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NORD STREAM 2
NATURAL GAS PIPELINE ROUTE THROUGH THE BALTIC SEA – ENVIRONMENTAL MONITORING PROGRAMME, FINLAND

RAMBØLL

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Natural Gas Pipeline Route through the Baltic Sea – Environmental Monitoring Programme, Finland

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CONTENTS

APPENDICES

1. INTRODUCTION

Nord Stream 2 AG is planning to construct two parallel offshore natural gas pipelines from Russia to Germany through the Baltic Sea. The length of the entire two-pipeline system is approximately 1,200 km. The pipelines pass through the territorial waters and/or Exclusive Economic Zones (EEZ) of Russia, Finland, Sweden, Denmark and Germany. In the Finnish EEZ the route follows the present Nord Stream pipeline route. The length of the route in the Finnish sector is 374 km. Pipelines are scheduled to be laid during 2018 and 2019. Hence the operation phase would commence at the beginning of 2020.

Nord Stream 2 AG is responsible for environmental monitoring and reporting during construction and operation of the pipelines. Specifications for the contents of monitoring are presented in the appropriate sections of this programme.

The monitoring programme was part of the Water Permit Application submitted to the Finnish authorities in September 2017. The monitoring programme has been updated in January 2018 based on the statements received to the Water Permit Application by extending the use of bubble curtains to almost all munitions to be cleared. The updated parts of the monitoring programme have been discussed with the supervising authorities.

2. ENVIRONMENTAL MONITORING DURING CONSTRUCTION AND OPERATION

2.1 General approach

Nord Stream 2's overall project environmental monitoring varies in spatial range, temporal frequency, duration and monitored parameters from area to area in accordance with the potential adverse impacts predicted and in relation to potential receptors. The monitoring activities also address requested reporting requirements at national levels.

The programme presented in this document concentrates on the monitoring activities that will be carried out in the Finnish EEZ during pipeline construction and operation. The programme has been developed with the following objectives:

- To document the state of the environment during construction
- To monitor that no major adverse environmental impacts will be caused during construction
- To verify the findings of the EIA and the modelling results used to predict environmental impacts

Environmental and social monitoring together with a specific Environmental and Social Management Plan (ESMP) (Construction and Operation) is an integral part of the overall Nord Stream 2 Health, Safety, Environment and Social Management System (HSES MS) consistent with ISO 14001 and OHSAS 18001.

In order to measure the effectiveness of mitigation measures and potential project-related impact the receptors/indicators identified within the monitoring programme should have/be:

- Low natural variability and broad applicability
- Measurable
- Supported by a sound historic data series
- Appropriate to the scale of impact, the impact mechanism and temporal and spatial dynamics.

The key principles, which have guided the development and implementation of the national environmental monitoring programmes for the Nord Stream 2 Project have been implemented already in the Nord Stream Project and are briefly described here:

Consistency: To the extent practicable is, a harmonised approach in terms of sampling and analysis protocols along the length of the route will be adopted. This ensures data that is more readily comparable and allows for improved environmental management and performance. Monitoring is, where possible, congruent with HELCOM guidelines. Thus, NSP2 will, for the specific SoW for each monitoring activity to align with the latest Manual for Marine Monitoring Manual prepared by HELCOM (HELCOM 2008).

Synergy: In addition to the environmental surveys the Project undertakes engineering inspection and maintenance led surveys. These include seabed investigations to understand seabed conditions, shallow geology, presence of obstacles and cultural heritage, and the condition of pipelines and their support structures. The results of the surveys will be complied in integrated survey reports.

Reporting and Data Sharing: It is important for the Project to have access to ongoing data acquisition programmes by third parties and government institutions. The Project is also committed to share its data with relevant stakeholders. At a Project-wide level, Nord Stream 2 is committed to report publically on its monitoring programme on a regular basis. At a national level, results will be shared with national authorities at a frequency agreed with the relevant national authority.

Seasonal and Inter-annual Variability: It is important to consider the inherent natural variability that is typical of many of the parameters used in marine monitoring programmes to avoid incorrect conclusions about its presumed impacts. Similarly, reference sites are used to account for the spatial variability that may occur in the marine environment. Where possible the co-use of 3rd party (HELCOM etc.) long term monitoring stations has been considered.

Review and Close Out: Monitoring is not an open-ended process. It is important to regularly review monitoring results, not just from the perspective of corrective action if required, for specific impacts. Overall it is important that the programme remains fit-for-purpose and delivers the main monitoring objectives throughout the Project lifetime. Expert review will therefore be conducted on a regular basis to ensure these objectives still hold true.

2.2 Scope and schedule

The programme presented in the following chapters concentrates on the monitoring activities that will be carried out in the Finnish EEZ during construction and operation of the pipelines. Based upon experience of the studied environmental impacts during construction of the Nord Stream pipelines in 2010–2012, most of the impacts were minor. Therefore, the approach is to concentrate on monitoring of impacts according to the proposal in the EIA Report which concentrates on a limited number of receptors, taking into account the statement of the EIA Coordinating Authority.

The EIA Coordinating Authority, Uusimaa ELY Centre, stated in its statement 26 July 2017 that *"the proposal for the monitoring programme of the project, which was presented in the [EIA] report, is appropriate. Detailed monitoring programmes will be prepared during and after the construction phase. Then, based on specified clearance and construction plans, the monitoring need of the spreading of solid substances and contaminants and related impacts must be re-assessed especially near sensitive objects."*

In addition to what was presented in the EIA report (Ramboll 2017), NSP2 is suggesting to monitor also turbidity and currents (sediment spreading) during the construction phase.

The following impact targets are considered relevant:

- Underwater noise
- Turbidity and current monitoring
- Commercial fishery
- Cultural heritage

Pipelines are also subject to technical inspections during their operation phase as described later in Chapter 3.

The proposed schedule for environmental monitoring is presented in Table 2-1. Monitoring will be most intensive during the construction phase. However regular monitoring will be carried out during operation as well, and will continue until it can be assured that there are no unexpected impacts to the selected monitoring targets.

The supervising authority for monitoring of underwater noise, turbidity and currents are the regional ELY-Centres. For fishery monitoring the approving authority is Southwest Finland ELY-Centre. For cultural heritage the approving authority is National Board of Antiquities.

Technical pipeline inspections will be carried out throughout the entire operational lifetime of the pipelines.

Table 2-1 presents the rough schedule of the planned environmental monitoring during the coming years. The final schedule of the monitoring will be negotiated with the authorities mentioned above. Baseline surveys for underwater noise, water quality, commercial fishery and cultural heritage have been conducted during 2016.

Table 2-1. Rough schedule for monitoring activities during 2017–2023 in the Finnish EEZ.

Monitoring target	2017	2018	2019	2020	2021	2022	2023
Underwater noise (during construction phase)		x					
Turbidity and current monitoring (during construction phase)		x	x				
Commercial fishery (questionnaire, analysis of tracking data)						x	
Cultural heritage (once prior to and once after construction phase)		x		x			

During munition clearance activity Nord Stream 2 has committed to observe marine mammals, fish and sea birds before and after detonations. This is a part of the mitigation measures to protect these animals from injuries and/or deaths that are potential during this activity. Visual observations will be performed by trained *marine mammal/bird observers* from one hour before the detonation (presence, number and species) to one hour after the detonation (injuries/deaths, estimate of number and species of dead fish).

Marine mammal observers are authorized to suspend the operations to mitigate potential impacts on marine biota. Munitions clearance subcontractor will take care of this monitoring and reporting.

2.3 Underwater noise

The construction phase of the Nord Stream 2 pipeline system, especially munitions clearance will generate underwater sound. The monitoring of underwater noise has been planned to carry out during munitions clearance as this activity can potentially have an environmental impact on the marine life. These sound levels will be monitored in the construction phase by direct actual measurements of underwater noise. These values will then be compared to values modelled in environmental assessment (Ramboll 2016) and in munitions-by-munitions evaluation (ARCB 2018) that may induce permanent threshold shift (PTS) and temporary threshold shift (TTS). These values are expressed as sound exposure levels (SEL). This underwater noise monitoring programme has been prepared by Luode Consulting (2017).

