

## Nord Stream Project

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## 1 Introduction

Nord Stream AG is installing and plans to operate an offshore natural gas pipeline from Russia to Germany. The Nord Stream Pipeline will connect the large natural gas resources of Russia with the European natural gas pipeline network. At full capacity, it will provide 55 billion cubic metres (bcm) of natural gas per year to European consumers.

The length of the entire two-pipeline system ('the Nord Stream Pipeline') will be approximately 1,220 km. The pipeline crosses the exclusive economic zones (EEZ) of Russia, Finland, Sweden, Denmark and Germany, and territorial waters (TW) of Russia, Denmark and Germany.

The pipeline construction works are planned to commence in 2010, with the second pipeline being completed in 2012. The Nord Stream Pipeline is designed to operate for 50 years. To ensure safe installation and the long-term integrity of the pipeline, some clearance of conventional munitions will be required.

The Baltic Sea is an area of strategic naval importance. The conventional munitions encountered along the route are principally a legacy of World War I (WWI) and World War II (WWII). These conventional munitions are categorized generally as deployed sea mines, depth charges, torpedoes and aircraft dropped bombs, and dumped munitions. /1/

The munitions clearance work involves the disposal through detonation of mines and other underwater explosive ordnance that could inhibit the safe construction and operation of the pipelines within the security corridor. This security corridor extends 25 m either side of each pipeline route. The number of identified conventional munitions to be cleared in the security corridor in the Finnish EEZ<sup>1</sup> is 27 at 26 locations (Figure 3 and Appendix 1) /2/.

The details (i.e. the frequency, time and location of monitoring, and methods) of the monitoring programme have been developed further during the permitting process and prior to the commencement of munitions clearance work, in cooperation with the munitions clearance Contractor, Finnish Environment Institute, Geological Survey of Finland, Finnish Meteorological Institute, The Finnish Border Guard, Regional Environment Centres and Employment and Economic Development Centres<sup>2</sup>.

The "Monitoring Programme for Munitions Clearance Finland" was approved by the decision No. 83/2009/2 of the Western Finland Environmental Permit Authority on 2 October 2009. Based on lessons learned during munitions clearance in 2009 and the results of munition buffer zone surveys a proposal for specifying the monitoring programme was submitted to the Centres for Economic Development, Transport and the Environment of Uusimaa and Southwest Finland on 21 April 2010. Furthermore, notifications according to permit provisions, e.g. minor pipeline re-routings to avoid the

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<sup>1</sup> Munitions were cleared under the permit No. 83/2009/2 granted on 2 October 2009 by Western Finland Environmental Permit Authority

<sup>2</sup> As a result of the restructuring of the administration, the regional Employment and Economic Development Centres and Environment Centres were integrated and on 1 January 2010 their names were changed to Centres for Economic Development, Transport and the Environment.

clearance of munitions, including specifications to monitoring programmes were made to the Centres during the clearance works in 2010. The Uusimaa Centre for Economic Development, Transport and the Environment has approved the proposed changes in a letter dated on 4 June 2010 (UUELY/742/07.00/2010) and a letter dated on 23 June 2010 (UUELY/742/07.00/2010). This revision G of the monitoring programme accommodates the approved changes.

## **2 General Approach**

The Monitoring Programme for Munitions Clearance Finland will form an integral part of Nord Stream's overall Project environmental and social monitoring programme. The purpose of the monitoring programme is to define how Nord Stream will monitor the impacts of the works, in this case munitions clearance in the Finnish Exclusive Economic Zone (EEZ), as regards to statutory monitoring pursuant to the Water Act and to demonstrate that appropriate mitigation measures are implemented and effective.

Nord Stream will also implement a focused, overall Environmental Monitoring Programme Finland for main construction activities that will be inline with this monitoring programme for munitions clearance. The Monitoring Programme for Munitions Clearance Finland has been developed with the following objectives:

- To confirm that the munitions clearance does not cause impacts not previously identified or greater impacts than predicted;
- To monitor that munitions clearance is carried out in accordance with national permit conditions;
- To monitor the recovery of the environment after munitions clearance. (Related monitoring activities are included in the overall environmental monitoring programme for Finland)
- To verify the modeling results used to predict environmental impacts

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

The environmental monitoring for munitions clearance comprises three major phases:

- baseline investigations (planning/permitting phase)
- monitoring during clearance works
- monitoring after clearance works

Although these steps require different actions, they are seen as part of a single overall approach. The munitions clearance will take place prior to all other pipe-lay activities. Monitoring, after clearance works, which will include monitoring of the recovery of the benthic environment, will be included in the overall environmental monitoring programme for Finland and documented during the pipeline operation phase.

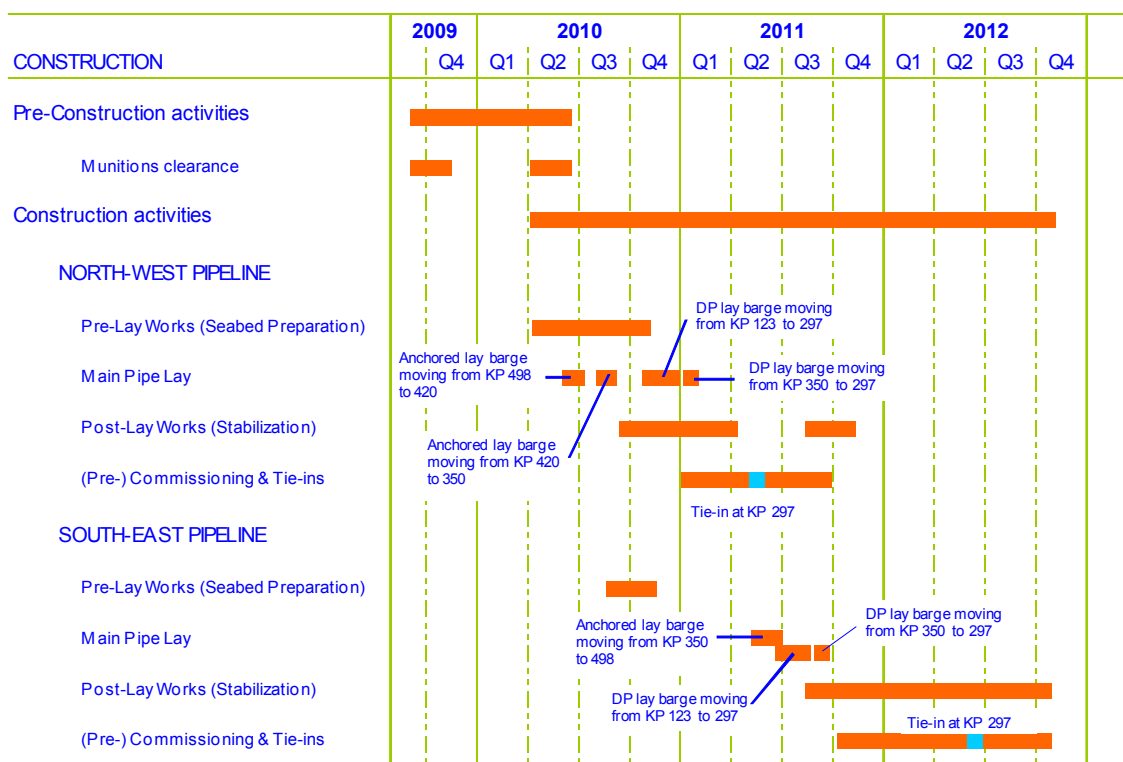
### 3 Construction and Monitoring Time Schedules

The pipeline construction period is estimated to last for approximately 2.5 years (Figure 1). According to plans, the building of the first pipeline (North-West pipeline) will take place from ca. April 2010 to October 2011 and the second pipeline (South-East pipeline) from ca. May 2011 to October 2012, except for the pre-lay works that will be done for both pipelines in 2010. Before the pipeline construction can start, munitions have to be cleared from the security corridor and partially from the anchor corridor.

Impacts from munitions clearance are mainly related to pressure waves and spreading of sediments containing contaminants and nutrients. Impacts from pressure waves to marine mammals, seabirds and fish are mitigated by implementing different measures. The aim of these mitigation measures is to ensure that marine mammals, seabirds or fish shoals are not present at the site during detonation. Timing of clearance works is an important part of mitigation of impacts. The impact on marine mammals will be the lowest during the ice free period as ice and drift ice are the breeding areas of ringed seal and gray seal. On the other hand, during the ice free period there are potentially impacts on seabirds as these are their migration and breeding seasons. However, this impact is not likely as the munitions to be cleared are located far away from nesting grounds and partly in shipping lanes with heavy traffic, which are not likely resting or feeding areas of migrating or breeding seabirds. Spawning seasons of sprat and herring are during the ice free period, but their spawning areas do not coincide with the munitions clearance sites. During the autumn and spring turnover and in the winter phytoplankton growth is not limited by nutrients and at those times the small release of nutrients from sediment has no impact on phytoplankton growth. As a conclusion, the best timing for munitions clearance is in the autumn or spring during the ice free period without temperature stratification in the water column.

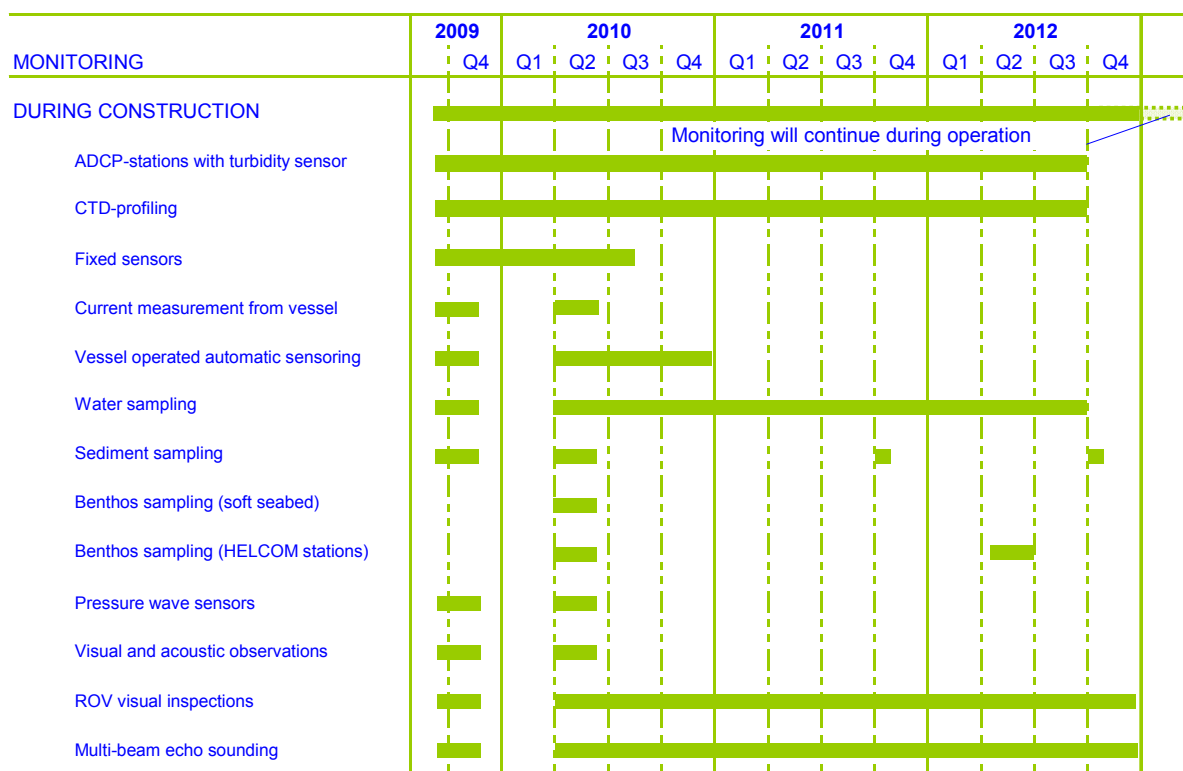
As shown in Figure 1 the first clearance phase was carried out during the ice-free period in late autumn 2009. The second clearance phase will commence in April 2010 after break-up of the ice. The clearance will last for approximately two months for each phase.

The current construction time schedule, based on a start of the main construction activities in April 2010, for different construction related activities in Finland is shown in Figure 1.



**Figure 1.** Nord Stream construction schedule in Finland (as of January 2010).

Timing of monitoring during construction follows the construction and therefore the monitoring activities will in many cases not be a continuous process. The time schedule for different monitoring activities in Finland, based on a start of the main construction activities in April 2010, is shown in Figure 2.



**Figure 2.** Overview of the Nord Stream monitoring schedule during construction in Finland (as of February 2010). More detailed information about the monitoring activities during munitions clearance is presented in Chapter 5.



#### **4 Baseline      Investigations**

The Nord Stream EIA report for the pipeline section in Finland 'Environmental impact assessment in the exclusive economic zone of Finland' /2/, presents in chapter 5 'Present situation in the project area' the baseline conditions in the project area. This addresses the following:

- Physical and chemical environment
- Biological environment
- Protected areas
- Socio-economic environment

Baseline field investigations have been performed during the EIA phase in 2005-2008. After the submission of the Finnish EIA report (March 2009) Nord Stream decided to strengthen the baseline along the exact pipeline route regarding sediment quality, nutrients and contaminants with particular emphasis on selected munitions clearance and rock placement sites in sedimentation areas.

In June and July 2009, a sampling and analysis programme was performed to sample sediments in the main rock placement areas and in the vicinity of selected munitions clearance sites /3/. The sediment samples were analyzed for nutrients, organic contaminants and heavy metals according to the same program as conducted by FIMR in 2007 and 2008. Dioxins were included as an additional parameter into the analysis. Therefore the dioxin concentrations in the sediment at locations where monitoring of water quality during munitions clearance will be performed are known (except for VOHE1). Additional water samples were taken near surface and near bottom. Some further sediment samples were taken along the pipeline route for mainly dioxin analysis making the total number of sampled locations to 33.

## 5 Monitoring during Clearance Works

The monitoring during clearance works aims to document that the environmental thresholds for the project, defined through the EIA and permitting procedures will be maintained or if necessary further mitigation measures may be implemented if the thresholds are exceeded. Following completion of the munitions clearance the overall environmental impact of the works will be documented.

According to the Finnish EIA potential impacts of munitions clearance include:

- Underwater noise and pressure waves from detonation, leading to:
  - Physical changes in the seabed morphology (craters)
  - Re-suspension of sediment and contaminants and nutrients contained in it
  - Mortality or injury of benthic invertebrates, fishes, seabirds and marine mammals
  - Behavioural disturbance of marine mammals
  - Potential damage to cultural heritage sites
  - Relocation and possible damage to debris (barrels)
  - Potential damage to existing infrastructure (cables)
- Interference to commercial shipping
- Interference to commercial fishing.

This Monitoring Programme for Munitions Clearance will therefore address these impacts as defined in the following sub-sections. Summary of the monitoring programme for munitions clearance is presented in Table 1 and the corresponding locations are presented in Table 2.

**Table 1.** Summary of the monitoring programme for munitions clearance.

Monitoring activities for munitions clearance	Locations						
	VOM1 VOM2 VOM3	VOHE1	CONTROL1 CONTROL2	FIX1 FIX2	NOISE1 NOISE2 NOISE3 NOISE4	Cultural Heritage, Barrels and Existing Infrastructure	All identified munitions
Current measurement from vessel <sup>1</sup>							X
Vessel operated automatic sensing <sup>2</sup>	X X						
Fixed sensors <sup>3</sup>				X			
Water sampling for analysis and calibration <sup>4</sup>	X X		X	X			
Water sampling for analyses <sup>5</sup>	X	X					
Sediment sampling for analysis <sup>6</sup>	X	X					
CTD-profiling <sup>7</sup>			X	X			
ROV visual inspections <sup>8</sup>						X X	
Multi beam Echo Sounding <sup>9</sup>							X
ADCP-stations with a turbidity sensor <sup>10</sup>			X				
Pressure wave sensors <sup>11</sup>					X		X
Visual and acoustic observations <sup>12</sup>							X

Parameters:

<sup>1</sup> Current velocity and direction

<sup>2</sup> Turbidity, temperature, conductivity and depth

<sup>3</sup> Turbidity, oxygen concentration, temperature and conductivity

<sup>4</sup> Turbidity, suspended solids, oxygen concentration and conductivity, total and dissolved P and N

<sup>5</sup> Metals

<sup>6</sup> Metals, dioxins and organic tin compounds

<sup>7</sup> Conductivity, temperature and depth

<sup>8</sup> Crater size and integrity of cultural heritage sites, barrels or cables

<sup>9</sup> Crater size

<sup>10</sup> Current velocity and direction, turbidity, conductivity, oxygen concentration and temperature

<sup>11</sup> Pressure waves

<sup>12</sup> The presence of marine mammals, seabirds and fish shoals

**Table 2.** The coordinates of monitoring locations.  
(Note: The mine coordinates are classified and are not presented here.)

