersion results (distances of LFL/2 concentration) will be considered in the risk analysis.

No congested or confined areas can be reached by a flammable cloud along the offshore pipeline, thus explosion scenarios cannot occur.

#### 13.3.3.4 Ignition probability

Starting from the release frequencies, see Section 13.3.3.1, the frequency of each specific scenario (flash fire and dispersion) has been calculated by using an event tree analysis, taking into account the probability of ignition, as depicted in Figure 13-8 below.

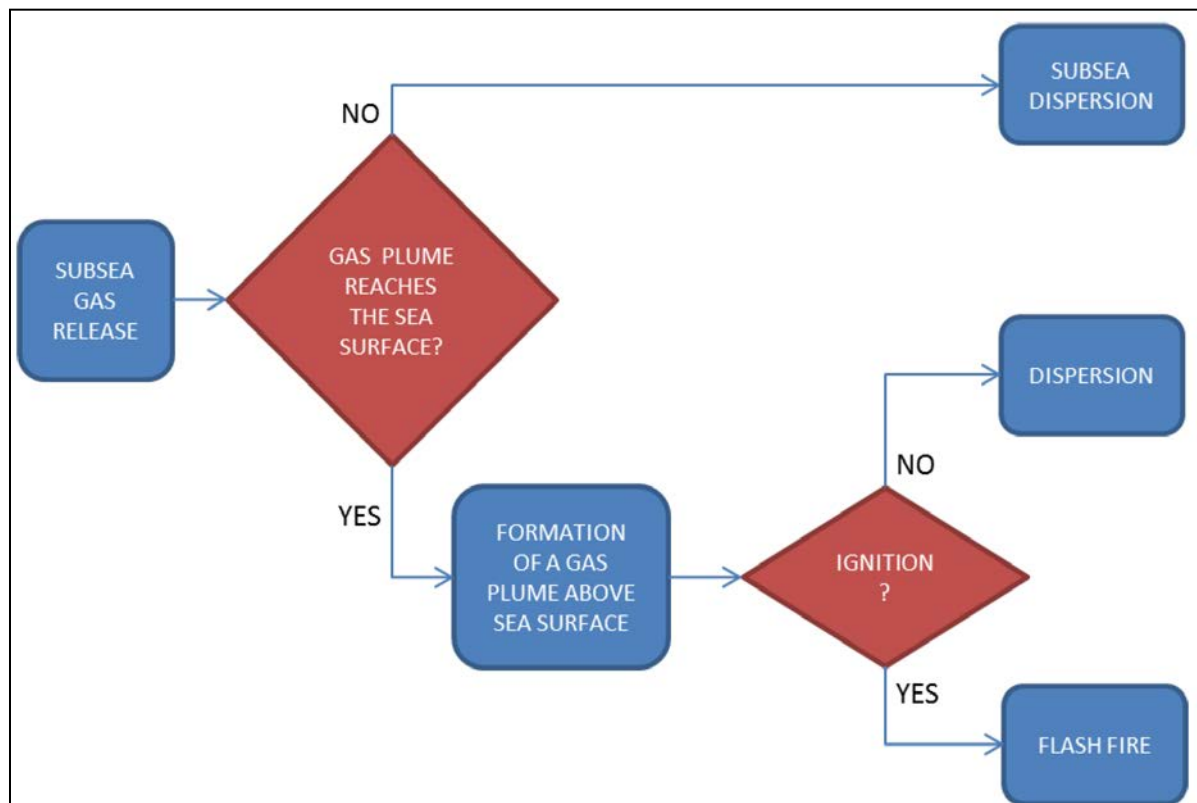


Figure 13-8 Event tree for subsea release.

Flash fires represent the only potential offshore scenario that may lead to fatalities. These may occur if the mixed gas cloud engulfs an ignition source while drifting due to the wind. The only ignition source that the mixed gas cloud may encounter is a ship navigating across the hazardous area. The hazardous area is assumed to be the cloud envelope at LFL/2 gas concentration.

In order to assess the ignition probability, two contributions have been evaluated:

- Probability of a ship crossing the hazardous area in the time interval of cloud persistence;
- Conditional probability of delayed ignition given a ship present in the area.

To estimate the ignition probabilities highlighted in Table 13-7, the cloud persistence time has been assumed in analogy to the NSP project taking into account leak detection time and local ship traffic.

**Table 13-7 Conditional ignition probability and cloud persistence time.**

Release size	Conditional ignition probability	Persistence time (h)
Pinhole	0.09	6
Hole	0.23	4
Rupture	0.64	2

### 13.3.3.5 Assessment of environmental impacts – gas release

#### Hydrography and seawater quality

Natural gas exhibits negligible solubility in water and thus has little effect on water quality in the event of an underwater leak. The gas will rise to the water surface, from where it will be released into the atmosphere. The extent to which it dissipates depends on meteorological conditions and the weight of the gas in relation to the surrounding air.

A short thermal impact (temperature drop to negative value caused by gas expansion, or Joule-Thomson effect) may occur in the surrounding water. Another possible impact on water quality from an accidental pipeline rupture and gas release is a possible updraft of bottom water. This could cause bottom water to be mixed with surface water, with an impact on salinity, temperature and oxygen conditions.

#### Marine life and protected areas

In the unlikely event of a gas release, it is judged that all marine organisms (benthic fauna, fish, marine mammals and birds) within the gas plume or the subsequent gas cloud will die or flee from the influenced area, which subsequently could impact the designation basis of protected areas (including Natura 2000 sites). The impact will be of limited time and space.

#### Climate and air

The solubility of methane in water is low, and it has been assumed for the calculations described here that all methane released in a rupture will enter the atmosphere. The recent IPCC 4<sup>th</sup> Assessment Report /374/ states that methane has a global warming potential 25 times greater than that of carbon dioxide, meaning the emission of one tonne of methane is equivalent to 25 tonnes of carbon dioxide. Thus, 148,000 tonnes of methane released into the atmosphere would be equivalent to the release of 3.7 million tonnes of carbon dioxide in terms of global warming potential.

For comparison, if the same volume of methane lost in a rupture was delivered to customers and burnt, forming carbon dioxide and water, then 407,500 tonnes of carbon dioxide would be produced. This means that the methane released from a potential rupture would have a carbon dioxide equivalence nine times greater than if the same volume of methane was burnt.

### 13.3.4 Maintenance and repair works

No repair works are anticipated during the operational lifetime of the pipeline. However, the dynamic forces in the sea (the combined current and wave loading) may cause erosion of the seabed around the pipelines (so-called scouring) so parts of it become unsupported, i.e. freespans emerge. To ensure the integrity of the pipelines, such freespans may require support established by, e.g., rock placement.

The environmental impacts of rock placement for freespan correction will be of the same type, but of lesser spatial and temporal extent as the planned rock placement for the construction of the pipelines (see Sections 10.2.1 and 10.2.2). The environmental impacts of such repair works will therefore be smaller than those shown in the impact assessment for the planned rock placement during the construction phase.

Nord Stream 2 AG will prepare procedures for effective and efficient coordination between Nord Stream 2 AG and the involved national authorities in the event of an unplanned intervention

(emergency repair) on the Nord Stream Pipeline System. The procedures will include an overview description of maintenance and emergency repair methods (Types of Service, ToS) considered to be the most feasible to ensure that safe operation of the pipeline can be resumed with minimal environmental impact.

### 13.4 Risk to third-party personnel (societal risk)

A number of risk assessments have been and are being carried out for construction and operation of NSP2. For the offshore part, a quantitative risk assessment (QRA) for the construction risk has been carried out by the company Global Maritime /352/. Similarly, QRAs has been carried out by the company Saipem for the operations risk in each of the five Parties of Origin (PoOs) /363/, /364/, /365/, /366/, /367/. This documentation has been prepared in line with the provisions of the EU Offshore Safety Directive (see Chapter 3 – Regulatory context).

#### 13.4.1 Construction risk assessment

The quantitative risk assessment for construction concluded that the individual risk to third-party personnel is limited to passing vessel collisions. The individual risk for all vessels (cargo, tanker and passenger) and all five PoOs has been found to  $3.6 \times 10^{-6}$  fatalities per year. This is lower than the maximum risk defined in the project tolerability criteria /352/:

- Maximum risk of fatality for workers  $10^{-3}$  per person per year;
- Maximum risk of fatality for the public  $10^{-4}$  per person per year;
- Broadly acceptable risk  $10^{-6}$  per person per year.

The group risks for third-party personnel for the totality of the route are shown on the frequency-number (F-N) curve below (Figure 13-9). The F-N curve is used to evaluate the risk of third-party fatalities. Risks above the red line are in the generally unacceptable region, whereas risks between the red and green lines are in the ALARP or tolerable region. Risks below the green line are in the broadly acceptable region.

From the figure it is noted that the risks to cargo ship crews are just inside the ALARP region defined by the red and green lines in the figure below. The other risks are well into the tolerable region.

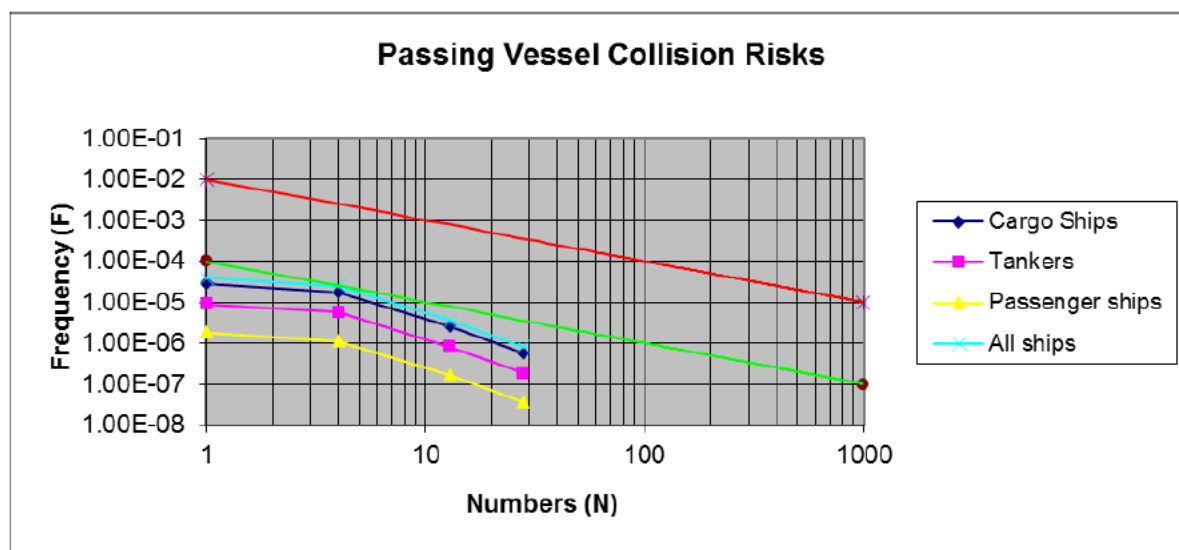


Figure 13-9 NSP2 construction passing vessel collision risk. The red and green lines define the boundaries between the generally unacceptable region, the ALARP region and the broadly acceptable region /352/.

#### 13.4.2 Operations risk assessment

The company Saipem has calculated the risk to third parties for the operation phase of NSP2 for sensitive sections in all five PoOs /363/, /364/, /365/, /366/, /367/. The results show that the

risks in Russia, Finland, Sweden and Denmark all are in the broadly acceptable region. In German waters, however, the risk in one sensitive section (Section 3) is in the ALARP region (see Figure 13-10).

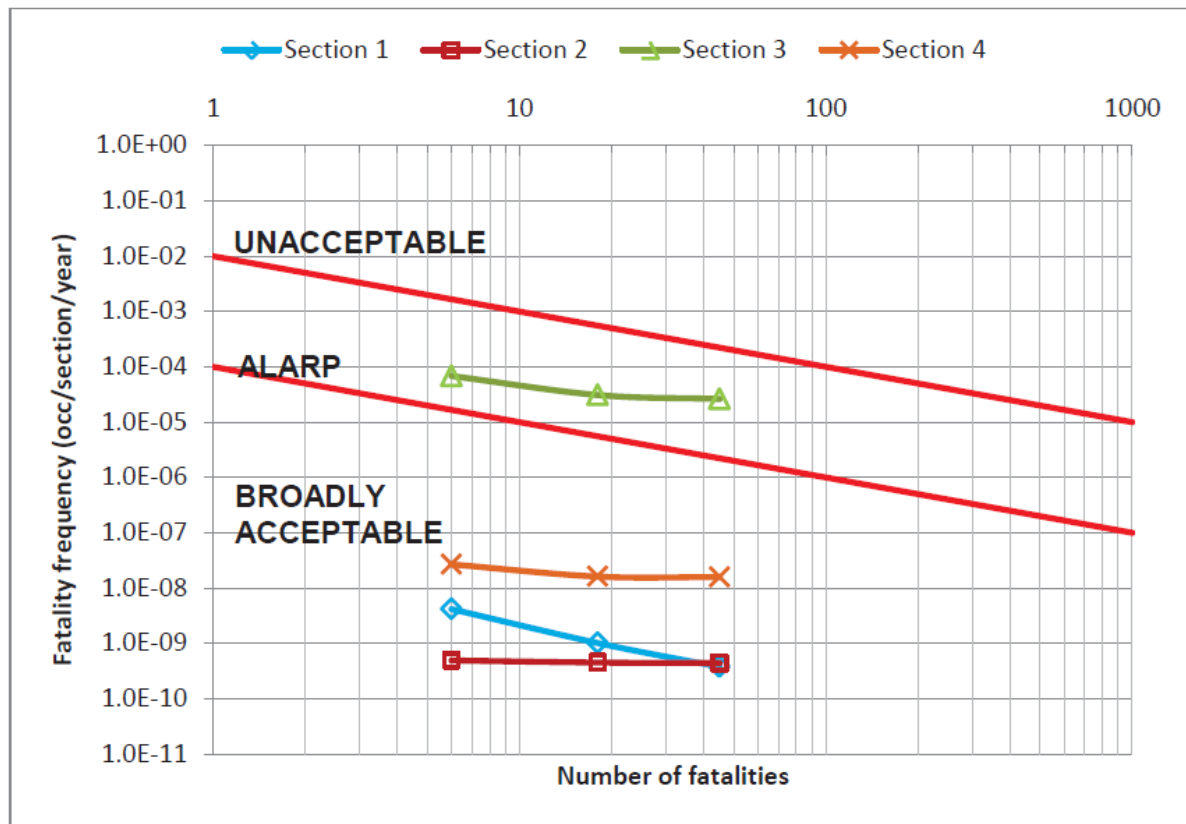


Figure 13-10 F-N curve for operational risk for each sensitive section in Germany /367/.

The risks shown in Figure 13-10 were calculated before protection measures were considered. Without protection measures, the individual risk for Section 3 was calculated to be  $6.85 \times 10^{-5}$  fatalities per year, i.e. above the threshold defined for separating the possible event from the unrealistic occurrences. With the implementation of a 0.5 m top cover as a protective layer, the risk is reduced to  $2.26 \times 10^{-9}$  fatalities per year, i.e. well in the broadly acceptable region /367/.

## 13.5 Emergency preparedness and response

### 13.5.1 General

To prevent or mitigate potential impacts from accidents and unplanned events during construction, Nord Stream 2 AG has developed a mitigation strategy. The scope of this strategy covers both normal ship operations and project-specific construction activities that pose a risk to the environment or to third parties.

Methods to prevent or mitigate potential impacts from unplanned events during construction include but are not limited to:

- Compliance with MARPOL requirements related to discharge of oil and waste products;
- Development of offshore spill response plans;
- Oil spill clean-up kits on vessels and construction sites to respond to any local spills;
- Preparation of procedures, hazard identification exercises and toolbox talks before the commencement of construction activities;
- Safe work procedures for anchor-handling in line with HELCOM requirements to mitigate any risks of contact with munitions or the remains of chemical weapons;
- Preparation and practising of emergency response procedures.



Contractors working for the project are required to have HSES management systems in place. This includes the requirement for HSES plans approved by Nord Stream 2 AG that are specific to the hazards and risks associated with the contractors' scopes of work and worksites. Nord Stream 2 AG, through audits and inspections at the contractors' worksites, will ensure that the above requirements are adhered to. Plans and procedures will be periodically tested and improvements made.

All incidents and nonconformities are reported to the appropriate level of management. Immediate notification of the authorities in the event of emergencies is part of the emergency response plans. Procedures are in place to immediately respond to incidents and nonconformities in order to minimise their consequences. HSES incidents are investigated in order to determine root causes and to prevent recurrence.

Nord Stream 2 AG will develop and implement an emergency response plan for the operation phase. This will be supported by the following:

- Pipeline inspection;
- Monitoring and pipeline emergency shutdown equipment including automation;
- Redundancy in control systems;
- Response procedures;
- Training and drills;
- Cooperation and coordination with relevant Baltic Sea emergency response agencies;
- Communication protocols;
- Ongoing review and improvement.

Although NSP2 will be designed and constructed to operate safely throughout its lifecycle, it is prudent to have plans and procedures in place to respond to foreseeable emergencies. Emergency preparedness and response (ERP) is an integral part of the NSP2 Health, Safety, Environmental and Social Management System (HSES MS).

The ERP plans and procedures will be in place to minimise HSES effects as follows:

- All NSP2 worksites, including those operated by contractors and suppliers, will have an emergency notification plan and assigned emergency responders to ensure proper and fast reaction to and management of emergencies.
- Emergency plans will be documented, accessible and easily understood.
- The effectiveness of plans and procedures will be regularly reviewed and improved, as required.
- Plans and procedures will be supported by training and, where appropriate, exercises.

Mitigation measures to address potential spills are documented in the offshore pollution prevention and waste mitigation strategy.

### **13.5.2 Navigation and vessel safety**

Vessel safety during construction in particular will be assured through a number of management actions:

- Communication and navigation systems and aids and associated procedures will be in place to ensure avoidance of collisions at sea.
- A single vessel will act as the centralized point of radio communications for each construction spread in order to manage movements.
- Tailored exclusion zones for the various construction vessel types will be maintained to ensure safe distances with third-party marine traffic.
- The relevant authorities in each country will be notified of key construction events.

- Special precautions will be taken to safeguard shipping traffic installation when crossing shipping zones and traffic separation zones.
- Weather forecasting will be used to identify the potential onset of unstable/poor weather conditions and criteria for the suspension of construction activities will be established.
- Pull tests and monitoring of construction vessel anchors will be undertaken to minimise the possibility of a dragged anchor.

### 13.5.3 Consultation activities

Nord Stream 2 AG will ensure that there is a suitable emergency response plan (in line with HELCOM requirements) in place to mitigate impacts caused by unplanned environmental accidents (e.g. fuel/oil spill, disturbance of munitions, pipeline failure or sea accidents/collisions).

The emergency plan will include measures such as assignment of responsibilities for key safety protocols, safety equipment, training and drills. Key consultation activities included as part of this plan include:

- Communicating the results of the risk assessment to local authorities and emergency management personnel before construction begins to ensure that they are aware of project related risks and that they can take precautions accordingly.
- Ongoing liaison with public authorities, particularly before major works or project activities will be carried out to ensure that they are aware of major project phases and project development activities that could have implications for public safety.

## 14. CUMULATIVE IMPACTS

### 14.1 Introduction and definition of cumulative impact

While the impacts of NSP2 have been considered in Chapter 10 – Assessment of environmental impacts, there is also a need to consider the potential for impacts to interact with impacts from other projects. These other projects may generate their own individually insignificant impacts, but when considered in combination with the impacts from NSP2, the impacts could amount to a significant cumulative impact, e.g., the combined sediment impacts from two or more (planned) projects within a certain timeframe and distance. Cumulative impacts are defined here as impacts that result from the in-combination affects of other projects together with those of NSP2.

This chapter describes projects identified and assessed for cumulative impacts within the national EIAs/ES. Projects identified in the national EIAs/ES that have not been considered further in the EIAs/ES have also not been included in the Espoo Report.

For the offshore sections of the pipeline crossing the waters of Finland, Denmark, and Sweden, a number of offshore projects with potential cumulative impacts have been identified and assessed. The locations of the projects are shown in Atlas Map PP-01-Espoo. Onshore and offshore projects as applicable are also considered at the landfall locations in Germany and Russia.

### 14.2 Methodology

This section sets out the parameters within which the cumulative impact assessment has been undertaken.

The receptors initially considered within this cumulative impact assessment are consistent with those considered within the national EIAs/ES /26/, /27/, /32/, /54/, /58/, /75/, /76/, /116/, /157/, /376/, /377/. A summary of the current status for the receptors is provided in Chapter 9 – Environmental baseline. Receptor sensitivity is assessed in Chapter 10 – Assessment of environmental impacts.

The spatial and temporal boundaries relevant to this cumulative impact assessment have been defined taking into consideration the characteristics of NSP2, and those of third party projects including their status with respect to the planning process. The magnitude and significance of impacts from other projects are described in the current chapter based on available information or using a conservative approach based on professional judgement.

The spatial boundaries are defined as the maximum distance at which there is the potential for a specific impact type to occur (based on areas defined within the assessments in Chapter 10 – Assessment of environmental impacts). The temporal boundaries are defined as the period during which NSP2 results in that specific impact type. Criteria for scoping projects in or out of the cumulative assessment vary to reflect the characteristics and receptors for offshore and onshore locations.

For impacts to be cumulative they must be of the same nature or they must be stressors of the same receptor (spatial overlap) and there must also be an overlap in time for the identified potential cumulative impacts.

Only receptors which have the potential to experience cumulative impacts are discussed for each project. Where receptors are not considered to have the potential to experience cumulative impacts, these have been screened out, based upon available knowledge, professional judgement and previous experience.

Planned projects identified and assessed for potential cumulative impacts are described in Section 14.3. Potential cumulative impacts from NSP2 and NSP are identified and assessed in Section 14.4.

Mitigation measures and environmental management in relation to impacts from NSP2 are described in Chapters 16 – Mitigation measures and 17 – Environmental management, respectively.

### 14.3 Cumulative impact assessment – planned projects

The national EIAs include an initial list of all planned and existing projects within a certain spatial range from the NSP2 project area where cumulative impacts may potentially arise.

Based on an initial screening of impacts and receptors relevant to planned projects, a limited number of projects are identified for further assessment of the potential for cumulative impacts. The identified projects are listed in Table 14-1. Assessments of the potential cumulative impacts from planned projects are presented in this section.

**Table 14-1** Planned projects which in combination with the NSP2 project have the potential to result in cumulative impacts.

Project	Approx. distance from NSP2	Status	Activities
<b>Russian section</b>			
Expansion of the Russian Unified Gas Supply System (UGSS), including Compressor Station (CS) and feeder lines to NSP2 south-east of the village of Bolshoye Kuzyomkino.	4.5 km	Construction of the first phase of network facilities is scheduled for completion by Q4 2019. This gas will feed NSP2.	Construction activities will include ground preparation and installation of the CS turbines and related infrastructure, including the connecting pipelines between the CS and the PTA.
Projects in and around the existing Ust Luga Port.	25 km	Planned completion of construction in 2019/20	Projects include: <ul style="list-style-type: none"> <li>• Construction of a LNG plant with a capacity of 2.5 mln. tons per year</li> <li>• Infrastructure project for the comprehensive development of port areas including the creation of a cargo airport, industrial and logistics facilities, office and business and residential areas.</li> <li>• Construction of a carbamide plant - industrial complex processing of natural gas in synthetic ammonia and granulated urea capacity of 1.5 million tons per year.</li> <li>• Reconstruction of the Mga-Gatchina-Weimar-Ivangorod and railway approaches to ports on the southern shore of the Gulf of Finland.</li> </ul>
<b>Finnish section</b>			
Balticconnector gas	Crossing	Construction and	Connection of Finnish and

Project	Approx. distance from NSP2	Status	Activities
pipeline between Inkoo in Finland and Paldiski in Estonia.		pipeline installation will take place between 2018–2019 and commissioning is expected late 2019 according to preliminary plans.	Estonian natural gas distribution networks.
<b>Swedish section</b>			
Wind farm outside the Southern Midsjö Bank	20 km	Construction planned to begin in 2019. No permits have been issued. Application in 2012.	Installation of max. 300 wind turbines, inter-array and landfall cables. Presence of wind farm and vessels.
Marine sand and gravel extraction at the Southern Midsjö Bank within the Polish EEZ	20 km	Ongoing (permit valid until 2031). A permit has been granted for a deposit.	Extraction and transport of raw material.
<b>Danish section</b>			
Bornholm Wind Farm A proposed offshore wind farm which would occupy an area of approximately 45 km <sup>2</sup> , with an estimated generation capacity of up to 50 MW.	18 km	Construction expected 2017-2018. Commissioning 2019. Planning stage, EIA has been undertaken by DEA.	Installation of wind turbines, inter-array and landfall cables. Presence of wind farm, and vessels.
Extraction areas south of Bornholm	>6 km (Closest extraction areas to NSP2 are along the southeast part of Rønne Banke).	Reservation. No valid permits issued for resource extraction.	Extraction and transport of sediment.
<b>German section</b>			
50Hertz Transmissions GmbH  Installation of power cables from an offshore wind farm (onshore and offshore routing)	Crossing	1 cable has been laid already. Plans for the remaining cables will be submitted in the near future.  Construction between 2016-2018.	Installation and operation of 6 AC-systems for the grid connection cables of the offshore wind farm clusters "Westlich Adlergrund" and "Arkona See".
Gascade Gastransport, OPAL Gastransport and EUGAL Gastransport  GRS and NSP2 feeder pipelines Lubmin, Greifswald	Contiguous with NSP2 PTA at the German landfall	Undergoing assessment process with construction over 2018 and 2019 and operational from 2019 onwards.	Construction of the NSP2 downstream facilities, including Gas Receiving Terminal and feeder lines.

It can be added that the national EIAs/ES have further identified the Baltic Pipe (sub-sea gas pipe between Denmark and Poland), and offshore wind parks in the Danish and Polish EEZs that may potentially contribute cumulatively. These projects are, however, currently insufficiently planned and therefore, cannot be considered reasonably foreseeable. Hence no assessments of cumulative impacts with NSP2 have been carried out nationally.

For the projects presented in Table 14-1, variations of the following impacts have been identified as potentially cumulative due to their magnitude:

- Release of sediments to the water column (construction);
- Change in seabed profile/ presence of the pipeline (operation);
- Generation of underwater noise (construction);
- Airborne noise (construction);
- Traffic disruption and safety (construction);
- Presence of vessels (construction and operation);
- Emissions to air (construction and operation);
- Visual impacts (construction and operation).

#### **14.3.1 Slavyanskaya Compressor Station (Russia)**

Expansion of the trunk gas pipeline network will entail the construction of 866 km of line pipe, construction of three new compressor stations, extension of five existing compressor stations, as well as the construction of a gas treatment plant, gas distribution station, gas metering station, crossover and branch gas pipelines in the Vologda and Leningrad Regions.

The Divenskaya CS and the Slavyanskaya CS, which will be the final extension point of the gas pipeline network and the dispatch point for the delivery of natural gas into the NSP2 pipeline, will be located within Kingisepp District.

Divenskaya CS will be located near the village of Sredneye Selo, 10 km south-east of Kingisepp and 45 km south-east of the NSP2 Pigging Area. The location of this facility is sufficiently distant from the NSP2 project for the project to be out of the NSP2 area of influence with respect to cumulative impacts.

Slavyanskaya CS will be located 2.8 km south-east of the village of Bolshoye Kuzyomkino, on the right bank of the Luga river, 4.5 km north-east of the NSP2 Pigging Area. This facility is judged to be within the NSP2 area of influence with respect to potential cumulative impacts and is considered further below.

Construction of the first phase of all network facilities is scheduled for completion by Q4 2019.

##### **14.3.1.1 Assessment of potential cumulative impacts and receptors affected**

###### **Airborne noise (construction)**

It is concluded, that airborne noise from NSP2 construction activities at the PTA and along the pipeline route will be limited to a distance of no more than 2 – 3 km from the NSP2 activities. Noise sources primarily include earthmoving equipment and generators. The same can be expected of the construction of the upstream CS. As the NSP2 facilities and CS are located some 4.5 km apart, airborne noise will not result in cumulative impacts.

No noise generating activities apply to the NSP2 operation phase and therefore, no cumulative impacts are anticipated.

### Emissions to air (construction and operation)

It is anticipated that pollutant emissions into the atmosphere will occur during the first phase of construction of the compressor stations and line facilities as reflected in Table 14-2 below.

**Table 14-2 Pollutant emissions to atmosphere during the construction phase.**

Pollutant	Emissions during CS construction (t)	Emissions during line facilities construction (t)	Emissions during construction of NSP2 onshore section (t)
NO <sub>x</sub>	199.57	228.388	83.78
PM	24.97	27.19	3.63
SO <sub>2</sub>	18.01	20.72	0.83
CH <sub>4</sub>	2,453.95	1,489.10	-

Based on the results of the assessment, an impact on air quality is anticipated in the immediate vicinity of the construction sites. Elevated concentrations may extend to a distance of approximately 200 m from the boundaries of the construction sites.

Thus, cumulative impacts on air quality during the construction phase may be expected only in the vicinity of the junction between the gas pipeline from Slavyanskaya CS and the NSP2 Pigging Area facilities if these facilities are in the active construction phase at the same time. However, the impact is anticipated to be localised and of low magnitude. Therefore the overall cumulative impact would not be significant.

Emissions during the operation phase are considered only with respect to the Slavyanskaya CS, as the nearest facility to the NSP2 gas pipeline network (see Table 14-3 below).

**Table 14-3 Pollutant emissions to atmosphere during the operation phase.**

Pollutant	Emissions during operation of Slavyanskaya CS (t/year)	Emissions during operation of NSP2 Pigging Area (t/year)
NO <sub>x</sub>	431.91	0.017
PM	0.03	<0.001
SO <sub>2</sub>	0.07	<0.001
CH <sub>4</sub>	414.62	40.508

The assessment shows that impacts on air quality may be anticipated around the CS site. The highest impact is attributed to nitrogen dioxide. However, at the boundary of the recommended 700 m sanitary separation zone for the compressor stations, no pollutant concentrations exceed the prescribed limits for air quality. There are also no relevant human receptors in the vicinity of the CS.

Emissions during the operation phase of the NSP2 Pigging Area are only anticipated in the form of short-duration starts of the emergency generator and discharge of gas via the vent stack. The greatest source of air pollution is attributed to methane. At the boundary of the recommended 300 m sanitary separation zone for the trunk pipeline facilities, no pollutant concentrations exceed the prescribed limits for air quality.

Thus, considering the distance of 4.5 km between Slavyanskaya CS and the NSP2 Pigging Area, no cumulative impact on air quality is anticipated during the operation phase.

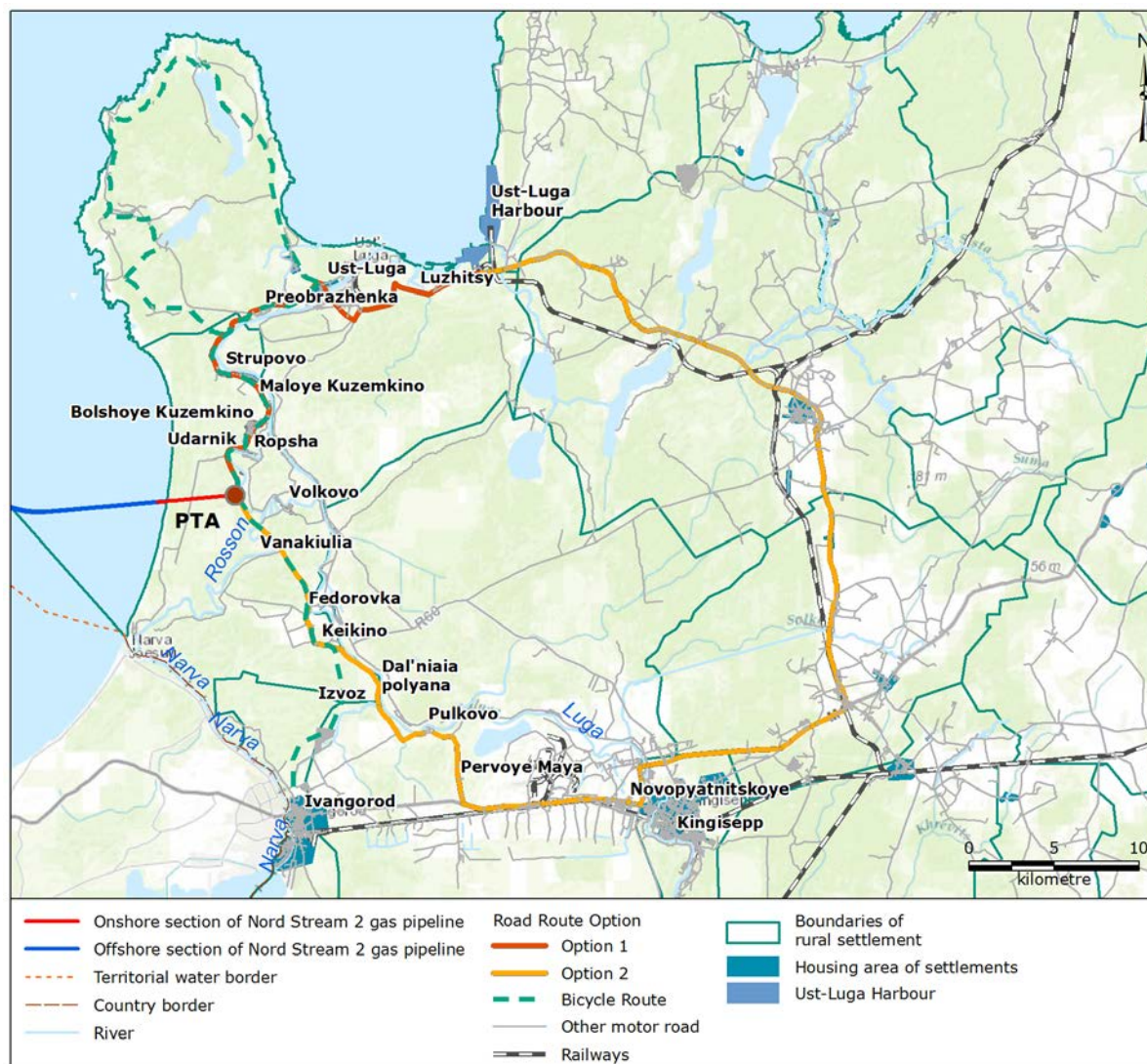
### Traffic disruption and safety (construction)

During construction of the landfall and onshore facilities in Russia the project will utilise two proposed access routes (see Figure 14-1) along existing roads to transport materials from the port in Ust Luga to the construction sites. For NSP2, some 20,000 vehicle movements in total (including between the port of Ust Luga and the NSP2 worksite) have been estimated over the

construction period, with peak construction traffic occurring during the first and last three months of construction.

Impacts on people as a result of transport to the site include:

- Increased road congestion;
- Increased risk of traffic-related accidents.



**Figure 14-1 Road routes to be utilised for the transportation of equipment and materials to the NSP2 PTA and worksite.**

The shorter route (Option 1) of approximately 34 km has a bridge weight limitation. Whilst both routes will be utilised, it is anticipated that approximately 80% of construction traffic will use the Option 1 route. This route is the quieter of the two, with approximately five vehicle movements observed in an hour. The Option 2 route is busier, especially in the area of the Kingisepp bypass, with vehicles (including many light vehicles and trucks) travelling to Ivangorod, Kingisepp and the Phosphorit industrial area.

The traffic increases resulting from the project will be much more prevalent on Route 1 as the roads to be utilized currently have very limited traffic. There are eight settlements along this route (Ust Luga, Preobrazhenka, Strupovo, Male Kuzemkino, Bolshoe Kuzemkino, Udarnik, Ropsha and Khanike). Residents within these communities will be receptors for this impact, as well as other road users. However, local residents will have less opportunity to find alternative routes than other road users so are identified to be of medium sensitivity/vulnerability. Other



road users are assessed as being of low to medium sensitivity/vulnerability depending on their ability to avoid Route 1 during the construction period.

Road users utilising Route 2 are not expected to see a significant increase in traffic from pre-project baseline levels, as only approximately 20% of construction traffic will take this route.

Increased traffic on Route 1 will elevate the risk of traffic-related accidents. Such incidents could lead to injuries or fatalities; residents of communities along the road, pedestrians (particularly children), families vacationing in the communities along the road, and cyclists are particularly vulnerable (designated as high sensitivity/vulnerability). Other road users are assessed as being of medium vulnerability.

The risk of traffic accidents is further amplified by the fact that there are no sidewalks for pedestrians along much of the roads and street lighting is limited. Nord Stream 2 AG will implement a TMP, SEP and EPRP to manage traffic-related impacts. It will also run an awareness raising campaign to inform stakeholders (particularly those most vulnerable, such as children) about potential project-related impacts.

The logistical arrangements for the construction of the CS and feeder lines have not been developed in any detail. It is anticipated that the Port of Ust Luga will be used for most deliveries to the upstream worksites so the road network in the vicinity of the Port will be shared by both NSP2 vehicles and those of the CS. However, as the upstream facilities and the NSP2 worksite are separated by a river and have different access requirements, most of the road network will not be shared.

A temporary, minor increase in the volume of traffic moving between the Estonian border and St Petersburg is anticipated as a result of NSP2 loads which will not lead to disruptions in traffic flow.

Regarding traffic disruption and safety, limited cumulative impacts in the vicinity of the Port are anticipated. However, such impacts can be managed with the development of joint TMPs addressing the scheduling and routing of traffic loads and the needs and sensitivities of the communities located along this section of the shared route.

The magnitude of traffic congestion impacts related to the project and in combination with the upstream facilities, during construction, is assessed as medium. There will be a significant change in traffic volumes on Route 1 that could lead to congestion and significant disruption to stakeholders. Local communities along this route will be affected, but impacts will be of relatively short duration. Considering the sensitivity of the receptors using this route, and assuming effective implementation of a TMP, residual impacts are assessed as minor.

The magnitude of project-related traffic accidents during construction is potentially large; this is because of the potential severity of an event. However, the duration of the impact is equivalent to the construction period and so does not present a long-term risk. Considering the sensitivity of receptors using the access routes, residual impacts will be managed through the TMP, SEP and EPRP to achieve residual impacts that are minor.

#### **14.3.1.2 Overall conclusion**

For sources of impact that include airborne noise and air emissions for the construction and operation phases of NSP2 and the upstream CS and feeder lines, no cumulative impacts are anticipated.

Regarding traffic disruption and safety, cumulative impacts are assessed to be minor. Such cumulative impacts will be managed with the development of a TMP addressing the scheduling and routing of traffic loads for the construction phase for the NSP2 project and the upstream

facilities and will reflect the needs and sensitivities of the communities located along the shared section of respective routes to the work sites.

Overall, there are no cumulative impacts that will lead to any transboundary impacts.

### 14.3.2 Projects in and around the existing Ust Luga Port

There are a suite of developments which will be implemented within and in the vicinity of the Ust Luga Port and are scheduled for construction over a similar timeframe to NSP2. These projects comprise the following:

- A fertilizer trans-shipment terminal
- A LNG plant with a capacity of 2.5 million tons per year
- A multi modal complex
- A urea plant
- A carbamide plant
- Various upgrades to the rail link to the port.

#### 14.3.2.1 Assessment of potential cumulative impacts and receptors affected

##### **Airborne noise (construction)**

Airborne noise from NSP2 construction activities at the PTA and along the pipeline route will be limited to a distance of no more than 2 – 3 km from the NSP2 activities. As the NSP2 facilities and port facilities are located some 25 km apart, airborne noise will not result in cumulative impacts.

No noise generating activities apply to the NSP2 operation phase and therefore, no cumulative impacts are anticipated.

##### **Emissions to air (construction and operation)**

An assessment of potential impact on air quality for the NSP2 project shows that there will be elevated levels of pollutants associated with construction equipment in the immediate vicinity of the construction sites. Elevated concentrations may extend to a distance of approximately 200 m from the boundaries of the construction sites. There are no receptors (communities) located within this area. As the NSP2 facilities and port facilities are located some 25 km apart, there will be no cumulative impacts on air quality.

Emissions in the operation phase of the NSP2 Piggings Area will be limited to short-duration starts of the emergency generator and discharge of gas via the vent stack. There will be no cumulative impacts on air quality.

##### **Traffic disruption and safety (construction)**

The volume of traffic and routing for NSP2 construction related loads was described in Section 14.4.1. There is the potential for elevated traffic congestion and related safety risk for vehicles leaving and entering the port area associated with NSP2 construction activities and those of the various port developments underway over 2018 and 2019. Cumulative traffic related risks in this area and along all transportation routes used by NSP2 will be managed through a TMP, SEP and EPRP involving interaction with the port authorities, municipal authorities and residents in the area.

#### 14.3.2.2 Overall conclusion

For sources of impact that include airborne noise and air emissions for the construction and operation phase for NSP2 and developments in and around the Ust Luga Port, no cumulative impacts are anticipated.

Regarding traffic disruption and safety, cumulative impacts are assessed to be minor. Such cumulative impacts will be managed with the development of a TMP. The plan will address scheduling and routing of traffic loads around the port area associated with the construction phase. The plan will also reflect the needs and sensitivities of the communities and other stakeholders located in the vicinity of the port.

Overall, there are no cumulative impacts that will lead to any transboundary impacts.

### 14.3.3 Balticconnector (Finland)

The Balticconnector (BC) is an 82 km bi-directional offshore gas transmission pipeline between Paldiski (Estonia) and Inkoo (Finland). The pipeline crosses NSP2 in the western part of the Gulf of Finland. The location of the area is shown in Atlas Map PP-01-Espoo.

Activities associated with the BC are similar to those of NSP2 and the construction phases of the two projects may overlap. Detailed planning of the two projects will, however, ensure that activities at the crossing site will be phase shifted in order to minimise impacts and risks.

The assessments in the following refer to the Finnish EIA /27/.

#### 14.3.3.1 Assessment of potential cumulative impacts and receptors affected

##### Release of sediments to the water column (construction)

In an area around the crossing of the pipelines, sediment dispersion from rock placement, munitions clearance and pipe laying have the potential to cause cumulative impacts including an increase in turbidity, release of nutrients and contaminants associated with the sediment and siltation of the project area.

However, as the water depth at the crossing is approximately 63 m and with anoxic conditions, no benthic communities will be subject to impacts from the sediment dispersion, and due to the anoxic conditions, no demersal fish are anticipated to be frequent in the crossing site.

Contaminants released from BC and NSP2 activities would be adsorbed to particles and re-sediment rapidly eliminating the potential for temporal overlap of this impact between the projects.

Based on this it is assessed that there will be no cumulative impacts on benthic communities (and therefore also no cumulative impacts on habitats) and fish as a result of the release of sediments and associated nutrients and contaminants from the two projects.

##### Generation of underwater noise (construction)

Underwater noise from munitions clearance and rock placement activities are potentially cumulative for NSP2 and BC. Underwater noise may potentially impact marine mammals, primarily grey seal, as well as fish.

Detailed time planning of the projects will ensure that the potential of causing cumulative underwater noise impacts will be limited if not entirely eliminated. Furthermore, mitigation measures such as the use of seal scarers will prevent the noise impulses from causing permanent impacts on these receptors.

Based on this and the low number of identified munitions found in the area during the NSP project, the probability of cumulative impacts associated with munitions clearance on seals is low.

##### Airborne noise (construction)

Airborne noise from different activities is potentially cumulative for NSP2 and BC. Airborne noise may potentially impact marine mammals and birds.

It is concluded that airborne noise from NSP2 construction activities can reach approximately 56 dB (comparable to noise levels offshore from wind, breaking waves, etc.) at a distance of around 2 – 3 km from the NSP2 activities. It is estimated that the same can be expected from BC. Detailed time planning of the projects will ensure that construction works will not be carried out simultaneously close to the crossing point and consequently that there will be no cumulative impacts due to airborne noise.

#### **Presence of vessels (construction)**

During the construction of NSP2 and BC, various vessels will be present for construction and supply activities. During operation, vessels are limited to maintenance activities, which are expected to include surveys every 1 - 2 years. The presence of vessels may cause avoidance behavior in fish, marine mammals and birds.

Detailed time planning of the construction phases for the two projects will ensure that construction activities are not carried out simultaneously close to the crossing point. Furthermore, safety zones around vessels will eliminate the risk of collisions.

Based on this, it is assessed that there will be no cumulative impacts due to the presence of vessels.

#### **Changes in seabed profile/presence of the pipeline (operation)**

Local changes in bathymetry where NSP2 and BC are established will result in local changes in habitats at the crossing site.

Due to the water depth (63 m) and anoxic conditions, no impacts on benthic flora or fauna are anticipated around the crossing point.

Based on this, it is assessed that there will be no cumulative impacts due to changes in the seabed profile/presence of the pipeline.

#### **14.3.3.2 Overall conclusion**

Based on the above and /27/ it is assessed that cumulative impacts on the environment from sediment dispersion, underwater noise, air emission, physical disturbance, airborne noise or the presence of vessels between the NSP2 project and the planned gas pipe BC will not be significant.

The assessment is based on the presumption of detailed planning of the two projects that ensures no simultaneous activities around the crossing point of the two projects.

#### **14.3.4 Midsjö Bank Wind Farm (Sweden)**

An area of 364 km<sup>2</sup> is reserved for a planned wind farm and an associated safety area outside the Southern Midsjö Bank. The location of the area is shown in Atlas Map PP-01-Espoo distance between the reserved area and the NSP2 route is approximately 20 km.

Activities associated with the wind farm include the construction of foundations and mounting of wind turbines, inter-array and landfall cables, as well as the presence of the wind farm and cables during the operation phase. During the construction and the operation phases, vessels are expected in the area.

The construction phase is planned for 2017-2019 and the estimated operation period is 25-30 years.

The assessments in the following refer to the Swedish ES /32/.

#### 14.3.4.1 Assessment of potential cumulative impacts and receptors affected

##### **Release of sediments to the water column (construction)**

Sediment dispersion from construction activities at the seabed, e.g. foundation works for the wind park and trenching and pipe-laying, have the potential to cause cumulative impacts including an increase in turbidity, release of nutrients associated with the sediment and sedimentation in the project area.

However, based on the modelling results of sediment dispersion from construction activities in the seabed for both the NSP2 project and the planned wind farm outside Southern Midsjö Bank, it has been concluded that due to the minimum distance of approximately 20 km between the two projects and the local extent of sediment dispersion and re-sedimentation, there will be no cumulative effects from simultaneous construction activities.

##### **Change in seabed profile/presence of the pipeline (operation)**

Local changes in the bathymetry where NSP2 is established, just as local changes at the wind farm area where wind farm foundations (artificial reef structures) will occupy former seabed areas, will result in local changes in the habitats.

It is assessed that because of the large distance of a minimum of 20 km between the projects there will be no cumulative impacts on benthic communities.

##### **Generation of underwater noise (construction)**

In the southern part of the Swedish EEZ underwater noise from construction of NSP2 is assessed to be restricted to pipe-lay and trenching and is therefore assessed to be more or less comparable with noise from maritime traffic in the area/at the navigation channels.

However, significant underwater noise from pile driving activities from construction of the planned wind farm may, if carried out at same time as the NSP2 project, have the potential for cumulative impacts.

According to the EIA for the wind park project outside the Southern Midsjö Bank /378/, mitigation measures to protect seals and porpoises will be implemented if necessary. Mitigation devices can be used to scare off seals and porpoises before piling if the noise is assumed to reach harmful levels. Alternatively, the noise from pile driving can be increased gradually, thereby causing the animals to withdraw from the noise source.

##### *Fish*

The potential impacts on fish from underwater vessel and construction noise are assessed to be local, i.e. within a few hundred meters from the proposed NSP2 pipeline route /32/.

Pile driving in connection with the foundation work is, however, expected to generate significant impulsive underwater noise. The potential impacts on fish related to underwater noise are assessed to be local, i.e. within 1 km of the monopile locations.

Given that the distance between NSP2 and the wind farm is more than 20 km, there is no potential for the impacts of underwater noise associated with construction activities of the two projects to overlap. Based on the above, it is assessed that there will be no cumulative impacts on fish due to underwater noise.

##### *Marine mammals*

Impacts on marine mammals from underwater noise during the construction phase of NSP2 are assessed to be local, and within 100 m from the proposed NSP2 pipeline route.

The impulsive underwater noise from pile driving will result in avoidance reactions (marine mammals fleeing the area), over a much larger area, possibly including the area where NSP2 activities are undertaken. However, based on the implementation of proposed mitigation measures (seal scarers), it is assessed that cumulative impacts on marine mammals as a result of underwater noise from the two projects will not be significant.

#### **Airborne noise (construction)**

In the Swedish ES /32/ it is assessed that airborne noise from NSP2 construction activities can be up to approximately 56 dB (comparable to noise levels offshore from wind, breaking waves, etc.) at a distance of around 2 – 3 km from the NSP2 activities.

The two projects are geographically “separated” by the main navigation channel, where the airborne noise level in general is elevated by vessel traffic, and in the Swedish ES /32/ it is assessed that no potential cumulative impact is expected due to the local spatial extent and distance (20 km) between the projects.

Based on this, it is assessed that there will be no cumulative impacts from airborne noise.

#### **Presence of vessels (construction)**

During construction of NSP2, various vessels will be present for construction activities potentially disturbing fish, marine mammals and birds. During operation, vessels are limited to maintenance activities, which are expected to include surveys every 1 - 2 years. Impacts will be of a short duration, localised, and are assessed to not be significant.

Should the construction of the wind farm and NSP2 be undertaken simultaneously, there will be increased vessel traffic in the vicinity of the projects. However, safety zones around project vessels will reduce the increased risks of collisions, and the wind turbine area is likely to be cordoned off for traffic.

Based on this, it is assessed that there will be no cumulative impacts from the presence of vessels.

#### **14.3.4.2 Overall conclusion**

Based on above and /32/ it is assessed that there will be no significant cumulative impacts on the environment from sediment dispersion, physical disturbance, underwater and airborne noise or the risk of collision between the NSP2 project and the planned wind farm outside Southern Midsjö Bank.

#### **14.3.5 Marine sand and gravel extraction at the Southern Midsjö Bank in the Polish EEZ (Poland)**

Sand and gravel is extracted from four extraction areas close to Southern Midsjö Bank inside the Polish EEZ. The region of extraction occupies an area of 25.6 km<sup>2</sup>, with a deposit volume of approximately 56 million tonnes. The extraction areas are located approx. 20 km from the NSP2 route, see Atlas Map PP-01-Espoo.

Extraction is carried out by a hopper dredger at water depths between 18 and 30 m. Activities associated with the extraction of the raw material are skimming the surface of the seabed, dredging and pumping up the sand.

The assessments in the following refer to the Swedish ES /32/.

#### **14.3.5.1 Assessment of potential cumulative impacts and receptors affected**

### **Release of sediments to the water column (construction)**

Sediment dispersion from NSP2 construction activities at the seabed, including trenching, rock placement and pipe-lay, will only result in very local impacts.

The sediment dispersion during raw material extraction may similarly lead to local, short-term increases in suspended sediments and sedimentation close to where the activities are undertaken.

Due to the local extent of sediment spill and sedimentation for both projects, the areas which are likely to experience an impact would not overlap. Therefore no cumulative impacts are expected.

### **Presence of vessels (construction and operation)**

During construction of NSP2, various vessels will be present for construction activities. During operation, vessels are limited to maintenance activities, which are expected to include surveys every 1 - 2 years. Impacts will be of a short duration and localised, and assessed to be not significant.

In combination with vessels extracting raw materials, the total number of vessels will increase. However, due to the distance of approximately 20 km between the two projects, no potential cumulative impacts are anticipated.

#### **14.3.5.2 Overall conclusion**

Based on the above and assessments in the Swedish ES /32/ it is assessed that there will be no cumulative impacts on the environment from sediment dispersion, physical disturbance, or the presence of vessels between the NSP2 project and the existing extraction areas inside the Polish EEZ at Southern Midsjö Bank.

#### **14.3.6 Bornholm Wind Farm (Denmark)**

The proposed Bornholm Wind Farm would occupy a designated area of approximately 45 km<sup>2</sup>. The offshore wind farm itself will take up approximately 11 km<sup>2</sup>. Cables from the wind farm are planned to connect to shore at the coast southeast of Rønne. The location of the area is shown in Atlas Map PP-01-Espoo.

Activities associated with the wind farm include the construction of wind turbines, inter-array and landfall cables, as well as the presence of wind farm and cables in the operation phase. During parts of the construction and operation phases, vessels are expected in the area.

The wind farm is currently in the planning stage, and an EIA has been undertaken. A tender process was initiated in 2015 by DEA. It is noted, however, that the project is reportedly on hold, pending a political decision.

The assessments in the following refer to the Danish EIA /26/.

#### **14.3.6.1 Assessment of potential cumulative impacts and receptors affected**

##### **Release of sediments to the water column (construction)**

During construction of NSP2, seabed disturbance and spill of seabed sediments are expected in connection with seabed intervention works. The modelling and monitoring of impacts during NSP and subsequent modelling for NSP2 have shown that post-lay trenching is expected to give rise to more sediment spill than rock dumping and pipe-lay activities in Danish waters. However, the impacts are local and short-term and assessed to be not significant for any of the receptors.

The sediment dispersion during construction of the Bornholm Wind Farm has been modelled /26/. The results show that the seabed sediments are coarse, and that re-suspended sediment and

increased sedimentation will occur within a distance of 500 m from the construction activity only, and within a short duration (days).

Due to the local extent of sediment spill and sedimentation for both projects, in combination with the short-term nature of the dispersion, no significant cumulative impacts are expected.

#### **Generation of underwater noise (construction)**

During construction of NSP2, underwater noise is expected in association with seabed intervention works (trenching and/or rock placement) and pipe-lay activities. The underwater noise during NSP2 will be short-term, of local extent and only occur during the construction phase.

During construction of the wind farm project, underwater noise is expected in association with seabed intervention and piling activities.

If piling is undertaken at the same time as NSP2 construction works take place, underwater noise generated during the construction of the two projects has the potential to lead to cumulative impacts /26/. The potential receptors which may be impacted by underwater noise have been identified and comprise fish, marine mammals and protected areas (including Natura 2000 sites).

#### *Plankton, benthic flora and fauna*

Plankton and benthic fauna are not considered particularly vulnerable to underwater noise, and due to the distance between the two projects (18 km), no significant cumulative impacts on plankton and benthic fauna are anticipated. There are no benthic flora in the NSP2 project area in Danish waters, and therefore no cumulative impacts are anticipated for benthic flora.

#### *Fish*

The impacts from underwater noise on fish during the construction of NSP2 are assessed applying underwater modelling. Potential impacts (TTS) from underwater noise on fish are assessed to be local, i.e. within 100 m from the proposed NSP2 pipeline route. With respect to the Bornholm Wind Farm, pile driving in connection with the foundation work is expected to generate significant underwater noise. The potential impacts on fish related to underwater noise are, however, assessed to be local, i.e. within 1 km of the monopile locations /26/.

Given that the distance between NSP2 and the Bornholm Wind Farm is more than 18 km, there is no potential for the impacts of increased noise associated with construction activities of the two projects to overlap. Furthermore, given that the potential impact on fish due to underwater noise is highly localised, there is no overlap between the potential disturbance areas for the two projects.

Based on the above, it is assessed that there will no cumulative impacts on fish.

#### *Marine mammals*

The impacts on marine mammals from underwater noise during the construction phase of NSP2 inside Danish waters are assessed to be local, with TTS impacts within 80 m of the proposed NSP2 pipeline route.

The EIA for the Bornholm Wind Farm presents results from the modelling of underwater noise generated from pile driving, which is considered to be the most significant noise source during the construction phase. The NSP2 route is outside the area where TTS or PTS is anticipated.

Based on the above, it is assessed that cumulative impacts on marine mammals will not be significant.



*Protected areas*

Protected areas are designated to protect the marine environment. As described above, no cumulative impacts are expected to occur on the marine receptors (fish, marine mammals), and as such no cumulative impacts are foreseen on protected areas.

**Airborne noise (construction)**

Airborne noise for NSP2 in Danish waters has been calculated and assessed to be of a short duration and localised, with impacts assessed to be of no or negligible significance.

The airborne noise from construction of the planned wind farm has likewise been calculated in the wind farm EIA. Although there is likely to be an increase in airborne noise (especially from piling activities) during construction, this will be of a short duration and localised.

Due to the local extent of impacts in combination with the short duration of emissions during the construction period, no significant cumulative impacts are expected.

**Presence of vessels (construction and operation)**

During construction of NSP2, various vessels will be present for construction activities. During operation, vessels are limited to maintenance activities, which are expected to include surveys every 1 - 2 years. Impacts will be of a short duration and localised, and assessed to be insignificant.

Vessel traffic associated with the construction of the wind farm will increase during the construction phase, as maintenance vessels will be present during the operation phase. Impacts from the presence of the vessels will be of a short duration and localised.

Due to the local extent of impacts associated with the presence of vessels, no cumulative impacts are expected.

**14.3.6.2 Overall conclusion**

Based on the above and /26/ it is assessed that there will be no cumulative impacts on the environment from sediment dispersion, underwater noise, airborne noise, or the presence of vessels between the NSP2 project and the planned Bornholm Wind Farm.

**14.3.7 Extraction areas west of Bornholm (Denmark)**

The areas reserved for sediment (sand and gravel) resource extraction on Rønne Banke, South of Bornholm is located approximately 6 km west of the NSP2 pipeline corridor. The location of the area is shown in Atlas Map PP-01-Espoo. No permits have been issued for the areas.

The assessments in the following refer to the Danish EIA /26/.

**14.3.7.1 Assessment of potential cumulative impacts and receptors affected****Release of sediments to the water column (construction)**

During construction of the NSP2 project, disturbance and spill of seabed sediments are expected in connection with seabed intervention works. Just south of the planned extraction areas, the NSP2 project is planned to cross the NSP project. At this location, the NSP2 construction activities will include both pipe-lay and rock placement. Based on the modelling and monitoring of impacts during NSP and subsequent modelling for NSP2 it has been assessed that there will be no overlap between sediment dispersion and sedimentation between the NSP2 project and the planned extraction of raw materials.

Due to the localised extent of sediment spill for both activities, no significant cumulative impacts are expected.

#### **Generation of underwater noise (construction)**

During construction of NSP2, underwater noise is expected in association with seabed intervention works and pipe-lay activities. The underwater noise during NSP2 will be short-term, localised and only occur during the construction phase.

During extraction of raw materials, the noise generated from the extraction activities is likely to be of a similar magnitude as the NSP2 activities, and also short-term.

Due to the localised extent and short-term nature of noise impacts for both activities, no significant cumulative impacts are expected.

#### **Presence of vessels (construction and operation)**

During construction of NSP2, various vessels will be present for construction activities. During operation, vessels are limited to maintenance activities, which are expected to consist of surveys every 1 - 2 years. Impacts will be of a short duration and localised, and are expected to be insignificant.

During extraction, additional vessels will be present in the area. Impacts will be localised to the extraction area and the route to Bornholm and the presence of vessels will be short-term.

Due to the local extent and short-term nature of the impacts for each project, no cumulative impacts are expected.

#### **14.3.7.2 Overall conclusion**

Based on above and conclusions in the Danish EIA /26/ it is assessed that there will be no significant cumulative impacts on the environment from sediment dispersion, underwater noise or the presence of vessels between the NSP2 project and the planned extraction area South of Bornholm at Rønne Banke.

#### **14.3.8 50Hertz Transmissions GmbH (Germany)**

50Hertz Transmissions GmbH intends to install 6 separate cable systems, which will connect the wind farms of the wind farm clusters "Westlich Adlergrund" and "Arkona-See" in the German Baltic Sea with the German onshore power network.

In order to reflect a worst case scenario for cumulative impacts, the assumption is that 3 cables will have been installed by end 2017 and another 3 cables will be installed before the end of 2018. This may lead to a temporal overlap between the NSP2 and 50Hertz construction programmes.

#### **14.3.8.1 Assessment of potential cumulative impacts and receptors affected**

##### **Release of sediments to the water column (construction)**

The NSP2 pipelines will be installed in trenches. The 50Hertz cables will be installed preferably by jetting, but also by pre-lay trenching where technically required. Thus, sediment transport associated with pre-lay trenching may occur in similar magnitudes, if more than one cable is considered. The monitoring programme implemented during the construction of NSP showed that sediments in the water column dispersed up to a distance of 500 m within the Greifswalder Bodden and 200 m within the Pomeranian Bay. Suspended material usually settled within a couple of hours.

Due to the local and temporary nature of the sediment dispersion from both projects, no cumulative impacts are anticipated.

### **Change in seabed profile/presence of the pipeline (operation)**

The seabed will be reconstructed with autochthonous material in both projects and regeneration is anticipated to be comparable. The NSP monitoring programme showed that within a period of two to four years after reinstatement, there has been a recovery of the seafloor. Consequently, changes in seabed integrity will be temporary and no confinements will remain after the regeneration process. Furthermore, the spatial extent of either project is limited to a designated corridor, preserving the habitats outside and maintaining the possibilities of spreading for the benthic communities.

Based on this, cumulative impacts are assessed to be not significant.

### **Generation of underwater noise (construction)**

Underwater noise emitted by ships leads to a displacement of marine mammals including harbour porpoises and seals, as well as fish. As the construction fleets of NSP2 and 50Hertz will operate simultaneously, the impacted areas can be added. However, vessels and construction equipment move continuously and undisturbed areas will constantly be available in the vicinity of the affected areas.

Based on this, cumulative impacts are assessed to be not significant.

### **Airborne noise (construction)**

Airborne noise in offshore areas has a limited range and is easily masked by the sounds from wind and waves. In areas where construction is carried out in nearshore areas, residents may be disturbed. As vessels and construction equipment move continuously, noise emissions will be temporary.

Due to the temporary effects of airborne noise and its local spatial extent, cumulative impacts are assessed to be not significant.

### **Presence of vessels (construction)**

Loons are the most sensitive birds with regards to the presence of vessels and show the highest flight distance of up to 3 km. Other birds, such as ducks, also exhibit avoidance behaviour when ships are approaching. The more ships that are operating at the same time, the bigger the area of disturbance for sensitive animals. Generally, the vessels and construction equipment move continuously and are channelled along shipping routes, which are often avoided by birds anyway. However, since NSP2 construction will not take place during the seabird staging season, cumulative displacement will affect only very few individuals during summer and autumn. Displacement effects for fish and marine mammals might increase by cumulative local construction related vessel traffic. Since construction will progress daily, this impact will not occur for a long period of time at any particular location along the routes.

Therefore, the disturbance caused by the presence of vessels is only temporary and cumulative impacts are assessed to be not significant.

#### **14.3.8.2 Overall conclusion**

Should the NSP2 pipelines and the remaining three 50 Hertz cables be installed simultaneously, negative cumulative impacts may occur. However, all impacts are temporary with a local spatial extent. Furthermore, there are sufficient undisturbed areas in the vicinity of the moving vessels and construction sites at all times. In conclusion, cumulative impacts are overall assessed to be not significant.

#### **14.3.9 Gas Receiving Station and NSP2 feeder line NEL and EUGAL, Lubmin (Germany)**

The GRS and NEL and EUGAL pipelines are downstream of NSP2. The GRS is contiguous with and located to the west of the NSP2 PTA. It serves to heat up the incoming gas for NSP2 and to release gas pressure. This process is necessary before the gas can be pumped into the

connecting European gas pipelines. Therefore, a gas pressure chamber and a heating plant will be built. The feeder pipelines are the physical connector between the GRS and the existing NEL (Northern European Natural Gas Pipeline). The planned EUGAL will transport the gas from the GRS southwards (European Pipeline Link).

The construction schedule for the NSP2 GRS and downstream feeder pipelines is as follows (NEL and EUGAL):

- GRS: Construction duration of 2 years (January 2018 to December 2019)
- NEL and EUGAL pipelines (first line): Construction duration of 3 months (planned implementation between January 2018 and December 2019)
- Implementation of EUGAL (second line): Through to 2020.

The construction of the NSP2 PTA will take place over 2018 and 2019 and there will consequently be simultaneous construction with the downstream facilities.

#### **14.3.9.1 Assessment of potential cumulative impacts and receptors affected**

Permanent changes in land cover and biological elements associated with the construction of NSP2 at the offshore-onshore transition zone will be avoided through the use of micro-tunneling techniques which will enable the coastal forest belt to be left untouched.

Permanent changes in land cover and biological elements associated with the construction of the NSP2 PTA and affecting an area of approximately 8 ha are smaller than those associated with the construction of the GRS and the NSP2 feeder pipelines, which will cover a larger area of 14 ha. The installation of the EUGAL pipelines will cover another 8 ha within the study area under consideration. Hence, the entire cumulative impact in relation to permanent changes in land cover and associated biological elements will add up to approx. 30 ha (and another 3 ha for additional temporary construction sites).

During construction, the following sources of impact are applicable to the PTA and contiguous GRS site:

- Noise generation;
- Emissions to air;
- Changes in landform, or land-cover and land use;
- Releases to land and water;
- Traffic movements.

#### **Noise generation and emissions to air**

At the Lubmin landfall, the planned NSP2 project and downstream facilities will cause noise and air emissions. These are short-term during the construction phase and long-term during the operation phase.

Emissions to air and airborne noise from the onshore worksite are considered to be the most important contributors to potential impacts on human receptors. These impacts will be of short to medium duration and small to medium scale and are therefore not significant.

#### **Changes to landform, or land-cover and land use**

Land use changes associated with NSP2, along with the loss of biotopes and habitats, will cause the main impacts on terrestrial flora and fauna and air quality.

The total loss of 30 ha of high value and sensitive mixed pine woodlands due to the construction of the PTA, the feeder lines and other NSP2 related onshore structures will be of high intensity (loss) and permanent. For breeding birds and reptiles, the loss of suitable habitats results in a

moderate and insignificant cumulative impact. The loss of bat and amphibian habitats results in minor cumulative impacts that are not significant.

The removal of forest structures also affects the landscape as important landscape affecting structures will be lost. The partial loss of landscape structures will be of medium intensity resulting in a medium cumulative impact that is not significant.

In terms of the micro-climate supporting function, the partial loss of climate affecting woodlands will be permanent and of a small scale; together with the high intensity (loss), it results in a high cumulative impact that is locally significant (within the industrial area).

The preparation of the NSP2 construction sites and related structures requires the exchange of naturally occurring soil and leveling of the construction site. Functional impairments of the soil by removing the topsoil will occur in the complete area of the PTA, including the ring road, the construction, laydown and storage sites. By the repeated crossing of heavy construction machines and the construction work itself, the area of construction will be frequently used and impaired by sealing and compaction. The resulting cumulative impacts will be of medium intensity, medium to permanent duration and occur on a medium scale: 33 ha. Overall, this results in a high cumulative impact ranking that will be locally significant (within the industrial area).

Impacts on visual amenity and recreational quality in the vicinity of the GRS and PT may also affect human receptors. However, as the residential areas, marina, and beach areas are some distance away and will be shielded by trees surrounding the construction site, cumulative impacts will not be significant.

#### **Releases to land and water**

Certain construction activities will require dewatering, especially for the micro-tunnel start shafts, anchor blocks and pipeline trenches. Thus, small amounts water will be discharged either into the surrounding pine forest or industrial harbour. The discharge water will be clean, natural groundwater not containing any pollutants. Construction activities for the GRS and NEL and EUGAL pipelines will not significantly impact groundwater levels (NEL feeder line construction only). The sandy, upper large scale aquifer will be affected only locally within the construction area.

#### **Traffic movements**

Traffic related to construction of the NSP2 landfall/PTA, GRS and NEL and EUGAL pipelines will follow the existing road network into the industrial area of Lubmin and will not add significantly to existing traffic volumes.

Construction related traffic for NSP2 will be managed through a TMP addressing the scheduling and routing of traffic loads for the construction phase both for the NSP2 project and the downstream facilities and will reflect the needs and sensitivities of the communities located along the shared section of respective routes to the work sites.

#### **14.3.9.2 Overall conclusion**

The impacts of NSP2 activities onshore for the construction and operation phases in combination with impacts associated with the construction and operation of the GRS and feeder pipelines are assessed as minor to moderate and not significant outside the construction area for airborne noise, air emissions and traffic disruption and safety, but high and significant for the change to landform, land use and land cover in relation to the receptors soil, air quality, terrestrial biotopes and landscape (material goods). This results in an overall minor cumulative impact if the surrounding character of the industrial park "Lubminer Heide" is considered and a moderate cumulative impact at the scale of the construction site.

## 14.4 Cumulative impact assessment - existing projects

Only existing projects which are considered to be of particular relevance to the assessment have been considered, the following criteria have been taken into consideration:

- For impacts to be cumulative they must be of the same nature or they must be stressors of the same receptor. Further, there must be both temporal and spatial overlap of the potential impacts.

The only project which is considered of particular relevance, and therefore included in this assessment, is the existing NSP, see Table 14-4.

**Table 14-4 Existing projects which in combination with the NSP2 project have the potential to result in cumulative impacts.**

Project	Distance from NSP2	Status	Activities
<b>Finland, Sweden, Denmark and Germany</b>			
Existing NSP	Parallel most of the way; except for crossings of the two pipeline systems, generally a distance of approx. 500 m to 1 km is kept.	In operation	Presence of the pipelines

For the project presented in Table 14-4 the following impacts have been identified as potentially cumulative due to their magnitude:

- Change in seabed profile/presence of the pipeline (operation);
- Release of contaminants from pipeline anodes (operation);
- Heat exchange between the pipelines and the surrounding environment (operation).

It should be noted that the existing NSP is part of the baseline and is only included in the current chapter as a response to issues raised in the consultation process to ensure transparency.

### 14.4.1 Existing pipeline – NSP

NSP runs approximately parallel to NSP2 for the majority of the route (not in Russia) and has been assessed with NSP2 for cumulative impacts in the Finnish, Danish, Swedish and German assessments. In Germany, the pipelines are buried and backfilled for most of the route.

#### 14.4.1.1 Assessment of potential cumulative impacts and receptors affected

##### **Change in seabed profile/presence of the pipeline (operation)**

###### *Bathymetry*

In areas where the pipeline is laid on the surface of the seabed or where it is buried but the trench is not backfilled, the presence of NSP and NSP2 form long-term impacts on the bathymetry of the seabed, as the pipelines themselves and the areas of rock placement and trenching represent a change from the original seabed.

Rock placement is used to create support structures where the seabed is uneven and where NSP2 crosses NSP. The support structures are of a relatively small spatial extent.

Trenching results in dispersion of the sediment from the trench to the sides of the trench. Although the trench is left open, monitoring of the installation of NSP showed that the impact on the bathymetry was not significant. Furthermore, monitoring of the trenching during construction of NSP revealed that no measurable physical effects on the seabed could be detected 25 m from the pipelines.

Pre-dredged trenches were backfilled by use of the excavated sediment. Hence, no permanent bathymetry changes remained along these trenches after construction. External inspection conducted up until 2016 revealed that the reinstated seabed remained stable during the first 5 years after construction. The only permanent impact is an alteration of sediment stratification within trenches. This impact does not affect the marine flora and fauna.

Based on the above, it is assessed that no significant cumulative impacts on the bathymetry will arise as a result of NSP in combination with NSP2.

#### *Hydrography*

Potential cumulative impacts on hydrography from NSP2 include changes in seabed topography and bathymetry, as well as changes to deep water current patterns resulting from changes in bathymetry.

The installation of the NSP2 pipelines creates a cumulative impact from a total of four pipelines. Since the pipeline routes do not pass through the Bornholm Strait or the Stolpe Channel, the main gateways for inflowing seawater to the Baltic Proper, there will be no hydraulic effect on the bulk flow.

Results from hydrographic monitoring of NSP substantiated with modelling for NSP2 suggest that the mixing caused by the pipelines is localised and within natural variations.

The cumulative impact on hydrography as a result of NSP in combination with NSP2 is therefore assessed to be not significant.

#### *Benthic flora and fauna*

Due to anoxic conditions and sediment types, there are no benthic flora (macro algae) in the deep water offshore sections of the pipeline; therefore only benthic fauna are discussed below.

The presence of the pipelines (a solid construction) on the seabed in soft bottom areas mainly consisting of mud and sand or areas with hard clay can be considered artificial reefs that may attract sessile organisms that otherwise are rare in the region. The introduction of new sessile species may potentially lead to local depletion of food or oxygen. However, due to anoxic conditions at deep parts of both the NSP and the NSP2 routes, benthic communities are very scarce. Moreover, the pipelines only occupy a negligible part of the total productive volume sustaining the ecosystem of the different regions of the Baltic Sea. Furthermore, the pipelines may function as vectors for different hard substrate benthic fauna types, including non-invasive species.