Main objectives for underwater noise monitoring programme are:

1. How far the noise originating from munition clearance operations can penetrate into sensitive areas in the archipelago
2. How high the maximum noise levels are
3. How well the modelled impacts during the EIA phase correspond to the measured values.
4. How the use of bubble curtain as mitigation measures affects the underwater noise levels

Regarding to background noise levels, monitoring will address on following:

1. The levels of background noise during munitions clearance in the Gulf of Finland
2. Does munitions clearance related activities (i.e. vessels) elevate the background noise level

Underwater noise monitoring is proposed to be conducted with stationary bottom mounted sensors in the Finnish territorial waters and with mobile noise monitoring systems in the Finnish EEZ areas. Stationary monitoring sensors will be used for time-series monitoring of long-distance effects.

Background noise levels and their potential changes will be calculated at stationary and mobile devices by comparing noise levels recorded before, during and after munition clearance. The recorded noise time-series will also be compared with the actual schedule of the activities so that it will be possible to know what activity was carried out at each point in time.

Any changes in background noise can be identified as increasing trend of recorded background noise over time. The origin of the increased background noise, if any, can be identified because different activities have very distinctive spectral characteristics.

Based on experience from previous construction projects, this method should allow to evaluate the background noise levels and if and how much the construction activities have changed the background noise.

Stationary monitoring is proposed to start two weeks prior to the start of munitions clearance activities and will last until the munition clearance activities are completed in the Gulf of Finland. It is suggested to include two underwater monitoring stations also to Estonian waters to monitor transboundary impacts.

2.3.1 Monitoring areas

The stationary monitoring areas were selected based on their location with respect to the highest density of munitions, water depths, location of the Natura 2000 sites and known seal populations and the distance to the pipeline route (Table 2-2, Figure 2-1 and Appendix 1) Four stationary monitoring areas along the Finnish coastline are 1) Hanko, 2) Porkkala Kallbådan, 3) Söderskär and 4) Eastern Gulf of Finland (Eastern GoF in Figure 2-1 and Appendix 1). In addition two areas along the Estonian coastline were selected for transboundary monitoring: 5) Malusi and 6) Uhtju. The underwater noise stationary monitoring in Eastern Gulf of Finland was included in line with the Southeast Finland ELY Centre statement (KASELY/1410/2017, 20.11.2017) to the Nord Stream 2 water permit application.

Table 2-2. Proposed monitoring locations.

Area	Latitude [WGS-84]	Longitude [WGS-84]	Water depth
Hanko A	59° 45,1´N	23° 20,4´E	>50 m
Hanko B	59° 49,3´N	23° 22,9´E	>50 m
Kallbådan A	59° 46,4´N	24° 16,3´E	>50 m
Kallbådan B	59° 51,4´N	24° 16,9´E	>50 m
Söderskär	60° 02,9´N	25° 45,6´E	>50 m
Eastern Gulf of Finland	60° 09,7´N	25° 46,1´E	>50 m
Malusi	59° 37,7´N	25° 18,7´E	>50 m
Uhtju	59° 41,5´N	25° 27,9´E	>50 m

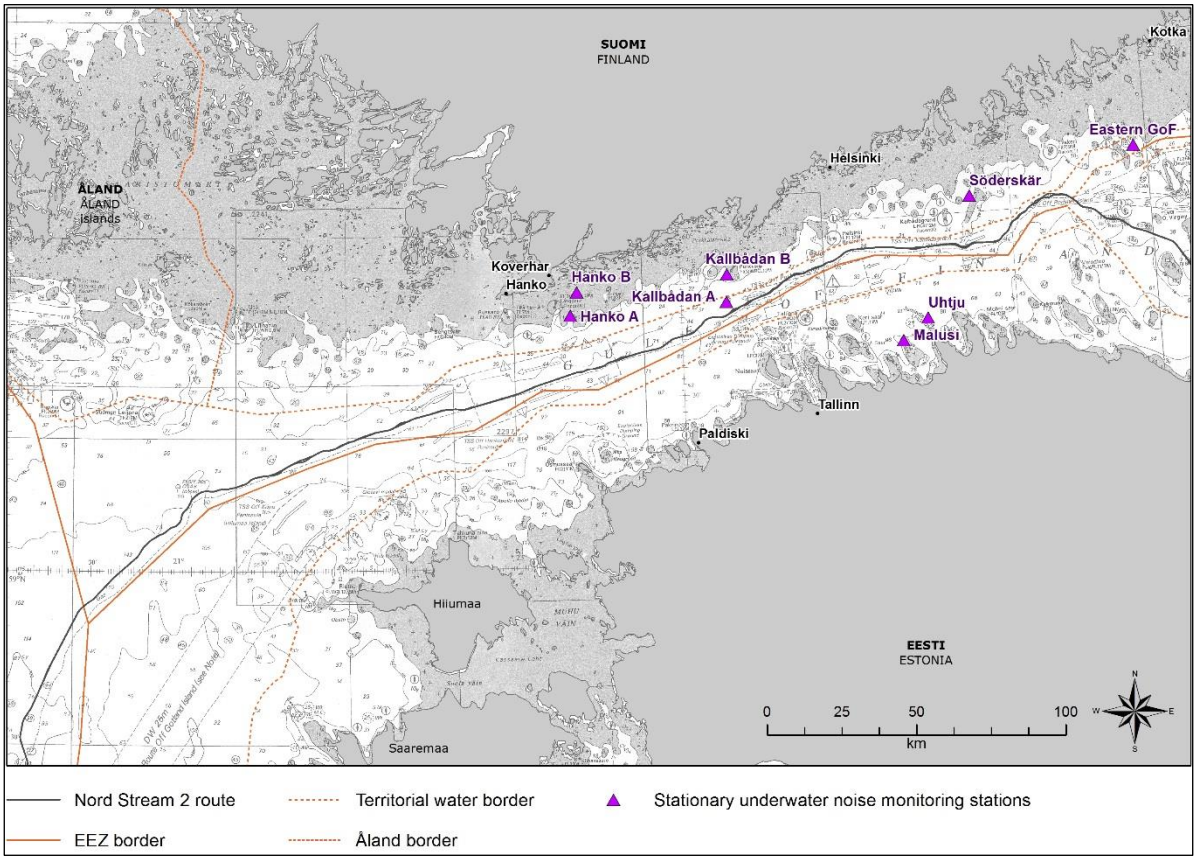


Figure 2-1. Proposed monitoring station locations.

Proposed monitoring locations are presented also in Appendix 1. In the Finnish EEZ the noise monitoring can be performed based on valid survey permits and a separate permit to be applied from Metsähallitus to approach and make installations near the protected seal sanctuaries. Monitoring consultant will obtain the needed environmental monitoring permits for monitoring in Estonia.

Proposed targets for short-term monitoring campaigns with mobile sensors will be selected based on charge weight and type. Based on the Munition evaluation documents nine targets are suitable for monitoring, four targets are located inside the installation corridor and five targets in the security corridor (Table 2-3). Selected munitions are fairly large and the burial depth in the sediment is low except for one munition in the west. Three munitions among the nine munitions presented in the table below will be selected for the short-term monitoring campaigns. The final selection of the munitions will be determined in co-operation with supervising authorities once the munitions clearance contractor have performed the re-evaluations of munitions.

Table 2-3. Potential targets for munition clearance monitoring campaigns (Source of Information Nord Stream 2).

Target ID	KP Line A	Offset (m) Line A	KP Line B	Offset (m) Line B	Depth (m)	Burial (%)	Classification	Explosive weight (kg)
[redacted]								

*assumed

2.3.2 Methods

Stationary monitoring stations

Monitoring will be carried out with bottom mounted sensors. The monitoring areas at Hanko and Porkkala Kallbådan will each have two monitoring arrays in order to record distance attenuation parameters during the clearance operation. Two sensor arrays will be installed with a 4–5 nautical mile separation from each other. The Hanko area is of scientific interest because it has many academic research sites and installations and Porkkala Kallbådan is known to have an intense seal population.

Monitoring areas at Söderskär, Eastern Gulf of Finland, Malusi and Uhtju are all equipped with a single hydrophone array and they will provide information about noise level increases and also data for model verifications.

The single hydrophone array has one hydrophone installed below the seasonal thermocline at 35 meters depth and another above the seasonal thermocline at 10 meters depth (Figure 2-2). By this way it is possible to detect the effect of the stratification on the sound attenuation and noise penetration. Seven identical arrays will be used in total. The systems record sound files onto internal memory.