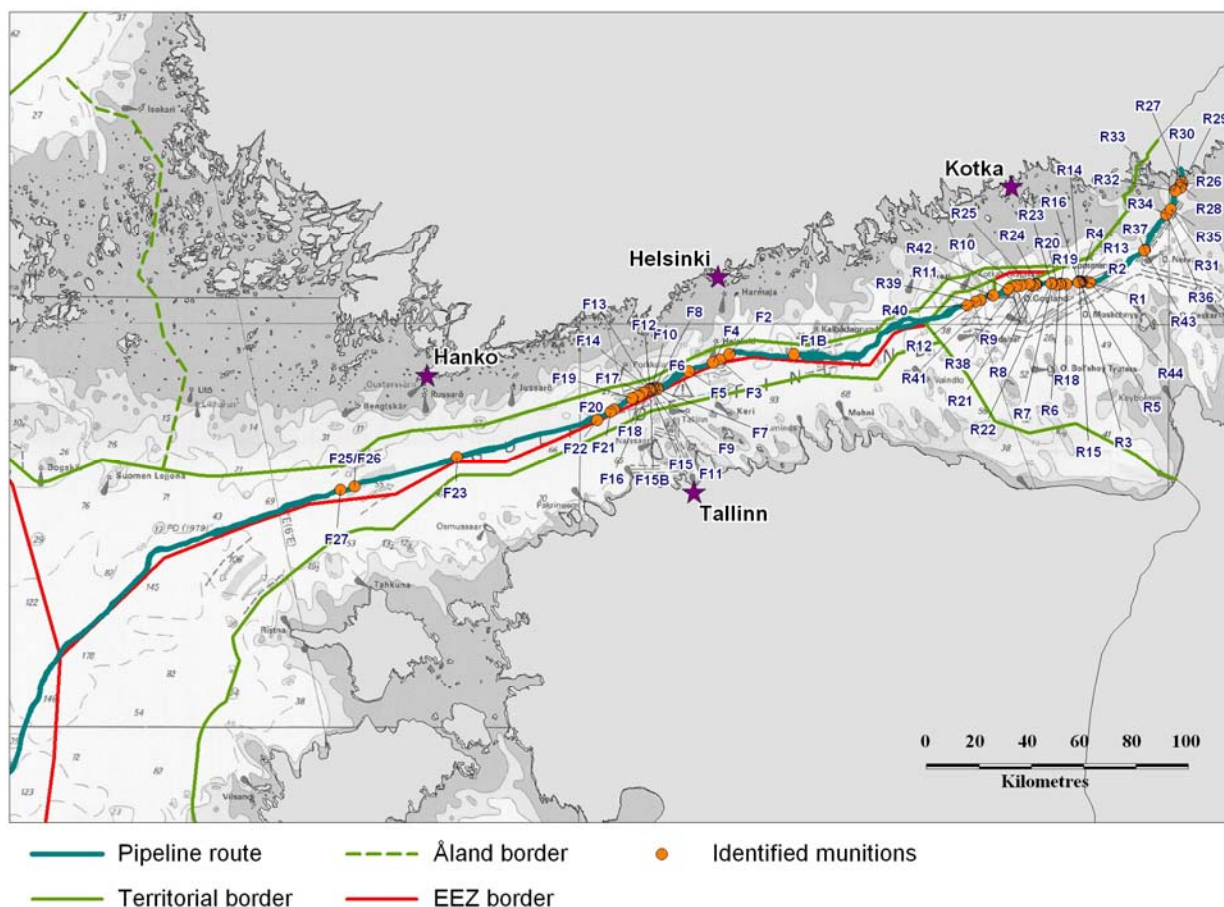
	Locations	X, m WGS84	Y, m WGS84
Vessel operated automatic sensing	VOM1	Mine coordinates classified	
	VOM2		
	VOM3		
Vessel operated automatic sensing for HELCOM stations	VOHE1	Mine coordinates classified	
Fixed sensors	FIX1	3008968	8407035
	FIX2	2975377	8393203
Control stations with ADCP and turbidity sensor	CONTROL1	2614305	8303632
	CONTROL2	2983939	8410301
Pressure wave sensors	NOISE1	Mine coordinates classified	
	NOISE2		
	NOISE3		
	NOISE4		

## 5.1 Seabed Morphology

The assessment of the changes in the seabed morphology resulting from munitions clearance has been performed within the EIA (Chapter 8.1.1 Impacts on seabed) /4/. This assessment has been extended for munitions clearance on a munition by munition basis /2/.

To verify the results of the environmental assessments, the possible changes in seabed morphology will be surveyed by means of a multi-beam echo sounder and visual inspection via ROV prior to the detonation of identified munitions. After the detonation the crater size created will be surveyed using the same devices. These pre- and post-detonation surveys will be carried out by the munitions clearance Contractor.

All 27 munitions at 26 different locations identified within the 50 meter wide security corridor will be monitored (Figure 3). The monitoring programme for seabed morphology during munitions clearance is presented in Table 3.



**Figure 3.** Locations of 27 identified munitions at 26 different locations within the 50 m wide security corridor in the Finnish EEZ where multi-beam echo sounding and ROV visual inspections will be carried out and the locations of 43 identified munitions in Russian waters.

**Table 3.** The monitoring programme for seabed morphology during munitions clearance.

Seabed morphology monitoring					
Project activity	Parameter	Unit M	ethod	Location	Timing
Munitions clearance	Crater / depression	m (depth, radius), m <sup>3</sup> (volume)	Multi-beam echo sounder and visual inspection via ROV	All munitions to be cleared	Prior to and after detonation

## **Reporting of Results**

The results of the ROV based seabed morphology survey will present the seabed features prior to and after the clearance in the immediate vicinity of the detonation site. The report will present an assessment of a crater size.

For each detonation site reporting will include:

- Contoured bathymetric data presented in A3 format
- 3 dimensional visualisation of the crater
- Assessment of the volume of displaced soil based on comparison of pre and post survey results.

Digital data will include:

- CD-ROM based reports in browse-capable .pdf format
- Charts in AutoCad 2000 compatible format
- Bathymetry in ASCII xyz-format (cleaned and gridded data)
- Video data

## **5.2 Water and Sediment Quality**

The assessment of sediment re-suspension and spreading resulting from munitions clearance has been performed within the EIA (Chapter 8.1.1 Impacts on seabed and 8.1.2 Impacts on water quality) /4/. This assessment has been extended for munitions clearance on a munition by munition basis /5/.

In order to reduce the dispersion of sediment and potential associated impacts detonations will be avoided at times, during which there are continuous strong currents due to weather conditions. Currents are considered to be strong either when the bottom close current speed (5 m from the seabed) or the average current speed throughout the water column exceeds 0.3 m/ s within the sector of 120 - 210 degrees (flow direction).

At each munitions clearance site current measurement will be performed once prior to the detonation. Current speed and direction will be measured in intervals of ten meters from 1 m below the surface to 5 m above the seabed by lowering a sensor from a support vessel through the water column. The measured results will be depicted as current profiles as a function of depth and provided to the competent Centres for Economic Development, Transport and the Environment and included in monitoring reports.

Sediment re-suspension and dispersion from munitions clearance will be investigated through a combination of in-situ measurements and water sampling to verify the assessment results with respect to:

- Total amount of re-suspended sediment
- Spatial range of sediment spreading
- Duration of sediment spreading

The quantification of the total amount of re-suspended sediment will be based on precise survey of the seabed prior to the detonation and following the detonation to determine the resulting crater size.

The verification of the assessment results with respect to the spatial range and duration of sediment spreading (turbidity) will be conducted using a combination of monitoring methods. These methods will include optic sensors to perform both vertical profiling and horizontal transects of the sediment plume, with measurements of turbidity, temperature, conductivity and depth. The selected methods are described in detail below.

Monitoring of re-suspension of sediments from munitions clearance will be performed mainly via in situ measurements at selected locations (Figure 4, Table 4 and Appendix 5). The in-situ measurements will be conducted over time intervals to allow assessment of the predicted migration of the sediment plume. The following sensing will be performed for monitoring the munitions clearance in the Finnish EEZ:

- Vessel operated automatic sensing (3 locations, VOM1, VOM2 and VOM3)
- Vessel operated automatic sensing for HELCOM stations (1 location, VOHE1)

In addition to these in-situ measurements, the following sensors will be installed in the Eastern Gulf of Finland to monitor potential transboundary impacts of sediment dispersion from munitions clearance in Russia:

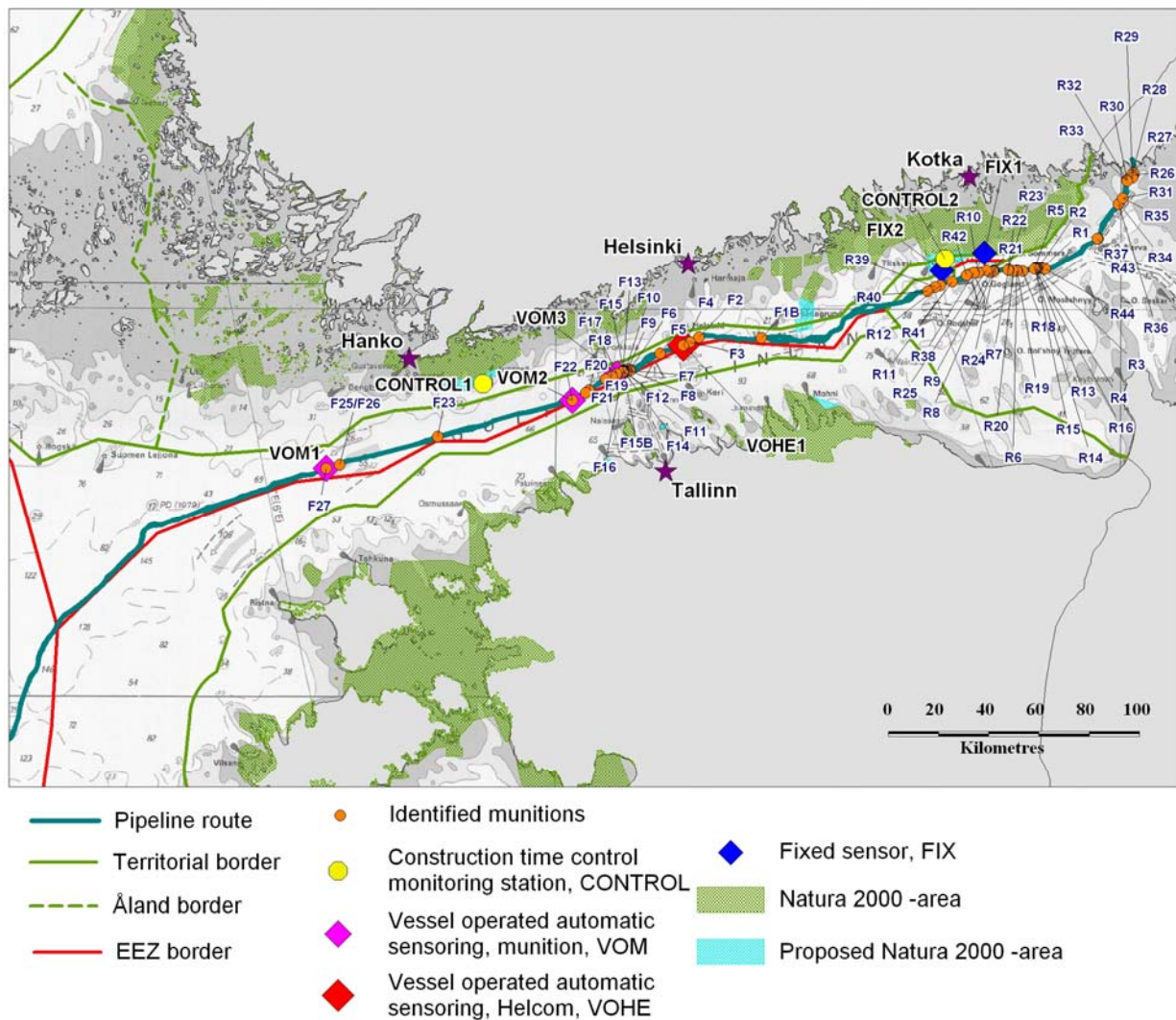
- Fixed sensing (2 locations, FIX1 and FIX2)

Furthermore, the following stations will be installed for control purposes:

- Long term monitoring with ADCP station (2 locations, CONTROL1 and CONTROL2)

The locations of sensing are shown in Figure 4. Summary of methods and parameters to be analysed are presented in Table 4.





**Figure 4.** Locations where water quality monitoring will be carried out during the munitions clearance. An A3 size map is presented in Appendix 5.



**Table 4.** The monitoring programme for water and sediment quality

Water quality monitoring					
Project activity	Parameter	Unit	Method	Location	Timing / frequency
<b>Munitions clearance</b>	Current speed and direction	m/s (current speed) and degree (direction)	Sensoring from vessel	All munitions to be cleared	Once prior to the detonation
	Sediment, nutrients and contaminant dispersion, conductivity, depth and temperature	NTU (turbidity), km (distance and height), h (duration), µs/cm (conductivity), °C (temperature) and m (depth)	Vessel operated automatic sensoring	3 locations based on large charge sizes, seabed of hard clay or mud or close to the Estonian border (VOM1-3)	Once before and two times directly after detonation
			Vessel operated automatic sensoring for HELCOM stations	1 location based on the close proximity to a HELCOM station (VOHE1)	Once before and two times directly after detonation
	Water samples for metal and nutrient analysis and calibration of sensors	mg/l and FTU (turbidity), mg/l (oxygen), µs/cm (conductivity) and µg/l (total and dissolved P and N, metals)	Water sampling for analysis and calibration	VOM1-3 and VOHE1 locations	Directly after detonation
	Sediment sampling for analyses of metals, dioxins and organic tin compounds and for normalization of the results	mg/kg, (As, Cd, Cr, Co, Cu, Hg, Ni, Pb, Zn), ng/kg (dioxines) and ug/kg (organic tin compounds). Grain size distribution, clay content and m -% (total organic carbon - TOC)	Sediment sampling with GEMAX-core sampler or similar	VOM1-3 and VOHE1 locations	Once before and once after detonation
<b>Long term monitoring during munitions clearance</b>	Current speed and direction, turbidity, conductivity, temperature and oxygen concentration	m/s (current speed), degree (direction), NTU (turbidity), µs/cm (conductivity), °C (temperature) and mg/l (oxygen)	ADCP with a turbidity sensor and CTD-profile	2 stations close to Natura 2000 area in Tammisaari archipelago and Eastern Gulf of Finland (CONTROL1-2)	Starts ca. 2 weeks before the clearance and continues ca. two weeks after the finalization of the pipeline construction, CTD-profile when uploading data
	Sediment dispersion, conductivity, temperature and oxygen concentration	NTU (turbidity), µs/cm (conductivity), °C (temperature) and mg/l (oxygen)	Fixed sensoring and CTD-profile	2 locations in the Eastern Gulf of Finland (FIX1-2)	Starts ca. 2 weeks before the clearance and continues ca. two weeks after the clearance, CTD-profile when uploading data
	Water samples for nutrient analysis and calibration of sensors	mg/l and FTU (turbidity), mg/l (oxygen), µs/cm (conductivity) and µg/l (total and dissolved P and N)	Water sampling for analyses and calibration of ADCP and turbidity sensors	FIX1-2 and CONTROL1-2 stations	Every time when data is uploaded.

The nearest existing Natura 2000 area is Kallbådan islet and water area (FI0100089) at a distance of 10.8 km from the closest munitions and the nearest proposed new Natura 2000 area is Sandkallans southern marine area (FI0100106) at a distance of 10.7 km from the closest munitions. As Natura 2000 areas are in excess of 10 km from the closest munitions clearance site no reference station in these areas will be established to monitor sedimentation during the munitions clearance.

**Vessel operated automatic sensing** during munitions clearance will be carried out at 4 locations. Altogether 3 locations (VOM1-3) have been selected for monitoring based on the sediment types at the munition sites (focus on soft sediment) and charge weight of munitions (focus on large charge sizes) or the proximity of munitions to the Estonian EEZ border (Figure 4):

- VOM1 – In location of munition F27 (R-12-3463) with 300 kg charge close to KP 366
- VOM2 – In location of munition F22 (R-09-192) with 115 kg charge, 0.46 km to the Finnish/Estonian EEZ border at KP 265
- VOM3 – In location of munition F17 (R-08-2805) with 350 kg charge close to KP 243

All selected munitions lie at the depth of 61-80 m. The seabed under munitions is very soft clay or silt and fine sand, which will result in sediment dispersion during the detonation.