Based on the above, no significant cumulative impacts on benthic fauna are expected.

#### *Commercial fishery*

During operation, the presence of NSP2 will present a cumulative impact together with NSP, as there will be four pipelines relatively close to each other. The two twin sets of pipelines may cause cumulative impact to the commercial fishery in the area as a larger zone can be considered a risk zone.

Particularly in areas where the pipelines are in free span, commercial fishing vessels will need to observe the same precautions for the new pipelines as for the NSP pipelines. There will, however, be no restrictions on mid-water trawling, which is the dominating form of commercial fishery in the regions with freespan sections. In areas where the pipeline is more or less embedded, experiences from NSP show that the fishing industry can co-exist with the pipeline. So far no gear has been reported lost or damaged. Natural embedment (and post-lay trenching) of the pipeline has in fact in most locations, depending on the seabed conditions, significantly reduced the risk and hassle for bottom trawling activities.

Based on the above, no significant cumulative impacts on commercial fishery are expected.

### **Release of contaminants from pipeline anodes (operation)**

#### *Water quality*

The release of zinc and other metals from the anodes during the lifetime of the pipelines will not result in general increases of the concentration of these metals in seawater or on the seabed, apart from a few meters around the pipelines.

Zinc and aluminium released from anodes will accumulate in the close vicinity of the pipelines when covered by sediment. The arising chemical compounds ( $ZnS$ ,  $Al(OH)_3$ ), generated under anoxic conditions, are basically inert and not bio-active.

Where NSP2 crosses NSP, there is a potential for multiple anodes to be located in close proximity to one another. However, due to dilution, elevated concentrations of metals will be localised to the area around the crossing, and it is assessed that the combined impact from the two pipelines will be negligible.

Due to the very localised impact, no cumulative impacts from release of contaminants from pipeline anodes are anticipated.

### **Heat exchange between the pipelines and the surrounding environment (operation)**

Heating/cooling impacts do occur at the landfalls in the vicinity of pipeline sections installed in covered trenches. Monitoring in Germany for NSP and modelling for NSP2 revealed that a sediment temperature deviation of  $>1^{\circ}K$  would be restricted to 1 m on top of the pipeline only. Hence, no cumulative impacts will result.



## 14.5 Summary of cumulative impacts

The potential cumulative impacts for planned and existing projects with the NSP2 project are summarised in Table 14-5.

**Table 14-5 Assessment of the cumulative impacts during construction and operation of NSP2.**

Planned and existing projects	Project	RU section	FI section	SE section	DK section	GE section	Trans
Upstream facilities and Ust Luga Port developments (Russia)			-	-	-	-	No
Balticconnector (Finland)		-		-	-	-	No
Midsjö Bank Wind Farm (Sweden)		-	-		-	-	No
Extraction Southern Midsjö Bank (Poland)		-	-		-	-	No
Extraction South of Bornholm (Denmark)		-	-	-		-	No
Bornholm Wind Farm (Denmark)		-	-	-		-	No
50Herz Transmissions GmbH (Germany)		-	-	-	-		No
Downstream GRS and feeder lines (Germany)							No
Existing pipeline (NSP)		-					No
<b>Impact ranking:</b>		<b>Negligible</b>	<b>Minor</b>	<b>Moderate</b>	<b>Major</b>		

## 14.6 Projects excluded from further assessment

Planned marine cables are excluded from the assessments as the only impact during both the construction and operation phases would be increased vessel traffic with associated impacts such as emissions and airborne and underwater noise, and such impacts have already been generally assessed for NSP2.

Cable crossings will not cause cumulative impacts on any receptors.

## 15. TRANSBOUNDARY IMPACTS

### 15.1 Introduction

The key objective of an EIA in a transboundary context is the assessment and communication of transboundary impacts. The Espoo Convention defines a transboundary impact as:

*"...any impact, not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party."*

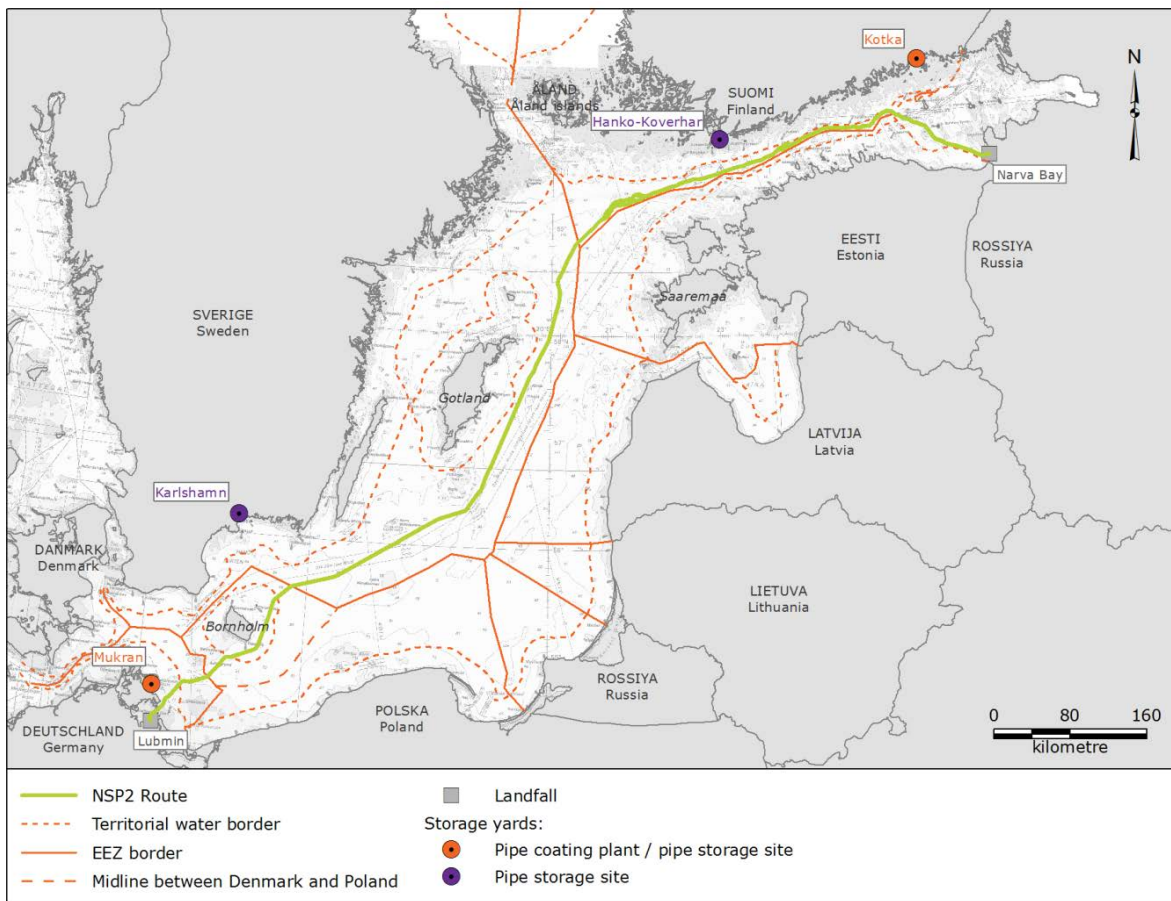
The Convention obliges signatory states to notify and consult one another on all projects in their territory that are likely to have significant adverse transboundary environmental impacts. The Convention defines the country in which the proposed activity takes place as the "Party of Origin" (PoO) and the countries that are impacted as each an "Affected Party" (AP). For transnational linear developments, such as transnational pipelines, there will be more than one PoO and countries that are PoOs will also (where they experience impacts from a project related activity or event occurring in another PoO country) be APs.

In the case of NSP2, the twin pipelines will pass through the EEZ and/or TW of Russia, Finland, Sweden, Denmark and Germany, hence each of these countries is a PoO under the terms of the Convention. Russia has signed but not ratified the Convention but for the purposes of the Espoo Report is designated as a PoO. Russia will participate in the NSP2 Espoo consultation process as a PoO to the extent possible under its legislation. The other littoral countries of the Baltic Sea, i.e. Estonia, Latvia, Lithuania and Poland are each an AP, as are Russia, Finland, Sweden, Denmark and Germany since these five countries will each be subjected to impacts from project related activities and events that are initiated in one or more of the other countries through which the pipelines will pass.

The PoO countries and AP countries, irrespective of whether they have ratified the Convention, are detailed in Table 15-1 and the proposed NSP2 route and the EEZ boundaries and TW limits of the PoO countries and AP countries are depicted in Figure 15-1.

**Table 15-1 Country designations.**

Designation used in the report	Applicable countries
PoO	Russia, Finland, Sweden, Denmark and Germany
AP	Russia, Finland, Sweden, Denmark, Germany, Estonia, Latvia, Lithuania and Poland



**Figure 15-1 The proposed NSP2 route and the EEZ boundaries and TW limits of the PoO countries and AP countries.**

In order to enable a more accurate understanding of the proximity of the proposed NSP2 route to the countries that are only APs (i.e. not also PoOs), Table 15-2 provides an overview of the shortest distance from the proposed NSP2 route to the EEZ borders or midline of the only AP countries.

**Table 15-2 Proximity of NSP2 route to EEZ borders (or national midline) of the only AP countries.**

	Estonia	Latvia	Lithuania	Poland
Shortest distance between NSP2 route and the EEZ border or midline of only AP countries	1.5 km	25.3 km	45.7 km	11 km

Following this introduction this chapter is structured as follows:

- Section 15.2: Method for assessment of transboundary impacts;
- Section 15.3: Regional or global transboundary assessment;
- Section 15.4: Transboundary impacts from planned activities;
- Section 15.5: Transboundary impacts from unplanned (accidental) events;
- Section 15.6: Conclusion and summary of all impacts from PoO countries on AP countries.

Within Section 15.4, transboundary impacts on each AP country are summarised in a tabular format in terms of their origin (PoO country). Each table itemises the impacts originating from the PoO country concerned and their impact on the AP countries. Summarising transboundary impacts in this manner allows the reader to easily determine the origin of each transboundary impact, their significance and whether they will affect a specific AP country or not.

## 15.2 Method for assessment of transboundary impacts

### 15.2.1 General approach

The assessment of transboundary impacts draws extensively upon the findings of the impact assessment presented in Chapter 10 – Assessment of environmental impacts, which was performed in line with the impact assessment methodology presented in Chapter 7 – Method adopted for production of Espoo environmental assessment documentation. All planned activities relating to the project, along the entire pipelines' length, during the construction and operation phases, have been examined for their potential to give rise to any transboundary impacts.

The method adopted first undertook an assessment of the potential for transboundary impacts to occur on physical and chemical receptors (as they define the conditions which may then affect the biological and socio-economic environment). Where transboundary impacts on the physical and/or chemical receptors have been assessed to be negligible or not occur (i.e. "no impact"), there is considered to be no potential for significant transboundary impacts on biological or socio-economic receptors. Where this is the case, potential indirect impacts on these biological and social economic receptors have thus been scoped out from further consideration. Where impacts on physical and/or chemical receptors have been assessed to be minor or above, the potential indirect impacts on biological (i.e. plankton, benthic flora and fauna, fish, mammals and birds) or socio-economic receptors have been assessed. The only exception to adopting this sequential approach to assessment relates to underwater noise generation, which has the potential to have direct impacts on biological receptors and therefore has been automatically scoped in for further consideration.

Transboundary impacts resulting from potential unplanned (accidental) events are described in Chapter 13 – Risk assessment and summarised in Section 15.5. Given that activities during the decommissioning phase are uncertain, as the decommissioning programme will be developed during the operation phase, transboundary impacts during the decommissioning phase are not specifically covered in this chapter. However, it is noted that regardless of the decommissioning option chosen (see Chapter 12 – Decommissioning), the potential for transboundary impacts will be similar in nature to those described within this chapter.

### 15.2.2 Classification of transboundary impact

Transboundary impacts from planned activities have been grouped into two categories:

- Those that occur where each pipeline crosses the EEZ boundary between two PoO countries, termed "back-to-back" impacts. Back-to-back impacts result from planned project activities, such as anchor handling and pipe-lay, that are carried out at, or in the immediate vicinity (within 500 m on either side) of the point where each pipeline crosses the EEZ boundary between two PoO countries. These impacts are generally a result of progressive works along the pipeline route or the physical presence of the pipelines across an EEZ boundary, and are anticipated to be identical or very similar in each of the two bordering EEZs; and
- Those that do not fall into this category (i.e. those that occur elsewhere along the pipeline route but are transboundary due to their respective "scale" and the proximity of the pipelines to EEZ boundaries). These in turn can be classified into two subcategories i.e. those that may affect receptors with consequences most relevant at individual national scales, or alternatively those where the consequences are most relevant at a regional or global scale, e.g. changes in greenhouse gas levels.

Back-to-back transboundary impacts have been adequately covered in Chapter 10 – Assessment of environmental impacts and as a result, they are not discussed further in this section. Where impacts may affect receptors at a regional or global scale, these have been assessed in Section 15.3, whilst the remainder of potential transboundary impacts are assessed for each AP in Section 15.4.

Transboundary impacts arising from potential unplanned (accidental) events are discussed in Section 15.5.

#### 15.2.2.1 Identification of potential transboundary impacts

Transboundary impacts associated with the NSP2 construction and operation phases may result from planned activities, including munitions clearance and seabed intervention works (dredging, post-lay trenching and rock placement), and from unplanned (accidental) events.

The assessments in Chapter 10 – Assessment of environmental impacts have identified sources of impact that may be transboundary in nature as a result of planned activities and thus require further consideration. In order to qualify for such consideration a source of impact must be of a scale that indicates that it could extend across a boundary into the territory of another country.

The identified such sources of impact that may result in a transboundary impact as identified in Chapter 10 – Assessment of environmental impacts comprise:

- Release of sediments to the water column;
- Release of contaminants and/or nutrients to the water column;
- Sedimentation on the seabed;
- Generation of underwater noise;
- Physical changes to seabed features (natural and man-made features);
- Safety zones around vessels (construction and operation)
- Presence of pipeline structures on the seabed; and
- Emissions of air pollutants and GHGs.

The first four sources of impact (release of sediments to the water column, release of contaminants and/or nutrients to the water column, sedimentation on the seabed, generation of underwater noise) are assessed for each AP. An overview of each of these sources of impact is provided in Section 15.4.1 with a summary of the project activities giving rise to them, their key propagation characteristics and temporal duration.

The latter four sources of impact (physical changes to seabed features, safety zones around vessels, presence of pipeline structures on the seabed, emissions of air pollutants and GHGs) are potentially affecting receptors on a regional or global scale and are assessed in Section 15.3 only.

### 15.3 Regional or global transboundary assessment

Receptors which require assessment at a regional or global scale, as opposed to on a national level, due to their categorisation as global or regional issues, comprise:

- Climate – given that greenhouse gas emissions are a global concern;
- Hydrography – given that the major Baltic inflows influence the conditions in the Baltic Sea as a whole;
- Shipping and ship traffic – given that the Baltic Sea is of regional/global importance to cargo transportation;
- Commercial fisheries – given that the Baltic Sea is of regional importance to commercial fishing activities;
- Existing and planned infrastructure – given that the interconnection of Baltic Sea countries via e.g. communications and power cables is of regional importance;
- Marine biodiversity – given that the biodiversity of the Baltic Sea is influenced by regional pressures and is of regional and global importance;
- Marine spatial planning – given that the Maritime Spatial Planning Directive (and related EU Directives) requires countries to cooperate at a regional scale to protect and create a framework for the sustainable use of marine waters in the Baltic Sea;

- Natura 2000 sites – due to the requirement to maintain the coherence and functioning of the Natura 2000 network as well as the integrity of individual Natura 2000 sites.

A transboundary assessment has been undertaken with respect to these regional or global receptors and is reported in Table 15-3 below.

**Table 15-3 Regional/global transboundary assessment.**

Regional/global receptors	Potential source of impact	Regional/global transboundary assessment
Climate	Emissions of GHGs	<p>The total emissions generated by NSP2 are assessed in Section 10.2.3. Only marine emissions are considered to have the potential for transboundary impacts.</p> <p>Assuming an even distribution of GHG (primarily CO<sub>2</sub>) emissions during the construction period of two years, NSP2 marine emissions will temporarily increase the total annual emission of CO<sub>2</sub> from vessels in the Baltic Sea by approximately 4%. Although CO<sub>2</sub> emissions in general have an impact at a global scale, the increased emission during the construction period of NSP2 is not anticipated to have a quantifiable impact on global climate.</p> <p>Given that total emissions of GHGs during the operation phase are substantially smaller than the total emissions from the construction phase, the impacts will also be of a smaller magnitude and therefore have not been assessed.</p> <p>In conclusion, the regional or global transboundary impacts on climate caused by GHG emissions will be <b>negligible</b>.</p>
Hydrography	Presence of pipeline structures on the seabed	<p>The marine environment in the Baltic Sea is heavily dependent on the rare, major inflows of saline water through the Danish Straits, as these are essentially the only means of water exchange in the deep parts of the basins in the Baltic Proper. It is therefore essential to ensure that the inflow of oxygenated deep water to the inner parts of the Baltic Sea via the Bornholm Basin is not negatively affected by the presence of NSP2.</p> <p>Since the NSP pipeline as well as the proposed NSP2 route do not pass through the Bornholm Strait or the Stolpe Channel, the main gateways for inflowing seawater to the Baltic Proper, there will be no hydraulic effect on the bulk flow. Increased mixing caused by NSP2 in combination with NSP may marginally increase the flushing of the deep water in the Baltic Proper which will somewhat improve the oxygen conditions and has the potential to decrease the area of anoxic bottoms. However, changes would be of such a low magnitude that based on modelling, it is concluded that the impact of the presence of NSP2 pipelines (in combination with baseline conditions, including NSP) on the hydrography in the Baltic Proper will be limited.</p> <p>In conclusion, the regional transboundary impacts on the Baltic Sea hydrography caused by the presence of the pipelines on the seabed will be <b>negligible</b>.</p>
Ship traffic	Safety zones around vessels (construction and operation)	<p>Safety zones around construction vessels and around inspection/maintenance vessels in the operation phase impose restrictions on ship traffic where the NSP2 route crosses or runs parallel to shipping lanes.</p> <p>During construction, the safety zones that will be imposed around construction vessels will be in the order of 3 km for an anchored lay barge, 2 km for a DP</p>

Regional/global receptors	Potential source of impact	Regional/global transboundary assessment
		<p>pipe-lay vessel, and 500 m for other vessels. During operation there may be some presence of vessels associated with inspection or maintenance with a safety zone of 500 m. However, the presence of these vessels will be very short, due the speed of movement/short presence of such vessels at any specific site. Hence impacts will be of short duration and of limited spatial extent at any specific location. NSP2 will, in conjunction with relevant construction contractors and authorities, announce the locations of the vessels and the extent of the requested safety zones through Notices to Mariners so that third party vessels can navigate around the safety zones. The width of the shipping lanes is sufficient for ships to safely navigate around the safety zone. This is confirmed by the experience during construction and operation of NSP.</p> <p>In conclusion, the regional transboundary impacts on ship traffic caused by the safety zones around vessels will be <b>negligible</b>.</p>
Commercial fisheries	<p>Safety zones around vessels (construction and operation)</p> <p>Presence of pipeline structures on the seabed</p>	<p>Fishermen of any AP may be fishing in the EEZ and, subject to bilateral agreements, TW of any PoO. The presence of construction vessels and safety zones around these vessels is assessed as having no transboundary impact on fishery since this impact is local and short-term (refer to Section 10.9.4). The presence of pipeline structures on the seabed can hinder fishery in two ways:</p> <ul style="list-style-type: none"> <li>- In smooth seabed areas where the pipelines are exposed on the seabed there is a potential for bottom trawl gear to get stuck if the approach angle to the pipelines is less than 15 degrees. In these areas fishermen will need to ensure their trawl gear crosses the pipelines at a steep angle. This could lead to fishermen having to adapt their trawl patterns.</li> <li>- In uneven seabed areas where there are freespanning sections of the pipelines, there is a potential of trawl gear getting hooked between the seabed and the pipeline. This could lead to fishermen avoiding fishing over the pipelines for safety reasons.</li> </ul> <p>In smooth seabed areas, experience from NSP has shown that the pipelines are embedded at least 50% for the majority of the route. Such experience has also demonstrated that fishermen can coexist with the pipelines since fishery patterns have not changed since installation of the pipelines and no fishery gear has been reported lost or damaged. Hence only very limited effects on fishery patterns and bottom trawling performed in smooth seabed areas may be anticipated from NSP2. Pelagic trawlers will be able to avoid the pipelines by allowing sufficient distance between the pipelines and the towed net.</p> <p>In uneven seabed areas, which along the NSP2 route occur mainly in the Gulf of Finland, bottom trawling is not practiced due to the nature of the main target species and the uneven seabed. The prevailing trawling method in this area is mid-water trawling so that only under certain circumstances (e.g. when setting out the trawl, when turning the vessel or accidentally) could the mid-water trawl make contact with a freespanning section of the pipeline. Hence there is only very limited likelihood for NSP2 to impact fisheries performed in uneven seabed areas.</p> <p>In conclusion, the regional transboundary impacts on fishery caused by the presence of pipelines on the seabed will be <b>negligible to minor at most</b>.</p>
Existing and planned	Physical changes to	Existing and planned infrastructure, e.g. power cables and communications cables, runs between various Baltic Sea countries. Since several of the owners

Regional/global receptors	Potential source of impact	Regional/global transboundary assessment
infrastructure	<p>seabed features (natural and man-made features)</p> <p>Presence of pipeline structures on the seabed</p>	<p>of, and customers for, the services provided by the subsea cables are located in countries other than where a source of impact (e.g. severing of cables) may occur, and could thus be affected by the resulting impact (e.g. damage or loss of service), there is potential for transboundary impacts of regional importance. As described in Section 9.10.8, NSP2 will cross many existing cables, the NSP pipelines and potentially additional cables and an additional pipeline that are currently being planned. Without appropriate planning the NSP2 construction activities on the seabed could damage such infrastructure. Nord Stream 2 AG will develop and adhere to crossing and/or proximity agreements between NSP2 and the relevant subsea cable and pipeline owners. In these agreements, the crossing methods and precautionary measures required during construction will be agreed on a case by case basis. Therefore, the impact during construction on existing infrastructure and those reliant on it (including in countries other than where any damage occurs) will be negligible. This is supported by experience from NSP for which no damage to third-party infrastructure was reported during its construction.</p> <p>The presence of the NSP2 pipelines on the seabed could constrain construction of future infrastructure on the seabed. However, NSP2 does not prevent any infrastructure to be constructed; it would rather only require consultations where work is performed within 300 – 500 m of NSP2 to agree on the technical methods and certain precautionary measures. It is therefore assessed that NSP2 does not prevent any future projects but will have to be taken into account in the planning of future projects that would be constructed within 300 – 500 m of NSP2.</p> <p>In conclusion, the regional transboundary impacts on existing and planned infrastructure caused by NSP2 will be <b>negligible</b>.</p>
Marine Biodiversity	<p>Release of sediments to water column</p> <p>Generation of underwater noise</p>	<p>Impacts arising from NSP2 have the potential to result in the loss of or change to composition of the functional groups/key flora or fauna species, which underpin the marine biodiversity of the Baltic Sea, as well as represent various trophic levels of the food web (e.g. plankton, which are the first level of the food web). In particular, generation of noise (particularly in Finland and Russia due to munitions clearance) has the potential to impact individual marine mammals which are protected under Annex II and IV of the Habitats Directive, as well as top predators within the food web. However, as demonstrated within Chapter 10 – Assessment of environmental impacts, impacts on the lower trophic levels would overall be local, temporary and assessed not to be significant; whilst impacts on the higher trophic levels would be limited to a few individuals and will not have an influence on the ecological functionality of the species. All other links within the food web would not experience any significant impacts, and it is therefore assessed that NSP2 will not have a significant impact on the biodiversity of the Baltic Sea.</p> <p>In conclusion, the regional transboundary impacts on biodiversity caused by NSP2 will be <b>negligible</b>.</p>
Marine Spatial Planning		<p>There are a number of EU legislative tools designed to protect the marine environment and create a framework for the sustainable use of marine waters in the Baltic Sea. These include the MSFD and WFD which are applicable to all EU member states. The BSAP is also relevant to the area impacted by NSP2 and is relevant to all PoOs and APs.</p>



Regional/global receptors	Potential source of impact	Regional/global transboundary assessment
		<p>Although there is the potential for underwater noise generated by munitions clearance in Finland and Russia to extend across national borders into Estonia, Finland and Russia, the impulsive noise will be short-term with no long-term detrimental impacts to the ecosystem predicted. No other potentially significant transboundary impacts which have the potential to affect compliance with the EU Directives are predicted. Therefore NSP2 will not prevent any EU Baltic State from achieving GES for any MSFD descriptors or WFD. Furthermore, NSP2 will not prevent any of the PoOs or APs from reaching the targets set out in the BSAP.</p>
Natura 2000 sites	Various	<p>As well as being important at the individual level, Natura 2000 sites together form a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types. When considering impacts on such sites it is thus necessary to ensure that the sites are safeguarded at both the individual and network levels to ensure the coherence and functioning of the overall network is maintained. Such a network in relation to NSP2 covers the Baltic Sea and is hence transboundary and regional in nature.</p> <p>The potential for existing or proposed Natura 2000 sites to be impacted by NSP2 is being considered within the various national EIAs/ES with the findings to date reported in Section 10.6.6. Based on the assessments undertaken to date there is limited potential for individual sites to be affected by NSP2, and hence also for the overall network coherence and functioning, to be affected. Additional Natura 2000 assessments and studies will be performed during the NSP2 permitting phase. Should these identify the potential for significant effects at the site level, their results and any proposed mitigation measures will be used to evaluate whether there is any potential for impacts on network coherence or functioning. The result of such assessments and evaluations will be provided to the relevant authorities as part of the permitting process to inform their decision.</p>

## 15.4 Transboundary impacts from planned activities

This section provides an overview of the first four sources of transboundary impact as stated in Section 15.2, with a summary of the project activities giving rise to them and their key propagation characteristics.

### 15.4.1 Overview of sources of transboundary impact

#### 15.4.1.1 Release of sediments to the water column

Munitions clearance and seabed intervention works (rock placement, post-lay trenching and dredging) will disrupt the seabed, which will lead to the suspension of sediments potentially increasing the SSCs within the seawater. An assessment of the release of sediment to the water column during construction is provided in Section 10.2.2.1. Details of the modelling carried out to support this assessment is documented in Section 10.1.2 and Appendix 3, and results are presented in the Atlas Map MO-01-Espoo to MO-07-Espoo. This analysis identified that only dredging in Russian waters, munitions clearance in Russian and Finnish waters and rock placement in Finnish and Russian waters have the potential to cause transboundary impacts. Impacts from other NSP2 activities including post-lay trenching in Swedish and Danish waters and rock placement in German, Swedish and Danish waters are proposed at a sufficient distance from neighbouring EEZs that no transboundary impacts are anticipated.

Of the above activities, dredging at the landfalls in nearshore Russian and German waters will result in the greatest increase in SSC for the longest periods of time and largest spatial extent. From the Russian dredging site, the suspended sediment plume will extend mostly northwards along the western shore of the Kurgalsky Peninsula, although for limited periods it may extend south, up to 12 km into Estonian waters (see Atlas Map MO-02-Espoo). No transboundary impacts will occur from dredging activities at the German landfall due to the enclosed conditions rendered by the bay and the distance of dredging activities in the Pomeranian Bay from the nearest country border (see Atlas Map MO-07-Espoo).

The spatial extent where elevated SSCs from munitions clearance and rock placement may be experienced is considerably lower than that predicted for dredging, with concentrations above 10 mg/l generally only in the vicinity of the activity (see Atlas Map MO-01-Espoo to MO-03-Espoo).

It is noted that the model results show that in the majority of areas where increases in SSCs will occur, levels will be within natural variations, as experienced e.g. during storm events (see Section 10.1.2). Further, the released sediments will typically be restricted to the lower 10 m of the water column, where, in offshore sections of the route, potential impacts are limited due the presence of the halocline limiting sediment spread into the euphotic zone.

#### **15.4.1.2 Release of contaminants and/or nutrients to the water column**

Munitions clearance and seabed intervention works (rock placement, post-lay trenching and dredging) will disrupt the seabed and release sediment to the water column. Any contaminants such as PAH (benzo(a)pyrene), dioxins/furans and zinc present within the sediment may also be re-suspended in the water column for a short period. Details of the modelling carried out can be found in Section 10.1.2 and Appendix 3 with key results being presented in Section 10.2.2.2 and the Atlas Map MO-04-Espoo and MO-05-Espoo. This analysis identified that dredging, munitions clearance and potentially rock placement in Russia and Finland (where higher concentrations of contaminants have been recorded in the sediments and greater sediment spread is expected) may have the potential to cause transboundary impacts. Contaminants in the sediment in Germany are of such a low level and dredging activities sufficiently distant from EEZ boundaries that no transboundary impacts are anticipated.

Post-lay trenching and rock placement in Sweden and Denmark are proposed at a sufficient distance from neighbouring EEZs and are limited in spatial extent such that that no transboundary impacts are anticipated.

Although NSP2 activities are planned in close proximity to the chemical munitions dumping site in Denmark, remobilization and redistribution of CWA will be limited to the close vicinity of the proposed pipelines (see Sections 10.2.2.2 and 10.13). Therefore, due to the large distance between the locations of seabed intervention works in Denmark and the nearest country borders, no transboundary impacts due to CWA spreading are anticipated.

#### **15.4.1.3 Sedimentation on the seabed**

Munitions clearance and seabed intervention works (rock placement, post-lay trenching and dredging) will disrupt the seabed, which will lead to the re-suspension and dispersion of sediments that will later resettle on the seabed. Details of the modelling carried out can be found in Section 10.1.2 and Appendix 3. Dredging in Russia has been identified as having the greatest potential to cause transboundary impacts. No transboundary impacts will occur from dredging activities at the German landfall due to the enclosed conditions rendered by the bay area and the long distance between the locations of the planned dredging site in the Pomeranian Bay and the nearest country border.

The spatial extent of the sedimentation from munitions clearance and rock placement in Russia and Finland is considerably lower than that predicted for dredging, but could nonetheless spread, be it to a small extent across national borders should such activities be undertaken very close to

them. Impacts from post-lay trenching and rock placement in Sweden and Denmark are proposed at a sufficient distance from neighbouring EEZs that no transboundary impacts are anticipated.

#### 15.4.1.4 Generation of underwater noise

Underwater noise will be generated by a range of NSP2 construction activities (rock placement, post-lay trenching, pipe-lay, anchor handling, construction vessel movements and munitions clearance) of which munitions clearance will be by far the loudest. Details of the modelling carried out can be found in Section 10.1.3 and Appendix 3. Results are presented in Atlas Map UN-01-Espoo to UN-05-Espoo. An analysis of these results indicates that underwater noise from munitions clearance in Russian and Finnish waters have the potential to cause transboundary impacts relating to blast injury, risk of onset of temporary and/or permanent hearing loss.

Noise predictions for munitions clearance, which may take place in Russia and Finland, show that the threshold for impacts (injury) on fish in the worst case is exceeded up to 1.5 km from the munitions detonation site, while those for marine mammals (risk of onset of temporary hearing loss) may be exceeded up to 44-60 km (maximum size charge) and 26 km (average size charge) from the detonation site. The equivalent maximum distances for risk of onset of permanent hearing loss in marine mammals are 23 km (maximum size charge) and 5 km (average size charge).

Threshold distances for “moderately severe blast injuries” are less than 1 km and about 2.8 km respectively for marine mammals at the surface and underwater at depth (40 m). The category “moderately severe blast injuries” covers non-trivial, but survivable injuries, where animals are considered able to recover on their own.

Although elevated noise levels may be experienced at a greater distance (which could cause behavioural changes or masking<sup>63</sup>), these will generally be comparable to background noise levels in the Baltic Sea and therefore do not have the potential to cause significant transboundary impacts.

Noise from rock placement also has the potential to cause transboundary impacts relating to onset of temporary hearing loss where it occurs within immediate vicinity of a country border (i.e. within 100 m). As for munitions clearance described above elevated noise levels may be experienced at a greater distance (which could cause behavioural changes or masking), these will generally be comparable to background noise levels in the Baltic Sea and therefore do not have the potential to cause significant transboundary impacts (e.g. in Sweden, noise from rock placement may extend into Estonia, which is located 5 - 25 km from the proposed NSP2 route, however noise levels would have reduced to such a level that no significant transboundary impacts related to behaviour have been identified.

Underwater noise from all other project activities will, beyond the immediate vicinity of the noise generating activity, generally be indistinguishable from background noise levels in the Baltic Sea and therefore do not have the potential to cause significant transboundary impacts.

#### 15.4.2 Assessment of potential transboundary impacts by Affected Party

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<sup>63</sup> Masking is the phenomenon whereby noise can negatively affect the ability of a species to detect and identify other sounds, e.g. from prey or communication between individuals within a species. In order to produce a masking effect the noise must be audible, roughly coincide with the masked sound levels and have energy in roughly the same frequency band as the masked sound. As the current level of knowledge about conditions where masking occur and how masking affects short-term and long-term survival of individuals is limited, it is not possible to assess masking.

#### 15.4.2.1 Assessment of potential transboundary environmental impacts on Russia

Although NSP2 will cross the border between Russian waters and the Finnish EEZ<sup>64</sup>, other than at this point, its alignment will not run close to the boundary of other PoOs. The only exception is in regard to the EEZ border of the Kaliningrad region, which shares a boundary with the Swedish EEZ. However, the proposed NSP2 route will be located more than 50 km away from the Russian-Swedish boundary and therefore no potential for transboundary impacts has been identified. Hence any potential for transboundary impacts from activities in PoOs into Russian waters will be restricted to the vicinity of the Russian-Finnish boundary crossing.

All four country specific sources of transboundary impact listed in Section 15.2 were identified in Chapter 10 – Assessment of environmental impacts as having the potential to give rise to transboundary, country specific impacts in Russian waters. They are therefore considered below and the results summarised in Table 15-4.

##### Release of sediments to the water column

Releases of sediments to the water column in Finnish waters from the following activities have the potential to generate transboundary impacts on receptors in Russian waters:

- Munitions clearance (Finland).

No dredging or post-lay trenching will occur in Finnish waters. Although rock placement will be required for the crossing structure between NSP and NSP2 in Finnish waters approximately 0.7–1.1 km east of the border with Russia, the modelling results (under rough weather conditions) indicate that the area where increases in SSCs may be experienced as a result of this activity will extend largely to the north in Finnish waters and will not extend into Russian waters.

##### *Munitions clearance (Finland)*

Based on the munitions density experienced during NSP it is considered unlikely that munitions will be encountered close to the Finnish/Russian border (see Atlas Map MU-01-Espoo). However, in the event that clearance is required in this location, modelling (under worst case scenario weather conditions) from a site close to the Russian border predicts that increases of SSCs of up to 5 mg/l could extend approximately 2 km into Russian waters, with higher concentrations (up to 25 mg/l) extending less than 1 km (Figure 15-2). Such increases would be confined to the lower part of the water column and levels would revert to pre-detonation conditions within hours of the detonation event (see Map Atlas MO-03-Espoo).

The magnitude of any transboundary impact on seawater quality is therefore considered to be negligible resulting a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in significant impact on the biotic environment.

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<sup>64</sup> The EEZ boundary between Russia and Finland coincides with the TW boundary of Russia.

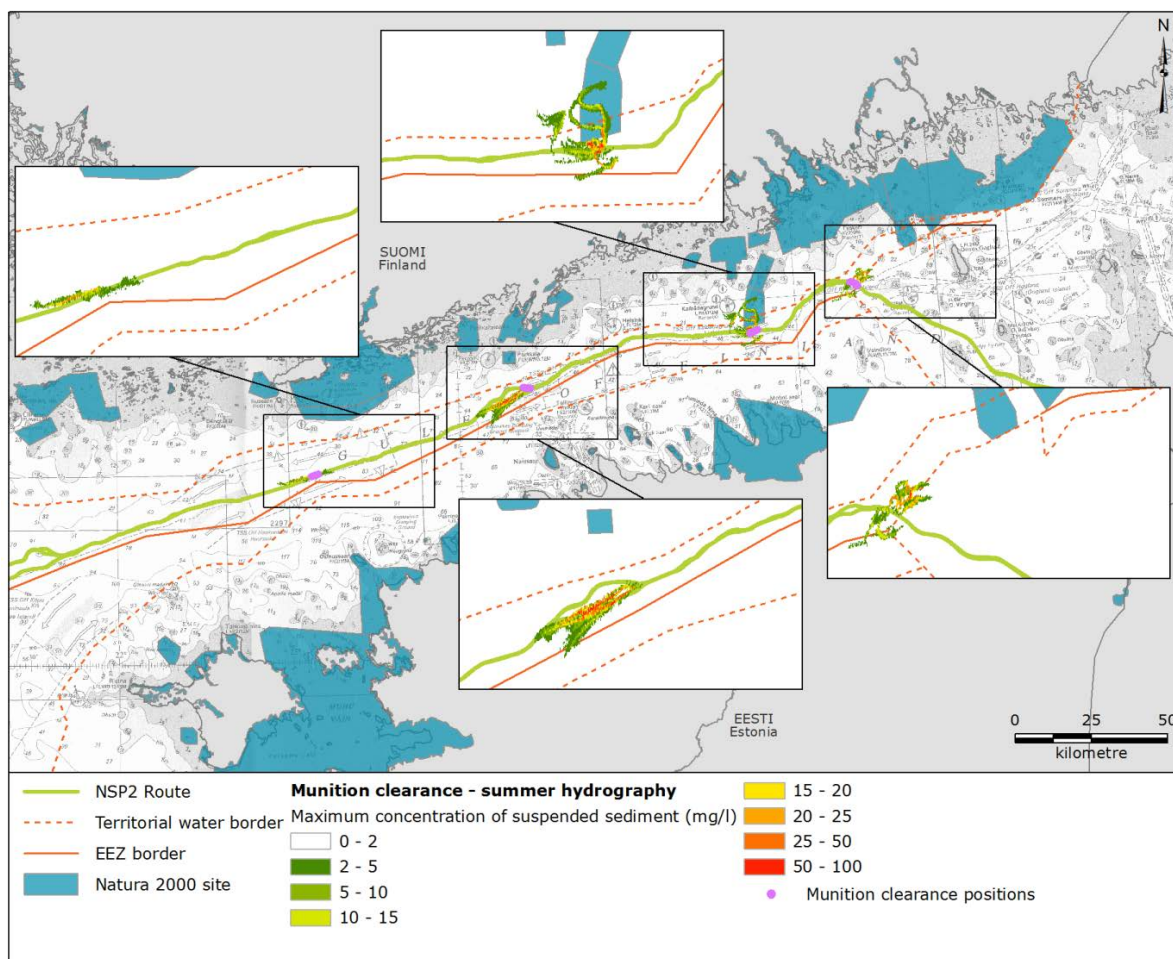


Figure 15-2 Maximum concentration of suspended sediment for munitions clearance in Finland, close to the border between Russia and Finland.

### Release of contaminants and/or nutrients to the water column

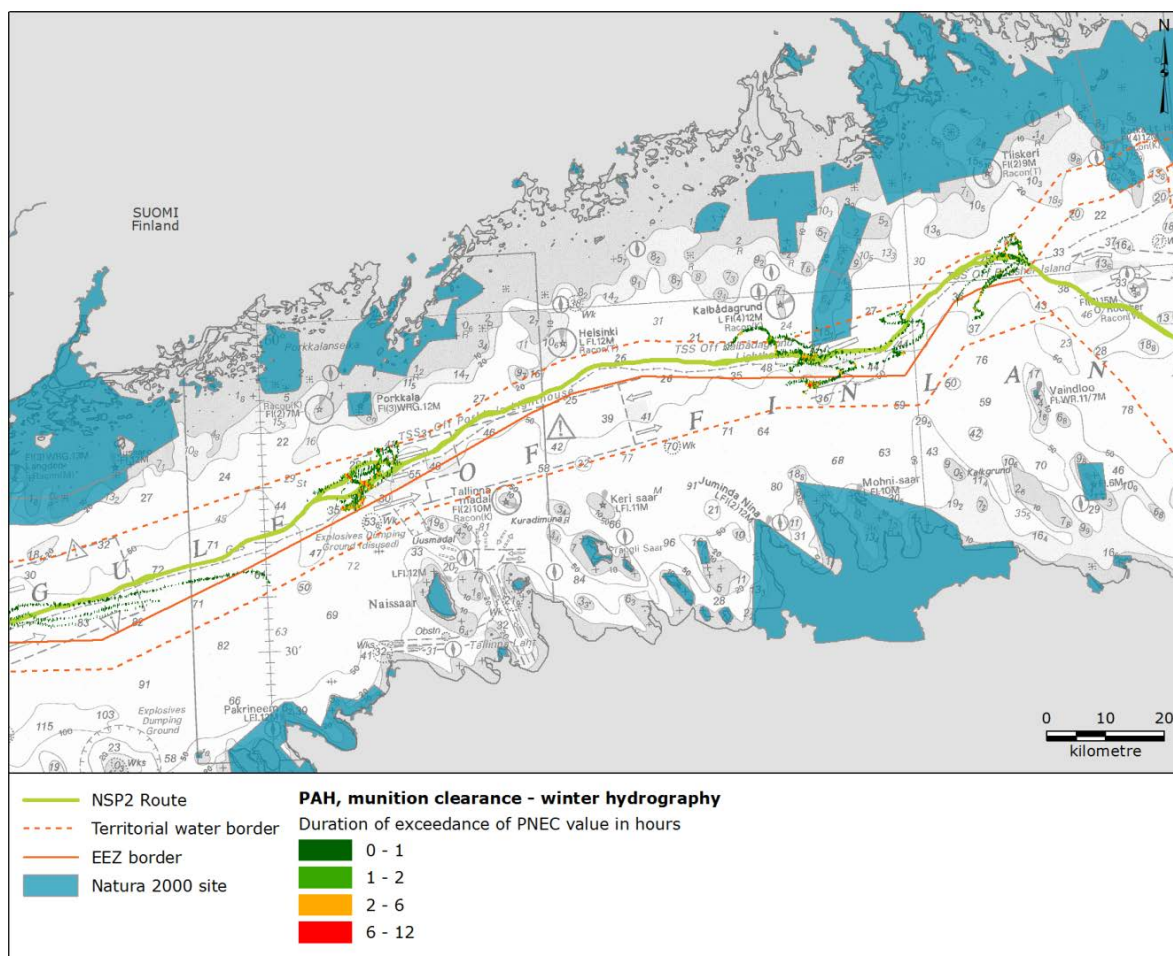
As releases of contaminants and/or nutrients to the water column are associated with mobilisation of sediments that may contain them, such releases may result from the same activities as described above in relation to release of sediment, i.e.:

- Munitions clearance (Finland).

As demonstrated above, since there will be no potential for a transboundary increase in suspended sediment concentrations in Russian waters from rock placement in Finland, there will be no potential for transboundary impacts relating to the release of contaminant and nutrients in water column.

#### *Munitions clearance (Finland)*

As described above, it is considered unlikely that munitions will be encountered close to the Finnish/Russian border. Modelling results (Appendix 3) shown in Figure 15-3 indicate that should detonation of munitions be required in Finland close to the Russian border, some exceedance of the PNEC value for PAH may occur in its vicinity (please note that the current modelling does not show any transboundary impacts into Russia), although the duration of such an event would be for a maximum of 6 hours. Due to the prevailing currents in these areas such exceedances are unlikely to cross into Russian waters. However, should this occur, as the PNEC value represents a 'no effect level' and not an acute toxic concentration level, such a short-term exceedance is considered to have a negligible impact magnitude on seawater quality and hence a **negligible** impact ranking. Any changes in seawater quality are thus insufficient to give rise to significant transboundary impacts on the biotic environment.



**Figure 15-3** Duration of exceedance of the PNEC value for PAH, i.e. worst case of all the modelled contaminants (PAH is the worst case). (Note that the EEZ boundary between Russia and Finland follows the TW border).

### Sedimentation on the seabed

The following activities in Finnish waters could result in sedimentation on the seabed in Russian waters:

- Munitions clearance (Finland).

As described above, any increase in SSCs from rock placement close to the Finnish/Russian border will not be transboundary in nature. Based on modelling, no transboundary impacts associated with sedimentation on the seabed from rock placement in Finland are anticipated in Russia.

#### *Munitions clearance (Finland)*

Based on the low level of any increase in SSCs that could be experienced in Russian waters from munitions clearance in Finland and Russia, described above, any increase in sediment depth associated with the settlement of such suspended material will be minimal resulting in a negligible impact magnitude and hence a **negligible** impact ranking. Any change in the levels of sedimentation would thus be insufficient to result in transboundary impacts on the biotic environment.

### Generation of underwater noise

The generation of underwater noise in Finnish waters has potential to result in transboundary impacts on receptors in Russian waters from the following activities:

- Munitions clearance (Finland).

As identified in Section 10.6, the main transboundary impacts in Russian waters that may arise from underwater noise generation in Finnish waters are blast injury, PTS and TTS<sup>65</sup> for marine mammals and fish.

In recognition of the high levels of concern regarding certain marine mammals the assessment, including of transboundary impacts, has considered impacts at two levels:

- Whether and to what extent NSP2 may affect functioning of a species population;
- Whether individuals of a species may experience impacts as a result of NSP2, irrespective of whether this results in changes in functioning of the population.

#### *Munitions clearance (Finland)*

The modelled impact distances for underwater noise propagation for representative munitions clearance locations are shown in Figure 15-4 and Figure 15-5 for average and maximum munitions sizes. Further details of the models and results are provided in Section 10.1.3.2, Appendix 3 and Atlas Map UN-1-Espoo to UN-4-Espoo.

From these figures (and Table 10.42 in Section 10.6.4.2) it can be deduced that detonation within Finnish waters close to the Russian border (representative site M1 and M2 in Finland) could result in underwater noise levels that exceed the thresholds for risk of onset of PTS/blast injury and TTS/avoidance behaviour in marine mammals, extending approximately 3.5 km and 15 km, respectively, from the detonation site. These levels could thus potentially result in transboundary impacts on species that might be present in Russian waters. The number of munitions to be cleared in this location is not currently known, but based on the experience of NSP (Atlas Map MU-01-Espoo), it is likely to be low. Munitions clearance could thus potentially result in transboundary impacts on species that might be present in Russian waters.

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<sup>65</sup> Definitions of PTS, TTS and blast injury are provided in Section 10.6.4.2.

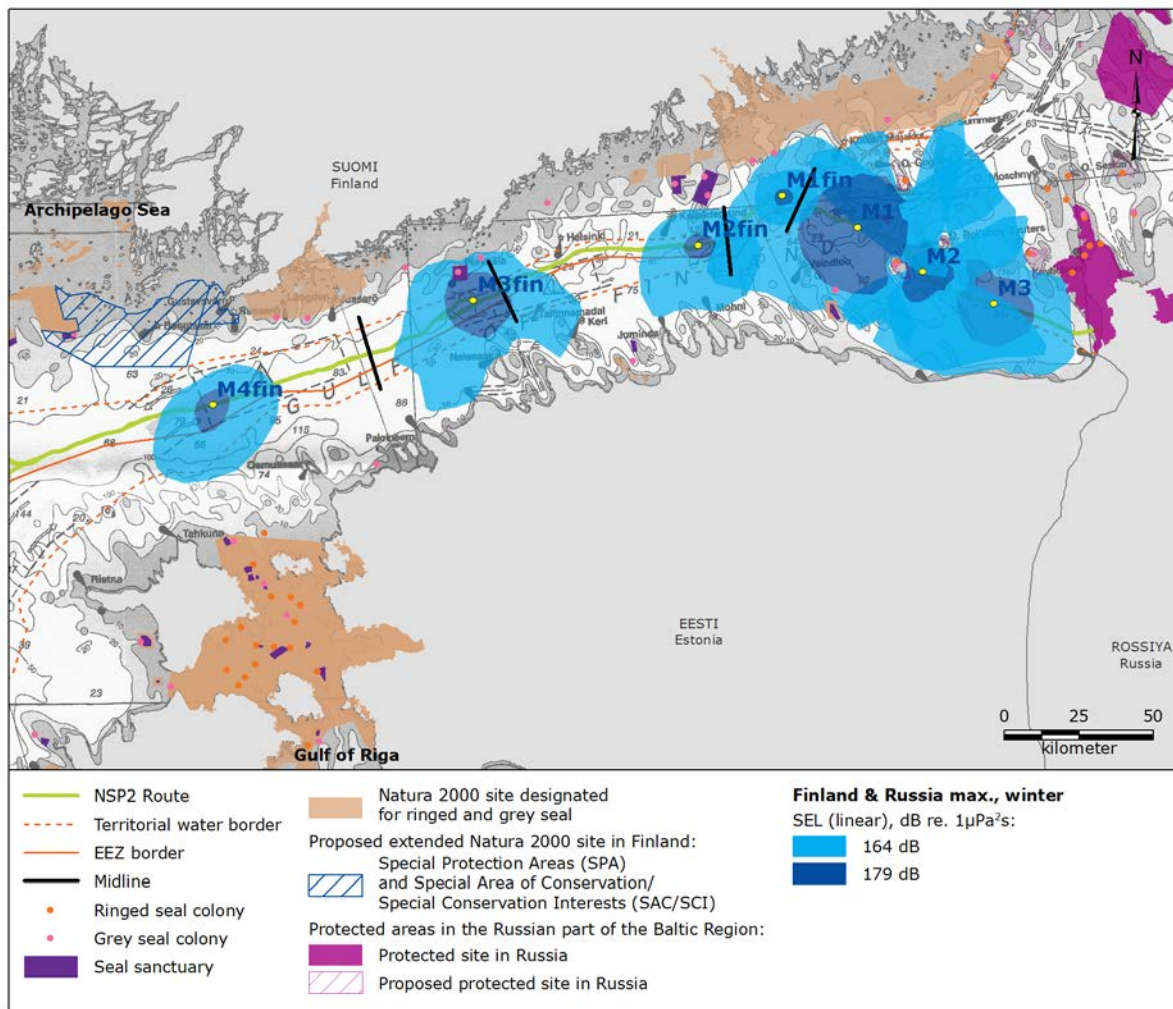
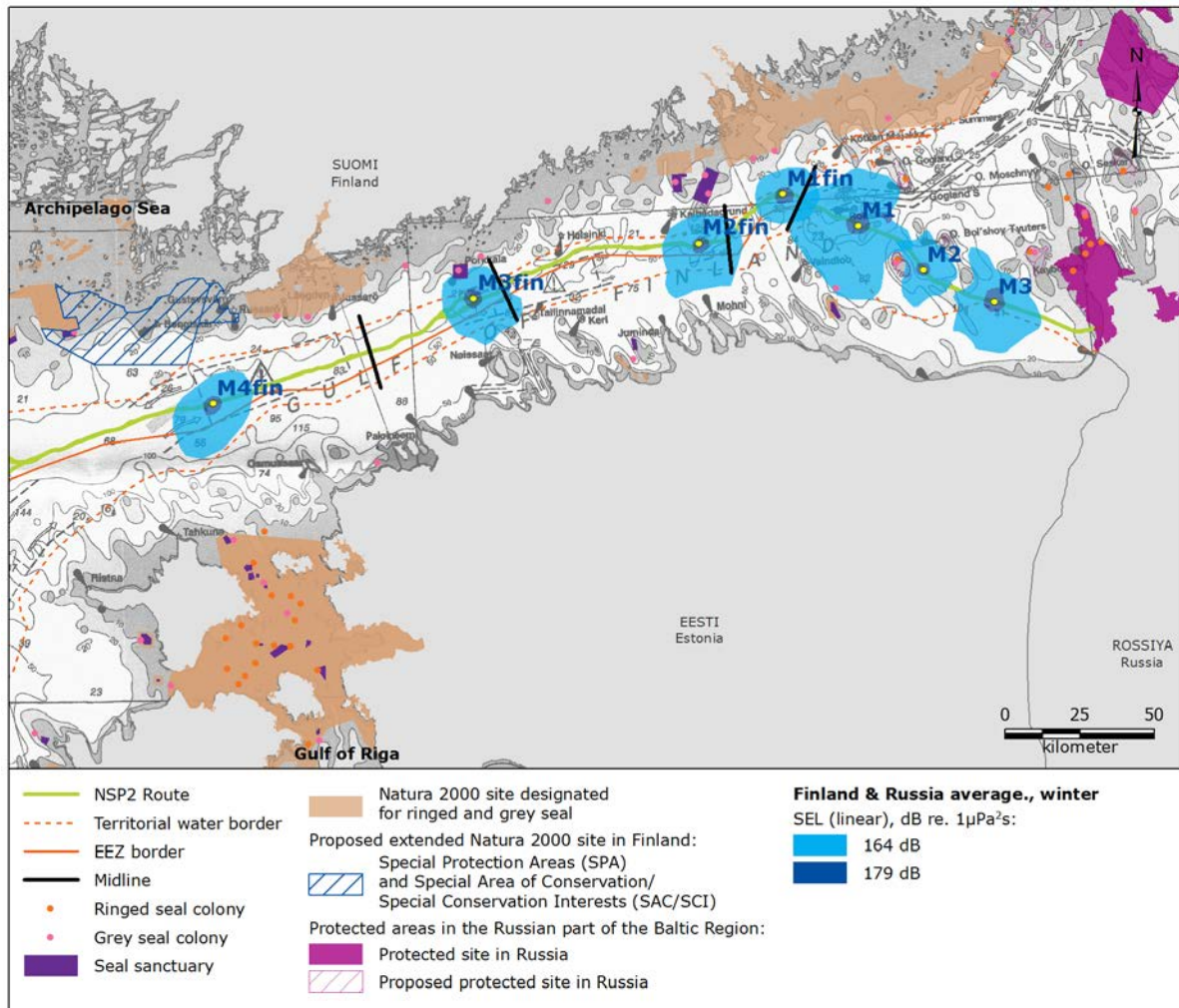


Figure 15-4 The maximum noise propagation from munitions clearance in Finnish and Russian waters, with an indication of the munitions areas (M1-M4). For more details see Appendix 3 and Atlas Maps UN-01-Espoo to UN-04-Espoo.





**Figure 15-5** The average noise propagation from munitions clearance in Finnish and Russian waters, with an indication of the munitions areas (M1-M4). For more details see Appendix 3 and Atlas Maps UN-01-Espoo to UN-04-Espoo.

Although grey seals are common in Russian waters close to the Finnish EEZ boundary, the low abundance of the Inner Gulf Of Finland ringed seal populations in this area makes this species relatively more vulnerable to any impact that may occur, as it could affect a relatively large proportion of the small population. Both species of seal are expected to be most abundant near the haul-out sites but these are not present in the vicinity of the Finnish border. The Ingermanlandsky proposed protected area in Russia, proposed for (amongst other) grey and ringed seals is located some 28 km from the location where NSP2 crosses between Finnish and Russian waters and will thus not be affected by transboundary impact relating to underwater noise generation in Finnish waters.

As described in Section 10.6.4, the use of seal scarers will substantially reduce the risk that marine mammals will suffer significant blast injury or death, but may nonetheless be subject to onset of a degree of PTS and non-lethal blast injury.

Thus the maximum transboundary impact ranking at the *individual* level for onset of PTS and blast injury is **moderate** for the Gulf of Finland ringed seal and for grey seal. At the *population* level, the impact ranking is **moderate** for the Gulf of Finland ringed seal (due to low abundance) and **minor** for grey seal (due to high abundance and population status).

Owing to the low densities of harbour porpoises present in Russian waters, the likelihood of transboundary impacts on such species from activities in Finnish waters is considered to be very

low. However, based on a precautionary approach, the transboundary impact ranking for onset of PTS and blast injury is assessed to be **minor** at both the *individual* and *population* levels.

Since any exceedances of TTS will be short-term and will not affect species functioning at the individual or population level, any transboundary impact ranking is **minor**, and not significant, both at an individual and population level for all species of marine mammal.

Since fish may experience a degree of injury up to 1.5 km from a detonation site, there is a potential for a small degree of transboundary impact, should large munitions be detonated in Finland close to the Russian border. In view of the low probability for such a requirement at this location, and the limited spatial extent of any transboundary impacts that occur, the impact ranking is **negligible**.

**Table 15-4 Potential transboundary impacts on Russia.**

Project component	Potential source of transboundary impact	Potential receptor for transboundary impact	Parties of Origin	
			Finland	Sweden *
Rock placement	Release of sediments to the water column	Seawater quality	None	None
	Release of contaminants and/or nutrients to the water column	Seawater quality	None	None
	Sedimentation on the seabed	Bathymetry and sediments	None	None
	Generation of underwater noise	Marine mammals and fish**	None	None
Munitions clearance	Release of sediments to the water column	Seawater quality		
	Release of contaminants and/or nutrients to the water column	Seawater quality		
	Sedimentation on the seabed	Bathymetry and sediments		
	Generation of underwater noise	Marine mammals**	3a, 3b	3c
Fish**			4	

	Negligible	Minor	Moderate	Major
<b>Impact ranking:</b>	<b>None</b>	No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.		
		No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.		
<p>Project components, sources of transboundary impacts and relevant receptors have been derived from the relevant sections of Chapter 10 – Assessment of environmental impacts.</p> <p>* Relevant to the Kaliningrad region only.</p> <p>** Ranking is the highest one that could be experienced by the specified receptor (for impacts resulting from blast injury, onset of PTS or TTS) at the <i>population</i> level. Rankings for lower scoring impacts and those at the <i>individual</i> level are provided in the text.</p> <p>3 = Marine mammals (3a Harbour porpoise, 3b grey seal, 3c Gulf of Finland ringed seal, 3d Gulf of Riga and Archipelago ringed seal)</p> <p>4 = Fish</p>				

### In-combination impacts

Munitions will be cleared one by one. Thus, it is concluded that no transboundary 'in-combination impacts' will occur.

#### 15.4.2.2 Assessment of potential transboundary environmental impacts on Finland

NSP2 will cross the EEZ boundaries between both Finnish and Russian waters and Finnish and Swedish waters; other than at these crossing points, its alignment in Russian and Swedish waters will not run close to Finnish waters. Hence any potential for transboundary impacts into Finnish waters from other PoOs will be restricted to those occurring in the vicinity of these two EEZ boundary crossings.

All four country specific sources of transboundary impact listed in Section 15.2 were identified in Chapter 10 – Assessment of environmental impacts as having the potential to give rise to transboundary country specific impacts in Finnish waters. They are therefore considered below and the results summarised in Table 15-5.

#### Release of sediments to the water column

Release of sediments to the water column in Russian waters from the following activity has the potential to generate transboundary impacts on receptors in Finnish waters:

- Munitions clearance (Russia).

No dredging will occur in Swedish waters, while dredging in Russian waters will be at the landfall and hence too far from the boundary with Finland to result in transboundary impacts. No post-lay trenching is proposed in Russian waters, while post-lay trenching in Swedish waters is not sufficiently close to the EEZ border for increases in SSCs to be experienced in Finnish waters. Finally, although rock placement is proposed along the northern section of the route in Swedish and Russian waters, modelling has shown that sediment spread will not extend into Finnish waters.

#### *Munitions clearance (Russia)*

Detailed mapping of munitions in Russian waters has not yet been undertaken. However, based on the munitions density experienced during NSP construction (Atlas Map MU-01-Espoo) it is

considered unlikely that munitions will be encountered close to the Finnish/Russian border. Modelling of sediment dispersion from munitions clearance at representative locations in Russian and Finnish waters indicates that increases in SSCs greater than 10 mg/l will be limited to selected locations within 5 km of the alignment and will typically last less than 3 hours (Atlas Map MO-03-Espoo). The magnitude of any transboundary impact on seawater quality is thus considered to be negligible, resulting a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in significant transboundary impacts on the biotic environment.

#### **Release of contaminants and/or nutrients to the water column**

As releases of contaminants and/or nutrients to the water column are associated with mobilisation of sediments that may contain them, such releases may result from the same activities as described above in relation to the release of sediment. These comprise:

- Munitions clearance (Russia).

As demonstrated above, since there will be no potential for a transboundary increase in suspended sediment in Finnish waters from rock placement in Sweden or Russia, there will be no potential for transboundary impacts relating to the release of contaminant and nutrients in water column.

#### *Munitions clearance (Russia)*

As described above, it is considered unlikely that munitions will be encountered close to the Finnish/Russian border. Modelling of the levels of PAH (benzo(a)pyrene), dioxins/furans from munitions clearance at representative locations in Russian and Finnish waters indicates that exceedances of PNEC values will be limited to locations within 10 km of the detonation site and will typically last for less than 1 hour (Atlas Map MO-05-Espoo). As the PNEC value expresses a 'no effect level' and is not an acute toxic concentration level, the short-term exceedance is considered to have a negligible impact magnitude on seawater quality. Should the detonation site be close to the Finnish border, the magnitude of any transboundary impact is thus considered to be similarly negligible, resulting a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in significant transboundary impacts on the biotic environment.

#### **Sedimentation on the seabed**

The following activities in Russian waters could result in sedimentation on the seabed in Finnish waters:

- Munitions clearance (Russia).

As demonstrated above, since there will be no potential for a transboundary increase in suspended sediment in Finnish waters from rock placement in either Sweden or Russia, there will be no potential for transboundary impacts relating to sedimentation on the seabed.

#### *Munitions clearance (Russia)*

Based on the low level of any increase in SSCs that could be experienced in Finnish waters from munitions clearance in Russia, described above, any increase in sediment depth resulting from the settlement of such suspended material will be minimal, resulting in a negligible impact magnitude and hence a **negligible** impact ranking. Any change in the levels of sedimentation is thus insufficient to result in significant transboundary impacts on the biotic environment.

#### **Generation of underwater noise**

The generation of underwater noise has the potential to result in transboundary impacts on receptors in Finnish waters from the following activities

- Rock placement (Sweden);
- Munitions clearance (Russia).

As identified in Section 10.6, the main transboundary impacts in Finnish waters that may arise from underwater noise generation are blast injury, PTS and TTS<sup>66</sup> for marine mammals and fish. There could also be impacts on sites in Finnish waters that are designated for these marine mammals.

In recognition of the high levels of concern regarding certain marine mammals, the assessment including of transboundary impacts has therefore considered impacts at two levels:

- Whether and to what extent NSP2 may affect the functioning of a species population;
- Whether individuals of a species may experience impacts as a result of NSP2, irrespective of whether this results in changes in the functioning of the population.

#### *Rock placement (Sweden)*

Rock placement is planned along the northern part of the route in Swedish waters close to the Finnish EEZ. Based on modelling, there is potential for underwater noise to extend into Finnish waters and exceed the threshold for TTS in fish and marine mammals within a distance of 100 m and 80 m from the activity, respectively. Therefore, there is potential for transboundary impact on species that might be present in Finnish waters. However, due to the very short duration of each rock placement activity (several hours), it would not be sufficient to affect species functioning at the individual or population level. Thus the overall transboundary impact ranking is **negligible**.

#### *Munitions clearance (Russia)*

The modelled impact distances for propagation of underwater noise for representative conventional munitions clearance scenarios are shown in Figure 15-4 and Figure 15-5 for average and maximum munitions sizes. Further details of the models and results are provided in Section 10.1.3.2, Appendix 3 and Atlas Maps UN-1-Espoo to UN-4-Espoo.

From Figure 15-4 and Figure 15-5 (and Table 10-42) it can be deduced that detonations within Russian waters close to the Finnish border (representative site M1 in Russia) could result in underwater noise levels that exceed the threshold for onset of PTS/blast injury and TTS/avoidance behaviour in marine mammals extending up to approximately 23 km and 56 km, respectively, from the detonation site for the maximum munitions size. This would reduce to approximately 5 km and 26 km, respectively, for PTS/blast injury and TTS/avoidance behaviour for the average munitions size. They could thus potentially result in transboundary impacts on species that might be present in Finnish waters.

There is generally a degree of uncertainty concerning the spatial and temporal distribution of seals in the Gulf of Finland. However, grey seals are understood to be common in Russian waters close to the Finnish EEZ boundary. The low abundance of the Inner Gulf of Finland ringed seal population in this area makes this species relatively more vulnerable to any impact that may occur, as it could affect a relatively large proportion of the small population.

As described in Section 10.6.4, the use of seal scarers will substantially reduce the risk that marine mammals suffer significant blast injury or death, but may nonetheless be subject to onset of a degree of PTS and non-lethal blast injury.

Thus the maximum transboundary impact ranking at the *individual* level for onset of PTS and blast injury is **moderate** for the Gulf of Finland ringed seal and grey seal. At the *population* level, the impact ranking is **moderate** for the Gulf of Finland ringed seal (due to low abundance) and **minor** for grey seal (due to high abundance and population status).

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<sup>66</sup> Definitions of PTS, TTS and blast injury are provided in Section 10.6.4.2.

Owing to the low densities of harbour porpoises present in Finnish waters, the likelihood of transboundary impacts on such species from activities in Russian waters is considered to be very low. However, based on a precautionary approach, the transboundary impact ranking for onset of PTS and blast injury is assessed to be **minor** at both the *individual* and *population* levels.

Since any exceedances of TTS will be short-term and will not affect species functioning at the individual or population level, any transboundary impact ranking is **minor**, and not significant, both at an individual and population level for all species of marine mammal.

Since fish may experience a degree of injury up to 1.5 km from a detonation site, there is a potential for a small degree of transboundary impact, should large munitions be detonated in Russia close to the Finnish border. In view of the low probability for such a requirement at this location, and the limited spatial extent of any transboundary impacts that occur, the impact ranking is **negligible**.

*Designated sites (see Atlas Map PA-02-Espoo)*

The Natura 2000 site Pernaja and Pernaja Archipelago (FI0100078), designated for grey seals, is 18 km from the pipeline crossing between Russia and Finland. Underwater noise modelling results indicate a small risk of TTS at the border of the Natura 2000 site from munitions detonation in Russia. Any transboundary impacts to the grey seal would be **minor** (see Atlas Map UN-1-Espoo to UN-4-Espoo).

The nearest seal sanctuary (ringed seals) in Finland from the location where the pipeline crosses from Russia into Finland is at a distance of 29 km. At this distance, any transboundary impacts on the ringed seal would be **minor** (see Atlas Map UN-1-Espoo to UN-4-Espoo).

**Table 15-5 Potential transboundary impacts on Finland.**

Project component	Potential source of transboundary impact	Potential receptor for transboundary impact	Parties of Origin	
			Russia	Sweden
Rock placement	Release of sediments to the water column	Seawater quality	None	None
	Release of contaminants and/or nutrients to the water column	Seawater quality	None	None
	Sedimentation on seabed	Bathymetry and sediments	None	None
	Generation of underwater noise	Fish and Marine mammals**	None	3a,b, 4
Munitions clearance	Release of sediments to the water column	Seawater quality		
	Release of contaminants and/or nutrients to the water column	Seawater quality		
	Sedimentation on seabed	Bathymetry and sediments		
	Generation of underwater noise	Marine mammals**	3a, 3b, 5	3c

	Fish	4										
<table border="1"> <tr> <td></td> <td style="background-color: #cccccc;">Negligible</td> <td style="background-color: #ffff00;">Minor</td> <td style="background-color: #ffcc00;">Moderate</td> <td style="background-color: #ff0000;">Major</td> </tr> </table> <p><b>Impact ranking:</b></p> <table border="1"> <tr> <td style="text-align: center;"><b>None</b></td> <td>No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.</td> </tr> <tr> <td></td> <td>No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.</td> </tr> </table> <p>Project components, sources of transboundary impacts and relevant receptors have been derived from the relevant sections of Chapter 10 – Assessment of environmental impacts.</p> <p>* Relevant to the Kaliningrad region only.</p> <p>** Ranking is the highest one that could be experienced by the specified receptor (for impacts resulting from blast injury, onset of PTS or TTS) at the <i>population</i> level. Rankings for lower scoring impacts and those at the <i>individual</i> level are provided in the text.</p> <p>3 = Marine mammals (3a Harbour porpoise, 3b grey seal, 3c Gulf of Finland ringed seal, 3d Gulf of Riga and Archipelago ringed seal)</p> <p>4= Fish</p> <p>5 = Natura 2000 and other designated sites</p>					Negligible	Minor	Moderate	Major	<b>None</b>	No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.		No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.
	Negligible	Minor	Moderate	Major								
<b>None</b>	No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.											
	No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.											

### In-combination impacts

In Russian waters, munitions will be cleared one by one and will not be carried out concurrently with seabed intervention works. Therefore, there will be no 'in-combination impacts' between seabed intervention works.

#### 15.4.2.3 Assessment of potential transboundary environmental impacts on Estonia

Although the pipeline does not pass through Estonia, Estonia shares TW and EEZ borders with Russia and EEZ borders with Finland and Sweden and could thus be subject to transboundary impacts arising from activities in those countries' waters. The distance from the Estonian EEZ to the NSP2 alignment ranges from 1.5 – 18 km for Russia and 1.8 – 6 km for Finland. Hence while no back to back transboundary impacts will occur, there is potential for country specific transboundary impacts arising from activities in Russian and Finnish waters. As the Estonian EEZ border is located 5 - 25 km from the NSP2 route in Swedish waters, no potential for significant transboundary impacts have been identified. Regional transboundary impacts are discussed in Section 15.3 while the country specific transboundary impacts are addressed below.

All four country specific sources of transboundary impact listed in Section 15.2 were identified in Chapter 10 – Assessment of environmental impacts as having the potential to give rise to transboundary country specific impacts in Estonian waters. They are therefore considered below and the results summarised in Table 15-6. Nord Stream 2 AG has also performed a citizen survey in Estonia. The results of this survey are summarized in this section but not included in Table 15-6 since the impact cannot be attributed to one (or several) PoO(s).

#### Release of sediments to the water column

Release of sediments to the water column in Russian and Finnish waters from the following activities has the potential to generate transboundary impacts on receptors in Estonian waters:

- Munitions clearance (Russia and Finland);
- Dredging (Russia).

No post-lay trenching is proposed in Finnish waters or Russian waters. Furthermore, no post-lay trenching is proposed along the northern section of the route in Swedish waters close to the Estonian EEZ. Although rock placement is proposed along the northern section of the route in Swedish and Russian waters, in the area close to the Estonian EEZ, modelling has shown that sediment spread will not extend into Estonian waters and therefore no transboundary impacts are anticipated.

#### *Rock placement (Finland)*

Numerical modelling has been performed in order to assess the release of sediment to the water column from rock placement. The results indicate that an increase in SSCs due to rock placement in the Finnish EEZ could potentially reach into Estonian waters. However, even the worst case scenario shows that the concentrations are very low, mainly 2-5 mg/l and occur for a short period of time (1-12 hours). As Atlas Map MO-02-Espoo shows, no concentrations above 10 mg/l will reach Estonia. The magnitude of any transboundary impact on Estonian seawater quality is thus considered to be negligible, resulting in a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in significant impacts on the biotic environment.

#### *Munitions clearance (Russia and Finland)*

Modelling of sediment dispersion from munitions clearance at representative locations in Russian and Finnish waters indicates that increases in SSCs in Estonian waters will be limited to selected locations but will generally be less than 10 mg/l and last for less than 12 hours (see Figure 2-1 in Appendix 3 and Atlas Map MO-03-Espoo). The magnitude of any transboundary impact on Estonian seawater quality is thus considered to be negligible resulting in a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in significant impacts on the biotic environment.

#### *Dredging (Russia)*

Numerical modelling has been carried out to assess SSCs from dredging activities at the Russian landfall area. Due to the prevailing current directions, sediments will mainly spread in a northerly direction (Figure 15-6). However, the calculations show that some suspended sediments may reach the coastal area of Estonia, extending up to approximately 12 km from the border. Within the entire dredging period (estimated 37 days) the total accumulated duration when increases in SSCs of higher than the 10 mg/l threshold within Estonian waters may be experienced will be a few days. Thus although detectable changes in SSCs may occur, they will be of both short duration and limited spatial extent as well as within the natural variations regularly experienced in this area. The magnitude of any transboundary impact on seawater quality is thus considered to be negligible, resulting in a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in significant transboundary impacts on the biotic environment but could potentially affect designated areas and monitoring sites, as described below.