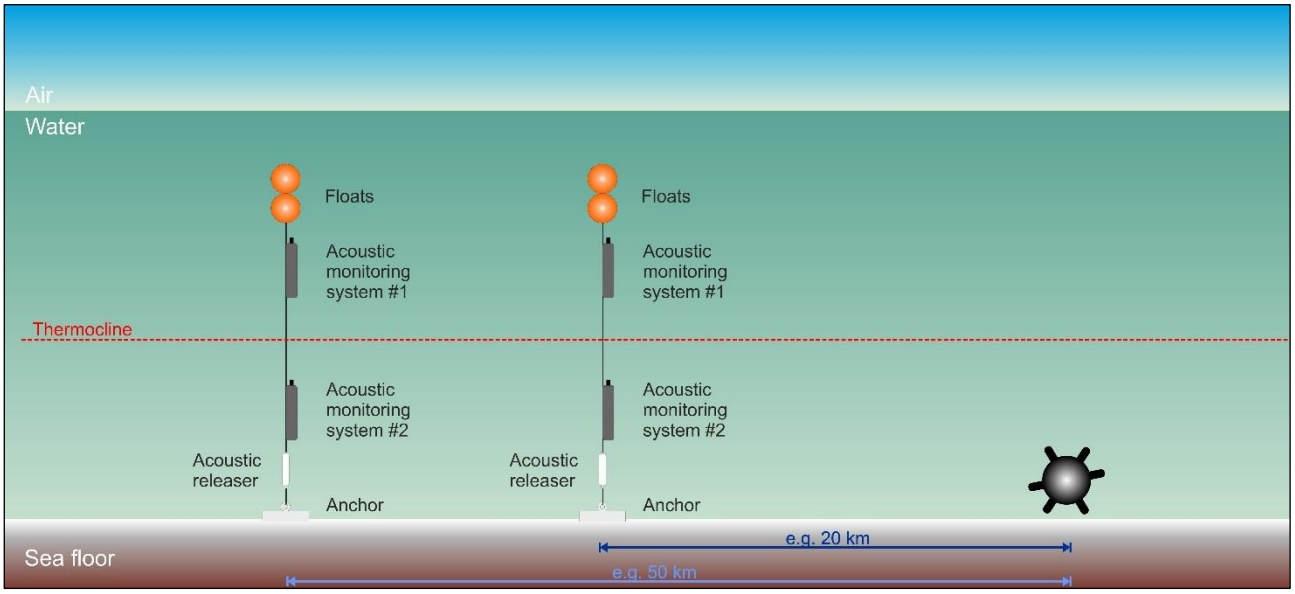


Figure 2-2. Proposed monitoring method (not in scale) for one or two hydrophone array installations.

Conductivity-Temperature-Depth (CTD) and sound velocity profiles will be measured at all stations during the installation of monitoring devices, servicing visits and de-commission phases of monitoring devices. CTD and sound velocity profiles are used to give background information about the stratification and presence of the seasonal thermocline. Strong vertical gradients can impact the noise penetration and attenuation. CTD-profiling should be done with Rinko, CastAway, EXO, Sea-Bird or Valeport type sensors equipped with fast conductivity, temperature and pressure sensors. Sound velocity profile can be measured by direct method or by using CTD data and velocity of sound in sea-water equations e.g. UNESCO.

Monitoring will be made with a 100% duty cycle i.e. continuous record when construction related activities will start. Recorded sound files are analysed against the known munition clearance events in order to evaluate how the different charges and types of munitions behave with respect to sound levels and frequencies. The initial schedule with stationary monitoring depends on the time-frame between the construction of Nord Stream 2 pipelines.

The measured data will be checked, and the pre-amplifier gain will be adjusted after the first construction activities. The sample rate will be dependent on the measurement period and frequency range. The highest frequency that can be recorded is one-half of the sample rate. Minimum frequency range will be 10 Hz–10 kHz.

Monitoring with mobile sensors

In addition to stationary monitoring, three monitoring campaigns will be carried out with a mobile monitoring device. This system consists of an anchored vertical hydrophone line with a minimum of three hydrophones and a vessel mounted system (Figure 2-3). The monitoring range will be from 1,000 to 5,000 meters depending on construction activity and required safety distances. CTD and sound velocity profiles will be recorded during each monitoring campaign. As duration of these monitoring campaigns is estimated to be 6–12 hours, a higher sampling frequency will be used. This allows obtaining information with higher temporal resolution for more detailed analysis of original sound source levels.

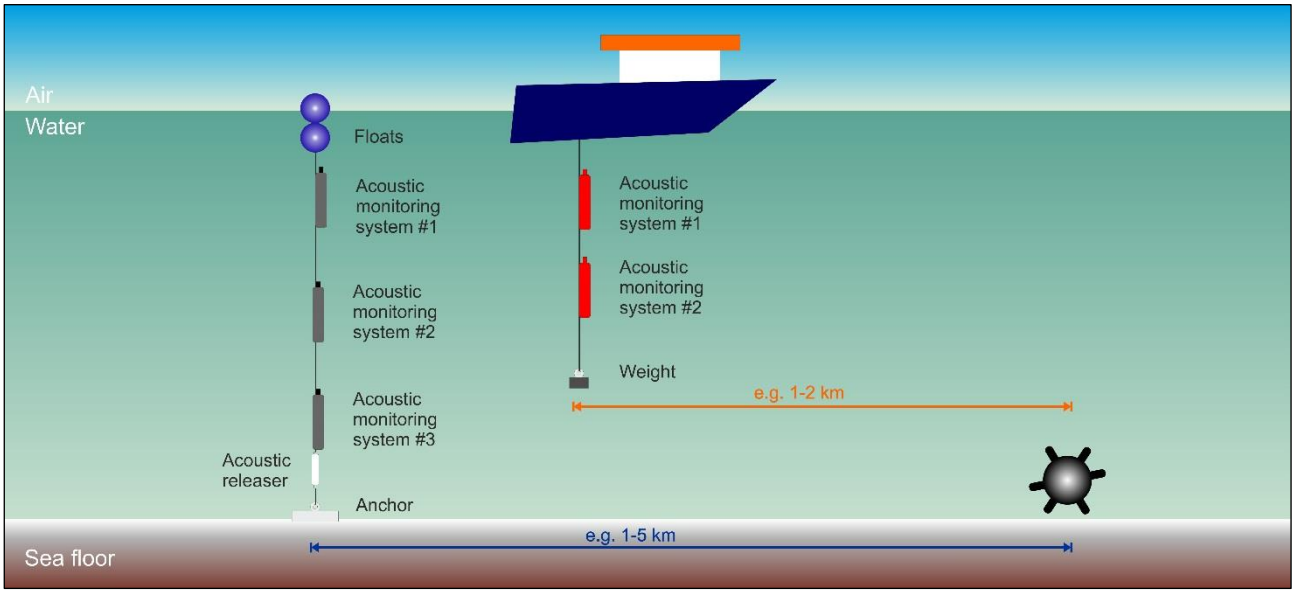


Figure 2-3. Proposed monitoring method (not in scale) for mobile sensors.

Data handling

Underwater noise metrics are dependent on the characteristics of the noise source. For impulsive sounds appropriate metrics are Sound Exposure Level, Peak Sound Pressure level and Peak-to-Peak Sound Pressure Level. For continuous sound sources the Sound Pressure Level is commonly used.

Data analysis can be made for example with Matlab or other mathematical program capable of analysing large datasets. Sound pressure levels should be calculated in the 10 Hz–10 kHz 1/3-octave bands over 1 second from the whole measurement period. Results are further processed to 5 minutes and 1 hour equivalent continuous sound pressure levels (Leq5min and Leq1h), L95, L50 and L5 percent statistical levels. Statistical noise levels LN are commonly used for environmental noise monitoring. All recorded events should be analysed separately. Values should be presented with local wind speed data collected from the nearest meteorological station.

2.4 Turbidity and current monitoring

The construction phase of the proposed Nord Stream 2 pipeline system will generate sediment spreading that can potentially have an environmental impact on the marine life. In the EIA phase a particle tracking and current model was used to estimate these impacts. In the construction phase sediment spreading will be monitored by measurements and the results will be compared against modelled levels. Sediment spreading can be measured with optical turbidity sensors. In addition to turbidity monitoring 3D current field will be measured in same locations with ADCP devices. Current measurements will be used to validate modelling results. In addition, data will be used as background information for interpretation of turbidity monitoring results.

2.4.1 Scope

Monitoring will be conducted with stationary bottom mounted sensors in the Finnish territorial waters. Stationary monitoring sensors will be used for time-series analysis of sediment spill extent and duration. 3D current monitoring data contains information about current direction, magnitude in separate vertical layers from bottom to surface and will be used to interpret turbidity monitoring results.