Altogether 1 location (VOHE1) has been selected for monitoring considering a HELCOM station as a potential impact target of turbidity spreading from munitions clearance based on guidance of the Meteorological Institute of Finland, Geological Survey of Finland and Finnish Environmental Institute. This location is (Table 5 and Figure 5).

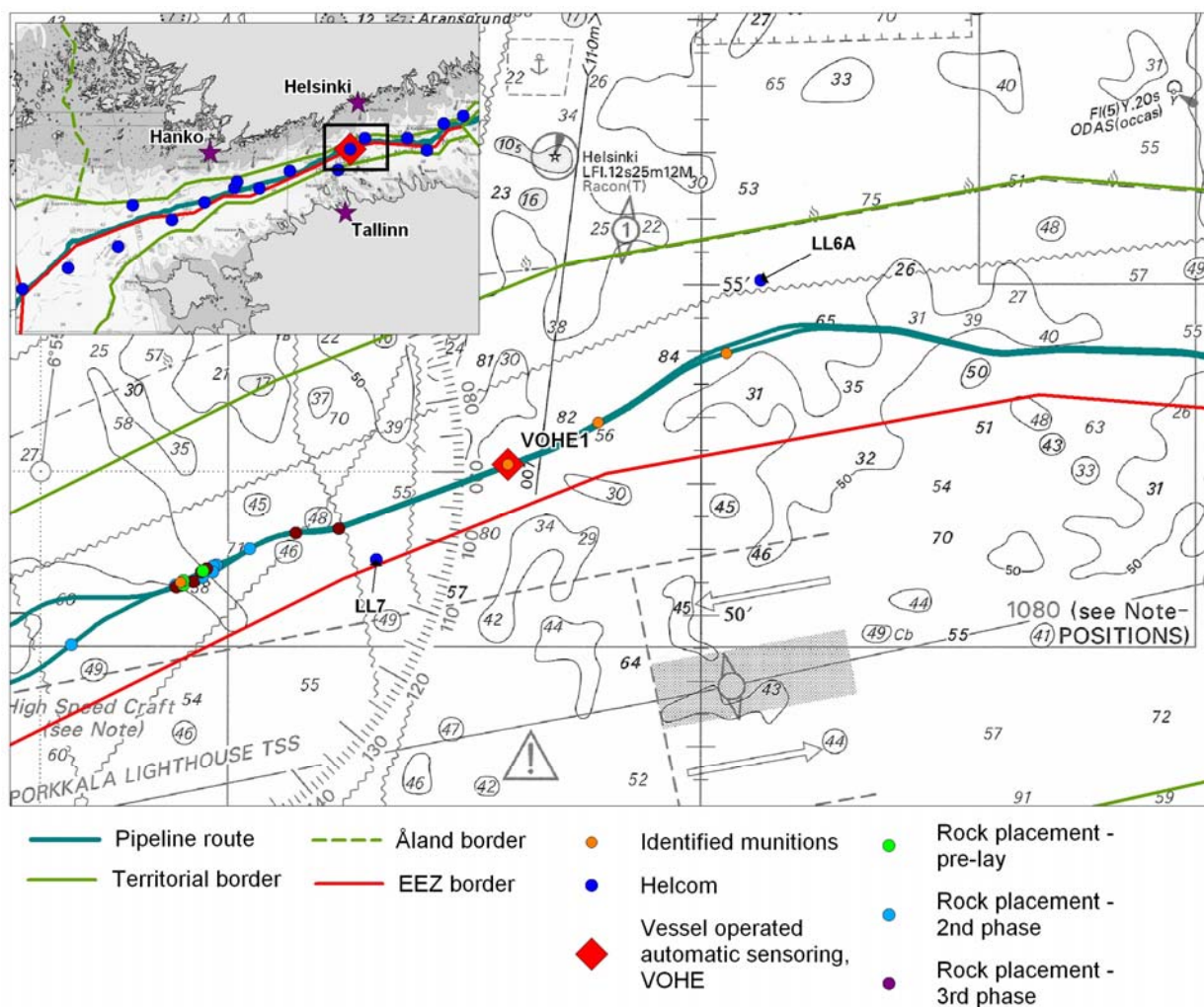
- VOHE1 – In location of munition F4 (R-07-2655) with a charge of 150 kg and 4.55 km from HELCOM-station LL7

Vessel operated automatic sensing at these 4 locations will be carried out with multi parameter sonde that will measure vertical turbidity, temperature, conductivity and depth. This automatic sonde is lowered from a support vessel through the water column. Data will be gathered from surface to bottom with 20 to 50 cm intervals. Research line grid (distance from one research spot to another along the line) depends on the charge size of the munition to be cleared and will be assigned prior to the measurement. The amount of lines during measurement is two. For munitions clearance the measurements at one sensing location will be done once prior to the detonation and two times after the detonation in order to receive sufficient data from the spreading and dilution of the sediment plume. The first measurement prior to detonation at each location is a reference measurement and represents natural background level of turbidity.

Data from vessel operated automatic sensing will be shown as transect figures. Data is presented as a function of distance from a munition, depth and turbidity. Results will be shown for both two perpendicular transects for each measurement round to present how the particulate matter in a plume behaves. Similar figures will be generated for salinity and temperature.

**Table 5.** Distances from HELCOM stations to the munitions clearance sites in the Finnish project area. The selected location is highlighted in yellow.

HELCOM station	Munitions clearance				
	Distance km	Number /Code	Charge, kg	Seabed	VOHE sensing site
LL3A	53.9	F1B / R-W6F-10740	350	sand	
LL4A	37.3	F1B / R-W6F-10740	350	sand	
GF2	23.5	F1B / R-W6F-10740	350	sand	
LL5	8.3	F1B / R-W6F-10740	350	sand	
LL6A	2.25	F2 / R-E7B-10466	0.8	gravelly sand	
LL7	4.55	F4 / R-07-2655	150	very soft clay	VOHE1
GF1	12.0	F7 / R-E8C-10223	30	silt and fine sand	
LL9	5.84	F22 / R-09-192	115	silt and fine sand	
JML	26.2	F23 / R-11-3395	100	very soft clay	
LL11A	12.7	F23 / R-11-3395	100	very soft clay	
LL11	8.49	F23 / R-11-3395	100	very soft clay	
LL12	16.7	F23 / R-11-3395	100	very soft clay	
LL13	8.35	F25/F26 / R-12-008	64	gravelly sand, large boulders	
AS7	25.0	F27 / R-12-3463	300	very soft clay	
LL15	44.9	F27 / R-12-3463	300	very soft clay	
LL17	86.0	F27 / R-12-3463	300	very soft clay	
NCB	124.1	F27 / R-12-3463	300	very soft clay	



**Figure 5.** Nord Stream vessel operated monitoring for HELCOM station during munitions clearance.

**Fixed sensors (FIX)** will be used at two locations in order to monitor possible sediment dispersion from munitions clearance in the Russian EEZ to the proposed or existing Finnish Natura 2000 areas. The measurements will be done with multi parameter sondes that will measure vertical turbidity, temperature, conductivity and oxygen concentration. These sensors will be anchored to the seabed and installed approximately 1 to 2 meters from the seabed. The sensors will collect data every 30 to 60 minutes from two weeks before until two weeks after munitions clearance. Two locations have been selected for fixed sensors close to the Russian border (Figure 4):

- FIX1 - close to the proposed Länsiletto Natura 2000 area at a depth of 50 m, approximately 2 km from the Russian EEZ border at KP 84

- FIX2 - in the Eastern Gulf of Finland at a depth of 40 m, approximately 0.43 km from the Russian EEZ border close to KP 101

Distances from the FIX stations to the closest munitions clearance sites in Russia are 5-7 km.

In order to obtain background information of temperature and salinity stratification, CTD-profiling will be conducted during service visits to upload data from the stations. At the same time the vertical distribution of turbidity will also be determined. The measurements will be performed using an automatic sonde that is lowered from a support vessel through the water column. The data will be gathered from the surface to the bottom with 20 to 50 cm intervals.

Fixed sensing data will be presented as time series figures together with the CTD profiling data from the same period. CTD data will be shown as a function of depth on each site.

**Long term monitoring with Acoustic Doppler Current Profiler (ADCP) stations (CONTROL)** with a turbidity sensor will be carried out at two different locations. These locations include (Figure 4):

- CONTROL1 - close to Natura 2000 area in Tammisaari archipelago, at the depth of approximately 22 metres
- CONTROL 2 - in the Eastern Gulf of Finland at the depth of approximately 37 metres

ADCP will measure changes in underwater current field (current speed and direction) throughout the whole water column. The station will be instrumented also with an automatic turbidity sensor. The turbidity sensor will be installed near the seabed and will monitor the turbidity, conductivity, temperature and oxygen concentration. The ADCP will be placed near the seabed ca. two weeks before the clearance works start. Data will be collected approximately every 1 to 2 metres from the seabed to the surface averaged over 30 to 60 minutes intervals. Data from the station will be used as a comparison for results obtained from other locations and to study the natural variability and seasonal changes. Monitoring will continue for ca. two weeks after the completion of the munitions clearance.

In order to obtain background information of temperature and salinity stratification, CTD-profiling will be conducted during service visits to upload data from the stations. At the same time the vertical distribution of turbidity will also be determined. The measurements will be performed using an automatic sonde that is lowered from a support vessel through the water column. The data will be gathered from the surface to the bottom with 20 to 50 cm intervals.

ADCP data will be presented as time series figures together with the CTD profiling data from the same period. In addition, current data will be analyzed and shown as distribution figures for current magnitude and direction. CTD data will be shown as a function of depth on each site.

**Water sampling from VOM and VOHE stations** will be carried out in order to calibrate the results (turbidity, suspended solids and conductivity) of the automatic sensing. In addition, oxygen concentration, phosphate phosphorous ( $\text{PO}_4$ ) and total phosphorus (P), nitrate-nitrite nitrogen ( $\text{NO}_3\text{-NO}_2$ ) ammonium nitrogen ( $\text{NH}_4$ ) and total nitrogen (N) as well as total metal concentrations (As, Cd,

Cr, Co, Cu, Hg, Ni, Pb, Zn) will be analysed from the water samples. At one location, that will be monitored during munitions clearance phase 1 or phase 2, also 8-10 water samples will be taken for the analysis of soluble metal concentrations. These samples will be taken at the first monitoring station where the munition has high ordered. All parameters will be analysed with standards presented in Table 6 or similar with same accuracy and reliability. The results will be combined with turbidity measurements to calculate the possible spreading of metals with suspended sediment from munitions clearance.

At each sampling site (VOM1-3 and VOHE1) water samples will be taken in intervals of ten meters and also from near surface and seabed (1 m from the surface and seabed). In addition, 4 to 6 samples will be taken according to the sensing data from sites that either represent the maximum turbidity concentration or at which elevated turbidity concentrations are no longer observed. Depths of the water samples will be decided in the field according to the vessel operated automatic sensing data. All samples will be analyzed by an accredited laboratory with normal laboratory methods used for quantification from brackish water. The munitions clearance monitoring programme for water quality is presented in Table 4.

**Water sampling from FIX and CONTROL stations** will be carried out during data upload visits in order to calibrate the results (turbidity, suspended solids, conductivity and oxygen concentration) of the automatic sensing and to analyze the concentration of both dissolved phosphate phosphorus ( $\text{PO}_4$ ), nitrate-nitrite ( $\text{NO}_3 - \text{NO}_2$ ) nitrogen and ammonium ( $\text{NH}_4$ ) nitrogen as well as total phosphorus (P) and nitrogen (N). These parameters will be analysed with standards presented in Table 6 or similar with same accuracy and reliability.

At each FIX and CONTROL station one water sample will be taken from the same depth as the actual sensor is located. Samples will be analyzed by an accredited laboratory. The munitions clearance monitoring programme for water quality is presented in Table 4.

Results from water sampling at VOM, VOHE, FIX and CONTROL stations will be presented as tables with locations and analyzed concentrations.



**Table 6.** Water analysis will be performed in line with the following standards or similar with same accuracy and reliability using an accredited laboratory and methods

Parameter	Accredited	Unit	Limit of quantification		Standard	Sample amount	uncertainty +/- %
Turbidity	Yes	FTU	0.1		SFS-EN ISO 7027	100 ml	10
Oxygen concentration	Yes	mg/l	0.5		SFS- 3040	100 ml	10
Phosphorus, total	Yes	µg/l	5		SFS 3036- MOD	100 ml	15
Phosphorus, PO <sub>4</sub> , 0,40 µm	Yes	µg/l	2		SFS 3036- MOD	100 ml	15
Nitrogen, total	Yes	µg/l	50		SFS-EN ISO 11905	100 ml	15
Nitrogen, NO <sub>3</sub> +NO <sub>2</sub> , 0,40 µm	Yes	µg/l	5		SFS-EN ISO 11905	100 ml	15
Nitrogen, NH <sub>4</sub> , 0,40 µm	Yes	µg/l	7		SFS-EN ISO 11905	100 ml	15
Parameter	Accredited	Unit	Limit of quantification		Standard	Sample amount	uncertainty +/- %
			Total	Soluble			
Arsenic, As	Yes	µg/l	0.1	0.1	SFS-EN ISO 17294 :2005	100 ml *	20
Kadmium, Cd	Yes	µg/l	0.01	0.01	SFS-EN ISO 17294 :2005	100 ml *	15
Cobolt, Co	Yes	µg/l	0.05	0.05	SFS-EN ISO 17294 :2005	100 ml *	20
Chrome, Cr	Yes	µg/l	0.2	0.05	SFS-EN ISO 17294 :2005	100 ml *	20
Copper, Cu	Yes	µg/l	0.1	0.05	SFS-EN ISO 17294 :2005	100 ml *	20
Nickel, Ni	Yes	µg/l	0.2	0.05	SFS-EN ISO 17294 :2005	100 ml *	20
Lead, Pb	Yes	µg/l	0.05	0.05	SFS-EN ISO 17294 :2005	100 ml *	20
Zinc, Zn	Yes	µg/l	0.5	0.5	SFS-EN ISO 17294 :2005	100 ml *	25
Mercury, Hg	Yes	µg/l	0.05	0.005	SFS-EN 1483:1997, modified	100 ml *	20

\* = all metals from the same 100 ml sample

**Sediment sampling from VOM and VOHE stations** will be performed in order to gather data on the concentrations of metals, dioxins and organic tin compounds and their possible spreading during munitions clearance (Table 8). Metals to be analysed from sediment samples are the same as from water samples (As, Cd, Cr, Co, Cu, Hg, Ni, Pb, Zn). Also the grain size distribution / clay content and total organic carbon (TOC) required for the normalization of the results will be analysed. Samples will be taken with a GEMAX-core sampler or similar.

Sampling in VOM1-2 and VOHE1 stations will be done once prior to the detonation and once after the detonation. At station VOM3, which is the same as SED3<sup>3</sup>, sampling will be performed once before the munitions clearance and once after the clearance as well as once after the completion of the construction of the first and once after the completion of the construction of the second pipeline. Samples at all stations will be taken at seven locations situated 50 m, 100 m, 200 m, 400 m, 800 m, 1600 m and 3600 m to the North of the monitored munition. At all locations surface sediment samples (0-2 cm) will be taken and at a distance of 50 m and 100 m from the munition also samples from 2-10 cm will be taken. The parameters to be analysed from the sediment samples are listed in

<sup>3</sup> See Chapter 6.3 of the Baltic Sea Natural Gas Pipeline Environmental Monitoring Programme – Finland.

Table 7. Samples will be analysed using the standards presented in Table 7 or similar with same accuracy and reliability. The samples will be analysed in an accredited laboratory.

In addition to sediment samples, at VOM 3 station a water sample will be taken near bottom (above the sediment) at a distance of 50 m from the munition while sediment sampling. This sample will be analyzed for soluble and total phosphorous and nitrogen. The nutrient concentrations will be analysed with standards presented in Table 6 or similar with same accuracy and reliability.

**Table 7.** Sediment samples will be analysed according to these standards or similar with same accuracy and reliability.