#### Designated sites

The northern part of the Struuga Natura 2000 site (SAC EE0070128) is a river habitat located around the lower course of the Narva River and includes a 16 km long river section from Narva town to the river mouth at Narva Bay, where it flows out into the area that would be affected by increases in SSCs. Seawater cannot enter river and Natura site against the flow direction in the Narva River. Consequently, **no impacts** on the river habitat and protected fish species through changes in the water quality from increased SSCs are anticipated.

#### International/national monitoring stations

Water quality monitoring stations located south of the nearshore dredging area in Estonia may be sensitive to an increase in SSC. These stations are located approximately 8 km from the Narva Bay nearshore area and 300-900 m from the Russian border (see Atlas Map MS-01). Figure 15-6 indicates that a 10 mg/l increase in SSCs could be experienced in their vicinity during dredging at the Narva Bay landfall. As such events would only occur under specific hydrological conditions and the total duration of all such events during the entire dredging period would be in the order



of days, with appropriate planning and consultation with the relevant authorities, it should be possible to minimise interference with monitoring campaigns at these stations. The impact ranking is assessed to be **negligible**.

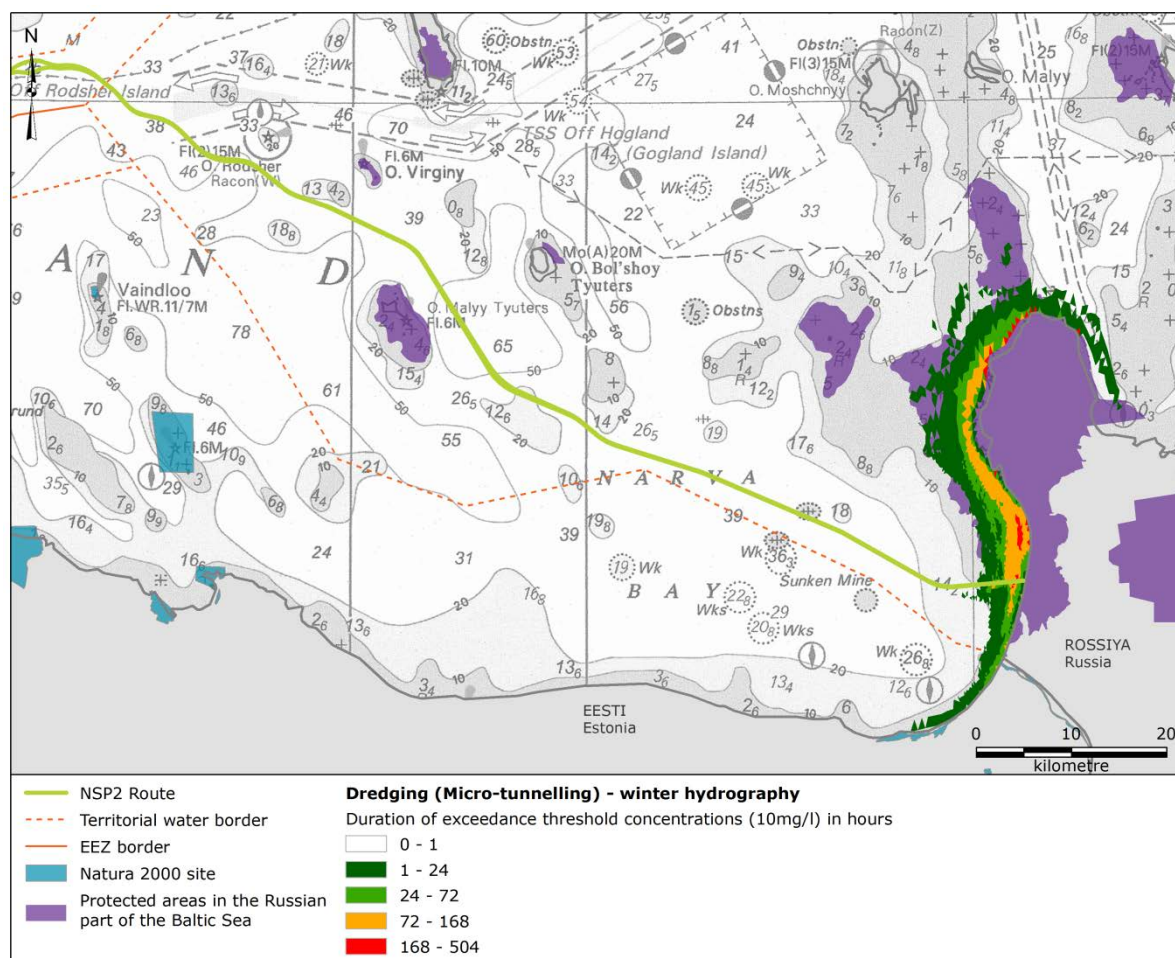


Figure 15-6 Duration of exceeding 10 mg/l during dredging at the Russian landfall location.

### Release of contaminants and/or nutrients to the water column

As releases of contaminants and/or nutrients to the water column are associated with mobilisation of sediments that may contain them, such releases may result from the same activities as described above in relation to the release of sediment. These comprise:

- Rock placement (Finland);
- Munitions clearance (Russia and Finland);
- Dredging (Russia).

As demonstrated above, since there will be no potential for a transboundary increase in suspended sediment in Estonian waters from rock placement in Sweden or Russia, there will be no potential for transboundary impacts relating to the release of contaminant and nutrients in water column arising from activities in those countries.

#### *Rock placement (Finland)*

As described above, any increase in SSCs from rock placement close to the Estonian border will generally not be transboundary in nature except for very small increases experienced over a limited spatial extent and for short periods of time. Hence there is limited potential for any transboundary impact on Estonian seawater quality resulting from the release of sediment associated contaminants. This is confirmed by modelling results which indicate that during rock placement activities in Finnish waters, the concentrations of contaminants (PAH -

benzo(a)pyrene, dioxins/furans and zinc) will not exceed PNEC values in the Estonian EEZ. **No transboundary impacts** are identified.

#### *Munitions clearance (Russia and Finland)*

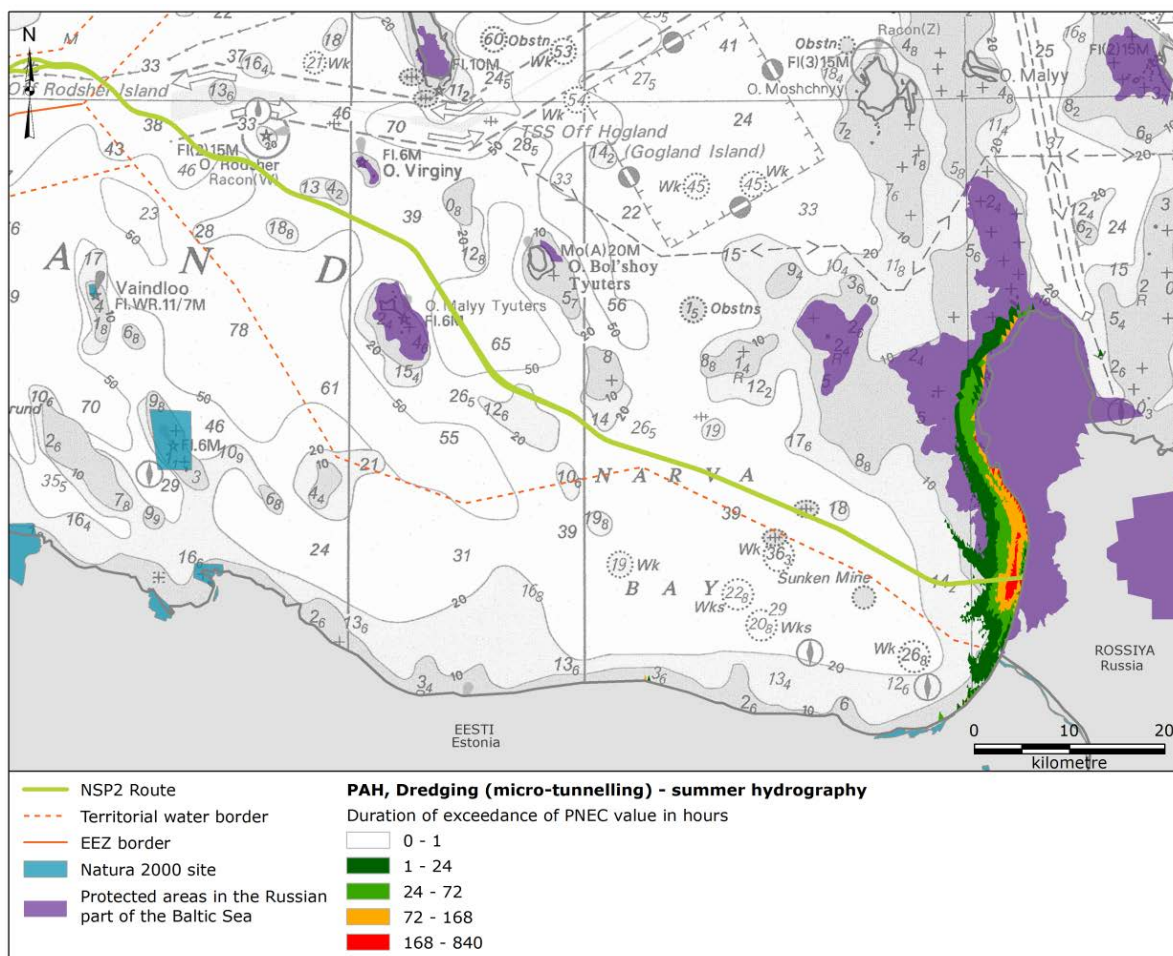
Modelling of levels of PAH (benzo(a)pyrene), dioxins/furans) from munitions clearance at representative locations in Russian and Finnish waters indicates that any exceedance of PNEC values will be limited to locations within 10 km of the detonation site and typically last for less than 1 hour (Atlas Map MO-05-Espoo). As the PNEC value expresses a 'no effect level' and is not an acute toxic concentration level, the short-term exceedance is considered to have a negligible impact magnitude on seawater quality. Should the detonation site be close to the Estonian border the magnitude of any transboundary impact is thus considered to be similarly negligible, resulting a **negligible** impact ranking. Any changes in SSCs are thus insufficient to result in a significant impact on the biotic environment.

#### *Dredging (Russia)*

The sediment dispersion into Estonian waters could potentially result in the release of sediment associated contaminants into such waters. Modelling of such releases indicates that while under normal conditions no exceedance of the PNEC value for PAH and dioxin would occur in Estonian waters, in a summer scenario, short-term exceedances (less than 24 hours over the whole 37 day dredging period) could occur (see Atlas Map MO-04-Espoo and Figure 15-7). As the PNEC value expresses a 'no effect level' and not an acute toxic concentration level, such a short-term exceedances are considered a negligible impact magnitude on seawater quality and hence **negligible** impact ranking is assigned. Any changes in seawater quality are thus insufficient to give rise to significant transboundary impacts on the biotic environment but could potentially affect monitoring sites, as described below.

#### International/national monitoring stations

Water quality monitoring stations located south of the nearshore dredging area in Estonia may be sensitive to increases in contaminant and nutrient levels during dredging in Russia. As described above, any increases would be short-term and result in at most a **negligible** impact ranking.



**Figure 15-7** Duration of exceedance of PNEC for benzo(a)pyrene (a representative of the polyaromatic hydrocarbons (PAH)), during dredging at the Russian landfall (worst case scenario).

### Sedimentation on the seabed

The following activities in Finnish and Russian waters could result in sedimentation on the seabed in Estonian waters:

- Rock placement (Finland);
- Munitions clearance (Finland and Russia);
- Dredging activities (Russian).

As demonstrated above, since there will be no potential for a transboundary increase in suspended sediment in Estonian waters from rock placement in Sweden or Russia, there will be no potential for transboundary impacts relating to sedimentation on the seabed from rock placement in those countries.

#### *Rock placement (Finland)*

Based on the low level of any increase in SSCs that could be experienced in Estonian waters from rock placement in Finland, described above, any settlement of suspended material will be minimal resulting in a negligible impact magnitude and hence a **negligible** impact ranking. Any change in the levels of sedimentation is thus insufficient to result in significant transboundary impacts on the biotic environment.

#### *Munitions clearance (Russia and Finland)*

Based on the low level of any increase in SSCs that could be experienced in Estonian waters from munitions clearance in Russia and Finland, described above, any settlement of suspended material will be minimal resulting in a negligible impact magnitude and hence a **negligible**

impact ranking. Any change in the levels of sedimentation is thus insufficient to result in significant transboundary impacts on the biotic environment.

#### *Dredging activities (Russia)*

Based on the low level of any increase in SSCs that could be experienced in Estonian waters from dredging at the Russian landfall, described above, any increase in sediment depth associated with the settlement of such suspended material will be minimal. This was confirmed by the modelling (see Figure 15-8) which predicted that a deposition rate of up to 200 mg/l (equivalent to 1 mm of sediment) may occur at very limited locations in Estonian waters resulting in a negligible impact magnitude and hence a **negligible** impact ranking. Any change in the levels of sedimentation is thus insufficient to result in transboundary impacts on the biotic environment but could potentially affect monitoring sites, as described below.

#### International/national monitoring stations

Water quality monitoring stations located south of the nearshore dredging area in Estonia may be sensitive to increases in sediment depth during dredging in Russia. As described above, any increases would be short-term and result in an at most a **negligible** impact ranking.

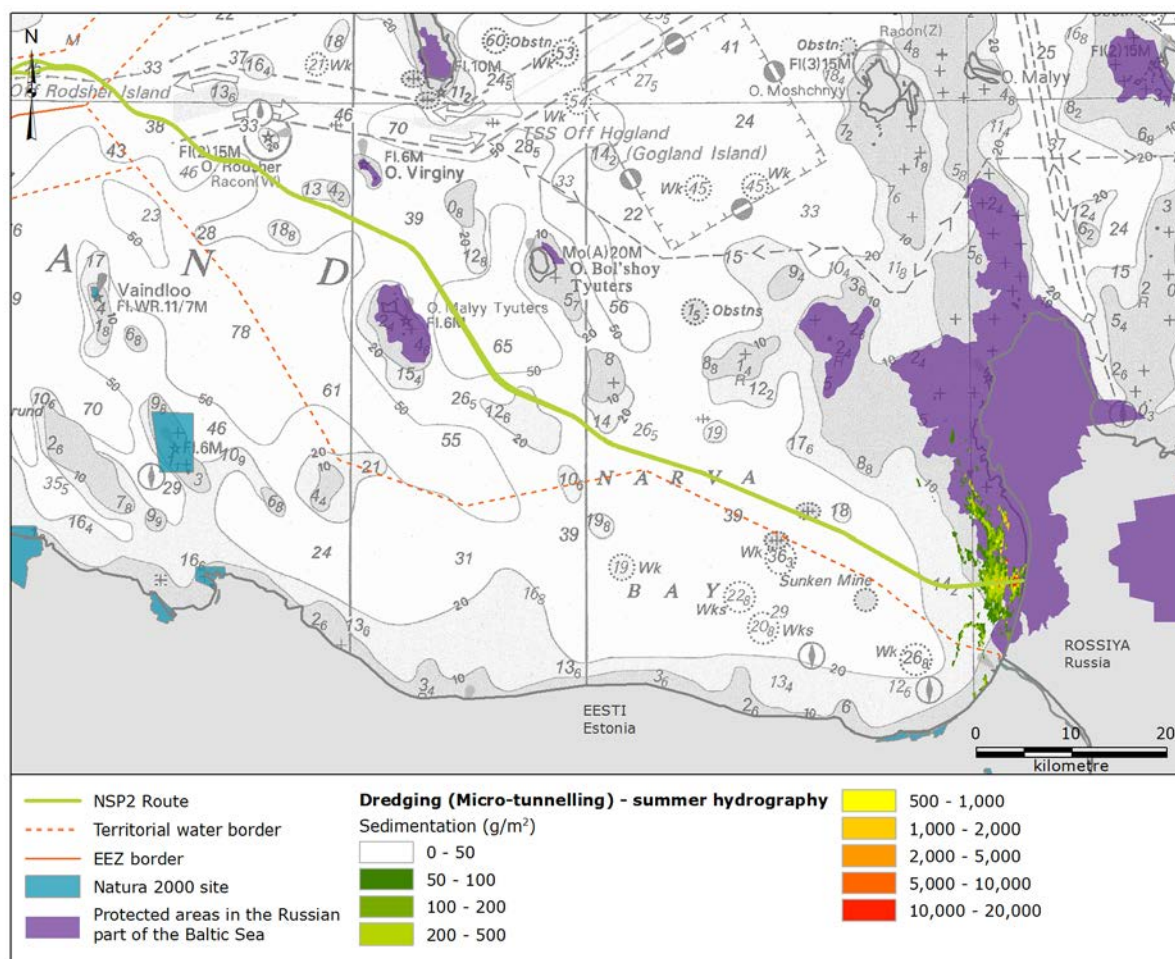


Figure 15-8 Sedimentation of released material due to dredging under typical summer conditions.

#### **Generation of underwater noise**

The generation of underwater noise in Russian and Finnish waters has potential to result in transboundary impacts on receptors in Estonian waters from the following activities:

- Munitions clearance (Russia and Finland).

As identified in Section 10.6, the main transboundary impacts in Estonian waters may arise from underwater noise generation in Finnish and Russian waters are blast injury and onset of PTS and TTS<sup>67</sup> for marine mammals. There could also be impacts on sites in Estonian waters that are designated for such species. The distance of NSP2 from the Estonian border is too far to result in transboundary impacts on fish.

In recognition of the high levels of concern regarding certain marine mammals the assessment including of transboundary impacts has therefore considered impacts at two levels:

- Whether and to what extent NSP2 may affect the functioning of a species population;
- Whether individuals of a species may experience impacts as a result of NSP2, irrespective of whether this results in changes in the functioning of the population.

#### *Munitions clearance (Finland)*

The modelled impact distances for propagation of underwater noise for representative conventional munitions clearance locations are shown in Figure 15-5 and Figure 15-5 for average and maximum munitions sizes. Further details of the models and results are provided in Section 10.1.3.2, Appendix 3 and Atlas Map UN-1-Espoo to UN-4-Espoo.

From Figure 15-4 and Figure 15-5 (and Table 10-42 in Section 10.6.4.2) it can be deduced that detonation within Finnish waters (at representative sites M1-M4 in Finland) could result in underwater noise levels that exceed the thresholds for PTS/blast injury and TTS at distances which, depending on the location of the munitions, range from 3.5-15 km and 15-44 km, respectively, from the detonation site for the maximum size of munitions. This distance would reduce to 3.5 km for PTS and 15-26 km for TTS for an average size munition. The proximity of the NSP2 alignment to the EEZ boundary with Estonia for much of its length in Finnish waters thus means that transboundary underwater noise related impacts into Estonia resulting from munitions detonation in Finland is likely.

For an average size munition, transboundary noise levels are unlikely to exceed the PTS threshold in Estonian waters, although the TTS threshold will be exceeded in small areas. In the event of the detonation of a large munition, exceedances of the PTS threshold could, however, be experienced with larger areas exceeding the TTS threshold.

The degree of impact will depend on the number of munitions detonated in each area and the species and populations present and will thus vary per location. However, in general, the Estonian coastline does not offer as many suitable haul-out sites for seals as the coastline of Finland and Russian waters in the eastern Gulf of Finland. As described below, the Uhtju Natura 2000 site (SAC EE0060220) will not be affected.

As described in Section 10.6.4, the use of seal scarers will substantially reduce the risk that marine mammals will suffer significant blast injury or death but may nonetheless be subject to onset of a degree of PTS and non-lethal blast injury.

#### Grey seals

Grey seals are understood to be common throughout the Gulf of Finland, including along the Finnish/Estonian border. The overall maximum transboundary impact ranking for onset of PTS and blast injury at the *individual* level is thus moderate, but due to their abundance and healthy population status, the ranking at the *population* level is **minor**. Similarly, due to their abundance, this ranking is considered also to apply at locations (notably in the vicinity of Finnish representative site M3) where multiple detonation events may occur.

#### Ringed seals

<sup>67</sup> Definitions of PTS, TTS and blast injury are provided in Section 10.6.4.2.

- M1 and M2 areas Finland: the low abundance of the Inner Gulf of Finland ringed seal populations in this area makes this species relatively more vulnerable than other ringed seal species to any impact that may occur, as it could affect a relatively large proportion of the small population.
- M3 area Finland: Transient Gulf of Finland ringed seal population and potentially lower numbers of the Gulf of Riga and Archipelago population (which have greater abundance and better status, and hence lower vulnerability to impact than the Gulf of Finland populations)
- M4 Gulf of Riga and Archipelago population.

Thus the maximum transboundary impact ranking for onset of PTS and blast injury at the *individual* level is **moderate** at all locations. At the *population* level, the impact ranking is also **moderate** in the vicinity of representative sites M1, M2 and M3 due to the presence of the Inner Gulf of Finland ringed seal population but **minor** in the vicinity of site M4 due to the dominant species present in this area being the Gulf of Riga and Archipelago population.

#### Harbour porpoises

Owing to the low densities of harbour porpoises present in Estonian waters the likelihood of transboundary impacts on such species from activities in Finnish waters is considered to be very low. However based on a precautionary approach the transboundary impact ranking for onset of PTS and blast injury are assessed to be **minor** at both individual and population level.

Since any exceedances of TTS will be short-term and not affect species functioning at individual or population level, the any transboundary impact magnitude will also be low for both species. When combined with the low sensitivity the transboundary impact ranking is **minor**, and hence not significant, both at an individual level and population level for all species of marine mammal.

#### Designated sites

Modelling of the possible impacts on Natura 2000 sites in Estonia, including the Uhtju Natura 2000 site (SAC EE0060220), which coincides with seal sanctuary Uhtju Island and is a haul out site for grey seal and a resting site for ringed seal, has been carried out. The concluded that there would be **no transboundary impact** from activities in Finland on Natura 2000 sites in Estonia.

#### *Munitions clearance (Russia)*

The modelled impact distances for propagation of underwater noise for representative conventional munitions clearance locations are shown in Figure 15-5 and Figure 15-5 for average and maximum munitions sizes. Further details of the models and results are provided in Section 10.1.3.2, Appendix 3 and Atlas Map UN-1-Espoo to UN-4-Espoo.

From Figure 15-4 and Figure 15-5 (and Table 10-42 in Section 10.6.4.2) it can be deduced that detonation within Russian waters (at representative sites M1-M3 in Russia) could result in underwater noise levels that exceed the thresholds for PTS/blast injury and TTS/avoidance behaviour at distances which, depending on the location of the munitions, range from 11-23 km and 55-60 km respectively, from the detonation site for the maximum size of munitions. This distance would reduce to 3-5 km for PTS and 13-26 km for TTS for an average size munition. The proximity of the NSP2 alignment to the EEZ boundary with Estonia for much of its length in Russia thus means that propagation of transboundary underwater noise related impacts into Estonia resulting from munitions detonation in Russia is likely.

For an average size munition transboundary noise levels are unlikely exceed the PTS threshold within Estonian waters although the TTS thresholds will be exceeded in small areas. In the event of the detonation of a large munition, exceedances of the PTS/blast injury threshold could, however, be experienced, with larger areas exceeding the TTS threshold.

As described above in relation to transboundary impacts from Finland to Estonia the degree of impact will depend on the location and species present, and proximity to haul out sites and colonies. A key site in Estonian waters close to the Russian boundary is the Uhtju Natura 2000 site (SAC EE0060220), which coincides with the seal sanctuary Uhtju Island and is a haul out site for grey seal and a resting site for ringed seal. This is located some 25 km south of the Russian representative site M1, this is discussed under "Designated sites" below. A grey seal colony is located immediately to the north of this site.

The effectiveness of seal scarers, as described above in relation to transboundary impacts from Finland to Estonia, also applies equally to transboundary impacts from Russia to Estonia.

#### Grey seals

As grey seals are understood to be common throughout the Gulf of Finland, the same analysis as provided above for transboundary impacts from Finland to Estonia relating to onset of PTS and blast injury applies, resulting in a **moderate** and **minor** impact ranking, respectively, at the *individual* and *population* levels.

#### Ringed seals

The Gulf of Finland ringed seal populations is the main species present in Estonian waters in the western part of the Gulf of Finland that could experience increases in underwater noise levels from munitions clearance in Russian waters. The low abundance of this species makes it relatively more vulnerable than other ringed seal populations or other seal species to any impact that may occur, as it could affect a relatively large proportion of the small population. The maximum transboundary impact ranking for onset of PTS and blast injury at the *individual* level is thus **moderate**. At the *population* level, the impact ranking is also **moderate**.

#### Harbour porpoises

Owing to the low densities of harbour porpoises present in Estonian waters, the likelihood of transboundary impacts on such species from activities in Russian waters is considered to be very low and they have therefore not been further considered. However, based on a precautionary approach, the transboundary impact ranking for onset of PTS and blast injury is assessed to be **minor** at both the *individual* and *population* levels.

Since any exceedances of TTS will be short-term and not affect species functioning at individual or population level, the any transboundary impact magnitude will also be low for both species. When combined with the low sensitivity the transboundary impact ranking is **minor**, and hence not significant, both at an individual level and population level for all species of marine mammal.

#### Designated sites (see Atlas Map PA-02-Espoo)

A Natural 2000 screening has been carried out to assess potential impacts on sites in Estonia, including the Uhtju Natura 2000 site (SAC EE0060220), which coincides with the seal sanctuary Uhtju Island and is a haul out site for grey seal and a resting site for ringed seal. Modelling results indicate that only for maximum size munitions may the TTS zone extend into the northern part of the Natura 2000 site. The impact will be of low intensity, temporary and fully reversible. The transboundary impact ranking for onset of TTS is assessed to be **minor** and therefore not significant.

#### **Results of citizen survey**

As part of the Finnish EIA, Nord Stream 2 AG performed a citizen survey in Estonia in spring 2016 to learn about the worries and expectations Estonian citizens may have in relation to NSP2. The 501 interviewees were selected in those towns and parishes which, considering the route of NSP2, border the coastline. The questionnaire included questions regarding overall environmental awareness, Nord Stream Projects 1 and 2, Estlink 1 and 2 (existing subsea electrical power cables between Estonia and Finland) and Balticconnector (planned subsea natural gas pipeline between Estonia and Finland).

The result of the survey shows that NPS2 raises some *worries* among some of the respondents of the Estonian survey. Only every fourth respondent (25%) considered NSP2 rather positive or very positive. When asked to describe their attitude towards NSP2 in their own words, most often (17%) the respondents mentioned the aspect of the project being harmful to the environment or marine life. Interestingly though, when asked to rate the safety of different natural gas transportation modes, subsea gas pipeline was evaluated as most safe (total 49%).

Due to the worries and concerns expressed in the citizen survey, the Finnish EIA considers that NPS2 activities in Finland may have a minor transboundary impact on the Estonian residents on the coastline. Nord Stream 2 AG will mitigate these concerns by proactively and transparently communicating to the Estonian public throughout the project.

**Table 15-6 Potential transboundary impacts on Estonia.**

Project component	Potential source of transboundary impact	Potential receptor for transboundary impact	Parties of Origin				
			Russia		Finland		Sweden
Rock placement	Release of sediments to the water column	Seawater quality	None				None
	Release of contaminants and/ or nutrients to the water column	Seawater quality	None		None		None
	Sedimentation on the seabed	Bathymetry and sediments	None				None
	Generation of underwater noise	Marine mammals**	None		None		None
Munitions clearance	Release of sediments to the water column	Seawater quality					
	Release of contaminants and/ or nutrients to the water column	Seawater quality					
	Sedimentation on the seabed	Bathymetry and sediments					
	Generation of underwater noise	Marine mammals**	3a, 3b, 5	3c	3a, 3b, 3d	3c	
		Fish**	None		None		
Dredging	Release of sediments to the water column	Seawater quality	6				
	Release of contaminants and/ or nutrients to the water column	Seawater quality	6				
	Sedimentation on the seabed	Bathymetry and sediments	6				



Project component	Potential source of transboundary impact	Potential receptor for transboundary impact	Parties of Origin										
			Russia	Finland	Sweden								
<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="background-color: #cccccc;">Negligible</th> <th style="background-color: #ffff00;">Minor</th> <th style="background-color: #ffcc00;">Moderate</th> <th style="background-color: #ff0000;">Major</th> </tr> </thead> </table> <p><b>Impact ranking:</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;"><b>None</b></td> <td>No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.</td> </tr> <tr> <td></td> <td>No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.</td> </tr> </table> <p>Project components, sources of transboundary impacts and relevant receptors have been derived from the relevant sections of Chapter 10 – Assessment of environmental impacts.</p> <p>* Relevant to the Kaliningrad region only.</p> <p>** Ranking is the highest one that could be experienced by the specified receptor (for impacts resulting from blast injury, onset of PTS or TTS) at the <i>population</i> level. Rankings for lower scoring impacts and those at the <i>individual</i> level are provided in the text.</p> <p>3 = Marine mammals (3a Harbour porpoise, 3b grey seal, 3c Gulf of Finland ringed seal, 3d Gulf of Riga and Archipelago ringed seal)</p> <p>5 = Natura 2000 and other designated site</p> <p>6 = Monitoring stations</p>						Negligible	Minor	Moderate	Major	<b>None</b>	No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.		No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.
Negligible	Minor	Moderate	Major										
<b>None</b>	No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.												
	No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.												

### In-combination impacts

In Russian and Finnish waters, munitions will be cleared one by one. The distance between the dredging in the landfall area in Russia and locations where rock placement will be carried out is so large that there will be no 'in-combination impacts' between the seabed intervention works. Similarly, the rock berms at the seabed will be constructed one by one or in sufficient distance and the sediment plumes will settle within a short time. Therefore, there will be no 'in-combination impacts' between seabed intervention works. It is concluded that no 'in-combination impacts' will occur.

#### 15.4.2.4 Assessment of potential transboundary environmental impacts on Latvia

Latvia shares EEZ borders with Sweden and could thus be subject to transboundary impacts arising from activities in Sweden. The closest distance from the Latvian EEZ to the NSP2 alignment is over 25 km. Although there is the potential for the release of sediment into the water column (and the associated spread of contaminants/sedimentation) and generation of underwater noise within Swedish waters as a result of seabed intervention works, the large distances between these activities in Swedish waters and the Latvian EEZ is such that no transboundary impacts have been identified.

#### 15.4.2.5 Assessment of potential transboundary environmental impacts on Lithuania

Lithuania shares EEZ borders with Sweden and could thus be subject to transboundary impacts arising from activities in Sweden. The closest distance from the Lithuanian EEZ to the NSP2 alignment is over 45 km. Although there is the potential for the release of sediment into the water column (and the associated spread of contaminants/sedimentation) and generation of underwater noise within Swedish waters as a result of seabed intervention works, the large distances between these activities in Swedish waters and the Lithuanian EEZ is such that no transboundary impacts have been identified.

#### **15.4.2.6 Assessment of potential transboundary environmental impacts on Poland**

Poland shares EEZ borders with Germany, Denmark and Sweden and could thus be subject to transboundary impacts arising from activities in these countries. The closest distance from the Polish EEZ to the NSP2 alignment in each country is 13, 11 and 40 km, respectively. Although there is the potential for the release of sediment into the water column (and the associated spread of contaminants/sedimentation) and generation of underwater noise as a result of seabed intervention works, the large distances between these activities in German, Swedish and Denmark waters and the Polish EEZ is such that no transboundary impacts have been identified.

#### **15.4.2.7 Assessment of potential transboundary environmental impacts on Sweden**

NSP2 will cross the EEZ boundaries between both the Finnish and Swedish waters, and the Swedish and Danish waters; other than at these crossing points, its alignment in Finnish and Danish waters will not run close to Swedish waters. Hence any potential for transboundary impacts into Swedish waters from other PoOs will be restricted to those occurring in the vicinity of the two EEZ boundary crossings.

Post-lay trenching/rock placement will be performed in Denmark but given the distance between the closest section for post-lay trenching/rock placement in Denmark and the Swedish border (a minimum of 35 km), no suspended sediment (or associated contaminants and sedimentation) will reach the Swedish EEZ. Numerical modelling has also been performed for underwater noise from rock placement activities in Danish waters and it has been concluded that no sound levels above ambient will reach the Swedish EEZ. Consequently, no transboundary impacts will reach the Swedish EEZ as a result of activities in Denmark.

Some post-lay rock placement in Finland is planned approximately 5 km from the Finnish-Swedish EEZ border. Modelling of the sediment spill during rock placement has shown that it will not reach Swedish waters (Figure 15-9). Munitions are not expected to be cleared in the western part of the Gulf of Finland; therefore given the distance between the closest munitions clearance in Finland and the Swedish border, no transboundary impacts are anticipated.

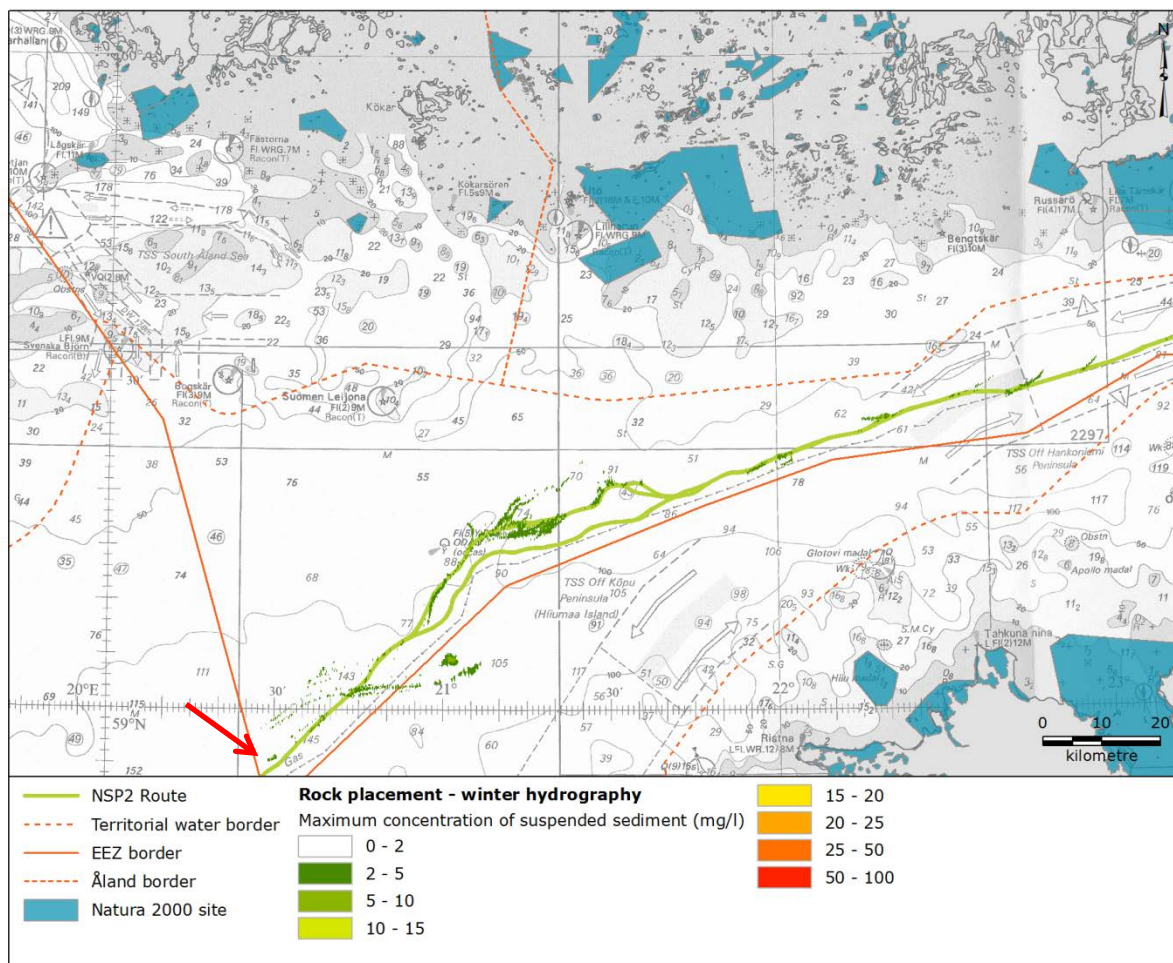


Figure 15-9 Modelled sediment dispersion from rock placement in the western Gulf of Finland.

#### 15.4.2.8 Assessment of potential transboundary environmental impacts on Denmark

Denmark shares EEZ borders with Sweden and Germany and could thus be subject to transboundary impacts arising from activities in these countries. Although there is the potential for the release of sediment into the water column (and the associated spread of contaminants/sedimentation) and generation of underwater noise as a result of seabed intervention works, the large distances between these activities in Swedish and German waters and Danish waters is such that no transboundary impacts have been identified. The closest potential rock placement or post-lay trenching locations in Germany and Sweden are 10 km and >45 km respectively, whilst the dredged section in Germany is over 25 km from the EEZ border with Denmark. Only back-to-back impacts as described in Section 15.3 have been identified.

#### 15.4.2.9 Assessment of potential transboundary environmental impacts on Germany

NSP2 will cross the border between the Danish EEZ and German EEZ; other than at this point, its alignment will in Danish EEZ not run close to the German EEZ. The distance between the closest intervention works in Denmark (post-lay trenching/rock placement) to the German EEZ is approximately 20 km. Modelling has shown that neither suspended sediments nor underwater noise impacts will reach the German EEZ. Consequently, no transboundary impacts from this will occur. Only back-to-back impacts as described in Section 15.3 have been identified.

### 15.5 Transboundary impacts from unplanned (accidental) events

Potential unplanned events include oil/fuel spills or ship collisions and are discussed further in Chapter 13 – Risk assessment.

### 15.5.1 Risk and transboundary impacts from oil spills

The risks associated with oil spills are described and evaluated in Chapter 13 – Risk assessment, where the increased ship traffic and the corresponding calculated increased frequency of ship collisions are assessed.

Depending on where a ship collision and any consequent oil spill occurs, there may be a risk of transboundary impacts. The risk is low, but if a larger oil spill occurs, the impacts on the marine environment can be significant, depending on when contingency measures are initiated. See Section 13.2.3.2 for further on the assessment of environmental impacts from an oil spill.

In HELCOM Recommendation 11/13, it is recommended that governments of the contracting parties to the Helsinki Convention should, in establishing national contingency plans, aim at developing the ability of their combating services.

It is recommended that contracting parties take the following steps to enable them to deal with spillages of oil and other harmful substances at sea:

- Maintain emergency response readiness permitting the first response unit to start from its base within two hours after having been alerted;
- Reach any place of spillage that may occur in the response region of the respective country within six hours from its start;
- Ensure well-organised, adequate and substantial response actions on the site of a spill as soon as possible, normally within a time not exceeding 12 hours.

It is recommended that contracting parties respond to major oil spillages:

- Within a time period which does not normally exceed two days and remove offshore pollution using mechanical collection devices. If dispersants are used, they must be used in accordance with HELCOM Recommendation 1/8, taking into account a time limit for the effective use of dispersants;
- To make available sufficient and suitable storage capacity for disposal of recovered or lighter oil within 24 hours after receiving information on the outflow quantity.

Based on HELCOM Recommendation 11/13, it is assumed that the countries around the Baltic Sea are capable of controlling a major oil spill within two days of a release. Therefore impacts on the marine environment, both regional and transboundary, will be minimised. See Section 13.5 for further on emergency preparedness and response.

### 15.5.2 Risk and transboundary impacts from gas release

The risks arising from a gas release are described and evaluated in Chapter 13 – Risk assessment. The probability of such an event is low.

If an accidental gas release were to occur, gas released from the NSP2 pipelines would probably rise through the water column as a plume of gas bubbles, eventually reaching the surface and dispersing into the atmosphere. The movement of gas through the water column would have the potential to impact marine organisms (such as fish and marine mammals), potentially resulting in acute or chronic impacts depending upon exposure levels. Given the offshore location of the NSP2 pipelines, affected socio-economic receptors would be limited to the existing vessel traffic of the Baltic Sea. However, as the gas is not toxic, atmospheric dispersion has no impact on the risk of fatalities, and no transboundary impacts would occur with respect to residential communities.

The total gas release frequency for the critical sections is estimated in Chapter 13 – Risk assessment, and it is considered that potential transboundary impacts would only occur if the leak were to occur in the immediate vicinity of the EEZ borders. The transboundary impact would

also depend on the type of leak, its magnitude and the type of repair required. See Section 13.3.3.5 for further on the assessment of environmental impacts from a gas release.

## 15.6 Conclusion and summary of all transboundary impacts from PoO countries on AP countries

The assessment of transboundary impacts draws extensively upon the findings of the impact assessment presented in Chapter 10 – Assessment of environmental impacts, which was performed in line with the impact assessment methodology presented in Chapter 7 – Method adopted for production of Espoo environmental assessment documentation and identified where there could be potential for the occurrence of transboundary impacts. Such potential transboundary impacts have been considered at two levels, i.e. where the impacts are primarily experienced at the country level and where the impacts are primarily experienced on a regional or global scale.

The assessment documented in Section 15.3 has shown that NSP2 will not lead to any significant transboundary impacts on a regional or global level. Impacts caused by NSP2 on the receptors in Baltic Sea region range from negligible to minor.

In relation to country level transboundary impacts, the following sources of impact have been further evaluated (see Section 15.4) to determine whether they may occur, and if so, their ranking:

- Release of sediments to the water column;
- Release of contaminants and/or nutrients to the water column;
- Sedimentation on the seabed;
- Generation of underwater noise.

This analysis has identified that of these, only the generation of underwater noise from munitions clearance (Russia and Finland) could result in **potentially significant** (at most moderate) transboundary impact. This relates to onset of permanent hearing loss and a degree of blast injury for the Gulf of Finland population of ringed seal. Three countries could potentially be affected by such transboundary impacts, i.e. Finland (from activities in Russia), Russia (from activities in Finland) and Estonia (from activities in both Russia and Finland), but will be limited to the eastern part of the Gulf of Finland where the ringed seal population is present.

For a substantial length of the Estonian border with Finland, the Gulf of Finland ringed seal population is largely absent so that impacts would be limited to grey seals and Gulf of Riga and Archipelago populations of ringed seals and harbour porpoise, resulting in a **minor** impact ranking, which is not significant.

The Uhtju Natura 2000 site (SAC EE0060220) in Estonia, the Pernaja and Pernaja Archipelago Natura 2000 site (FI0100078) which includes sanctuaries in Finland designated for seals are located on the outer limit of the temporary and reversible impact zones for both seal species, so that there is a small risk of TTS at the border of these sites. Consideration of the possible impacts on Natura 2000 sites (including the above sites) has been carried out and concluded that any potentially transboundary impact on them will be at most **minor** (from munition detonation in Russia), and therefore **not significant**.

All other sources of impact during construction and operation of NSP2 will, at most, lead to negligible (i.e. **not significant**) impacts on any of the APs. Table 15-7 provides a summary of all assessed sources of impacts from PoO countries on AP countries and the transboundary impact rankings that may result from them.

Table 15-7 Summary of the potential transboundary impacts.

PoO	Project component	Potential source of transboundary impact	AP								
			RU*	FI	SE	DK	GE	EST	LAT	LIT	POL
Russia	Rock placement	Release of sediments to the water column		None				None			
		Release of contaminants and/or nutrients to the water column		None				None			
		Sedimentation on seabed		None				None			
		Generation of underwater noise **		None				None			
	Munitions clearance	Release of sediments to the water column		1				1			
		Release of contaminants and/or nutrients to the water column		1				1			
		Sedimentation on seabed		2				2			
		Generation of underwater noise **		3a, b,5	3c	4			3a, b,5	3c	
	Dredging	Release of sediments to the water column		None				1,6			
		Release of contaminants and/or nutrients to the water column		None				1,6			
		Sedimentation on seabed		None				2,6			
		Generation of underwater noise **		None							
Finland	Rock placement	Release of sediments to the water column	None		None			1			
		Release of contaminants and/or nutrients to the water column	None		None			None			
		Sedimentation on seabed	None		None			2			
		Generation of underwater noise **	None		None			None			
	Munitions clearance	Release of sediments to the water column	1		None			1			
		Release of contaminants and/or nutrients to the water column	1		None			1			
		Sedimentation on seabed	2		None			2			
		Generation of underwater noise **	3a, b	3 c	4		None		3a, b,d	3c	
Sweden	Rock placement	Release of sediments to the water column	None	None		None		None	None	None	None
		Release of contaminants and/or nutrients to the water column	None	None		None		None	None	None	None
		Sedimentation on seabed	None	None		None		None	None	None	None
		Generation of underwater noise **	None	3a,b, 4		None		None	None	None	None
	Post-lay trenching	Release of sediments to the water column	None	None		None			None	None	None
		Release of contaminants and/or nutrients to the water column	None	None		None				None	None

PoO	Project component	Potential source of transboundary impact	AP									
			RU*	FI	SE	DK	GE	EST	LAT	LIT	POL	
		Sedimentation on seabed	None	None		None				None	None	None
		Generation of underwater noise **	None	None		None				None	None	None
Denmark	Rock placement	Release of sediments to the water column			None		None					None
		Release of contaminants (incl. CWA) and/or nutrients to the water column			None		None					None
		Sedimentation on seabed			None		None					None
		Generation of underwater noise **			None		None					None
	Post-lay trenching	Release of sediments to the water column			None		None					None
		Release of contaminants and/or nutrients to the water column			None		None					None
		Sedimentation on seabed			None		None					None
		Generation of underwater noise **			None		None					None
Germany	Rock placement	Release of sediments to the water column				None						None
		Release of contaminants and/or nutrients to the water column				None						None
		Sedimentation on seabed				None						None
		Generation of underwater noise **				None						None
	Dredging	Release of sediments to the water column				None						None
		Release of contaminants and/or nutrients to the water column				None						None
		Sedimentation on seabed				None						None
		Generation of underwater noise **				None						None

**Impact ranking:**

Negligible	Minor	Moderate	Major
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<b>None</b>	No transboundary impact predicted to occur from those potentially identified as transboundary in the assessment reported in Chapter 10 – Assessment of environmental impacts.
	No potential for transboundary impact identified in the assessment reported in Chapter 10 – Assessment of environmental impacts.

PoO	Project component	Potential source of transboundary impact	AP								
			RU*	FI	SE	DK	GE	EST	LAT	LIT	POL
<p>*: Including the Kaliningrad region.</p> <p>** : Ranking is the highest one that could be experienced by specified receptor (for impacts resulting from blast injury, onset of PTS or TTS) at the <i>population</i> level. Rankings for lower scoring impacts and those at the <i>individual</i> level are provided in the text.</p> <p>Affected receptor:</p> <ul style="list-style-type: none"> <li>1 = Seawater quality</li> <li>2 = Bathymetry</li> <li>3 = Marine mammals (3a Harbour porpoise, 3b grey seal, 3c Gulf of Finland ringed seal, 3d Gulf of Riga and Archipelago ringed seal)</li> <li>4 = Fish</li> <li>5 = Natura 2000 and other designated sites</li> <li>6 = Monitoring stations</li> </ul>											



## 16. MITIGATION MEASURES

Nord Stream 2 AG is committed to designing, planning and implementing the project with the lowest impact on the environment as is reasonably practicable. The environmental and social management system (ESMS), which will ensure that the mitigation measures described below are implemented during the construction and operation phases of NSP2, is detailed in Chapter 17 – Environmental management.

In developing mitigation measures, the primary goal of the process has been to avoid or minimise any identified negative impacts. If it has been impossible to avoid an impact (i.e. there is no other technical or economically feasible alternative), minimisation measures have been planned. In cases where it is not possible to reduce the significance of negative environmental impacts through management actions, restoration or offset measures will be considered.

A key objective during the planning and designing of NSP2 has been to identify the means of reducing the impact of the project on the receiving environment. To achieve this, mitigation measures have continually been developed and integrated into the various phases of the project in accordance with the mitigation hierarchy (as reflected in the box below and repeated in Chapter 5 – Alternatives for ease of reference). The Nord Stream 2 AG approach to developing design related mitigation addressing avoidance measures with respect to route planning and construction methods is described in the assessment of alternatives in Chapter 5 – Alternatives. This chapter primarily addresses minimisation, restoration and offset measures for the project scheme, as described in Chapter 6 – Project description.

These mitigation measures have been identified through the consideration of legal requirements, best practice industry standards, applicable international standards (including World Bank EHS Guidelines and International Finance Corporation Performance Standards), experience from NSP and other infrastructure projects, as well as the application of expert judgement.

## Mitigation philosophy and approach

### Avoidance

Avoidance or prevention of potentially negative impacts can be achieved through an iterative planning and design process. For example, where feasible, it has been possible to prevent potentially negative environmental impacts by locating the pipelines away from sensitive or valuable receptors, such as Natura 2000 sites and cultural heritage sites, and by avoiding areas contaminated by CWAs. Avoidance reduces the need for further steps in the mitigation hierarchy.

### Minimisation

For impacts that cannot be completely avoided, management actions can be implemented to minimise the duration, intensity, extent and/or likelihood of impacts (addressing noise levels, turbidity thresholds, discharge limits, communication, etc.). For example, potential impacts from interaction with military practice areas can be mitigated by advance contact and coordination with the appropriate authorities.

### Restoration

Restoration involves the re-establishment of the composition, structure and function of an ecosystem with the aim of returning it to its original (pre-disturbance) state or to a healthy state (close to the original).

### Offset measures

Generally considered as the final stage in the mitigation hierarchy, offset measures will be considered for impacts that cannot be avoided, minimised or reversed. Offsets can be physical (e.g. contributing to long-term biodiversity improvements) or economic (e.g. compensating fishermen for reduced fishing areas).

## 16.1 Offshore physical-chemical environment

Table 16-1 summarises the measures that Nord Stream 2 AG will adopt to mitigate potential impacts to receptors within the physical-chemical environment, as identified in Chapter 10 – Assessment of environmental impacts. The sources of impact provided below correspond to those identified in Table 8-1.

**Table 16-1 Measures to mitigate potential impacts to receptors within the offshore physical-chemical environment.**

Source of impact	Mitigation measure	R	F	S	D	G
Releases of air pollutants and contaminants to the water column (from vessel operation)	All project vessels will be compliant with the requirements of the Helsinki Convention (Convention on the Protection of the Marine Environment of the Baltic Sea Area) and the prescriptions for the Baltic Sea Area as a MARPOL 73/78 Special Area.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from unplanned events)	An Oil Spill Prevention and Response Plan (OSPRP) will be produced as a contingency for Tier 2 and 3 spills.	X	X	X	X	X
Release of contaminants to the water column (from	Tier 1 oil spills will be responded to using an approved Shipboard Oil Pollution Emergency Plan (SOPEP). The	X	X	X	X	X

Source of impact	Mitigation measure	R	F	S	D	G
vessel operation)	SOPEP will cover hazardous materials, waste and oil.					
Release of contaminants to the water column (from vessel operation)	Prior to deployment to the project and on a routine basis during construction activities, hydraulic equipment, including dredger buckets, cutters, and hoses, will be inspected to avoid accidental leakage of fluids.	X	X	X	X	X
Release of contaminants to the water column (from vessel operation)	Hazardous materials management plans will be developed and implemented to safeguard both environmental and human health.	X	X	X	X	X
Release of contaminants to the water column (from vessel operation)	Dedicated chemical stores on vessels will be equipped with closed drainage systems or secondary containment which prevent any spills from entering the marine environment.	X	X	X	X	X
Release of contaminants to the water column (from vessel operation)	Inventories of hazardous materials will be maintained on vessels and associated Material Safety Data Sheets (MSDS) will be held for all chemicals used on project vessels. Hazardous materials will be stored, labelled and packaged in a secure manner in line with the requirements of MARPOL Annex III.	X	X	X	X	X
Release of contaminants to the water column (from vessel operation)	Repairs to vessels and construction equipment associated with offshore works that are undertaken in harbours in the region will be managed to avoid any chemical or hydrocarbon contamination of the quay side and water body.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from vessel operation)	Contractor waste management plan(s) and supporting procedures will be developed and implemented for each vessel.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from vessel operation)	Approved and licensed waste contractors will be engaged for waste disposal.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from vessel operation)	All NSP2 contractors will implement systems for the minimisation, sorting, and segregation of the different waste streams in order to optimise recycling opportunities and to minimise the mixing of different types of waste.	X	X	X	X	X
Release of contaminants to the water column (from vessel operation)	All engineering, operational planning and actual operations will ensure zero discharge of chemicals, oil rags and other hazardous materials to sea. Hazardous materials management plans will be developed and implemented to safeguard both environmental and human health.	X	X	X	X	X

Source of impact	Mitigation measure	R	F	S	D	G
Release of contaminants and/or nutrients to the water column (from vessel operation)	In line with IFC EHS Guidelines, antifouling coatings applied to project vessels, will be free of tributyltin (TBT) or other biocides that are harmful to fresh or brackish water environments.	X	X	X	X	X
Release of sediments to the water column (from pre-lay trenching)	Dredge Spoil and Turbidity Management Plans will be developed to address threshold turbidity levels above which dredging activities will have to be temporarily suspended or modified dredge and backfill techniques will have to be implemented. Such plans will incorporate: <ul style="list-style-type: none"> <li>• Continuous turbidity measurements from fixed stations located in the vicinity of dredging activities and from background turbidity monitoring stations.</li> <li>• Procedures and contingency plans in the event that turbidity levels are greater than allowed, including remedial action to temporarily suspend activities where threshold turbidity levels defined by Nord Stream 2 AG are exceeded.</li> <li>• Spoil handling, dredging, transport, storage and backfilling at all work locations.</li> <li>• Dredger equipment will be selected to minimise impacts.</li> </ul>	X				X
Release of sediments to the water column (from pre-lay trenching)	Leakage of dredge spoils into the marine environment from trailer suction hopper dredgers and dump barges, where used, will be avoided.	X				X
Release of sediments to the water column (from pre-lay trenching)	As far as practicable, dredged spoil material will be re-used as backfill material.	X				X
Physical changes to seabed features, release of sediments to water column; sedimentation on seabed (from rock placement)	Rock placement will be a controlled operation utilising a fall pipe and instrumented discharge head located near the seabed to ensure precise placement of rock material.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from rock placement)	Clean rock will be used offshore and will be free of clay, silt and lime, and contaminants such as heavy metals that can be dissolved in the water.	X	X	X	X	X
Physical changes to seabed features (from all construction activities)	No work equipment, cables or other objects will be dumped into the sea or left on the seabed.	X	X	X	X	X

Source of impact	Mitigation measure	R	F	S	D	G
Physical changes to seabed features (from all construction activities)	In those areas where an anchored lay barge will be used, an anchor corridor survey will be completed to identify, verify and catalogue potential obstructions or sensitive features. 'No-go zones' for anchor placement will be identified and implemented.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from unplanned events)	All NSP2 worksites, including those operated by contractors and suppliers, will have an emergency notification plan and assigned emergency responders to ensure proper and fast reaction to and management of emergencies.  The emergency response plans for offshore activities will be in line with HELCOM requirements, including provision for the mitigation of impacts caused by unplanned environmental accidents (e.g. fuel/oil spill, disturbance of dumped munitions, pipeline failure or sea accidents/collisions).	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from unplanned events)	Emergency plans will include response procedures, assignment of responsibilities for key safety protocols, safety equipment and resourcing, training and drills, and measures to periodically review and revise the plans. Key consultation activities will be included as a part of planning.	X	X	X	X	X
Release of contaminants and/or nutrients to the water column (from unplanned events)	All incidents and nonconformities are reported to Nord Stream 2 AG management. In the event of emergencies, the authorities will be notified in accordance with the emergency response plan.	X	X	X	X	X
Physical changes to seabed features, release of sediments to water column; sedimentation on seabed (from pre-lay trenching and backfilling)	Measures will be undertaken to minimise seabed intervention in hard soil biotopes within the Site of Community Interest (SCI) in the Territorial Waters, Mecklenburg-West Pomerania (see Table 16.2, row 12).					X
Physical changes to seabed features; release of sediments to water column; sedimentation on seabed (from pre-lay trenching and backfilling)	The following measures will be undertaken to minimise seabed intervention in soft soil biotopes within the Greifswalder Bodden in the Territorial Waters off Mecklenburg Vorpommern:  <ul style="list-style-type: none"> <li>• The route optimisation process will seek to minimise disturbance to soft soil areas which are designated as biotypes 1110 and 1160 and which are the subject of biotope protection according to § 30 BNatSchG.</li> <li>• Both pipeline strings will be laid in a common trench with a bottom width as narrow as possible within the SCI areas to be crossed.</li> </ul>					X

Source of impact	Mitigation measure	R	F	S	D	G
	<ul style="list-style-type: none"> <li>• The cover above the pipelines within trenches will be minimised in order to reduce trenching volumes.</li> <li>• Where feasible, the trench profile will be constructed with a steep slope angle (preferably 1:2.5).</li> <li>• Dredging techniques will be selected to ensure compliance with required tolerances for dredging parameters within the SCI areas "Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht" (DE 1749-302) and "Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom" (DE 1747-301).</li> </ul>					
Physical changes to seabed features (from pre-lay trenching and backfilling)	<p>The following measures will be undertaken to restore the seabed around the trench areas and within the temporary marine storage site in the Territorial Waters off Mecklenburg-West Pomerania:</p> <ul style="list-style-type: none"> <li>• Offshore construction activities, including pipe-laying, will be phased to ensure that the period is minimised in which the pipe trenches are left open.</li> <li>• Excavated spoil will be used as much as possible for backfilling of the pipeline trenches.</li> <li>• The bathymetry of the seabed in the vicinity of the trenches and the temporary storage site near the island of Usedom (which will be cleared) will be reinstated to the following tolerances: pipeline trenches <math>\pm 20</math> cm, temporary storage site <math>\pm 50</math> cm.</li> <li>• During backfilling of the pipeline trenches, the properties of the seabed substrate (topsoil) will be restored to the best possible extent. The upper 30 cm of the excavated soil material, which is populated by macrozoobenthos, is to be stored separately in accordance with the dredge spoil plan and backfilling will be undertaken to ensure that the topsoil is returned to its original location in the trench.</li> <li>• For reef areas (LRT 1170) within SCI, the original reef structures will be surveyed, mapped and reinstated (after the backfilling of the pipe trenches) using stone with a grain sizes of between 63 and 200 mm. The local, naturally occurring till is to be replaced by imported intimate backfill comprising a sand and gravel mix. In total, a hard ground surface of approx. 60,000 m<sup>2</sup> is to be restored.</li> </ul>					X

Mitigation measure applicability: R = Russia; F = Finland; S = Sweden; D = Denmark; G = Germany.

## 16.2 Offshore biological environment

Table 16-2 summarises the measures that Nord Stream 2 AG will adopt to mitigate potential impacts to receptors within the biological environment, as identified in Chapter 10 – Assessment of environmental impacts. The sources of impact provided below correspond to those identified in Table 8-2.

**Table 16-2 Measures to mitigate potential impacts to receptors within the offshore biological environment.**

Source of impact	Mitigation measure	R	F	S	D	G
Introduction of non-indigenous species (from vessel operation)	<p>Ballast water management plans will include measures to ensure adherence to OSPAR/HELCOM General Guidance on the Voluntary Interim application of the D1 Ballast Water Exchange Standard in the North East Atlantic.</p> <p>To reduce the risk of non-indigenous species invasion through ballast water, project vessels will conduct ballast water exchange before entering the Baltic Sea.</p> <p>Vessels leaving the Baltic Sea and transiting through the North-East Atlantic to other destinations will not exchange ballast water in the Baltic Sea or until the vessel is 200nm off the coast of North-West Europe and in waters deeper than 200m.</p> <p>Ballast tanks will be cleaned regularly and washing water delivered to reception facilities ashore in line with IFC EHS Guidelines on shipping and the International Convention for the Control and Management of Ships' Ballast Water and Sediments.</p>	X	X	X	X	X
Generation of underwater noise (from munitions clearance)	To minimise munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland.	X	X			
Generation of underwater noise (from munitions clearance)	Route planning will take the presence of munitions on the seabed into account and where possible, the pipelines will be routed around munitions to avoid the impacts associated with clearing.	X	X	X	X	X
Generation of underwater noise (from munitions clearance)	If consistent with safe practice and in agreement with competent authorities, conventional munitions that cannot be avoided through pipeline rerouting will be relocated away from the pipelines corridor.	X	X			X
Generation of underwater noise (from munitions clearance)	In agreement with the competent authorities, where conventional munitions are required to be cleared through <i>in situ</i> detonation, mitigation measures will be implemented to avoid or reduce potential impacts on fish, diving seabirds and marine mammals.	X	X			
Generation of underwater	In agreement with the competent authorities, marine	X	X			

Source of impact	Mitigation measure	R	F	S	D	G
noise (from munitions clearance)	mammal observers (MMOs) will be stationed on munitions clearance vessels to check for the presence of marine mammals and diving seabirds (such as sea-ducks and auks) and detonation will be delayed if they are observed in the area.					
Generation of underwater noise (from munitions clearance)	In agreement with competent authorities, acoustic deterrent devices (ADDs, also referred to as "scrammers") for seals and harbour porpoises will be deployed prior to detonation to drive animals away from the detonation zone. Several ADDs in appropriate arrays will be used if required to increase the area of the avoidance zone.	X	X			
Presence of vessels (from pipe-laying and rock placement)	Construction activities, such as pipe-laying and rock placement, are not foreseen in the winter ice conditions. Should work be performed in "marginal" winter ice, then the necessary safety measures shall be implemented in coordination with the maritime authorities; moreover, should there be a potential impact on breeding seals, the competent environmental authority will be notified with supporting impact assessment and mitigation measures.	X	X			
Presence of vessels (from pipe-laying, rock placement and post-lay trenching)	In order to avoid unnecessary disturbance on birds and harbour porpoises, the major shipping lanes will be used by project vessels as far as practical. Areas marked as "areas to be avoided" on the Swedish nautical chart will be avoided. When passing through the main area in between Hoburgs bank and Northern Midsjöbank, project vessels will be channelled.			X		
Presence of vessels (from pipe-laying and pre-lay trenching and backfilling)	To avoid impacts associated with the herring spawning and seabird resting periods in German waters, the following seasonal restrictions will apply to offshore construction activities, excluding the associated survey works: <ul style="list-style-type: none"> <li>• <b>15 May – 31 December.</b> Within Natura 2000 sites DE 1747-402, 1747-301 and DE 1749-302, construction activities will be restricted to this period. This restriction applies between shoreline and KP 53, which includes the Greifswalder Bodden.</li> <li>• <b>1 September – 31 December.</b> Within Natura 2000 sites DE 1649-401 and 1552-401, construction activities will be restricted to this period. This restriction applies between KP 53 and KP 17.</li> <li>• <b>15 May – 31 December.</b> Within Natura 2000 site DE 1552-401, construction activities will be restricted to this period. This restriction applies between KP 17 and KP 0 (German EEZ boundary).</li> <li>• <b>15 May – 31 October.</b> Within Natura 2000 site DE 1552-401, stationary construction activities, such as above water tie in, are further restricted to this period between KP 17 and KP 10.</li> </ul>					X



Source of impact	Mitigation measure	R	F	S	D	G
Physical changes to seabed features, release of sediments to water column; sedimentation on seabed (from pre-lay trenching and backfilling)	<p>The following measures will be undertaken to minimise seabed intervention in hard soil biotopes within the Greifswalder Bodden and Site of Community Interest (Territorial Waters, Mecklenburg Vorpommern) respectively and to manage impacts on protected plants and animals:</p> <ul style="list-style-type: none"> <li>• The route optimization process will seek to minimise disturbance to reefs which are designated as biotope type 1170 (FFH-LRT 1170) and biotope types 1110 and 1160, and which are the subject of biotope protection according to § 30 BNatSchG.</li> <li>• Both pipeline strings will be laid in a common trench with a bottom width as narrow as possible within the SCI areas to be crossed.</li> <li>• The cover above the pipelines within trenches will be minimised in order to reduce trenching volumes.</li> <li>• Where feasible, the trench profile will be constructed with a steep slope angle (preferably 1:2.5).</li> <li>• Dredging techniques will be selected to ensure compliance with required tolerances for dredging parameters within the SCI areas "Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht" (DE 1749-302) and "Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom" (DE 1747-301).</li> </ul>					X
Release of sediments to the water column (from pre-lay trenching)	<p>Mechanical dredging equipment (e.g. back hoe dredgers) will be selected for trenching to minimise the impacts associated with turbidity plumes within the Greifswalder Bodden and the Boddenrandschwelle, FFH-areas, and SCI areas (Territorial Waters Mecklenburg-West Pomerania). This equipment will reduce sediment losses, thereby reducing turbidity, including the suspension of nutrients and pollutants, and will minimise spoil volumes.</p> <p>Hydraulic dredging techniques (e.g. trailing suction hopper dredger) will only be used in the Greifswalder Bodden for backfilling and if trench maintenance dredging is required prior to pipe-lay.</p>					X
Light (from offshore working areas)	Light emissions generated during offshore construction activities (EEZ, Territorial Waters Mecklenburg-West Pomerania) will be limited to active work areas and will be managed through directional lighting and other measures to allow for safe working conditions, while at the same time, avoiding excessive or unnecessary light pollution.					X
Physical changes to	The seabed disturbed by trenching activities and backfilling at					X

Source of impact	Mitigation measure	R	F	S	D	G
landform and site restoration	<p>the marine temporary storage site (Territorial Waters Mecklenberg-West Pomerania) will be restored and impacts will be managed as follows:</p> <ul style="list-style-type: none"> <li>• Offshore construction activities, including pipe-laying, will be phased to ensure that the period is minimised in which the pipe trenches are left open.</li> <li>• Excavated spoil will be used as much as possible for backfilling of the pipeline trenches.</li> <li>• The bathymetry of the seabed in the vicinity of the trenches and the temporary storage site near the island of Usedom (which will be cleared) will be reinstated to the following tolerances: pipeline trenches <math>\pm 20</math> cm, temporary storage site <math>\pm 50</math> cm).</li> <li>• During backfilling of the pipeline trenches, the properties of the seabed substrate (topsoil) will be restored to the best possible extent. The upper 30 cm of the excavated soil material, which is populated by macrozoobenthos, is to be stored separately in accordance with the dredge spoil plan and backfilling will be undertaken to ensure that the topsoil is returned to its original location in the trench.</li> <li>• For reef areas (LRT 1170) within SCI, the original reef structures will be surveyed, mapped and reinstated (after the backfilling of the pipe trenches) using stone with a grain sizes of between 63 and 200 mm. The local, naturally occurring till is to be replaced by imported intimate backfill comprising a sand and gravel mix. In total, a hard ground surface of approx. 60,000 m<sup>2</sup> is to be restored.</li> </ul>					

Mitigation measure applicability: R = Russia; F = Finland; S = Sweden; D = Denmark; G = Germany.

### 16.3 Socio-economic receptors (including cultural heritage)

Table 16-3 summarises the measures that Nord Stream 2 AG will adopt to mitigate potential impacts to receptors within the socio-economic environment, as identified in Chapter 10 – Assessment of environmental impacts. The sources of impact provided below correspond to those identified in Table 8-3.