Main objectives for turbidity and current monitoring program are to evaluate:

1. How far the sediments originating from construction operations can travel
2. How high the sediment spill can rise from seabed
3. How high the maximum turbidity readings are
4. How much the construction related sediment spreading elevates the background levels in each monitoring location
5. How well the modelled impacts during the EIA phase match with the measured values

Turbidity time-series can be used as indicator for dispersion as impurities and harmful substances are mainly bounded with clay particles in sediment. Turbidity is well recognized parameter for monitoring of suspended matter in water and therefore it is recommended using for sediment tracking. Turbidity sensors measure turbidity in FNU-/FTU-units and these units can be transformed to solid substance concentrations (mg/l) in water by using local conversion factors based on laboratory analysis. Similar methods are commonly used on dredging and dumping operations. Based on turbidity measurements, very rough estimate of the amount of re-suspended matter could be calculated.

Short-term monitoring of monitoring targets (rock placement/munitions clearance, Table 2-4) will start 1–2 weeks prior to construction operation in the area and will last 1 week after the operation is completed in each monitoring location. This allows moorings to be shifted to a new location along the pipeline.

In addition to short-term monitoring stations, two long-term monitoring stations will be established to collect background information about natural and seasonal variability of turbidity levels (i.e.: Control stations, Table 2-4). These reference stations will be equipped with sensors to measure salinity, temperature and dissolved oxygen levels in addition to turbidity sensor. Long-term monitoring will start 2 weeks prior and last 4 weeks after the completion of construction phase.

2.4.2 Monitoring areas

The stationary monitoring areas were selected based on their location with respect to the activity type, level and duration. Proposed monitoring locations are two rock placement sites and two munition clearance sites. In addition, one monitoring station will be installed in the proximity of the Natura site "Sea Area South of Sandkallan" (reefs as a conservation objective, later called as Sandkallan Natura 2000 area/site) where both munition clearance activities and rock placement activities are going to be carried out.

Monitoring areas have been selected taking into account the seabed sediments. Sediment consists normally of clay but near the Sandkallan Natura 2000 area the type is hard bottom complex. Monitoring is focused on the pre-lay activities because during that period disturbance of seabed sediments is highest. Duration of monitoring is planned as follows: approximately 3 weeks for monitoring of munition clearances locations, few months at max for monitoring of rock-berms locations and approximately a year and a half for the Control stations and the station in the proximity of Sandkallan Natura site.

Background monitoring is proposed to be done in the same locations with the previous Nord Stream-project (stations **Control 1** and **Control 2**; Table 2-4). These control stations are approximately 14.6 km (Control 1) and 27.6 km (Control 2) from the proposed pipeline route.

Description of the monitoring stations (see also Table 2-4, Figure 2-4 and Appendix 2):

- **Rock placement #1:** a large rock placement site (about 23.000 m^3) located on Line A (A1036), very soft well stratified clay, monitoring locations ca. 100-500 m from activity
- **Rock placement #2:** a medium-large rock placement site (about 9.000 m^3) located on Line B (B1022), very soft clay, monitoring locations ca. 100-500 m from activity
- **Munition clearance #1:** a munition clearance site for the clearance of a 115 kg munition (medium size munition) located on soft sediment, monitoring locations ca. 100-500 m from activity
- **Munition clearance #2:** a munition clearance site for the clearance of a 350 kg munition (large size munition) located on soft sediment, monitoring locations ca. 100-500 m from activity
- **Munitions clearance/rock placement:** 1 station in the proximity of Sandkallan Natura 2000 area (, 1.9 km from pipeline A

Table 2-4. Location of monitoring sites and parameters to be measured.

Location	Type / Activity	Lat	Lon	Parameters	Number of moorings	Duration
Control #1 Western Gulf of Finland	Background	59°43,969´N	23°28,970´E	turbidity, salinity, temperature, oxygen	1	start: 2 weeks prior the end: 4 weeks after construction time has ended
Control #2 Eastern Gulf of Finland	Background	60°10,631´N	26°45,129´E	turbidity, salinity, temperature, oxygen	1	start: 2 weeks prior the end: 4 weeks after construction time has ended
Rock placement #1	Pipeline crossing	60°2,089´N	26°13,675´E	turbidity, salinity, temperature, oxygen + currents	3 water quality 1 ADCP	start: 1–2 weeks prior the end: 2 weeks after rock placement
Rock placement #2	Rock placement	59°41,573´N	24°5,101´E	turbidity, salinity, temperature, oxygen + currents	3 water quality 1 ADCP	start: 1–2 weeks prior the end: 2 weeks after rock placement
Munition clearance #1	Munition clearance			turbidity, salinity, temperature, oxygen + currents	3 water quality 1 ADCP	start: 1–2 weeks prior the end: 1 week after clearance operation
Munition clearance #2	Munition clearance			turbidity, salinity, temperature, oxygen + currents	3 water quality 1 ADCP	start: 1–2 weeks prior the end: 1 week after clearance operation
Munition clearance / rock placement	Proximity of Sandkallan protected area			turbidity, salinity, temperature, oxygen + currents	3 water quality 1 ADCP	start: 2 weeks prior the end: 4 weeks after construction time has ended

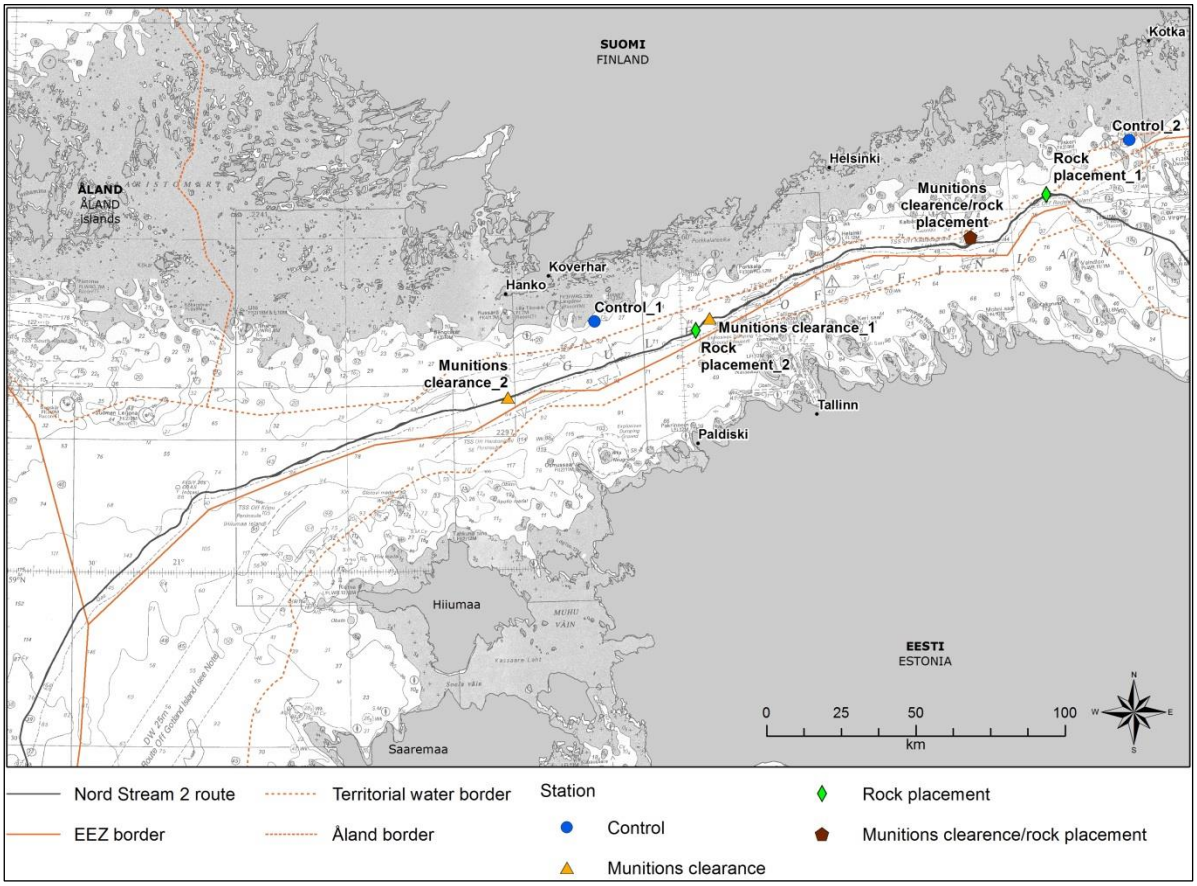


Figure 2-4. Proposed monitoring stations in the Finnish EEZ during the construction activities of NSP2.