Parameters	Accredited	Unit	Limit of quantification	Description/ reference standards	Uncertainty +/- %
Grain size	yes			Sedigraph (micromeritic) X-ray method Measures grain size with a diameter of 300 to 0.10 µm (spherical)	10
Dry weight	yes			SFS 3008	
Loss of ignition, LOI	yes			SFS 3008	
Total organic carbon, TOC	yes			ISO10694	
Arsenic, As	yes	mg/ kg	5.0	ISO 17294-2, EPA 3051A, ISO 11466	25
Mercury, Hg	yes	mg/ kg	0.1	ISO 17294-2, EPA 3051A, ISO 11466	35
Cadmium, Cd	yes	mg/ kg	0.4	ISO 17294-2, EPA 3051A, ISO 11466	20
Cobalt, Co	yes	mg/ kg	5.0	ISO 17294-2, EPA 3051A, ISO 11466	25
Chrome, Cr	yes	mg/ kg	5.0	ISO 17294-2, EPA 3051A, ISO 11466	25
Copper, Cu	yes	mg/ kg	5.0	ISO 17294-2, EPA 3051A, ISO 11466	25
Lead, Pb	yes	mg/ kg	10.0	ISO 17294-2, EPA 3051A, ISO 11466	25
Nickel, Ni	yes	mg/ kg	5.0	ISO 17294-2, EPA 3051A, ISO 11466	30
Zinc, Zn	yes	mg/ kg	5.0	ISO 17294-2, EPA 3051A, ISO 11466	30
Organic tin compounds	yes	µg/ kg	1	DIN ISO 23161	
Dioxins	yes	ng/ kg	0.455	EPA 16131, EPA 82902 and DIN 38414-243, all in combination with EN ISO 17025:2005	20-30
Pre-treatment (microwave)				EPA 3051A, ISO 11466	

The sedimentation data from all monitored munitions (Table 8) will be combined in graphs in order to present the spreading of sediment due to detonation of munitions with different charge sizes in relation to distance. Metal concentrations in sediment samples before and after detonation will also be provided.



**Table 8.** Information about monitored munitions at VOM1-3 and VOHE1 stations /5/

Calculated spreading of suspended sediment and contaminations									
Sample point	Munition location	Munitions number / ID	Charge	Water Depth	Sediment / Seabed Type	Diameter crater	Released sediment	Concentration > 10 mg/l for max. 18 hrs.	
								Extent	Area
	KP		kg	m		m	tonnes	km	km <sup>2</sup>
VOM1	366	F27 / R-12-3463	300 7	8	Very soft clay	7.0	583	4.3	2.5
VOM2	264 F22	/ R-09-192	115 6	1	Silt and fine sand	5.4 2	70	2.8	0.9
VOM3	243	F17 / R-08-2805	350 7	1	Very soft clay	7.3	667	4.1	2.7
VOHE1	213	F4 / R-07-2655	150 7	4	Very soft clay	5.8	329	2.8	2.4

### 5.3 Pressure waves

The assessment of the pressure wave and the resulting acoustic pulse has been performed within the EIA (Chapter 8.1.4 Noise impacts) /4/ to evaluate the effects of the detonation of underwater explosives on marine mammals and fish. This assessment has been extended on a munition by munition basis to consider the impact to cultural heritage, barrels and existing infrastructure /2/.

To verify the assessment, the pressure wave and the resulting acoustic pulse will be measured to document peak pulse and attenuation over distance at four selected locations. During the measurements one blast wave sensor will be located close to the seabed<sup>4</sup> at the distance of 500 m from the munition and another close to the selected object of protection or both sensors will be located close to selected objects of protection. The following four measurement locations have been selected based on charge sizes of munitions and objects of protection on the seabed:

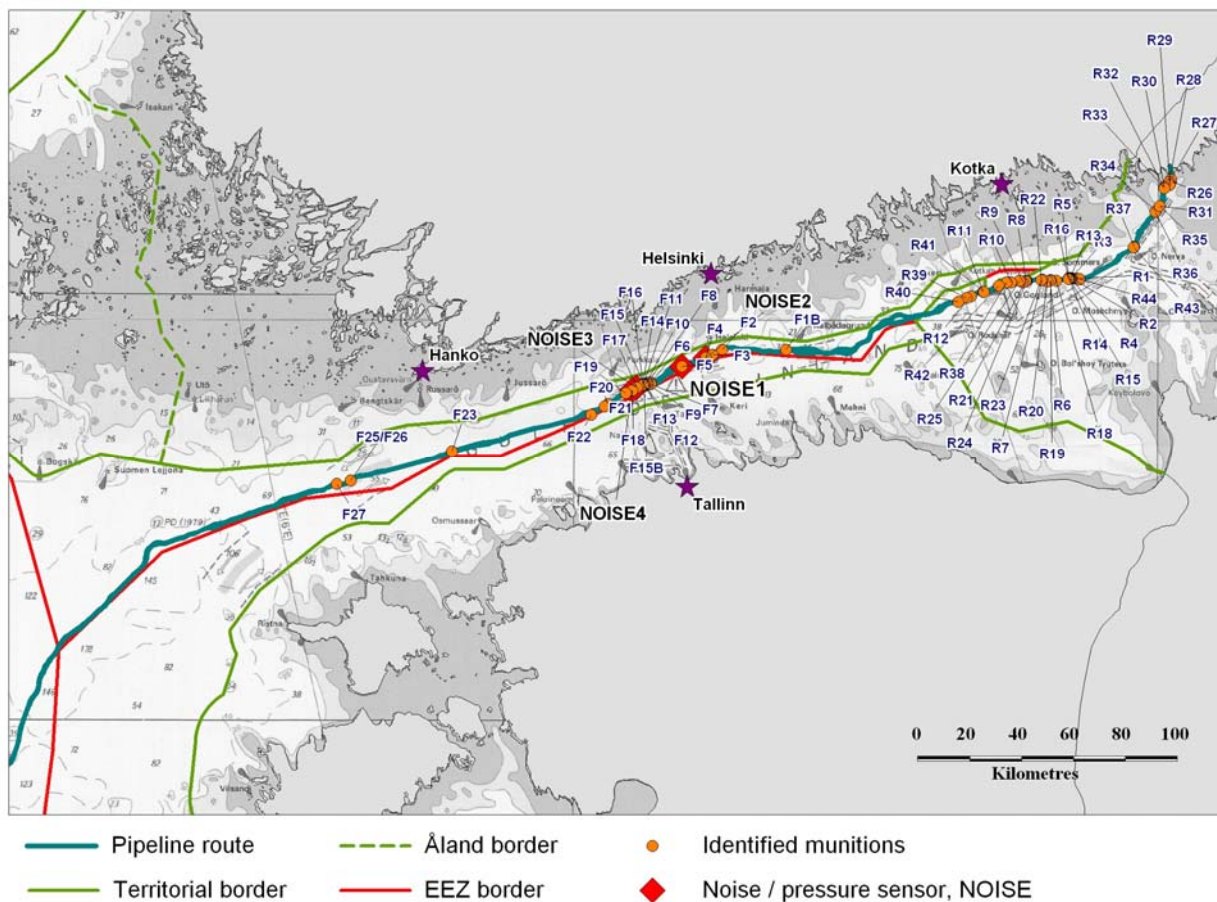
- NOISE1 - during the detonation of the first munition with a larger charge size (> 100 kg). Upon the finalization of the clearance plan, the measurement was decided to be carried out during the detonation of the munition F5 (R-8AG-W-014). Blast wave sensors will be located at the distance of 500 m and 1000 m from the munition.
- NOISE2 - during the detonation of the munition F4 (R-07-2655) with a charge size of 150 kg. The munition is located at the distance of 1.17 km from the wreck Rusalka (MB-07-2736). Blast wave sensors will be located at the distance of 500 m from the munition and close to the wreck.
- NOISE3 - during the detonation of the munition F17 (R-08-2805) with a charge size of 350 kg in the vicinity of the Estlink cable (owner: Energia). Blast wave sensors will be located at Joint 9 and Joint 6, at distances of 1.01 km and 2.36 km from the munition respectively.
- NOISE4 - during the detonation of the munition F18 (R-08-159) with a charge size of 115 kg in the vicinity of the Estlink cable (owner: Energia). Blast wave sensors will be located at Joint 9 and Joint 6, at distances of 1.22 km and 0.87 km from the munition respectively.

<sup>4</sup> Since 29 April 2010 the sensors were located in midwater due to loss of sensors situated close to the seabed in two occasions.

The locations for NOISE1, 2, 3 and 4 are shown in Figure 6. In addition, one blast wave sensor is deployed on the passive acoustic monitoring (PAM) buoy in the water column at the distance of about 300 m from the munition at each detonation site.

The blast wave sensors include a hydrophone with an operating frequency of up to 400 kHz and a pressure range of 0 to 200 bar. The over pressure produced by the detonation is recorded in psi. The blast wave sensors are radio linked to the vessel. The recording frequency is up to 500 kHz and sensors will be active 5-10 min before each blast. Data gathered is presented graphically showing the pressure in relation to time.

The summary of the monitoring programme for pressure waves from munitions clearance is presented in Table 9.



**Figure 6.** Locations where pressure wave monitoring will be carried out during the munitions clearance.

**Table 9.** The monitoring programme for pressure waves from munitions clearance.

Underwater noise Monitoring					
Project activity	Parameter	Unit Me	thod	Location	Timing
Munitions clearance	Pressure wave	psi (pressure), s (time)	Pressure wave sensor close to the seabed	4 locations (Noise1-4)	During detonation
	Pressure wave	psi (pressure), s (time)	Pressure wave sensor on the PAM buoy	Each detonation site	During detonation

#### 5.4 Cultural Heritage, Barrels and Existing Infrastructure

An assessment of the potential impacts from the munitions clearance on cultural heritage sites and existing infrastructure has been performed within the EIA (Chapter 8.4.4 Impacts on existing and planned infrastructure and Chapter 8.4.5 Impacts on cultural heritage) /4/. This assessment has been extended on a munition by munition basis to consider the impact of the pressure wave resulting from the munitions clearance to individual cultural heritage sites, barrels and existing infrastructure /2/.

The distances of and impacts on individual cultural heritage sites, barrels with environmental risk classes 2 and 3 and existing infrastructure from munitions clearance on a munition by munition basis are shown in Appendix 2.

#### Cultural Heritage

As shown in Appendix 2, the pressure waves from munitions clearance are anticipated to cause no impact on the cultural heritage sites. Therefore the monitoring will concentrate on wrecks that are located within 1.0 km from munitions that need to be cleared. These wrecks include (Figure 7):

- S-08-2939 (0.98 km from the munition F6, R-8AG-W-009 with a charge size of 30 kg)
- 3\_9<sup>5</sup> (0.87 km from the munition F7, R-E8C-10223 with a charge size of 30 kg and 0.92 km from the munition F9, R-8CG-E004 with a charge size of 30 kg),
- 4\_9 (0.54 km from the munition F21, R-09-04 with a charge size of 0.8 kg)
- S-09-49167 (0.87 km from the munition F21, R-09-04 with a charge size of 0.8 kg)
- R-07-41172 (0.7 km from the munition F3, R-07-004 with a charge size of 150 kg).

Based on the consultation with the Finnish National Board of Antiquities, the following wrecks located further away from the munitions to be cleared will also be inspected (Figure 7):

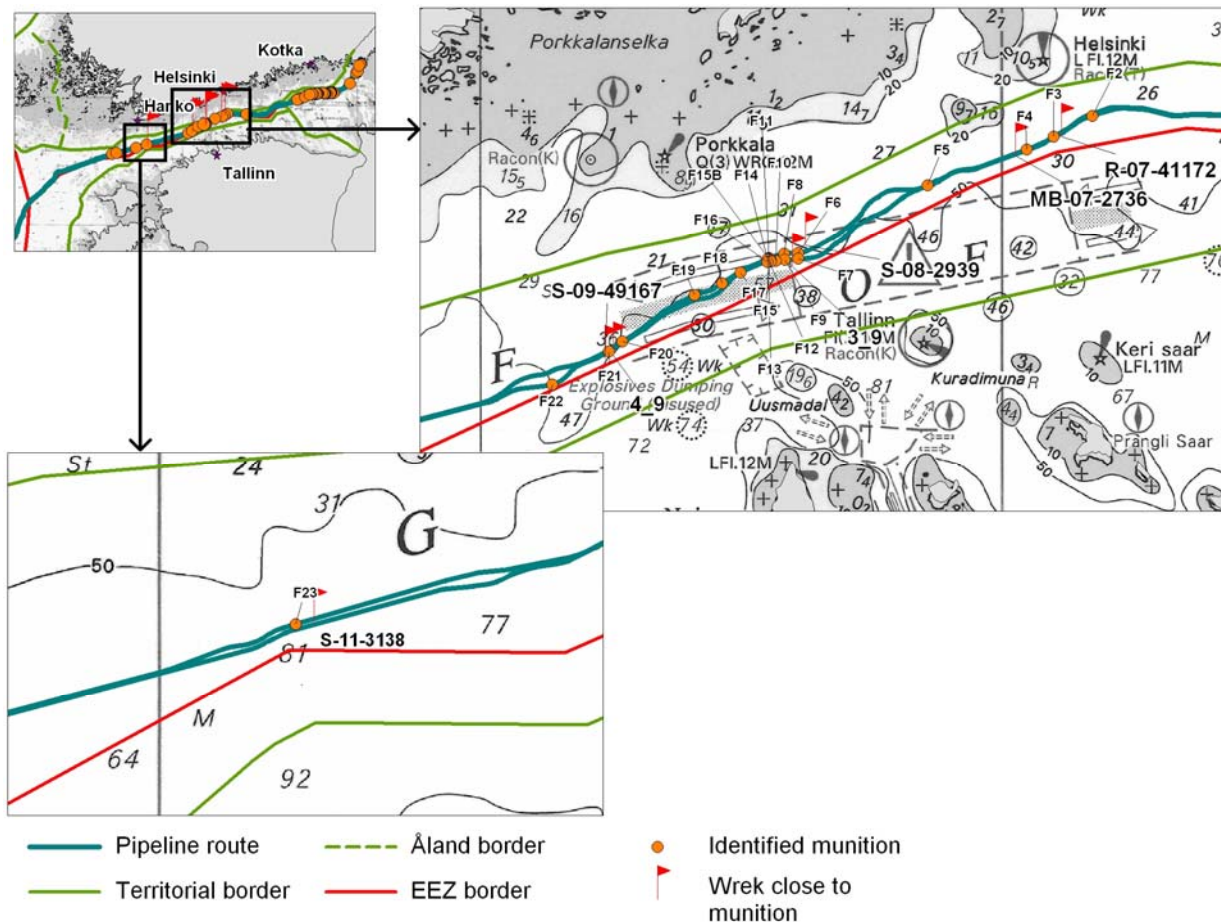
- S-11-3138 (1.29 km from the munition F23, R-11-3395 with a charge size of 100 kg)
- MB-07-2736 - Rusalka (1.17 km from the munition F4, R-07-2655 with a charge size of 150 kg)

The cultural heritage sites will be inspected via ROV visual inspection prior to the detonation and following the detonation to confirm that there has been no adverse impact. These pre- and post-detonation surveys will be carried out by the munitions clearance Contractor. The Finnish National

<sup>5</sup> Same wreck as R-08-45980. The as-left survey of the wreck after the detonation was repeated on 21 July 2010 to clarify location uncertainties.

Board of Antiquities will be notified prior to the clearance activities and will be provided with the monitoring reports after the clearance activities.

The locations of the wrecks included into the survey are presented in Figure 7 and the monitoring programme for cultural heritage sites in Table 12.



**Figure 7.** Identified cultural heritage sites (wrecks) to be monitored by ROV visual inspection prior to and after detonation of munitions in the security corridor.

## Barrels

Appendix 4A shows the distances of all barrels from individual munitions and Appendix 4B the expected displacements of all barrels due to munitions clearance on a munition by munition basis. As presented in Appendix 2 munitions clearance is anticipated to cause no release of content from barrels having an environmental risk class 2 or 3<sup>6</sup>.

<sup>6</sup> Classification of the environmental risk class of barrels according to the condition and exposure of



Until May 6 2010 all barrels identified within 1.0 km from the munitions to be cleared were monitored. Beyond the distance of 1 km from a detonation the peak pressure is too low to cause any measurable impact (a displacement of more than 0.5 m) /2/. Upon receiving the Decision No. 68/2010/4 by the Regional State Administrative Agency for Southern Finland<sup>7</sup> effective on May 7 2010 the monitoring of barrels concentrated on barrels classified as environmental risk class 2 or 3 that had been identified within 1.0 km from the munitions to be cleared. Barrels classified as environmental risk class 0 and 1 are excluded from the monitoring because their content is already fully or at least partly exposed to sea water. The barrels to be inspected are listed in Table 10 and shown in Figure 8.