**Table 16-3 Measures to mitigate potential impacts to socio-economic receptors (including cultural heritage).**

Source of impact	Mitigation measure	R	F	S	D	G
Release of contaminants to the water column (from pipe-laying and seabed intervention activities)	In the event that chemical munitions are encountered through design surveys, a local rerouting will be performed to avoid interaction.				X	

Source of impact	Mitigation measure	R	F	S	D	G
Release of contaminants (from pipe-laying and seabed intervention activities)	In areas with potential risk of chemical munitions, precautionary measures to prevent human contact with chemical agents will be undertaken. This will include adequate training of staff and the provision of equipment in accordance with the HELCOM guidelines for preventative measures and first aid.				X	
Release of contaminants (from pipe-laying)	Contact with identified chemical munitions will be avoided by marking the positions of the munitions in the navigation database as "areas to avoid". The anchor touchdown points and anchor wire sweep will then be planned to circumvent the positions of the identified chemical munitions. This procedure is considered to negate the impacts from known chemical munitions.				X	
Release of contaminants (from pipe-laying and seabed intervention activities)	Chemical munitions that are identified as chance finds during construction and over the operating life of the pipeline will be managed through the Chance Finds Procedure. The identification and handling of munitions will be agreed with the Admiral Danish Fleet (ADF).				X	
Release of contaminants (during operation)	Contact with any dumped chemical munitions will be avoided in the operation phase and munitions will be left where found.				X	
Physical changes to seabed features (from pipe-laying)	Where the pipelines cross existing infrastructure such as cables and pipelines, Nord Stream 2 AG will liaise with the owner of the installations regarding designs for safe crossing.	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	Cable crossing designs will ensure that: <ul style="list-style-type: none"> <li>• A separation is maintained between the pipeline and the cable by either concrete mattress or placed rock.</li> <li>• The operation of the cable will not be impaired.</li> </ul>	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	Pipe-lay activities at cable crossing locations will be monitored through pipeline touch-down monitoring (TDM) to ensure accurate pipe-laying on top of protective concrete mattresses and to avoid damage to cables.	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	Anchor procedures will ensure that interaction with existing pipelines and cables is avoided. This will include: <ul style="list-style-type: none"> <li>• Anchor patterns to safely avoid sensitive sites and ensure compliance with safety distances including ICPC standards for cables;</li> <li>• Lifting and control of anchors, including use of mid-wire buoys to limit the length of the anchor wire in contact with the seabed in the vicinity of sensitive sites and existing infrastructure;</li> <li>• Lifting anchors rather than dragging along the seabed during relocation by anchor handling vessels.</li> </ul>	X	X	X	X	X

Source of impact	Mitigation measure	R	F	S	D	G
Physical changes to seabed features (from pipe-laying)	In those areas where an anchored lay barge will be used, an anchor corridor survey will be completed to identify, verify and catalogue potential obstructions or sensitive features. Restricted zones will be identified and implemented as required to protect sensitive features.	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	In the pipeline routing process for NSP2, an initial avoidance buffer of up to 200 m (to be determined in consultation with the competent authorities) will be placed around all CHOs within the nearshore and offshore regions of the project area to provide for sufficient separation distances between wrecks and the pipeline route.  Route alternatives will be assessed to avoid impacts on wrecks and measures will be undertaken to ensure that wrecks of cultural heritage importance are protected. The final exclusion zone will be agreed with the competent authorities once the route has been finalised and installation vessel type has been confirmed.	X	X	X	X	X
Physical changes to seabed features (from trenching and pipe-laying)	The following authority coordination measures will be undertaken to address impacts on cultural heritage:  <ul style="list-style-type: none"> <li>• In order to prevent damage to cultural heritage objects, a safety distance between a given object and the NSP2 route will be defined in cooperation with the competent authorities. For objects located within this safety distance, further measures for prevention and mitigation of impacts, including vessel anchor patterns, will be agreed upon in cooperation with the competent authorities.</li> <li>• Should previously unknown cultural heritage objects be discovered during construction works, the competent authorities will be notified and, in cooperation with the authorities, a Chance Finds Procedure will be implemented.</li> <li>• A monitoring programme will be agreed between Nord Stream 2 AG and the competent authorities to verify that cultural heritage objects have not been affected by construction.</li> </ul>	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	For archaeologically significant wreck sites located within the anchor corridor, the competent cultural heritage authority will be consulted and control measures will be agreed to ensure that there will be no impact on these locations and objects.	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	Prior to construction, a pre-lay survey will be undertaken. Should unforeseen potential CHOs be encountered, the Chance Finds Procedure will be implemented.	X	X	X	X	X

Source of impact	Mitigation measure	R	F	S	D	G
Physical changes to seabed features (from pipe-laying)	Plans and procedures for the placement and use of pipe-laying vessel anchors will be prepared to ensure that wires and chains are used in a manner that avoids impacts on known cultural heritage sites.	X	X	X	X	X
Physical changes to seabed features (from pipe-laying)	A Chance Finds Procedure will be implemented to manage actions in the event of chance finds of objects that could potentially be cultural heritage objects, munitions, or existing installations.	X	X	X	X	X
Impacts on socio-economic receptors (for all relevant construction activities)	Stakeholder Engagement Plans that are geographically specific and tailored to project risks, impacts and the interests of the Affected Communities will be developed and implemented.	X	X	X	X	X
Impacts on socio-economic receptors (for all relevant construction activities)	Affected Communities will be provided with access to relevant project information to enable them to understand the risks, impacts and opportunities of the project.	X	X	X	X	X
Impacts on socio-economic receptors (for all relevant construction activities)	Affected Communities will be provided with the opportunity to express their views on project risks, impacts and mitigation measures.	X	X	X	X	X
Impacts on socio-economic receptors (for all relevant construction activities)	Where there are Affected Communities, a grievance mechanism will be established to receive and facilitate resolution of concerns and grievances about the project's environmental and social performance.	X	X	X	X	X
Restriction zones around DP and anchor vessels (associated with vessel movements)	The contractor will implement a safety zone in the order of 3,000 m (approximately 1.5 nm) for the anchor lay barge, 2,000 m (approximately 1 nm) for DP pipe-lay vessel, and 500 m radius for other vessels with restricted in their manoeuvrability, to be agreed with the authorities.	X	X	X	X	X
Restriction zones around DP and anchor vessels	For Traffic Separation Scheme (TSS) Off Kalbådgrund and TSS Off Porkkala Lighthouse, consultation will be taken with the pipe-lay contractor and competent authorities, regarding reducing the safety zone around the pipe-lay vessel from a radius of 1.0 nm to radius of 0.5 nm.		X			
Restriction zones around DP and anchor vessels (associated with vessel operation)	While installing the pipelines in the deep water route, a guard vessel will be used, as agreed upon by the Swedish authorities and Nord Stream 2 AG. The guard vessel will solely monitor the temporary safety zone in order to avoid violations. Project vessels may be used for this function.			X		
Restriction zones around DP and anchor vessels	At TSS Off Kalbådgrund Nord Stream 2 AG will have a tug vessel with appropriate capabilities for towing large vessels located on the 15.1 m shoal area during the pipe-lay periods.		X			

Source of impact	Mitigation measure	R	F	S	D	G
Restriction zones around DP and anchor vessels (associated with vessel movements)	Nord Stream 2 AG, in coordination with the relevant construction contractors and the Maritime Authority, will announce the locations of the construction vessels and the size of the requested Safety Exclusion Zones through Notices to Mariners in order to increase awareness of the vessel traffic associated with the project.	X	X	X	X	X
Restriction zones around DP and anchor vessels (associated with vessel movements)	Where appropriate for construction activities, a fisheries representative will be present on one of the construction vessels to provide direct information to the fishermen and other marine users.			X	X	
Restriction zones around DP and anchor vessels (associated with vessel movements)	Nord Stream 2 AG will communicate construction activities to operators of raw material extraction sites which are crossed by the pipeline route.					X
Physical changes to seabed features (from munitions clearance)	To minimise munitions clearance, a dynamically positioned lay barge will be used in the heavily mined areas of the Gulf of Finland. In the event that non-detonated munitions are identified near an underwater cultural heritage (UCH) site, there will be a case by case assessment made by a marine archaeologist, in consultation with the competent authorities. If clearance by detonation is to take place in the vicinity of an UCH site, the effects of the detonation will be assessed and measures will be taken to prevent damage to the UCH site.	X	X			
Release of sediments to water column, physical changes to seabed features (from munitions clearance and sea bed interventions)	Nord Stream 2 AG will coordinate with the Finnish Environmental Institute (SYKE) so that munitions clearance and rock placement activities would not be done simultaneously or just before (ca. one week) the annual benthos monitoring campaign. This is scheduled for May and is applicable to a radius of 2 km around the monitoring sites LL11, LL5, LL6A and LL7S.		X			
Presence of vessels and release of contaminants (from seabed intervention activities)	Should construction works be scheduled to be performed in the vicinity of long-term monitoring stations at a similar time to the planned measurement/sampling programme, then Nord Stream 2 AG will consult with the competent authority to minimise interference.			X	X	
Traffic disruption and safety (from land transport of rock)	Rock transport from the motorway along secondary roads to port facilities has the potential to impede traffic flow. Accordingly, Nord Stream 2 AG and its contractors will develop traffic management plans in consultation with the Roads Authority to address traffic congestion and safety. Consideration will be given to requesting the reprogramming of traffic lights to improve traffic flow by reducing stops at junctions.		X			
Traffic disruption and	Traffic management plans and supporting documentation will	X	X	X		X

Source of impact	Mitigation measure	R	F	S	D	G
safety (from land transport of materials)	be developed and implemented in consultation with road traffic authorities where transportation of materials to and from project worksites takes place.					
Emissions to air; noise generation; waste generation (from pipe storage and coating)	Nord Stream 2 AG will have a permanent site representative at the coating plants and yard facilities for the duration of the coating operations.		X			X
Physical changes to seabed features (from the presence of the pipeline)	No fishery restrictions will be imposed around the pipelines during operation.	X	X	X	X	X
Release of contaminants (from pipe-laying)	During project activities that include seabed interaction in the precautionary area, HELCOM guidelines for chemical munitions will be followed.				X	
Vessel movements (for all construction activities)	Nord Stream 2 AG will in due time contact and coordinate with the appropriate authorities to ensure that there will be no conflict between military activities and the construction of the NSP2 pipelines.	X	X	X	X	X
Vessel movements (for all construction activities)	Risk assessments will be undertaken for planned construction activities in military exercise areas and liaison with the competent authorities for the safe crossing of these areas will be undertaken.	X	X	X	X	X
Presence of vessels (associated with dredging and backfilling)	Exceedances of the applicable guide values for noise emissions will be avoided at all times in the coastal area off Mecklenburg-West Pomerania through the selection of equipment that ensures compliance with the guide values.					X
Presence of vessels (light)	To minimise impacts on the residential zones of Thiessow and Lubmin, the following measures will be implemented: <ul style="list-style-type: none"> <li>• Restrict light on deck at night to essential work activities.</li> <li>• Angle deck lighting to less than 60° and undertake daily checks.</li> </ul>					X

Mitigation measure applicability: R = Russia; F = Finland; S = Sweden; D = Denmark; G = Germany.

#### 16.4 Landfalls (onshore environment)

Table 16-4 summarises the measures that Nord Stream 2 AG will adopt to mitigate potential impacts to receptors within the onshore environment, as identified in Chapter 10 – Assessment of environmental impacts. The sources of impact provided below correspond to those identified in Table 8-3.

**Table 16-4 Measures to mitigate potential impacts on the onshore environment.**

Source of impact	Mitigation measure	R	G
Physical changes to landform (from all	Construction activities, workers, equipment and materials will be strictly limited to defined and demarcated work areas and excavated	X	X

Source of impact	Mitigation measure	R	G
construction activities	areas and active work sites will be fenced.		
Emissions to water (from site preparation and earthworks)	Liquid Discharges, Surface Water Runoff and Drainage Management Plans and supporting documentation will be produced and their requirements will be implemented. Amongst other things, the Plans will manage drainage to avoid soil erosion and pollution of water bodies.	X	X
Emissions to water (from site preparation and earthworks)	Dewatering plans and procedures will be developed and implemented to control erosion and the egress of sediment laden liquid discharges into surface water bodies and the marine environment, and to manage aquifer recharge.  The procedures will be applicable to trenching and excavation works requiring dewatering.	X	X
Site restoration	Onshore clearing and reinstatement plans and supporting documentation, addressing vegetation clearing and its timing, protection of trees, topsoil preservation, drainage, earthworks, introduced species and rehabilitation (including seed mixes that reflect biodiversity requirements) will be produced for all disturbed areas.	X	X
Physical changes to landform (from site preparation)	A Chance Finds Procedure will be developed and implemented to manage any new biodiversity components that may be encountered during execution of detailed surveys or during construction and that may not have been previously identified (such as bats, nesting birds or ephemeral plant species).	X	X
Physical changes to landform (from site preparation and earthworks)	Cultural Heritage Monitors (archaeological supervision) will observe ground clearing, stripping, and excavation activities in areas assessed to have a risk of encountering cultural heritage.  Should cultural heritage objects be identified during ground breaking work and in subsequent construction activities, the Chance Finds Procedure shall be implemented.	X	
Physical changes to landform (from site preparation and earthworks)	A Chance Finds Procedure shall be developed and implemented to manage actions in the event of chance finds of objects that could potentially be cultural heritage objects or munitions.	X	X
Emissions to air, land and water (from all construction activities)	Chemicals and hazardous substances used during all phases of the project will be selected and managed to minimise the potential adverse environmental impact associated with their transport, transfer, storage, use and disposal.	X	X
Emissions to land and water (from all construction activities)	Onshore spill prevention and response management plans and supporting documentation will be produced and their prescriptions implemented.	X	X
Emissions to land and water (from all	Chemical and fuel storage facilities will be located to avoid pollution and will be designed and constructed in such a way that spills and	X	X



Source of impact	Mitigation measure	R	G
construction activities)	leaks can be constrained or isolated, particularly in areas where there is an elevated risk of spill. Biodegradable hydraulic oil will be used where possible.		
Emissions to land and water (from all construction activities)	Parking and refuelling spaces for construction machinery and transport vehicles will be provided in dedicated, bunded, hard-standing areas capable of containing any spills and prevent contaminants reaching water bodies.	X	X
Transportation to and from site	A wash-down area for site construction vehicles will be constructed and utilised for vehicles leaving the work site.	X	
Emissions to land and water (from all construction activities)	Mobile plants that include pumps and generators will be equipped with secondary containment or equipped with drip trays.	X	X
Emissions to air, land (from transportation of materials)	Dust suppression techniques will be employed where necessary to protect vegetation health, worker health and amenity.	X	X
Emissions to air (from relevant construction activities)	Noise levels associated with key construction activities, including pre-commissioning, will be monitored and managed to ensure compliance with standards at the closest receptors.	X	X
Waste (from all construction activities)	A waste management strategy and plan will be developed and implemented for project waste.	X	X
Waste (from all construction activities)	All waste generated through construction will be stored for collection and final disposal by licensed waste contractors. No waste will be incinerated onsite.	X	X
Waste (from all construction activities)	The project will implement a waste hierarchy including practical measures to avoid, minimise, re-use and recycle wastes.  To minimise the quantity of waste going to landfill, waste will be segregated to facilitate recycling and reuse.	X	X
Pipe-laying and survey	All equipment containing sealed radiation sources will be inventoried, stored and utilised in a safe and secure manner.	X	X
Work camp	Worker camps and other accommodation will be compliant with IFC minimum standards (Worker's accommodation: processes and standards, 2009).	X	X
Emergency preparedness	All NSP2 worksites, including those operated by contractors and suppliers, will have an emergency notification plan and assigned emergency responders to ensure proper and fast reaction to and management of emergencies.  Emergency plans will include response procedures, assignment of responsibilities for key safety protocols, safety equipment and	X	X

Source of impact	Mitigation measure	R	G
	resourcing, training and drills, and measures to periodically review and revise the plans. Key consultation activities will be included as a part of planning.		
Emergency preparedness	All incidents and nonconformities will be reported to the appropriate level of management. In the event of emergencies, the authorities will be notified in accordance with the emergency response plan.	X	X
Light (from working areas)	Lighting will be managed to minimise impacts on bats and breeding birds.	X	X
Emergency preparedness	Fire safety and firefighting plans and associated training will be developed and implemented for onshore use.	X	X
Emissions to water (from tunnelling)	For tunneling activities, bentonite injection operations (for application at the TBM cutting face) will be managed to avoid or minimise the release of bentonite into the marine environment.		X
Emissions to land and water (from tunnelling)	To avoid pollution and minimise water usage associated with tunneling operations, closed circuit or closed loop slurry systems will be implemented to transport excavated spoil material.		X
General	To offset potential residual impacts, Nord Stream 2 AG will, in consultation with stakeholders, develop and implement a package of conservation support initiatives to achieve a net gain with respect to biodiversity.	X	X

Mitigation measure applicability: R = Russia; G = Germany.

## 16.5 Additional generally applicable project-wide mitigation measures

Table 16-5 summarises the overarching commitments proposed by Nord Stream 2 AG that apply to the project as a whole. While they do not mitigate a specific impact identified in Chapter 10 – Assessment of environmental impacts, they reflect best industry practise and Nord Stream 2 AG's commitment to implementing this project in a way that minimises impacts on the environment.

**Table 16-5 Additional project-wide mitigation measures.**

Mitigation measure	R	F	S	D	G
NSP2 will be compliant with national standards and applicable international standards, including DNV GL certification and the IFC Performance Standards.	X	X	X	X	X
A project environmental management and monitoring programme, which includes monitoring before, during and after construction of the pipelines, will be developed and implemented in consultation with the competent authorities in the affected countries.	X	X	X	X	X
Environmental and socio-economic monitoring results will be made publicly available.	X	X	X	X	X
Nord Stream 2 AG will periodically audit its contractors (including ancillary activities) to ensure that they operate in accordance with their environmental permits.	X	X	X	X	x
For the operational lifetime of the pipelines, the following will be implemented:	X	X	X	X	X

Mitigation measure	R	F	S	D	G
<ul style="list-style-type: none"> <li>• A pipeline integrity management plan.</li> <li>• An emergency and repair plan.</li> </ul>					
Nord Stream 2 AG will notify the competent authorities of unplanned events during pipeline operation.	X	X	X	X	X

Mitigation measure applicability: R = Russia; F = Finland; S = Sweden; D = Denmark; G = Germany.

## 17. HEALTH, SAFETY, ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM

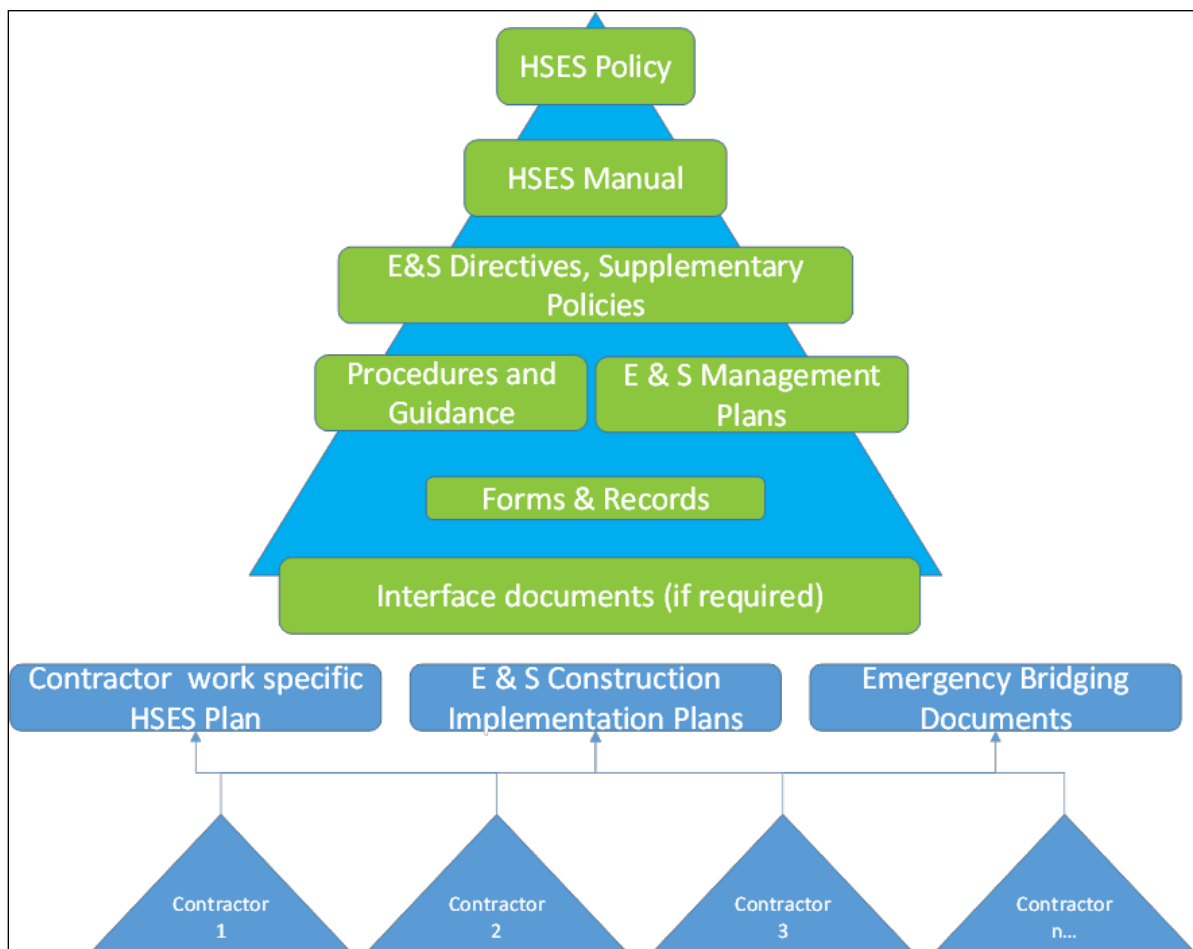
### 17.1 Introduction

The health, safety, environmental and social (HSES) policy for NSP2 outlines the general principles of HSES management. It sets the goals as to the level of health, safety, environmental and social responsibility performance required of Nord Stream 2 AG staff and contractors /379/, /380/, /381/, /382/, /383/, /384/, /385/, /386/.

The policy is implemented through a health, safety, environmental and social management system (HSES MS) aligned to the international standards OSHAS 18001<sup>68</sup> and ISO 14001, based on the plan-do-check-act (PDCA) cycle and the IFC performance standards on environmental and social (E&S) sustainability. The system enables Nord Stream 2 AG to identify all relevant HSES requirements for the project and systematically control the risks.

The current HSES MS is applicable to the planning and construction phases of NSP2. It will be adjusted once the pipeline system is commissioned so as to manage HSES issues for the operation phase.

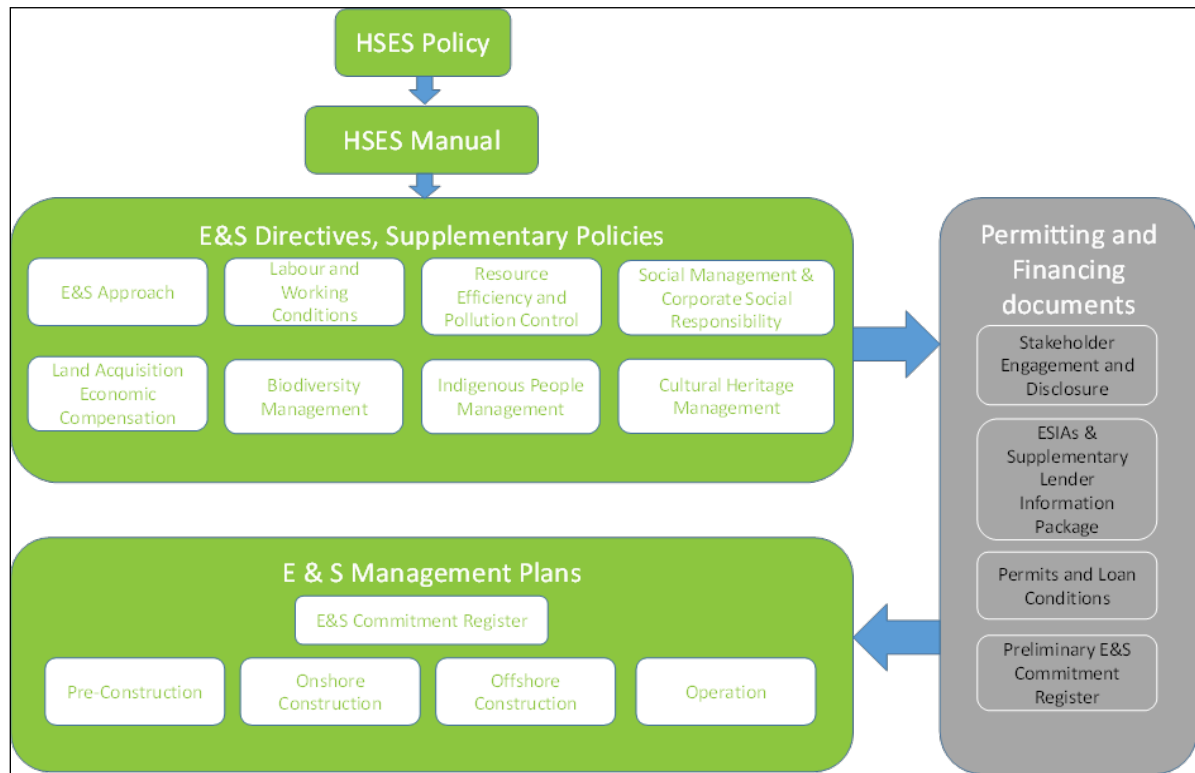
The hierarchy of documentation in the HSES MS and the interface with the management systems of contractors and suppliers are shown in Figure 17-1. Contractor plans and bridging documents may be combined in certain cases, depending on the scope of work and exposure to HSES risks.



<sup>68</sup> OSHAS 18001 is expected to be replaced by ISO 45001 by the end of 2016.

**Figure 17-1 Structure of the HSES management system (planning and construction phases).**

The hierarchy of E&S management documents and their relationship to permitting and financing documents is presented in more detail in Figure 17-2.



**Figure 17-2 Sub-structure of the E&S management system.**

The HSES MS covers the management of health, safety, environmental and social risks arising during the planning and construction of NSP2. It also covers the management of security where this has an impact on the safety of personnel and project-affected communities, the integrity of project assets and the reputation of Nord Stream 2 AG. Implementation of the HSES MS commenced in August 2015.

Each of the 10 key principles which comprise the management standards are presented as a high-level statement of the standard, followed by a number of expectations that arise from the standard and a list of supporting documents and references. The relationship of the management standards to the PDCA concept that is designed to manage all aspects of an organisation's activities and to promote performance improvements is shown in Figure 17-3.

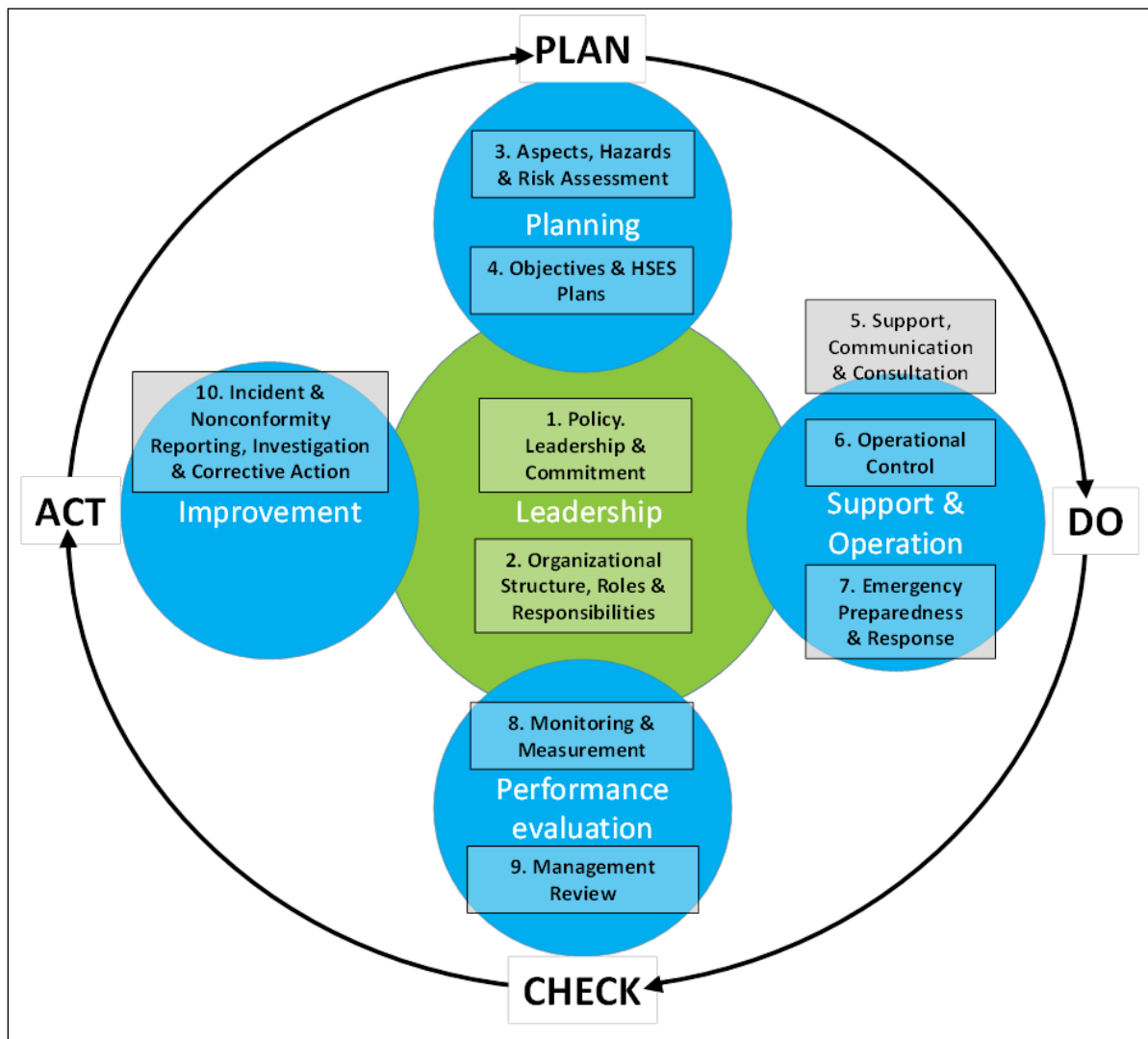


Figure 17-3 The 10 management standards aligned to the PDCA management system model.

## 17.2 Policy, leadership and commitment

Senior management will define the general HSES principles, set the expectations and provide the resources to develop, implement and maintain the HSES MS. They will demonstrate commitment and leadership through example.

Expectations:

- The HSES policy defines the general principles to be applied in NSP2. These principles include the recognition that harming people or the environment is not an acceptable or sustainable business practice. More detailed principles are provided in the E&S directives and supplementary policies.
- The HSES policy is committed to complying with all applicable standards, striving for continual improvement in HSES performance and setting measurable objectives and targets.
- The HSES policy will be signed by senior management to demonstrate their formal commitment to HSES management.
- Senior management will provide leadership and visibly demonstrate their commitment to the policy in order to drive the process for exemplary HSES performance. The necessary resources will be made available to develop and implement the HSES MS in order to achieve the objectives of the HSES policy.

HSES management is an essential part of the project. In order for all duties to be performed with due regard to HSES, specific roles and responsibilities will be defined and communicated.

Company and contractor personnel will be appropriately trained, experienced and competent to work in a manner that minimises HSES risk.

Expectations:

- HSES will be defined as a line management responsibility and will be integrated into all functions of the organisation.
- HSES roles and responsibilities will be defined for all safety, environmental and social critical functions (managers, supervisors, work force). Such activities will only be performed by personnel who can demonstrate the appropriate level of competence.

## **17.3 Planning**

### **17.3.1 Aspects, hazards and risk assessment**

Activities will be planned so that the project can be conducted efficiently, where risk is minimised and legal compliance is assured. Planning involves the systematic identification of legal requirements, hazards, aspects and potential impacts, followed by an assessment of the risk and its control to a tolerable level.

Expectations:

- All activities will be conducted in a manner that complies with the relevant laws and regulations.
- There will be a systematic and documented identification of health, safety and security hazards and environmental and social aspects and potential impacts of all planned activities.
- Hazard and potential impact information will be used to make an assessment of risk in terms of likelihood and consequence during the implementation of the project activity.
- All project information that is relevant to project-affected communities and any other external stakeholders will be disclosed as part of a comprehensive stakeholder engagement programme. Feedback from stakeholders will inform the HSES studies, risk assessments and management plans.
- Risk assessment information will be used to determine safeguards and mitigation measures to control risk to a tolerable level.
- The feasibility of risk control measures will be assessed with reference to the magnitude of the risk, legal requirements, accepted industry practice and the business needs of the company.
- Procedures will be established for updating hazard and risk assessments when there are changes to activities and when non-routine tasks are undertaken.
- Procedures will be established for ensuring that hazard and risk assessment information and documentation are communicated to those persons involved in the activity.

### **17.3.2 Objectives and health, safety, environmental and social plans**

The general purpose of the management system is to prevent NSP2 activities from putting people and the environment at risk. Specific objectives will be set, measured with key performance indicators (KPIs) and communicated in order for the system to be efficient and effective.

Expectations:

- Nord Stream 2 AG will set HSES objectives and targets following the management review of the management system. This will occur at least annually.
- Objectives and targets will relate to the significant risks and impacts of the activities.
- The objectives and targets will be measurable, and performance during the year will be monitored by management.
- An HSES plan that describes the actions, time frames and responsible persons required to reach the objectives and targets will be developed.

## 17.4 Support and operation

### 17.4.1 Support, communication, consultation and documentation

Arrangements will be in place for the communication of relevant HSES information, both internally (within the project) and externally. Communication will be in a language and style that is appropriate to those persons receiving the information. Personnel will be consulted on HSES matters and will be encouraged to participate in improvement initiatives.

There will be active engagement with stakeholders, and all relevant information will be disclosed. Information on aspects, hazards and risks will be properly documented. Written procedures will define how these management standards will be implemented in order to meet expectations.

Expectations:

- All personnel will have basic HSES training and induction, relevant to the risks in their workplace and any legal requirements.
- HSES roles and responsibilities will be communicated to the relevant persons.
- Resources will be made available to ensure the competence of personnel to undertake their HSES responsibilities.
- Relevant personnel will be involved in the hazard and risk assessment processes and in the development and review of HSES procedures.
- The results of risk assessments and the required risk control measures (including emergency procedures) will be communicated to relevant personnel.
- There will be a system for disseminating HSES information throughout the project in order to promote lateral learning and the sharing of best practices.
- There will be a system for authorising communication of HSES information, including emergency response, to relevant external parties, in compliance with communication guidelines.

### 17.4.2 Operational control

All company and contractor operations will be conducted according to the HSES standards that have been set to minimise risk. Contractors will be selected and appointed with due regard to their HSES capability and past performance. Detailed HSES requirements will be defined in the invitations to tender (ITTs) and draft contracts, and HSES will form part of the technical evaluation of bids.

The adverse HSES consequences of temporary and permanent changes in the project will be assessed, managed and authorised.

Expectations during planning and construction:

- Policies and procedures will be developed to mitigate the risks that employees and project- affected persons are exposed to.
- Activities undertaken by contractors, subcontractors and suppliers will be subject to detailed, contractually binding HSES requirements.



- The company will ensure that contractors and suppliers are monitored to ensure compliance with HSES requirements.

Expectations during operation:

- Procedures will be developed and implemented to ensure that the risks associated with operating and maintaining the pipeline system are adequately controlled.
- All equipment will be used within its safe operating limits and in compliance with the relevant regulatory requirements.
- Protective and safety systems will be periodically tested and subject to a preventative maintenance programme.
- Systems will be in place for reassessing risk and applying appropriate controls when operational parameters change (management of change).
- Operational changes will be approved by an appropriate authority who has taken proper regard of the risk implications.

### 17.4.3 Emergency preparedness and response

Plans and procedures will be in place to respond to foreseeable emergencies and to minimise the HSES effects. Plans and procedures will be periodically tested and improvements made.

Expectations:

- All NSP2 worksites, including those operated by contractors and suppliers, will have an emergency notification plan and assigned emergency responders to ensure proper and fast reaction to and management of emergencies.
- Emergency plans will be documented, accessible and easily understood.
- The effectiveness of plans and procedures will be regularly reviewed and improved as required.
- Plans and procedures will be supported by training and, where appropriate, exercises.
- Equipment for detecting and responding to emergencies will be subject to a preventative maintenance programme, testing and calibration, according to the relevant standards.

## 17.5 Performance evaluation

### 17.5.1 Monitoring and measurement

Monitoring and measurement of HSES performance will be required in order to correct deficiencies in the system and to provide a quantifiable measurement of improvement over time.

Expectations:

- The performance criteria selected by Nord Stream 2 AG to measure its HSES objectives and targets will be reported to senior management on a regular basis.
- The scope and frequency of inspections and audits will reflect the level of risk.
- An audit schedule will form part of the HSES plan.
- Audits will be carried out according to an agreed and transparent system.
- There will be a balance between a programme of self-assessment and external audit.
- Monitoring and measuring equipment will be installed at locations where a failure to detect a release of hazardous material or energy would result in a serious incident or breach of legal requirements.
- Good HSES performance will be recognised and rewarded.

### 17.5.2 Management review

Management will formally review the effectiveness of the implementation of the HSES MS. Actual performance will be compared with the requirements of the policy and the HSES MS, and opportunities for improvement will be identified.

Expectations:

- Management of the project will undertake a review, at least on an annual basis.
- HSES performance will be reviewed in terms of incidents, audit findings and how well objectives and targets have been met.
- The effectiveness of the HSES MS to deliver on the requirements of the HSES policy will also be reviewed, taking into account likely changes in legislation and project activities.
- Opportunities for improvement in HSES performance will be identified and will form the basis of the HSES plan for the next period.

## 17.6 Improvement

### 17.6.1 Incident and nonconformity reporting, investigation and corrective action

Procedures will be in place to immediately respond to incidents and nonconformities in order to minimise their consequences. HSES incidents will be investigated to determine root causes and to prevent recurrence. Audits and inspections will be carried out to ensure HSES standards are maintained and, where applicable, to correct deficiencies. All incidents and nonconformities will be reported to the appropriate level of management.

Expectations:

- Procedures will be in place for immediately responding to incidents.
- Procedures will be in place for reporting incidents (actual and potential accidents) to the appropriate level of management and, where applicable, to external authorities.
- The resources devoted to incident investigation and corrective action will reflect the potential consequences and not only the actual consequences of the incident.
- Investigations will be conducted in a fair and just manner to determine root causes and to identify corrective actions that will be effective.
- Preventative actions and lessons learned from incidents will be communicated appropriately in the project.
- The scope and frequency of inspections and audits will reflect the level of risk;
- An audit schedule will form part of the HSES plan.
- Audits will be carried out according to an agreed and transparent system.
- Good HSE performance will be recognised and rewarded.

## 18. PROPOSED ENVIRONMENTAL MONITORING

### 18.1 Introduction

The purpose of an environmental monitoring programme is to verify the environmental impacts identified, described and evaluated in the Espoo Report. Furthermore, the data collected from the monitoring programme may establish the need for environmental mitigation measures if, contrary to expectations, the data indicate unwanted environmental impacts.

Evaluating environmental impacts caused by construction and operation of the planned NSP2 within the EEZ and TW of Russia, Finland, Sweden, Denmark and Germany should include environmental monitoring activities before, during and after construction activities, depending on the respective objective. The main objectives of the monitoring activities during the lifecycle of the project are described below:

- Monitoring activities prior to construction are supplemental to the baseline investigations and serve to provide additional information based on authority requests, modifications to the project design or changes to conditions in the project area;
- Monitoring activities during construction will aim to verify the input parameters used for e.g., the modelling of sediment and underwater noise;
- Monitoring activities after construction will aim to verify the evaluation of the environmental impacts from construction activities and the presence of NSP2 on/in the seabed.

To discuss the requirements of the environmental monitoring programme for NSP2, the monitoring programme developed for NSP, as well as its results and conclusions, should be taken into consideration. Therefore, experience from the NSP monitoring programme and the proposed NSP2 monitoring programme are addressed in this chapter.

On the basis of the results from monitoring carried out for NSP, it is concluded that the impacts on the environment had a minor to insignificant effect that was limited to the immediate vicinity of the pipelines. In light of this information, the proposed parameters for the NSP2 monitoring programme are highlighted in Table 18-1. The parameters are considered for the monitoring programme to:

- Verify the environmental impacts identified, described and evaluated in the Espoo Report and national EIAs/ES developed for the NSP2 project;
- Meet the expected high interest expressed by various stakeholders and the general public.

**Table 18-1 Proposed parameters to be monitored as part of the NSP2 monitoring programme.**

Country	Proposed monitoring parameters for NSP2		
	Before construction	During construction	During operation
Russia	Cultural heritage (onshore and offshore) <sup>69</sup>	Sediment quality Water quality Emissions (onshore) Soil quality Flora and fauna (onshore and offshore) Cultural heritage (offshore) Commercial fishery	Sediment quality Water quality Emissions (onshore) Soil quality Flora and fauna (onshore and offshore)

<sup>69</sup> Monitoring before construction in Russia will consist of a detailed survey to verify the results of the 2016 baseline survey.

Finland	Underwater noise Cultural heritage	Underwater noise	Cultural heritage (after construction phase) Commercial fishery
Sweden	Cultural heritage Commercial fishery	Water quality Maritime traffic	Cultural heritage Commercial fishery
Denmark	Cultural heritage Commercial fishery Chemical munitions objects CWAs in the sediment	Water quality Maritime traffic CWAs in the sediment	Cultural heritage Commercial fishery Chemical munitions objects CWAs in the sediment
Germany	Sediment quality Soil quality Flora and fauna (onshore and offshore) Cultural heritage	Water quality Emissions (onshore and offshore) Flora and fauna (offshore) Cultural heritage Maritime traffic	Sediment quality Natura 2000 sites Cultural heritage

It should be noted that this serves as a preliminary proposal for monitoring, and the precise approach to the final monitoring programme, including procedures, locations and periods of monitoring will be established in consultation with the competent authorities and specialist institutions.

The experience gained from the NSP monitoring programme and the proposed environmental monitoring parameters for NSP2 are briefly described below.

## 18.2 Sediment quality

### 18.2.1 Russia

The NSP bottom sediment quality monitoring programme included sampling in Portovaya Bay and along the pipeline route in 2009 (before construction of Pipeline 1) and in 2012 (after construction of Pipeline 2) for analyses of physical parameters, nitrogen and nitrogen-containing compounds, hydrocarbons and metals. The results indicated no considerable changes in sediment physical characteristics or level of contaminants and therefore no negative impact caused by NSP construction works.

The purpose of bottom sediment monitoring for NSP2 would be to document any changes in the level of contamination in marine sediment compared to baseline conditions. Focus will be given to locations where trenching occurs, as this activity results in the greatest sediment disturbance. The monitoring programme will be developed at a later stage of the project in accordance with Russian legal requirements and with the approval of the Russian water authorities.

### 18.2.2 Finland

The results of the NSP sediment quality monitoring programme, which was conducted between 2010 and 2012, indicated either no impact or temporary, local and minor sediment movement impact during construction and no permanent negative impact during operation.

On the basis of the results of the NSP sediment quality monitoring programme, sediment quality monitoring is not proposed for NSP2.

## 18.3 Water quality

### 18.3.1 Russia

The NSP water quality monitoring programme was undertaken between 2009 and 2014 and initially focused on discrete activities anticipated to give rise to the greatest impact, such as

trenching and rock placement. However, no significant impact on water quality was measured, so the programme was altered to instead focus on general monitoring stations located along the route. The results indicated no significant impact on surface and bottom water quality during construction and operation. Specifically, concentrations of suspended sediments, organic pollutants and metals remained below environmental limits and the levels of sanitary and bacteriological parameters were also in compliance with established hygienic specifications. Furthermore, monitoring of water quality in connection with wet pre-commissioning activities indicated no negative effect on water quality or the marine environment.

The objectives of the water quality monitoring programme for NSP2 are:

- To verify the results of suspended sediment modelling;
- To provide data on water quality for the water authorities.

The assessments of impacts on water quality from rock placement and trenching have been based on extensive model simulations of sediment spreading and experience from NSP monitoring activities. If the monitoring results correspond with what was found during NSP (no significant impact from trenching and rock placement activities), the programme will be altered in the same way so as to focus instead on general monitoring stations located along the route.

Dry pre-commissioning has been proposed as the preferred pre-commissioning method, which will not result in the discharge of hydrotest water. However, if wet pre-commissioning is employed, hydrotest water would be discharged in the Russian sector and the water quality monitoring programme will be supplemented to include sampling in association with this activity. Based on the NSP monitoring results, no significant impact from hydrotest water discharge is expected.

### 18.3.2 Finland

The results of the NSP water quality monitoring programme, which was conducted between 2010 and 2012, indicated only a temporary and local water quality change (i.e. turbidity increases) during construction, which was restricted to the water layer nearest to the seabed. No permanent adverse impacts were observed after the construction phase.

On the basis of the results of the NSP water quality monitoring programme, water quality monitoring is not proposed for NSP2.

### 18.3.3 Sweden

The results of the NSP water quality monitoring programme, which was conducted between 2010 and 2012, indicated that the risk of significant levels of sediment spreading into the Natura 2000 sites is very low. NSP2 is located east of the existing NSP, hence further away from the existing Natura 2000 sites. However, because of the sensitivity of the areas, potentially higher amounts of seabed intervention works to be undertaken for NSP2 and authority request as a result of consultations, monitoring is deemed reasonable.

The water quality monitoring programme is proposed as a vessel-based programme in order to confirm the conclusions of the assessment undertaken for NSP. It is anticipated that monitoring will focus on turbidity levels during trenching along defined sections, with the objective being continuous monitoring of areas where elevated turbidity levels can be expected.

### 18.3.4 Denmark

During construction activities, suspended seabed sediments will spread in the water column, increasing turbidity, and will re-settle thereafter. The extent of the affected areas will depend on the type and concentration of the suspended sediments and the physical properties of these

specific areas. The assessments of environmental impacts caused by construction activities have been based on extensive model simulations of the spreading of sediment and experience from monitoring activities during NSP, which were conducted during construction works from 2011 to 2012.

The purpose of the NSP2 water quality monitoring programme would be to confirm the model results for the activity resulting in the most suspended sediments, which has shown to be post-lay trenching.

#### **18.3.5 Germany**

Monitoring of water quality was conducted for NSP during construction works in 2010, and aimed to measure suspended sediments during dredging and pipe-laying and monitor the development of turbidity plumes. The concentrations of suspended matter always remained below the defined thresholds. Monitoring results showed that re-suspended material settled relatively quickly and confirmed the modelling results for the Pomeranian Bay. The extent of turbidity plumes in the Greifswalder Bodden was less than anticipated.

The water quality monitoring programme for NSP2 aims to verify adherence to thresholds pertaining to turbidity offshore. A specific monitoring schedule will be created prior to the start of construction works, and will comprise procedures and instructions regarding monitoring tasks, reporting obligations and procedures in case deviations from specifications and requirements are observed.

### **18.4 Underwater noise**

#### **18.4.1 Finland**

Monitoring of underwater noise in relation to potential impacts on marine mammals was not conducted for NSP.

The NSP2 underwater noise monitoring programme proposes measurement in areas known to be important for marine mammals (e.g., seal sanctuaries) during munitions clearance activities that involve detonation *in situ*. It is anticipated that peak pressures will be measured at various distances from the detonation point, followed by a comparison of monitoring results with modelling results.

### **18.5 Offshore emissions (air, noise, light)**

#### **18.5.1 Germany**

Offshore noise monitoring was conducted during the construction of NSP through measurements of underwater noise in 2010 and 2011. The measured values did not exceed the predefined thresholds at any time during construction, and mainly ranged between 100 and 140 dB re 1  $\mu$ Pa.

The offshore emissions monitoring programme for NSP2 aims to verify adherence to thresholds pertaining to noise, light and pollutants. A specific monitoring schedule will be created prior to the start of construction works, and will comprise procedures and instructions regarding monitoring tasks, reporting obligations and procedures in case deviations from specifications and requirements are observed.

### **18.6 Onshore emissions (air, noise, light)**

### 18.6.1 Russia

Onshore air quality and noise were monitored between 2010 and 2012, before, during and after the construction of NSP. The results showed that the air quality in the onshore section remained in accordance with the requirements of government health norms established for air quality in populated areas and the measured noise levels did not exceed allowable levels. As such, it can be concluded that NSP construction and operation have not led to any significant air quality or noise impact in the vicinity of the onshore area.

Air quality and noise will be monitored during construction and operation of NSP2. The purpose of the monitoring programme is to measure air quality and noise within the working zone, outside the temporary construction site and at the boundary of residential areas to ensure compliance with regulatory thresholds.

### 18.6.2 Germany

Onshore emissions were not monitored for NSP.

The onshore emissions monitoring programme for NSP2 aims to verify adherence to thresholds pertaining to noise, light and pollutants. A specific monitoring schedule will be created prior to the start of construction works, and will comprise procedures and instructions regarding monitoring tasks, reporting obligations and procedures in case deviations from specifications and requirements are observed.

## 18.7 Soil quality

### 18.7.1 Russia

Soil monitoring was conducted prior to and during construction of NSP between 2009 and 2012 in areas within and outside of the Russian landfall area. Samples were analysed for metals, phenols, petroleum products, and bacteriological and parasitological indicators. Monitoring was also performed in one location during the operation phase of NSP2, with samples being analysed for metals, petroleum products and toxicity levels (for infuzoria). All monitored parameters were below the permissible levels as well as below the corresponding levels of regional background levels, and overall, no changes in the levels of measured parameters were detected.

For NSP2, significant physical impacts on soil are expected in connection with earthworks conducted at the landfall construction site. However, on the basis of the NSP monitoring results, considerable chemical impacts are not expected. During construction, monitoring will be focused on the protection of topsoil and pollution from petroleum products, and during operation, the focus will be on the reinstatement of soil facility outside the PTAR and associated infrastructure.

## 18.8 Marine flora and fauna

### 18.8.1 Russia

The NSP monitoring programme for marine flora and fauna covered macrophytes, benthic flora and fauna, fish (including salmon migration), plankton, marine mammals and birds.

#### 18.8.1.1 Macrophytes

Macrophyte monitoring was carried out during and after construction between 2011 and 2014 in Portovaya Bay, in order to observe the general condition, composition and structure of helophytes (coastal wetland plants), hydrophytes (fully submerged flowering plants) and benthic flora (algae) communities. The results indicated that recovery of helophyte and hydrophyte plant communities encountered above the waterline was complete by the close of the monitoring programme, and communities of immersed hydrophytic vegetation were partially restored, based on the indicators of productivity, abundance and species diversity. On the basis of the monitoring results, it can be concluded that NSP has had no negative impact on aquatic vegetation.

### 18.8.1.2 Benthic flora and fauna

The purpose of the benthic flora and fauna monitoring programme for NSP was to evaluate the impacts of construction and monitor recovery. Monitoring was carried out before, during and after pipeline construction between 2010 and 2014 in the shallow waters of Portovaya Bay and in the deep water section. Samples were analysed for species diversity, abundance and biomass of meio- and macrozoobenthos. The distribution of zoobenthos in the studied area was overall typical for the region and subject to natural seasonal and annual fluctuations. Therefore, it can be concluded that NSP has had no significant impact on benthic fauna.

### 18.8.1.3 Fish and plankton

The purpose of the fish and plankton monitoring programme for NSP was to assess the condition of fish populations, to monitor migration of salmon populations, and to document potential changes in the plankton community as a result of NSP construction activities.

Fish surveys were conducted both prior to and following pipeline construction between 2010 and 2014 at coastal and deep-water monitoring sites. The results from the last year of monitoring showed a slight decrease in species diversity and abundance, despite comparable occurrence of detected species in relation to the previous monitoring years. These changes in fish species composition, biomass and abundance can be attributed to a reduced number of monitoring stations, differences in the timing of the surveys, and natural factors.

Monitoring of salmonid species (*Salmonidae*) was carried out before, during and after pipeline construction in 2010, 2011, 2013 and 2014 in Portovaya Bay and/or in the vicinity of the island of Maly Fiskar. No salmonid species, including juveniles, were detected during any of the surveys carried out as part of the monitoring programme, nor were any detected during prior baseline surveys. As such, it is not possible to draw any conclusions concerning the potential impact on salmonid species from the construction and operation of NSP.

Monitoring of plankton was carried out before, during and after pipeline construction between 2010 and 2014 in the shallow areas of Portovaya Bay and in the deep water area of the Gulf of Finland. In general, the species composition, abundance and distribution of phyto- and zooplankton in the surveyed area corresponded to the natural levels of the eastern Gulf of Finland over the survey period. Therefore, the construction and subsequent operation of NSP has not had any significant negative impact on plankton communities. The concentration of the photosynthetic pigment, chlorophyll a, was also measured in Portovaya Bay and the results corresponded to the limits of the interannual variability of the indicated values. On the basis of the monitoring results, it was concluded that there was no negative impact caused by NSP on the photosynthetic pigments of phytoplankton.

### 18.8.1.4 Marine mammals

The purpose of the marine mammal monitoring programme for NSP was to observe impacts on population size and disruption in relation to the construction of the pipeline. Surveys were performed during and after construction between 2010 and 2014 on the nearby islands and in adjacent areas, as well as in control areas. By the end of the monitoring period, increased numbers of individual grey seals and grey seal haul-out areas were detected in the study area. On the basis of the monitoring results, it can be concluded that NSP has not had any negative impact on marine mammals.

### 18.8.1.5 Birds

The purpose of the bird monitoring programme for NSP was to monitor the population dynamics of nesting and migratory birds, as well as vulnerable bird populations, in relation to construction and operation of the pipelines. Monitoring was carried out along the pipeline route, on adjacent



islands, and in a control area between 2010 and 2014. The results indicated an ongoing positive tendency in the development of bird populations in the area, including increased species diversity and abundance, as well as the emergence of rare and protected bird species, in the vicinity of the pipelines. Consequently, it can be concluded that construction and operation of NSP has not had a negative impact on seabirds in the region.

Based on the NSP monitoring results, the NSP2 survey results and the interaction of the project area with nature reserves, the NSP2 monitoring programme will cover the following parameters:

- Condition of fish population in relation to construction activities;
- Migration of salmonids;
- Documentation of changes in the plankton community in relation to construction activities;
- Observation of marine mammals.

During the operation phase, the monitoring programme will solely focus on marine birds, and will cover nesting and migration in protected areas within the project areas, including the Kurgalsky and Ingermanlandsky nature reserves.

## **18.8.2 Germany**

The marine flora and fauna monitoring programme for NSP in Germany was performed during and after construction of the pipeline between 2010 and 2016. Monitoring covered macrophytes, benthic flora and fauna, fish, marine mammals (harbor porpoises, grey seals) and birds.

### **18.8.2.1 Macrophytes**

The purpose of macrophyte monitoring was to determine the impact of construction works and to monitor recovery. It was carried out after the construction of NSP between 2011 and 2013. The results indicated a proceeding recolonisation of areas previously disturbed by construction activities. Macrophytes at areas with varying degrees of impact showed partly restored communities with similar species diversity and abundance. All sites investigated showed a range of species characteristic of the local soft bottom habitats.

### **18.8.2.2 Benthic flora and fauna**

Monitoring of macrozoobenthos was carried out after construction in the Greifswalder Bodden and the Pomeranian Bay annually between 2011 and 2013 and in 2016. The aim of monitoring was to document changes in benthic communities caused by construction works and the operating pipeline as well as to document the recovery process. The results showed that the recovery process was completed by the end of the monitoring programme. A survey along the pipeline section where the pipelines were buried in the seabed showed that the species diversity and abundance was typical for the region. The benthic communities in the areas where the pipeline lays on top of the seabed were dominated by mussels. An influence on surrounding soft bottom fauna could not be verified.

### **18.8.2.3 Fish**

Fish surveys were conducted after the construction of the pipeline between 2011 and 2013. The results from areas near the landfall at Lubmin showed a fish community structure typical for the shallow waters of Greifswalder Bodden. Through a comparison of results with those of earlier investigations, no measurable impacts on fish attributable to construction works could be determined.

### **18.8.2.4 Marine mammals**

The purpose of the marine mammal monitoring programme for NSP was to observe impacts on the population size and disruption in relation to the construction of the pipeline. Surveys were

performed during and after construction between 2010 and 2013. The monitoring results showed that noise caused by construction vehicles used for NSP can be detected by harbour porpoises and grey seals, but no measurable changes in the affected areas were observed and no negative impacts were discovered. Since the conclusion of construction works, the abundance of grey seals in the Greifswalder Bodden and harbour porpoises in Pomeranian Bay actually increased.

#### **18.8.2.5 Birds**

The purpose of the NSP monitoring programme for birds was to monitor and assess the potential impacts of the pipeline on seabirds. On the basis of data collected annually between 2010 and 2014 and again in 2016 during and after construction activities, no deterioration in conservation status was found for any of the monitored species. Comparisons of density and populations showed stable or increasing populations depending on the species considered. Overall, no noticeable changes were found. Therefore, it was concluded that NSP has had no significant impacts on seabirds.

No specific construction monitoring of marine flora and fauna is anticipated in connection with NSP2. This is on account of the comprehensive investigations completed during construction of NSP and the assumption that the project-related impacts from NSP2 will be comparable. Post-construction monitoring will focus on the compensation measures implemented as part of the ecological site control. This includes surveillance and control of the restoration of the biotope structure around the pipe trenches and the requirements related to nature and species protection. A specific monitoring schedule will be created prior to the start of construction works, and will comprise procedures and instructions regarding monitoring tasks, reporting obligations and procedures in case deviations from specifications and requirements are observed.

### **18.9 Natura 2000 sites**

#### **18.9.1 Germany**

Monitoring of Natura 2000 sites was carried out during and after construction of NSP in the course of the offshore monitoring between 2011 and 2013, including biotic (flora and fauna) and abiotic (turbidity, seabed structure, sediment, etc.) surveys. The results of the seabed survey showed that the impacts of pipeline construction varied depending on construction technology and effect intensity. Alongside former pipe trenches and the temporary marine interim storage area, changes in bathymetry were negligible, and the seabed profile had returned to its natural condition within four years after construction. Affected soft bottom habitats and restored reefs have been recolonized with growing populations.

A seabed survey by means of multi-beam echo-sounder and side-scan sonar will be undertaken after the conclusion of pipe-laying. The documentation of the environmental status after completion of the construction activities serves as technical surveillance regarding the restoration of protected habitat types and the temporary marine storage site. Additionally, after the completion of construction activities, monitoring will aim to document the regeneration of the affected target species, the protection purposes and conservation objectives of the five Natura 2000 sites to be crossed. The protected resources to be examined include: all protected habitat types along the route, seabirds, grey seals, and porpoises.

### **18.10 Terrestrial flora and fauna**

#### **18.10.1 Russia**

Terrestrial flora and fauna surveys were carried out before, during and after construction of NSP, between 2010 and 2014. Monitoring of vegetation was performed to determine the general status of the vegetation cover and the productivity, diversity and potential changes in the flora communities at the Russian landfall construction site and at control areas away from the construction site. Although some changes to the vegetation communities were detected

immediately after construction activities, successful restoration was observed by the close of the monitoring programme. As such, it can be concluded that NSP did not lead to significant or long-term changes to terrestrial flora, including populations of rare and protected species.

Monitoring of terrestrial fauna was performed to determine the species composition, population structure, vulnerability and potential changes in the fauna communities within and in the vicinity of the construction site. No unexpected, negative impacts on fauna were directly attributable to NSP construction works.

As the preferred NSP2 route crosses the Kurgalsky nature reserve, monitoring is planned to be conducted during both construction and operation of the pipeline, covering the following aspects:

- Reinstatement of modified habitats;
- Changes to environmental services in the buffer zone of the pipeline route and construction site;
- Relocation of protected species;
- Implementation of the biodiversity action plan, including mitigation measures to prevent impacts to biodiversity and monitoring and control of habitats in the project area of influence.

## **18.10.2 Germany**

Post-construction monitoring of terrestrial flora and fauna, including vegetation, reptiles and breeding birds, was conducted in Germany in the course of NSP in 2011 and 2013. Monitoring of a possible change of the vegetation due to the construction of the NSP pipeline revealed no project-related long-term changes in terrestrial flora. The development of vegetation on the newly designed or restored areas of vegetation (mainly dune vegetation) showed a sequence of characteristic transient ruderal areas, common for arid and sandy open areas that are located within regions of favourable climatic conditions. A general trend of vegetation development could not be obtained within the period of investigation. A repetition of the monitoring will be conducted in 2018.

NSP monitoring of terrestrial fauna was performed to identify possible project-related impacts on the local breeding bird and reptile population. The results of the breeding bird monitoring revealed a positive population development of valuable breeding bird species.

The results of the reptile monitoring in 2011 and 2013 showed that all species occurring in the area before the construction of NSP could still be observed afterwards. All measures applied in the course of the project seem to have succeeded and no project-related long-term impacts on the terrestrial fauna could be documented. A repetition of the monitoring will be conducted in 2018.

As no protected areas will be crossed in the course of the onshore works of NSP2, no comparable monitoring on the terrestrial flora and fauna is planned during construction or operation the project. Only baseline investigations were carried out to determine the local flora and fauna populations.

## **18.11 Cultural heritage**

### **18.11.1 Russia**

Monitoring of cultural heritage for NSP focused on two wrecks, which were examined before, during and after construction, between 2010 and 2011. The wrecks were inspected using SSS and dives. Results from a comparison of data collected between years showed that construction

works and the presence of the pipelines on the seabed did not have any effects on the position and condition of the two monitored wrecks.

Onshore and offshore cultural heritage has been studied as part of comprehensive NSP2 pre-construction surveys, and rescue archaeological activities will be performed before the start of construction if needed. In the case that an unmapped cultural heritage object is encountered during construction, a chance finds procedure will be implemented and no specific monitoring activities are required.

#### **18.11.2 Finland**

The NSP cultural heritage monitoring programme aimed to monitor impacts to known cultural heritage sites from pipeline construction and operation. Wrecks that were located close to construction works were monitored via ROV prior to and following potentially destructive activities, including munitions clearance, pipe-handling and anchor handling. The results, which were gathered between 2010 and 2015, indicated no impact either during or after construction.

With regards to NSP2, all cultural heritage sites within the potential impact range of any unexploded ordnance management activities are anticipated to be visually inspected via ROV before and after such activities. Furthermore, post-lay inspections are proposed for certain cultural heritage sites known to be located close to the pipeline route to ensure that pipe-lay, anchor handling or rock placement activities has not affected their integrity. Post-lay inspections to document possible changes *in situ* are proposed for all other potential cultural heritage sites within the anchoring corridor where anchoring procedures cross the 200 m safety perimeter. If anchoring procedures additionally cross the general 50 m minimum safety distance for potential cultural heritage sites, a more detailed site management plan should be deployed pre- and post-lay.

#### **18.11.3 Sweden**

The purpose of the NSP cultural heritage monitoring programme was to document the condition of wrecks before construction, to safeguard wrecks during construction and to verify the condition of wrecks after construction. Monitoring of cultural heritage was carried out as visual inspections by ROV prior to and after construction between 2009 and 2012. Based on the monitoring results, one wreck was impacted by an anchor chain during construction, and no construction related changes occurred with respect to the eight other wrecks.

The purpose of cultural heritage monitoring for NSP2 would be the same as for NSP. In order to prevent damage to cultural heritage sites during pipe-laying or seabed intervention works, detailed security surveys will be performed before and after construction activities. The surveys consist of a geophysical assessment, visual inspection and an expert evaluation of findings. A controlled installation procedure, including locations where archaeologically significant wreck sites should be safeguarded and the safety zones to be used, will be agreed with the competent Swedish authorities.

#### **18.11.4 Denmark**

The NSP monitoring programme for cultural heritage aimed to document that protected cultural heritage sites were not damaged or disturbed during construction and that the presence of the pipelines did not cause erosion around protected wrecks. The programme included monitoring of two wrecks identified within 50 m of NSP, which was carried out as an ROV-based multi-beam survey and a visual inspection by ROV before, during and after construction between 2010 and 2014. Authority experts were on board pipe-lay vessels to ensure that cultural heritage objects were not disturbed by construction activities. Monitoring showed that both wrecks were in the same condition as they were prior to construction of NSP and that no erosion around the two wrecks had occurred.

The purpose of the cultural heritage monitoring programme for NSP2 would be to register the condition of wrecks before and after construction, i.e., to verify that construction has not affected any CHOs. The Viking Ship Museum will perform a screening of the geophysical data with the aim of assessing potential CHOs. On the basis of this evaluation, a visual inspection will be performed and/or exclusion zones will be established around protected wrecks upon agreement with the Danish Agency for Culture and Palaces. The pipe-lay contractor will be informed of all agreed restriction zones.

#### **18.11.5 Germany**

Cultural heritage monitoring was not monitored for NSP.

The purpose of the cultural heritage monitoring programme for NSP2 in Germany is to document whether impacts on protected cultural heritage can be avoided during construction activities. To avoid any impacts, a safety zone between the proposed pipeline route and objects of cultural heritage has been defined in cooperation with the competent national authorities. In the case that CHOs are discovered during construction activities, the competent authority will be notified.

### **18.12 Maritime traffic**

In general, the purpose of monitoring in relation to maritime traffic would be to minimise the risk of collisions or other accidents involving commercial ship traffic and/or vessels performing construction activities for NSP2.

#### **18.12.1 Sweden**

The purpose of the control and monitoring of maritime traffic for NSP was to minimise the risk of collisions or other accidents involving commercial shipping traffic and/or vessels carrying out construction activities for the project between 2009 and 2010. Precautionary measures were successfully implemented during construction of the pipelines, and no accidents or incidents involving third-party vessels occurred.

The purpose of the control and monitoring of maritime traffic for NSP2 will be similar to that of NSP. Mitigation and risk-reduction measures have been analysed and implemented in ship traffic management procedures (or plans). Safety zones of varying sizes will be established around all vessels performing underwater construction work. Vessels within the construction spread, or additional vessels, can serve as guard vessels during certain construction activities or in particularly sensitive areas such as shipping lanes. Information on upcoming and ongoing construction activities will be provided to the competent authorities.

The ship traffic management procedures will be developed by the contractors before the start of construction activities to ensure the safety of both third-party shipping and the vessels involved in construction activities. These procedures include, e.g., normal and emergency communication lines and flowcharts, safety measures and responsibilities, required safety zones and vessel management systems (such as the AIS for identification and locating of vessels).

#### **18.12.2 Denmark**

Monitoring of maritime traffic was conducted between 2010 and 2012 prior to and during construction of NSP, to verify the impacts from pipeline construction. The monitoring results confirmed that impacts were local, short-term and not significant.

The purpose of maritime traffic monitoring for NSP2 would be to minimise the risk of collisions or other accidents involving commercial ship traffic and/or vessels performing pipeline construction activities. To mitigate this risk, a temporary safety area will be established around the pipe-laying vessel as it progresses along the NSP2 route. Only vessels involved in the construction of the

pipeline will be allowed inside the safety area, and unauthorized navigation, diving, anchoring, fishery or work on the seabed will be prohibited.

Ship traffic management procedures will be developed by the contractors before the start of construction activities to ensure the safety of both third-party shipping and the vessels involved in construction activities. These procedures include, e.g., normal and emergency communication lines and flowcharts, safety measures and responsibilities, required safety zones and vessel management systems (such as the AIS for identification and locating of vessels).

### **18.12.3 Germany**

Monitoring of maritime traffic was conducted to document impacts from construction of NSP in 2010. Construction activities in Germany took place in an area of the Baltic Sea that was already highly frequented by maritime traffic. As such, the impacts on maritime traffic during construction works were determined to be local and short-term, without noticeable effects.

The maritime traffic monitoring programme for NSP2 aims to document the project-related ship traffic during construction. A specific monitoring schedule will be created prior to the start of construction works, and will comprise procedures and instructions regarding monitoring tasks, reporting obligations and procedures in case deviations from specifications and requirements are observed.

## **18.13 Commercial fishery**

### **18.13.1 Russia**

Although bottom trawling is not presently allowed in the Russian sector, all fishery activities in the offshore and nearshore sections of the project area will be recorded prior to construction.

### **18.13.2 Finland**

Commercial fishery was monitored between 2010 and 2015 in Finland to document and evaluate potential impacts of pipeline construction and operation on commercial fishing behaviour in the Gulf of Finland. The analyses were based on VMS satellite tracking data and fishermen questionnaires. The results of the monitoring programme indicated a minor negative impact on trawling during both construction and operation.

Following construction of NSP2, monitoring of the potential impact on commercial fishery will be carried out in two ways: a questionnaire will be sent to fishermen trawling in the Gulf of Finland, and VMS satellite tracking data will be used to analyse fishing vessel movements and fishing patterns close to the pipelines.

### **18.13.3 Sweden**

The NSP commercial fishery monitoring programme aimed to evaluate whether any changes to the fishery pattern and/or fish catch pattern occurred after installation of the pipeline. The analyses were based on VMS data for bottom trawling and bottom net fishery by Swedish fishing vessels, reviewed for the years 2010 through 2014. No changes in fishery patterns or annual fish landings were ascribed to the presence of the NSP system on the seabed.

The purpose of fishery monitoring for NSP2 would be to evaluate whether any changes to the fishery pattern and/or fish catch pattern occur after installation. It is anticipated that the analyses will be based on fishery data collected by the Swedish Agency of Marine and Water Management (SwAM) as part of the statutory recording of the fishery pattern and fish catches by the Swedish fishing fleet. The fishery pattern will be evaluated on the basis of VMS data and the fish catch pattern will be evaluated on the basis of logbook data.

#### **18.13.4 Denmark**

Commercial fishery was not monitored for NSP.

The purpose of the fishery monitoring programme for NSP2 would be to evaluate whether any changes to the fishery pattern and/or fish catch pattern occur after the pipeline installation. It is expected that the pipelines will, to a small extent, reduce the ability of fishermen to bottom trawl wherever they want, as trawling patterns will need to be adapted to the presence of the pipelines or the gear will need to be lifted when crossing the pipelines.

#### **18.14 Chemical munitions objects**

##### **18.14.1 Denmark**

Chemical munitions objects monitoring was conducted in Denmark for NSP between 2010 and 2012 to document that identified chemical munitions objects had not been disturbed during the construction or operation of NSP. Detailed munitions surveys prior to construction led to the discovery of seven chemical munitions objects east of Bornholm. The ADF assessed these objects, and it was agreed with ADF that the chemical munitions were to be left on the seabed and not disturbed during installation of NSP. This was ensured through the use of a controlled pipe-lay with ROV monitoring. Authority experts were on-board the pipe-lay vessels to ensure traces of chemical munitions were not brought on board the construction vessels. Post-lay munitions monitoring indicated that the condition of all seven munitions objects was unchanged. Hence, there were no impacts on these objects from the construction of NSP in Danish waters.

Similar to the programme for NSP, the purpose of the NSP2 monitoring programme for munitions in Danish waters would be to document that identified munitions objects are not disturbed during pipeline construction or operation. The scope of monitoring during construction will depend on the type of lay vessel used.

#### **18.15 CWAs in the sediment**

##### **18.15.1 Denmark**

Monitoring of CWAs in Denmark was performed prior to and after construction of NSP between 2008 and 2012 in order to document potential changes in the concentration of CWA compounds in the seabed sediment. The monitoring focused on impacts from trenching, the activity that was assessed to have the greatest impact on the seabed environment and thereby the greatest potential for disturbing buried CWA-related compounds. A comparison of results from the sampling campaigns suggests that the detection frequencies and levels of CWA-related compounds were comparable between years and that the potential CWA-related risks to fish and benthic communities were also comparable and low.

The purpose of CWA monitoring in connection with NSP2 would be similar; namely, to document any changes in the levels of CWA in the marine sediment after construction in comparison with the baseline conditions. Similar to the monitoring campaign carried out for NSP, monitoring would focus on locations where trenching has been carried out, as this activity results in the largest sediment disturbance. Based on the experience from NSP, it has been assessed that, in general, construction activities on the seabed may have only a very local effect on the spreading of CWAs.

It is planned that munitions experts from the ADF will be on board construction vessels to ensure that traces of CWAs are not brought on board and that the proposed handling procedures are implemented.

## 19. KNOWLEDGE GAPS AND UNCERTAINTIES

### 19.1 Introduction

There may be several reasons for technical deficiencies or lack of knowledge in an EIA. It is important to draw attention to the fact that the nature of an EIA is *predictive*. Therefore, it is challenging to precisely predict what kind of impacts on the environment will occur and the duration of these impacts. Furthermore, the significance of impacts or certain aspects in relation to each other (e.g. synergism) is sometimes subjective.

It should be noted that, due to the long-term monitoring programme in place for NSP (ongoing since 2009), a wealth of information is available for use. This includes studies to investigate the actual impacts during construction and operation and the recovery of affected resources and receptors. As such, the overall data and knowledge basis for the NSP2 impact assessments is quite strong.

In the early phase of this project, preliminary assessments were made in order to identify the most important data and information needed for the national EIAs/ES and Espoo Report. Based on these assessments, a number of surveys and data-collection activities were initiated to minimise the data/information gaps prior to undertaking the environmental impact assessment. This chapter discusses the most significant remaining knowledge gaps and uncertainties, as reported in the national EIAs/ES /26/, /27/, /32/, /54/, /58/, /75/, /76/, /116/, /157/, /376/, /377/ and in Chapter 9 – Environmental baseline and Chapter 10 – Assessment of environmental impacts of this report. Many of them are common to offshore projects and are not considered to be critical to the assessment of impacts associated with the NSP2 project.

### 19.2 Knowledge gaps

The Baltic Sea has been extensively investigated by numerous researchers, meaning that this Espoo Report has been able to draw on an extensive amount of data, such as the data published by HELCOM, the various national research institutions of the Baltic Sea countries, and from the implementation of other infrastructure projects in the Baltic Sea. Furthermore, data gathered during the pre-construction, construction and operation phases of the NSP project have provided a strong foundation for the baseline and impact assessments required for this report. The bank of published data has been further supplemented by an extended field survey programme and studies undertaken by Baltic Sea specialists on behalf of Nord Stream 2 AG to collect specific baseline data along the proposed pipeline corridor.

Inevitably, however, knowledge gaps remain. In common with other marine ecosystems, the present understanding of how the system functions in physical, chemical and biological terms is far from complete. With reference to this Espoo Report, the following issues and known data and knowledge gaps must be additionally taken into account.

#### 19.2.1 Gaps in baseline information

The most pertinent gaps in baseline information, which could have influenced the assessment of resource or receptor sensitivity and impact magnitude, include the following:

- Environmental monitoring results can differ based on the selection of monitoring stations, even for those located in close proximity to one another. Therefore, a certain degree in natural variability of the monitored parameters should be taken into account when interpreting monitoring results.
- As the project design is subject to further modifications, calculation of the surface areas on the seabed needed for rock placement involves some uncertainties and therefore only provides an estimation of the project footprint. Surface areas were estimated based on the current project design and experience from NSP.



- It was not possible to obtain a complete picture of fishing activity in the project area, as data on e.g. fish catches by Polish vessels in 2014 and on any fishery activity by Russian vessels were not available.
- As Russia is not part of the EU, it is not covered under the MSFD or the WFD, and therefore a project-wide assessment of compliance with marine strategic planning initiatives could not be made.
- There is a limited understanding of the natural variability and trends in population size and the spatial and temporal distribution of several species of interest, particularly marine mammals and birds. Long-term ecological data are needed for the study of biological systems over seasonal and annual timeframes, but these are generally lacking.

It should be noted that none of the gaps described above are considered likely to significantly change the baseline described in this report.

### 19.2.2 Gaps in understanding of impacts

The most pertinent gaps in the understanding of the scale, duration and intensity of the impacts include the following:

- Numerical modelling has been undertaken for noise propagation (underwater and airborne) and sediment dispersion. Internationally recognised, state-of-the-art models have been applied, but as the models are dependent on input, some assumptions were required.
- Incomplete information is available on the sensitivity of all birds, marine mammals, and fish in the project area to noise and pressure waves. Where species-specific data were not available, data from other species were used to approximate the sensitivity of a given species to noise and its expected response to stimulus.
- There are multiple pressures that can individually influence biodiversity and the relative impact of an individual pressure is difficult to discern. The state of biodiversity is determined based on the cumulative and synergistic impacts of all pressures. Therefore, the lack of information or uncertainties regarding each separate receptor that together constitute biodiversity yield uncertainties in assessing the impacts on biodiversity.

It should be noted that none of the gaps described above are considered likely to significantly change the outcome of the assessments made in this report.

### 19.3 Uncertainties

The EIA process identifies and assesses potential impacts based on current and historical baseline information. As EIAs are, by nature, forward-looking and predictive, a degree of uncertainty concerning the actual type and significance of impacts is unavoidable. However, by employing the most state of the art survey and analysis methods, collecting baseline data over a broad spatial and temporal range, and accounting for the experience gained from NSP, uncertainty surrounding many potential impacts from NSP2 was markedly reduced.

Where a relatively high level of uncertainty still remains, this report has taken a precautionary approach to impact identification and assessment and has described the mitigation measures that have been integrated into the project design and implementation to further reduce anticipated impacts.

In addition, Chapter 18 – Environmental monitoring of this report includes a proposal for a monitoring programme that covers the pre-construction, construction and operation phases of the project. The purpose of monitoring is to collect additional data and information in order to resolve gaps and uncertainties, thereby minimising the lack of knowledge and verifying the predicted impacts from the project.