2.4.3 Methods

Stationary monitoring will be carried out with bottom mounted sensors. Sensors will be installed at fixed depths: 2, 5 and 15 meters above the seabed (Figure 2-5). In the previous NSP project highest turbidity readings were found to stay in lowest 10-meter layer and therefore three monitoring depths are proposed.

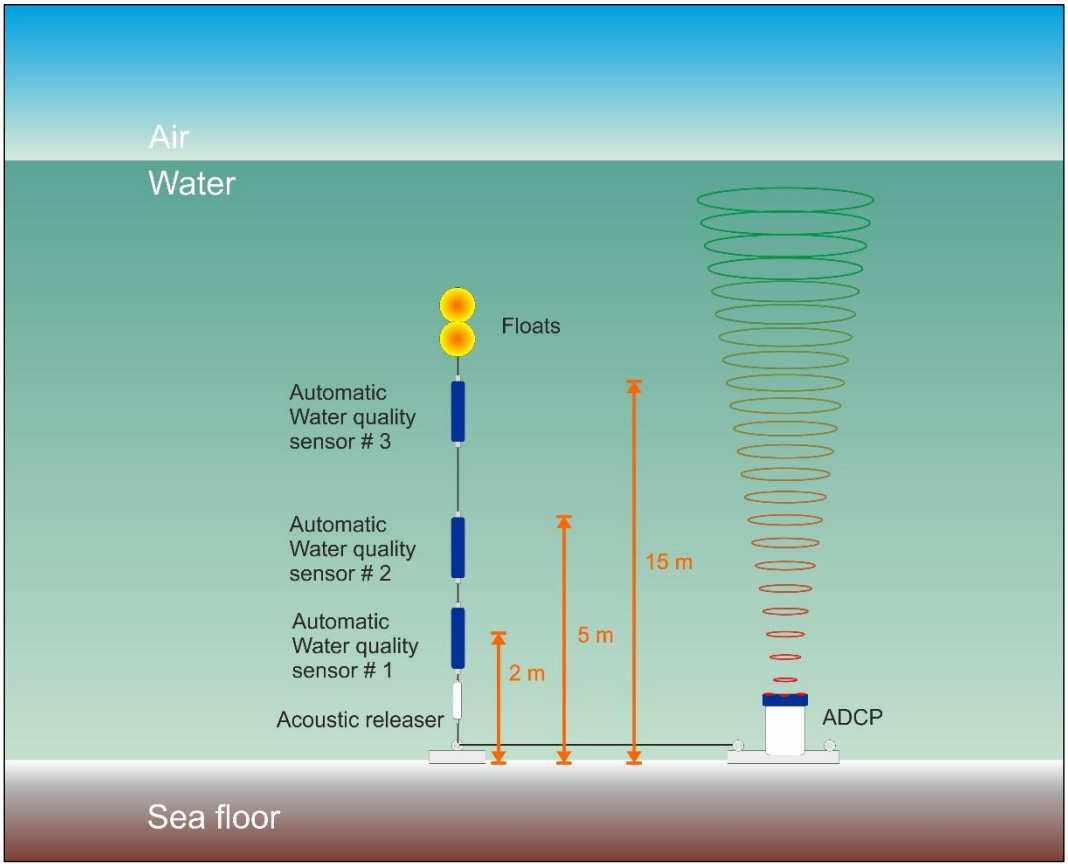


Figure 2-5. Example of monitoring setup.

Turbidity readings are measured with optical sensors equipped with automatic cleaning. Proposed monitoring interval is 15 minutes.

In each selected monitoring locations three identical monitoring moorings will be used in a triangular shape around the monitoring site (Figure 2-6). One monitoring will be equipped with ADCP device for current monitoring. Current monitoring will be done at 15 minutes interval, with adequate ping rate (e.g. 15–30 sec).

Long-term monitoring stations will be equipped with only one mooring. No ADCP data will be recorded at these stations.

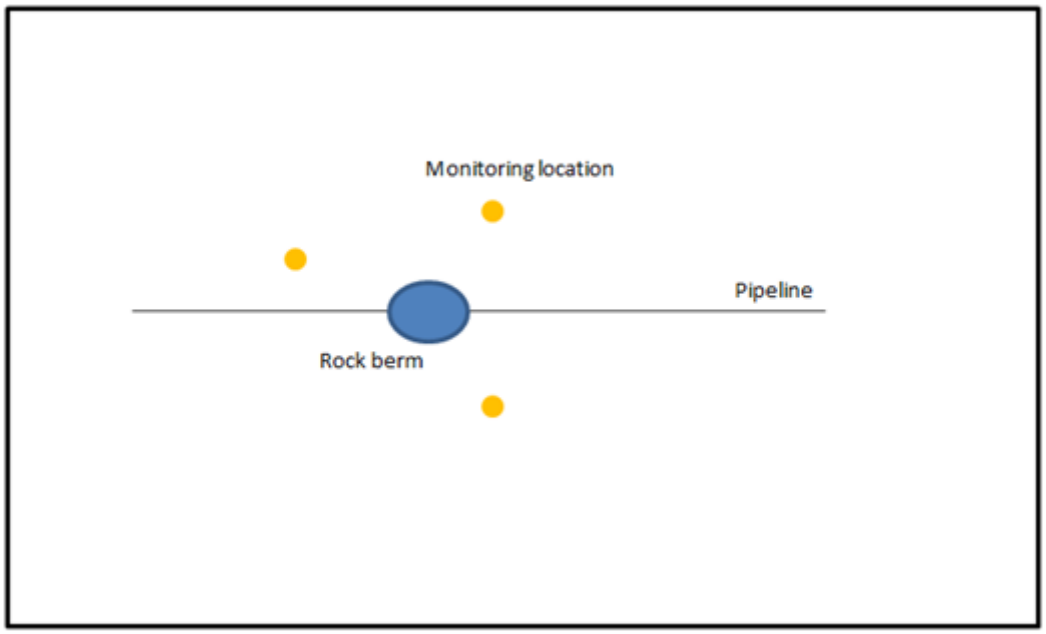


Figure 2-6. Schematic diagram of triangular monitoring installation around the monitoring site.

2.5 Commercial fishery

After the construction of the pipelines, during the operation phase, a survey targeting Finnish fishermen trawling in the NSP2 pipeline area in the Finnish EEZ will be performed. For this purpose, a fishery questionnaire will be developed. The survey will be carried out to get the idea how fishermen have experienced the construction phase and how the presence of the twin pipeline system on the seabed has affected their fishing behaviour. In the questionnaire there will be questions related to fishing methods, fish catches and fishing areas and of possible changes in these during the project. Also, questions related to hindrance experienced by fishermen when trawling in the pipeline area will be compiled.

In addition to the fishery questionnaire, the fishing vessels' avoidance of the pipeline area and possible changes in fishing patterns in the Finnish EEZ will be monitored. For this purpose, the tracking data obtained prior to the construction will be compared with the tracking data that will be gathered two years after construction of the pipeline system (Table 2-5).

Table 2-5. Schedule for monitoring activities during 2017–2022 in the Finnish EEZ.

Parameters, methods and timing of monitoring				
Target group	**Parameter**	**Method**	**Data coverage**	**Reporting**
Finnish commercial offshore trawl fishermen	Fishing behaviour etc. (compared with previous monitoring results)	Questionnaire	Finnish fishermen trawling in the Finnish EEZ during 2018–2021	Two years after the construction phase in 2022
Finnish offshore trawling fleet operating in the project area in the Finnish EEZ	Fishing patterns etc. (compared with previous monitoring results)	Analysing of vessel Monitoring System (VMS) satellite tracking data	Trawl fishery in the pipeline area in the Finnish EEZ during 2017–2021	Two years after the construction phase in 2022

2.6 Cultural heritage

Historically and archeologically significant underwater cultural heritage (UCH) sites have been taken into consideration when planning the routing of the pipelines in the Finnish EEZ. Visual surveys (detailed mapping) were carried out in summer 2016 to identify possible UCH sites (wrecks) on the seabed along the route alignment. All potential underwater cultural heritage sites that are located nearby the pipeline route (±250 m) have been evaluated carefully.