These barrels will be monitored via ROV visual inspection prior to the detonation and following the detonation to confirm that there has been no adverse impact on them. The pre- and post-detonation surveys will be carried out by the munitions clearance contractor. The monitoring programme for barrels is presented in Table 12.

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the content to the sea water:

- Class 0: barrels in which the content is and has been fully exposed to sea water
- Class 1: barrels which have holes, ruptures or punctures, and in which the content has been at least partly exposed to sea water
- Class 2: barrels which most likely have holes, ruptures or punctures, and in which the content has probably been partly exposed to sea water
- Class 3: barrels with no observed openings, and most likely contain the very same substances as they did at dropping or drop moment

<sup>7</sup> Due to the application submitted to the Regional State Administrative Agency following the interim monitoring report for munitions clearance in 2009, the Agency amended “the first chapter of the permit provision 1) of the decision no 83/2009/2 of the Western Finland Environmental Permit Authority of 2 October 2009 to read as follows:

Before the detonation, a remote-controlled device must be used to check the object to be detonated, and to inspect the previously identified barrels classified as belonging to risk category 2 or 3 and located within a 1,000-metre radius. The inspection must be carried out again after the detonation to ensure that the munition has been made harmless by the detonation, and to note any movement of the barrels, and the condition of the barrels.”

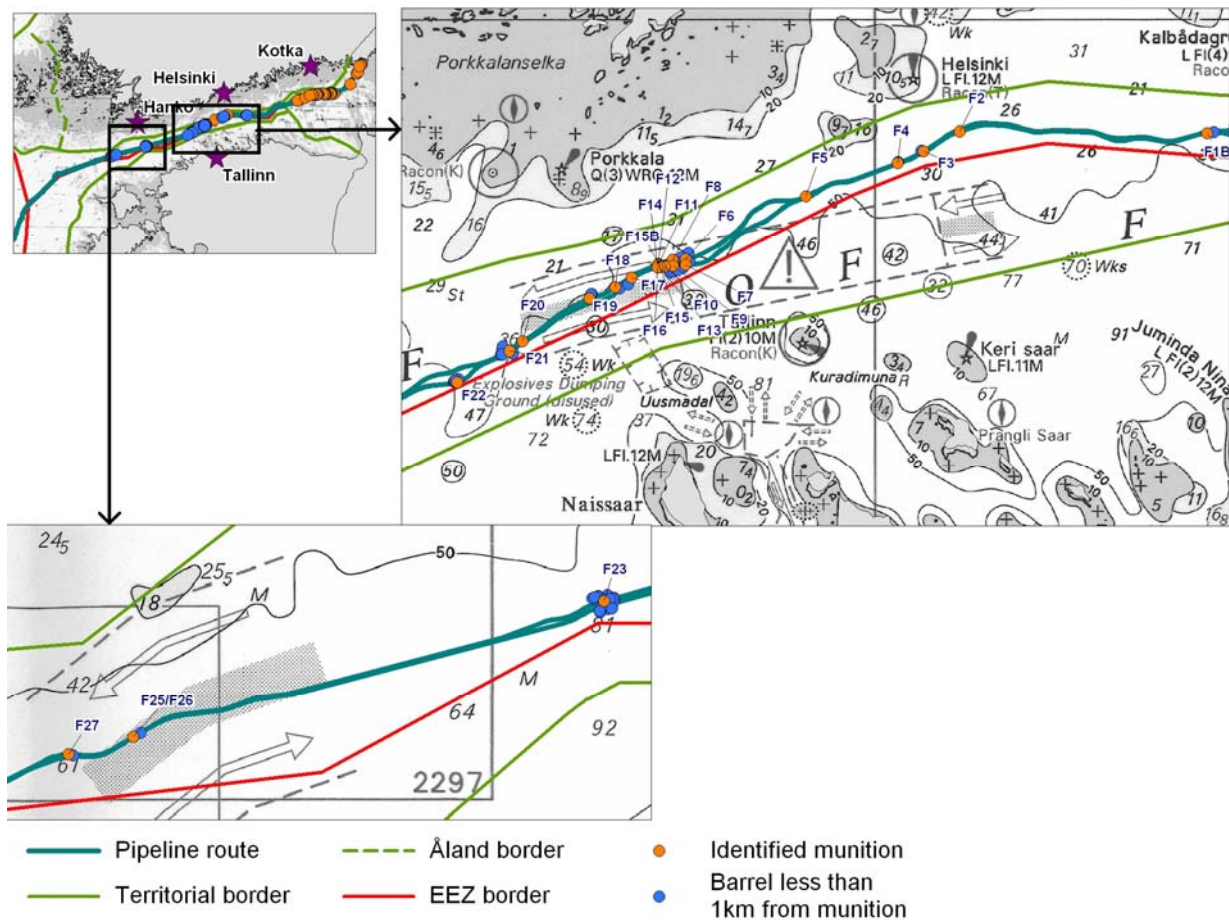
**Table 10.** Barrels to be monitored via ROV visual inspection prior to and after detonation

Munition ID	Barrels within 1 km to be monitored	Environmental risk class
<sup>1</sup> R-W6F-10747 (F1B)	R-06-20629	1
<sup>1</sup> R-07-004 (F3)	R-07-40688	0
<sup>1</sup> R-07-2655 (F4)	07-S-73	3
<sup>1</sup> R-8AG-W-009 (F6)	R-08-44156	0
	R-W8A-10041	0
	R-08-2938	0
	R-08-45979	3
	R-08-42672	0
	R-08-321109	3
<sup>1</sup> R-E8C-10223 (F7)	R-08-44156	0
	R-W8A-10041	0
	R-08-46223	0
	R-08-45979	3
	R-08-42672	0
	R-08-321109	3
<sup>1</sup> R-W8A-10317-A (F8)	R-08-42672	0
	R-08-44339	0
	08-S-33	0
	R-08-44744	0
<sup>1</sup> R-8CG-E-004 (F9)	R-E8C-10227	3
	R-08-46223	0
	R-08-45575	0
	08-S-33	0
	R-08-44744	0
	R-08-58162	3
	R-08-45979	3
	R-08-45629	0
	R-E8C-10226A	0
	R-E8C-10226B	3
	R-08-44339	0
	R-08-321109	3
<sup>2</sup> R-8CG-E-003 (F10)	R-E8C-10227	3
<sup>2</sup> R-W8A-10312 (F11)	R-08-58162	3
<sup>2</sup> R-W8A-10313 (F12)	R-E8C-10226B	3
<sup>2</sup> R-08-009 (F13)		
<sup>2</sup> R-W8A-10005 (F14)		
<sup>2</sup> R-8CG-E-002-A (F15)		
<sup>2</sup> R-08-44944 (F15B)		
<sup>2</sup> R-8CG-E-001 (F16)		
<sup>2</sup> R-08-2805 (F17)	R-08-45237	3
<sup>1</sup> R-08-159 (F18)	R-08-44979	1
<sup>1</sup> R-09-27 (F19)	R-09-48197	0
	R-09-48198	0
<sup>1</sup> R-09-04 (F21)	R-09-47641	0

Munition ID	Barrels within 1 km to be monitored	Environmental risk class
	R-09-48737	3
	R-09-49088	1
	09-S-14	1
	R-09-48535	0
<sup>1</sup> R-09-192 (F22)	R-09-49717	1
	R-09-49742	0
	R-09-49719	1
	R-09-326883	1
	R-09-326892	0
	R-09-49718	1
	R-09-49716	1
	R-09-49727A	1
	R-09-49736	1
	R-09-49740	0
	R-09-49750	1
	R-09-49727B	1
<sup>1</sup> R-11-3395 (F23)	R-11-26568	0
	R-11-3396	2
	R-11-26567	1
	RPS-11-1330	1
	RPS-11-42	0
	R-11-26569A	0
	R-11-26569B	3
	R-11-3397	1
	R-11-26249	0
	R-11-25305	0
	R-11-26112	0
	R-11-3321	0
	R-11-25639	0
	R-11-26043	0
	RPS-11-2216	3
	RPS-11-241	3
	RPS-11-41	3
	RPS-11-2219	0
	R-11-25197	0
	R-11-26257	3
	R-11-300686	0
	R-11-26250	0
	RPS-11-2218	0
	R-11-26247	0
<sup>1</sup> R-12-008 (F25 + F26)	R-12-380	0
<sup>2</sup> R-12-3463 (F27)	R-12-130141	2

<sup>1</sup> Munitions cleared until 6 May 2010

<sup>2</sup> Munitions cleared from 7 May to 15 June 2010



**Figure 8.** Identified barrels located within 1 km from the munitions. These barrels will be monitored by ROV visual inspection prior to and after detonation

### Cables

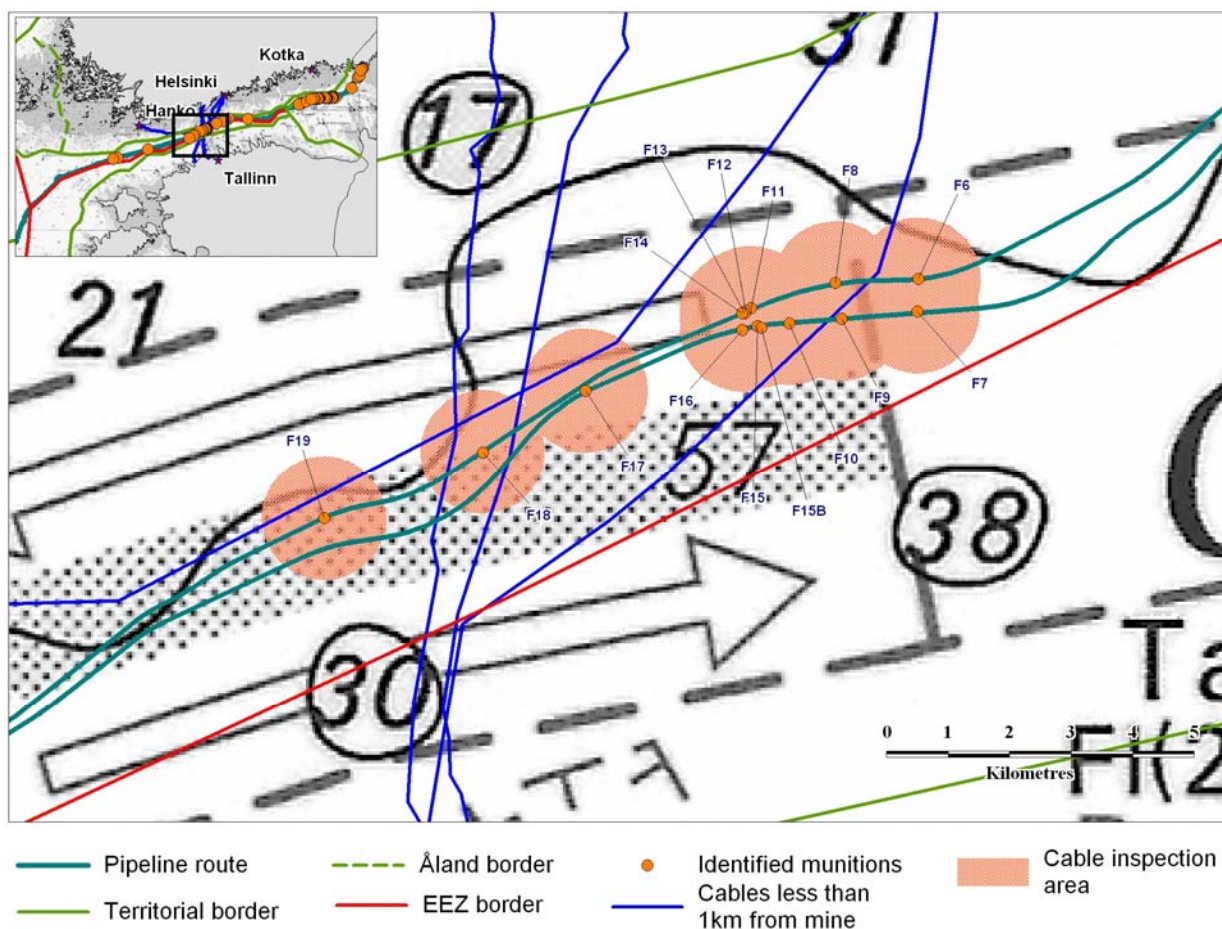
As shown in Appendix 2, the pressure waves from munitions clearance are anticipated to cause no impact on the existing infrastructure (cables). Therefore the monitoring will concentrate on cables that are located within 1.0 km from munitions that need to be cleared. The cables to be inspected are listed in Table 11 and shown in Figure 9.



**Table 11.** Cables to be monitored via ROV visual inspection prior to and after detonation

Munition ID	Charge weight, [kg TNT]	Cable	Distance to munition, [km]
R-8AG-W-009 (F6)	30	EE-SF3 Lauttasaari - Meremoisa (owner: Elion)	0.67
R-E8C-10223 (F7)	30		0.92
R-W8A-10317 (F8)	30		0.34
R-8CG-E-004 (F9)	30		0.14
R-8CG-E-003 (F10)	30		0.39
R-W8A-10312 (F11)	30		0.98
R-W8A-10313 (F12)	30		1.02
R-08-009 (F13)	30		1.01
R-W8A-10005 (F14)	30		1.02
R-8CG-E-002 (F15)	30		0.70
R-08-44944 (F15B)	30		0.70
R-8CG-E-001 (F16)	300		0.83
R-08-2805 (F17)	350	UESF2 Helsinki - Hanko (owner: Telenor Sweden)	0.47
R-08-159 (F18)	115		0.58
R-09-27 (F19)	115		0.35
R-08-159 (F18)	115	Estlink Helsinki-Tallinn (owner: Energia)	0.44
R-08-159 (F18)	115	FEC1 Porkkala-Kakumäe (owner: Elisa)	0.47

These cables will be surveyed to inspect the cable seabed configuration prior to and following the detonation to confirm the assessment results. The pre- and post-detonation surveys will be carried out by the munitions clearance contractor. In addition, the cable operators will be informed prior to and following the clearance activities in case of any adverse impact to the cable performance. The monitoring programme for cables is presented in Table 12.



**Figure 9.** Cables located within 1 km from munitions that will be monitored by ROV visual inspection prior to and after detonation. The purple circles with a 1 km radius around the munitions show the cable inspection areas

**Table 12.** The munitions clearance monitoring programme for cultural heritage, barrels and existing infrastructure.

Cultural Heritage, Barrels and Existing Infrastructure Monitoring					
Project activity	Parameter	Unit Me	thod	Location	Timing
<b>Munitions clearance</b>	Integrity of cultural heritage sites	Intact / damage	Visual inspection by ROV	All wrecks (5) within 1.0 km from munitions and wrecks S-11-3138 and MB-07-2736 close to munitions F23 and F4	Prior to and after detonation
	Integrity of barrels	Intact / damage and displacement	Visual inspection by ROV	Until May 6 2010 all barrels within 1.0 km from munitions; from May 7 2010 all barrels with environmental risk class 2 or 3 within 1.0 km from munitions	Prior to and after detonation
	Integrity of cables	Intact / damage	Visual inspection by ROV	All cables (4) within 1.0 km from munitions	Prior to and after detonation

### Reporting of Results

ROV inspections will be reported in the form of a catalogue of all features inspected. These catalogues will present feature type, description, coordinates and images and link to associated video files.

ROV inspections will entail the following:

- **Wrecks:** general overview highlighting sensitive objects
- **Barrels:** 360 degree visual inspection
- **Cables:** longitudinal traverse – visual inspection and bathymetry

Direct comparison between pre- and post-survey will be presented, together with indications of movement / condition of wrecks and barrels and de-burial / movement / condition of cables.

Reports will be submitted in both hard copy and digital format. The digital report will include:

- CD-ROM based reports
- Charts in AutoCad 2000 compatible format
- All acquired processed data in commonly accepted digital data formats.

### **5.5 Ecological Impacts – Mitigation and Monitoring Measures**

An assessment of potential impacts on fish, marine mammals and seabirds caused by noise emissions and pressure waves resulting from munitions clearance has been performed within the EIA (Chapter 8.2.3 Impacts on fish and fish stocks, 8.2.4 Impacts on marine mammals and 8.2.5 Impacts on seabirds) /4/. This assessment has been extended on a munition by munition basis to consider the impact of the pressure wave resulting from the clearance of individual munitions on fish, marine mammals and seabirds /2/.