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**NORD STREAM 2**  
**ESPOO REPORT**

# **APPENDIX 1**

**NSP2 STAKEHOLDER ISSUES AND PROJECT  
RESPONSES**

In November 2012, Nord Stream AG issued a Project Information Document (PID) covering the Nord Stream Extension, now called NSP2, for review and reference. In February 2013, a meeting between the Parties of Origin (PoOs) was held to discuss the content of the PID and the procedures for the project according to the Espoo Convention.

Following this meeting and taking into account the comments, Nord Stream AG submitted the final PID to the PoOs in March 2013. In April 2013, the PoOs submitted the PID to the Affected Parties (Aps) as prescribed by Article 3 ("Notification") of the Espoo Convention. The public consultation phase on the PID subsequently took place in all countries in parallel with the display of the national EIA programmes as required by the national legislation of each country. All APs expressed their interest in participating in the Espoo procedure for the Nord Stream Extension and submitted comments on the PID resulting from the public consultation phase.

Over 100 comments related to the PID were received from authorities, organisations and private individuals. Appendix 1 provides a list of received comments and the respective responses.

Issue	Comments	Project Response
<b>Impacts on biological environment</b>		
Minimising impacts on marine mammals, birds and fish spawning/nursery areas.	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Potential impacts on ringed seals and breeding areas should be carefully assessed.</li> <li>- Construction activities should be avoided during sensitive periods of the year (when biological activity is the highest). It is recommended that the report should specify dates for the planned work.</li> <li>- Potential impacts on birds, such as the long-tailed duck during pipe-laying and operational activities in overwintering areas should be described in the report.</li> <li>- Important fish spawning and nursery areas and the potential impacts on these areas should be included in the impact assessment.</li> </ul>	<ul style="list-style-type: none"> <li>- The assessments, taking into account sensitivity, are documented in Section 10.6. Timing of the construction activities will, as far as reasonable and practical, take into account the seasonal variation in the sensitivity of the environment.</li> <li>- The impacts on birds and fish are addressed in Section 10.6.</li> </ul>
<b>Impacts on physical environment</b>		
Minimising impacts on seabed and sediments	<p>Specific issues to be considered during the construction phase:</p> <ul style="list-style-type: none"> <li>- Seabed intervention works that may disrupt the seabed, resulting in sediment dispersal should be investigated.</li> <li>- It is recommended that the amount of phosphorus and environmental toxins released from the NSP pipelines will be included in the NSP2 report.</li> </ul> <p>Specific issues to be considered during the evaluation of sediments:</p> <ul style="list-style-type: none"> <li>- Sediment samples should be evaluated and compared to relevant sediment quality guidelines.</li> <li>- Analyses of sediments should include background information such as the description of bottom sediments, sediment grain size, sediment age and the concentration of organic matter.</li> <li>- Solid analyses should include the analyses of the hazardous constituents such as dioxins and mercury and volumes present in the sediments.</li> </ul>	<ul style="list-style-type: none"> <li>- The impacts of seabed interventions work are documented in Section 10.2.</li> <li>- The impacts of release of contaminants and nutrients are documented in Section 10.2.</li> <li>- Information on contaminants in seabed sediments is included in Appendix 4.</li> <li>- General information of seabed sediments is available in Section 9.2. Analysis of hazardous constituents is undertaken along the entire pipeline route for NSP2.</li> </ul>
Minimising impacts on marine geology	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Seabed intervention works that may affect geological conditions, resulting in landslides should be investigated.</li> </ul>	<ul style="list-style-type: none"> <li>- Landslide potential was investigated by SGU for NSP and found not to be a risk (see Section 9.2) and is valid also for the NSP2 route. Risk assessments for NSP2, which include seismic risks, are documented in Chapter 13 Risk assessment.</li> </ul>
Minimising impacts on the climate	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Potential impacts on the climate impact should be</li> </ul>	<ul style="list-style-type: none"> <li>- Emissions of GHG are addressed in the</li> </ul>



Issue	Comments	Project Response
	described more thoroughly.	Chapter 10 Assessment of environmental impacts.
Minimising impacts on noise	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Pipe-laying activities may result in an increase in noise levels and may affect fish populations.</li> <li>- Noise from compressor stations and gas flow through pipelines may cause impacts on marine mammals.</li> </ul>	<ul style="list-style-type: none"> <li>- The impacts on underwater noise on the marine life is documented in Section 10.6.</li> <li>- Noise from compressor station (on land) is not relevant for marine mammals.</li> </ul>
<b>Impacts on socio-economic environment</b>		
Planned and future projects	<p>Specific issues to be considered for energy supply:</p> <ul style="list-style-type: none"> <li>- Economic and structural energy supply issues should be addressed as well as alternatives to them.</li> <li>- An analysis of the suitability and efficiency of onshore gas pipelines should be conducted.</li> <li>- An analysis should be conducted indicating how the discovery of natural gas production in shale bedrock within the EU will impact the need for these pipelines.</li> </ul> <p>Specific issues to be considered for planned objects:</p> <ul style="list-style-type: none"> <li>- Status of planned infrastructure projects should be included.</li> </ul>	<ul style="list-style-type: none"> <li>- Strategic, geopolitical issues are considered outside the scope. Specific issues related to NSP2 are addressed in Chapter 2 Project Justification and in Chapter 5 Alternatives.</li> <li>- Planned infrastructure projects are included in Chapter 14 Cumulative impacts.</li> </ul>
Minimising impacts on fishery	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- The schedule for the construction activities should be aligned with fishing regulations and should be specified in the report.</li> </ul>	<ul style="list-style-type: none"> <li>- Will be addressed in the Construction Management Plans (CMP) for NSP2.</li> </ul>
Minimising impacts on maritime traffic and navigation	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Potential impacts on maritime traffic should be investigated.</li> <li>- Risk assessment of maritime traffic should be conducted.</li> </ul>	<ul style="list-style-type: none"> <li>- This is addressed in Section 9.10 and in Chapter 13 Risk assessment.</li> </ul>
Minimising impacts on cultural heritage resources	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- A detailed geophysical (acoustic) mapping of the seabed should be conducted and used as a basis for the study and interpretation of the marine cultural environment in the area.</li> <li>- Based on the bottom mapping, ocular diver inspection should take place in strategic places where cultural heritage sites have been identified to prevent any potential impacts on the resources.</li> <li>- It is recommended that sampling should occur in potential locations for mesolithic settlements. The samples should be taken in the form of core samples and/or manually with divers in places that have been identified from the geographic bottom mapping as a point of departure.</li> </ul>	<ul style="list-style-type: none"> <li>- The surveys carried out for identifying cultural heritage is described in Section 9.10, and the possible impacts are documented in Section 10.9.</li> <li>- Possible mesolithic settlements are addressed in Section 9.10. Marine archaeologist will be involved if settlements or wrecks are found.</li> </ul>

Issue	Comments	Project Response
Munitions, conventional/ chemical	Specific issues to be considered: <ul style="list-style-type: none"> <li>- Munitions should be surveyed along the pipeline route.</li> <li>- Potential interference of chemical war agents and munitions should be investigated.</li> <li>- Pipe-laying activities may lead to the release of dioxin and dioxin-like compounds (dl PCB) due to the removal of CWAs.</li> </ul>	<ul style="list-style-type: none"> <li>- CWA and conventional munitions screening is outlined in Sections 9.13 and 9.14. The risk related to munitions is outlined in Chapter 13 Risk assessment.</li> </ul>
People and health	Specific issues to be considered: <ul style="list-style-type: none"> <li>- Dioxines, mercury and other harmful chemicals may enter the food chain of sea organisms and may affect human health. Potential impacts on human health should be investigated.</li> </ul>	<ul style="list-style-type: none"> <li>- Release of dioxin, mercury and other harmful chemicals from seabed sediments is assessed in Section 10.2.</li> </ul>
<b>Cumulative impacts</b>		
Cumulative impacts	Specific issues to be considered: <ul style="list-style-type: none"> <li>- Cumulative impacts caused by future developments in the Baltic Sea should be assessed.</li> <li>- Direct, indirect cumulative impacts should be included in the report</li> <li>- Cumulative impacts identified from NSP should be used to assess cumulative impacts for NSP2.</li> <li>- Cumulative impacts should be in line with the EU Maritime Strategy Framework Directive and HELCOM Baltic Sea Action Plan.</li> </ul>	<ul style="list-style-type: none"> <li>- Both direct, indirect and cumulative impacts are addressed in this Espoo EIA, in line with applicable EU directives and HELCOM guidelines (Chapter 10 Assessment of environmental impacts and Chapter 14 Cumulative impacts.</li> </ul>
<b>Transboundary impacts</b>		
Minimising transboundary impacts on sediment dispersal	Specific issues to be considered: <ul style="list-style-type: none"> <li>- Seabed intervention works may result in dispersal of sediments, resulting in transboundary impacts. Potential impacts of dispersal of sediments should be assessed.</li> </ul>	<ul style="list-style-type: none"> <li>- Sediment dispersion is included in the assessment of transboundary impacts as outlined in Section 10.2 and Chapter 15 Transboundary impacts.</li> </ul>
Minimising impacts on munitions, conventional/ chemical	Specific issues to be considered: <ul style="list-style-type: none"> <li>- Seabed intervention works may lead to emission of pollutants due to the potential presence and disturbance of chemical munitions, resulting in transboundary impacts.</li> </ul>	<ul style="list-style-type: none"> <li>- Possible interference with CWA is an integrated part of the impact assessment; this is documented in Section 10.13.</li> </ul>
Minimising impacts on maritime traffic and navigation	Specific issues to be considered: <ul style="list-style-type: none"> <li>- Potential indirect impacts on maritime traffic, such as the decrease of shipping activities, should be assessed as this may result in transboundary impacts.</li> </ul>	<ul style="list-style-type: none"> <li>- Ship traffic is included in Section 10.9, and possible transboundary impacts are addressed in Chapter 15 Transboundary impacts.</li> </ul>
Minimising impacts on	Specific issues to be considered:	

Issue	Comments	Project Response
fishery	<ul style="list-style-type: none"> <li>- Potential indirect impacts on fishing, such as a decrease in fishing activities, should be assessed as this may lead to transboundary impacts.</li> <li>- The project activities may disrupt bird and fishing areas and may result in transboundary impacts.</li> </ul>	<ul style="list-style-type: none"> <li>- Fishery is included in Section 10.9, and possible transboundary impacts are addressed in Chapter 15 Transboundary impacts.</li> <li>- Impact on birds is included in Section 10.6 Marine areas, and possible transboundary impacts are addressed in Chapter 15 Transboundary impacts.</li> </ul>
Natura 2000 sites	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Adverse impacts on the fragile ecosystem of the Baltic Sea should be investigated.</li> </ul>	<ul style="list-style-type: none"> <li>- The fragility of the Baltic Sea is documented in Chapter 9 Environmental baseline and the impacts of NSP2 on the ecosystem is documented in Chapter 10 Assessment of environmental impacts.</li> </ul>
People and Health	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Possible collisions with vessels, especially on the shallow waters and in places where gas pipeline routes cross the navigation routes may lead to transboundary impacts on human health.</li> </ul>	<ul style="list-style-type: none"> <li>- This is included in Chapter 13 Risk assessment.</li> </ul>
<b>Environmental monitoring</b>		
Environmental Monitoring	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Noise monitoring measurements of the existing NSP should be conducted to assess noise impacts of the NSP2.</li> <li>- Ongoing inspections during construction and operational phases on marine environments should be undertaken.</li> <li>- The report should contain the monitoring results of existing pipelines,</li> <li>- Environmental monitoring results from the NSP should be incorporated into the NSP2 report.</li> </ul>	<ul style="list-style-type: none"> <li>- Noise monitoring for NSP has been taking place since 2009 and monitoring is ongoing. The results from the noise monitoring results will be used as a guideline for the NSP2 and are used (in combination with modelling of underwater noise from construction and operation of NSP2) when determining the significance of the impacts caused by noise (Section 10.6).</li> <li>- Monitoring results from NSP is referred to in Appendix 3 NSP2</li> </ul>

Issue	Comments	Project Response
		modelling and NSP experience. The monitoring programme for NSP2 will be agreed with the relevant national authorities (see Chapter 18 Proposed environmental monitoring).
<b>Impacts during various Phases of the Project</b>		
Impacts during pre-commissioning activities	<p>Specific issues to be considered for the usage of additives:</p> <ul style="list-style-type: none"> <li>- It is recommended that as a risk-reducing measure, other possibilities for treatment should be disclosed and weighed against one another for example, cleaning of water before discharge.</li> </ul>	<ul style="list-style-type: none"> <li>- Avoiding pressure testing is being considered (see Section 6.8.1); if pressure testing is carried out, only environmentally-friendly chemicals might be used. Is outlined in the section on pre-commissioning.</li> </ul>
Impacts during construction phase	<p>Specific issues to be considered for the ditching and placement of stone on the seabed:</p> <ul style="list-style-type: none"> <li>- A description should be included on which sections of the seabed will be affected, what type of environment may be affected as well as what impact the ditching and placement of stone respectively will have on the environment.</li> </ul>	<ul style="list-style-type: none"> <li>- This is addressed in Chapter 6 Project description and in Chapter 10 Assessment of environmental impacts.</li> </ul>
Impacts during decommissioning phase	<ul style="list-style-type: none"> <li>- The potential impacts of the removal of the pipelines should be assessed.</li> </ul>	<ul style="list-style-type: none"> <li>- The environmental aspects of decommissioning are addressed in Chapter 12 Decommissioning.</li> </ul>
<b>Stakeholder engagement</b>		
Stakeholder engagement	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Authorities from the affected countries should be involved with the project and the project should be discussed with the affected countries responsible for the planning.</li> </ul>	<ul style="list-style-type: none"> <li>- Authorities are actively involved in both the national and the Espoo EIA processes as outlined in Chapter 4 Espoo process.</li> </ul>
<b>Alternatives</b>		
0 - Alternative	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- The zero alternative should be investigated.</li> </ul>	<ul style="list-style-type: none"> <li>- The zero alternative is addressed in Chapter 5 Alternatives.</li> </ul>
Route Alternatives	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Alternatives should be considered in the landfall areas to avoid impacts on sensitive onshore habitats.</li> <li>- Alternatives should be considered through or close to vulnerable or protected areas such as Natura</li> </ul>	<ul style="list-style-type: none"> <li>- Relevant offshore alternatives are outlined in Chapter 5 Alternatives. Onshore alternatives are</li> </ul>

Issue	Comments	Project Response
	2000 sites. - Onshore and offshore alternatives should be thoroughly assessed and motivation should be given on preferred alternative.	considered outside the scope of the report.
<b>Mitigation measures</b>		
Compensation	Specific issues to be considered: - It is recommended that the compensatory measures that may be made in each country should be described in greater detail in the report. - It is recommended that there should be some form of economic security before work on the pipeline construction commences. The security should cover the cost of taking up and taking care of the pipelines and restoration work on the seabed.	- Possible compensation measures are addressed in the national EIAs/ES. - Financial issues related to decommissioning are considered outside the scope of this report.
<b>Risk assessment</b>		
Emergency preparedness	Specific issues to be considered: - The report should address risks and impacts of accidents resulting from the construction and operation of the pipelines. - An updated contingency plan for various types of accidents should be included in the report to prevent or reduce the effects of any incidents. The contingency plan should include the various lifecycles of the project. - Additionally, the plan includes actions referring to the use of anti-corrosion substances; substances biologically active added to water during pressure test, noise emission, emission of vibration and air pollutants; lifting of sediments; polluting with heavy metals; expansion of the oxygen-free zone; or the removal and methods of securing of ammunition and other dangerous substances. - Coast guards should be informed when environmental rescue services are needed. - Company should disclose how it is organised to deal with them and what actions will be taken, both during the construction phase and during the operational phase, and also show what preparations have been made to deal with possible sabotage. - Gas leaks from pipelines may result in eutrophication. - Uncontrolled gas leaks, navigation collisions, finding unexploded bombs, catastrophic meteorological phenomena, seismic dangers and possible terrorist attacks are potential impacts and should be included in the report.	- Addressed in Chapter 13 Risk assessment. - Emergency response plans are part of the Construction Management Plans (CMP's). The principles are outlined in Section 13.5. - Impacts of planned activity are documented in Chapter 10 Assessment of environmental impacts. - Emergency response plans, which are part of the Construction Management Plans (CMP's), include scrambling of coastguards. - Impacts on the marine environment caused by accidental events are included in Chapter 13 Risk assessment, which includes all relevant risks.
<b>Pipeline design</b>		
Materials	Specific issues to be considered: - Materials and the substances that are to be used for corrosion protection and joints for the pipeline should be included in the report.	- Pipeline coating, anodes, chemicals, etc. are included in Chapter 6 Project description, and

Issue	Comments	Project Response
		assessment of the environmental impacts in Chapter 10 Assessment of environmental impacts.
<b>General key issues</b>		
Quality assurance review	<p>Specific issues to be considered:</p> <ul style="list-style-type: none"> <li>- Quality assurance reviews by authorities should be considered.</li> </ul>	<ul style="list-style-type: none"> <li>- The Espoo report will in general not be submitted for authority review in draft version.</li> </ul>
Other	<p>Other issues to be considered:</p> <ul style="list-style-type: none"> <li>- All additional sources of pollution related to the project in the Baltic Sea should be defined.</li> <li>- The report should clearly state the impact of the project of the environments of each of the affected countries.</li> <li>- It is very important that the report follows the precautionary principle. The previous NSP EIA has some problems and many insufficient aspects in the report were noted. The NSP2 EIA must take into account also the comments made during the NSP and assess the impacts that were taken into consideration during the first EIA.</li> <li>- Environmental impacts for such a large project should be studied collectively for the whole project and not be divided into parts.</li> </ul>	<ul style="list-style-type: none"> <li>- All NSP2-caused sources of pollution are included in the assessment.</li> <li>- This is addressed in Chapter 15 Transboundary impacts.</li> <li>- Comments to NSP and monitoring results from NSP are used as basis for designing the NSP2 work. See also Appendix 3 NSP2 modelling and NSP experience.</li> <li>- This Espoo EIA report addressed the overall impacts of the project in line with the EU recommendations.</li> </ul>

**NORD STREAM 2**  
**ESPOO REPORT**

# **APPENDIX 2**

## **PROTECTED SPECIES LIST**

The table in this appendix presents the protected species of the Baltic Sea Region. Regional distribution is presented in the column "Region". The terrestrial flora and fauna is presented by the onshore areas for each of the landfall areas, Russia and Germany. In some cases only Latin names exist. Information on national protection status can be found in the EIAs/ES.

### Guideline to understand the table

#### Red list categories

CR: Critically endangered  
 EN: Endangered  
 VU: Vulnerable  
 NT: Near threatened

The following red list categories are not listed in the table:

LC: Least concern  
 DD: Data deficient  
 NE: Not evaluated  
 NA: Not applicable  
 RE: Regionally extinct

#### Conservation status

- /1/ Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.  
 /2/ Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.  
 /3/ IUCN. 2016. The IUCN Red List of Threatened Species. <http://www.iucnredlist.org/>  
 /4/ HELCOM. 2013 HELCOM Red List of Baltic Sea species in danger of becoming extinct. Balt. Sea Environ. Proc. No. 140. Only category CR, EN, VU and NT area listed.  
 /5/ National Red List status is listed the HELCOM report /4/. This column only regards the PoOs countries RU, FI, SE, DK and DE. For species not listed in HELCOM report the national red list status comes from national red list databases (DK: [www.redlist.dmu.dk](http://www.redlist.dmu.dk)).  
 /6/ National Protection is defined as an unique national protection, i.e. not implementations of international protections or protection of red listed species. Only relevant protections are listed (e.g. hunting and fishing regulations are not relevant for this project). This column only regards the PoOs countries RU, FI, SE, DK and DE.

- A) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Appendix I  
 B) Bern Convention  
 C) Bonn Convention  
 D) Washington Convention, Annex II  
 E) Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS),  
 F) Regional agreement under the Bonn Convention  
 G) Red Data Book of Baltic Region

#### Legend for Russian conservation status

<sup>1</sup>Red Book of Russian Federation - 1<sup>1</sup>: Under the threat of extinction, 2<sup>1</sup>: Reducing in numbers, 3<sup>1</sup>: Rare species, 5<sup>1</sup>: Restoring.

<sup>2</sup>Red Book of the Leningrad region

- for terrestrial flora - 2(V)<sup>2</sup>: Vulnerable species, 3(R)<sup>2</sup>: Rare species, \* The species is proposed for the exclusion from the new edition of the Red Data Book of the Leningrad region.
- for terrestrial fauna – 3(NT)<sup>2</sup>: Near threatened, 3(VU)<sup>2</sup>: Vulnerable, 3(LC)<sup>2</sup>: Least Concern.
- for marine mammals - 2(EN)<sup>2</sup>: Endangered.
- for birds - 1 (CR)<sup>2</sup>: Critically Endangered, 2(EN)<sup>2</sup>: Endangered

<sup>3</sup>Red Data Book of the Eastern Fennoscandia (N Len) – 0<sup>3</sup>: Extinct, 1<sup>3</sup>: Endangered, 2<sup>3</sup>: Vulnerable, 3<sup>3</sup>: Rare.

<sup>4</sup>Red Data Book of the Baltic Region – 1<sup>4</sup>: Endangered, 2<sup>4</sup>: Vulnerable, 3<sup>4</sup>: Rare.

#### Other categories

nm: not mapped

M: migratory species designated in Natura 2000 sites, relevant for NSP2.



TAXA		Protection status							
Common name	Latin name	Habitats/ Birds Directive /1/2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
<b>Terrestrial flora</b>									
-	<i>Androsace septentrionalis</i>	-	-	-	-	RU	3 <sup>3</sup>	RU	RU
Sea hedge mustard	<i>Cakile maritima</i>	-	-	-	VU (DE)	-	-	DE	DE
-	<i>Cardamine impatiens</i>	-	-	-	-	RU	1 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
Sand sedge	<i>Carex arenaria</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
-	<i>Carex pseudocyperus</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
Common centaury	<i>Centaureum erythraea</i>	-	-	-	VU (DE)	P (DE)	-	DE	DE
-	<i>Corallorhiza trifida</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
Sand pink	<i>Dianthus arenarius</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
Oblong-leaved sundew	<i>Drosera intermedia</i>	Not applied	-	-	2(V) <sup>2</sup>	RU	3 <sup>3</sup> , 2 <sup>4</sup>	RU	RU
-	<i>Eleocharis mamillata</i>	-	-	-	-	RU	3 <sup>3</sup>	RU	RU
Royal helleborine	<i>Epipactis atrorubens</i>	Not applied	-	-	2(V) <sup>2</sup>	RU	1 <sup>3</sup> , 2 <sup>4</sup>	RU	RU
Hemp-agrimony	<i>Eupatorium cannabinum</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
-	<i>Gagea lutea</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Geranium robertianum</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Hammarbya paludosa</i>	-	-	-	-	RU	3 <sup>3</sup>	RU	RU
Dwarf everlast	<i>Helichrysum arenarium</i>	-	-	-	NT (DE)	P (DE)	-	DE	DE
Meadow oat-grass	<i>Helictotrichon pratense</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
Sea sandwort	<i>Honckenya peploides</i>	-	-	-	NT (DE)	-	-	DE	DE
Water violet	<i>Hottonia palustris</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	3 <sup>4</sup>	RU	RU
Yellow flag	<i>Iris pseudacorus</i>	-	-	-	-	-	P (DE)	DE	DE
Sheep scabious	<i>Jasione montana</i>	-	-	-	NT (DE)	-	3 <sup>3</sup>	DE	DE, RU
Compact rush	<i>Juncus conglomeratus</i>	-	-	-	NT (DE)	-	-	DE	DE
Blunt-flowered rush	<i>Juncus subnodulosus</i>	-	-	-	VU (DE)	-	-	DE	DE
-	<i>Listera cordata</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Malaxis monophyllos</i>	-	NT	-	-	-	2 <sup>3</sup>	RU	RU
-	<i>Mycelis muralis</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU

TAXA		Protection status							
Common name	Latin name	Habitats/ Birds Directive /1//2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
Bird's-nest orchid	<i>Neottia nidus-avis</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
-	<i>Oenantheaquatica</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Platantherabifolia</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Platanthera chlorantha</i>	-	-	-	-	-	2 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
-	<i>Polygala amarella</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
Eastern pasque flower	<i>Pulsatilla patens</i>	Not applied	-	-	2(V) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
Small pasque flower	<i>Pulsatilla pratensis</i>	Not applied	-	-	3 <sup>1</sup> , 2(V) <sup>2</sup>	RU	3 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
Brown beak sedge	<i>Rhynchospora fusca</i>	Not applied	-	-	3 <sup>1</sup> , 3(R) <sup>2</sup>	RU	3 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
-	<i>Rorippa amphibia</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
-	<i>Scleranthus perennis</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
Fen ragwort	<i>Senecio paludosus</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	2 <sup>3</sup>	RU	RU
Tatarian Catchfly	<i>Silene tatarica</i>	Not applied	-	-	3(R) <sup>2</sup>	RU	2 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
-	<i>Thymus serpyllum</i>	-	-	-	2(V) <sup>2</sup>	RU	-	RU	RU
Sea mayweed	<i>Tripleurospermum maritimum</i>	Not applied	-	-	2(V) <sup>2</sup>	RU	1 <sup>3</sup>	RU	RU
-	<i>Ulmus glabra</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Valeriana officinalis</i>	-	-	-	-	-	3 <sup>4</sup>	RU	RU
-	<i>Veronica spicata</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
-	<i>Viola rupestris</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
<b>Bryophytes</b>									
-	<i>Aulacomnium androgynum</i>	-	-	-	3 <sup>1</sup> , 3(R) <sup>2</sup>	RU	2 <sup>3</sup>	RU	RU
-	<i>Calypogeia suecica</i>	-	-	-	-	RU	2 <sup>3</sup>	RU	RU
-	<i>Frullania dilatata</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Jamesoniella autumnalis</i>	-	-	-	-	-	3 <sup>3</sup>		RU
-	<i>Leskea polycarpa</i>	-	-	-	-	-	1 <sup>3</sup>	RU	RU
-	<i>Lophozia ascendens</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Mnium hornum</i>	-	-	-	2(V) <sup>2</sup>	RU	-	RU	RU
-	<i>Orthotrichum obtusifolium</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU

TAXA		Protection status							
Common name	Latin name	Habitats/ Birds Directive /1//2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
-	<i>Orthotrichum pallens</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
-	<i>Phaeoceros carolinianus</i>	-	-	-	-	-	1 <sup>3</sup>	RU	RU
-	<i>Pohlia annotina</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
-	<i>Pohlia bulbifera</i>	-	-	-	-	-	2 <sup>3</sup>	RU	RU
-	<i>Pohlia prolifera</i>	-	-	-	-	-	1 <sup>3</sup>	RU	RU
-	<i>Schistostega pennata</i>	-	-	-	-	-	1 <sup>3</sup>	RU	RU
-	<i>Sphagnum palustre</i>	-	-	-	3(R) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
-	<i>Ulotia crispa</i>	-	-	-	3(R) <sup>2</sup>	RU	2 <sup>3</sup>	RU	RU
<b>Lichens</b>									
-	<i>Anaptichia ciliaris</i>	-	-	-	-	RU	3 <sup>3</sup>	RU	RU
Seaside horsehair	<i>Bryoria subcana</i>	Not applied	-	-	-	-	-	RU	RU
-	<i>Cladonia cariosa</i>	-	-	-	-	-	3 <sup>3</sup>	RU	RU
Tree lungwort	<i>Lobaria pulmonaria</i>	Not applied	-	-	2 <sup>1</sup> , 3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Ramalina fraxinea</i>	-	-	-	3(R) <sup>2</sup> <sup>1</sup>	RU	3 <sup>3</sup>	RU	RU
<b>Fungi</b>									
-	<i>Ceriporiopsis pannocincta</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Diplomitoporus lindbladii</i>	-	-	-	3(R) <sup>2</sup>	RU	-		RU
-	<i>Gloeoporus taxicola</i>	-	-	-	2(V) <sup>2</sup>	RU	-		RU
-	<i>Hapalopilus aurantiacus</i>	-	-	-	3(R) <sup>2</sup>	RU	-		RU
-	<i>Leptoporus mollis</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Postia leucomallella</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Rigidoporus crocatus</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Pycnoporellus fulgens</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Skeletocutis lenis</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Steccherinum collabens</i>	-	-	-	3(R) <sup>2</sup>	RU	-	RU	RU
-	<i>Steccherinum pseudozilingianum</i>	-	-	-	4(I) <sup>2</sup>	RU	-	RU	RU

TAXA		Protection status							
Common name	Latin name	Habitats/ Birds Directive /1//2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
-	<i>Tyromyces fissilis</i>	-	-	-	2(V) <sup>2</sup>	RU	-	RU	RU
<b>Terrestrial invertebrates</b>									
-	<i>Amara quenseli</i>			-	VU (DE)	-			
-	<i>Bembidion tenellum</i>			-	VU (DE)			DE	DE
-	<i>Buprestis octoguttata</i>	-	-	-	3(NT) <sup>2</sup>	RU		RU	RU
-	<i>Carabus violaceus</i>	-	-	-	3(VU) <sup>2</sup>	RU		RU	RU
-	<i>Cicindela maritima</i>	-	-	-	3(VU) <sup>2</sup>	RU	-	RU	RU
-	<i>Dolomedes plantarius</i>	-	VU		3(NT) <sup>2</sup>	RU	-	RU	RU
-	<i>Drepanopteryx phalaenoides</i>	-			3(NT) <sup>2</sup>	RU	-	RU	RU
-	<i>Dyschirius angustatus</i>			-	NT (DE)			DE	DE
-	<i>Formica rufa</i>	-	NT	-	-	-	-	RU	RU
-	<i>Harpalus autumnalis</i>			-	VU (DE)			DE	DE
-	<i>Harpalus flavescens</i>			-	VU (DE)			DE	DE
-	<i>Laphria gibbosa</i>	-	-	-	3(VU) <sup>2</sup>	RU	-	RU	RU
-	<i>Licinus depressus</i>			-	NT (DE)			-	DE
-	<i>Myrmeleon formicarius</i>	-	-	-	3(VU) <sup>2</sup>	RU	-	RU	RU
-	<i>Peltis grossa</i>	-	-	-	4(DD) <sup>2</sup>	RU	-	RU	RU
-	<i>Perforatella bidentata</i>	-	-	-	3(LC) <sup>2</sup>	RU	-	RU	RU
-	<i>Tachina grossa</i>	-	-	-	3(NT) <sup>2</sup>	RU	-	RU	RU
-	<i>Vertigo pusilla</i>	-	-	-	3(LC) <sup>2</sup>	RU	-	RU	RU
-	<i>Zygaena filipendulae</i>	-	-	-	3(LC) <sup>2</sup>	RU	-	RU	RU
<b>Terrestrial vertebrates</b>									
Slow worm	<i>Anguis fragilis</i>	-	-	-	-	-	3 <sup>3</sup>	DE, RU	DE, RU
European common toad	<i>Bufo bufo</i>	-	-	-	-	-	-	DE	DE
European roe deer	<i>Capreolus capreolus</i>	Not applied	-	-	3 (VU) <sup>2</sup>	RU	-	RU	RU
-	<i>Eptesicus nilssoni</i>	-	-	-	-	-	3 <sup>4</sup>	RU	RU
Serotine bat	<i>Eptesicus serotinus</i>	Annex IV	-	-	-	-	-	DE	DE

TAXA		Protection status							
Common name	Latin name	Habitats/ Birds Directive /1//2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
European tree frog	<i>Hyla arborea</i>	Annex IV	-	-	-	-	-	DE	DE
Smooth newt	<i>Lissotriton vulgaris</i>	-	-	-	-	-	-	DE	DE
European otter	<i>Lutra lutra</i>	Annex II & IV	NT	NT	3 (VU) <sup>2</sup>	RU	A, B (Appendix II), C (Appendix I), 3 <sup>3</sup>	RU, DE	RU
-	<i>Microtus (=Terricola) subterraneus</i>	-	-	-	3 (VU) <sup>2</sup>	RU	-	RU	RU
Brandt's bat	<i>Myotis brandtii</i>	Annex IV	-	-	NT (DE)	-	-	DE	DE
Pond bat	<i>Myotis dasycneme</i>	Annex II & IV	NT	-	-	RU	-	RU, DE	DE
Daubenton's bat	<i>Myotis daubentonii</i>	Annex IV	-	-	-	-	-	DE	DE
Greater mouse-eared bat	<i>Myotis myotis</i>	Annex II & IV	-	-	NT (DE)	-	-	DE	DE
Natterer's bat	<i>Myotis nattereri</i>	Annex IV	-	-	-	-	-	DE	DE
Grass snake	<i>Natrix natrix</i>	-	-	-	NT (DE), 3(NT) <sup>2</sup>	RU	1 <sup>4</sup>	RU, DE	DE, RU
Leisler's bat	<i>Nyctalus leisleri</i>	Annex IV	-	-	-	-	-	DE	DE
Common noctule	<i>Nyctalus noctula</i>	Annex IV	-	-	NT (DE)	-	-	DE	DE
Nathusius' pipistrelle	<i>Pipistrellus nathusii</i>	Annex IV	-	-	-	-	-	DE	DE
Common pipistrelle	<i>Pipistrellus pipistrellus</i>	Annex IV	-	-	-	-	-	DE	DE
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	Annex IV	-	-	-	-	-	DE	DE
Brown long-eared bat	<i>Plecotus auritus</i>	Annex IV	-	-	NT (DE)	-	-	DE	DE
Siberian flying squirrel	<i>Pteromys Volans</i>	Not applied	-	-	3(VU) <sup>2</sup>	RU	-	RU	(RU)
Moor frog	<i>Rana arvalis</i>	Annex IV	-	-	VU (DE)	-	-	DE	DE
European common frog	<i>Rana temporaria</i>	-	-	-	-	-	-	DE	DE
Parti-coloured bat	<i>Vespertilio murinus</i>	Annex IV	-	-	-	RU	-	RU, DE	DE
Viviparous lizard	<i>Zootoca vivipara</i>	-	-	-	-	-	-	DE	DE
<b>Benthic flora</b>									
-	<i>Alisma wahlenbergii</i>	Annex II & IV	VU	VU	EN (FI, SE)	FI, RU, SE	-	nm	-
Braun's Stonewort	<i>Chara braunii</i>	-	-	VU	VU (FI, SE)	-	-	nm	-

TAXA		Protection status							
Common name	Latin name	Habitats/ Birds Directive /1//2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
Convergent stonewort	<i>Chara connivens</i>	-	-	-	NT (ES)	-	-	-	-
-	<i>Chara horrida</i>	-	-	NT	EN (FI), CR (DE), NT (SE)	-	-	nm	-
Coral stonewort	<i>Chara tomentosa</i>	-	-	-	VU (DE)	-	-	-	-
Water pygmyweed	<i>Crassula aquatica</i>	-	-	NT	VU (FI), NT (SE)	-	-	nm	-
Bladder wrack	<i>Fucus vesiculosus</i>	-	-	-	VU (DE)	DE	-	nm	-
Black carageen	<i>Furcellaria lumbricalis</i>	-	-	-	VU (DE)	DE	-	-	-
Fourleaf Mare's Tail	<i>Hippuris tetraphylla</i>	Annex II	-	EN	EN (FI), CR (SE)	FI, SE	-	nm	-
Foxtail Stonewort	<i>Lamprothamnium papulosum</i>	-	-	EN	CR (DE), EN (SE)	DE	-	nm	-
Many-branched Stonewort	<i>Nitella hyaline</i>	-	-	VU	VU (FI)	-	-	nm	-
Starry Stonewort	<i>Nitellopsis obtusa</i>	-	-	NT	VU (FI)	-	-	nm	-
-	<i>Persicaria foliosa</i>	Annex II	-	EN	EN (FI), NT (SE)	FI	-	nm	-
Flat-stalked pondweed	<i>Potamogeton friesii</i>	-	-	NT	VU (DK), NT (FI, SE)	-	-	nm	-
Beaked Tasselweed	<i>Ruppia maritima</i>	-	-	-	VU (DE)	-	-	DE	DE
Fennel Pondweed	<i>Stuckenia pectinata</i>	-	-	-	-	-	-	DE	DE
-	<i>Ulva clathrata</i>	-	-	-	-	-	-	DE	DE
Horned Pondweed	<i>Zannichellia pallustris</i>	-	-	-	-	-	-	DE	DE
<b>Benthic fauna</b>									
-	<i>Alderia modesta</i>	-	-	NT	-	-	-	FI, ES	-
-	<i>Corophium multisetosum</i>	-	-	NT	-	-	-	-	-
-	<i>Clitellio arenarius</i>	-	-	-	-	-	-	DE	DE
-	<i>Deshayesorchestia deshayesii</i>	-	-	VU	-	-	-	DE	-
Spire snail	<i>Ecrobia ventrosa</i>	-	-	-	-	DE	-	DE	DE
-	<i>Fabriciella baltica</i>	-	-	-	-	DE	-	DE	DE
-	<i>Halitholus yoldiaearcticae</i>	-	-	-	VU (DE)	DE	-	DE	DE

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Chalky macoma	<i>Macoma calcarea</i>	-	-	VU	CR (DE), VU (PL)	-	-	DE, PL, SE	-
-	<i>Manayunkia aestuarina</i>	-	-	-	-	DE	-	DE	DE
-	<i>Melita palmata</i>	-	-	-	NT (DE)	DE	-	DE	DE
-	<i>Monoporeia affinis</i>	-	-	-	VU (DE), 3(VU) <sup>2</sup>	DE, RU	-	DE, RU	DK, FI, SE, DE, RU
Blunt gape	<i>Mya truncata</i>	-	-	NT	EN (DE), VU (SE)	-	-	-	-
Copenhagen cockle	<i>Parvicardium hauniense</i>	-	-	VU	VU (SE)	-	-	DE, FI, PL, SE	-
-	<i>Pontoporeia femorata</i>	-	-	-	NT (DE)	-	-	DE	DK, SE
-	<i>Saduria entomon</i>	-	-	-	-	DE	-	DE	FI, SE, DE
-	<i>Streblospio shrubsolii</i>	-	-	-	NT (DE)	DE	-	DE	DE
-	<i>Travisia forbesii</i>	-	-	-	-	DE	-	DE	DK, DE
-	<i>Tubificoides heterochaetus</i>	-	-	-	NT (DE)	DE	-	DE	DE
<b>Fish**</b>									
Allis shad	<i>Alosa alosa</i>	Annex II	-	-	-	DE	-	DE, PL, SE	-
Twaite shad	<i>Alosa fallax</i>	Annex II	-	-	-	DE	-	DE, LA, LI, PL, SE	-
European eel	<i>Anguilla anguilla</i>	-	CR	CR	CR (DK, SE), EN (FI, DE)	DE, SE	-	DK, ES, FI, DE, LA, LI, PL, SE	-
Asp	<i>Aspius aspius</i>	Annex II	-	NT	NT (FI, SE)	-	-	ES, FI	-
Barbel	<i>Barbus barbus</i>	-	-	-	-	DE	-	DE, PL	-
Spined loach	<i>Cobitis taenia</i>	Annex II	-	-	VU (FI)	-	-	ES, FI	-
Whitefish	<i>Coregonus maraena</i>	-	VU	EN	EN (FI)***	-	-	DK, ES, FI, DE, LA, LI, PL, SE	-
Bullhead	<i>Cottus gobio</i>	Annex II*	-	-	-	DE	-	ES, FI	-
Lumpsucker	<i>Cyclopterus lumpus</i>	-	-	NT	NT (SE)	-	-	DK, ES, FI,	DE

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								DE, LA, LI, PL, SE	
Four-bearded rockling	<i>Enchelyopus cimbrius</i>	-	-	NT	-	-	-	DK, ES, DE, LA, LI, PL, SE	-
Cod	<i>Gadus morhua</i>	-	VU	VU	VU (SE)	-	-	DK, ES, FI, DE, LA, LI, PL, SE	DE
River lamprey	<i>Lampetra fluviatilis</i>	Annex II	-	NT	NT (FI), CR (DE)	DE	-	DK, ES, FI, DE, LA, LI, PL, SE	-
Burbot	<i>Lota lota</i>	-	-	NT	NT (SE)	-	-	DK, ES, FI, DE, LA, LI, PL, RU, SE	RU
Snake blenny	<i>Lumpenus lampretaeformis</i>	-	-	-	CR (DE)	-	-	DK, ES, FI, DE, PL, SE	-
Whiting	<i>Merlangius merlangus</i>	-	-	VU	VU (SE)	-	-	DK, SE, DE, PL	DE
Razor-fish	<i>Pelecus cultratus</i>	Annex II	-	-	CR (DK)	-	-	DK, ES, FI, DE, LA, LI, PL, SE	-
Sea lamprey	<i>Petromyzon marinus</i>	Annex II	-	VU	VU (DK), NT (SE)	-	-	DK, DE, SE	-
Minnow	<i>Phoxinus phoxinus</i>	-	-	-	-	-	-	ES, FI, LA, LI, PL, SE	-
Salmon	<i>Salmo salar</i>	-	-	VU	VU (DK, FI, DE)	DE, RU	-	DK, ES, FI, DE, LA, LI, PL, RU, SE	RU
Trout	<i>Salmo trutta</i>	-	-	VU	CR (FI)	-	-	DK, ES, FI,	DE



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								DE, LA, LI, PL, SE	
Turbot	<i>Scophthalmus maximus</i>	-	-	NT	-	-	-	DK, ES, FI, DE, LA, LI, PL, SE	DE
Grayling	<i>Thymallus thymallus</i>	-	-	CR	VU (DK), CR (FI), EN (DE)	-	-	ES, FI	-
Eelpout	<i>Zoarces viviparus</i>	-	-	NT	NT (DE)	-	-	DK, ES, FI, DE, LA, LI, PL, SE	DE
<b>Marine mammals</b>									
Grey seal	<i>Halichoerus grypus grypus</i>	Annex II	-	-	VU (DK), EN (DE), 1 <sup>1</sup> , 2(EN) <sup>2</sup>	DK, RU	B (Appendix III)	ES, DK, DE, FI, PL, SE, RU	DE, RU
Ringed seal	<i>Phoca hispida botnica</i>	Annex II	-	VU	NT (FI, SE), 2 <sup>1</sup> , 2(EN) <sup>2</sup>	SE, RU	B (Appendix III)	ES, FI, RU, SE	RU
Harbour seal	<i>Phoca vitulina vitulina</i>	Annex II	-	See below	VU (SE)	DK	C	SE	-
Harbour seal (Southern Baltic sub-population)	<i>Phoca vitulina vitulina</i>	See above	-	-	See above	See above	See above	See above	-
Harbour seal (Kalmarsund sub- population)	<i>Phoca vitulina vitulina</i>	See above	-	VU	See above	See above	See above	See above	-
Harbour porpoise	<i>Phocoena phocoena</i>	Annex II Annex IV	VU	See below	VU (DK, SE), EN (DE)	DK, FI, DE, RU, SE	B (Appendix II), C (Appendix II), D, E, F	DK, DE, FI, PL, SE	-
Harbour porpoise (Baltic sub-population)	<i>Phocoena phocoena</i>	See above	See above	CR	See above	See above	See above	See above	-
Harbour porpoise	<i>Phocoena phocoena</i>	See above	See	VU	See above	See above	See above	See above	-

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(Western Baltic sub-population)			above						
<b>Birds</b>									
-	<i>Actitis hypoleucos</i>	-	-	NT	-	-	-	RU	RU
-	<i>Anthus pratensis</i>	-	NT	-	-	-	-	RU	RU
Razorbill	<i>Alca torda</i>	M	NT	-	NT (DK), 3(NT) <sup>2</sup>	FI, RU, DE	3 <sup>3</sup>	DK, ES, FI, DE	RU, DE
Northern pintail	<i>Anas aquta</i>	M	-	-	VU (DE), 3(NT) <sup>2</sup>	DE, RU	-	RU	RU
Eurasian teal	<i>Anas crecca</i>	M	-	-	NT (DK)	DE	-	ES	-
Northern shoveler	<i>Anas clypeata</i>	-	-	-	-	-	3 <sup>4</sup>	RU	RU
Eurasian wigeon	<i>Anas penelope</i>	M	-	-	VU (DK)	DE	2 <sup>4</sup> , G	ES	RU
Mallard	<i>Anas platyrhynchos</i>	M	-	-	-	DE	-	ES	RU
Garganey	<i>Anas querquedula</i>	M	-	-	NT (DK)	DE	-	FI	-
Gadwall	<i>Anas strepera</i>	M	-	-	3(LC) <sup>2</sup>	FI, DE, RU	2 <sup>4</sup>	RU	RU
Greylag goose	<i>Anser anser</i>	-	-	-	3(NT) <sup>2</sup>	RU	3 <sup>3</sup> , 2 <sup>4</sup>	RU	RU
Bean goose	<i>Anser fabalis</i>	M	-	EN	NT (FI), NT (SE)	DE	-	Not listed	-
Common pochard	<i>Aythya ferina</i>	M	VU	-	-	DE	-	ES	DE
Tufted duck	<i>Aythya fuligula</i>	M	-	NT	VU (FI)	DE	-	ES	RU, DE
Greater scaup	<i>Aythya marila</i>	M	-	VU	EN (FI), VU (SE)	FI, DE	3 <sup>3</sup> , 2 <sup>4</sup>	ES, FI	DE, RU
-	<i>Botaurus stellaris</i>	-	-	-	3(NT) <sup>2</sup>	RU	3 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
Light-bellied brent goose	<i>Branta bernicla hrota</i>	M	-	NT	3 <sup>1</sup> , 3(LC) <sup>2</sup>	FI, DE, RU	-	RU	RU
Barnacle goose	<i>Branta leucopsis</i>	Annex I	-	-	NT (DK), 3(LC) <sup>2</sup>	FI, DE, RU	-	DE, RU	RU
-	<i>Bubo bubo</i>	-	-	-	2 <sup>1</sup> , 2(EN) <sup>2</sup>	RU	2 <sup>3</sup> , 2 <sup>4</sup>	RU	RU
Common goldeneye	<i>Bucephala clangula</i>	M	-	-	NT (DK)	DE	G, 3 <sup>4</sup>	ES	RU, DE
Southern dunlin	<i>Calidris alpina schinzii</i>	Annex I	-	EN	EN (DK, FI), CR (DE, SE), 1 <sup>1</sup>	FI, DE, RU	1 <sup>3</sup> , 1 <sup>4</sup>	RU	RU

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					1(CR) <sup>2</sup>				
Curlew sandpiper	<i>Calidris ferruginea</i>	-	VU	-	-	-	-	RU	RU
Black guillemot	<i>Cephus grylle</i>	M	-	NT	EN (FI), NT (SE), 3(NT) <sup>2</sup>	FI, DE, RU	-	ES, FI, DE, PL, SE, RU	DE, RU
Ringed Plover	<i>Charadrius hiaticula</i>	M	-	NT	NT (FI), CR (DE), 3(VU) <sup>2</sup>	FI, DE, RU	3 <sup>3</sup> , 1 <sup>4</sup>	RU	RU
Black tern	<i>Chlidonias niger</i>	Annex I	-	-	EN (DK), CR (FI)	FI, DE	-	ES, DE	-
-	<i>Ciconia ciconia</i>	-	-	-	3(LC) <sup>2</sup>	RU	3 <sup>4</sup>	RU	RU
-	<i>Circus cyaneus</i>	-	NT	-	3(NT) <sup>2</sup>	RU	2 <sup>4</sup>	RU	RU
Long-tailed duck	<i>Clangula hyemalis</i>	M	VU	EN	EN (SE), NT (FI)	DE	-	DE, PL, SE, RU	RU, DE
Corncrake	<i>Crex crex</i>	-	-	-	3(LC) <sup>2</sup>	RU	-	RU	RU
Tundra / Bewick's swan	<i>Cygnus columbianus / bewickii</i>	Annex I	-	-	5 <sup>1</sup> , 3 (VU) <sup>2</sup>	RU, DE, FI	-	ES, FI, DE, RU	RU
Whooper swan	<i>Cygnus cygnus</i>	Annex I	-	-	3(VU) <sup>2</sup>	FI, RU, DE	G, 0 <sup>3</sup> , 1 <sup>4</sup>	ES, FI, DE, RU	RU
Mute swan	<i>Cygnus olor</i>	M	-	-	-	FI, DE	G, 2 <sup>4</sup>	ES	RU, DE
-	<i>Dendrocopos leucotos</i>	-	-	-	3(NT) <sup>2</sup>	RU	-	RU	RU
-	<i>Dryocopus martius</i>	-	-	-	-	-	3 <sup>4</sup>	RU	RU
-	<i>Falco columbarius</i>	-	-	-	-	-	3 <sup>4</sup>	RU	RU
-	<i>Falco tinnunculus</i>	-	-	-	3(LC) <sup>2</sup>	RU	3 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
-	<i>Fulica atra</i>	-	NT	-	-	-	-	RU	RU
-	<i>Emberiza rustica</i>	-	VU	-	-	-	-	RU	RU
-	<i>Gallinago media</i>	-	NT	-	3(VU) <sup>2</sup>	RU	2 <sup>3</sup> , 2 <sup>4</sup>	RU	RU
Black-throated diver	<i>Gavia arctica</i>	Annex I	-	CR	CR (ES), 2 <sup>1</sup> , 3(VU) <sup>2</sup>	FI, RU, DE	G, 3 <sup>3</sup> , 1 <sup>4</sup>	FI, DE, PL, RU	RU
Red-throated diver	<i>Gavia stellata</i>	Annex I	-	CR	NT (SE), 2(EN) <sup>2</sup>	DE, RU	-	FI, DE, RU	DE

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Eurasian oystercatcher	<i>Haematopus ostralegus</i>	-	VU	-	3 <sup>1</sup> , 3(NT) <sup>2</sup>	RU	2 <sup>4</sup>	RU	RU
White-tailed sea-eagle	<i>Haliaeetus albicilla</i>	Annex I	-	-	VU (FI), 3 <sup>1</sup> , 3(VU) <sup>2</sup>	RU, FI, DE	G, 2 <sup>3</sup> , 2 <sup>4</sup>	ES, DE, RU	RU
Caspian tern	<i>Hydroprogne caspia</i>	Annex I	-	VU	CR (DE), VU (SE), 3 <sup>1</sup> , 3(VU) <sup>2</sup>	FI, DE, RU	2 <sup>3</sup> , 2 <sup>4</sup>	FI, DE,	RU
-	<i>Lagopus lagopus</i>	-	VU	-	2 <sup>1</sup> , 2(EN) <sup>2</sup>	RU	3 <sup>4</sup>	RU	RU
-	<i>Lanius excubitor</i>	-	VU	-	3 <sup>1</sup> , 3(NT) <sup>2</sup>	RU	3 <sup>3</sup> , 3 <sup>4</sup>	RU	RU
Red-backed shrike	<i>Lanius collurio</i>	Annex I	-	-	-	DE	-	-	DE
European herring gull	<i>Larus argentatus</i>	M	-	-	-	DE	-	DE, RU	RU, DE
Common gull	<i>Larus canus</i>	M	-	-	-	FI DE	-	ES, DE, RU	RU, DE
Lesser black-backed gull	<i>Larus fuscus</i>	M	-	VU	EN (FI), NT (SE), 3(VU) <sup>2</sup>	FI, DE, RU	-	ES, FI, DE, RU	DE, RU
Great black-backed gull	<i>Larus marinus</i>	M	-	-	NT (FI)	DE	1 <sup>4</sup>	DE, RU	DE, RU
Mediterranean gull	<i>Larus melanocephalus</i>	Annex I	-	EN	-	FI, DE	-	DE	DE
Little gull	<i>Hydrocoloeus minutus</i>	Annex I	-	NT	-	FI, DE	-	DE, RU	DE, RU
Black-headed gull	<i>Larus ridibundus</i>	M	-	-	VU (FI)	FI, DE	-	ES, DE, RU	DE, RU
-	<i>Limosa limosa</i>	-	VU	NT	3(VU) <sup>2</sup>	RU	2 <sup>4</sup>	RU	RU
Wood lark	<i>Lullula arborea</i>	Annex I	-	-	NT (DE), 3(VU) <sup>2</sup>	DE, RU	-	RU	DE, RU
Velvet scoter	<i>Melanitta fusca</i>	M	EN	VU-EN	EN (FI), NT (SE)	FI, DE	G, 2 <sup>4</sup>	ES, FI, DE, PL, RU	RU, DE
Common scoter	<i>Melanitta nigra</i>	M	-	EN	-	FI, DE	-	FI, DE, PL, RU	DE, RU
Smew	<i>Mergus albellus</i>	Annex I	-	-	3 (NT) <sup>2</sup>	FI, DE, RU	2 <sup>3</sup> , 1 <sup>4</sup>	FI, PL, RU	DE, RU
Common merganser	<i>Mergus merganser</i>	M	-	-	VU (DK), NT (DE)	FI	G	ES, RU	RU, DE
Red-breasted merganser	<i>Mergus serrator</i>	M	-	VU	EN (FI)	FI, DE	G, 3 <sup>4</sup>	ES, DE, PL, RU	RU, DE
-	<i>Milvus migrans</i>	-	-	-	3(VU) <sup>2</sup>	RU	3 <sup>3</sup> , 3 <sup>4</sup>	RU	RU

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Eurasian curlew	<i>Numenius arquata</i>	-	VU	-	2 <sup>1</sup> , 3(NT) <sup>2</sup>	RU	-	RU	RU
Whimbrel	<i>Numenius phaeopus</i>	-	-	-	3(NT) <sup>2</sup>	RU	-	RU	RU
-	<i>Oenanthe oenanthe</i>	-	-	NT	-	-	-	RU	RU
Great cormorant	<i>Phalacrocorax carbo</i>	M	-	-	-	FI, DE	-	DE, RU	DE, RU
Red-necked phalarope	<i>Phalaropus lobatus</i>	Annex I	-	-	VU (FI)	FI, DE	-	DE	-
Ruff	<i>Philomachus pugnax</i>	-	-	VU	3(NT) <sup>2</sup>	RU	3 <sup>3</sup>	RU	RU
-	<i>Phylloscopus trochiloides</i>	-	-	-	-	-	3 <sup>4</sup>	RU	RU
-	<i>Picus canus</i>	-	-	-	3(NT) <sup>2</sup>	RU	3 <sup>4</sup>	RU	RU
Horned /Slavonian grebe	<i>Podiceps auritus</i>	Annex I	VU	VU - NT	NT (SE), EN (FI), CR (DE), 3(NT) <sup>2</sup>	FI, DE, RU	-	DE, RU	DE, RU
Great crested grebe	<i>Podiceps cristatus</i>	Annex I	-	-	NT (FI)	FI, DE	-	DE	DE
Red-necked grebe	<i>Podiceps grisegena</i>	M	-	EN	-	FI, DE	-	FI, DE, PL	DE
Steller's eider	<i>Polysticta stelleri</i>	Annex I	VU	EN	-	FI, DE	-	FI	-
Water rail	<i>Rallus aquaticus</i>	-	-	-	4(NE) <sup>2</sup>	RU	2 <sup>4</sup>	RU	RU
Common eider	<i>Somateria mollissima</i>	M	NT	VU - EN	VU (FI, SE), 3(LC) <sup>2</sup>	DE, RU	2 <sup>4</sup>	ES, DE, SE, RU	DE, RU
Common tern	<i>Sterna hirundo</i>	Annex I	-	-	EN (DE)	FI, DE	-	ES, FI, DE	DE
Arctic tern	<i>Sterna paradisaea</i>	Annex I	-	-	CR (DE), 3(LC) <sup>2</sup>	FI, DE, RU	3 <sup>4</sup>	ES, FI, DE, RU	DE, RU
Sandwich tern	<i>Sterna sandvicensis</i>	Annex I	-	-	EN (SE), CR (DE)	FI, DE	-	DE	DE
Little tern	<i>Sternula albifrons</i>	Annex I	-	-	NT (DK), EN (FI), CR (DE), VU (SE), 2 <sup>1</sup> , 2(EN) <sup>2</sup>	FI, DE, RU	2 <sup>4</sup>	ES, DE, RU	DE, RU
-	<i>Surnia ulula</i>	-	-	-	3(VU) <sup>2</sup>	RU	1 <sup>4</sup>	RU	RU
Barred warbler	<i>Sylvia nisoria</i>	Annex I	-	-	VU (DE)	DE	-	-	DE
Common shelduck	<i>Tadorna tadorna</i>	M	-	-	VU (FI), 3(NT) <sup>2</sup>	FI, DE, RU	3 <sup>3</sup> , 1 <sup>4</sup>	FI	RU
Common redshank	<i>Tringa totanus</i>	-	-	NT	-	-	3 <sup>4</sup>	RU	RU

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Common name	Latin name	Habitats/ Birds Directive /1//2/	IUCN status /3/	HELCOM Red List status /4/	National Red List status /5/	National protection /6/	Other international protection and conservation status	Region	Observed during baseline survey
-	<i>Turdus iliacus</i>	-	NT	-	-	-	-	RU	RU
Common murre	<i>Uria aalge</i>	M	-	-	NT (DK), EN (FI)	FI, DE	-	DE, RU	DE, RU
Northern lapwing	<i>Vanellus vanellus</i>	-	VU	NT	-	-	-	RU	RU
<p>* except the Finnish population</p> <p>** Regions for fish are regions that NSP2 goes through, Bothnian Sea, Bothnian Bay, Kattegatt and the Danish Straits are not included.</p> <p>*** Rassi, P., Hyvärinen, E., Juslén, A. &amp; Mannerkoski, I. (eds.) 2010: The 2010 Red List of Finnish Species. Ympäristöministeriö &amp; Suomen ympäristökeskus, Helsinki. 685 p.</p>									

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**NORD STREAM 2**  
**ESPOO REPORT**

**APPENDIX 3**

**NSP2 MODELLING AND NSP EXPERIENCE**



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## Abbreviations and definitions

Ave	average
B(a)P	benzo(a)pyrene
CO	carbon monoxide
CO <sub>2</sub>	carbon dioxide
dB	decibel (dB), a logarithmic used for expressing sound intensity
dBSEA	modelling software to predict underwater noise levels
DCE	Danish Center for Environment and Energy
DDT	dichlordiphenyltrichlorethan
DHI	Danish Hydraulic Institute
DP	dynamically positioned
DW	dry weight
EEZ	Exclusive Economic Zone
EIA	environmental impact assessment
EQS	environmental quality standards
ERL	Effect-Range Low
ES	environmental study
EU	European Union
FOI	Swedish Defence Research Agency
FTA	Finnish Hydrographic Office of Finnish Transport Agency
HC	hydrocarbon
HELCOM	Helsinki Commission
HFO	heavy fuel oil
Hz	Hertz, measure of frequency, 1/s
ICES	International Council for the Exploration of the Sea
IFO	intermediate fuel oil
IMO	UN International Maritime Organization
Max	maximum
MDO	marine diesel oil
MFO	medium fuel oil
MGO	marine gas oil
N	nitrogen
NO <sub>x</sub>	nitrogen oxides
NSP	Nord Stream 1 Pipeline system
NSP2	Nord Stream 2 Pipeline system
P	phosphorous
PAH	Polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD/F	polychlorinated dibenzo-p-dioxin/dibenzofurans
PEC	predicted environmental concentration
PM	particulate matter
PNEC	predicted no effect concentration
PTS	permanent threshold shift
RMS	root mean square
SEL	single event sound exposure level
SELcum	single event sound exposure level, cumulative sound exposure level
SO <sub>2</sub>	sulphur dioxide
SPL	sound pressure level
SSC	suspended sediment concentration
TEQ	toxic equivalent
TNT	trinitrotoluene
TSP	total suspended particles
TTS	temporary threshold shift
TW	Territorial Waters
WHO	World Health Organization

# 1. NUMERICAL MODELLING AND ASSESSMENT METHODS

This chapter presents the methodology and results of numerical modelling and calculations undertaken in relation to NSP2, as well as experience gained from NSP. The modelling results from NSP2 have been summarised in Section 10.1, and together with the baseline analysis documented in Section 9, have informed the assessment of NSP2 project-wide impacts reported in Sections 10.2-10.5 (Physical and Chemical), Sections 10.6-10.8 (Biological) and Sections 10.9–10.12 (Socio Economic).

For each of the above, Section 3 sets out the modelling methodology (including overall method, modelled scenarios (where relevant) and the criteria used for assessing impacts on receptors), whilst the results of the modelling are provided in Chapter 2.

## 1.1 Sediment and contaminants dispersion modelling

### 1.1.1 Modelling method

The modelling is based on the flexible mesh version of the MIKE 3 model package for three-dimensional modelling of currents, water levels and transport of suspended sediment, contaminants and oil spill.

The hydrodynamic model basis is delivered by DHI, in a MIKE 3 hydrodynamic (HD) set-up covering the entire Baltic Sea dedicated to the NSP2 project. The model set-up includes a fine mesh along the pipeline corridor and in the Gulf of Finland. A full year of hindcast data covering 2010 has been produced by the model as a basis for the NSP2 project. A description of the model and the calibration of the model is found in /1/.

For modelling transport of suspended sediment and contaminants the MIKE 3 particle tracking (PT) module is used, which is a Lagrangian particle transport type of model. For the modelling of oil spill MIKE 3 OS is used, which is a dedicated oil spill model.

A three-dimensional model is set up for modelling the transport and fate of dissolved and suspended substances. The numerical particle transport model MIKE 3 PT is used for this purpose. The substances can be discharged or accidentally spilled in estuaries, coastal areas or in the open sea.

The following input has also been used to model the sediment spill and/or contaminants dispersion:

- Sediment and seabed characteristics;
- Spill rates calculated on the basis of trenching rate ( $\text{m}^3/\text{s}$ ), density of the specific sediment type ( $\text{kg}/\text{m}^3$ ), spill percent (2%), dry matter content in the specific sediment type and grain size distribution in the specific sediment type; and
- Contaminant in sediment (for contaminant dispersion only).

The settling velocity of the dispersed sediments is determined by the sediment grain sizes and the fluid properties. Seabed samples along the NSP2 route have been used in order to determine the most representative sediment size distributions for each of the modelled areas. Settling velocity for contaminants have been set at zero /2/.

### 1.1.2 Model scenarios

The modelling has been carried out for for Russia, Finland, Sweden and Denmark using three different hydrographic scenarios of one month duration chosen on the basis of one year of hindcast data (modelling for Germany has been carried out separately). The periods used for the simulations are /2/:

- **Summer scenario (June 2010):** Representation of relatively calm current conditions with low particle transport capacity and with relatively high temperature and salinity stratification.
- **Normal scenario (April 2010):** Representation of average current conditions with average particle transport capacity and with average temperature and salinity stratification.
- **Winter scenario (November 2010):** Representation of relatively strong current conditions with high particle transport capacity and with relatively low temperature and salinity stratification.

Scenarios for the seabed intervention works in the waters of Russia, Finland, Sweden and Denmark are defined as a basis for model simulations of sediment and contaminant spill during the construction period. The modelling is carried out for one pipeline only (based on a worst case scenario, i.e. the pipeline with the greatest extent of intervention works). The seabed intervention scenarios used for the EIA are defined differently from country to country /3/, /4/, /5/, /6/, /7/.

Sediment dispersion has been modelled for sediment spill from rock placement, munitions clearance, dredging and trenching as shown in Table 1-1. The assumptions regarding sediment spill, etc., for the modelling are shown in Table 1-2.

**Table 1-1 Overview of sediment spill modelling scenarios for seabed interventions.**

Country	Activity	Pipeline	Hydrography	Parameters Modelled
Russia	Rock placement	Line B	Summer	Sediment Contaminants
	Munitions clearance		Winter	
	Dredging		Normal	
Finland	Rock placement	Line A	Summer	Sediment Contaminants
	Munitions clearance		Winter Normal	
Sweden	Trenching	Line B	Summer	Sediment
	Rock placement		Winter Normal	
Denmark	Trenching	Line B	Summer	Sediment
	Rock placement		Winter Normal	

**Table 1-2 Assumptions for sediment spill dispersion modelling.**

Method	Volume of seabed material handled	Spill percentage	Spill height
Dredging, Russia	Scenario 1: 376,304 m <sup>3</sup> for open trench without cofferdam Scenario 3: 475,000 m <sup>3</sup> for microtunnel	5%	Entire water column
Trenching (ploughing)	Volume of 6.29 m <sup>3</sup> /m in the trenching corridor	2%	Lower 5 m
Rock placement	Impacted seabed evaluated on basis of volume of rock berms	1% of rock volume calculated on basis of energy considerations	Lower 2 m
Munitions clearance	Crater volumes evaluated on basis of	100% of fine grained sediments	Distributed in the lower 15 m of the water

Method	Volume of seabed material handled	Spill percentage	Spill height
	theoretical calculations and NSP experience		column

The background for the assumptions regarding spill percentage and height above the seabed of the released spill is outlined in /2/.

The sediment is transported due to advection by the mean current, vertical and horizontal dispersion and the settling of the sediment. On an irregular seabed the released sediment may also be transported horizontally to either a deeper or shallower area with another distance to the seabed than the point of release. The vertical movements are assumed to transport the sediment particles within the vertical interval 0-10 m above the seabed. It is assumed that very little of the suspended sediment is dispersed to above 10 m above the seabed. The result of the spill modelling is based on the above considerations shown as the average concentrations within the lowest 10 m of the water column /2/.

Dispersion of contaminants is modelled for Russia and Finland only. This is due to the general increased concentrations of contaminants in the sediment in the Gulf of Finland, due to authority requirements and due to the fact that modelling of potential transboundary impacts of contaminants in sediments is most relevant in the Gulf of Finland.

For Finland and Russia, modelling has focused on the most critical contaminants in terms of effects on the environment. The most critical contaminants are found by comparing the concentration of the contaminant in the sediment with the Environmental Quality Standards (EQS). The contaminants with the highest ratio between these two parameters will potentially have the highest impact on the environment compared with other contaminants, as long as transport, dispersion and decay is assumed to be the same for all substances.

In the modelling it is anticipated that all contaminants are conservative substances, i.e. no decay has been assumed. The transport and dispersion will be the same for all contaminants.

The basis for the modelling in the various areas, including water properties, seabed sediment composition and sediment settling velocity, has been documented in /2/.

It shall be noted that the analysis of the contaminants along the pipeline route in Russia shows large spatial variations in concentrations. As a conservative measure, the 95%-percentile of the measured concentrations has been adopted for the modelling. This approach was selected in order to cover the high variability in concentrations of contaminants that often is observed for seabed sediments. However, concentrations of the various contaminants are in general significant lower in the nearshore area than in the offshore areas. So the results of the modelling done for the dredging in Russia (near shore) can be considered to be very conservative.

#### 1.1.2.1 Criteria for assessing impacts on receptors

The impact of sediment spill on receptors is a consequence of the change in the physical and chemical environment imposed by the sediment spill. These changes are related to:

- Increased turbidity (light attenuation caused by suspended sediments) of the water;
- Release of particle-associated contaminants and nutrients from the mobilised sediments;
- Increased sedimentation to the seabed;
- Change of seabed surface sediment composition.

The increased turbidity (lower transparency) of the water can cause avoidance reactions in fish and have an impact on foraging/diving birds, etc. It can also have an impact on benthic flora by reducing the availability of light.

Release of particle-associated contaminants can have a toxic effect on marine life (either directly and/or following bioaccumulation in organisms) and on predators of marine life (including humans). Release of nutrients from sediment can increase primary production, i.e. have eutrophication effects.

Increased sedimentation to the seabed can impact benthic flora and fauna by burying macroalgae, amphipods, mussels, etc.

Change of seabed surface composition can have an impact if hard surfaces are covered by loose sediments and thereby hamper settling of mussel spat. Also, in case of large amounts of sedimentation, the characteristics (grain size distribution, organic content, degree of consolidation, etc.) of the seabed surface might change.

#### 1.1.2.2 Sediment dispersion modelling in Germany

A numerical model has been set up to predict and analyse the spill relating from dredging in connection with installation of the Nord Stream 2 pipeline in German waters. The investigated situation involves dredging of 2,481,830 m<sup>3</sup> sediment from which a total of 80,112 tons is considered as total spill to the open marine environment. The fate of this small fraction is described using a numerical modelling tool. This modelling tool takes into account the transport, settling, deposition and resuspension of the spilled sediment. The natural sediment available in the area has not been investigated in this project.

The numerical model applied is the MIKE 3 modelling complex using the hydrodynamic (HD module) and the cohesive sediment transport (MT) module. The HD module describes the hydrographic conditions in the study area, considering a larger regional model and meteorological conditions. The MT module describes the transport, settling, deposition and erosion of fine grained sediment.

The model domain for the 3D model covers an area of approximately 190 km from the island of Zealand (Denmark) to the island of Bornholm (Denmark) and 150 km from Bornholm to the Polish north coast. The mesh is composed of 21,942 elements. Element areas vary from 5.75 × 10<sup>6</sup> m<sup>2</sup> far away from the area of interest to the smallest element being 1,530 m<sup>2</sup> in the trench area. The model runs for a total of 61 days. This allows a stable current condition to establish before spill is induced to the model for further simulation of 16 days after dredging has been completed.

Based on project information, a plan was made that could resemble the actual dredging works. The total area is subdivided into five subsections with individual dredging parameters (see Table 1-3):

- Pomeranian Bay, northern section: This section comprises two parallel sections, each dredged by large Trailer Suction Hopper Dredgers (TSHD). The distance between the parallel stretches is approximately 50–60 m;
- Pomeranian Bay, southern section 1: This section includes the merging of the two parallel sections and a stretch southward. This section is dredged by four small TSHDs;
- Pomeranian Bay, southern section 2: This section is dredged by three Backhoe Dredgers (BHD);
- Boddenrandschwelle: This small stretch is dredged by three BHDs;
- Greifswalder Bodden: This section is dredged by three BHDs.

The dredging volumes, spill amounts and summary of dredgers are provided in the tables below. Throughout the area it is anticipated that the bed sediment has a dry density of 1,850 kg m<sup>3</sup>. This number is used to convert the dredged amounts from m<sup>3</sup> to tons. The spill is computed in tons rather than m<sup>3</sup>.

Spill percentage is set as 8% of the fines for the TSHD equipment and 3% of the fines for the BHD equipment. These numbers are in accordance with what has been reported in areas with limited current speed like the Baltic Sea.

**Table 1-3 Overview of dredging stretches applied in the numerical model and sediment and dredging data, Germany.**

	Total m <sup>3</sup> to be dredged	Amount of fines in the sediment bed	Total spill (tons)	Dredging rate for each dredger in operation (m <sup>3</sup> hour <sup>-1</sup> )	Number of days to complete the stretch
Pomeranian Bay, northern section	1,032,256	25%	38,193	16,650	31 days; 2 dredgers
Pomeranian Bay, southern section 1	365,523	30%	16,229	18,280	5 days, 4 dredgers
Pomeranian Bay, southern section 2	200,244	30%	3,334	20,020	3.3 days, 3 dredgers
Boddenrandschwelle	195,521	30%	3,255	7,240	9 days, 3 dredgers
Greifswalder Bodden	688,286	50%	19,100	13,770	16.6 days, 3 dredgers
<b>Total</b>	<b>2,481,830</b>		<b>80,112</b>		<b>33 days</b>

Separately from the dredging and spill simulations, a simulation on the disposal at the Usedom storage area was done. This was modelled as a total disposal of 50,000 m<sup>3</sup> divided into 30 barge loads, one every 48 minutes during 24 hours. For each disposal it was anticipated that 15% of the disposed volume goes into suspension evenly distributed over the water column. The remaining 85% of the material sinks to the seabed where it becomes available for bed load transport and/or resuspension. Quantification of this transport is however beyond the scope of the present document.

## 1.2 Oil spill modelling

### 1.2.1 Russia

Oil spill dispersion has been modelled in Russian waters using the software 'SpillMod' developed by the Russian State Institute of Oceanography. A number of accidental spill scenarios during the project construction work were selected randomly and a separate scenario of oil behaviour, slick trajectory and fate was modelled for each selected scenario under each set of hydrometeorological conditions /8/.

The modelling takes into account all major processes of the 'spill-environment' interaction, such as /8/:

- Spreading of oil over the sea surface;
- Slick movement due to wind and currents;
- Weathering of oil due to evaporation and emulsification (formation of an oil-in-water emulsion);
- Changes of oil properties due to weathering (density, viscosity, 'water-in-oil' emulsification); and
- Deposition of oil on the shoreline.