There are three underwater cultural heritage or World War II historical sites relatively close to the pipeline route. These are presented in Table 2-6.

Table 2-6. Significant UCH and World War II historical sites found approximately less than 250 m from the pipeline route.

Target (NSP2 ID)	Category	Description	Value	Pipeline offset to A and B lines*	Pipeline offset to A and B lines**	Protection
S-R05-7978	Wreck (wooden barge)	Probably a cannon barge from the late 18th-early 19th century.	Age >100 years. Significant UCH site.	152 m (Line A) 65 m (Line B)	147 m (Line A, debris) 58 m (Line B, debris)	A 50 m minimum safety perimeter is recommended for the wrecksite. A post-pipelay inspection is recommended for the site due to the relatively short offset distance to line B routing.
S-R09-09806 (SD-Alt1-3372)	Barrage (anti-submarine net)	Sections of the "western" and "eastern" parts of the "Walross" anti-submarine net (barrage) from World War II.	Significant World War II historical site.	131 m (Line A) 228 m (Line B)	0 m (Line A and Line B) Extends across the pipeline routes A and B	Detrimental interventions with the site must be minimised. A post-pipelay inspection is recommended as both A and B line routings are likely to cross the net installation.
S-R11-2395	Wreck (steel, motor vessel)	A badly devastated 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.	386 m (Line A) 311 m (Line B)	296 m (Line A, debris) 253 m (Line B, debris)	Due to the vast scatter of debris, a 250 m safety perimeter is recommended for the site.

* Offset to the center of the main wreckage/target
** Offset to the closest point of the target (scattered debris, loose objects etc.)

Wreck S-R11-2395, which is potential World War II historical site, will be left out from the monitoring due to the distance to the construction activities. UCH sites to be included in the monitoring will be wooden barge S-R05-7978, a significant UCH site, and barrage/anti-submarine net S-R09-09806, which is significant World War II historical site (Table 2-7 and Figure 2-7).

The condition and location of these two cultural heritage sites will be surveyed prior to start of construction activities in late 2017 or early 2018. In order to verify that UCH sites will not be affected by the construction of the pipelines, a post-construction survey will be performed. It will consist of an ROV (Remotely Operated Vehicle) visual inspection and an MBES survey. Possible impacts of the construction activities to the UCH sites can be detected by comparing the baseline survey (late 2017 or early 2018) and post-construction survey results.

Table 2-7. Monitoring of impacts on cultural heritage.

Parameters, methods and timing of monitoring				
Target group	**Parameter**	**Method**	**Location**	**Timing / frequency**
S-R05-7978 (wreck of wooden barge) **and** **S-R09-09806 (barrage/anti-submarine net)**	Location (coordinates) and Condition (intact/damage)	ROV visual inspection MBES survey	Location of UCH sites	Once prior to construction activities in late 2017 or early 2018. Once, when all construction activities have been finalised

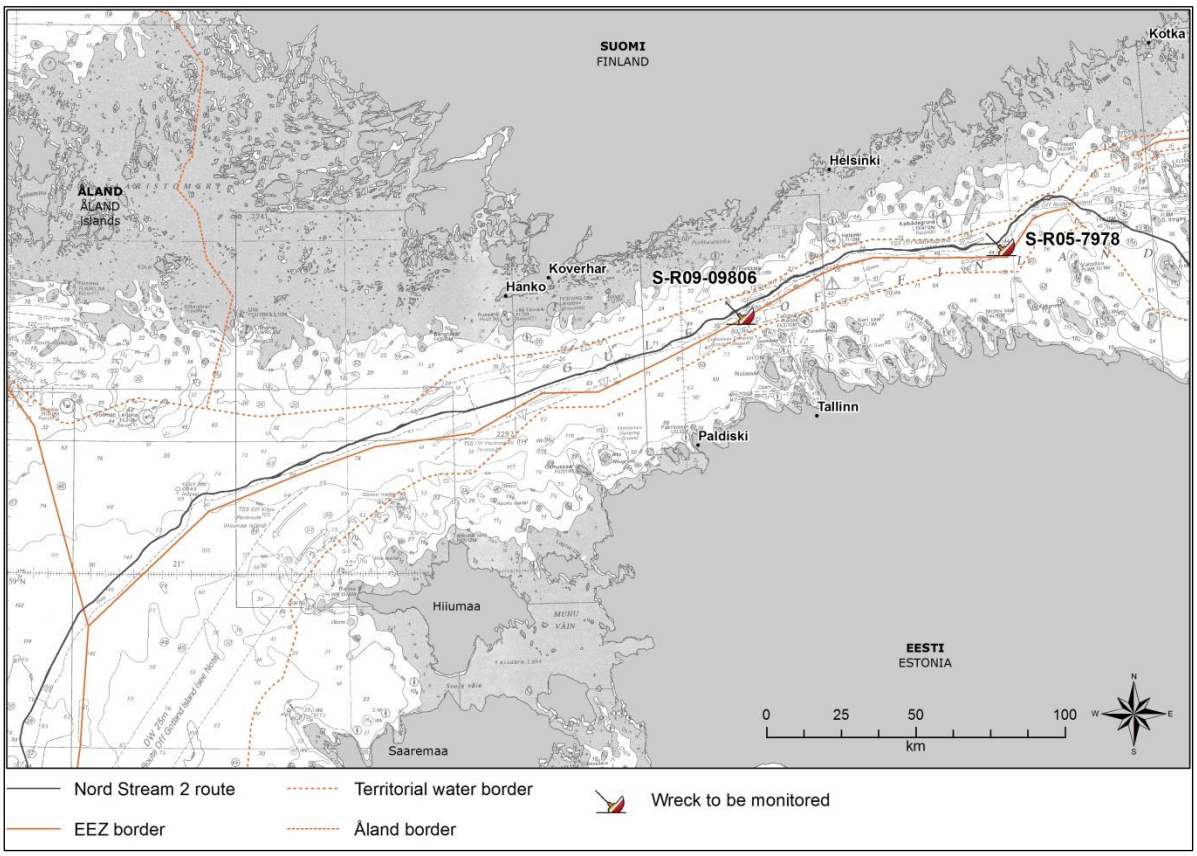


Figure 2-7. Monitoring locations of cultural heritage objects.

3. TECHNICAL INSPECTIONS DURING OPERATION

In addition to environmental monitoring, regular inspection surveys of the pipeline system will be carried out as part of the inspection, maintenance and repair (IMR) programme throughout the operation phase. The main goal of inspection surveys is to ensure the safe and reliable operation of the pipeline system throughout its lifetime.

Before the start of operation of the pipeline system an Inspection and Monitoring Strategy has been developed. It describes the main types of inspections, their requirements and frequency. All the inspection requirements identified during the design phase as affecting the overall pipeline integrity (safety and reliability) during operation are covered in the Inspection and Monitoring Strategy.

Four types of inspections are planned for the entire route of the pipelines from Russia to Germany:

- External offshore inspection for the main marine section of the system (deeper than approximately 15 metres),
- Internal inspection over the full pipeline length (pig-trap Russia to pig-trap Germany)
- Shallow water and onshore inspections surveys using geophysical surveys of the buried sections (Russia and Germany) – not required to be performed in Finland
- External inspections of the exposed onshore section (Russia and Germany) – not required to be performed in Finland

External Offshore Inspection will evaluate the pipeline / seabed configuration and the external condition of the pipelines. This inspection survey will be executed from a Survey Vessel equipped with ROVs or AUVs having visual, acoustic and electro-magnetic survey tools. During offshore external inspections the following information is determined:

- Damages to the pipelines e.g. to concrete coating and field joints
- Damage to pipeline support structures e.g. rock berms and cable crossing support mattresses
- Damage or depletion of anodes and deficiencies of cathodic protection
- Significant movement of pipelines, in particular if movement is outside of the installation corridor
- Locations where rock placement has to be carried out as a remedial action to support the pipeline, based on the survey inspection information
- Possible new objects (UXO, CHO or other) and targets within the pipeline installation corridor
- The location and condition of 1 wreck and 1 barrage in the vicinity of the pipelines
- The location of the munitions in the vicinity of the pipelines

All collected data are compared with previous surveys and annual inspection surveys to allow comparison to the design and as-built condition. Historical trending is used to assess the development of such items as free spans, seabed scour, areas prone to damage, and consumption and physical loss of anodes (prediction of anode wastage).