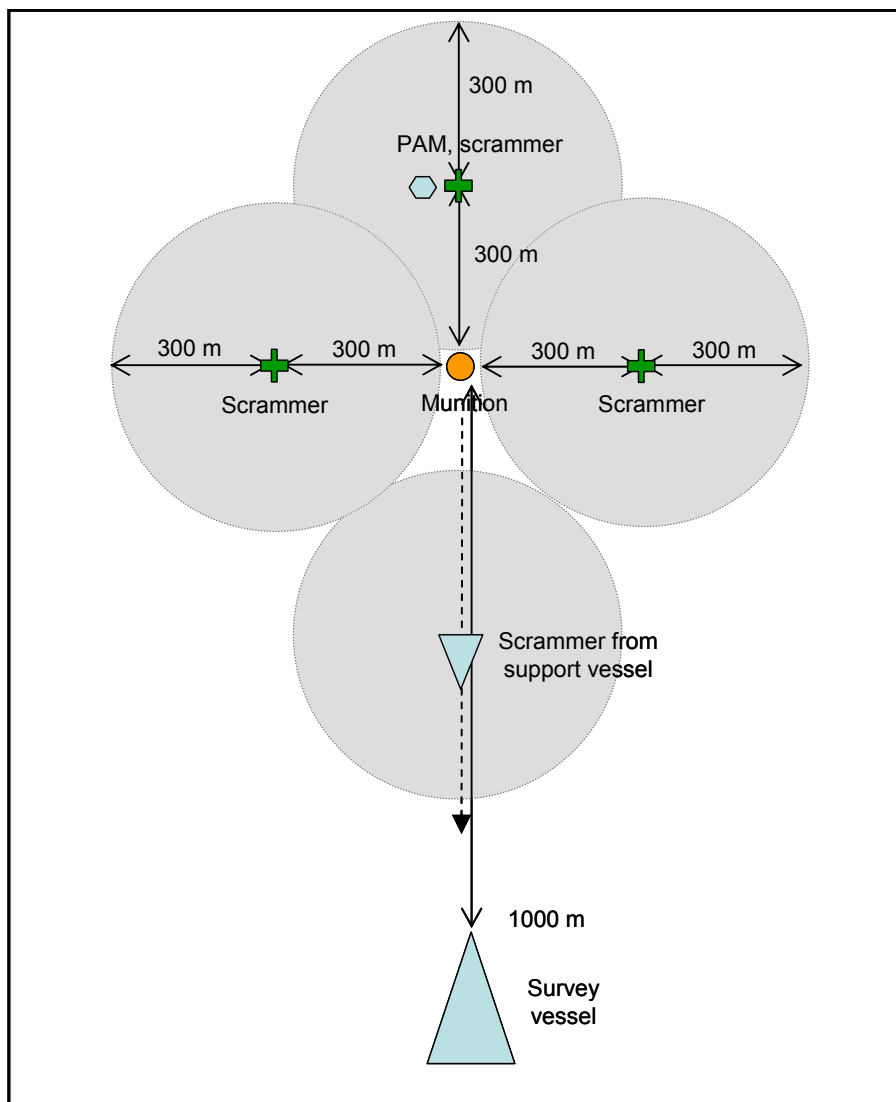
As defined in Nord Stream's Munitions Construction Management Plan the primary approach to mitigate impacts on fish, seabirds and marine mammals during clearance works is to displace them from the safety zone prior to the detonation. The Appendix 2 shows the estimated lethal, injury and safe ranges for marine mammals, seabirds and fish. As presented, the anticipated safe range is estimated to vary from 600 m to 3000 m and the injury range from 80 m to 500 m for detonations to be performed in phase 1. The implementation of the mitigation approach will be designed separately to all munitions by the clearance Contractor in the munition specific clearance plans. The approach for all single detonations except for F16 and the simultaneous detonation of F15 and F15B involves the measures presented below:

1. Observations to determine, to the extent practicable, whether marine mammals, fish shoals or seabirds are within the injury/safety zone around the detonation location. Observations will commence at least 60 minutes prior to planned detonation. Observation methods will include:
  - **Visual observation** of the presence of marine mammals and seabirds by qualified Marine Mammal Observers (MMOs) from the survey vessel. To support effective observations they will be carried out in calm to slight sea conditions and daylight hours.
  - **Passive Acoustic Monitoring (PAM)** to detect vocalisations of marine mammals. The PAM buoy is equipped with a high sensitivity hydrophone (operating frequency up to 150 kHz).. The PAM system will be deployed at the distance of about 300 m from the munition prior to each detonation and the signals will be transmitted to the survey vessel by radio. The range of detection is determined by the frequency and source level of the animals' calls. The vocalizations are recorded in dB starting 1 hour prior to the detonation. The recorded results will be presented graphically or in audio format.
  - **Active acoustic fish surveys** by sonar sweep to detect the presence of fish shoals. The sonar sweep is sensitive to frequencies of 50-200 kHz and has a 50/200 kHz transducer. The recorded data is shown on a high resolution display. Acoustic fish survey will be carried out from the support vessel prior to each detonation.

If marine mammals, seabirds or fish shoals are identified within the injury/ safety zone, the detonation will be delayed.

2. The displacement activities within the safety zone of the detonation site will be undertaken after the observations. The methods will include:
  - **Acoustic deterrent devices** ("seal scrammer") to displace seals and harbour porpoises from the clearance site prior to the detonation. The scrammers produce high frequency sound with a maximum acoustic output of 189 dB. Their anticipated effective range for seals ca. 300 m. The number of planned scrammers is four: one next to the PAM 300 m from the munition, two anchored on the seabed 300 m from the munition and one from the support vessel. The standard layout of the environmental mitigation equipment prior to the detonation is shown in Figure 10.

- **Acoustic fish scarers** comprising detonation of small explosive charges (50 to 500 g) to displace fish. They will be deployed from the support vessel at ca. 20 m below the surface and within 30 seconds of the detonation of each munition.
3. Marine mammals may be attracted to the munitions clearance area in case of dead or injured fish after the detonation. To minimise this effect the Contractor will recover any fish killed during the clearance activity by using a surface trawl from the support vessel.



**Figure 10.** Standard layout of the environmental mitigation equipment prior to the detonation  
View is from above.

The mitigation approach for the single detonation of F16 and the simultaneous detonation of F11, F12, F13 and F14 involves similar measures, but the layout and extent of the mitigation equipment will differ from that presented in Figure 10. The extended layouts for environmental mitigation equipment at these locations are presented in Appendix 6.

Extended layout is required for the single detonation of F16 because due to the presence of other munitions on the seabed the deployment of mitigation equipment closer to F16 is not regarded safe. Further, the extended layout complies with the precautionary principle, should the detonation of F16 lead to the associated detonation of any other of the surrounding munitions. For the simultaneous detonation of F11, F12, F13 and F14 an extended layout is required to provide enough coverage over the larger impact area. Further, due to the presence of other munitions on the seabed the deployment of mitigation equipment closer to these munitions is not regarded safe either on the northern or southern sides of the munitions.

Ecological supervision will be provided during the course of the clearance campaign to ensure that the displacement activities are properly implemented.

The monitoring programme for marine mammals, seabirds and fish shoals is presented in Table 13.

**Table 13.** The munitions clearance monitoring programme for marine mammals, seabirds and fish shoals.

Marine mammals, seabirds and fish monitoring					
Project activity	Parameter	Unit Me	thod	Location	Timing
<b>Munitions clearance</b>	Presence of marine mammals or seabirds	Present / absent, number and species	Visual observation by MMO, PAM	All munitions	Prior to detonation
	Presence of fish shoals	Present / absent	Sonar sweep	All munitions	Prior to detonation
	Injured marine mammals or seabirds	Yes / no, number and species	Visual observation	All munitions	After detonation
	Mortality of fish	Yes / no, estimated amount and species	Visual observation and surface trawl	All munitions	After detonation

### **Reporting of Observations**

Qualified MMOs onboard will have daily log sheets which will record every sighting of marine mammals, seabirds and fish shoals prior to the detonation and also any incidents of injured seabirds or marine mammals and mortality of fish after the detonation. The clearance Contractor will report this data to Nord Stream within the daily reporting. The observation records will be provided to the authorities as a copy of the log book.



## **5.6 Interference to Commercial Shipping – Mitigation and Monitoring Measures**

An assessment of the potential impacts from the construction activities on commercial shipping has been performed within the EIA (Chapter 8.4.1 Impacts on ship traffic) /4/. This assessment has been extended for all construction activities in the report “Nord Stream Construction and the Impact to Ship Traffic” /6/ and for munitions clearance in the report “Phase 1 Munitions Clearance: Impacts to Third Party Shipping within Estonian EEZ” /7/.

All movements of vessels of 300 GT or more are monitored by the GOFREP (Gulf of Finland Reporting system in international waters of the Gulf of Finland). GOFREP is a mandatory ship reporting system and adopted by the International Maritime Organization (IMO). GOFREP was established to improve maritime safety, to protect the maritime environment and to monitor compliance with the International Regulations for Preventing Collisions at Sea. The sea areas in the Gulf of Finland are monitored jointly by Finland, Estonia and the Russian Federation. Minor vessels outside of GOFREP will be notified about the clearance works through notices to mariners.

During the munitions clearance activities vessel movements will be monitored in accordance with a ship traffic management plan. The ship traffic management plan will be developed by the munitions clearance contractor in close consultation with the Finnish Maritime Administration and will interface with GOFREP to ensure the safety of third party shipping.

The Finnish Maritime Administration will be notified of the clearance operations well in advance of the commencement of work. Daily and weekly based reporting will be provided to the relevant GOFREP Vessel Traffic Service (VTS) centres whilst the activities are on-going.

A further mitigation measure to avoid adverse impacts on the commercial shipping is the establishment of a safety zone around each munitions clearance site during the clearance works. During the pre-detonation and post-detonation inspection surveys the safety zone will be a radial distance of 1 km from the cleared munition and during the detonation phase 2 km from the cleared munition. The safety zones on a munition by munition basis in different phases of the clearance procedure are presented in /7/.

In the detonation phase the detonation may only proceed after the Party Chief of the Clearance Contractor has confirmed that all party representatives onboard including a ship's captain, a marine mammal observer, a supervisor and the Nord Stream technical representative are in agreement to continue. The ship's captain will be responsible for VHF announcements and notifications and for monitoring that the safety zone and its vicinity are clear of third party vessels. Notification on the imminent subsea detonations is transmitted for the benefit of any vessels in the area and any land based local authorities.

## **5.7 Interference to Commercial Fishing - Mitigation Measures**

An assessment of the potential impacts from the munitions clearance on commercial fishing has been performed within the EIA (Chapter 8.4.2 Impacts on fishery) /4/.

To mitigate the adverse impacts on commercial fishing vessels a safety zone will be established around each munitions clearance site during the clearance works. During the pre-detonation and

post-detonation inspection surveys the safety zone will be a radial distance of 1 km from the cleared munition and during the detonation phase 2 km from the cleared munition. The safety zones on a munition by munition basis in different phases of the clearance procedure are presented in /7/. The negative impact of this mitigation measure is that potential fishing activities are excluded from the safety zone during the works. Nord Stream will notify the fishing associations about these exclusion zones prior to the commencement of munitions clearance works.



## 6 Compliance Assurance during Clearance Works

The objective of Nord Stream's compliance assurance is to control that the munitions clearance Contractor properly implements the agreed munitions clearance operations, for which it is responsible. These operations comprise the following tasks /8/:

1. Confirmation of munitions type and size of contained charge;
2. Visual inspection of 'objects of protection' (wrecks, barrels or similar) located within the surrounding seabed area to a distance of 1.0 km from the ordnance item;
3. Implementation of the environmental mitigation measures;
4. Establish and monitor an area clear of shipping in accordance with the ship traffic management plan and in conjunction with the coastguard and local authorities;
5. Placement of appropriate calculated detonation charges to dispose of the identified munitions;
6. Detonation of 'detonation charge' by appropriate methods and from a safe distance;
7. Inspection of munitions and immediate seabed area following detonation to demonstrate successful clearance of the munitions;
8. Removal of any remaining debris for proper disposal onshore;
9. Removal of dead fish;
10. Inspection of blast area influence zone to conform no adverse impact to other objects (i.e. third party infrastructure, cultural heritage sites and barrels) that may be impacted by the clearance and to determine the crater size;
11. Confirm successful completion of operations;
12. Field report following each detonation including lessons learnt section for implementation to subsequent clearance activities.

The individual tasks will be carried out according to the procedures agreed upon between the Contractor and Nord Stream. The procedural documentation will be included into a munition by munition Clearance Plan that the Contractor shall develop and issue for Nord Stream review minimum two months prior to vessel mobilization. Procedural documentation particularly relevant to environmental monitoring during munitions clearance comprises the following:

- Emergency Response Plan
- Environmental Management Plan including:
  - International standards and national legislation and regulations
  - Commitments from National EIAs and 'Espoo Report'
  - Development of procedures to achieve the environmental objectives
  - Mitigation and monitoring measures and implementation plan
  - Waste management and disposal plans for recovered 'debris' associated with the munitions clearance
- Ship traffic management plan to interface with the national maritime authorities, ensuring the safety of third party shipping

The Contractor's compliance with the defined procedures will be audited through offshore inspections and reporting. The offshore inspections will be conducted by a technical representative and an environmental specialist from Nord Stream, who will stay on-board the Contractor's vessel during clearance operations. The reports particularly relevant to environmental monitoring during munitions clearance include a daily progress report and a field report. The daily progress report

provides a concise description of daily operations and has to be issued by the Contactor to Nord Stream the following day. The Contractor is also requested to deliver a field report on the clearance of each individual munition on an on-going basis. This will include the results related to the implementation of the Environmental Management Plan and lessons learnt to pursue the continuous improvement of clearance operations. Moreover, the Contractor shall maintain regular notification and liaison with the relevant local and national authorities and associations as well as the cable operators throughout the execution of the clearance work.

## 7 Reporting of Monitoring Results

Nord Stream is committed to report publically on its monitoring activities on a regular basis. At national levels monitoring results will be shared with competent authorities as agreed upon. The national monitoring results for Finland will be summarized in a report on yearly basis in the Finnish and Swedish languages and submitted to the following authorities in the end of each year during the planned monitoring period.

- Uusimaa Regional Environment Centre
- Southwest Finland Regional Environment Centre
- Uusimaa Employment and Economic Development Centre
- Employment and Economic Development Centre for Southwestern Finland
- Environmental Authority of the City of Länsi-Turunmaa
- Environmental Authority of the City of Espoo
- Environmental Authority of the City of Hanko
- Environmental Authority of the City of Helsinki
- Environmental Authority of the City of Raasepori
- Environmental Authority of the City of Porvoo
- Environmental Authority of the Municipality of Kemiönsaari
- Environmental Authority of the Municipality of Inkoo
- Environmental Authority of the Municipality of Kirkkonummi
- Environmental Authority of the Municipality of Siuntio
- Environmental Authority of the Municipality of Pernaja
- Environmental Authority of the Municipality of Sipoo

In terms of the activity munitions clearance, the annual report will provide a summary of the impacts from munitions clearance based on the monitoring results. The report will cover the monitoring results for all monitored parameters, including the observations of marine mammals, seabirds and fish shoals, in a summarized manner. The impacts of released contaminants and nutrients contained in particulate matter and dissolved in the water column will be evaluated.

For munitions clearance in the security corridor a separate monitoring report in the Finnish and Swedish languages will be prepared within 3 months after the finalization of the activity and a hard copy of the report will be delivered to the above listed authorities as agreed. Unexpected events and chance finds will be reported immediately according to the procedure that will be developed in consultation with relevant authorities.

If the munitions will be cleared in two phases having a period of at least two months in between, a clarifying report about the impacts of the detonations and a comparison of the actual impacts with the assessed ones will be prepared based on the monitoring and observations during the work. The report will be submitted to the Western Finland Environmental Permit Authority approximately one month after the completion of the first phase, depending on the availability of laboratory results.

## 8 References

- /1/ Nord Stream AG, 2009, Nord Stream Espoo Report: Key Issue Paper Munitions: Conventional and Chemical
- /2/ Witteveen+Bos, 2010, Nord Stream Munitions clearance: Environmental impacts on munition by munition basis Finnish EEZ
- /3/ Ramboll, 2009, Environmental Field Survey Finland 2009
- /4/ Nord Stream AG, 2009, Environmental impact assessment report, Natural gas pipeline through the Baltic Sea, Environmental impact assessment in the exclusive economic zone of Finland.
- /5/ Witteveen+Bos, 2010, Nord Stream Munitions clearance in Finnish Exclusive Economic Zone: Sediment and contaminant spreading on munition by munition basis Gulf of Finland
- /6/ Nord Stream AG, 2009, Nord Stream Construction and the Impact to Ship Traffic
- /7/ Nord Stream AG, 2009, Phase 1 Munitions Clearance: Impacts to Third Party Shipping within Estonian EEZ
- /8/ Nord Stream AG, 2009, Munitions Clearance Services: Baltic Sea.