The hydrometeorological conditions used for the modelling in Russian waters consist of the hydrometeorological situations obtained from the re-analysis of monitoring data for the past 10 years and modelling of hydrometeorological conditions as vector fields of wind and waves. A total

of 51,360 hydrometeorological situations were used in the modelling for the summer-autumn operations period /8/.

The maximum estimated spill sizes, which were identified in the risk analysis, were used as input data:

- Heavy oil spill of 1,250 tonnes released over a six hour period; and
- Diesel spill of 250 tonnes released over a one hour period.

Locations of potential spills within Russian waters along the gas pipeline route were selected based on a sufficiently wide range of potential spill sources differing in the distance to the shoreline and to the boundaries of protected offshore areas /8/.

The modelling was carried out for summer and autumn, respectively, to include the most characteristic periods throughout the year.

### 1.2.2 Finland, Sweden and Denmark

The hydrodynamic oil spill modelling was carried out as outlined in Section 1.2.

For the modelling of oil spill the MIKE ECO Lab/Oil spill module is used, which is a Lagrangian model for predicting the fate of marine oil spills including both transport and changes in chemical composition /3/.

The fate of spilled oil in the marine environment depends on factors such as the quantity spilled, the physical and chemical properties of the spilled oil, the climatic and sea conditions, and whether the oil remains at sea or is washed ashore.

The physical parameters of the oil determine the conditions under which oil is transported and degraded. The major factors are meteorological parameters (air temperature, wind, solar radiation, etc.) and hydrographical parameters (water temperature, currents, waves, etc.).

Particles in the surface waters are affected by wind in two ways: indirectly via the currents that include the wind, but also directly as an extra force directly on the oil slick /3/.

The oil spill model also includes weathering processes in addition to drift from wind and currents.

The Mike 3 OS model is a deterministic model. It determines the evolution of an oil spill under a given set of forcing such as current, wind, temperature, etc.

However, the consequences of an oil spill depend on the forcing. The impact of an oil spill will vary depending on the wind direction during the drift period. One wind scenario might cause contamination of a specific coastline, while another scenario under different wind forcing might not cause an impact on the same coastline.

In order to take into account this variability of meteorology (wind) and hydrology (current), a large number of simulations were carried out for same spill scenario, but under various forcing. The suite of results was analysed statistically. It is possible to estimate the probability map for oil contamination for an oil spill occurring at a random time.

The drift of an oil spill is governed by the hydrographical and meteorological conditions (wind, currents, temperature, etc.) at the time of release and during the subsequent transport period. Two spills with only a few days between them may have completely different impact areas. Therefore 120 simulations were carried out through the year, with three days between each of them. Each simulation has a duration of seven days, which means a four-day (57%) overlap. To include the effects of the yearly variability of the hydrographical and metrological conditions, the



results from the 120 simulations were averaged. In this way, a risk assessment was performed where the combined spill concentrations (impact on the surroundings), together with the yearly probability of occurrence, are assessed.

Four oil spill locations were chosen for the oil spill simulations: two in the Finnish EEZ, one in Sweden and one in Denmark. The oil spill locations were identified on the basis of the intensity of maritime traffic in the Baltic Sea (based on AIS data from 2011), the position of protected areas, and the preferred pipeline route.

Drift simulations were carried out to determine the likelihood of an area being contaminated by spilled oil. The likelihood was based on multiple oil spill simulations covering a whole year. A full year of hindcast data covering 2010 has been produced by the hydrodynamic model for application as the basis for the environmental modelling that was used for the environmental assessments of NSP2.

Results are presented as two-dimensional maps, which cover one-year averages of maximum and mean oil spill concentrations, together with the probability of occurrence and the travel times of the oil slick. Oil concentrations are presented solely in the top layer of the water column because very little or no vertical mixing with lower layers occurs. If depth-averaging with lower layers were carried out, the presented concentrations would be too low.

Results are presented after two different simulation periods: two days (response time for combatting oil spillages) and seven days (conservative response time, with regard to spreading, for combatting oil spillages along the pipeline).

More specifically, the following outputs were gathered for each oil spill location (Denmark, Sweden and Finland):

- One year averages of maximum and mean concentrations from the different spill locations after simulation periods of two days (response time) and seven days (conservative response time);
- One year averages of exceedance (number of hours) of 15 mg/l oil concentrations after simulation periods of two days and seven days; and
- Yearly averaged and shortest travel times for obtaining exceedance of 15 mg/l oil concentrations in a specific area.

### 1.2.3 Criteria for assessing impacts on receptors

The maximum and mean concentrations refer to the maximum and mean concentrations obtained during the specific simulation period (two days or seven days). The exceedance of a concentration of 15 mg/l is, according to MARPOL 73/78, a critical limit with regard to oil contamination and sets the permitted oil concentration limit for discharges from ships.

Results for concentrations and exceedance probabilities from the averaging of 120 simulations, covering the whole year, represent the product of the specific concentration, or hourly exceedance of 15 mg/l (consequence), and the probability of occurrence in a specific area (i.e. risk analysis is performed). Since concentrations and probability of occurrence of concentrations higher than 15 mg/l in the periphery of the oil slick are low, risks in these areas will be low. Concentrations will increase towards the location of the spill.

## 1.3 Underwater noise propagation modelling

### 1.3.1 Modelling method

The underwater sound propagation model calculates estimates of the sound field generated from underwater sound sources /9/,/10/,/11/,/12/. The modelling results are used to determine the potential impact distances (noise maps/contour plots) from the identified significant underwater noise sources for the various identified marine life for the area. Based on source location and underwater source sound level, the acoustic field at any range from the source is estimated using dBSEA's underwater acoustic propagation computer program, configured to perform a combined method calculation, using the parabolic equation method for frequencies under 500 Hz (Hertz). and the ray tracing method for frequencies over 500 Hz. /14/. The parabolic equation method is more suited for lower frequencies and ray tracing is suited better for higher frequencies.

The sound propagation modelling uses acoustic parameters appropriate for the specific geographic region of interest, including the expected water column sound speed profile, the bathymetry, and the bottom geo-acoustic properties, to produce site-specific estimates of the radiated noise field as a function of range and depth. The acoustic model is used to predict the directional transmission loss from source locations corresponding to receiver locations. The received level at any three-dimensional location away from the source is calculated by combining the source level and transmission loss, both of which are direction-dependent. Underwater acoustic transmission loss and received underwater sound levels are a function of depth, range, bearing, and environmental properties. The output values can be used to compute or estimate specific noise metrics relevant to safety criteria filtering for frequency-dependent marine mammal hearing capabilities.

Underwater sound source levels are used as input for the underwater sound propagation program, which computes the sound field as a function of range, depth, and bearing relative to the source location.

The model assumes that outgoing energy dominates over scattered energy, and computes the solution for the outgoing wave equation. An approximation is used to provide two-dimensional transmission loss values in range and depth, i.e., computation of the transmission loss as a function of range and depth within a given radial plane is carried out independently of neighbouring radials (reflecting the assumption that sound propagation is predominantly away from the source).

The received underwater sound levels at any location within the region of interest are computed from the 1/1-octave band source levels by subtracting the numerically modelled transmission loss at each 1/1-octave band centre frequency and summing across all frequencies to obtain a broadband value. For this study, transmission loss and received levels were modelled for 1/1-octave frequency bands between 10 and 3000 Hz. Because the source of underwater noise considered in this study are predominantly low-frequency sources, this frequency range is sufficient to capture essentially all of the energy output. The received levels will be converted to all the applicable underwater acoustic parameters.

Bathymetry data for the whole Baltic Sea including Russia is provided from FTA (Finnish hydrographic office of the Finnish Transport Agency) with varying horizontal resolution of 500 to 1,000 m.

Water column data (salinity, temperature, speed of underwater sound/depth) is provided from ICES (International Council for the Exploration of the Sea) HELCOM specific measurement stations positioned close to the selected modelling positions.

Seabed conditions (sand, clay /depth) are provided from NSP geological survey data for areas close to the modelling positions.

The sound propagation model will run with the model (Peak, RMS, SEL, SELcumulative (two-hour)) scenarios, source levels, activity time and environmental parameterisation and generate noise maps. The levels depicted in the noise maps will be the maximum predicted level for that location at any depth down to the seabed and will include the following acoustic parameters for each of the identified significant sound sources:

For pipeline operation (constant sound):

- SELcum (24 hour), Cumulative Sound Exposure Level (linear), dB re.  $1\mu\text{Pa}^2\text{s}^1$

For rock placement, dredging and vibro-piling (periods of constant sound):

- SELcum (2 hour), Cumulative Sound Exposure Level (linear), dB re.  $1\mu\text{Pa}^2\text{s}^2$

For munitions clearance (impulse sound):

- SEL, single event Sound Exposure Level (linear), dB re.  $1\mu\text{Pa}^2\text{s}$

Based on an underwater noise prediction study undertaken for the pipeline operation phase /13/, the potential for underwater noise to be generated during pipeline operation (primarily compressor noise) has been modelled for the first 20 km of the proposed NSP2 (from the compressor station in Russia).

For sources during construction, the results of the acoustic modelling (noise maps and impact distances) will be reported in terms of the underwater sound levels of each specific acoustic metric for distances up to 50 km. Additionally, a vertical sound propagation profile plot for the dominant sound source frequency band will be generated to show the variation in underwater sound propagation with regard to sea depth.

### 1.3.2 Model scenarios

The following activities have the potential to generate underwater noise during the construction and operation of NSP2:

- Pipe-lay;
- Rock placement;
- Trenching (post-lay trenching by plough);
- Munitions clearance;
- Dredging (pre-lay trenching at landfalls);
- Vibro-piling (cofferdam); and
- Pipeline operation (noise from gas in pipelines).

On the basis of the above, Nord Stream 2 AG has performed underwater noise modelling in the Russian, Finnish, Swedish and Danish waters for the following activities:

- Russia: three munitions clearance locations, one rock placement position, one cofferdam sheet piling (vibro piling) section (350 m), one dredging section at the landfall at KP 0.3, and underwater noise from gas in the pipeline during operation close to the compressor station from KP 0 - 20 km;
- Denmark: two representative rock placement positions;
- Sweden: two representative rock placement positions; and
- Finland: two representative rock placement positions, four munitions clearance locations.

These activities were selected based on predicted underwater noise levels (i.e. the noisiest planned activities), the remaining activities (e.g. pipe-lay and trenching) will generate less noise

<sup>1</sup> A 24 hour sound exposure level was used for operational impacts due to constant nature of the impacts, whereby the effective cumulative exposure could be greater than other intermittent temporary construction activities.

<sup>2</sup> A 2 hour sound exposure level was used for rock placement, dredging and vibro-piling due to the limited duration.

and therefore have not been modelled. The positions were selected based on where the various activities are anticipated to take place and the proximity to environmentally sensitive areas. It is considered that modelling noise propagation at these locations will be representative of other locations along the proposed NSP2 route. Modelling of underwater noise has been performed for both winter (December-March) and summer (July-September) conditions, each of which have different underwater sound propagation characteristics. This approach ensures that the modelling identifies the maximum underwater noise levels.

### 1.3.3 Criteria for assessing impacts on receptors

This section identifies the threshold values which have been used to assess potential impacts on biological receptors (namely marine mammals and fish).

#### 1.3.3.1 Marine mammals and fish criteria

Table 1-3 and Table 1-4 summarise threshold values for assessing impacts on marine mammals and fish, respectively. The threshold values are associated with different impacts (i.e. temporary threshold shift (TTS) and permanent threshold shift (PTS)) for each receptor.

The threshold values have been established based on an assessment of available values from the most recent scientific literature /15/, /16/.

**Table 1-4 Marine mammal threshold values for onset of PTS and TTS. All levels are broadband, unweighted sound exposure levels (dB re. 1  $\mu\text{Pa}^2\text{s}$ ).**

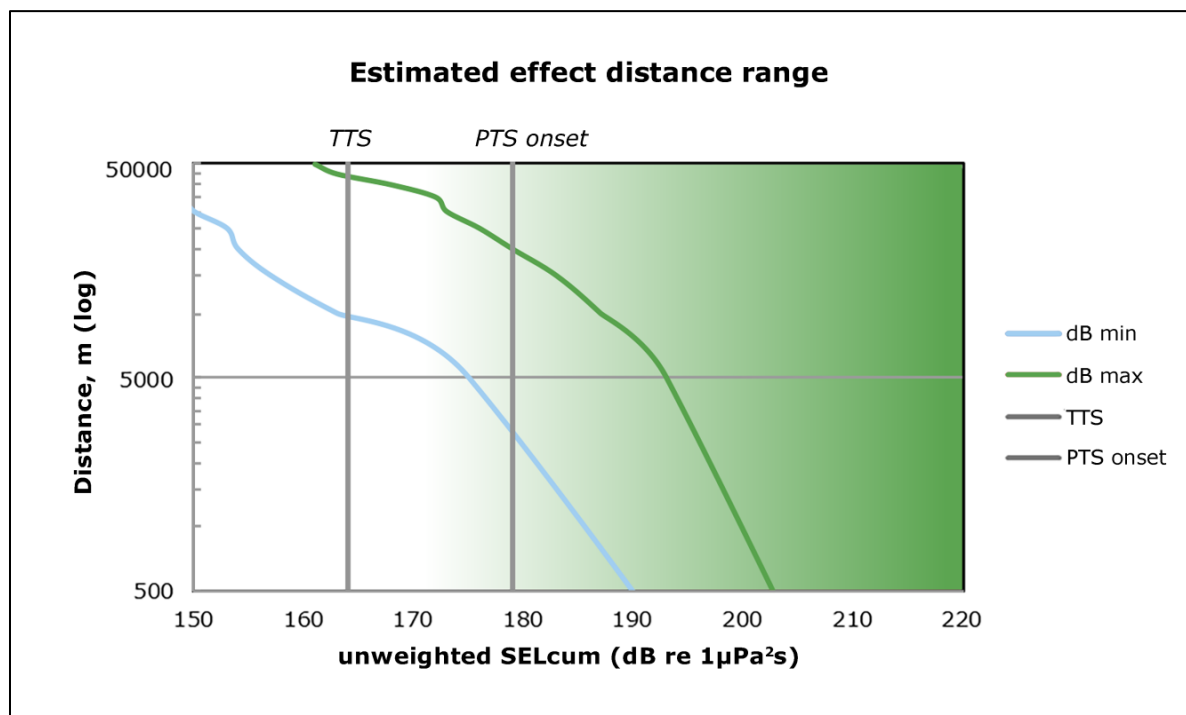
Activity	Receptor	Threshold Values (dB re 1 $\mu\text{Pa}^2\text{s}$ SELcum)	
		TTS	PTS
Rock placement, Dredging, Vibro-piling, Pipeline operation	Grey seal and ringed seal	188	200
	Harbour porpoise	188	203
Munitions clearance	Grey seal and ringed seal	164	179
	Harbour porpoise	164	179

**Table 1-5 Threshold values for fish for onset of TTS, injury and mortality /17/, /18/.**

Activity	Receptor	Impact	Threshold Values (dB re 1 $\mu\text{Pa}^2\text{s}$ SEL(Cum) *)
Rock placement, Dredging, Vibro-piling, Pipeline operation	Fish	Mortality (mortal injury)	207 dB
		Injury	203 dB
		TTS	186 dB
Munitions clearance	Eggs and larvae	Injury	210 dB

\*: SEL(Cum) for 1 event

An estimate of the effect distance range as a function of SEL thresholds has been made from all munitions clearance modelling scenarios and is shown in the following figure.



**Figure 1-1** Modelled effect distances range as a function of SEL threshold. The green curve is the maximum propagation and the blue curve represents minimum propagation for all the modelled location conditions. Vertical lines bordering the green shaded areas represent the TTS, PTS, onset thresholds.

#### 1.3.4 Underwater noise modelling in Germany

Germany, noise sources include:

- Noise due to movements of ships.
- Suction and pump noise of the TSHDs.
- Noise caused by backhoe dredger activities.
- Pipe-lay barge noise.

The underwater noise resulting from the ships' movement is primarily caused by cavitation noises from propellers and thrusters, as well as motor noise. Because of the possible high variances, two operating modes are considered for the ships, (i) at full speed and (ii) at slow speed. The source levels were determined with a frequency-independent propagation loss of  $-20 \log_{10}(R)$  with R being the measured distance. Presuming an identical propagation loss, the ships' emissions cause source levels between 162 dB and 179 dB.

For dredging and backfilling of the pipe trench, mainly Trailing Suction Hopper Dredger (TSHD) shall be used. Within Greifswalder Bodden and at a maximum water depth of 10 m, backhoe dredgers and smaller suction dredgers with a length of less than 100 m are used. Some bigger suction dredgers are also used within Pomeranian Bay.

Measurements were carried out on 7 TSHDs of a length between 72 m and 120 m and compared to further literature values. As a result, source level differences of 14 dB were recorded for the 7 suction dredgers, and 16 dB for the used literature values. Beside model-based differences, the source level fluctuations are also caused by different sediments. Sand causes a few dB less suction noise than gravel.

Noise emissions resulting from backhoe dredger activities are composed of single acoustic events. Performed measurements show that the loudest single events are the shovel touchdown on the seabed (115 dB), the digging process (108 dB) and lifting (105 dB, each at a distance of 1 km). At a distance of 1 m, a one-minute average source level of 150 dB results.

Similar to other ships, the emissions of the lay barge are primarily determined by the noise of their motors and propellers.

During the installation of the existing Nord Stream pipeline, no noise emissions caused by the direct pipe-laying were recorded at a distance of 1 km. At the moment the lay barge passed the measuring positions, the noise impact was either dominated by other ships, or emissions in the range of the background noise of < 105 dB were recorded. A source level of 168 dB is estimated for the prognosis which results in 105 dB at a distance of 1 km.

Actually, a low emission contribution is expected from the lay barge during the pipe-lay activities as the used approach also includes the noise emissions from all ships in the surroundings.

To determine underwater noise levels the calculation model is set up to simulate average ship movements during a 24 hour pipe-lay shift. It is assumed that the lay barge, four anchor tugs and one traffic control vessel move along a 3.8 km pipeline route section. Additionally two pipe transport vessels and one supply vessel are considered to move in a distance of less than one kilometre from the lay barge. This "pipe-lay fleet" is representing the underwater sound source.

## 1.4 Airborne noise propagation calculations

### 1.4.1 Offshore

Modelling was undertaken based on the characteristics which result in the highest noise level. In practical terms: downwind and a moderate negative temperature gradient (lower temperature near the ground). This situation was estimated using the General Prediction Model /19/. This method anticipates a geometrical noise transmission (6 dB reduction in noise levels for each doubling of the distance).

Airborne noise from the pipe-lay vessel (considered worst case) during construction activities was modelled for the existing Nord Stream pipelines.

The General Prediction Model /19/ calculates the noise according to:

$$L_{pA} = L_{WA} - 8 - 20 \log(r) - a_i r$$

where:

$L_{pA}$	is A-weighted noise level (dB)
$L_{WA}$	is sound power level of noise source (dB)
$r$	is distance from noise source to receiver (m)
$a_i$	is air absorption coefficient (dB/m)

Because the air absorption varies depending on frequency of the sound, the calculation must be performed for each 1/1 octave frequency band, 63 – 4,000 Hz. For the purpose of estimation of the environmental noise from pipe-laying activity, the noise sources shown in Table 1-6 have been identified.

**Table 1-6 Sound power level, LWA (dB) for representative vessel sound power level.**

1/1 octave centre frequency (Hz)	Total	63	125	250	500	1,000	2,000	4,000
Pipe-laying vessel	113	103	108	105	108	103	94	82
Supply vessel i.e. Pipe supply vessel Rock supply vessel Other supply vessels	110	100	105	102	105	100	91	79
Tugboat	105	95	100	98	100	95	86	74

The long propagation of sound over the sea is possible due to low-level jets (high-speed winds) that can be present a few hundred meters above sea level. These jets will affect the sound waves by bending them downwards, towards the ocean surface. The ocean surface, on the other hand, is an almost perfect reflector of the sound waves, which implies that the noise can propagate long distances with low attenuation. This results in a noise attenuation of approximately 3 dB per doubling of distance instead of the normal 5-6 dB. Typical sounds from industry, construction and traffic ranges in the frequency spectra between 63-8,000 Hz. At 8,000 Hz the sound power level is low and the air adsorption, high. As such, the attenuation of sounds of 8,000 Hz is approx. double compared to sounds at 4,000 Hz (0.05 dB/m compared to 0.022 dB/m). For this reason, frequencies above 4,000 Hz have been excluded in the model.

#### 1.4.2 Landfall area, Russia

Airborne noise propagation has been modelled for onshore and offshore construction activities, including RoW clearance and road construction, onshore pipe-lay, construction of PTA and MT, dredging, pipe-lay and pre-commissioning, /20/. For the operation phase there will be only occasional (once a year) release of gas at the PTA, which has been also included in the modelling scenario.

The modelling is based on the assumption that noise propagates unimpeded. The calculations are made for a hypothetical time interval characterised by operation of the maximum quantity of equipment and machinery. The following formulas and methodology were used:

- 1) *Octave band sound pressure level from a noise generation source.*

Noise impact in reference points was modelled using Russian standard GOST 23337-78 'Methods for measuring noise in residential areas and inside residential and public buildings'.

Noise levels in reference points were determined in accordance with the following formula:

$$L_{rp} = L_{out} - 20 \cdot \lg(r) + 10 \cdot \lg(F) - 0.001 \cdot \beta a \cdot r - 10 \cdot \lg(\Omega)$$

where:

- 'L<sub>out</sub>' is the sound power level of equipment at the outlet into the atmosphere, dB;
- 'r' is the distance from the noise source to the reference point, m;
- 'F' is the directivity factor, F = 1;
- 'βa' is the attenuation coefficient, dB/km;
- 'Ω' is the space angle of sound emission:
- Ω=2π for noise sources located on the ground surface or on enclosures of buildings; and
- Ω= 4π for noise sources located in open space.

The modelling was performed using the software 'Ekolog-Shum version 2.3.1.4199'.

Reference point sound levels from vehicles were calculated using the following formula:

$$L_{rp} = L_{sce} + \Delta LA_{rfl} - 20 \lg(r/r_0)$$

where:

- ' $L_{sce}$ ' is the sound level at the distance of 7.5 m from the source, dBA;
- ' $\Delta LA_{ref}$ ' is the adjustment for the reflected sound influence, dBA, which depends on  $hrf/B$ , where ' $hrf$ ' is the height of the reference point from the ground surface (conventionally assumed to be  $hrf = 12$  m; ' $B$ ' is the width of the street measured from the opposite building facades, m);
- ' $r$ ' is the distance to the reference point, m; and
- ' $r_0$ ' is the distance from the noise source to the base point where the noise was measured, m (for transport/ traffic flow  $r_0 = 7.5$  m).

## 2) Total octave band sound pressure level

It was defined at the reference point as the energy sum of the octave band sound pressure levels from each noise source and is calculated using the following formula:

$$L_{pT \Sigma \lambda} = 10 \lg \sum 10^{0.1 L_{pTi \lambda}}$$

where:

- $L_{pT \Sigma \lambda}$  is the octave band sound pressure level (dB) in the frequency band ' $\lambda$ ' created by noise source ' $i$ '.

For pipe-lay activity the same information on the sound power level as per Table 1-5 was used. For pre-commissioning activities compressors will be supplied with power from one diesel generator with a capacity of 200 kW.

**Table 1-7 Sound power level, LWA (dB) for pre-commissioning equipment sound power level.**

1/1 octave centre frequency (Hz)	63	125	250	500	1,000	2,000	4,000	8,000
Compressor	92	94	96	108	112	95	91	84
Generator 1000-1500 kW	85.9	84.8	79.9	77.9	74.4	69.9	64.9	54.9

For onshore equipment the following data for vehicles and equipment generating non-continuous noise was used.

**Table 1-8 Sound power level, LWA [dB] for typical onshore construction equipment sound power level.**

Equipment/ machinery	LA, dBA	Lmax, dBA
Bulldozers	81	87
Excavators	73	81
Front wheel loader	92	97
Cranes	73	78
Pipe truck	77	82
Pipe-layer	71	76
Loaders/pickup trucks 4x4	65	70
Harvester	81	87
Trail tractor	73	81
Timber truck	75	80
Dump truck	77	82



For impact assessment a combination of Russian national and international standards were used. Russian norms only regulate acceptable noise level for human receptors; therefore, for assessing impacts on fauna, criteria applied in Germany for bird protection areas were adopted. Permissible noise levels were assessed against the Russian standard SN 2.2.4/2.1.8.562-96 Noise at workplaces, inside residential and public buildings, and within residential development areas /21/.

**Table 1-9 Permissible sound levels.**

Area	Time of environmental impact	Sound levels LAeq, dBA	Sound levels Lmax, dBA
Boundary of residential buildings	daytime	55	70
	night-time	45	60
Bird protection area	daytime		65
	night-time		50

The modelling was focused on the potential worst case scenario involving simultaneous operation of equipment and machinery with the maximum noise generation levels. Noise impact was evaluated at three reference points:

- The nearest residential area (as required under national legislation);
- An eagle nesting area (ecologically sensitive area); and
- The boundary of the offshore proposed Ingermanlandsky nature reserve (island Maly Tyuters, ecologically sensitive area).

#### 1.4.3 Landfall area, Germany

The orientation values for immission provided by the German Act, AVV Baulärm form the basis of the evaluation of impact intensity, as shown in Table 1-10. It is assumed that only machines that meet the criteria of the Geräte- und Maschinenlärmschutzverordnung (32. BImSchV 2002) /22/ will be used during construction.

**Table 1-10 Immission guide values, German landfall area.**

Area	Sound levels, day (dBA) (07:00 – 20:00)	Sound levels, night (dBA) (20:00 – 07:00)
Purely Residential Area	50	35
General Residential Area	55	40
Commercial Area	65	50
Commercial and Industrial Area	70	

These immission values should not be exceeded at any time during construction activities.

The construction activities considered for noise evaluation modelling at the German Landfall area are based on a basic construction time schedule which divides the construction process in main phases such as site preparation, ground works, pipe works etc., and allocates respective machinery to each phase.

Aside from construction also pre-commissioning activities are part of the noise evaluation models. Pre-commissioning activities will take place 24/7 over a period of approx. 140 days during which a compressor station is operated consisting of the following machinery:

- 34 compressors 500 kW
- 6 diesel generators 80 kW
- 4 tank trucks 235kW
- 4 pumps 150 kW

Noise emissions propagation has been modelled on basis of DIN-ISO 9613-2 taking into account construction machinery emission values provided by manufacturers and literature. DIN ISO 9613-2 implies that noise calculations are done frequency dependent and under consideration of a so called "ground effect" which considers damping effects of the surrounding areas. The applied ground effect values are as shown in Table 1-11.

**Table 1-11 Ground effect values, German landfall area.**

Area	Ground Effect Values
Water surfaces	0.0
Open land	0.6
Forest areas	1.0

The noise propagation model has been furthermore supplemented by a digital elevation model of the region, together with the following propagation parameters:

Atmospheric pressure	1013 mbar
Relative humidity	70 %
Temperature	10 °C
Emission heights	1.0 m to 5.0 m above ground, dependent on applied machinery
Immision heights	3.0 m (ground floor) and 5.6 m (1 <sup>st</sup> floor)

The propagation parameters are a standard configuration as per DIN ISO 9613-2 for low damping of acoustic sound propagation. The noise propagation model has been configured to provide rather conservative (louder) results.

## 1.5 Airborne emissions

### 1.5.1 Methodology

Calculations of air emissions offshore and onshore have been based on the following documents, /23/, /24/, /25/, /26/, /27/, /28/, /29/ and /30/. Regarding volumes that are used in the calculations i.e. rock volumes shipped and used and to some extent the amount of line pipes shipped and used, the different volumes should be seen as assumptions made on the current state and are as such subject to change. Wherever possible the volumes are based on input from NSP2 and/or experience from NSP. The calculations are, however, based on worst case scenarios and the results from this report should therefore be seen as conservative.

#### 1.5.1.1 Scope: Activities included in air emission calculations

##### Activities to be included

The following activities (described in general terms) are included in the calculation of the overall emission loads from construction and operation of NSP2 (including both on- and offshore activities in all five countries):

1. Operation of weight-coating plants in Kotka (Finland) and Mukran (Germany) and operation of rock quarries (Finland).
2. Transport of rock material from rock quarries in Finland to the port at Kotka.
3. Transport activities inside/at interim stockyards (Kotka, Koverhar, Karlshamn, Mukran) and the Mukran weight-coating yard (onshore operations), including transport from the interim stockyards/weight-coating yard to/from port and ships at port.
4. Transport of coated pipes to interim stockyards (offshore operations).
5. Onshore/nearshore activities at the landfall areas in Germany and Russia.
6. Offshore pipe-laying activities:
  - Munitions clearance;

- Crossing installations;
  - Transport of coated pipes from interim stockyards to the NSP2 route;
  - Pipe-laying;
  - Pre-lay or post-lay rock material placement;
  - Pre-lay or post-lay trenching;
  - Fuel supply, crew change, other materials.
7. Pre-commissioning.
  8. Operation (inspection, maintenance and repair).

#### **Activities not included**

The following activities are not included in the air emissions calculations for the overall NSP2 project:

##### *Road transport using major roads*

Onshore transport of pipes, rock material, fuel, consumables, etc. using major roads is not included since the volume of the traffic created by the project is assessed not to constitute a significant increase in traffic flows or impact on local air quality. However, transport using smaller (regional) roads (e.g. transport of rock material from the highway through Kotka to the Kotka coating plant) may contribute significantly to local environmental impacts and therefore is included.

##### *Surveys*

Geotechnical, geophysical and biological surveys prior to the actual pipe installation work are not included. Surveys required by authorities, e.g. monitoring of environmental impacts during construction, are not included since the scale of the activities is expected to be limited and the frequency is expected to be low.

#### **1.5.1.2 Scope: Compounds to be included**

The combustion of fuel during the operation of vessels, construction machinery and other equipment for NSP2 will result in the emission of a number of air pollutants, i.e. carbon dioxide, nitrogen oxides, sulphur dioxide, particulates, carbon monoxide and hydrocarbons. The vast majority of engines will use fuel oil, and the emissions will occur offshore and in less populated areas onshore. The emission of compounds such as carbon monoxide (CO) and hydrocarbons (HC) that mainly cause local impacts is assessed to be of less importance compared with nitrogen oxides, sulphur dioxide and particulates, which can have impacts over larger distances (regional), as well as carbon dioxide and methane, being a greenhouse gas with global impact. Therefore, the following pollutants are included in the air emission calculations:

- Carbon dioxide (CO<sub>2</sub>);
- Nitrogen oxides (NO<sub>x</sub>);
- Sulphur dioxide (SO<sub>2</sub>);
- Particulate matter (PM); and
- Methane (CH<sub>4</sub>).

##### *Carbon dioxide (CO<sub>2</sub>)*

CO<sub>2</sub> is the most important of the climate gases, i.e. the emissions of CO<sub>2</sub> contribute to the greenhouse effect. The majority of the global emissions of CO<sub>2</sub> originate from the burning of fossil fuels such as coal, oil, gas and natural gas used in power plants, dwellings, industry and transport. Furthermore, increasing CO<sub>2</sub> levels in the atmosphere may contribute to lower pH in water bodies when dissolved in water.

The CO<sub>2</sub> emissions from vessels working in the Baltic Sea are for the calculations here set at 3.1 tonnes CO<sub>2</sub>/tonnes fuel /31/.

*Nitrogen oxides (NO<sub>x</sub>)*

NO<sub>x</sub> is a term covering NO and NO<sub>2</sub>. NO<sub>x</sub> are formed during the combustion of fuel in gas and diesel engines due to oxidation of nitrogen in the combustion air and in the fuel. Emissions of NO<sub>x</sub> contribute to acidification, which can cause impacts on ecosystems in both terrestrial and marine environments. Furthermore, NO<sub>x</sub> emissions contribute to eutrophication, where high nutrient concentrations stimulate growth of plants and algae and thereby impact the natural state of ecosystems in terrestrial and marine environments. On a local scale, NO<sub>x</sub> emissions contribute to the formation of ground-level ozone and impact human health. It is estimated that about 15% of anthropogenic NO<sub>x</sub> emissions are due to shipping /32/.

The NO<sub>x</sub> emissions from vessels working in the Baltic Sea are for the calculations here set at 12 g NO<sub>x</sub>/kWh (medium speed 4-stroke diesel ship engines 2000-2010) /33/. For evaluation purposes, NO<sub>x</sub> has been treated as NO<sub>2</sub>.

*Sulphur dioxide (SO<sub>2</sub>)*

Sulphur is naturally present in fuels and is emitted from the burning of coal and oil at power plants and on mobile sources, such as ships. SO<sub>2</sub> contributes to acidification and can impact human health and cause degradation of buildings on a local/regional scale. Continuous tightening of the allowed sulphur content in fuels has gradually reduced the SO<sub>2</sub> emissions from ships. It is estimated that about 7% of anthropogenic SO<sub>2</sub> emissions are due to shipping /32/.

The SO<sub>2</sub> emissions from vessels working in the Baltic Sea, which has been designated a Sulphur Emission Control Area (SECA), are for the calculations here set at 0.001 tonnes SO<sub>2</sub>/tonnes fuel, in accordance with the limit values on sulphur content in marine fuels /34/. As of 1 January 2015, the maximum sulphur content inside a SECA is 0.1%. This means that ships must use low-sulphur fuel or have an on-board desulphurization system.

*Particulate matter (PM)*

The combustion of fuels results in the emissions of particulate matter, e.g. soot particles (primary particles). However, the majority of particles with regard to air pollution originate from pollution "born" as gases and transported over long distances, e.g. inorganic sulphate particles formed as a result of atmospheric oxidation of sulphur dioxide. Particulate matter can be transported long distances and may have impacts on human health. Particulate matter is usually considered as PM<sub>10</sub> (particles < 10 µm) and PM<sub>2.5</sub> (particles < 2.5 µm), respectively. Research implies that the even smaller particles, called ultra-fine particles, are the most harmful to human health.

The particle emissions from vessels working in the Baltic Sea are for the calculations here set at 0.0018 tonnes total suspended particles (TSP)/tonnes fuel /33/. TSP is applied, thereby taking the total particle amount into consideration.

*Methane (CH<sub>4</sub>)*

CH<sub>4</sub> is one of the important climate gases, i.e. the emissions of CH<sub>4</sub> contributes to the greenhouse effect. Methane in ambient air may occur naturally. However, over the past 250 years, i.e. since the beginning of the Industrial Age, the level of methane has increased by 2.5 times. Major sources of methane are animal farming and agriculture. Concentration of methane in confined space may cause asphyxia. Given regular releases of natural gas through vents at the PTA at the landfall Russia during the operation phase, it has been decided to undertake calculations of predicted emissions specifically for the Russian onshore section.

**1.5.1.3 Calculation Method****Finland, Sweden and Denmark**

Emissions are – whenever possible - calculated on the basis of the operation time of the individual type of equipment used for various activities, hereby leaving out distances covered from the calculation because distances are considered to be associated with some uncertainty.

The energy consumption of equipment, e.g. vessels, is needed in order to calculate the emissions because emission factors for compounds are often given in mass/kWh.

The theoretical maximum workload (in kWh) of the equipment used for NSP2 may then be calculated using the following formula:

$$\text{Energy consumption (kWh)} = \text{Effect (kW)} \times \text{availability (hours)} \quad \text{Eqn. 1}$$

The emission is in general calculated using the following formula:

$$\text{Emission (tonnes)} = \text{Energy consumption (kWh)} \times \text{time slice (\%)} \times \text{emission factor} \left( \frac{\text{tonnes}}{\text{kWh}} \right) \quad \text{Eqn. 2}$$

The time slice takes into account that the engine may not be in operation during the whole period the equipment is available for the project. For example, a pipe-laying vessel is expected to be in operation (nearly) 100% of the time available during construction, whereas a support vessel may be in operation only part of the time available. Depending on the activity, allowance for sailing has been included, either from actual calculated sailing time or it is included in the total availability of the vessels.

The expected time slice for each type of equipment is defined on the basis of the time slice for similar operations during NSP, together with information on the days of operation/availability for each kind of equipment. Whenever possible, the operation time has been deduced on the basis of the current project description. The reasons for assumptions, etc. are stated in the respective sections for the different activities.

For some equipment, e.g. generators, the emissions may be calculated on the basis of fuel consumption.

The individual equipment, machinery, etc. may use different fuel types, such as:

- Heavy fuel oil (HFO);
- Marine fuel oil (MFO);
- Intermediate fuel oil (IFO); and
- Light marine distillates (further divided into marine diesel oil (MDO) and marine gas oil (MGO)).

However, it is assessed that the variation in emission factors between the various fuels is negligible. Therefore the same emission factors are applied in all cases.

Power usage of the various types of equipment has been collected from data sheets with references to the source in each case. In the event that this information is not available, data from NSP are applied.

The emissions from the various onshore and offshore operations are calculated as masses, i.e. total emissions from the total project, as well as emissions for each country.

Fuel consumption for machinery depends on the type and age of the engine. For the calculations here, a fuel consumption rate of 195 g/kWh is assumed for all engines /31/.

In cases where a sailing distance (or flying distance in the case of helicopter support) is needed to calculate emissions, a maximum distance of 100 nautical miles (nm) is used.

It should be noted that the air emissions calculated based on the above-mentioned assumptions are associated with uncertainties, e.g. related to engine type, number of engines, working load of

the engines and the exact fuel type. Despite the data limitations and uncertainties, however, it is assumed that the estimated range of emissions presented in this document will be in the order of magnitude of the emissions that will arise.

### Calculations of air emissions onshore and nearshore to KP 3.3 for Russia

Calculations of air emissions from onshore activities have been carried out by Nord Stream AG /30/.

Methodology for air emissions calculation has been aligned with calculation method for other countries, i.e. Finland, Sweden and Denmark, to the extent possible. A different methodology in accordance with the national standards is used for the Russian EIA.

The emissions arising from on-land machineries, such as cranes, excavators, etc. is based on working time. Emissions are calculated using the following formula:

$$\text{Emission (tonnes)} = \text{Working time (hours)} \times \text{time slice (\%)} \times \text{emission factor} \left( \frac{\text{tonne}}{\text{hour}} \right) \quad \text{Eqn. 3}$$

The emissions arising from on-land transportation of pipes, consumables from Ust-Luga port to onshore construction site is based on a distance of on-land transportation by trucks. Emissions are calculated using the following formula:

$$\text{Emission (tonnes)} = \text{Distance (km)} \times \text{Trucks in total (pcs)} \times \text{emission factor} \left( \frac{\text{tonne}}{\text{km}} \right) \quad \text{Eqn. 4}$$

Power usage of the various types of equipment is collected from data sheets with references to the source in each case. In the event that this information is not available, data from NSP are applied. Fuel consumption for machinery depends on the type and age of the engine. For this purpose, a fuel consumption rate of 195 g/kWh has been assumed for all engines.

### Calculations of air emissions onshore and offshore for Germany

Calculations of air emissions from onshore activities at the German landfall at Lubmin 2 and from offshore activities have been carried out by Nord Stream AG /28/, /29/.

The emission calculations are based on the available data regarding the used equipment, its performance, operating periods, utilization, model years, etc., as well as type- and fleet-specific emission factors, used fuels and legal regulations (emission limits).

The emitted air pollutants SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> as well as CO<sub>2</sub> are determined in this assessment for the German offshore section for the offshore works within the pipeline route sections I to III:

- Pipeline route section I: EEZ border up to KP 31;
- Pipeline route section II: KP 31 to KP 55;
- Pipeline route section III: KP 55 to landfall at Lubmin; and
- Landfall (Microtunnel).

And for the onshore construction activities near Lubmin it includes:

- Construction of the pig receiving station;
- Pre-commissioning;
- Commissioning; and
- Construction of the GASCADE gas receiving station.

The emission rules are based on emission factors which are given performance-related for NO<sub>x</sub> and PM<sub>10</sub>, and consumption-related for CO<sub>2</sub>, both for ships and onshore equipment.

The immission prognosis rests upon the procedure according to the „Technical Instructions on Air Quality Control“ („Technische Anleitung zur Reinhaltung der Luft“ / TA Luft). According to this instruction, dispersion calculations are to be carried out using a Lagrangian particle model, according to VDI guideline 3945, page 3. Ships' emissions are regulated internationally by the IMO (International Maritime Organization); in MARPOL Annex VI, respective emission limits are defined. According to that, a maximum sulphur content of 0.1% is allowed for marine fuel within Sulphur Emission Control Areas (SECA), including the Baltic Sea since 2006.

The sulphur dioxide emissions for the sulphur content are calculated directly from the power (kW) of the single motors and the average fuel consumption in (gFuel/kWh), considering the respective molar masses. The specific fuel consumption for all ship types is assumed with 190 g/kWh. The emission factors for PM<sub>10</sub> are assumed at 0.45 g/kWh for ships older than model year 2000, and 0.3 g/kWh for ships younger than model year 2000. It is assumed that PM<sub>10</sub> completely consists of particles smaller than 2.5 µm. For the few lorries (tank trucks, concrete mixer vehicles, lorries for nitrogen supply), the exhaust gas limit values (EURO V) for NO<sub>x</sub> and PM<sub>10</sub>, valid since 2008, are selected.

For the offshore activities, a 24/7 operation is assumed. In the onshore section, the hourly emissions are only emitted between 07:00 and 18:00 from Monday to Friday, except for the tunnel construction, which is running 24/7.

#### **Calculations of air emissions from ancillary facilities**

Calculations of air emissions from ancillary activities in Sweden and Finland have been carried out by Ramboll, following the same methodology as outlined for Finland, Sweden and Denmark above /24/, /25/. The ancillary activities in Germany have been estimated on the basis of calculations for Finland and are reported in /27/.

## 2. NSP2 MODELLING RESULTS AND NSP EXPERIENCE

### 2.1 Sediment and contaminants dispersion

The results summarised in this section represent the total impact from the activities in each PoO across the entire construction period. Therefore, when analysing the results, consideration should be given to the fact that activities in each PoO (and their resulting impacts) will have some geographical and temporal separation (i.e. SSC will be highest in areas where seabed intervention works occur, and not all seabed intervention works within a particular PoO will occur simultaneously).

Furthermore, it should be noted that the maximum duration of the SSC increase is not consistent across the total area. Therefore, the maximum durations referenced apply, in most instances, to only a small proportion of the total area.

Sediment dispersion was modelled by taking the specific sediment conditions (grain size distribution) at the locations where seabed intervention works (rock placement, trenching, dredging, munition clearance) are planned, into account.

The concentration of contaminants used in the modelling of contaminants dispersion in Russia and Finland are based on chemical analysis of sediment samples from environmental field surveys carried out in 2015 – 2016 along the planned NSP2 pipeline route. As input for the model in Russia and Finland (modelled separately), the 95% percentile concentration (for each contaminant) for all results from Russian and Finnish waters respectively was used.

For the majority of the sections of the NSP2 route, this approach of using the 95% percentile value will be very conservative. As an example of this, the survey results showed very low concentrations of many of the contaminants at the Russian landfall location. This was also the case for some sections along the NSP2 route offshore. As a consequence the results of modelling of dispersion of contaminants at the Russian landfall area shown in atlas maps and figures are very conservative.

The table below shows the differences in concentrations and the 95% percentile of contaminants (zinc, benzo(a)pyrene (B(a)P) and dioxins/furans) for the Russian nearshore (landfall) and offshore section along the NSP2 pipeline route. Based here upon it can be seen that the 95% percentile concentrations is between a factor 1.8 - 18 lower at the landfall location. For dioxins/furans shown on Atlas maps the concentration and the 95% percentile is up to a factor 4.7 and 7.8 lower at the landfall respectively. This will more or less result in a reduction of the area affected, with the same factor (for dioxins/furans between a factor 4.7 – 7.8).

Concentration of contaminants in sediment inside Russian waters				
Substance		Offshore	Nearshore	Whole section <sup>1</sup>
Zinc (mg/kg DM)	Min-max	12.9 – 168	3.9 – 10.7	
Zn (mg/kg DM)	95% percentile	164	9.1	160
Benzo(a)pyrene	Min-max	0.001 – 0.078	0.001 – 0.056	
B(a)P (mg/kg DM)	95% percentile	0.050	0.027	0.049
Dioxins/Furans	Min-max	0 – 32.2	0 – 6.8	
WHO(2005)PCDD/F TEQ (ng/kg DM)	95% percentile	18.9	2.2	17.1

1: 95% percentile values used as input for modelling.

#### 2.1.1 Munitions clearance

##### Modelling results

Dispersion of seabed sediments and sediment-associated contaminants mobilised by munitions clearance has been modelled for positions in Finland and Russia, respectively. The assumptions



for the modelling are outlined in Chapter 1 and in /4/, /7/. The results of the modelling are summarised in Table 2-1. Three hydrographic scenarios (summer, normal and winter) were modelled, and the intervals shown in the table cover these three scenarios.

**Table 2-1 Dispersion and re-sedimentation of seabed sediments and sediment-associated contaminants mobilised by munitions clearance in Finland and Russia (common for both pipelines). The areas are not necessarily limited to the country within which the activity takes place.**

Parameter	Unit	PoO	
		Finland	Russia
Locations and number of munitions	No.	4 locations x 6 munitions <sup>1</sup>	34 munitions <sup>2</sup>
<b>Dispersion and re-sedimentation of sediments:</b>			
Total suspended sediment dispersed	Tonnes	1,030	1,520
Total area where conc. >10 mg/l <sup>3, 4</sup>	km <sup>2</sup>	33-46	13-19
Total area where conc. >15 mg/l <sup>3, 4</sup>	km <sup>2</sup>	16-28	8-11
Max duration of conc. >10 mg/l <sup>3</sup>	Hours	7-13	6-9
Max duration of conc. >15 mg/l <sup>3</sup>	Hours	5-10	6-8
Area where sedimentation >200 g/m <sup>2 4</sup>	km <sup>2</sup>	0.0	0.7-0.9
<b>Dispersal of sediment-associated contaminants:</b>			
Total area where conc. >PNEC <sub>BaP</sub> <sup>4</sup>	km <sup>2</sup>	99-118	34-40
Total area where conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>4</sup>	km <sup>2</sup>	19-21	17-21
Total area where conc. >PNEC <sub>Zn</sub> <sup>4</sup>	km <sup>2</sup>	2-3	1-2
Max duration of conc. >PNEC <sub>BaP</sub>	Hours	12-19	10-17
Max duration of conc. >PNEC <sub>PCDD/F TEQ upper</sub>	Hours	5-7	9-11
Max duration of conc. >PNEC <sub>Zn</sub>	Hours	3	2-5
<p>1: Modelling undertaken based on four locations, each assumed to require clearance of six objects (three medium size (charge size = 30-64 kg TNT) and three large size (charge size = 100-350 kg TNT) objects, releasing 20 m<sup>3</sup> and 42 m<sup>3</sup> seabed sediments, respectively). At each location, it has been assumed that there would be a distance of 1 km between objects, and that clearance would occur over a period of six days (one object/day).</p> <p>2: Modelling undertaken based on an assumed clearance of 34 objects, alternating between an equal amount of medium size (charge size = 30-64 kg TNT) charges releasing 20 m<sup>3</sup> of seabed sediments and large-size (charge size = 100-350 kg TNT) charges and 42 m<sup>2</sup> of seabed sediments, respectively. At four locations, it has been assumed that two objects may require detonation in the same place and at the same time i.e. a medium and a large-sized object detonated simultaneously, causing release of 62 m<sup>3</sup> seabed sediments.</p> <p>3: Results show suspended sediment concentration in the bottom 10 m of the water column (i.e. 10 m closest to the seabed).</p> <p>4: Areas refer to the extent where SSC, sedimentation or toxicity exceed the chosen threshold value. The areas are not necessarily limited to the country within which the activity takes place.</p>			

In the following, examples of modelling results are presented.

Sediment dispersion due to munitions clearance in the Finnish EEZ and Russian waters has been modelled using a generic scenario. Four locations in the Gulf of Finland were chosen and the locations were selected either in areas with a high density of munitions or in the vicinity of protected areas. The generic scenario is based on clearance of a typical midsize charge (30-64 kg trinitrotoluene (TNT)) and clearance of a typical large-size charge (100-350 kg TNT) /4/, /7/.

At each location, six munitions objects (shifting between medium-sized and large-sized charges, 1 km in between the charges) are assumed to be cleared one at a time, with a 24 hour interval. The crater (volume) in the seabed from munitions clearance has been calculated/modelled for medium and large size munitions to be 20 m<sup>3</sup> and 42 m<sup>3</sup>, respectively.

All the scenarios in the Finnish EEZ/Russian waters assume clearance of 24/34 munitions, split evenly between medium and large sized munitions. The total sediment volume released during the munitions clearance modelling scenario is 744 m<sup>3</sup>/1,054 m<sup>3</sup>. The duration of the scenario for Finland/Russia is 24/34 days /4/, /7/.

The spill of sediment is anticipated to be the fine-grained (less than 0.2 m diameter) amount of the sediments which were in the crater before detonation. This mass is estimated on basis of the bulk density of the specific sediment type (kg/m<sup>3</sup>), the dry matter content in the specific sediment type and the percentage of fine-grained sediments below 0.2 mm in the specific sediment type. The total sediment spill for Finland and Russia, respectively, is calculated to be 1,030/1,520 tonnes for Finland/Russia /4/, /7/.

The areas and durations of exceedances of a concentration of suspended sediment of 10 mg/l in the lowest 20 m of the water column from munitions clearance in the Gulf of Finland (four locations for Finland) are shown in Table 2-1 and in Figure 2-1 and Figure 2-2.

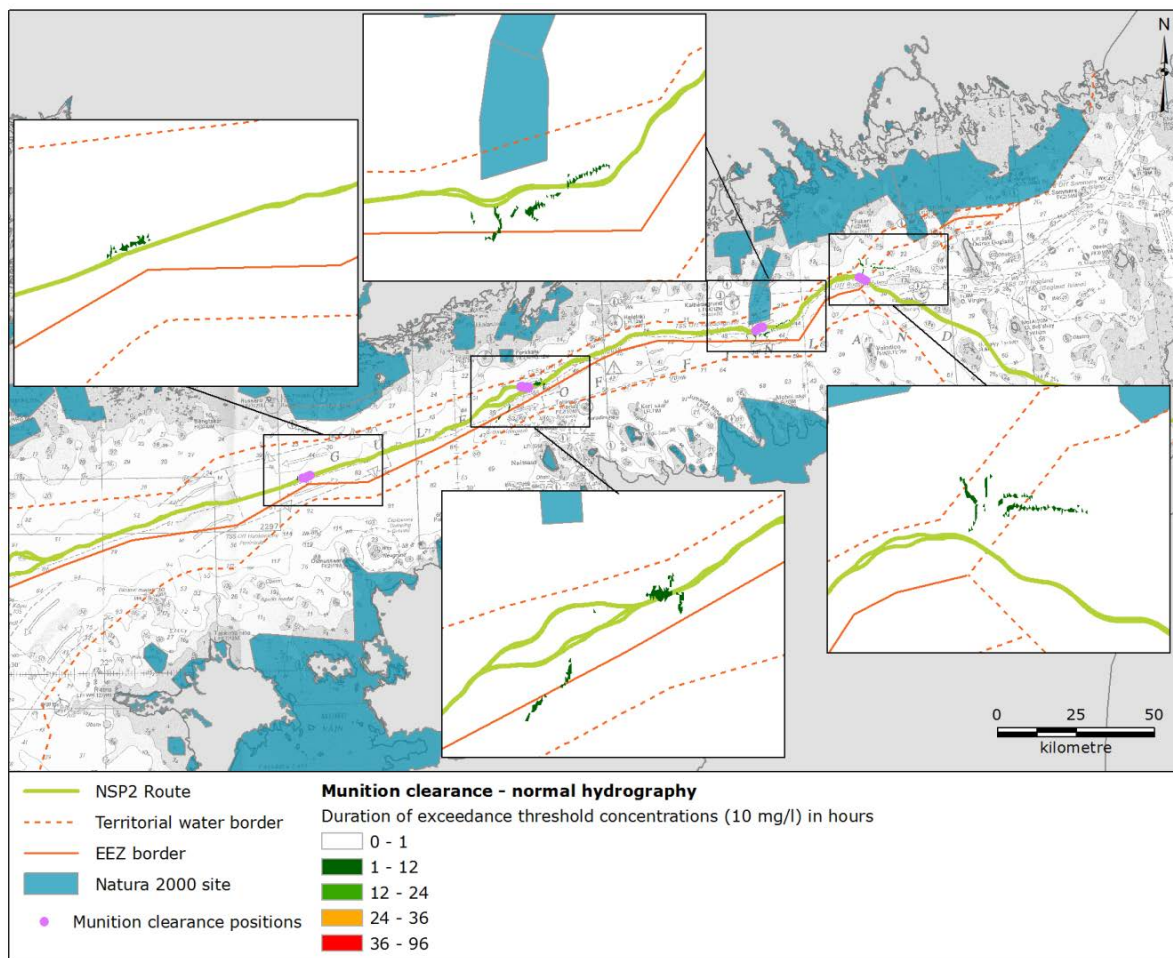
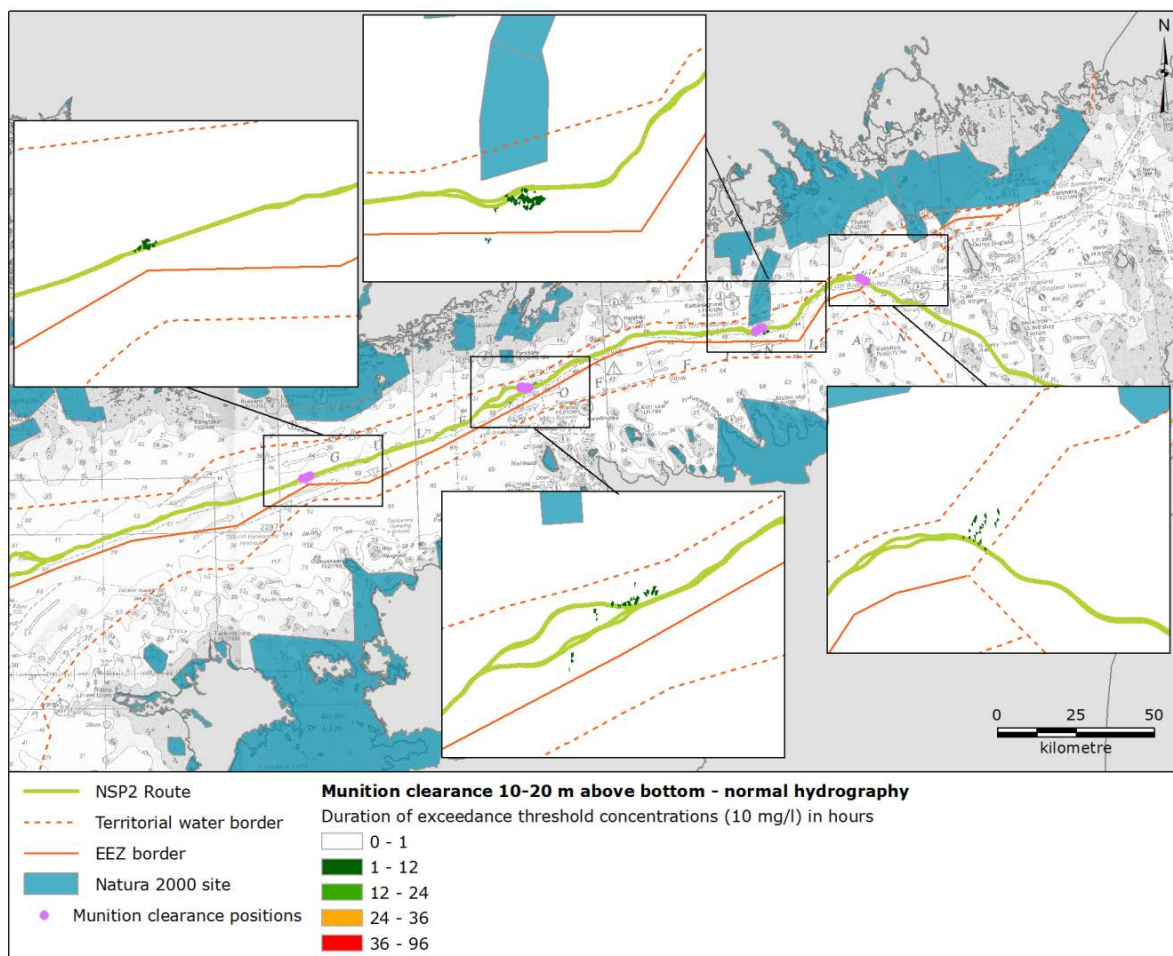


Figure 2-1 Durations and areas with exceedances of suspended sediment >10 mg/l (0-10 m above the seabed) from munitions clearance under normal hydrographic weather conditions.



**Figure 2-2 Durations and areas with exceedances of suspended sediment >10 mg/l (10 - 20 m above the seabed) from munitions clearance under normal hydrographic weather conditions.**

The content of contaminants in the sediment has been estimated based on samples from the Gulf of Finland collected as part of the NSP2 surveys. The dispersion of contaminants is modelled similar to the dispersion modelling for sediment. Only the dissolved and bioactive fraction is modelled. Consequently, the contaminants are not settling and for precautionary reasons, no decay is assumed. The model results are given as concentration of dissolved/bioactive contaminants and are denoted as predicted environmental concentration (PEC). This is the estimated exposure concentration in the water body based on spill and spreading.

The method for predicted no-effect concentration (PNEC) has been documented in /2/. The PNEC estimates the lower limit of the concentration range in the water body known to cause effects. The relative toxicity has been quantified as the ratio between the predicted environmental concentration (PEC) and the predicted no-effect concentration (PNEC). The relatively most toxic (PEC/PNEC) substances, taking the concentration of substances in sediment into account, are calculated to be benzo(a)pyrene (B(a)P), a representative of the polycyclic aromatic hydrocarbons (PAH), WHO (2005), PCDD/F TEQ upper (dioxin/furans) and zinc, in descending order /4/. The modelling results shown below will therefore focus on the concentrations of benzo(a)pyrene (B(a)P).

Exceedance of the PNEC value does not necessarily mean that there will be an impact on the marine flora and fauna. The internationally accepted PNEC values used and described in /2/ have been calculated based on results from laboratory tests (short term, long term and No Observed Effect Concentration (NOEC) studies) on marine flora and fauna, and an "assessment factor"

(security factor) ranging from 10 – 10,000 depending on test results available for marine flora and fauna.

Figure 2-3 shows the relationship between the area and duration where the PNEC value of B(a)P is exceeded. From the figure it is clear that the duration of exceedance of PNEC inside a specific area is very short, for the majority of the impacted area. In total, modelling showed that exceedance of the PNEC value for B(a)P covered areas of 118 km<sup>2</sup> (Finland) and 45 km<sup>2</sup> (Russia).

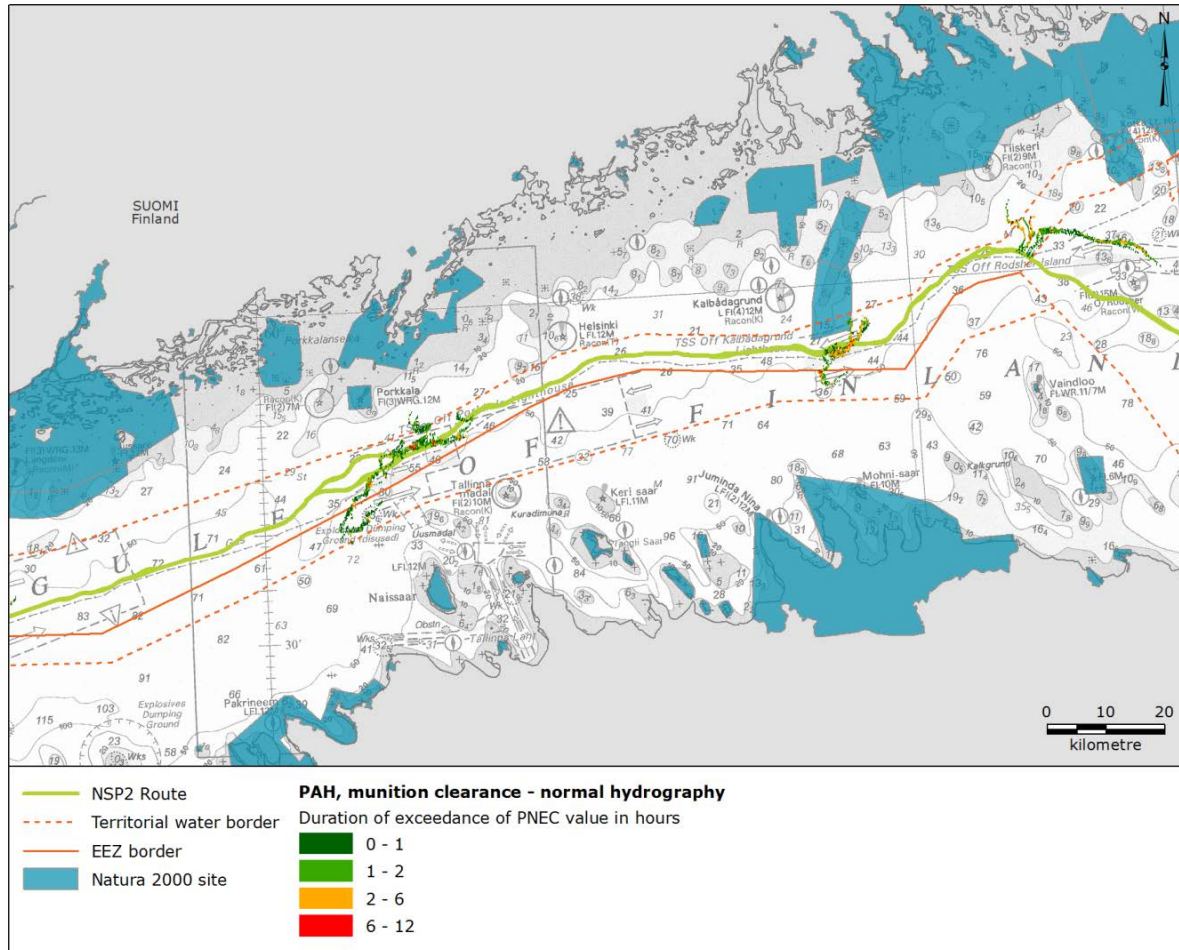
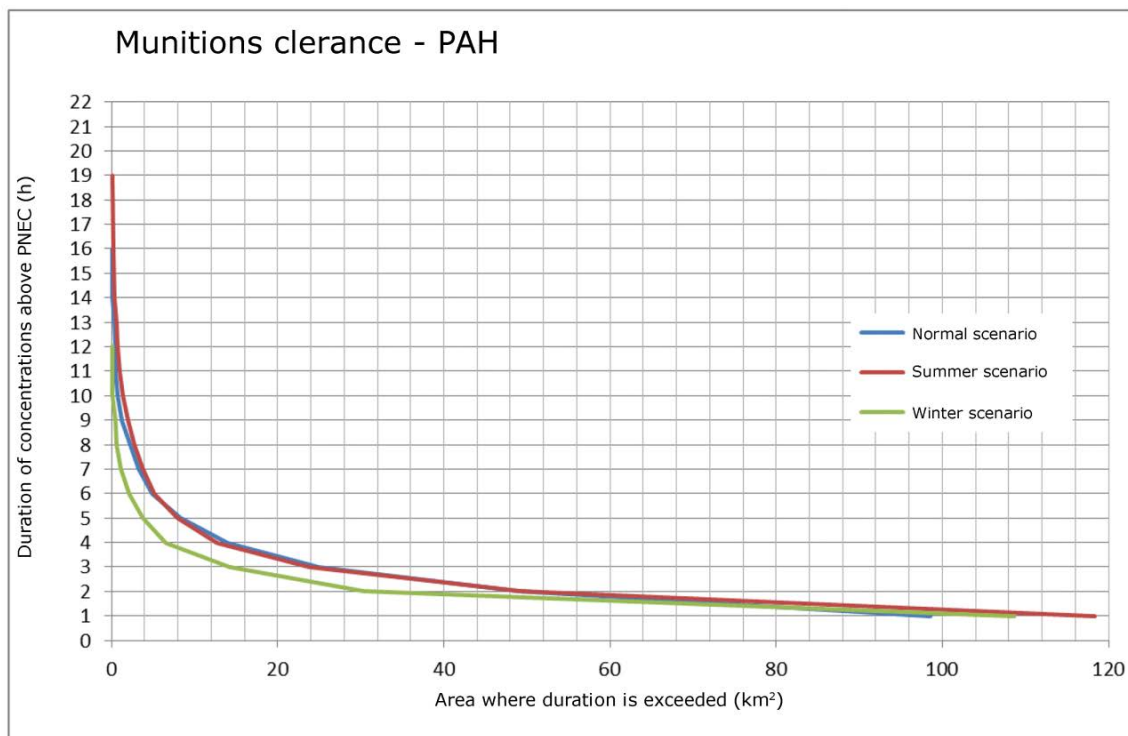


Figure 2-3 Duration and area of exceedance of PNEC for benzo(a)pyrene during munitions clearance under normal conditions. Eastern part of the Gulf of Finland.



**Figure 2-4** Graph of area vs. duration for benzo(a)pyrene (PAH) from munitions clearance scenarios in the Finnish EEZ. The graph shows the size of the areas in which the different durations of the relative toxicity (PEC/PNEC) are exceeded /4/.

In conclusion, the PNEC value is exceeded for all three contaminants in the munitions clearance scenarios in some areas. As for B(a)P, dioxins/furans and zinc, the duration where the PNEC value is exceeded at a specific location is below one day /4/, /7/. Figure 2-4 shows the area where the  $PNEC_{B(a)P}$  value is exceeded and the duration of exceedance for a specific area for munitions clearance in Finnish waters. The same picture is seen for Russia and for the two other contaminants modelled.

### Experience from NSP

Munitions clearance by blasting was carried out in Swedish, Finnish and Russian waters during the NSP project.

#### *Craters in the seabed*

Monitoring of the clearance of 49 munitions objects in Finnish waters revealed that the environmental impact of all clearance operations was significantly less than predicted in the EIA', which was based on worst case assumptions, and that the crater volume/total amount of released sediment was about 10% of the volume assumed /35/,/36/.

A comparison of the predicted crater volume and the actual crater volume measured after munitions clearance were carried out for NSP. Predicted volume (seabed sediment to be suspended into the water column) is up to approximately 300 m<sup>3</sup>, while the actual measured volume of dispersed sediment was up to approximately 50 m<sup>3</sup>. In all cases, the actual volumes were several times lower than predicted. The craters created from the munitions clearance had a diameter of up to 7-8 m /37/.

The impacts of the detonations on the seabed were much lower than originally predicted /38/.

The overall results on the bathymetry from monitoring of munitions clearance showed as described above that the impacts were significantly smaller than predicted in the NSP EIAs. In

the NSP EIAs the overall impacts from munitions clearance on the seabed bathymetry were assessed to range from negligible to minor significance.

#### *Dispersion of sediments and contaminants*

Prior to the NSP construction works, the environmental impacts related to conventional and chemical munitions were assessed. The assessment of the spreading of sediments and contaminants released into the water column, transported by currents and then re-deposited during munitions clearance, was made by combining computer modelling and expert opinion /39/.

The analysis showed that, on average, munitions clearance results in re-suspended sediment with a concentration above 1 mg/l within 1-2 km, with a maximum in some locations of 5 km, of the disturbance area for 13 hours. A concentration above 10 mg/l is expected to last for 4 hours on average and close to the clearance site. Sedimentation is limited and rarely exceeds 0.1 kg/m<sup>2</sup> /39/.

Monitoring in connection with munitions clearance took place in Finland in 2009 and 2010. The concentration of suspended sediments caused by the munitions clearance was not higher than 10 mg/l for a maximum of 18 hours at any of the monitored locations. The extent of the turbidity plumes, if any, extended 200-300 m around the detonation point. Contaminant or nutrient concentrations did not increase from the background values in the vertical sampling profiles /38/.

### **2.1.2 Rock placement**

#### **Modelling results**

Dispersion of seabed sediments mobilised by rock placement has been modelled for Russia, Finland, Sweden and Denmark, respectively. For the modelling in Finland and Russia, modelling of dispersion of sediment-associated contaminants was also carried out. The assumptions for the modelling are outlined in /2/. The results of the modelling are summarised in Table 2-2. Three hydrographic scenarios (summer, normal and winter) were modelled, and the intervals shown in the table cover these three scenarios.

**Table 2-2 Dispersion of seabed sediments and sediment-associated contaminants mobilised by rock placement in Russia, Finland, Sweden, and Denmark. The areas refer to the extent of spilled sediments where the SSC, sedimentation or toxicity are above a certain threshold value.**

Parameter	Unit	PoO				
		Denmark	Sweden	Finland		Russia
				NSP2, alt. E1E2 <sup>1</sup>	NSP2, alt. W1W2 <sup>2</sup>	
Locations	No.	4	125 + 79 <sup>3</sup>	248 + 46 <sup>3</sup>	248 + 51 <sup>3</sup>	74
Rock volume	m <sup>3</sup>	86,720	518,479	1,102,500	1,211,500	711,304
Duration of rock placement activities	days	7.4	49	35	38	31
<b>Dispersion and re-sedimentation of sediments:</b>						
Total suspended sediment dispersed	Tonnes	128	1,372	2,593	2,848	804
Total area where conc. >10 mg/l <sup>4</sup>	km <sup>2</sup>	0.00	0.08-0.15	4-6	10	0.1-0.9
Total area where conc. >15 mg/l <sup>4</sup>	km <sup>2</sup>	0.00	<0.02	0.6-1.7	3	0.0-0.3
Max duration of conc. >10 mg/l	Hours	0	0.5-13	7-18	7	1.5-4
Max duration of conc. >15 mg/l	Hours	0	0-0.5	1.5-7.5	1.5	0-0.5
Area where sedimentation >200 g/m <sup>2</sup>	km <sup>2</sup>	0.06-0.11	0.1-1	0-0.05	0.00	0-0.1
<b>Dispersal of sediment-associated contaminants<sup>4</sup>:</b>						
Total area where conc. >PNEC <sub>BaP</sub> <sup>5</sup>	km <sup>2</sup>	-	-	2.9-9.6	-	<0.02
Total area where conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>5</sup>	km <sup>2</sup>	-	-	<0.02	-	<0.02
Total area where conc. >PNEC <sub>Zn</sub> <sup>5</sup>	km <sup>2</sup>	-	-	<0.02	-	<0.02
Max duration of conc. >PNEC <sub>BaP</sub>	Hours	-	-	8-22	-	0
Max duration of conc. >PNEC <sub>PCDD/FTEQupper</sub>	Hours	-	-	0	-	0
Max duration of conc. >PNEC <sub>Zn</sub>	Hours	-	-	0	-	0
1: NSP2 route, including the alternatives E1 and E2. 2: NSP2 route, including the alternatives W1 and W2 (sediment dispersion only calculated for winter hydrography). 3: The second value listed represents the number of spot rock placement locations. The number of locations modelled is a sum of the two values. 4: Results show suspended sediment concentration in the bottom 10 m of the water column (i.e. 10 m closest to the seabed). 5: Dispersal of sediment-associated contaminants was not modelled for Denmark, Sweden or the Finnish Alternative (E2+W2). Justification for this approach is provided in Section 2.1.						

As Table 2-2 shows, the highest number of locations, and highest amount of rocks used, is in Finland. Examples of results from modelling of sediment dispersion are presented in Section 2.1 is therefore shown only for Finland /4/. Results for the other countries can be found in /5/, /6/ and /7/, and in the Espoo Atlas MO-01 – MO-08.

The rock placement operation works used for the model scenario with respect to pre-lay, post-lay and pipeline crossings for line A in Finland are shown in Figure 2-5. As seen in the figures, some sections are split into two and mark the alternative pipeline route. As it has not yet been decided which of the two routes shall be used, both are modelled.