Internal inspection is executed with internal pipeline guides. Intelligent pigs that run through the entire pipeline length in the direction of the gas flow inspect for possible metal losses of pipeline body due to corrosion and change of local pipe geometry (dents).

In pipeline internal inspections potential local anomalies in the pipeline geometry are detected with pipeline inspection gauges (pigs):

1. Pipe internal or external metal losses (wall thickness anomaly) e.g. due to corrosion
2. Individual wrinkles (internal diameter anomaly)
3. Out-of-roundness (ovality) dents
4. Change in curvature of the pipelines (bending)

The location and extent of the anomalies as for aforementioned parameters are proposed to be reported, if

1. Pipe wall thickness anomaly is greater than 10% of wall thickness
2. Pipe internal diameter anomaly is greater than 2.5 mm
3. Pipe ovality is greater than 1% of internal diameter
4. Pipeline bending is greater than 0.125% of bending strain (pipeline radius/bend radius)

The frequency and the starting date of each following inspection will depend on the results of the previous inspection surveys.

The Inspection and Monitoring Strategy will also provide for special inspections in case of any unexpected events which may impair the safety and reliability of the system. If the pipeline parameters are discovered to deviate critically from the design limits in any of the inspections, an appropriate maintenance or repair programme will be implemented.

4. REPORTING

4.1 General

Annual reports

The monitoring results and conclusions of the environmental impacts during construction and operation of the pipelines will be presented in annual reports. The reports will be prepared in English, Finnish and Swedish. The reports will be submitted to authorities for each calendar year by the end of May the following year.

In construction phase, the annual report provides a brief description of the construction activities carried out during a year. In operation phase, general information on the operation of the pipelines (gas flow, maintenance activities etc.) will be reported. Monitoring methods and activities conducted during a year will be described in the annual report. Environmental conditions as a background information will be presented in the reports.

The annual report summarises the monitoring results from all monitored activities for each monitored parameter. In the annual report, the significance of environmental impacts is assessed and discussed based on monitoring results of each monitoring target. The results will be compared with the monitoring results from Nord Stream project (a similar gas pipeline project in the same sea area in the Finnish EEZ). The annual report provides conclusions of the monitoring and recommendations for future monitoring.

Quarterly reports during construction

In addition to the annual reports, quarterly reports will be prepared during construction phase. The quarterly reports will be prepared in English, Finnish and Swedish. The reports will be submitted to authorities 3 months after the end of each quarter. The objectives of these reports are to present:

- Construction activities carried out during the quarter
- Environmental conditions during the quarter
- Monitoring activities carried out during the quarter
- Preliminary monitoring results from the quarter (the results that are available by the time of submission)
- Unplanned events, chance finds, anomalies
- If necessary, possible changes to monitoring activities and methods
- A rough estimate of environmental impacts

Reporting of unplanned events

In addition to annual and quarterly reports, unplanned events and chance finds will be reported immediately to authorities.

4.2 Underwater noise

Reporting will be made after the munition clearance period has ended and will be submitted as part of a quarterly- and/or an annual report.

Reporting will include information about recorded sound parameters and characteristics in the archipelago and Natura 2000 sites, including information concerning sound penetration estimate and maximum sound levels vs. background levels. In addition, a comparison between modelled and measured impacts should be included in the report. CTD profiles and changes in thermocline depth and density should be included in the report together with an evaluation of impacts of the seasonal thermocline on datasets measured above and below the thermocline.

Data analysis from mobile monitoring systems will include information about the detailed distance attenuation over shorter distances and frequency variations when the distance from the sound source is increasing. These values can be used for model validation and more detailed estimation of noise impact on marine life. Depending on locations and environmental conditions, data between two stationary monitoring stations can be compared for a single munition clearance event.

Data files as well as analysed parameters will be delivered to Nord Stream 2 as WAV files and Excel datasheets included analysed sound parameters (see above in same chapter). WAV files will include a calibration tone at the beginning and end of the recording for calibration and later analysis.

CTD and sound velocity data is delivered as temperature [°C], depth [m], salinity [PSU / ‰] and SV [m/s] readings together with time, date and position data.

In addition, based on consultation with the Uusimaa ELY Centre, the following documents will be prepared and provided to the ELY Centres:

- Preliminary results of underwater noise gathered from the first week of munitions clearance campaign
- Interim technical underwater noise report after the first three weeks of underwater noise monitoring

Preliminary results from three mobile monitoring sensors, which are planned to be deployed during the first week of the munitions clearance campaign will be submitted. These rather detailed sound pressure level at detonation location can be calculated in 24-hour time frame, after data is downloaded and analysed. Preliminary results from the three campaigns can be submitted within 7-10 days after the start of munitions clearance campaign.

In order to compare measured and modelled noise levels, Nord Stream 2 will prepare an interim technical report where the data collected by an additional service visit to selected stationary monitoring stations in the vicinity of the clearance operations during the first two weeks of the munitions clearance campaign will be evaluated together with the data collected from 3 mobile monitoring campaigns. In the technical report, the noise levels of each munition clearance event will be compared with the assessed results. This report is available approximately three weeks after the munition clearance operations started. Considering that munition clearance is programmed to last about two months, it is estimated that after three weeks from the beginning of the munitions clearance less than half of the munitions will have been cleared. Once the technical report is available, NSP2 will present the results to ELY-Centre.

4.3 Turbidity and currents

Reporting will be done during the monitoring and after the monitoring period has ended and will be submitted as part of quarterly and annual reports.

Calibrated and quality controlled water quality and currents readings are published together with time and location information. Reporting will include information about used instruments, installation method, water depths and other auxiliary data.

Data files including also original raw data will be delivered to Nord Stream 2 as excel files. In addition, technical reporting will include time-series figures and short discussion. Data will be analyzed separately against modelled results.

4.4 Commercial fishery

Based on the monitoring activities, impacts of the construction works on fishing behaviour and fishing patterns in the project area in Finnish waters will be reported as preliminary scheduled in Table 2-5. The results are compared with the data of the previous monitoring activity among the Finnish offshore trawl fishermen operating in the Finnish EEZ. Fishery monitoring will be reported and submitted as a part of the annual report.

4.5 Cultural heritage

Reporting concentrates on the comparison of the baseline survey results with the post-construction survey results of the condition of chosen wrecks. By comparison of the positions and still images of the wreck features observed during different time periods it can be established whether the wrecks have been interfered with or otherwise affected by the pipeline construction works.

The monitoring of cultural heritage will be reported in quarterly and annual reports. Individual wreck monitoring reports will be provided to the National Board of Antiquities.

5. CHANGING OF MONITORING PROGRAMME

Potential changes in the monitoring programme are subject to the approval by the supervising authorities or regarding fishery monitoring, approval by the fishery authority.