## 9 Revision Record

Rev.	Date	Description	Prepared	Checked	Approved		
			Nord Stream				
G	2010-08-30	Re-issue for use	TSA/ MTU	JKU	SBO		
F	2010-04-19	Re-issue for use	TSA/ MTU	JKU	SBO		
E	2009-10-27	Issue for use	TSA/ MTU	JKU	SBO		
D1	2009-09-11	Issue for consultation	TSA/ MTU	JKU	SBO		
D	2009-09-01	Issue for consultation	TSA/ MTU	JKU	SBO		
C	2009-08-23	Issue for consultation	TSA/ MTU	JKU	SBO		
B	2009-08-06	Issue for consultation	TSA/ MTU	JKU	SBO		
A	2009-05-22	Issue for consultation	TSA	JKU	SBO		
01	2009-05-05	Issue for comments	TSA	SBO			



**Appendix 1** Munitions to be cleared from the security corridor in the Finnish EEZ<sup>8</sup>

Munition number	Munition ID	Charge, kg	Simultaneous detonation (SD)	Seabed	Monitoring station
F1B	R-W6F-10740	350		sand	
F2	R-E7B-10466	0.8		gravelly sand	
F3	R-07-004	150		clay with coarse sediments	
F4	R-07-2655	150		very soft clay	VOHE1
F5	R-8AG-W-014	300		crystalline bedrock	
F6	R-8AG-W-009	30		clay with coarse sediments	
F7	R-E8C-10223	30		silt and fine sand / some gravel	
F8	R-W8A-10317	30		silt and fine sand	
F9	R-8CG-E-004	30		silt and fine sand	
F10	R-8CG-E-003	30		silt and fine sand / some gravel	
F11	R-W8A-10312	30	SD	silt and fine sand	
F12	R-W8A-10313	30		silt and fine sand	
F13	R-08-009	30		silt and fine sand	
F14	R-W8A-10005	30		silt and fine sand	
F15	R-8CG-E-002	30	SD	silt and fine sand / gravel patches	
F15B	R-08-44944	30			
F16	R-8CG-E-001	300		silt and fine sand	
F17	R-08-2805	350		very soft clay	VOM3, SED3
F18	R-08-159	115		silt and fine sand	
F19	R-09-27	115		crystalline bedrock / coarse sediments	
F20	S-09-3135	300		gravelly sand / sandy clay	
F21	R-09-04	0.8		gravelly sand	
F22	R-09-192	115		silt and fine sand	VOM2
F23	R-11-3395	100		very soft clay	
F25/F26	R-12-008	2 X 32		gravelly sand, large boulders	
F27	R-12-3463	300		very soft clay	VOM1

<sup>8</sup> The munitions were cleared under the permit No. 83/2009/2 granted on 2 October 2009 by Western Finland Environmental Permit Authority.



Appendix 2 (I) Summary of the impacts from munitions clearance on a munition by munition basis - phase 1 /2/

Munitions												Mammals and fish			Infrastructure						Cultural Heritage					Barrels							Protected Areas (Natura-2000)		Military areas		Distance to long term monitoring stations		Distance to FIN / EST-EZ boundary				
MU1	MU2	MU3	MU4	MU5		MU7	MU8	MU9	MU10	MU11	MU12	MF1	MF2	MF3	I1	I2	I3	I4	I5	I6	C1	C2	C3	C4		C5	B1	B2	B3	B4		B5			B6	B7				Firing danger area	Restricted area		
Approx. KP and W or E pipe (C16)		Munitions ID	Charge	Distance to the nearest pipe C16-5		Distances to nearest munition	Water Depth	Sediment / Seabed Type	Munition Discription	Radius crater	Released sediment	Safe range for mammals and fish	Injury range for mammals and fish mortality 25-75%	Letal range for mammals/prob. fish mortality 75-100%	Distance	Peak pressure	Owner Cable	From/to	Status	Impact assessment	Distance	Peak pressure	ID	Description	Impact assessment	Distan ce	Peak pressure	Barrel ID	Description	Estimated horizontal displacement	Impact asessment	km	Area ID	km	km	km	St.	km					
	KP		kg	m		m	m			m	tonnes	m m m			km	MPa					km	MPa					km	MPa			m												
F18	181.135	R-W6F-10740	350	7.3 N			69.0	Sand	Finnish EMZ SE mine	5.8	333	2100	280	35																				20.3	FI0100077	11.0	20.1	8.1	LL5	2.35			
F2	206.497	R-E7B-10466	0.8	4.1 NW			4079	Gravelly sand	German burst buoy (Spreng buoy).	2.0	14	600	80	10																				22.9		2.6	8.7	2.2	LL6A	2.72			
F3	210.607	R-07-004	150	3.6 NW			2795	Clay with coarse sediments	Contact mine Russian origin.	4.6	165	1700	220	30																				20.9		4.0	11.0			1.46			
F4	213.402	R-07-2655	150	1.1 NW			2795	Very soft clay	Contact mine Russian origin.	5.8	329	1700	220	30																				19.3	FI0100026	4.8	12.9	4.6	LL7	1.27			
F5	223.229	R-8AG-W-014	300	2.9 NW			5353	Crystalline bedrock	German EMC mine.	No crater; munition on bedrock		2000	260	35	1.80	0.12	Linux: Pangea SEG3	Helsinki (FIN)- Tallinn (EST)																15.4		5.2	17.0			1.94			
F6	237.320	R-8AG-W-009	30	1.4 S			528	Clay with coarse sediments	German UMA contact mine.	4.2	127	1200	160	20	0.67	0.20																		12.9		5.9	5.8			1.65			
F7	237.357	R-EBC-10223	30	20.9 S			528	Silt and fine sand/some gravel	German UMA contact mine.	4.2	127	1200	160	20	0.92	0.14																		13.2		6.4	6.1	12	GF1	1.19			
F8	238.668	R-W8A-10317	30	24.5 S			597	Silt and fine sand	German UMA mine.	4.2	127	1200	160	20	0.34	0.43																		11.9		5.4	4.8			2.2			
F9	238.596	R-8CG-E-004	30	4.2 N			597	Silt and fine sand	German UMA mine.	4.2	127	1200	160	20	0.14	1.16																		12.4		6.0	5.2			1.63			
F10	239.449	R-8CG-E-003	30	8.0 N			658	Silt and fine sand/some gravel	German UMA mine.	3.3	63	1200	160	20	0.39	0.37	Elion: EE-SF3	Lautsaari (FIN)- Merenolisa (LAT)																11.8	FI0100089	5.6	4.7			1.95			
F11	240.094	R-W8A-10312	30	22.0 SE			103	Silt and fine sand	German UMA mine.	4.2	127	Simultaneously	3000	500	100	0.98																		11.2		5.2	4.2			2.44			
F12	240.198	R-W8A-10313	30	21.8 SE			43	Silt and fine sand	German UMA mine.	4.2	127					1.02																					11.2		5.2	4.2			2.45
F13	240.232	R-08-009	30	3.7 NW			32	Silt and fine sand	German UMA mine.	4.2	127					1.01																					11.2		5.2	4.2			2.42
F14	240.265	R-W8A-10005	30	1.9 SE			32	Silt and fine sand	German UMA mine.	4.2	127	Simultaneously	2300	350	70	1.02																		11.2		5.2	4.2			2.44			
F15	239.966	R-8CG-E-002	30	2.7 NW			63	Silt and fine sand/gravel patches	German UMA mine.	3.3	63					0.70																					11.5		5.5	4.5			2.13
F15B	239.966	R-08-44944	30				63		German UMA mine.	3.3	63					0.70																											
F16	240.219	R-8CG-E-001	300	11.1 NW			253	Silt and fine sand	German UMA mine.	7.0	583	1200	160	20	0.83	0.28																		11.4		5.4	4.4			2.2			

Appendix 2 (II) Summary of the impacts from munitions clearance on a munition by munition basis - phase 1 /2/

Munitions												Mammals and fish			Infrastructure						Cultural Heritage					Barrels							Protected Areas (Natura-2000)		Military areas		Distance to long term monitoring stations		Distance to FIN / EST-EEZ boundary			
MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9	MU10	MU11	MU12	MF1	MF2	MF3	I1	I2	I3	I4	I5	I6	C1	C2	C3	C4		C5	B1	B2	B3	B4	B5	B6			B7	Firing danger area				Restricted area		
Approx. KP and W or E pipe (C16)		Munitions ID	Charge	Distance to the nearest pipe C16-5		Distances to nearest munition	Water Depth	Sediment / Seabed Type	Munition Discription	Radius crater	Released sediment	Safe range for mammals and fish	Injury range for mammals / prob. fish mortality 25-75%	Lethal range for mammals/prob. fish mortality 75-100%	Distance	Peak pressure	Owner Cable	From/to	Status	Impact assessment	Distance	Peak pressure	ID	Description	Impact assessment	Distance	Peak pressure	Barrel ID	Description	Estimated horizontal displacement	Impact assesment	km	Area ID	km	km	km	St.	km				
	KP		kg	m		m	m			m	tonnes	m m m			km	MPa						km	MPa				km	MPa				m										
F17	242.956	R-08-2805	350	11.4 SE		1948	71.0	Very soft clay	German EMF mine.	7.3	667	2100	280	35	1.61	0.14	Telenor Sweden: UESF1	Helinki (FIN)-Hango (FIN)	Assumed to be exposed	No impact							0.77	0.32	R-08-45237	200 lt barrel, both ends closed and cap hole clogged; quite corroded and slightly contracted but apparently undamaged.	3	0.17					10.8	5.2	4.7		2.44	
F18	245.068	R-08-159	115	7.9 NW		1948	68.5	Silt and fine sand	Russian contact mine M 08.	4.3	135	1600	210	30	1.01	0.23	Energia	Helinki (FIN)-Tamm (EST)	Assumed to be exposed								1.38	0.12			0.03	No impact					11.1	5.4	5.3		2.31	
F19	247.894	R-09-27	115	2.8 NW		2787	68.0	Crystalline bedrock/coars e granular	Russian contact mine M 08.	0.4	0	1600	210	30	0.44	0.42	Elisa: FEC1	Porkkala-Kakumäe	Assumed to be exposed								1.08	0.15	R-09-327236	200 lt barrel, both ends and cap hole closed; fairly corroded but apparently undamaged.	3	0.04					11.7	5.2	5.8		2.44	
F20	255.893	S-09-3135	300	11 NW		1569	63.0	Crystalline bedrock/coars e granular	German EMC mine.	1.0	2	2000	260	35	1.71	0.09	Telenor Sweden: UESF1	Helinki (FIN)-Hango (FIN)	Assumed to be exposed																		16.1	5.9	8.5		1.37	
F21	257.385	R-09-04	0.8	0.1 SE		1569	65.0	Gravelly sand	German burst buoy (Spreng buoy). Charge to clear is larger than original charge	1.6	7.0	600	80	10	0.58	0.31	Telenor Sweden: UESF2												0.82	0.07	R-09-48737	100 lt container; top closed. Quite corroded and contracted, but apparently undamaged.	3	0.01	No impact					17.2	6.0	9.1
F22	263.621	R-09-192	115	9 NW		6137	61.0	Silt and fine sand	Russian contact mine M 08.	5.4	270	1600	210	30	1.46	0.11	Telenor Sweden: UESF1	Helinki (FIN)-Hango (FIN)	Assumed to be exposed																		21.8	5.7	11.0	5.8	LL9	0.46
F23	319.304	R-11-3395	100	16.5 SE		14745	81.0	Very soft clay	Finnish S-40 mine.	5.3	245	1600	200	25	0.35	0.74	Telenor Sweden: UESF2	Kalinograd (RUS)-Sudzhensk (RUS)	Assumed to be exposed								1.29	0.10	S-11-3138	Wreck of a typical coastal vessel from the 20th century. Many parts of the wreck are broken up.			No impact									
F25 / F26	360.517	R-12-008	64	3.5 NW		5602	64.0	Gravelly sand, large boulders	Possible 2 air dropped bombs. No mine. Charge assumed: 2 * 32 kg	3.8	92	1400	180	25	1.60	0.10	Russian military: UOCBP																									
F27	366.326	R-12-3463	300	27.3 SE		5602	78.0	Very soft clay	German EMC II mine.	7.0	583	2000	260	35	1.51	0.14																										

## Appendix 2 (III) /2/

### Legend

Colour legenda for munitions charge	less than	100 kg			white
	more or equal than	100 kg	less than	200 kg	
	more or equal than	200 kg	less than	300 kg	
	more than	300 kg			
Colour legenda for distances	less than	0.5 km			
	more or equal than	0.5 km	less than	1 km	
	more or equal than	1 km	less than	2 km	
	more than	2 km			white
Colour legenda for peak pressure	less than	0.1 MPa			white
	more or equal than	0.1 MPa	less than	1 MPa	
	more or equal than	1 MPa	less than	10 MPa	
	more than	10 MPa			
Colour legenda for barrel displacement	less than	0.5 m			white
	more or equal than	0.5 m	less than	1 m	
	more or equal than	1 m	less than	2 m	
	more or equal than	2 m			

Appendix 3 Summary of the sediment spreading due to munitions clearance on a munition by munition basis - phase 1 /5/

Munitions									MU13	Spreading of suspended sediment and contaminations												Distance to FIN/ EST- EEZ boundary	Notes
MU1	MU2	MU3	MU4	MU7	MU8	MU9	MU11	MU12		SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SC1	SC2	SC3	SC4		
Approx. KP and W or E pipe (C16)		Munitions ID	Charge	Distances to nearest munition	Water Depth	Sediment / Seabed Type	Diameter crater	Released sediment	Concentration > 10 mg/l for max. 18 hrs.				Maximum concentration > 3 mg/l				Maximum concentration > PNEC of SUM16PAH						
									Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ				
	KP		kg	m m			m	tonnes	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area			
									km	km <sup>2</sup>	km	km <sup>2</sup>	km	km <sup>2</sup>	km	km <sup>2</sup>	km	km <sup>2</sup>	km	km <sup>2</sup>	km		
F1B	181.135	R-W6F-10740	350		69.0	sand	5.8	333	4.3	2.7	1.9	1.2	7.8	8.9	5.5	6.2	3.9	4.4	1.5	1.7	2.35	Note 1	
F2	206.497	R-E7B-10466	0.8	4079	68.3	Gravelly sand	2.0	14	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.72		
F3	210.607	R-07-004	150	2795	78.0	Clay with coarse sediments	4.6	165	4.8	3.8	3.3	2.7	7.3	10.6	5.8	8.5	5.8	8.4	4.3	6.2	1.46		
F4	213.402	R-07-2655	150	2795	74.0	Very soft clay	5.8	329	2.8	2.4	1.6	1.3	6.2	6.4	4.9	5.1	4.1	4.2	2.8	2.9	1.27		
F5	223.229	R-8AG-W-014	300	5353	41.0	Crystalline bedrock	No crater; munition on bedrock		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.94	Note 2	
F6	237.320	R-8AG-W-009	30	528	66.0	Clay with coarse sediments	4.2	127	0.4	0.2											1.65		
F7	237.357	R-E8C-10223	30	528	66.0	Silt and fine sand/some gravel	4.2	127	0.4	0.2											1.19		
F8	238.668	R-W8A-10317	30	597	64.5	Silt and fine sand	4.2	127	1.2	0.7											2.2		
F9	238.596	R-8CG-E-004	30	597	65.0	Silt and fine sand	4.2	127	0.4	0.2											1.63		
F10	239.449	R-8CG-E-003	30	658	66.0	Silt and fine sand/some gravel	3.3	63	0.5	0.3											1.95		
F11	240.094	R-W8A-10312	30	103	64.0	Silt and fine sand	4.2	127	4.0	2.0	2.0	1.0	25	90	12	40	23.0	80.0	10.0	35.0	2.42		
F12	240.198	R-W8A-10313	30	43	65.0	Silt and fine sand	4.2	127															
F13	240.232	G-08-009	30	32	65.0	Silt and fine sand	4.2	127															
F14	240.265	R-W8A-10005	30	32	64.0	Silt and fine sand	4.2	127															
F15	239.966	R-8CG-E-002	30	253	65.0	Silt and fine sand/gravel patches	3.3	63													2.13	Note 3	
F15B	239.666	R-08-44944	30		65.0	Silt and fine sand/gravel patches	3.3	63													2.2		
F16	240.219	R-8CG-E-001	30	253	65.0	Silt and fine sand	4.2	127													2.44		
F17	242.956	R-08-2805	350	1948	71.0	Very soft clay	7.3	667													2.31		
F18	245.068	R-08-159	115	1948	68.5	Silt and fine sand	4.3	135	0.0	0.0											2.44		
F19	247.894	R-09-27	115	2787	68.0	Crystalline bedrock/coarse granular	0.4	0	0.0	0.0											0.0	0.0	0.0
F20	255.893	S-09-3135	300	1569	63.0		1.0	2	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.04	
F21	257.385	R-09-04	0.8	1569	65.0	Gravelly sand	1.6	7	2.8	0.9	2.4	0.8	6.6	3.9	6.1	3.7	3.3	1.9	2.8	1.7	0.46		
F22	263.621	R-09-192	115	6137	61.0	Silt and fine sand	5.4	270	2.2	0.7	0.4	0.1	5.2	3.0	3.4	1.9	2.3	0.7	0.5	0.1	1.81		
F23	319.304	R-11-3395	100	14745	81.0	Very soft clay	5.3	245	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.79		
F25/25	360.517	R-12-008	64	5602	64.0	Gravelly sand. Large boulders	3.8	92	4.3	2.5	0.3	0.2	6.5	5.3	2.5	2.0	4.8	7.8	0.8	1.3	4.00		
F27	366.326	R-12-3463	300	5602	78.0	Very soft clay	7.0	583															