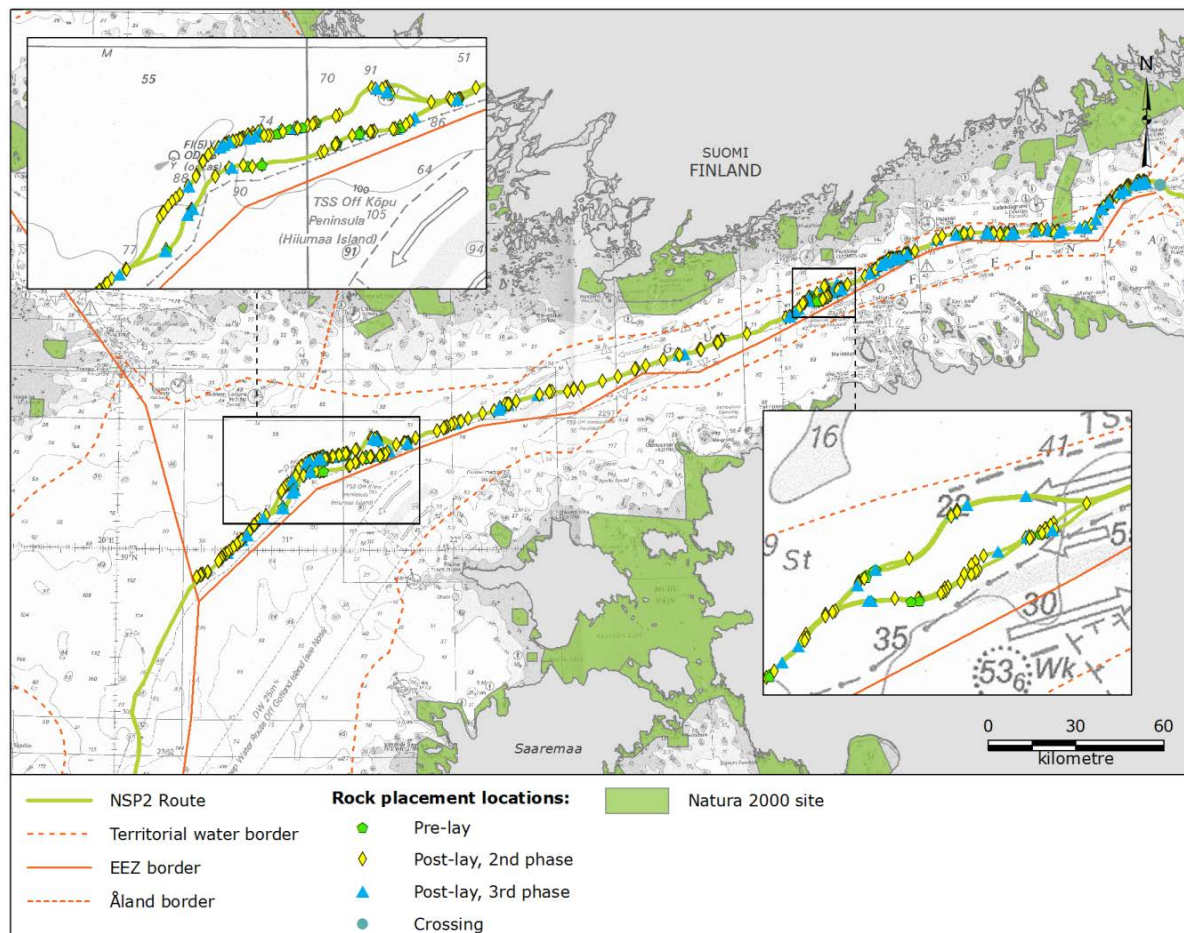


Figure 2-5 Map of Finnish EEZ with planned rock placement for pre-lay, post-lay and pipeline crossing for Line A /4/.

The assumptions used for modelling of sediment spill rates related to rock placement include /2/:

- 30% of the rock volume contributes to the sediment spill;
- A velocity of the falling rock inside the tube of 1.44 m/s;
- 10% of the total energy will cause resuspension of sediments.

For the modelled rock placement scenarios in the Finnish EEZ the maximum concentration of suspended sediment never exceeds 61 mg/l during winter conditions and 22 mg/l during normal and summer conditions, with no significant concentrations outside the pipeline corridor /4/.

The maximum concentration of suspended sediments caused by rock placement in the Finnish EEZ is shown for normal hydrographic conditions for the eastern part of the Gulf of Finland in Figure 2-6. From the figure it is clear that the increase in SSC due to sediment dispersion caused by rock placement is very local around the pipeline route, and does not extend into any protected areas.

Sedimentation does not exceed 400 g/m<sup>2</sup> at any location after rock placement operations (summer) and 170 g/m<sup>2</sup> (winter and normal conditions). The corresponding thickness depends on the density, which again is dependent on the consolidation of the material. In the environmental impact assessments related to sedimentation to the seabed, it is assumed that sedimentation of 200 g/m<sup>2</sup> corresponds to a layer of approximately 1 mm unconsolidated sediments at the seabed surface.



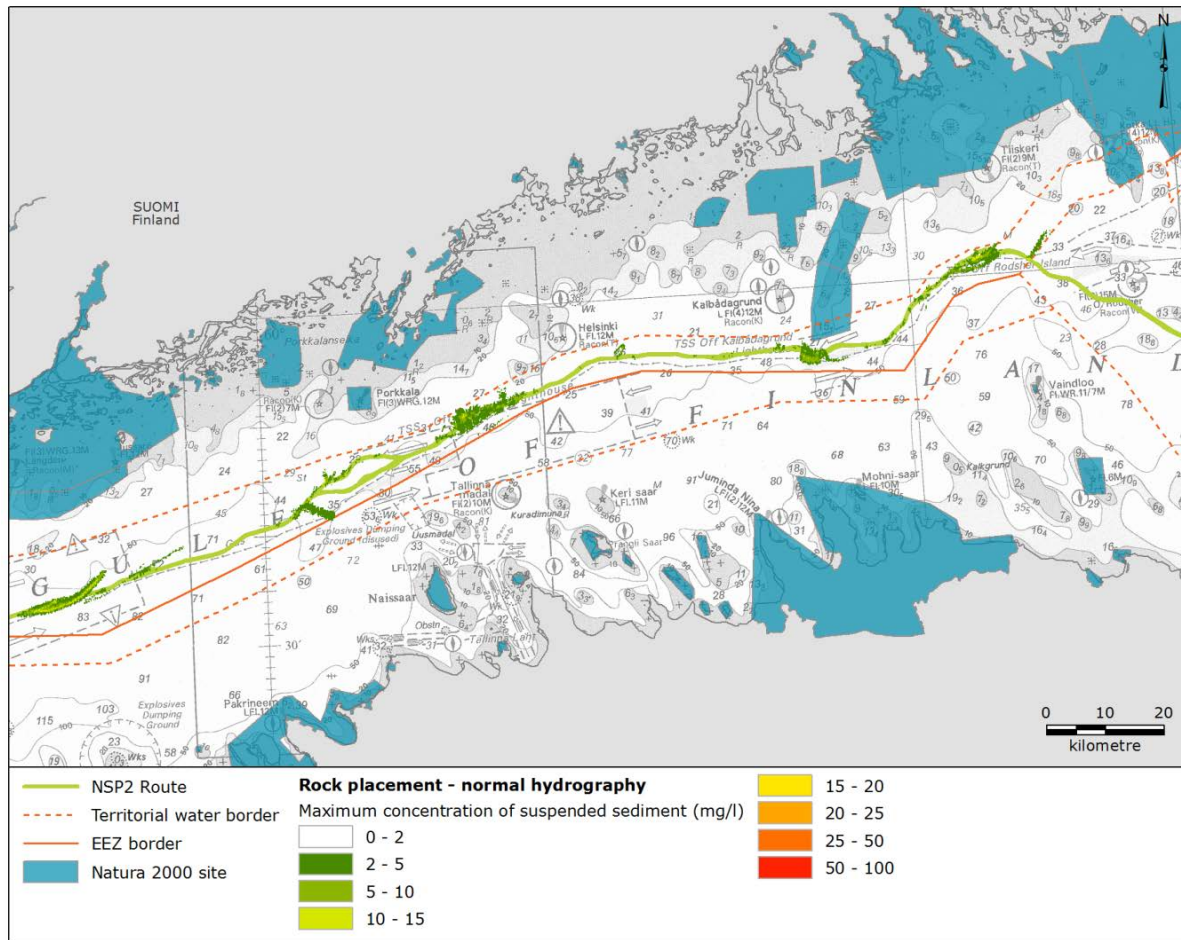


Figure 2-6 Maximum SSC for rock placement under normal hydrographic conditions. Eastern part of the Gulf of Finland /4/.

The area and duration where the SSC is >2 mg/l is shown in Figure 2-7.

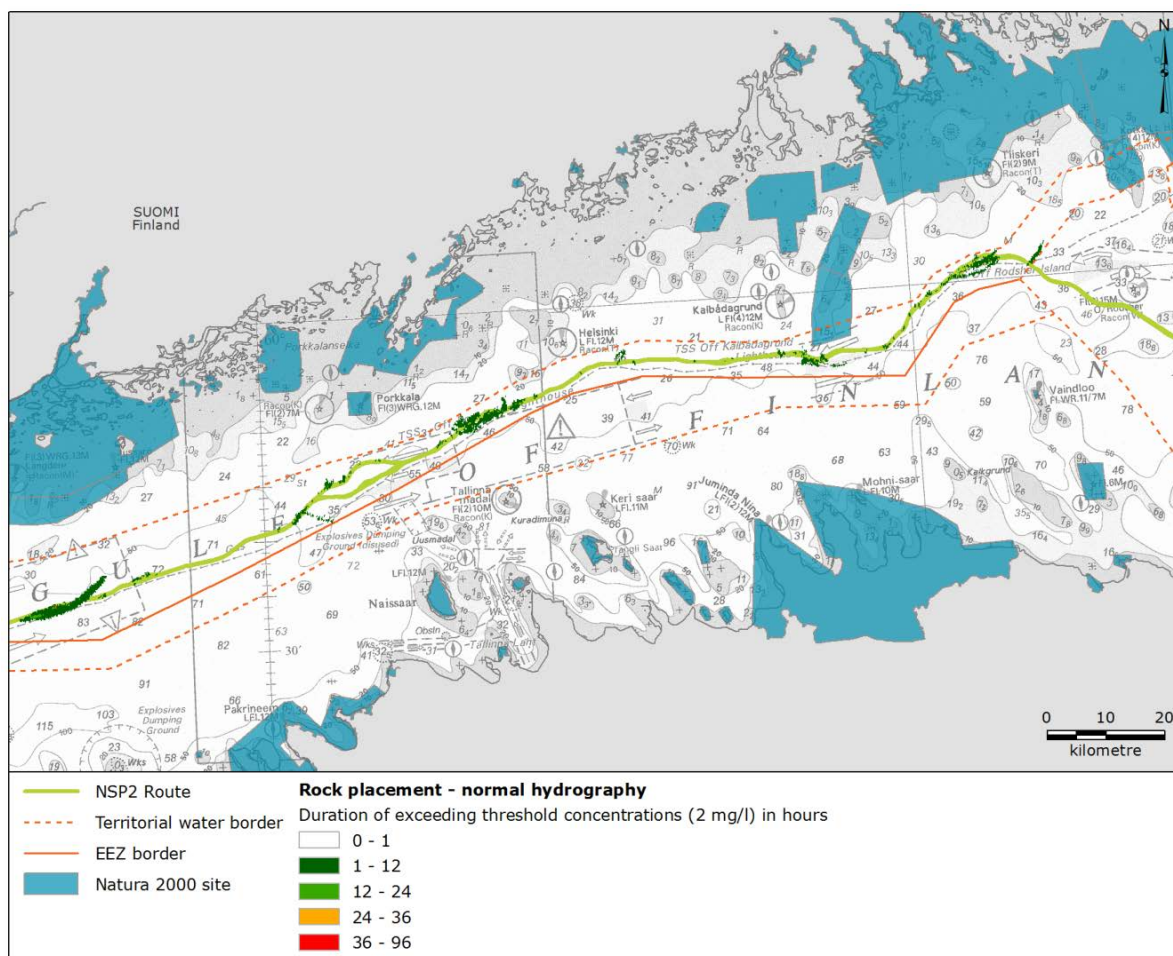
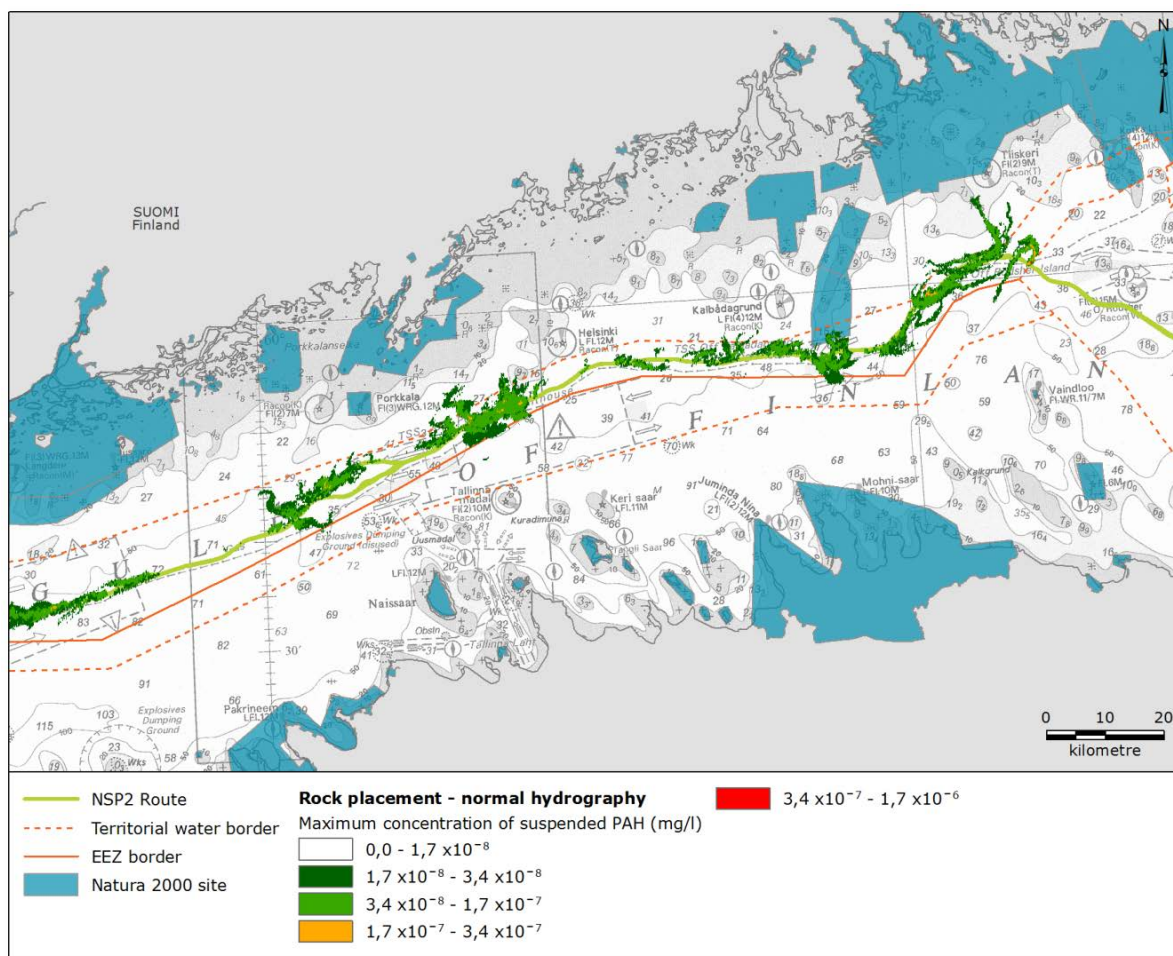


Figure 2-7 Area and duration of exceedance of 2 mg/l for rock placement under normal hydrographic conditions in the eastern part of the Gulf of Finland /4/.

The total area (including all approximately 300 rock placement locations) inside where the concentration of suspended sediment will be >10 mg/l will be between 18/7 km<sup>2</sup> (Line A/Alternative, respectively). In comparison this area will be 4/13/0 km<sup>2</sup> for Russia, Sweden, and Denmark, respectively.

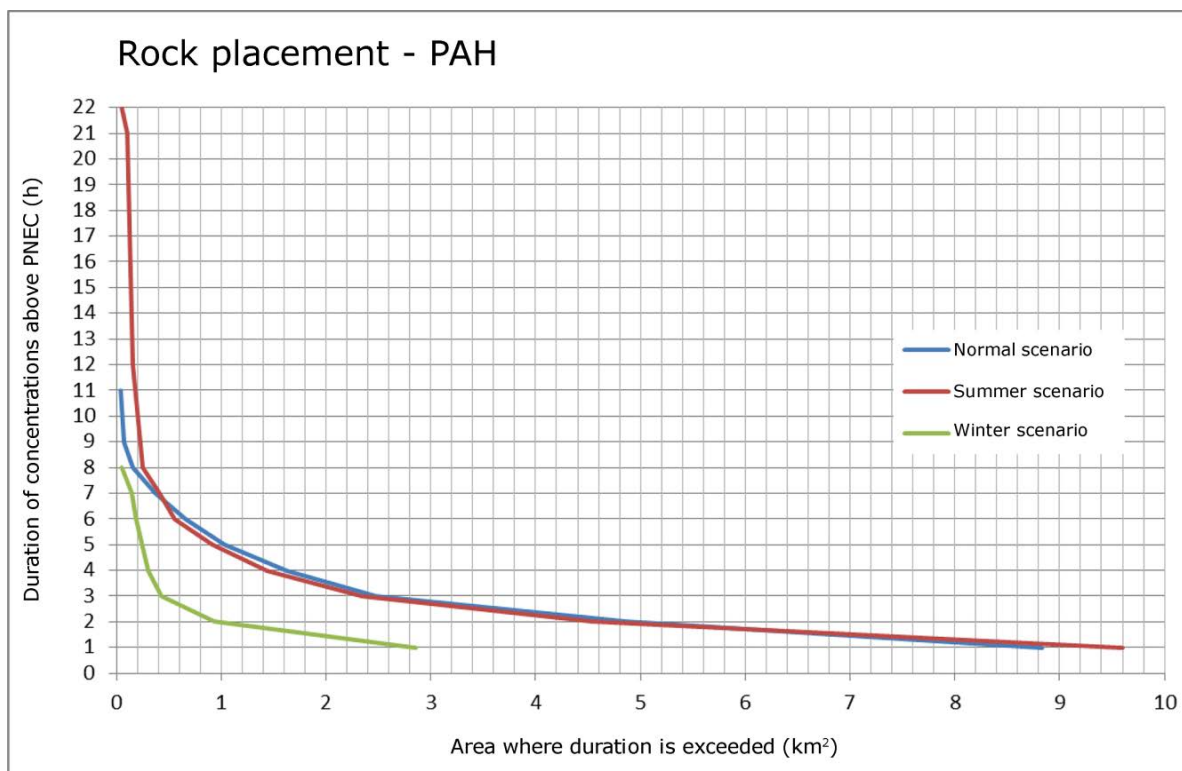
In Figure 2-8 the modelled maximum concentrations of benzo(a)pyrene (PAH compound) during rock placement under normal conditions in the eastern part of the Gulf of Finland is shown. From the figure it is clear that the PNEC value can be exceeded locally in the proximity of the rock placement locations.



**Figure 2-8** Maximum concentration of benzo(a)pyrene (PAH) during rock placement under normal conditions. Eastern part of the Gulf of Finland. PNECB(a)P is  $1.7 \times 10^{-6}$  /4/.

Figure 2-9 shows the relationship between the area where the  $PNEC_{B(a)P}$  value is exceeded and the duration for PAH from rock placement. From the figure it is clear that the duration is relatively short, for the majority of the area up to a few hours; and excessive concentrations have disappeared less than 12 hours after the placement, see also Table 2-2.

For the rock placement scenarios in the Finnish EEZ and Russian waters, only B(a)P (of the three investigated contaminants) in Finnish waters show concentrations exceeding the PNEC value. The PNEC value for B(a)P is only exceeded in a very small area - less than  $10 \text{ km}^2$  distributed along the entire pipeline route within the Finnish EEZ and only for a very short period of time in most of the impacted area. In 90% of the impacted area the PNEC value is exceeded for less than five hours in the normal and summer scenarios and even less in the winter scenario, as can be seen from Figure 2-9 /4/.



**Figure 2-9** Graph of area vs. duration for benzo(a)pyrene (PAH) from rock placement scenarios in the Finnish EEZ. The graph shows the size of areas in which the different durations of the relative toxicity (PEC/PNEC) are exceeded /4/.

### Experience from NSP

Monitoring of the sediment spreading as a consequence of rock placement has taken place in Russia in 2010 and in Finland in 2010 and 2011.

The measurements in Russia in 2010 showed maximum values of SSC caused by rock placement significantly lower than calculated by numerical modelling.

Measurements in Finland in 2010 have confirmed that the increase in SSC is limited to the lowermost 10 m of the water column, the impact distance from the rock placement site, defined as the 10 mg/l contour, was less than 1 km, and the measured duration of the SSC increase was less than predicted by numerical modelling /38/. The results from monitoring in Finland in 2011 showed turbidity peaks above 10 mg/l at only one sensor, specifically on three occasions with a total duration of 6.5 hours. Based on the monitoring results from 2010 and 2011 it was concluded that the modelled SSC caused by rock placement correlated well with the monitored values /40/.

### 2.1.3 Post-lay trenching (ploughing)

Dispersion of seabed sediments mobilised by post-lay trenching by ploughing has been modelled for Sweden and Denmark, respectively. The results of the modelling are summarised in Table 2-3. Three hydrographic scenarios (summer, normal and winter) were modelled, and the intervals shown in the table cover these three scenarios.

**Table 2-3** Dispersion of seabed sediments mobilised by post-lay trenching in Denmark and Sweden (calculated for one pipeline). The areas are not necessarily limited to the country within which the activity takes place.

Parameter	Unit	PoO	
		Denmark	Sweden
Total length of post-lay trenching/number of sections (total)	km	18.7/3 (139)	72.4/6 (510)

Parameter	Unit	PoO	
		Denmark	Sweden
length of pipeline in country)			
Duration of post-laying trenching	days	2.6	10
<b>Dispersion and resedimentation of sediments:</b>			
Volume of sediment handled	m <sup>3</sup>	129,300	448,390
Total suspended sediment dispersed	Tonnes	1,243	6,467
Total area where conc. >10 mg/l <sup>1</sup>	km <sup>2</sup>	11.8-21.7	55-134
Total area where conc. >15 mg/l <sup>1</sup>	km <sup>2</sup>	6.8-7.7	37-85
Max duration of conc. >10 mg/l	Hours	2.5-6.5	11-16
Max duration of conc. >15 mg/l	Hours	2.0-5.5	10-14
Area where sedimentation >200 g/m <sup>1</sup>	km <sup>2</sup>	0.5-0.6	3
1: Results show suspended sediment concentration in the bottom 10 m of the water column (i.e. 10 m closest to the seabed).			

For both Denmark and Sweden, the sediment dispersion modelling has been carried out for line B, which has the largest extent of planned seabed intervention works.

Based on experience from NSP, the model is assuming a trenching speed of 300 m/h, so trenching operations will cover a period of 10 days (240 hours). These assumptions do not include any time for relocation of the equipment. In the modelling, a total volume of trenching of 448,390 m<sup>3</sup> is planned /3/, /41/.

#### Sweden

Within Sweden, the modelling considered post-lay trenching at the locations shown in Figure 2-10. Due to the location of the release (5 m above the seabed, see Table 1-2) and because sediment is settling through the water column, the highest sediment concentrations are found near the seabed. Therefore, all results in Sweden related to suspended sediment are based on an average of the lower 10 m of the water column /41/.

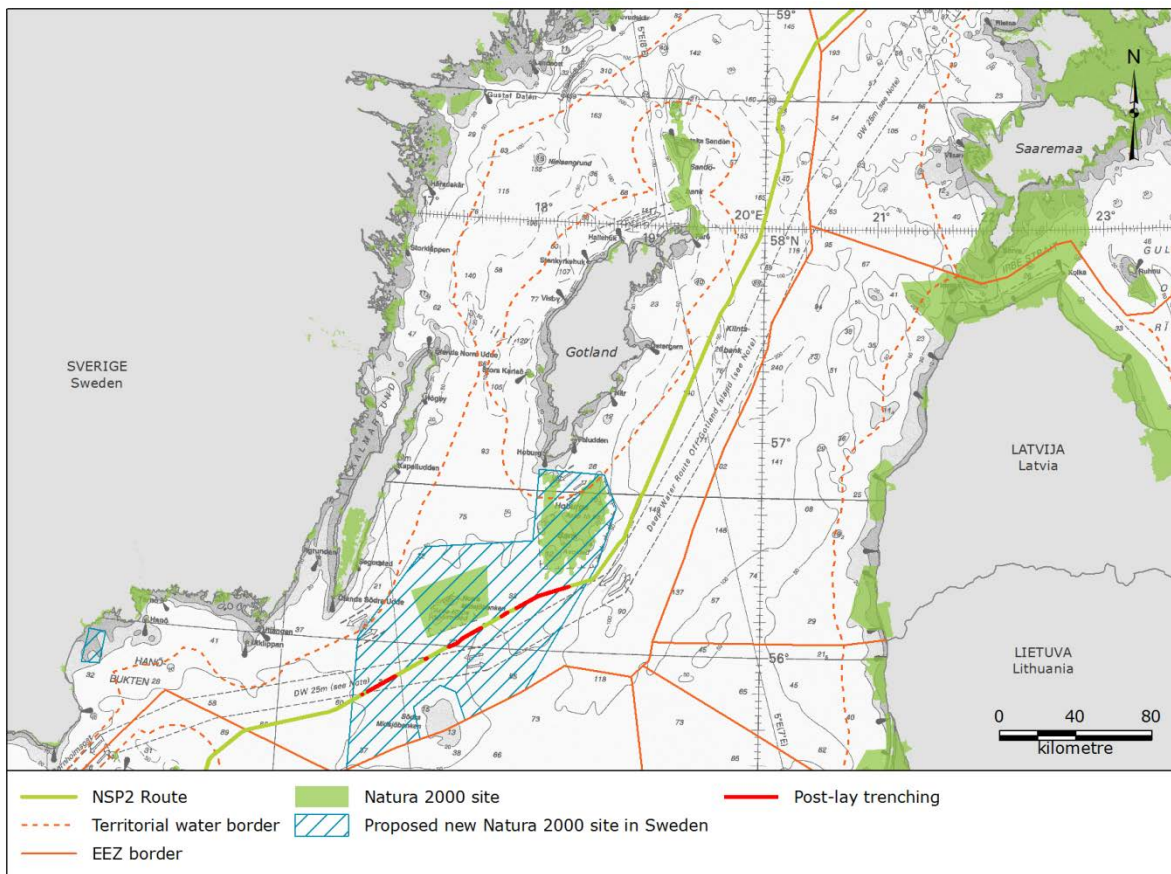


Figure 2-10 Planned post-lay trenching locations in the Swedish EEZ /3/, /41/.

Figure 2-11 shows areas where SSC is >5 mg/l from trenching in the Swedish EEZ, under normal hydrographic conditions. From the figure it is clear that the area with increased SSC of >5 mg/l from trenching can occur up to several kilometres from the pipeline route. The area does, however, not extend into any protected areas (Natura 2000 sites).

It should be considered that the increased SSC shown in the figure is a cumulative picture; the trenching would occur sequentially at discrete stretches along the proposed route and therefore specific areas would be affected at different times during the construction phase.

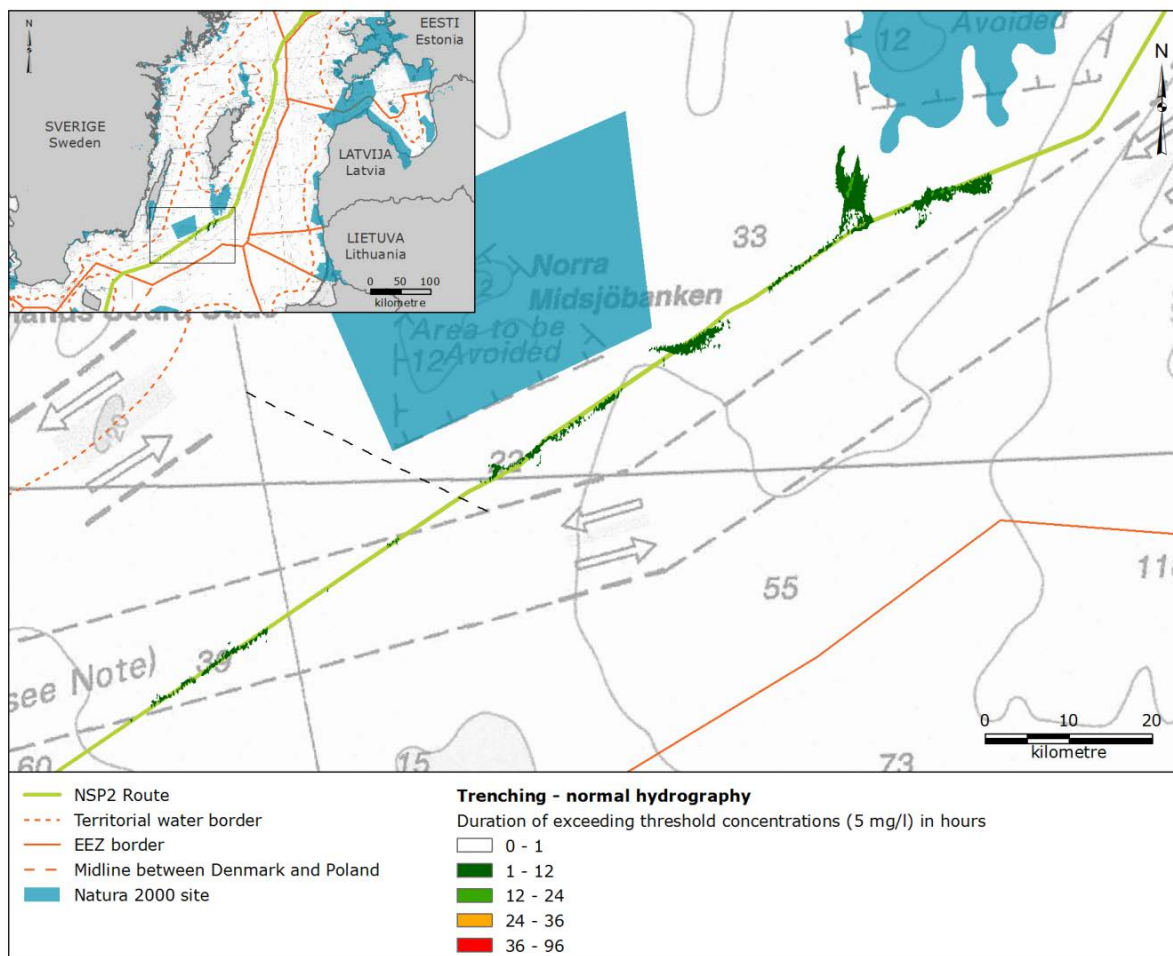


Figure 2-11 Duration of exceedance of 5 mg/l for trenching under normal hydrographic conditions.

### Denmark

For post-lay trenching in Denmark, modelling has been carried out for the scenario shown in Figure 2-12. This scenario is based on the first estimate of the seabed interventions for NSP2, called EIA1, issued by Nord Stream 2 AG, based on the preliminary design carried out by the contractor installing the NSP2 pipelines /3/, /42/.

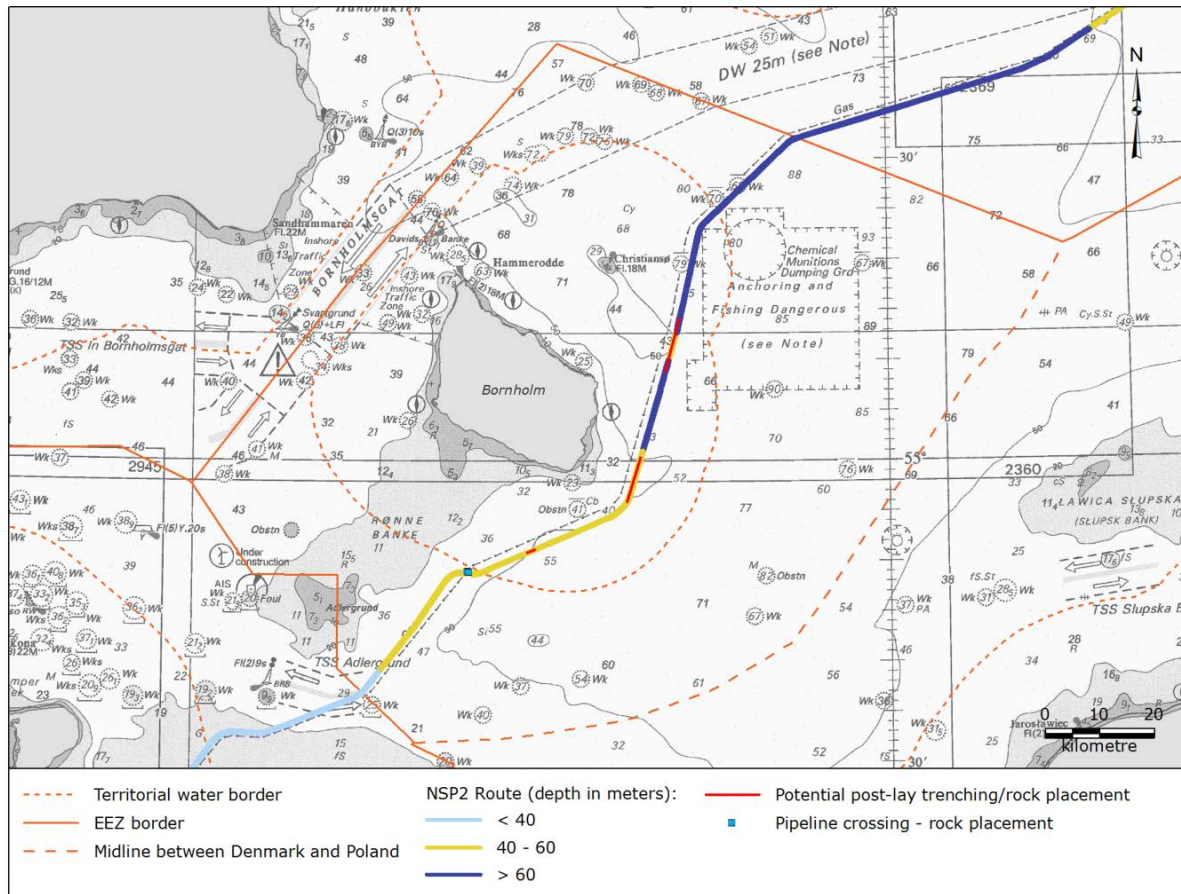


Figure 2-12 Seabed interventions scenario for Denmark /3/, /42/.

Figure 2-13 shows area and duration where SSC is >2 mg/l under normal hydrographic conditions during trenching. From the figure it is clear that the area with increased SSC from trenching can occur up to several kilometres from the pipeline route. The area does, however, not extend into protected areas (Natura 2000 sites) as outlined in /42/.





## 2.1.4 Dredging at landfalls

### Modelling results - Russia

Table 2-4 summarises the results of the modelling of dispersion and re-sedimentation of sediments and sediment-associated contaminants due to dredging in Russia. The scenario modelled is the so-called microtunnel concept as outlined in Chapter 6 Project description, with results presented for both pipelines. Three hydrographic scenarios (summer, normal and winter) were modelled, and the intervals shown in the table cover these three scenarios.

**Table 2-4 Dispersion of seabed and sediment-associated contaminants mobilised by dredging in Russia (calculated for the microtunnel concept, both pipelines). The areas are not necessarily limited to the country within which the activity takes place.**

Parameter	Unit	PoO
		Russia
Length (Section)	km (KP – KP)	2.75 (KP 0.50 – KP 3.25)
Duration of dredging	days	37
Total volume of dredged sediment	m <sup>3</sup>	475,000
<b>Dispersion and re-sedimentation of sediments:</b>		
Total suspended sediment dispersed	Tonnes	39,908
Total area where conc. >10 mg/l <sup>1</sup>	km <sup>2</sup>	121-265
Total area where conc. >15 mg/l <sup>1</sup>	km <sup>2</sup>	101-215
Max duration and area with conc. >10 mg/l the whole period	Hour	340-397
	km <sup>2</sup>	0.17
Max duration and area with conc. >15 mg the whole period	Hours	329-345
	km <sup>2</sup>	0.08
Area <sup>1</sup> where sedimentation >200 g/m <sup>2</sup>	km <sup>2</sup>	11-12
<b>Dispersal of sediment-associated contaminants:</b>		
Total area where conc. >PNEC <sub>BaP</sub> <sup>1</sup>	km <sup>2</sup>	109-172
Total area where conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>1</sup>	km <sup>2</sup>	81-108
Total area where conc. >PNEC <sub>Zn</sub> <sup>1</sup>	km <sup>2</sup>	47-53
Max duration of conc. >PNEC <sub>BaP</sub> <sup>2</sup>	Hours	374-825
Max duration of conc. >PNEC <sub>PCDD/F TEQ upper</sub> <sup>3</sup>	Hours	349-820
Max duration of conc. >PNEC <sub>Zn</sub> <sup>4</sup>	Hours	256-723
1: Areas refer to the extent where SSC, sedimentation or toxicity are above a certain threshold value.		
2: PNEC <sub>BaP</sub> : Predicted no effect concentration for benzo(a)pyrene.		
3: PNEC <sub>PCDD/F TEQ upper</sub> : Predicted no effect concentration for dioxins/furans.		
4: PNEC <sub>Zn</sub> : Predicted no effect concentration for zinc.		

It shall be noted that the analysis of the contaminants along the pipeline route in Russia shows large spatial variations in concentrations. As a conservative measure, the 95%-percentile of the measured concentrations has been adopted for the modelling. This approach was selected in order to cover the high variability in concentrations of contaminants that often is observed for seabed sediments. However, concentrations of the various contaminants are in general significant lower in the nearshore area than in the offshore areas. So the results of the modelling done for the dredging in Russia (near shore) can be considered to be very conservative.

As shown in the table above the total areas where the concentration will be >PNEC value for zinc (Zn), benzo(a)pyrene (B(a)P), dioxins/furans (WHO(2005)PCDD/F TEQ) would, if using the 95% percentile for the modelling of the nearshore area only, be ≤0.06 km<sup>2</sup>, ≤97 km<sup>2</sup>, ≤21 km<sup>2</sup>, respectively (see for comparison of area table above).

Figure 2-14 and Figure 2-15 show the duration and the area where the concentration of sediment in the water is >10 mg/l and >15 mg/l, respectively, during the 37 days of dredging at the

Russian landfall. The figures show that the highest duration with exceedance of 10 mg/l and 15 mg/l is:

- Close to the construction location.
- Close to the shoreline, where the water depth is low.

Outside the areas mentioned above an exceedance of 10 mg/l has been modelled to have a maximum total duration of up to 1-3 days, and outside Russia in Estonia up to approx. 1 day in total for the period of 37 days during dredging.

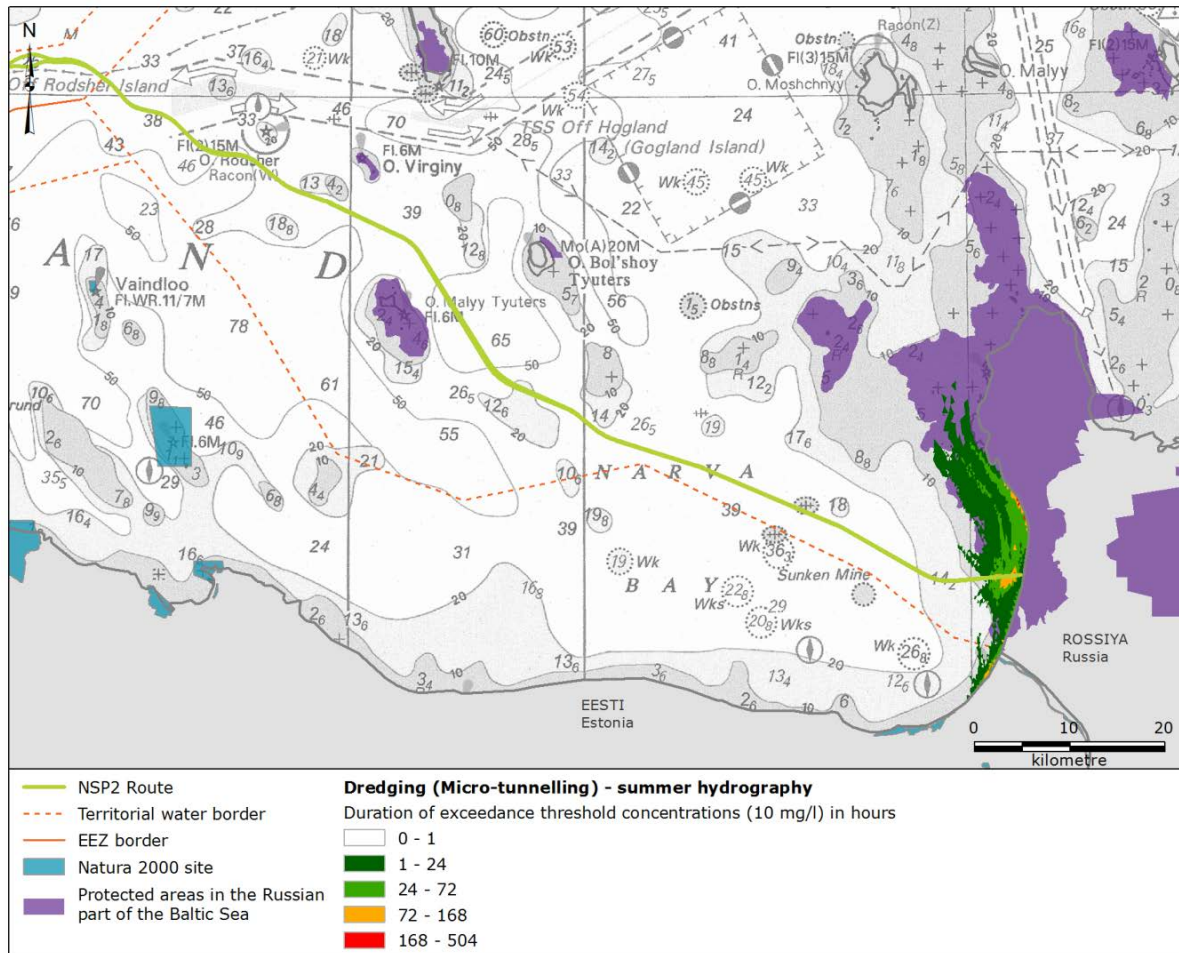


Figure 2-14 Duration of exceedance of 10 mg/l during dredging at the Russian landfall location under typical summer conditions //.

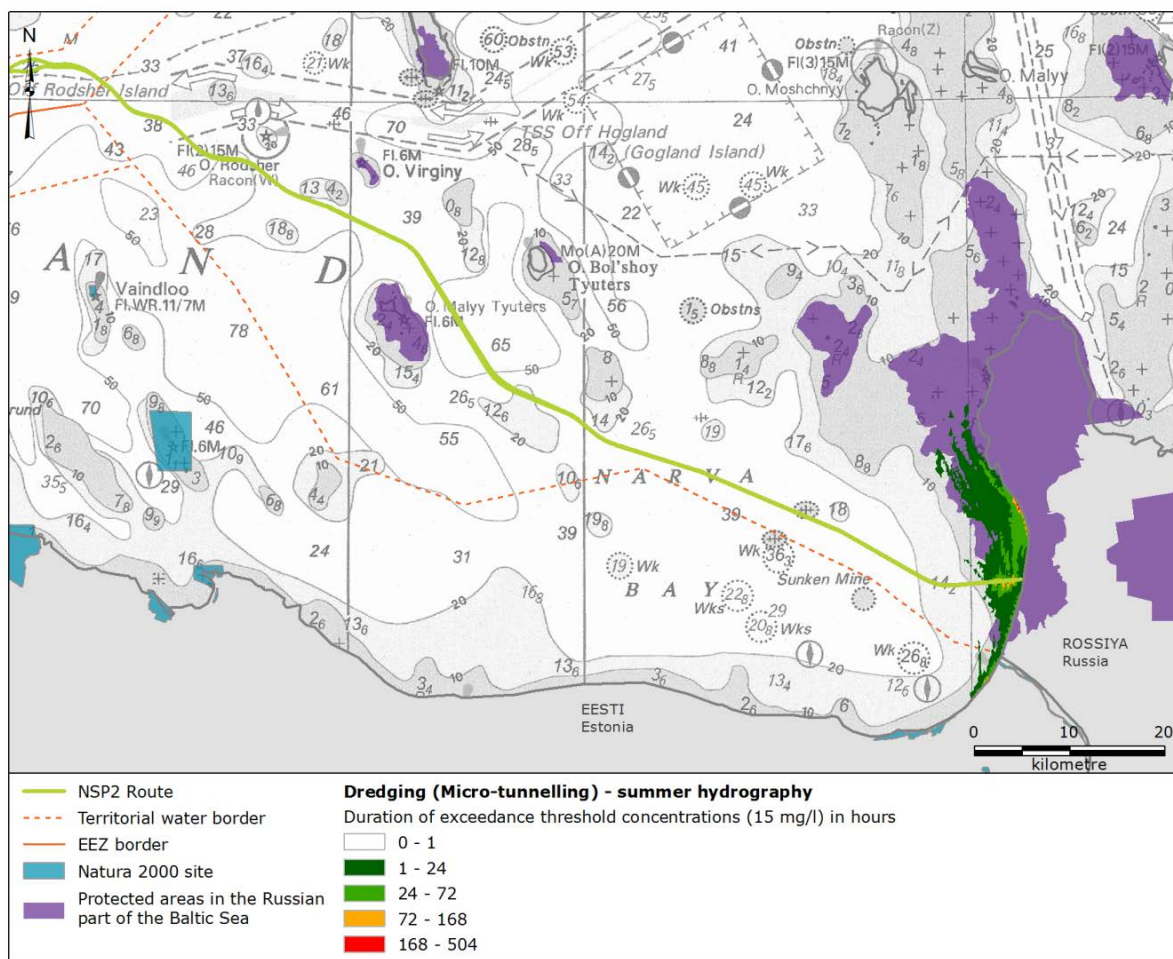


Figure 2-15 Duration of exceedance of 15 mg/l during dredging at the Russian landfall location under typical summer conditions /7/.

As for rock placement and munitions clearances the exceedance of the PNEC values for contaminants B(a)P, dioxins/furans and zinc has been modelled during dredging. Figure 2-16 shows the exceedance, duration and area of the PNEC value for B(a)P close to the Russian landfall. The figure shows, as for suspended sediment (see above), that the highest duration is located close to the construction location, and close to the shoreline. As the current conditions flow in general to the north along the shoreline, the duration of the exceedance outside Russia, in Estonia, is limited to approx. one day in total during the dredging period.

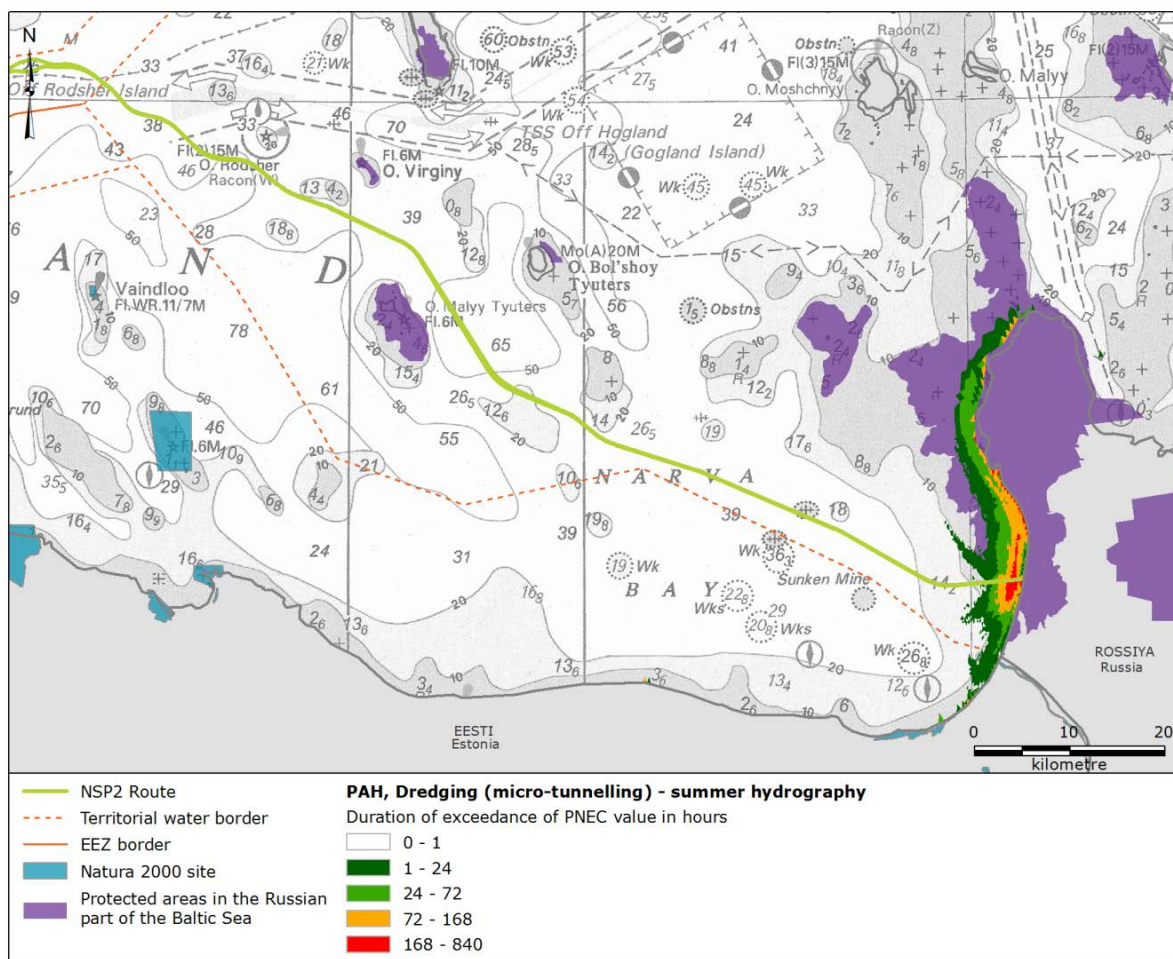


Figure 2-16 Duration of exceedance of PNEC for benzo(a)pyrene during dredging at the Russian landfall under typical summer conditions /7/.

Sedimentation of suspended sediment from dredging activities at the Russian landfall is shown on Figure 2-17. From the figure it can be seen that sedimentation more than 500 g/m<sup>2</sup> (corresponding to a sediment layer of approx. 2 – 3 mm) is restricted to the immediate area where dredging will be undertaken.

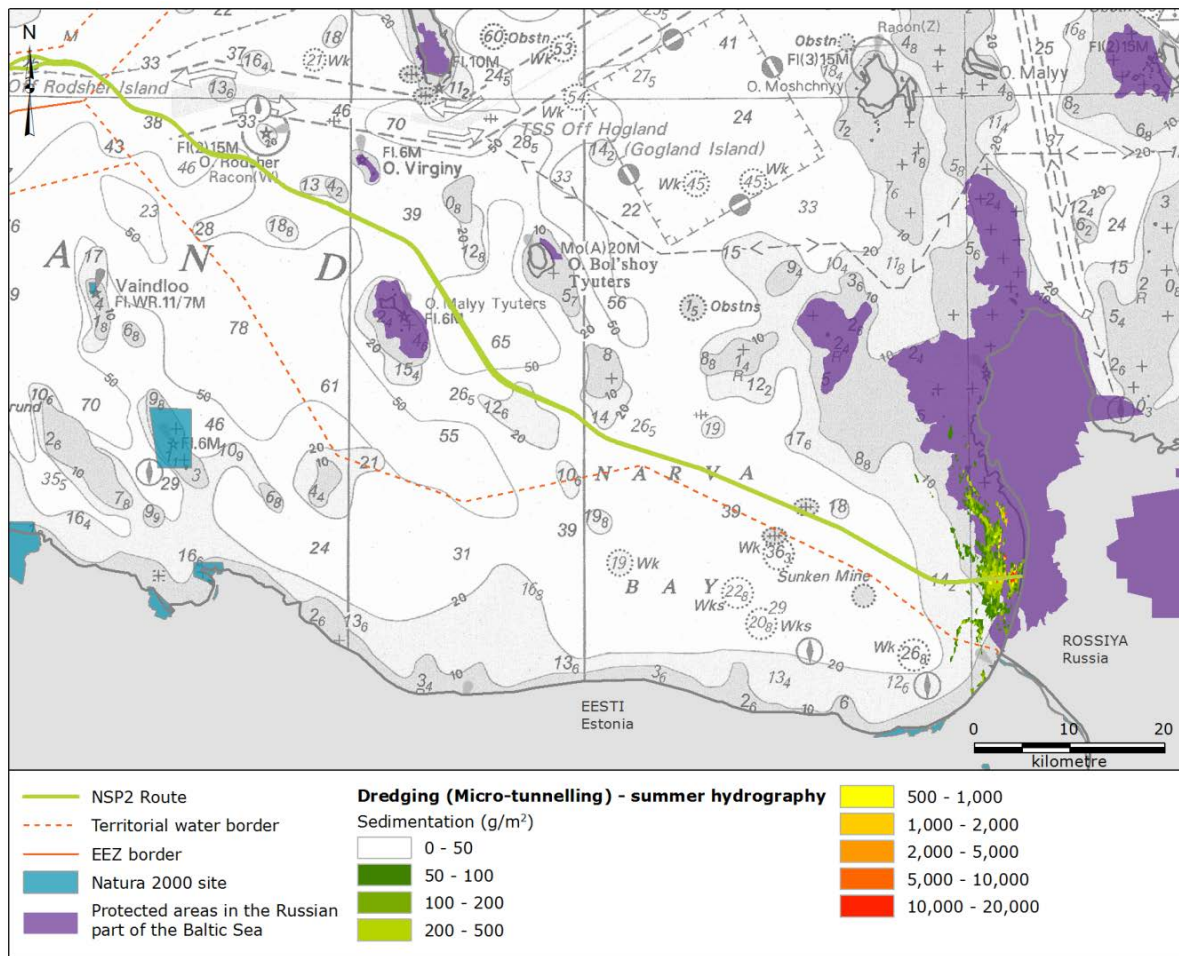


Figure 2-17 Sedimentation of released material due to dredging scenario 3 under typical summer conditions.

### Modelling results - Germany

Where dredging will occur in Germany (Pomeranian Bay and the Greifswalder Bodden), the natural sea floor will be removed along an approximately 50 km stretch of the pipeline route, covering a total area of the seabed of approximately 1.4 km<sup>2</sup>. The material will be stored at the marine interim storage and partly refilled after pipe-laying. The excavation will have a total volume of approximately 2.5 mio m<sup>3</sup>.

The results from the modelling show that during the dredging operations the suspended sediment concentrations close to the dredgers can rise to more than hundred mg/l. At a distance of 500 m from the operations the concentration in the surface has however decreased to approx. 30 mg/l. A few days after the dredging has been completed, the concentrations approach the natural sediment concentration in the area.

Sediment deposition shows different patterns in the open waters and in the Greifswalder Bodden. In the open waters the deposition is smooth and covers an area close to the trench. This layer is very thin and does not exceed 25 g/m<sup>2</sup> in general. In the Greifswalder Bodden with low currents the deposition occurs within a smaller area close to the trench. The deposition can reach up to 3000 g/m<sup>2</sup> close to the trench.

The dredged sediment is temporarily stored at the Usedom storage area east of the trench. The effects of the disposal were modelled over 24 hours. The model shows very high concentrations at the time of disposal. These high concentrations are of a very short duration and decrease quickly after the end of the disposal. The disposal leads to an uneven deposition of the sediments. These sediments are available for later bedload transport and/or resuspension.

### **Experience from NSP**

Experience from construction works at sea have demonstrated that the total spill percentage for dredging operations can be kept below 5% of the dredged mass. For dredging works the sediment is lifted through the water column and placed on a barge or as dams. Numerical modelling of dredging works has been based on a conservative spill percentage two times the above mentioned 5%, i.e. 10% /46/, /49/.

Monitoring of impacts inside the dredged and backfilled areas for NSP has shown that the recovery process of the sediment conditions was in line with the predictions and that the recovery process was completed within a period of three years /46/.

Monitoring of sediment dispersion caused by dredging and backfilling near the landfall areas has been carried out in Russia and Germany 2010 and 2011, and in Finland (transboundary impacts from Russia) in 2010.

Monitoring in Portovaya Bay in Russia in 2010 was carried out during dredging a trench for laying pipes at the landfall point and on the seabed to a depth of 14 m, laying both strings of the pipeline and backfilling the trench.

During dredging operations SSC measurements were carried out along transects perpendicular to the pipeline route. Peak concentrations of suspended solids did not exceed 56 mg/l. During pipe-lay operations SSC measurements showed average concentrations of suspended solids 500 m from the lay barge of 7.6 mg/l. During post-lay backfilling of the trench SSC measured 100 m from the backfilling operation showed average concentrations of 4.3 mg/l /38/.

Monthly observations of water quality in Portovaya Bay in 2010 and 2011 compared with observations completed prior to the commencement of pipeline construction in 2009 indicate no significant impacts on the physical, biological and chemical parameters of Portovaya Bay. The basic water quality parameters measured were within the natural variation that is typical of the coastal waters of the eastern Gulf of Finland /38/, /40/.

The measurements in Finland showed no transboundary impacts from the activities in Russia /38/.

Measurements in Germany showed turbidity values 500 m from the construction site above the 24-hour threshold value of 50 mg/l only twice. The increased turbidity values as a result of seabed intervention works corresponded well with the results of the numerical modelling in the German EIA /38/, /40/, /50/.

## **2.1.5 Offshore pipe-lay**

### **Experience from NSP**

Pipe-laying including use of an anchored lay barge or a DP vessel will result in impacts on the seabed bathymetry and seabed sediments from:

- Sediment dispersion and re-sedimentation from laying the pipeline on the seabed.
- Sediment dispersion, re-sedimentation and the physical impacts from the anchors/anchor wires sweeping the seabed.
- Depending on the water depth the DP vessel will result in impact on the seabed with sediment dispersion and re-sedimentation caused by the thrusters of the DP vessel.

*Impacts from pipe-lay directly on seabed*

Calculations carried out for NSP showed that impacts from pipe-lay directly on the seabed will only result in very small (0.3 - 0.6 tonnes/km pipeline) amounts of sediment to be re-suspended and subsequently settle to the seabed /53/.

*Impacts from anchored positioned pipe-lay vessel*

As shown in /51/, anchors for keeping the pipe-lay vessel in position (when using an anchored positioned pipe-lay vessel) are spread over a large area of the seabed. Seabed sediments are brought into suspension, both from the impact of the anchors at the seabed and from sweeping of the anchor wires along the seabed surface.

The impacts of anchors and anchor chains on the seabed were assessed before construction of NSP /51/. The assessment was made for the lay barge Castoro-Sei. It was assumed that the lay barge would be positioned with 12 anchors, each of a weight of 25 tonnes, and each fastened to anchor winches with 3,000 m anchor wire of 76 mm. The distance between two positions of one anchor during operation of the lay barge was approximately 500 m. In one position the distance between two anchors next to each other was assumed to be 200-1,000 m, depending on the water depth.

During transport of the anchors from one position to another the anchors were lifted from the seabed, to avoid disturbances on the seabed from any anchor or anchor wire, and it was expected that no or very little sediment will be released during transport of the anchors.

The processes which may create suspension of sediment were therefore when the anchors were laid down on the seabed, when they were pulled up again and when the anchor wire was sweeping across the seabed during movement of the lay barge.

The anchor wire was assumed to rest on the seabed in a stretch of 100 to 150 m from the anchor. When the lay barge was moving forward the anchor wire would be sweeping across the seabed in a circular section as shown in the sketch in Figure 2-18 and /51/. This could create some suspension of sediment even though the movement of the anchor wire was very slow /51/.



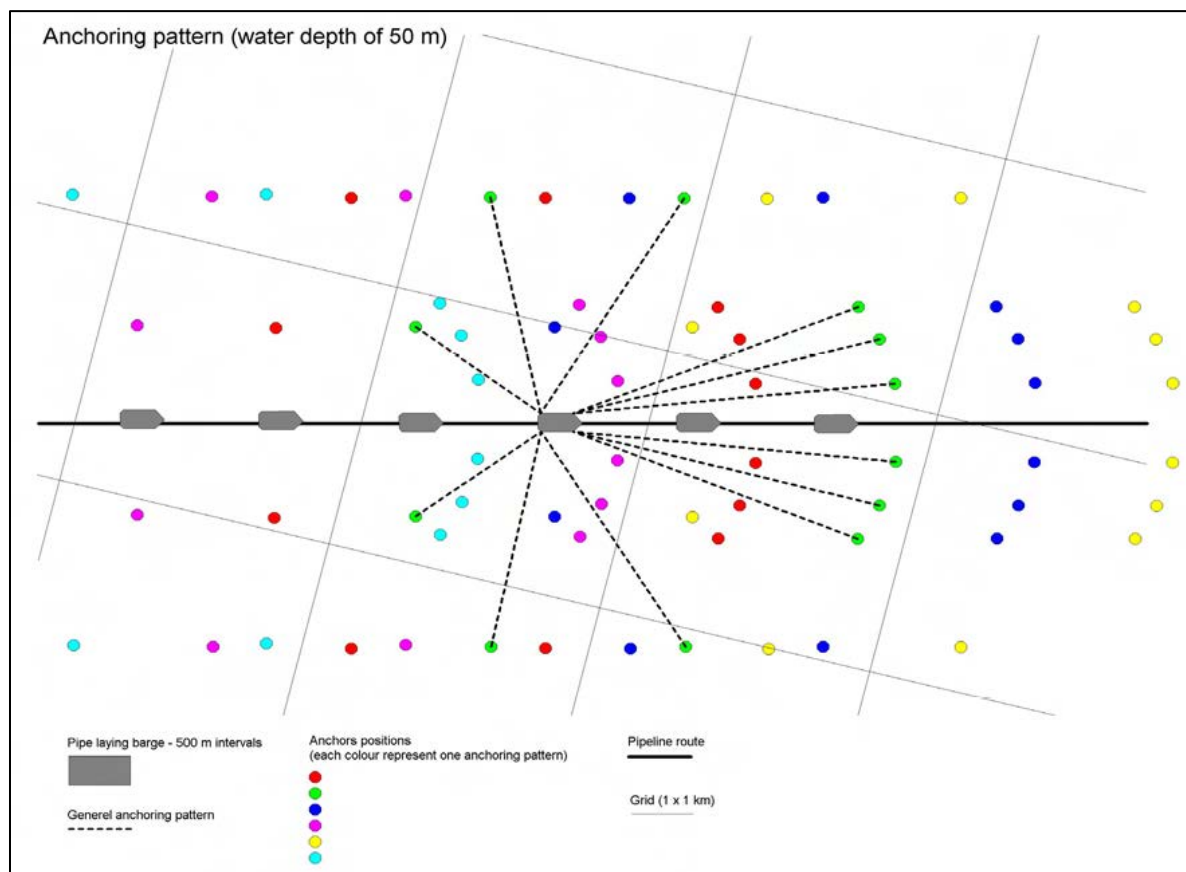


Figure 2-18 Anchor patterns on the seabed as the lay vessel moves forward.

When the anchor was dumped at a new position and when it was taken up again the estimate of the size of the release of sediment to the water column was of the order of magnitude of 10 - 160 kg in total. With 12 anchors and approximately 0.5 km between anchoring positions, there were approximately 24 anchor-handling operations per kilometre of pipeline. In total, based on conservative assumptions, the release of sediment from anchor handling was estimated to reach up to 0.4 – 1.8 tonnes per anchor position.

From this evaluation the sweeping process would give a release of sediment of more than 10 times the release from the other processes together and was therefore seen to be the most important process in connection with suspension of sediment.

The total release of sediment in connection with sweeping was calculated to be approximately 10 – 38 tonnes/km of the pipeline in areas with soft sediment. It was estimated that the suspended sediment was distributed within the lower 10 m of the water column.

Assuming the release of sediment was distributed instantaneously in the lower 10 m of the water column in the anchor corridor the average sediment concentration was approx. 0.5 - 2 mg/l. As the releasing process is dynamic and some of the sediment released has already settled before new sediment is released the actual concentrations will be lower than this /51/.

Dispersion of sediment and impacts on the seabed from the above has been assessed in the EIAs/ES for NSP /52/, /53/, /54/, /55/. Monitoring during the construction works has subsequently provided more specific information, which enables a more precise quantitative assessment valid for NSP2.

During the construction of NSP, monitoring of the sediment spill caused by anchor handling was carried out in the Finnish EEZ /59/. Only at the monitoring station close to the anchors a slight

increase in the turbidity was measured, which confirmed that the assessment carried out for the activity as part of the EIA work for NSP was conservative.

#### *Impacts from DP pipe-lay vessel*

Calculations and mathematical modelling of erosion of the seabed caused by the thruster of a DP vessel have shown that the erosion rate decreases with increasing depth and increasing dry density of the sediments. Furthermore, erosion of the seabed will not take place at water depths larger than 50 m and only very loose sediments can be affected at water depths larger than 40 m /60/.

In the Russian EEZ water samples for suspended solids at various depths were collected 1,000 m from the pipe-lay operations undertaken by the dynamically positioned (DP) lay barge *Solitaire* on 1 September 2010. In most samples SSC were below the detection limit (2.0 mg/l). The highest levels of SSC were 3.0 mg/l /38/.

In 2011, monitoring during pipe-lay in the deep water section in Russia was carried out in June, August and September. The lowest concentrations were measured in September, when the highest concentrations in the surface and the bottom layer were 3.7 mg/l and 4.2 mg/l, respectively. In June, the highest SSC in the surface and bottom layer were 5.7 mg/l and 5.1 mg/l, respectively. In August, the highest SSC in the surface and bottom layer were 5.3 mg/l and 8.2 mg/l, respectively. All measured SSC levels were well below the limit set by the authorities in Russia, which is 20 mg/l, and no negative effects on water quality were detected /55/.

In the Finnish EEZ, monitoring of water quality during pipe-lay with *Solitaire* was carried out in November-December 2010. During pipe-lay in the vicinity of fixed turbidity sensors there were no turbidity recordings above background levels /38/.

Monitoring of water quality during pipe-lay with the anchored lay barge was carried out in the Finnish EEZ in June-July 2010. The observations derived from fixed sensors near the seabed and from vessel-operated monitoring support the assessment that pipe-lay causes no, or only negligible SSC during normal operation /38/.

## 2.2 Underwater noise

### 2.2.1 Introduction

An overview of the methods used for modelling the propagation of underwater noise, including the assumptions for the modelling and the modelling scenarios, is given in Section 1.3 – Underwater noise propagation modelling. Underwater noise has been modelled for munitions clearance, rock placement, dredging, vibro-piling and for noise from the gas in the pipeline during operation.

### 2.2.2 Overview of underwater noise modelling

The potentially significant underwater noise sources as part of the construction and operation of the proposed pipelines that have been modelled are shown in Table 2-5.

**Table 2-5 Modelling of underwater noise for NSP2.**

Activities	RUS	FIN	SWE	DEN	GER
Munitions clearance	X	X	-	-	-
Rock placement	X	X	X	X	-
Dredging	X	-	-	-	X
Vibro-piling	X	-	-	-	-
Pipe-lay	-	-	-	-	X
Pipeline operation	X	-	-	-	-

Underwater noise source levels and frequency data have been collected, analysed and corrected to be applicable for each specific activity. Each noise activity length (time) has been determined in order to predict the cumulative, average and maximum noise levels.

It is noted that the sound exposure levels and associated impact zones should be viewed as precautionary ranges as it is unlikely that a marine mammal or fish would stay in a stationary location or within a fixed radius of a vessel (or any other noise source) for the required length of time.

Calculations have been carried out for the hydrographic conditions during both summer and winter. The noise propagation is largest during the winter situation and is therefore to be considered 'worst case' – therefore plots of the winter situation are presented in the following sections.

The threshold noise levels (TTS, PTS) defined for the project for fish and marine mammals referred to in the following sections are listed in Section 1.3.

### **2.2.3 Underwater noise from munitions clearance**

Underwater noise modelling from munitions clearance were carried out for Russia and Finland, /9/, /12/.

The munitions clearance underwater sound source levels used for the Russian and Finnish munitions clearance locations are based on actual maximum and average measured peak pressure data collected during munitions clearance for NSP in Finland.

Underwater noise modelling was carried out at four locations for Finland and at three locations in Russia. Figure 2-19 and Figure 2-20 show the modelling results from munitions clearance (average munition charge) at the four locations in Finland, showing results for both summer and winter, respectively. Figure 2-21 and Figure 2-22 show the modelling results from the same locations, but assuming maximum charge. The 164 dB contour (light blue) represents the TTS for grey seal, ringed seal and harbour porpoise, while the 179 dB contour is equal to the PTS for the mentioned species. The results show no greater difference between the summer and winter situation /9/.

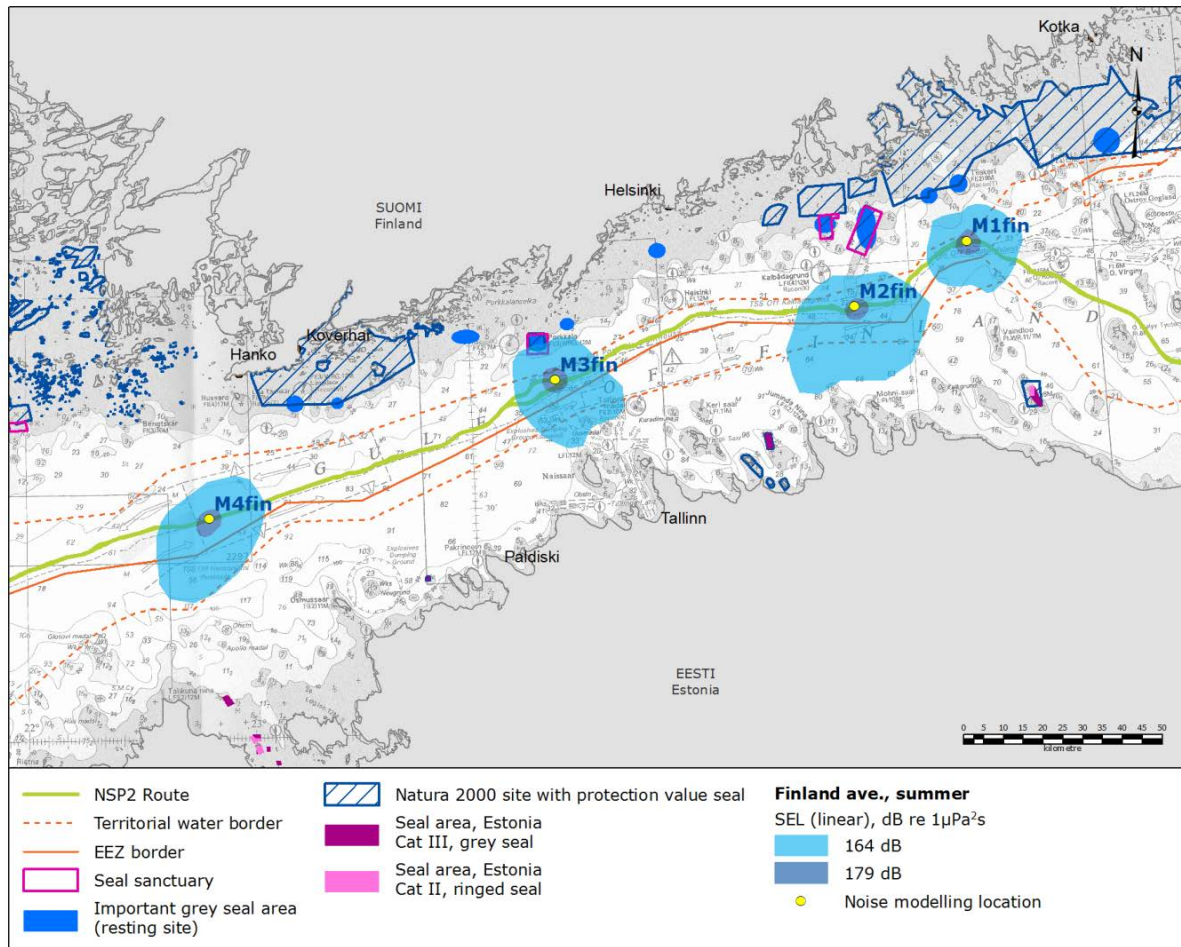


Figure 2-19 Munitions clearance (average) underwater sound exposure levels contour plots SEL (1 event), dB re. 1µPa<sup>2</sup>s (summer).