6. REFERENCES

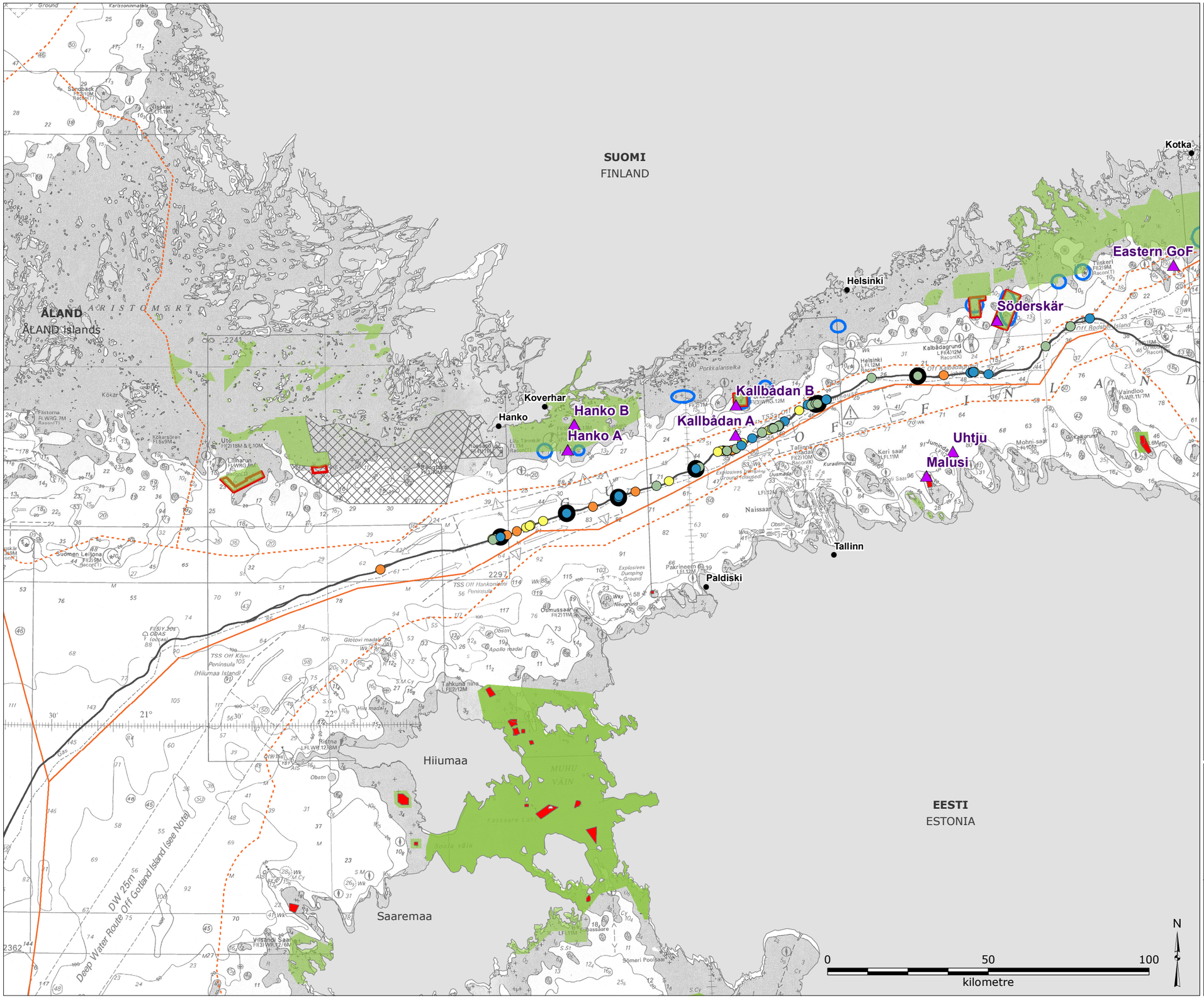
ARCB 2018. Update of summary tables of environmental impact assessment of munition clearance on munition by munition basis Finnish EEZ. W-PE-EIA-PFI-REP-999-MBYM02EN-01. January 16, 2018.

HELCOM 2008. Manual for Marine Monitoring in the Combine Programme of HELCOM. [http://helcom.fi/Documents/Action%20areas/Monitoring%20and%20assessment/Manuals%20and%20Guidelines/Manual%20for%20Marine%20Monitoring%20in%20the%20COMBINE%20Programme%20of%20HELCOM.pdf] Received September 12 in 2017.

Luode Consulting Oy 2017. Underwater noise monitoring in the Gulf of Finland during the munition clearance operations – Scope of Work. 1 August 2017. Nord Stream 2. Document No: W-PE-EMS-PFI-SOW-812-UNMFINEN-01.

Ramboll 2016. Nord Stream 2. Underwater noise modelling. Finland. Document No: W-PE-EIA-PFI-REP-805-030600EN. 32 s.

Ramboll 2017. Nord Stream 2. A Natural Gas Pipeline Through the Baltic Sea. Environmental Impact Assessment Report, Finland. April 2017.



Legend:

- Nord Stream 2 route
- Territorial water border
- Åland border
- EEZ border
- Stationary underwater noise monitoring stations

Identified munitions, kg

- 2 - 25
- 26 - 75
- 76 - 150
- 151 - 300
- 301 - 795
- Munitions, no bubble curtain applied
- Seal sanctuary
- Natura 2000 site designated for seals
- Proposed Natura 2000 extension
- Important grey seal area (resting site)
- Seal protection area, Estonia

Note:
Munitions found from the installation and security corridor

References:
- Limits of Exclusive Economic Zones and Territorial Waters: IBRU May 2010
- Background sea charts are "Not to be used for navigation"
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Date: 2018-01-12
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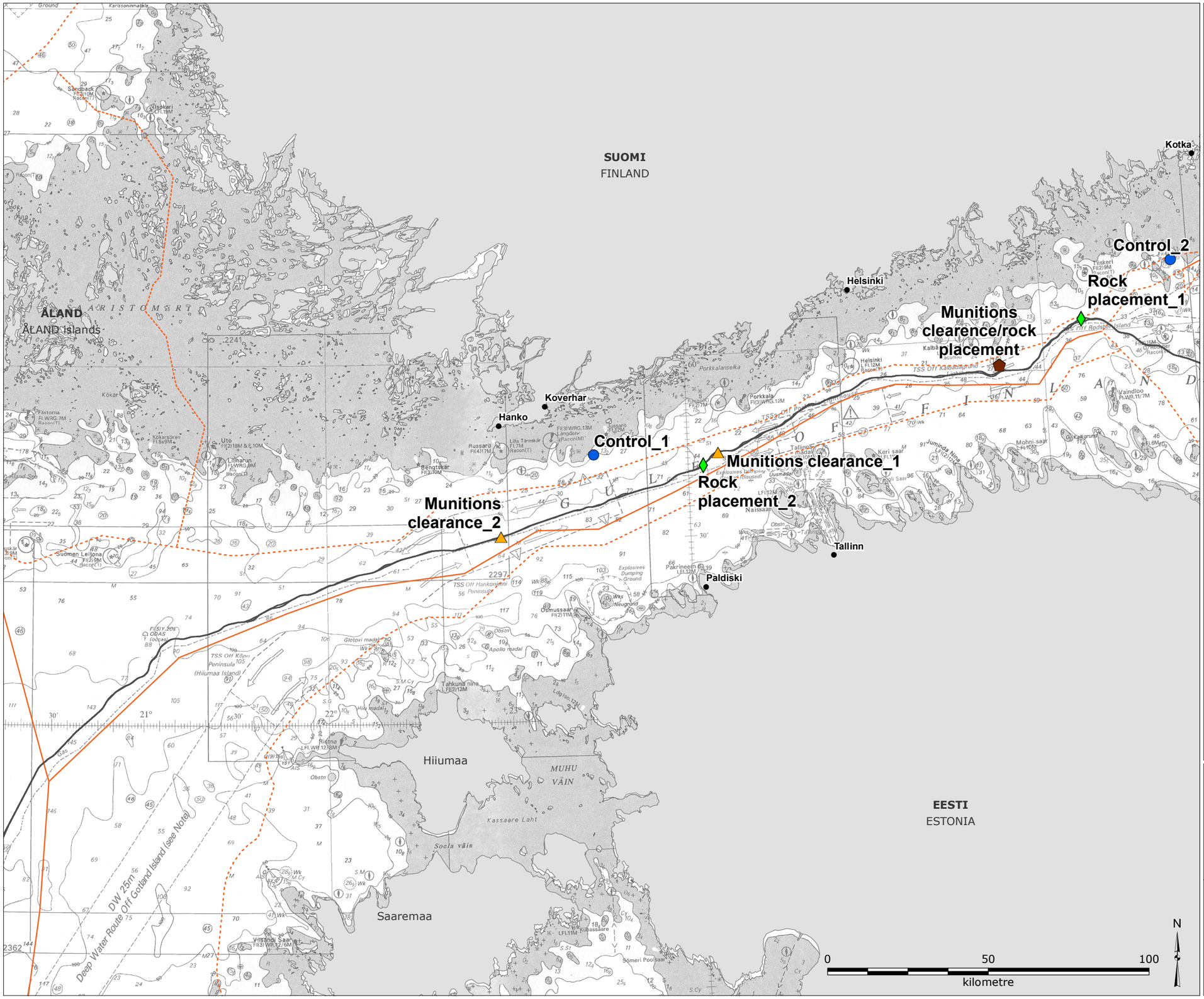
Controlled: SURH

Appendix 1

Monitoring locations

RAMBØLL



Legend:

- Nord Stream 2 route
- Territorial water border
- Åland border
- EEZ border

Station

- Control
- Munitions clearance
- Rock placement
- Munitions clearence/rock placement

References:

- Limits of Exclusive Economic Zones and Territorial Waters: IBRU May 2010
- Background sea charts are "Not to be used for navigation"
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Controlled: SURH

Appendix 2

Monitoring locations - water quality

RAMBOLL