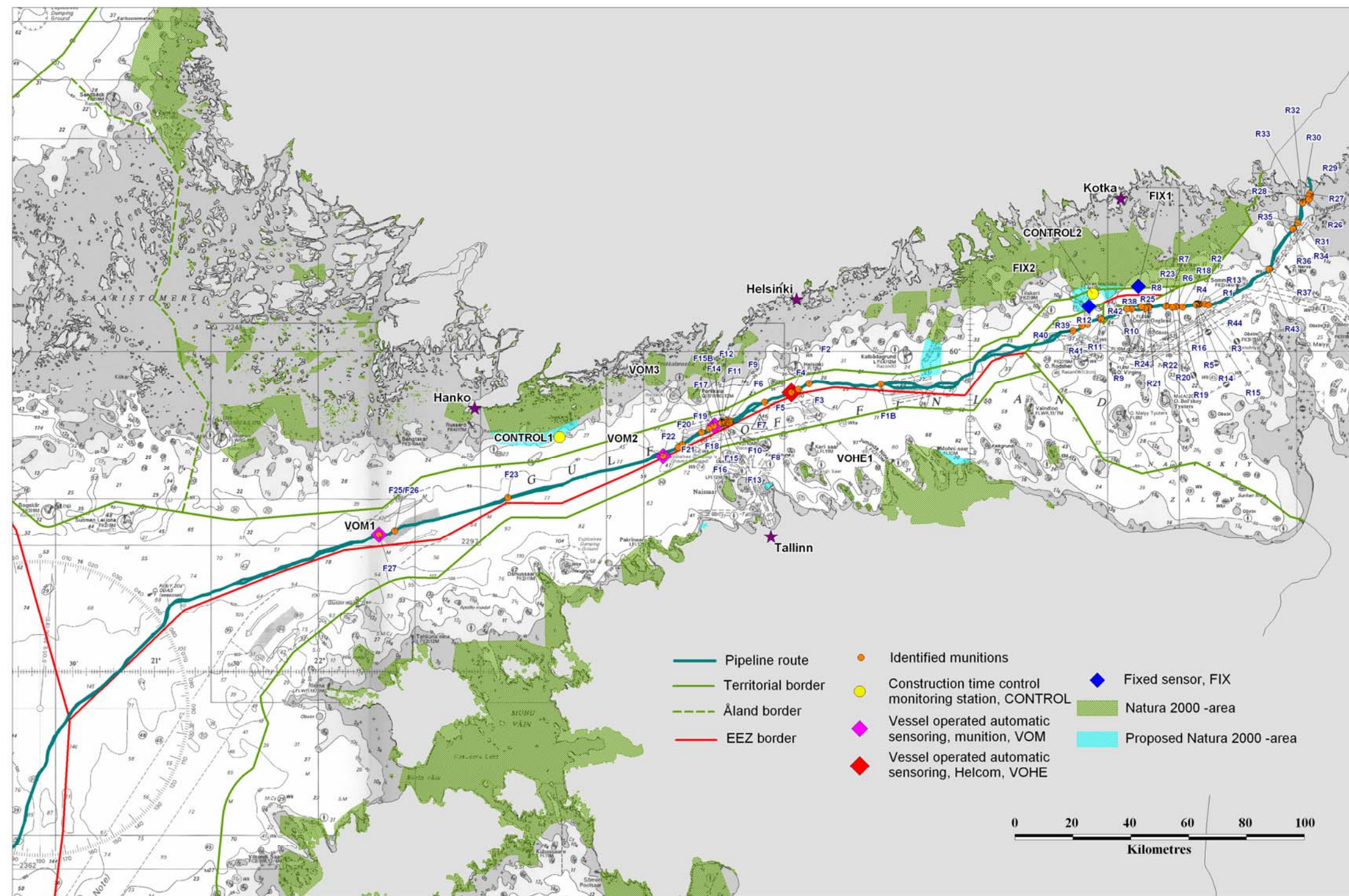
Appendix 4A Distances between barrels and munitions in [km] on a munition by munition basis /2/

Object	Risk	F1B	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F15B	F16	F17	F18	F19	F20	F21	F22	F23	F25/26	F27	Phase 1	Phase 2
		R-W6F-10747	R-E7B-10466	R-07-004	R-07-2655	R-8AG-W-014	R-8AG-W-009	R-E8C-10223	R-W8A-10317	R-8CG-E-004	R-8CG-E-003	R-W8A-10312	R-W8A-10313	G-08-009	R-W8A-10005	R-8CG-E-002	R-08-44944	R-8CG-E-001	R-08-2805	R-08-159	R-09-27	S-09-3135	R-09-04	R-09-192	R-11-3395	R-12-008	R-12-3463		
07-S-73	3				0.10																							phase 1	
08-S-33	0						1.45	1.35	0.43	0.19	0.77	1.35	1.45	1.47	1.50	1.28	1.25	1.53										phase 1	
R-08-2938	0						0.70	1.21	1.74	1.96																		phase 1	
R-08-321109	3						0.88	0.42	1.30	0.96	1.80																	phase 1	
R-08-42672	0						0.50	0.85	0.93	1.17	1.89																	phase 1	
R-08-43011	0										1.38	0.72	0.65	0.65	0.63	0.96	0.98	0.82										phase 1	
R-08-43240	1								1.49	1.72	1.04	0.51	0.53	0.57	0.58	0.82	0.82	0.84										phase 1	
R-08-43254	0										1.57	0.92	0.84	0.82	0.79	1.10	1.13	0.91										phase 1	
R-08-43649	0								1.69	1.81	1.02	0.36	0.32	0.33	0.32	0.63	0.65	0.56										phase 1	
R-08-44156	0						0.44	0.45	1.71	1.65																		phase 1	
R-08-44339	0						1.34	1.21	0.50	0.11	0.89	1.49	1.58	1.61	1.64	1.41	1.38	1.66										phase 1	
R-08-44744	0						1.16	1.19	0.22	0.49	1.10	1.59	1.69	1.72	1.76	1.58	1.56	1.83										phase 1	
R-08-44979	1																		1.60	0.49								phase 1	
R-08-450082	0								1.55	1.47	0.62	0.30	0.28	0.25	0.26	0.10	0.13	0.15										phase 1	
R-08-45237	3																		0.76	1.38								phase 1	
R-08-45575	0							1.78	1.28	0.76	0.76	1.37	1.43	1.43	1.45	1.13	1.10	1.33										phase 1	
R-08-45629	0						1.77	1.43	1.18	0.59	0.99	1.64	1.71	1.71	1.74	1.43	1.40	1.65										phase 1	
R-08-45979	3						0.90	0.42	1.33	0.99	1.82																	phase 1	
R-08-46223	0						1.30	0.91	1.17	0.65	1.39					1.89	1.86											phase 1	
R-08-58162	3								1.09	0.99	0.14	0.52	0.59	0.61	0.64	0.38	0.35	0.63										phase 1	
R-E8C-10177	0						1.73	1.72																				phase 1	
R-E8C-10202	0								1.77	1.69	0.84	0.44	0.36	0.32	0.30	0.33	0.36	0.08										phase 1	
R-E8C-10226A	0								1.01	0.90	0.07	0.59	0.67	0.69	0.72	0.47	0.44	0.72										phase 1	
R-E8C-10226B	3								1.01	0.90	0.07	0.59	0.67	0.69	0.72	0.47	0.44	0.72										phase 1	
R-E8C-10227	3								1.02	0.91	0.08	0.58	0.66	0.68	0.71	0.46	0.43	0.71										phase 1	
R-W8A-10041	0						0.03	0.54	1.32	1.39																		phase 1	
09-S-14	1																						0.93					phase 1	
R-09-47641	0																						0.78					phase 1	
R-09-48535	0																						0.85					phase 1	
R-09-48737	3																						0.82					phase 1	
R-09-48737	3																						0.82					phase 1	
R-09-49088	1																						1.52	0.37				phase 1	
R-09-49717	1																							0.34				phase 1	
R-09-49718	1																							0.32				phase 1	
11-S-66	2																								1.63			phase 1	
11-S-88	0																								1.95			phase 1	
R-11-130002	3																								1.26			phase 1	
R-11-130007	0																								1.32			phase 1	
R-11-25197	0																								0.54			phase 1	
R-11-25197	0																								0.54			phase 1	
R-11-25305	0																								0.64			phase 1	
R-11-25363	0																												
R-11-25364	0																												
R-11-25639	0																								0.57			phase 1	
R-11-25787	2																												
R-11-25868	1																								1.09			phase 1	
R-11-25890	0																												
R-11-25903	3																												
R-11-25933	0																								1.54			phase 1	
R-11-26043	0																								0.72			phase 1	
R-11-26112	0																								0.60			phase 1	
R-11-26148	0																								1.54			phase 1	
R-11-26247	0																								1.00			phase 1	
R-11-26249	0																								0.59			phase 1	
R-11-26249	0																								0.59			phase 1	
R-11-26250	0																								0.62			phase 1	
R-11-26257	3																								0.59			phase 1	
R-11-26264	0																								1.18			phase 1	
R-11-26267	0																								1.57			phase 1	
R-11-26567	1																								0.62			phase 1	
R-11-26568	0																								0.65			phase 1	
R-11-26569A	0																								0.83			phase 1	
R-11-26569B	3																								0.83			phase 1	
R-11-26698	0																												
R-11-26794	3																								1.89			phase 1	
R-11-27035	0																								1.33			phase 1	
R-11-27310	0																												
R-11-27502	0																								1.26			phase 1	
R-11-28021	0																								1.73			phase 1	
R-11-300686	0																								0.15			phase 1	
R-11-300686	0																								0.15			phase 1	
R-11-3321	0																								0.86			phase 1	
R-11-3380	0																								1.63			phase 1	
R-11-3396	2																								0.77			phase 1	
R-11-3397	1																								0.93			phase 1	
R-11-																													

Object	Risk	F1B	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F15B	F16	F17	F18	F19	F20	F21	F22	F23	F25/26	F27	Phase 1	Phase 2
		R-WGF-10747	R-ETB-10466	R-07-004	R-07-2685	R-3AG-W-014	R-3AG-W-009	R-ERC-10223	R-WMA-10317	R-SCG-E-004	R-SCG-E-003	R-WMA-10312	R-WMA-10313	G-08-009	R-WMA-10005	R-SCG-E-002	R-00-44944	R-SCG-E-001	R-08-2805	R-08-169	R-09-27	S-09-3135	R-09-04	R-09-192	R-11-3395	R-12-2008	R-12-3463		
07-S-73	3				1.69																							phase 1	
08-S-33	0						0.01	0.02	0.17	0.66	0.05			0.03			0.03	0.04										phase 1	
R-08-2938	0						0.06	0.02	0.01	0.01																		phase 1	
R-08-321109	3						0.04	0.19	0.02	0.03	0.01																	phase 1	
R-08-42672	0						0.13	0.04	0.03	0.02	0.01																	phase 1	
R-08-43011	0										0.01			0.09			0.04	0.13										phase 1	
R-08-43240	1								0.01	0.01	0.03			0.15			0.06	0.13										phase 1	
R-08-43254	0										0.01			0.06			0.03	0.11										phase 1	
R-08-43649	0								0.01	0.01	0.03			0.35			0.10	0.27										phase 1	
R-08-44156	0						0.16	0.16	0.01	0.01																		phase 1	
R-08-44339	0						0.02	0.02	0.13	1.27	0.04			0.02			0.02	0.03										phase 1	
R-08-44744	0						0.02	0.02	0.54	0.13	0.02			0.02			0.02	0.02										phase 1	
R-08-44979	1																		0.04	0.22								phase 1	
R-08-450082	0								0.01	0.01	0.08			0.50			1.80	1.46										phase 1	
R-08-45237	3																		0.17	0.03								phase 1	
R-08-45575	0							0.01	0.02	0.05	0.05			0.02			0.03	0.05										phase 1	
R-08-45629	0						0.01	0.01	0.02	0.09	0.03			0.02			0.02	0.03										phase 1	
R-08-45979	3						0.04	0.18	0.02	0.03	0.01																	phase 1	
R-08-46223	0						0.02	0.04	0.02	0.07	0.01																	phase 1	
R-08-58162	3									0.02	0.03	0.95		0.12			0.67	0.22										phase 1	
R-E8C-10177	0						0.01	0.01																				phase 1	
R-E8C-10202	0								0.01	0.01	0.04			0.40			0.35	2.30										phase 1	
R-E8C-10226A	0								0.03	0.04	1.83			0.12			0.20	0.17										phase 1	
R-E8C-10226B	3								0.03	0.04	1.83			0.09			0.48	0.17										phase 1	
R-E8C-10227	3								0.03	0.04	1.65			0.09			0.50	0.18										phase 1	
R-W6A-10041	0						2.85	0.11		0.02	0.01																	phase 1	
09-S-14	1																						0.01					phase 1	
R-09-47641	0																						0.01					phase 1	
R-09-48535	0																						0.01					phase 1	
R-09-48737	3																						0.01					phase 1	
R-09-48737	3																						0.01					phase 1	
R-09-49088	1																					0.04	0.05					phase 1	
R-09-49717	1																								0.41			phase 1	
R-09-49718	1																							0.47				phase 1	
11-S-66	2																									0.02		phase 1	
11-S-88	0																									0.01		phase 1	
R-11-130002	3																									0.03		phase 1	
R-11-130007	0																									0.03		phase 1	
R-11-25197	0																									0.17		phase 1	
R-11-25197	0																									0.17		phase 1	
R-11-25305	0																									0.12		phase 1	
R-11-25363	0																											phase 1	
R-11-25364	0																											phase 1	
R-11-25639	0																									0.16		phase 1	
R-11-25787	2																											phase 1	
R-11-25868	1																									0.04		phase 1	
R-11-25890	0																											phase 1	
R-11-25903	3																											phase 1	
R-11-25933	0																									0.02		phase 1	
R-11-26043	0																									0.10		phase 1	
R-11-26112	0																									0.14		phase 1	
R-11-26148	0																									0.02		phase 1	
R-11-26247	0																									0.05		phase 1	
R-11-26249	0																									0.14		phase 1	
R-11-26249	0																									0.14		phase 1	
R-11-26250	0																									0.13		phase 1	
R-11-26257	3																									0.14		phase 1	
R-11-26264	0																									0.03		phase 1	
R-11-26267	0																									0.02		phase 1	
R-11-26567	1																									0.13		phase 1	
R-11-26568	0																									0.12		phase 1	
R-11-26569A	0																									0.07		phase 1	
R-11-26569B	3																									0.07		phase 1	
R-11-26698	0																											phase 1	
R-11-26794	3																									0.01		phase 1	
R-11-27035	0																									0.03		phase 1	
R-11-27310	0																									0.03		phase 1	
R-11-27502	0																									0.01		phase 1	
R-11-28021	0																									1.13		phase 1	
R-11-300686	0																									1.12		phase 1	
R-11-300686	0																											phase 1	
R-11-3321	0																									0.07		phase 1	
R-11-3380	0																									0.02		phase 1	
R-11-3396	2																									0.08		phase 1	
R-11-3397	1																									0.05		phase 1	
R-11-38095	0																									0.03		phase 1	
RPS-11-1328	3																									0.04		phase 1	
RPS-11-1330	1																									0.07		phase 1	
RPS-11-1942</																													



## Appendix 5 Locations for water and sediment quality monitoring during munitions clearance



**Appendix 6** Extended layouts for environmental mitigation equipment at selected clearance sites