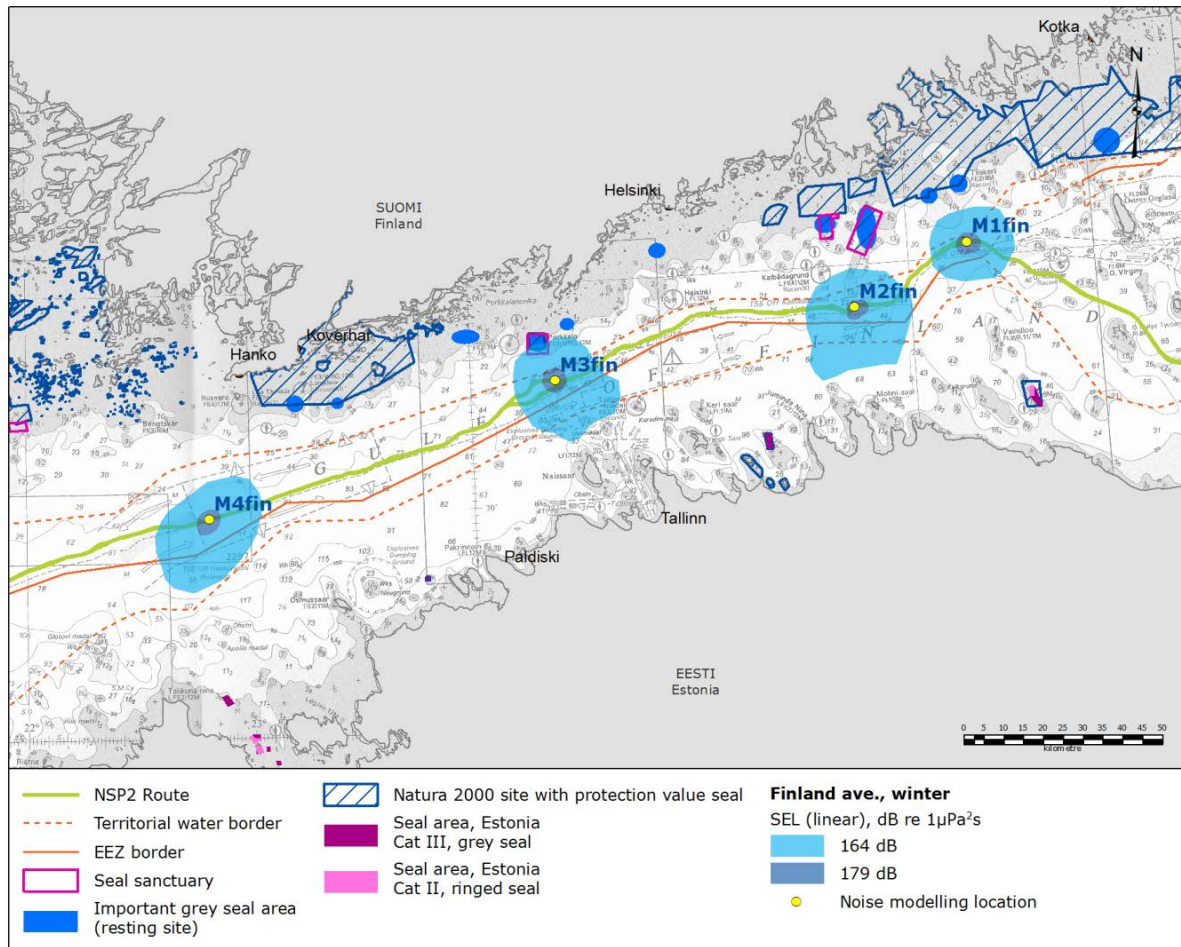


Figure 2-20 Munitions clearance (average) underwater sound exposure levels contour plots SEL (1 event), dB re. 1 $\mu$ Pa<sup>2</sup>s (winter).

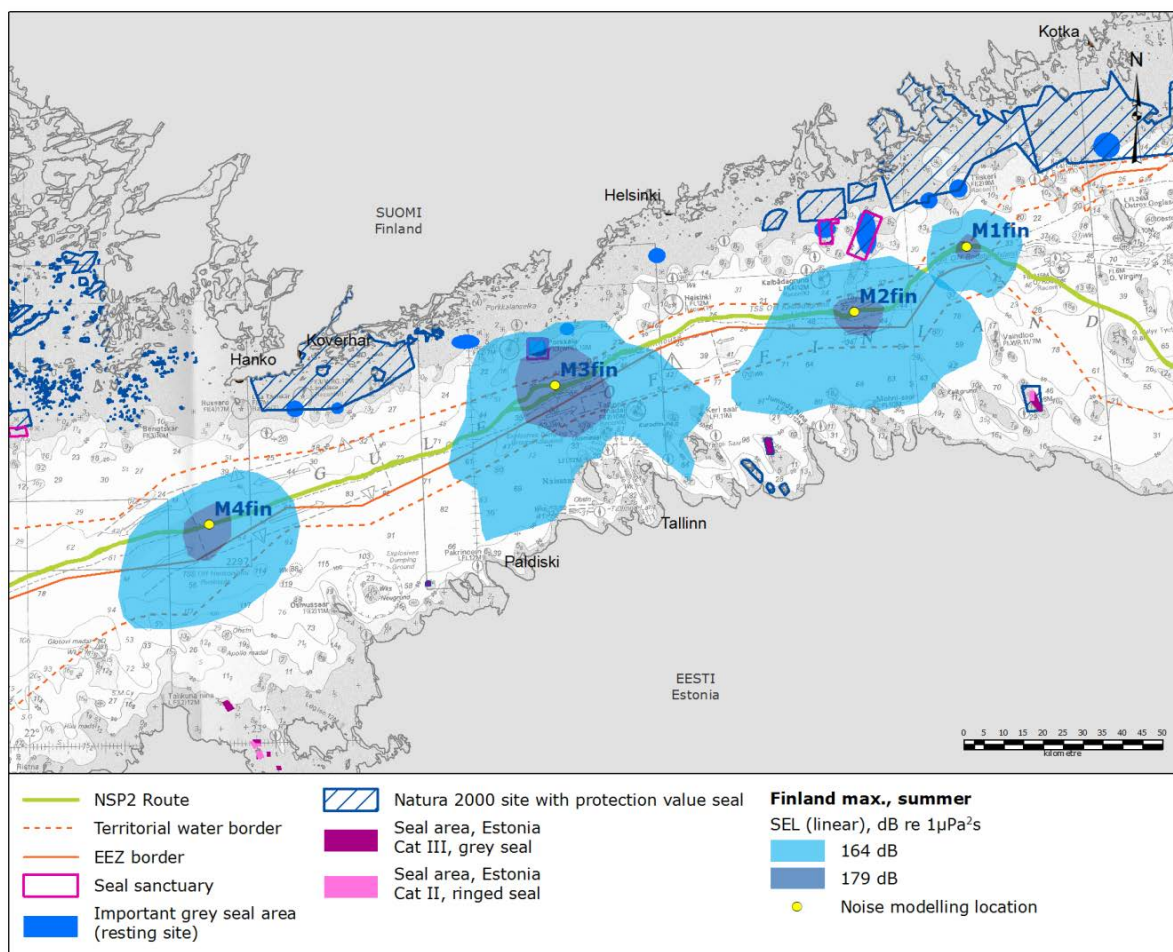


Figure 2-21 Munitions clearance (max) underwater sound exposure levels contour plots SEL (1 event), dB re. 1µPa<sup>2</sup>s (summer).

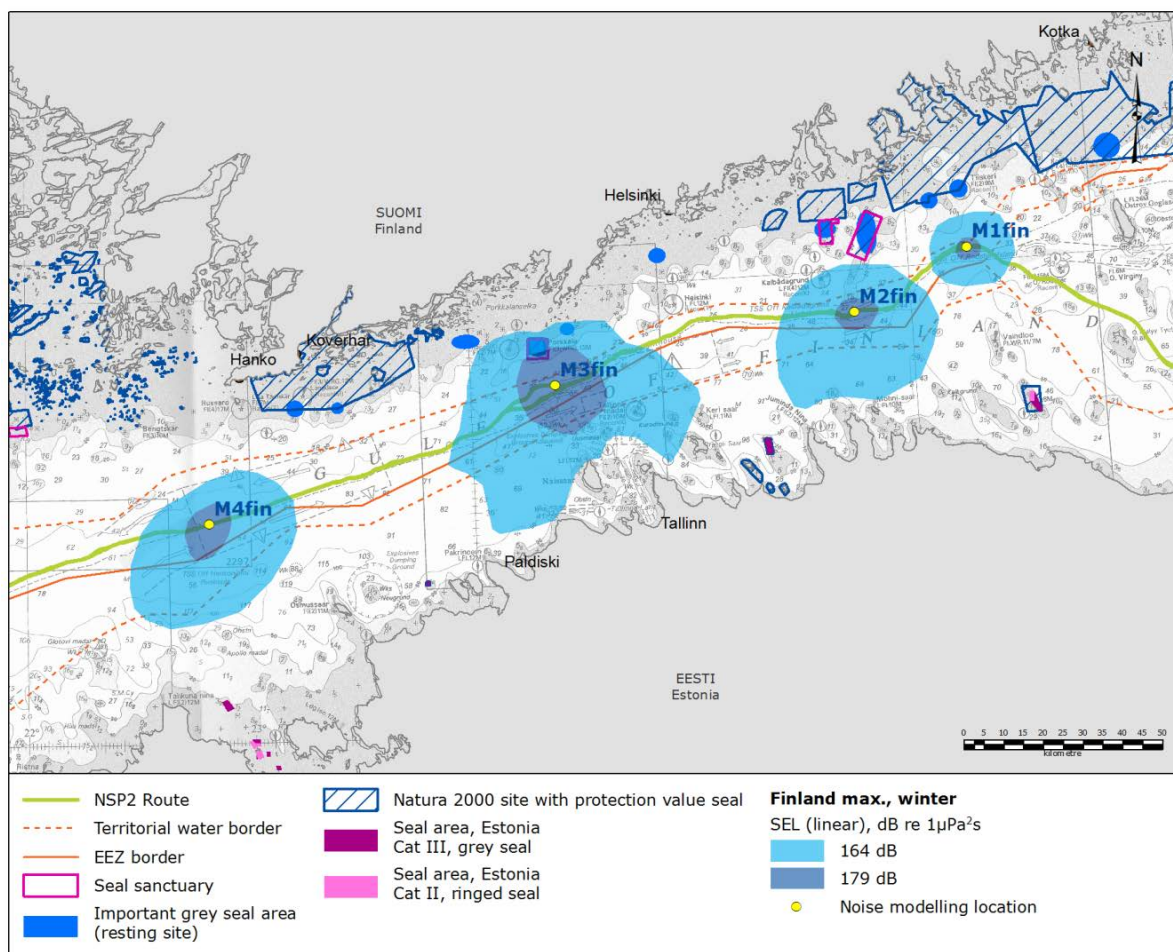


Figure 2-22 Munitions clearance (max) underwater sound exposure levels contour plots SEL (1 event), dB re. 1µPa<sup>2</sup>s (winter).

Munitions clearance at the westernmost location inside Russian waters (M1) is shown in Figure 2-23. for an average and maximum charge, respectively. The same is shown for the more easterly stations M2 (Figure 2-24) and M3 (Figure 2-25) /12/.

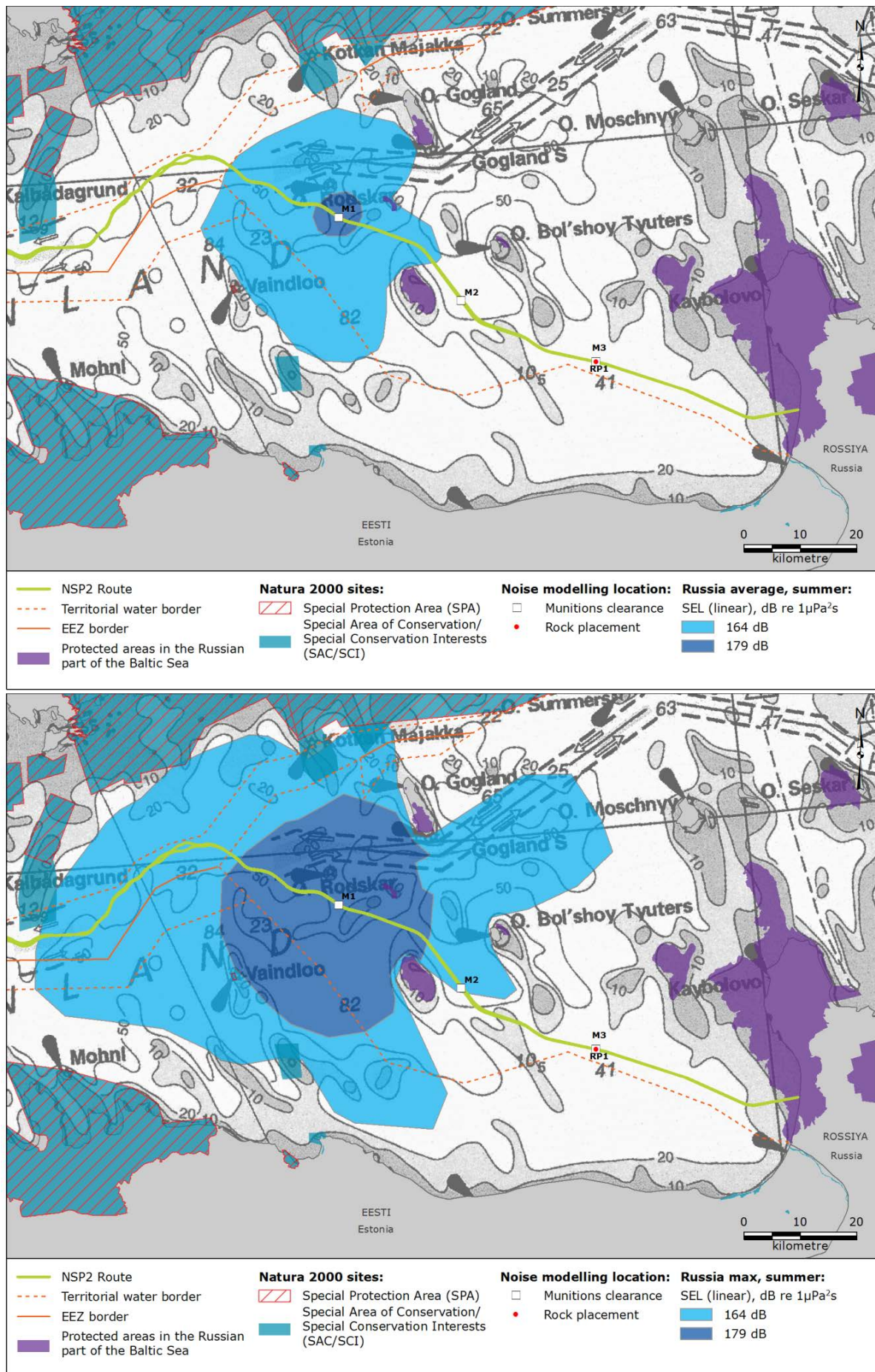


Figure 2-23 M1 munitions clearance (ave and max) underwater sound exposure levels contour plots SEL (1 event), dB (summer).



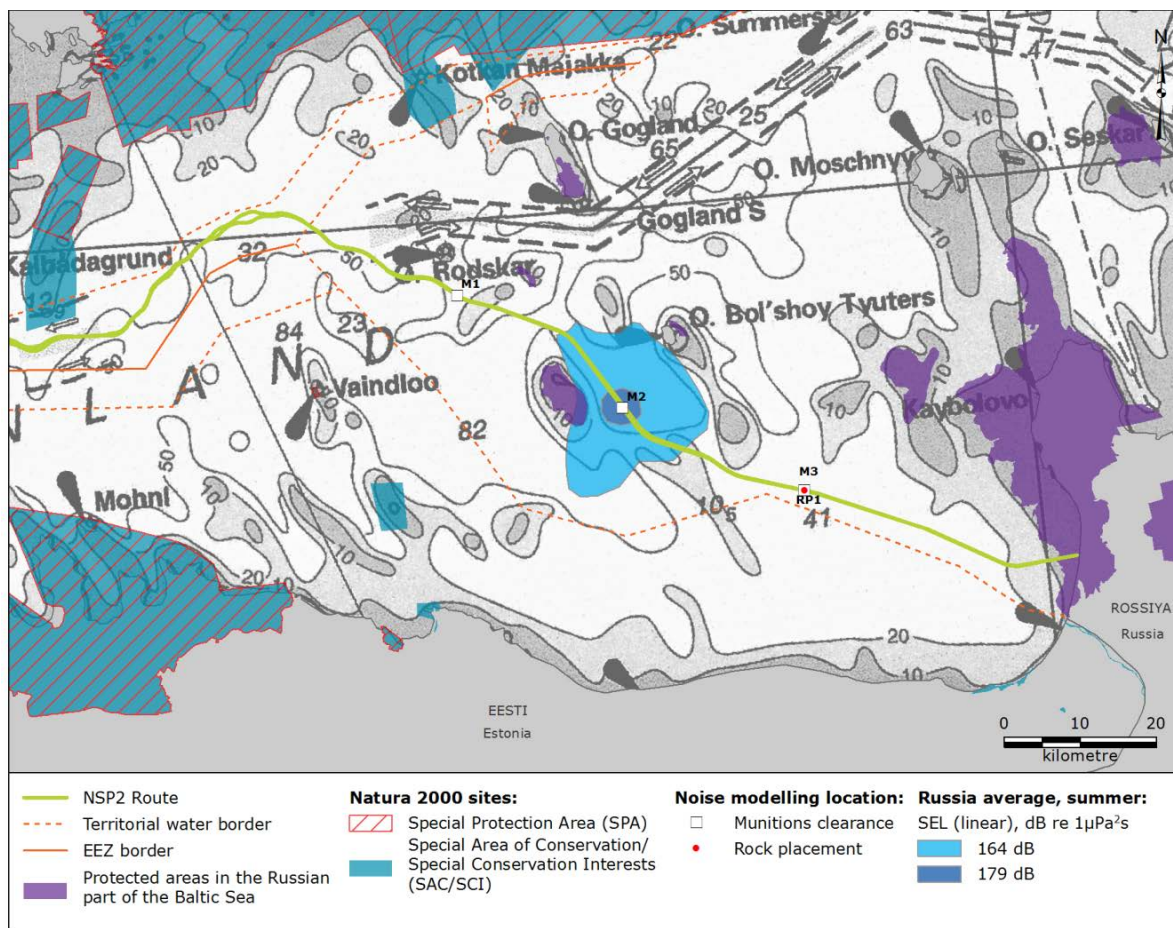


Figure 2-24 M2 munitions clearance (ave) underwater sound exposure levels contour plots SEL (1 event), dB (summer).

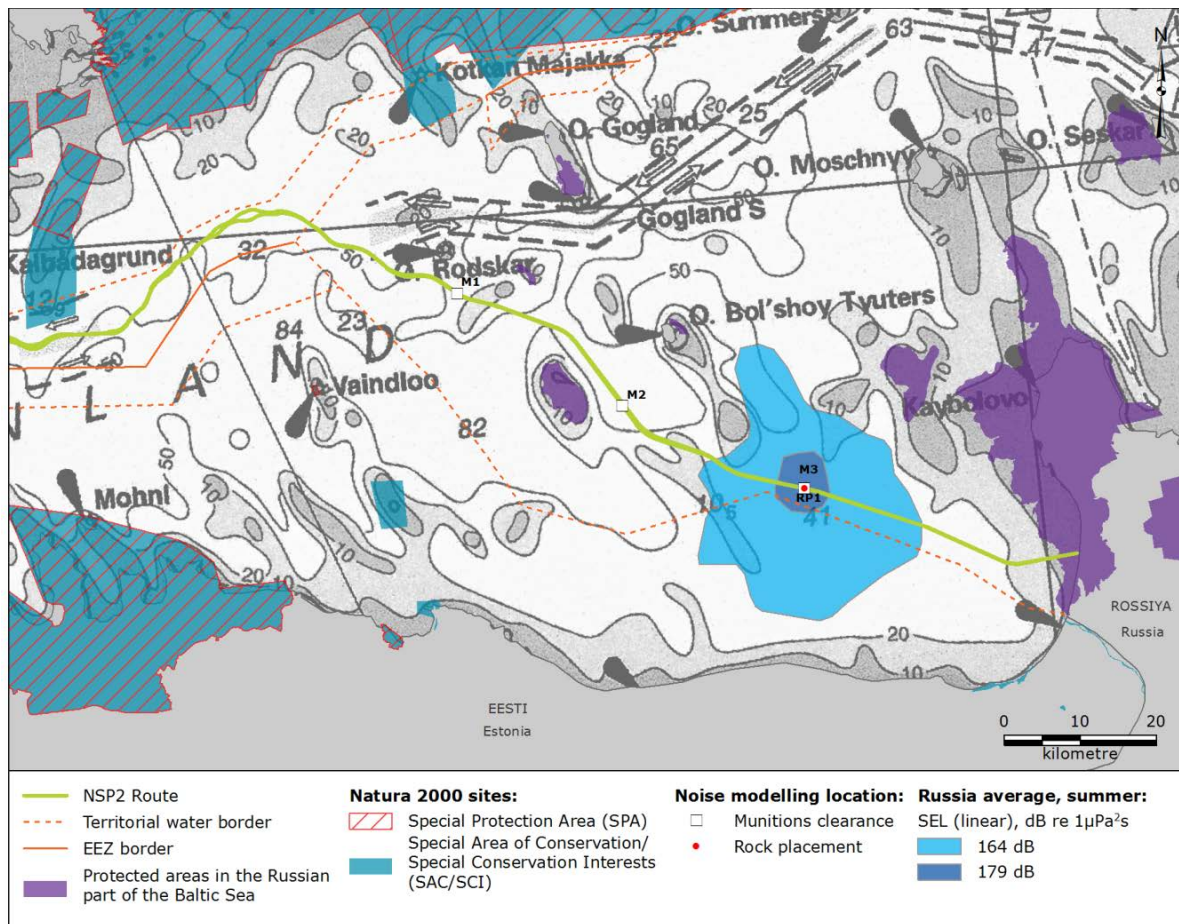


Figure 2-25 M3 munitions clearance (ave) underwater sound exposure levels contour plots SEL (1 event), dB (summer).

#### 2.2.4 Underwater noise from rock placement and dredging

During rock placement, pipe-lay, trenching and other construction activities, the dominating underwater noise relates to the surface activities and associated vessels, such as ship engines, thrusters, conveyors and rock placement. During construction of NSP, monitoring of underwater noise from construction activities was performed in a joint project with the Swedish Defence Research Agency (FOI). In the FOI study, noise levels in the range 126 – 130.5 dB re 1 $\mu$ Pa were measured during trenching and pipe-laying activities. In the study, it was concluded that the noise levels generated during the trenching and pipe-laying activities were comparable to regular shipping, and slightly higher than the ambient noise levels in the Baltic Sea, 110-116 dB re 1 $\mu$ Pa /41/.

In light of these findings, noise modelling for rock placement activities for NSP2 has been performed. The modelling has used representative examples of rock placement locations inside Russian, Finnish, Swedish and Danish waters, see /9/, /10/, /11/, /12/. The maximum distance where noise from the rock placement activities is audible is up to approx. 25-30 km, where noise levels of 110 dB are recorded, which is the corresponding ambient noise level in the Baltic Sea, see Figure 9-9, main report. At this sound level, noise from NSP2 activities is comparable to the noise generated by existing ship traffic /41/.

The SEL(cum) levels are presented and related to threshold levels used in the assessment to evaluate impact on the biological environment. The applied threshold levels for fish and marine mammals relating to TTS and PTS are shown in Figure 2-26. The modelling results show that an exceedance of threshold levels causing TTS is only detected in the vicinity of the pipeline (80 m or less). Underwater noise from rock placement did not exceed threshold levels causing PTS.

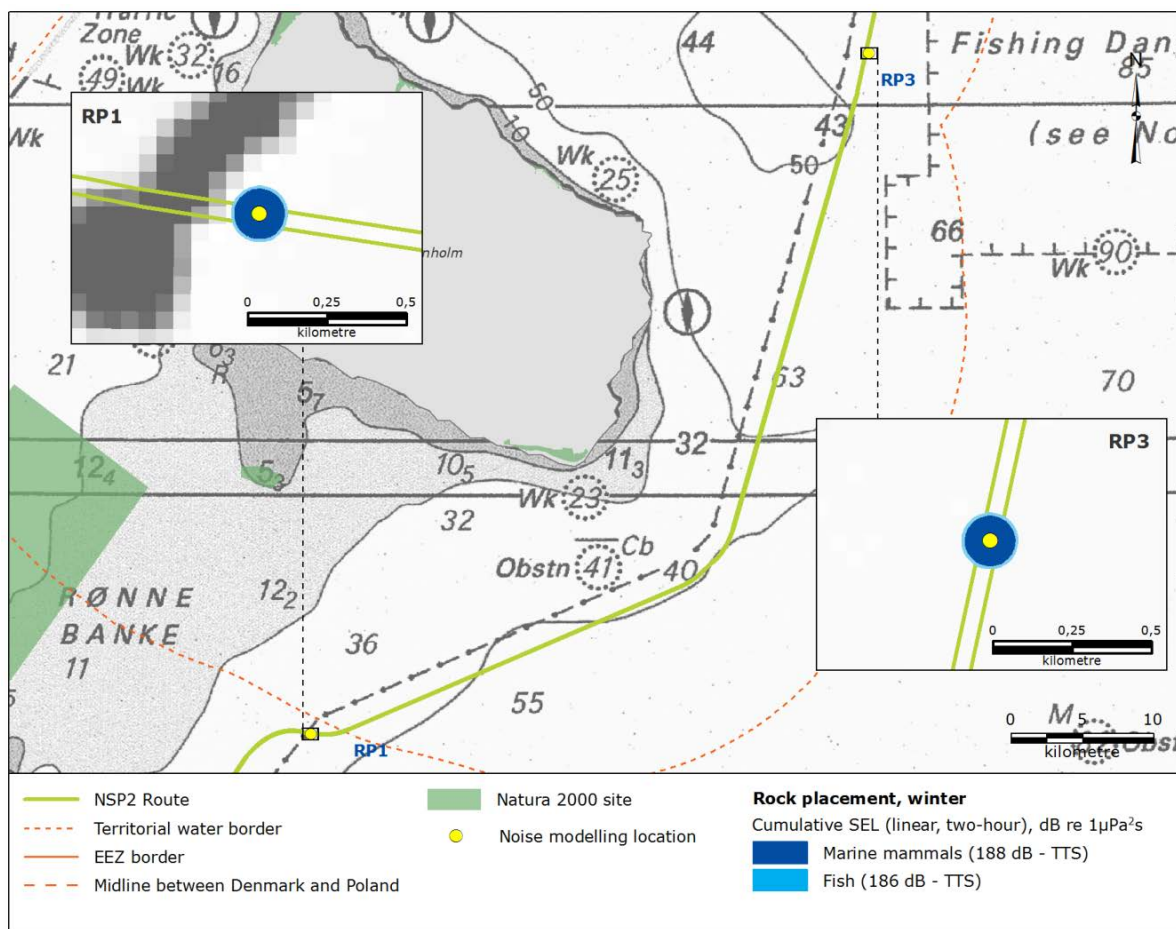


Figure 2-26 Rock placement, Denmark (winter) underwater sound exposure level (SEL, 2 hours) contour plots to the threshold limits 186 and 188.

Modelling of underwater noise in relation to rock placement inside Swedish, Finnish and Russian waters is shown in Figure 2-27, Figure 2-28 and Figure 2-29, respectively.

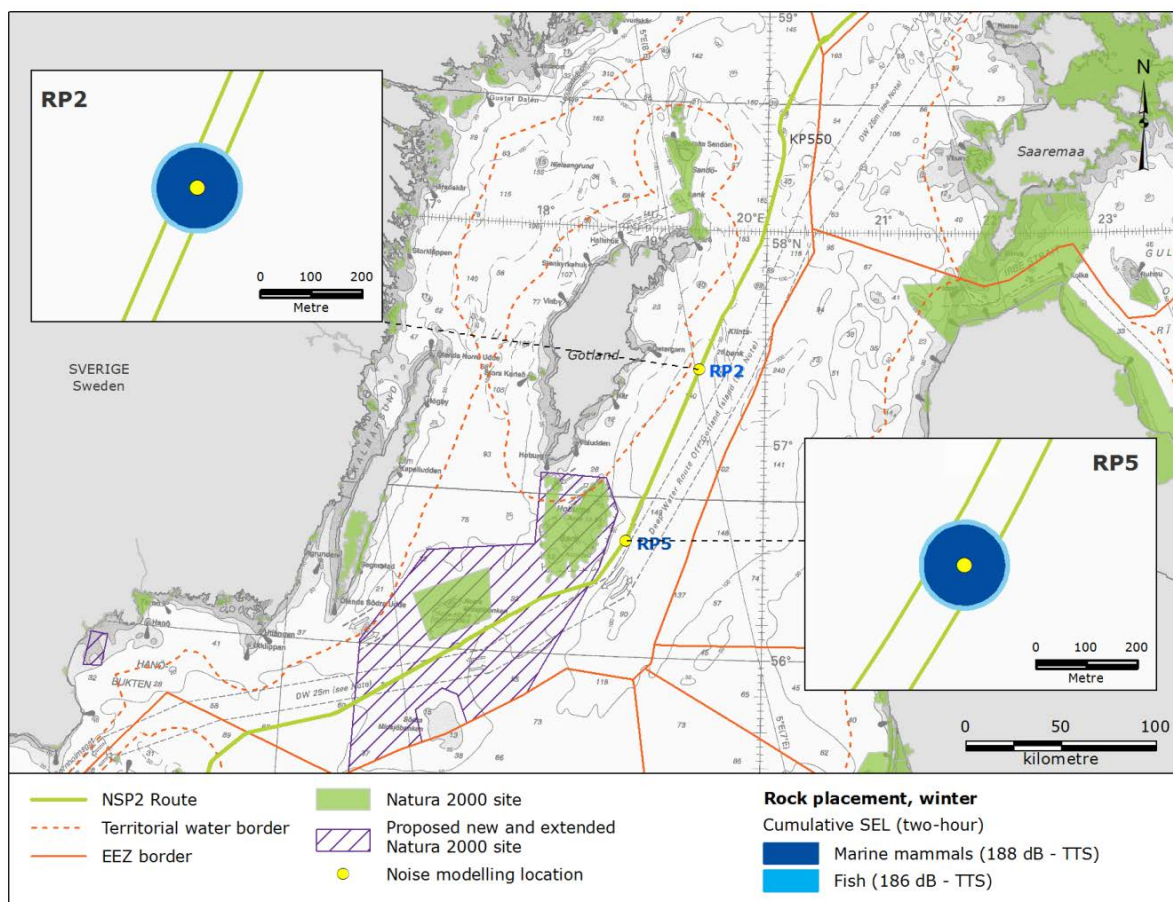


Figure 2-27 Rock placement (RP2Sweden) (RP5Sweden) underwater sound exposure levels noise levels contour plots SEL to the threshold limits, dB (summer/winter).

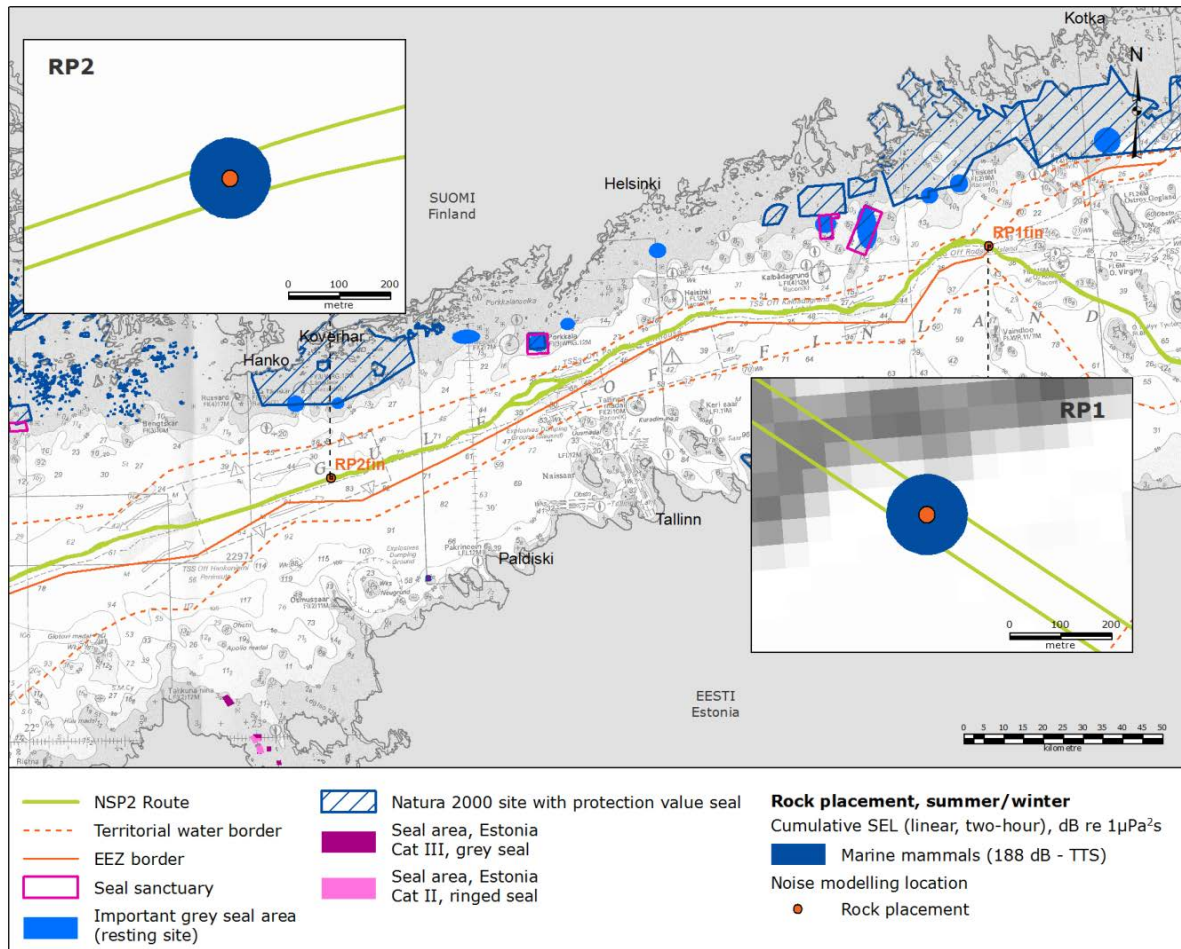


Figure 2-28 Rock placement inside Finnish waters underwater sound exposure levels, noise level contour plots to the threshold limits, dB re. 1μPa<sup>2</sup>s (summer/winter).

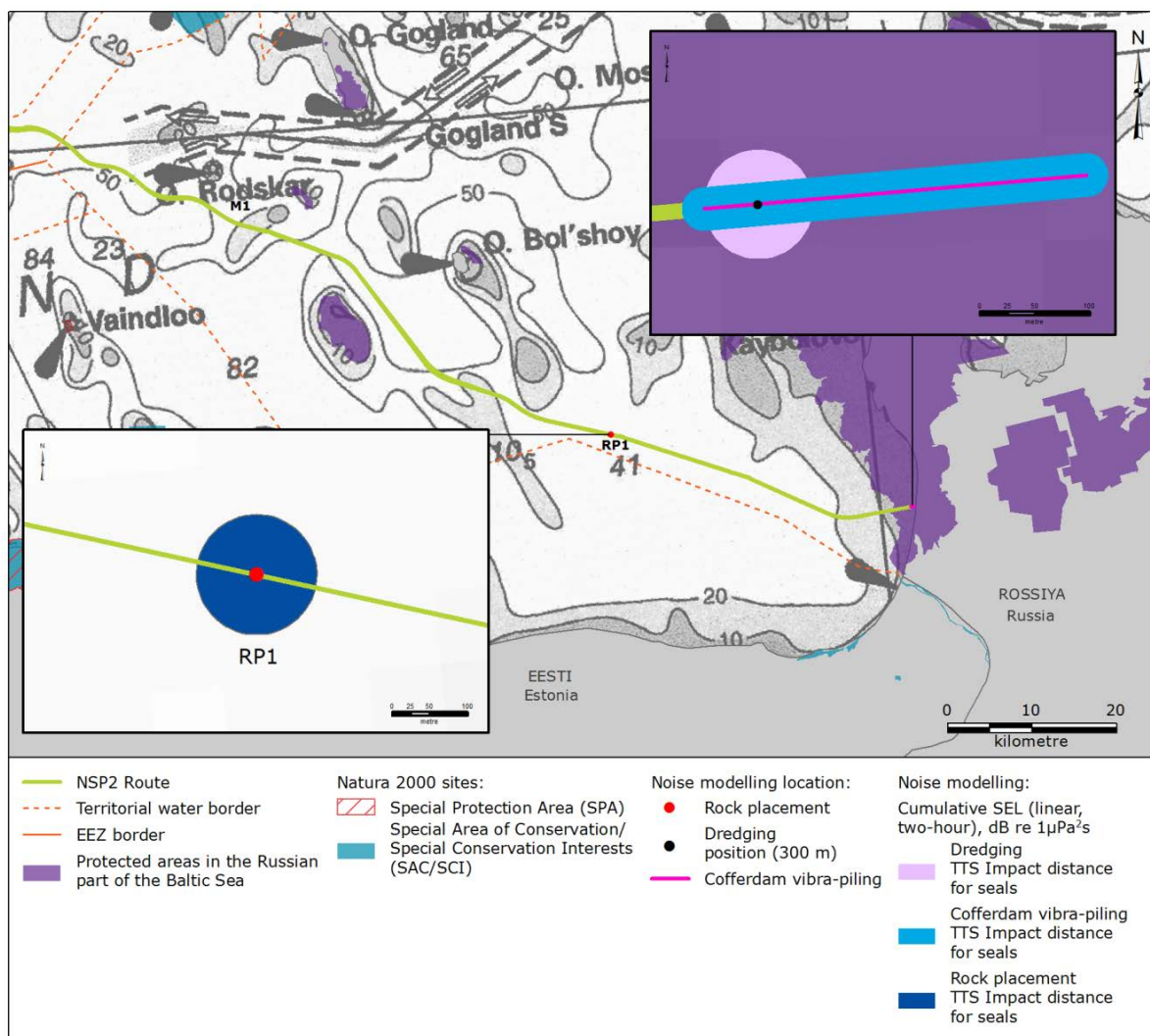


Figure 2-29 Rock placement inside Russian waters underwater sound exposure levels, noise level contour plots to the threshold limits, dB (summer/winter).

### 2.2.5 Underwater noise from pipeline operation

Underwater noise from pipelines during operation has been monitored during 2016 inside the Finnish EEZ for the eastern part of the NSP pipeline section one meter from the NSP pipeline. The results from monitoring showed no differences in noise level between the stations close to the pipeline and reference stations.

Furthermore, modelling of underwater noise close to the Russian landfall from 0 KP – 20 KP has been undertaken /12/.

Underwater noise levels from the compressors and gas flow in the first 20 kilometres of the pipeline is being assessed for potential environmental impacts. Source levels for pipeline operation are based on the study performed by Nord Stream in 2008 /13/. Additional reduction of noise from the partial sediment coverage of the pipeline is included in the modeling. For underwater noise from pipeline operation, a 24 hour sound exposure level was used because operation will be constant over the years and the effective cumulative exposure could be greater than the intermittent temporary construction activities.

The results from modelling showed that there will be no exceedance of the PTS or TTS value for marine mammals or TTS for fish along the NSP2 pipeline during operation /12/.

### 2.2.6 Underwater noise, Germany

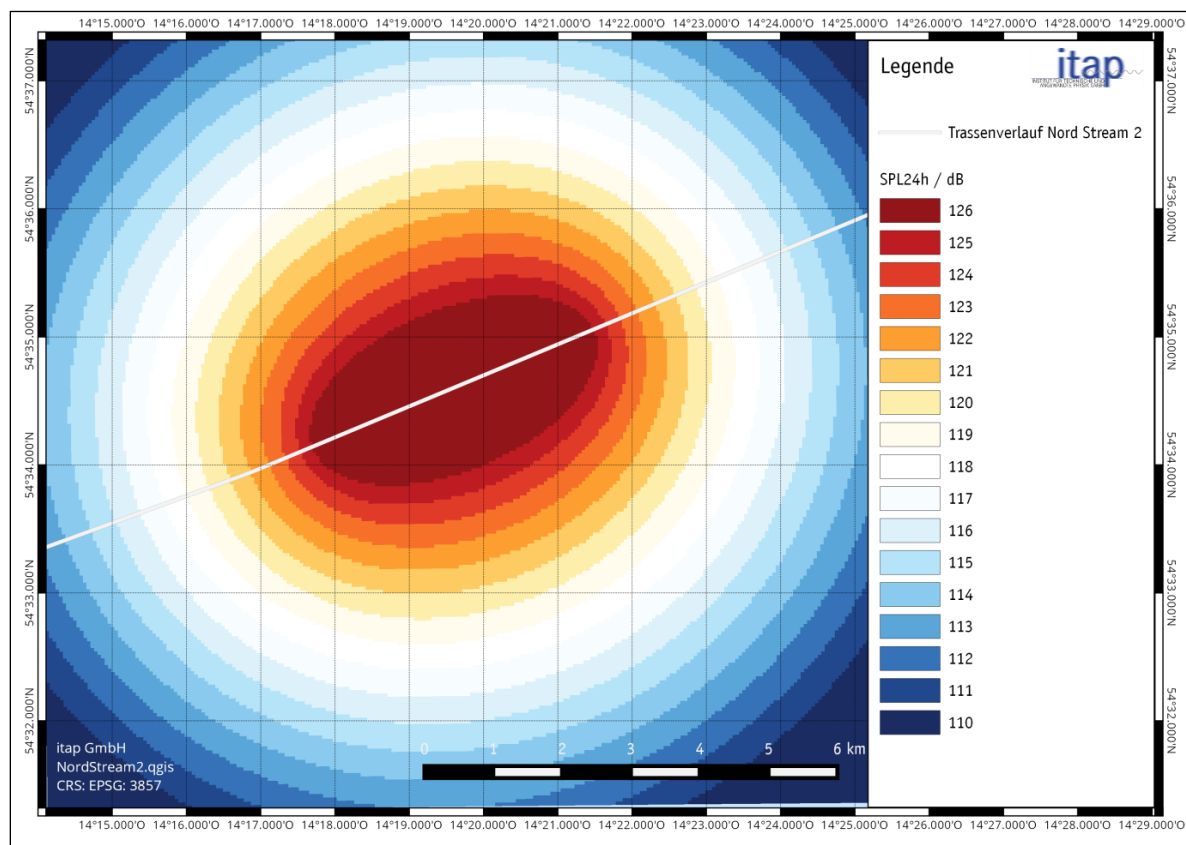
Within the prognostic calculations, the equivalent continuous sound pressure levels SPL (in dB re 1  $\mu\text{Pa}^2$ ) of different equipment is determined as a function of the location in forms of wide band levels and in 1/3-octave band. Furthermore, the levels are compared to the background noise level resulting from the present ship traffic.

The emissions to be expected are given in Table 2-6. Furthermore, distances are given at which the background noise levels are reached, which were measured in 2010 and averaged over 24 hours.

**Table 2-6 Expected emissions from different types of equipment during construction of NSP2.**

Water depth [m]	Type	Source level at 1 m distance [dB]	SPL at 1 km distance [dB]	Distance at 145 dB [m]	Distance at 112 dB [m]	Distance at 102 dB [m]
2.5	Ship, full speed	183	113	33	1,122	3,276
	Ship, slow speed	153	83	2	45	128
	Pipe-lay vessel	168	99	8	232	687
	Backhoe dredger	150	81	2	36	102
	TSHD approx. 70 m length	186	108	29	698	1,948
$\geq 10$	TSHD approx. 70 m length	186	115	32	1,523	5,208
	TSHD approx. 120 m length	200	129	142	8,043	19,579
28	Ship, full speed	183	119	43	2,578	8,091
	Ship, slow speed	153	89	2	61	205
	Pipe-lay vessel	168	105	9	409	1,464

Figure 2-30 shows the isophones of emission ( $\text{SPL}_{24\text{h}}$  [dB re 1  $\mu\text{Pa}^2$ ]) for the pipe-lay fleet at 28 m water depth for the duration of 24 hours. A SPL of 112 dB reflects the ambient background noise near the traffic separation scheme at Adlergrund in the German EEZ.



**Figure 2-30** Isophones of emission (SPL24h) for the pipe-lay fleet at 28 m water depth for the duration of 24 hours. A SPL of 112 dB reflects the ambient background noise near the traffic separation scheme at Adlergrund in the German EEZ.

## 2.3 Airborne noise

### 2.3.1 Pipe-lay activities

Airborne noise from vessels is generated from the main and auxiliary engines and from ventilation fans. The noise level from a noise source diminishes over increasing distance. This is due to the fact that the noise spreads over an expanding area as the distance increases. Theoretically, the level will be reduced by 6 dB (reduction to one-fourth) for each doubling of the distance (geometrical attenuation) /42/.

Normally, noise-prediction calculations are carried out for situations that will result in the highest typical noise levels. In practical terms: downwind and a moderate negative temperature gradient (lower temperature near the ground). This situation can be estimated using the General Prediction Model. This method anticipates geometrical attenuation /42/.

Airborne noise from the pipe-lay vessel during construction activities was modelled for the existing NSP pipelines. At a distance of 4,100 m from the vessel, the noise level was calculated by modelling to be 33 dB, comparable to the ambient noise level /53/. The noise levels from construction activities during the installation of NSP2 are assumed to be the same as during the installation of NSP. The calculated noise levels are shown in Figure 2-31 for a location close to land inside Danish waters /42/.



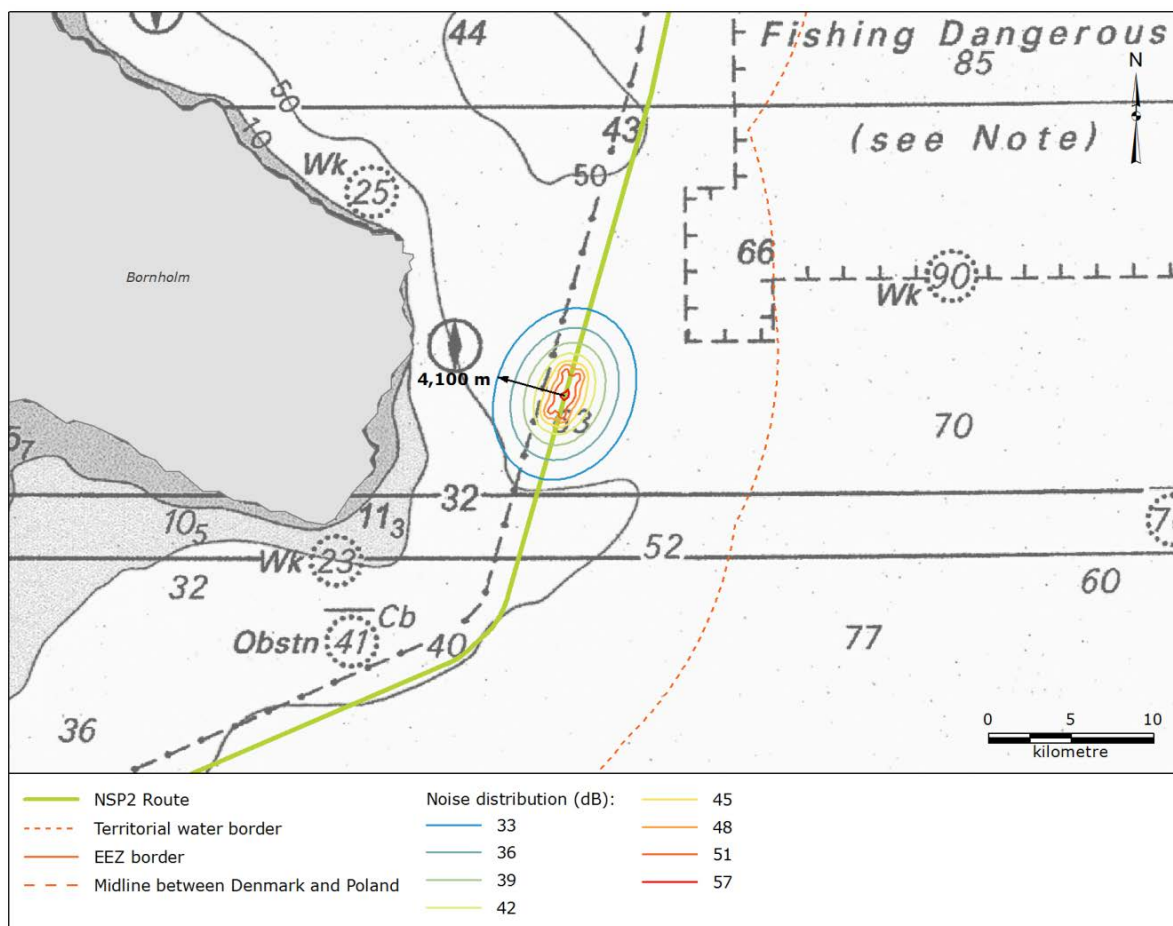


Figure 2-31 Distribution of airborne noise from the pipe-lay vessel in Denmark /42/.

### 2.3.2 Landfall area, Russia

The modelling results for simultaneous onshore and nearshore operations (worst case) indicated that the noise level in the eagle nesting area (see Section 1.4.2) will be 44.2 dBA, i.e. in accordance with the guidelines.

The modelling results for onshore operations indicated that the noise level at the boundary of the nearest residential area will be in the range of 28.1 dBA to 32.3 dBA depending on the activity, i.e. in accordance with the Russian standard.

The modelling results for offshore pipe-laying operations indicated that noise level at the minimum distance from the protected area will be 32.7 dBA, i.e. in accordance with the guidelines.

Based on a comparison against the Russian standard, the acoustic discomfort area for the offshore operations will be approximately:

- 500 m during daytime (55 dBA); and
- 1,200 m during night-time (45 dBA).

### 2.3.3 Landfall area, Landfall area, Germany

According to the expert opinion on noise emissions, orientation values will be met or fall short for the adjacent settlement areas (Lubmin). At the eastern border of Lubmin, the highest noise emissions are to be expected during pile driving (approx. 168 days). The highest values in the area of the Marina Lubmin are expected for the same construction period and they will be around 53 dB(A) during the day and 37 dB(A) during the night. Even the highest values fall below the legal orientation values, /43/, /44/, /45/.

Also during pre-commissioning (24 hour operation of the devices for 7 days a week) the calculations in the expert opinion (BMH 2017b) show that the compressor station temporarily necessary (conservative approach for the calculation: 34 compressors and other equipment) can be installed and used in a way that the requirements for noise emissions will be met, /43/, /44/, /45/.

## 2.4 Experience from NSP regarding operational activities

### 2.4.1 Possible blocking of inflow of saline water to the Baltic Sea

As shown in Section 9.2.2 and 10.2.2, the marine environment in the Baltic Sea is heavily dependent on the rare, major inflows of saline water through the Danish Straits. In order to assess the possible impacts of the introduction of the NSP pipelines on the flow into the Baltic Sea and on the vertical mixing in the water column, a theoretical study to highlight these issues was executed by SMHI /61/.

The study concluded the following with regards to the impact of the NSP pipelines on the salinity, volume flow and oxygen concentration of new deep water in the Baltic Proper /61/.

- The mixing of the new deep water might increase by 0-1.0%;
- The salinity of the new deep water might decrease by 0-0.02 psu;
- The natural variability in and below the halocline in the East Gotland Basin is around 0.5 psu;
- Flows of volume, salt and oxygen might increase by 0-1.0%;
- If topographic steering takes place it can affect at most 1.7% of the inflow;
- The pipelines will have no hydraulic effect on the inflow;
- Dams (closed depth contours) created by the pipeline have no significant importance on the phosphorus dynamics;
- The pipelines will have no effect on or will possibly slightly counteract eutrophication in the Baltic Proper.

Increased flow volume will not change the volume of deep water in the Baltic Proper but it decreases its residence time. Therefore, increased transport of oxygen would tend to improve the oxygen conditions below the halocline in the Baltic Proper and thereby increase the deposition of phosphorus in the deep water. Although the effect is very small, the pipelines may thus tend to decrease the effects of eutrophication in the Baltic Proper. From these findings the report concluded that the impact of the pipelines on the deep water in the Baltic Proper will be negligible /61/.

A hydrographic monitoring programme was carried out in the Bornholm Basin in order to verify the assumptions for the theoretical analysis of the possible blocking and mixing effects of the water inflow to the Baltic Sea caused by the presence of the NSP pipelines /62/.

In conclusion, the findings of the monitoring programme suggest that the mixing caused by the pipelines in the Bornholm Basin will at most be 20% of the worst case estimations presented in the theoretical analysis. It should be noted that these estimations were considerably below any level of effect, which could be measured to result from the pipelines lying on the seabed. One reason for the reduced estimate is that the mean height of the pipelines above the seabed is actually 0.7 m as opposed to 1.0 m, which was the conservative assumption for the theoretical analysis. However, the main reason for the reduced estimate of the mixing effect by the pipelines is due to a better understanding of the currents in the Bornholm Basin, which has been obtained by the observations performed by SMHI /38/.

An analysis of the hydrographic effects of adding the NSP2 pipelines was made as an update of the analysis and monitoring results carried out for NSP as outlined above /63/.

Adding two new pipelines crossing the dense bottom current in the eastern Bornholm Basin should double the mixing effect if the height of the pipes is the same as the height of the NSP pipelines. The increased mixing by all four pipelines should thus be 0–0.4%. This should increase the flow of the bottom current by 0–86 m<sup>3</sup>/s and decrease its salinity by 0–0.008%. There will also be an increase in oxygen transport in the interval 0–1 kg/s assuming that the maximum oxygen concentration of inflowing new deep water passing the Stolpe Channel is about 12 g/m<sup>3</sup>. This will marginally increase the flushing of the deep water in the Baltic Proper, somewhat improving the oxygen conditions, which might decrease the area of anoxic bottoms and thereby decrease the leakage of phosphorus from anoxic bottoms. For comparison, it should be noted that Stigebrandt and Gustafsson /64/ estimated that oxic conditions in the deep basins of the Baltic Proper would require a long term mean oxygen supply of about 100 kg/s.

The leakage of phosphorus from dams created by the NSP pipelines in the depth interval 60–80 m was estimated to be 0–13 tonnes P/yr if the mean height of the pipelines equals 0.7 m and the dams are oxygen free all the time. With the same area of dams created by the NSP2 pipelines there should be an additional leakage of 0–13 tonnes P/yr. The total leakage from the dams created by the four pipelines should then be 0-26 tonnes P/yr. The upper limit requires that the dams are anoxic all the time which is a conservative assumption, in particular since dams in the interval 40–60 m should be ventilated each autumn/winter by convection in the surface layer. The estimated upper limit is at most 0.026% of the present internal leakage of P from anoxic bottoms in the Baltic Proper, which is 100,000 tonnes P/yr as reported in /65/.

#### 2.4.2 Release of contaminants from sacrificial anodes

Sacrificial anodes of zinc and aluminium (including impurities such as traces of cadmium, lead, copper and other metals) are attached to the pipeline throughout the marine section in order to reduce corrosion of the steel pipes. The composition of zinc and aluminium anodes to be used for the NSP2 project is shown in Chapter 6, where metals in the highest concentration and/or of the highest toxicity to the marine environment can be limited to zinc, aluminium and cadmium. Among these three metals aluminium is of low toxicity to marine organisms when compared to cadmium and zinc. Throughout the lifetime of the pipelines these will slowly be corroded meaning that zinc, aluminium and trace metals are released to the water column as dissolved ions. It has been estimated that approximately 50% of the anode material will be sacrificed during the 50 year design life.

Based on the amount of anodes to be used for the NSP2 pipeline, Table 2-7 shows the amount of metals to be released to the Baltic Sea from the anodes assuming approximately 50% of the anodes will be sacrificed after 50 years.

**Table 2-7 Amount of metals released from the NSP2 anodes assuming 50% of the anodes material will be sacrificed over a 50 year period.**

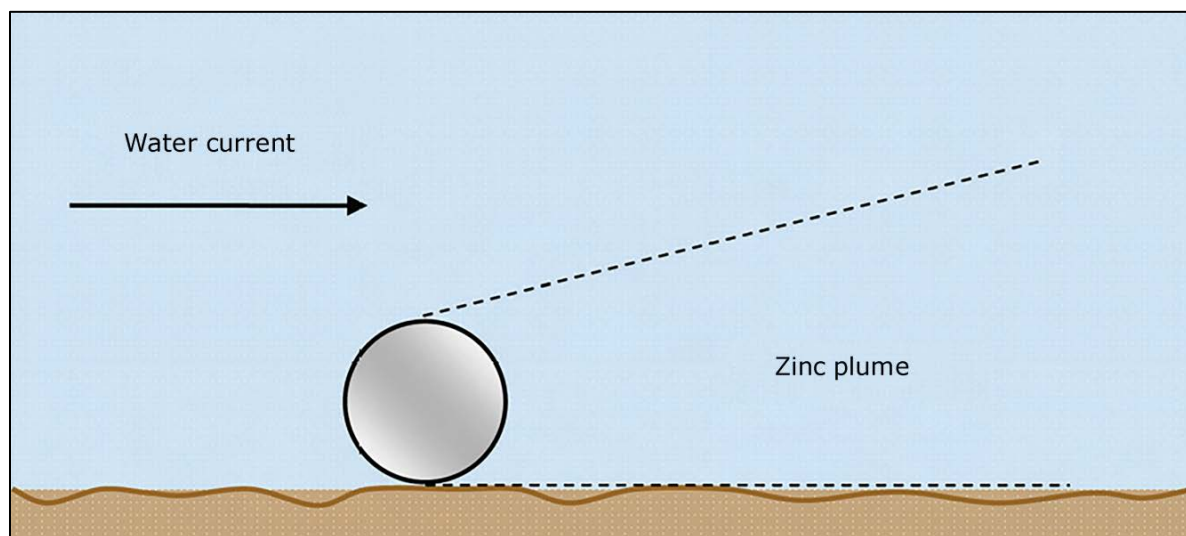
Anodes for NSP2			
Element	Content (%)	Content (Tons)	Release in 50 year period in tons
<b>Zinc anodes of 5,116 tons (Russia, Finland, Sweden, Germany)</b>			
Zinc (Zn)	Approx. 99	5,065	2,533
Cadmium (Cd)	0.025-0.07	1.28 – 3.58	0.64 – 1.79
Aluminium (Al)	0.1-0.5	5.12 – 25.6	2.56 – 12.8
<b>Aluminium anodes of 5,269 tons (Finland, Sweden, Denmark, Germany)</b>			
Aluminium (Al)	Approx. 95	5,006	2,503
Cadmium (Cd)	0.002	0.11	0.05
Zinc (Zn)	4.75 – 5.75	250 - 303	125 - 152
<b>Total release of metals to the Baltic Sea every year during a 50 year period</b>			
Aluminium (Al)			50.1 – 50.3
Cadmium (Cd)			0.014 – 0.37

Anodes for NSP2			
Element	Content (%)	Content (Tons)	Release in 50 year period in tons
Zinc (Zn)			53.2 – 53.7
The content of other trace metals analysed in zinc/aluminium anodes is very low and the amount released from anodes will be low compared to metals shown above, and/or be of no ecotoxicological significance to the marine environment.			

As part of the NSP EIA work the release of metals from the pipeline in the operational phase was assessed /52/, /55/. The expected concentrations of metal ions in the water column (PEC) immediately around the anode have been calculated and compared with the acceptable levels within the marine environment and background mean concentrations measured from water samples, see Figure 2-32. The assumptions for the modelling were quite conservative, assuming a current velocity of only 0.01 m/s, which is the lowest mean value derived from long-term measurements of bottom water velocities at two locations in the Gulf of Finland /52/.

Advection-dispersion calculations show that the distance from the zinc anodes where elevated zinc concentrations may be found (exceedance of the PNEC value:  $PEC > PNEC$ ) is up to a few meters from the zinc anodes. The zinc is thus quickly diluted in the sea. Therefore, any impacts on marine benthic flora and fauna are considered local only /52/,/56/.

The concentrations of cadmium and other trace metals from the anodes in the water column around the anodes will be so low that they will fall below the annual average environmental quality standard values (AA-EQS) and PNEC values as defined by the EU and OSPAR commission /57/,/58/, and as described for NSP /52/.



**Figure 2-32** Principle in the simplified advection-dispersion model used in the NSP EIA work for estimating the spreading of released metal from the anodes /52/.

Monitoring was carried out for the NSP pipeline anodes in the Finnish EEZ. Water samples were sampled 1 – 2 m from the NSP anodes one meter above the seabed by ROV. The concentrations of metals on both sides of the pipeline were low and below the detection limit. There was no difference in concentrations between the sampling stations around the anodes at a reference station 60 m away from the anodes /66/.

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**ESPOO REPORT**

# **APPENDIX 4**

**METALS, ORGANIC CONTAMINANTS, CWAS  
AND NUTRIENTS ANALYSED IN SEDIMENT  
SAMPLES ALONG THE NSP2 ROUTE**



Concentration of metals and organic contaminants along the planned NSP2 route						
Substance	Unit	Russia (not normalised) <sup>1</sup>	Finland <sup>2</sup>	Sweden	Denmark	Germany
		Min – Max Normalized concentration (n=93)	Min-Max Normalized concentration (n=136)	Min-Max Total concentration (n=51)	Min-Max Total concentration (n=14)	Min-Max Total concentration (n=42)
<b>METALS</b>						
Arsenic (As)	mg/kg DW	<0.20–11.4	1-48	<0.5 – 18.3	3.6 - 19.1	<1 – 53
Cadmium (Cd)	mg/kg DW	<0.5-2.5	0.2-2	0.02 – 0.88	0.02 - 0.48	<0,1 – 6
Chromium (Cr)	mg/kg DW	<2-35	2-74	1.32 – 65.2	11.1 - 50.1	1,8 - 83
Cobalt(Co)	mg/kg DW	-	-	0.8 – 27.4	4.28 - 20.7	-
Copper (Cu)	mg/kg DW	<2-81.6	1-42	1.04 – 64.6	8.54 - 57.8	2,7 – 90
Mercury (Hg)	mg/kg DW	<0.1-0.3	<0.1	<0.01 – 0.42	0.01 - 0.14	<0,03 – 0,8
Nickel (Ni)	mg/kg DW	<2-94.2	2-46	<5 – 45.5	9 – 43.5	0,8 – 130
Lead (Pb)	mg/kg DW	<2-162.5	2-40	2.7 – 48.2	8.2 - 80.8	<2 – 89
Zinc (Zn)	mg/kg DW	10.8-413	4-180	6.1 – 209	27.2 - 207	4,1 – 280
Vanadium (V)	mg/kg DW	-	-	3.04 – 81.5	13.5 - 77.3	-
<b>ORGANIC CONTAMINANTS</b>						
<b>Polycyclic aromatic hydrocarbons (PAH)</b>						
Naphthalene	mg/kg DW	<0.001—0.012	<0.01 – 0.11	<0.002 – 0.021	<0.002-0.046	<0,01
Acenaphthene	mg/kg DW	<0.001-0.032	-	<0.002 – 0.004	<0.002-0.009	<0,01

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Acenaphthylene	mg/kg DW	<0.001-0.015	-	<0.002 – 0.006	<0.002-0.010	<0,10
Fluorene	mg/kg DW	<0.001—0.010	-	<0.0020 – 0.009	<0.002-0.016	<0,01
Anthracene	mg/kg DW	<0.001-0.011	<0.01 – 0.18	<0.002 – 0.019	<0.002-0.029	<0,01
Phenanthrene	mg/kg DW	<0.001—0.050	-	<0.002 – 0.048	<0.002-0.110	<0,01 – 0,016
Fluoranthene	mg/kg DW	<0.001—0.075	<0.01 – 0.31	<0.002 – 0.150	<0.002-0.280	<0,01 – 0,052
Pyrene	mg/kg DW	<0.001-0.078	<0.01 – 0.29	<0.002 – 0.100	<0.002-0.250	<0,01 – 0,038
Benz(a)anthracene	mg/kg DW	<0.001-0.033	<0.01 – 0.51	<0.002 – 0.063	<0.002-0.140	<0,01 – 0,019
Chrysene	mg/kg DW	<0.001-0.049	<0.01 – 0.21	<0.002 – 0.045	<0.002-0.120	<0,01 – 0,017
Dibenzo(a,h)anthracene	mg/kg DW	<0.001-0.004	-	<0.002 – 0.078	<0.002-0.075	<0,01
Benzo(a)pyrene	mg/kg DW	<0.001-0.074	<0.01 – 0.28	<0.002 – 0.089	<0.002-0.190	<0,01 – 0,031
Benz(b)fluoranthene	mg/kg DW	<0.001-0.088	-	<0.002 – 0.240	<0.002-0.340	<0,01 – 0,046
Benz(k)fluoranthene	mg/kg DW	<0.001—0.055	<0.01 – 0.36	<0.002 – 0.100	<0.002-0.180	<0,01 – 0,019
Benz(ghi)perylene	mg/kg DW	<0.001-0.123	<0.01 – 0.55	<0.002 – 0.340	<0.002-0.460	<0,01 – 0,035
Indeno(123cd)pyrene	mg/kg DW	<0.001—0.138	<0.01 – 0.64	<0.002 – 0.480	0.002-0.550	<0,02 – 0,099

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Polychlorinated biphenyls (PCB ( $\Sigma$ 7 EU Congeners) <sup>3</sup> )	µg/kg DW	1.04 – 55	<1 - 306	<0.1 – 40	<0.1 – 3.6	<0,1 – 50,7
Monobutyltin (MBT)	µg/kg DW	<10-227	-	<1.00 – 1.78	<1-7.26	<1 – 2
Dibutyltin (DBT)	µg/kg DW	<10-12.9	-	<1.00 – 1.40	<1-5.47	<1 – 2
Tributyltin (TBT)	µg/kg DW	<10-78.1	<0.64 – 192	<1.00 – 1.34	<1-5.79	<1 - 3
Triphenyltin (TPhT)	µg/kg DW	<10	<0.57/<0.7 <sup>4</sup>	-	-	<1
Cis-chlordane	µg/kg DW	-	-	<0.100 – 0.451	<0.1-0.132	-
Trans-chlordane	µg/kg DW	-	-	<0.001	<0.1-0.148	-
Hexachlorocyclohexane (HCH)	µg/kg DW	-	-	<0.10 – 0.14	<0.4-0.37	<0,05 – 0,16
Dichlorodiphenyldichloroethane $\Sigma$ (DDE(o,p and p,p))	µg/kg DW	-	-	<0.1 – 1.81	0.12-3.29	<0,1 – 0,16
Dichlorodiphenyldichloroethane $\Sigma$ (DDD(o,p and p,p))	µg/kg DW	-	-	<0.1 – 4.8	0.12-10.1	<0,1 – 0,17
Dichlorodiphenyltrichloroethane $\Sigma$ (DDT(o,p and p,p))	µg/kg DW	-	-	<0.1 – 3.4	<0.1-0.43	<0,1 – 13,0
Trans-nonachlor	µg/kg DW	-	-	<0.1	<0.1- 0.11	-
Hexachlorobenzene (HCB) mg/kg	µg/kg DW	-	-	<0.1- 0.14	<0.1-0.23	<0,1
WHO(2005)PCDD/F TEQ (upper) of dioxins/furans	ng/kg DW	17.1	1.92 – 143	-	-	-
<b>CHEMICAL WARFARE AGENT (CWA)<sup>5</sup></b>						
<b>Intact CWA</b>						
Sulphur mustard (H)	µg/kg DW	-	-	-	0.6	-

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Adamsite (DM)	µg/kg DW	-	-	-	17 - 2,000	-
Triphenylarsine (TPA)	µg/kg DW	-	-	-	0.56 – 13	-
α-Chloroacetophenone (CN)	µg/kg DW	-	-	-	2.3	-
<b>CWA degradation products and derivatives</b>						
1,4-Dithiane (from H)	µg/kg DW	-	-	-	0.27 – 0.34	-
1,4,5-Oxadithiepane (from H)	µg/kg DW	-	-	-	0.21 – 0.44	-
1,2,5-Trithiepane (from H))	µg/kg DW	-	-	-	0.27 – 1.6	-
5,10-Dihydrophenarsazin-10 – ol 10-oxide (from DM)	µg/kg DW	-	-	-	2.9 – 576	-
Diphenylarsinic acid (DPAA) (from Clark 2 (DC))	µg/kg DW	-	-	-	4.1 – 1,764	-
Diphenylpropylthioarsine (DPPT) (from Clark 2 (DC))	µg/kg DW	-	-	-	1.2 – 59	-
Triphenylarsine oxide (TPAO) (from TPA)	µg/kg DW	-	-	-	4.2 – 234	-
Phenylarsonic acid (PAA) (from Clark 2)	µg/kg DW	-	-	-	3.7 – 145	-
Dipropyl phenylarsonodithioite (DPPA) (from Trichloroarsine (TCA))	µg/kg DW	-	-	-	1.2 – 98	-
Tripopyl arsenotrithioite (TPAT) (from Trichloroarsine (TCA))	µg/kg DW	-	-	-	3.5	-
<b>NUTRIENTS</b>						
Total organic carbon	mg/kg (DW)	1,000 – 67,000	2,000 – 81,000	<1,000 – 37,000	8,000-45,000	882 – 7,839
Total nitrogen	mg/kg (DW)	2,000 -10,000	500 – 11,000	118 - 7,160	345-3,110	80 – 3,200

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Total phosphorus	mg/kg (DW)	1,270 – 5,440	47 - .6,218	180 – 1,540	600-1,220	63 - 310
<p>           -: : Not analyzed/No result            n: Number of sampling stations for chemical analysis.            1: Russia: Results normalized as done for Finland, see 2.            2: Finland: Results normalized For metals: Normalized to clay content &lt;2 µm and to TOC x 2, and substance specific normalization factor defined by MoE (2015). For organic compounds: Normalized according MoE (2015) to TOC x 2. Ref: Ympäristöhallinnon ohjeita 1/2015. Guidelines for dredging and depositing dredged materials. Ministry of the Environment Finland.            3: PCB Congener: PCB 28, 52, 101, 118, 138, 153, 180.            4: Below detection limit ranging from &lt;0.57 - &lt;0.7 µg/kg DW.            5: 1,4-D = 1,4-Dithiane; 1,4,5-O = 1,4,5-Oxadithiepane; 1,2,5-T = 1,2,5-Trithiepane; 5,10-D = 5,10-Dihydro-phenarsazin-10-ol 10-oxide; DPAA = Diphenylarsinic acid; DPPT = Diphenylpropylthioarsine; TPAO = Triphenylarsine oxide; PAA = Phenylarsonic acid; DPPA = Dipropyl phenylarsonodithioite; TPAT = Tripropyl arsenotrithioite.         </p> <p>           Russia: Survey June-July 2016 by the consultants Svarog and Eco-Express Service. Surface sediment layer 0-30 cm for analysis. Results referring to sediment samples taken from following depth: (0 – 2) cm depth, (2 – 10) cm depth, and (10 – 30) cm.         </p> <p>           Finland: Survey December 2015 and June 2016 by the Luorde consultant. Surface sediment layer 0-30 cm for analysis. Results referring to sediment samples taken from following depth: (0 – 2) cm depth, (2 – 10) cm depth, and (10 – 30) cm.         </p> <p>           Sweden: Survey October 2015 by Danish Hydraulic Institute (DHI). Surface sediment layer 0-2 cm for analysis. Results referring to analysis of the total sample.         </p> <p>           Denmark: Survey October 2015 and June 2016 (CWA supplementary survey) by Danish Hydraulic Institute (DHI). Surface layer 0-2 cm for analysis for metals and organic contaminants. Surface layer 0 - 5 cm for analysis of CWA. Results referring to analysis of the total sample.         </p> <p>           Germany: Survey April 2016 by Institut für Angewandte Ökosystemforschung (IfAO). Surface sediment layer 0 – 15 cm for analysis. Metal concentrations referring to sample grain size &lt;20 µm. Concentrations of organic parameters referring to total sediment samples. DDT-group: only p,p'-isomers analysed. Set of analysis parameters according to GÜBAK-guideline.         </p>						