Nord Stream Project

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Monitoring Programme for Munitions Clearance in Phase 2 Finland

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1 Introduction

The monitoring programme for munitions clearance in phase 2 Finland is part of the overall environmental monitoring programme for Finland. Nord Stream's general monitoring approach, environmental management framework and baseline investigations in the Finnish EEZ are presented in Ch. 1-4 of the overall programme.

In munitions clearance phase 2, a total of 23 munitions will be cleared in the security and anchor corridor in the Finnish EEZ. Munitions to be cleared in phase 2 are listed in Table 1.

Table 1. Munitions to be cleared in phase 2 in the Finnish EEZ

Munition number	Munition ID	KP (C16)	Corridor[1]	Charge, kg	Seabed
F33	R-11-200030	331.725	SC	4 x 0.454	Clay with coarse sediment
F34	R-12-51010	350.414	AC	115	Very soft clay
F35	R-13-31989	375.664	AC	250	Very soft clay
F36	R-14-35290	418.695	AC	250	Very soft clay
F37	R-08-2767	~ 218.110 [4]	SC	46[5]	Sand and gravel
F38	R-08-450077	~ 218.110 [4]	SC	46[5]	Sand and gravel
F38B [2]	R-08-001-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38C [2]	R-08-002-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38D [2]	R-08-003-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38E [2]	R-08-004-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38F [2]	R-08-005-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38G [2]	R-08-006-FAB	218.148	SC	46	Clay/ Soft clay
F38H [2]	R-08-007-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38J [2]	R-08-009-FAB	~ 218.110 [4]	SC	46	Clay/ Soft clay
F38K [2]	R-08-010-FAB	218.169	SC	46	Clay/ Soft clay
F39	R-08-1000069	223.737	SC	20	Coarse sediment
F40	R-08-90	246.670	SC	115	Soft clay
F41	R-09-1000149	260.554	SC	300 [6]	Glacial till, coarse sediment with boulders
F42	R-09-1000202	261.973	SC	40	Coarse sediment
F43 [3]	R-08-44066	241.75	SC	300	Clay/ Soft clay
F44 [3]	R-08-200957	241.946	SC	300	Clay/ Soft clay
F45 [3]	R-09-1116855	258.12	SC	60	Clay with course sediment
F46 [3]	R-10-3227	298.42	SC	200	Fine sediment

[1] SC: security corridor, AC: anchor corridor

[2] Munitions were identified during the surveys prior to relocation of munitions F37 and F38.

[3] Munitions were identified during the control survey prior to pipelay. F43-F45 are newly found munitions and F46 an earlier found object that was re-evaluated to be a munition by the clearance Contractor.

[4] Munitions will be lifted and shifted to the pre-defined clearance area for detonation due to their proximity to cable EE-SF2.

[5] In the original munition by munition impact assessment the charge size was estimated to be 25 kg. However, in the pre-detonation inspection the charge size was confirmed to be 46 kg.

[6] In the original munition by munition impact assessment the charge size was estimated to be 40 kg. However, in the pre-detonation inspection the charge size was confirmed to be 300 kg.

As presented in Chapter 1 of the overall monitoring programme, Southern Finland Regional State Administrative Agency approved the revision C2 of the “Baltic Sea Natural Gas Pipeline Environmental Monitoring Programme - Finland” including its appendix 4 “Monitoring Programme for Munitions Clearance in Phase 2 Finland” (revision 02) by the decision No. 4/2010/4 on 12 February 2010. Based on lessons learned during munitions clearance in 2009, a proposal for specifying the appendix 4 was submitted to the Centres for Economic Development, Transport and the Environment on 21 April 2010. Furthermore, during the clearance works in 2010 notifications according to permit provisions, e.g. about minor pipeline re-routings to avoid clearance of munitions and earlier unidentified objects found during the control survey prior to pipelay and during the surveys prior to detonations, were made to the Centres. These notifications also included specifications to the monitoring programme. The Uusimaa Centre for Economic Development, Transport and the Environment has approved the proposed changes in a letter dated on 4 June 2010 (UUDELY/742/07.00/2010) and a letter dated on 23 June 2010 (UUDELY/742/07.00/2010). This revision B of the monitoring programme for munitions clearance in phase 2 accommodates the approved changes.

2 Monitoring during Clearance Works

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
  - Behavioral 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 phase 2 will therefore address these impacts as defined in the following sub-sections. Further specifications and amendments based on the first monitoring results and lessons learnt from the clearance campaign in 2009 have been included. A summary of the monitoring programme for munitions clearance phase 2 is presented in Table 2.

Table 2. Summary of the monitoring programme for munitions clearance in phase 2 in Finland.

Monitoring activities for munitions clearance	Locations			
	VOM4	NOISE2-4	Cultural Heritage, Barrels and Existing Infrastructure	All identified munitions
Current measurement from vessel[1]				X
Vessel operated automatic sensoring [2]	X			
Water sampling for analysis and calibration [3]	X			
Water sampling for analysis [4]	X			
ROV visual inspections [5]			X	X
Multi beam Echo Sounding [6]				X
Pressure wave sensors [7]		X		X
Visual and acoustic observations [8]				X
Parameters:	[1] Current velocity and direction [2] Turbidity, temperature, conductivity and depth [3] Turbidity, suspended solids, oxygen concentration and conductivity, phosphorus and nitrogen [4] Metals [5] Crater size and integrity of cultural heritage sites, barrels or cables [6] Crater size [7] Pressure waves [8] The presence of marine mammals, seabirds and fish shoals			

2.1 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) /1/. This assessment has been extended for munitions clearance phase 2 on a munition by munition basis /2/, /3/, /4/, /5/, /6/.

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 all 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 identified munitions will be monitored (Figure 1). The monitoring programme for seabed morphology during munitions clearance is presented in Table 3.

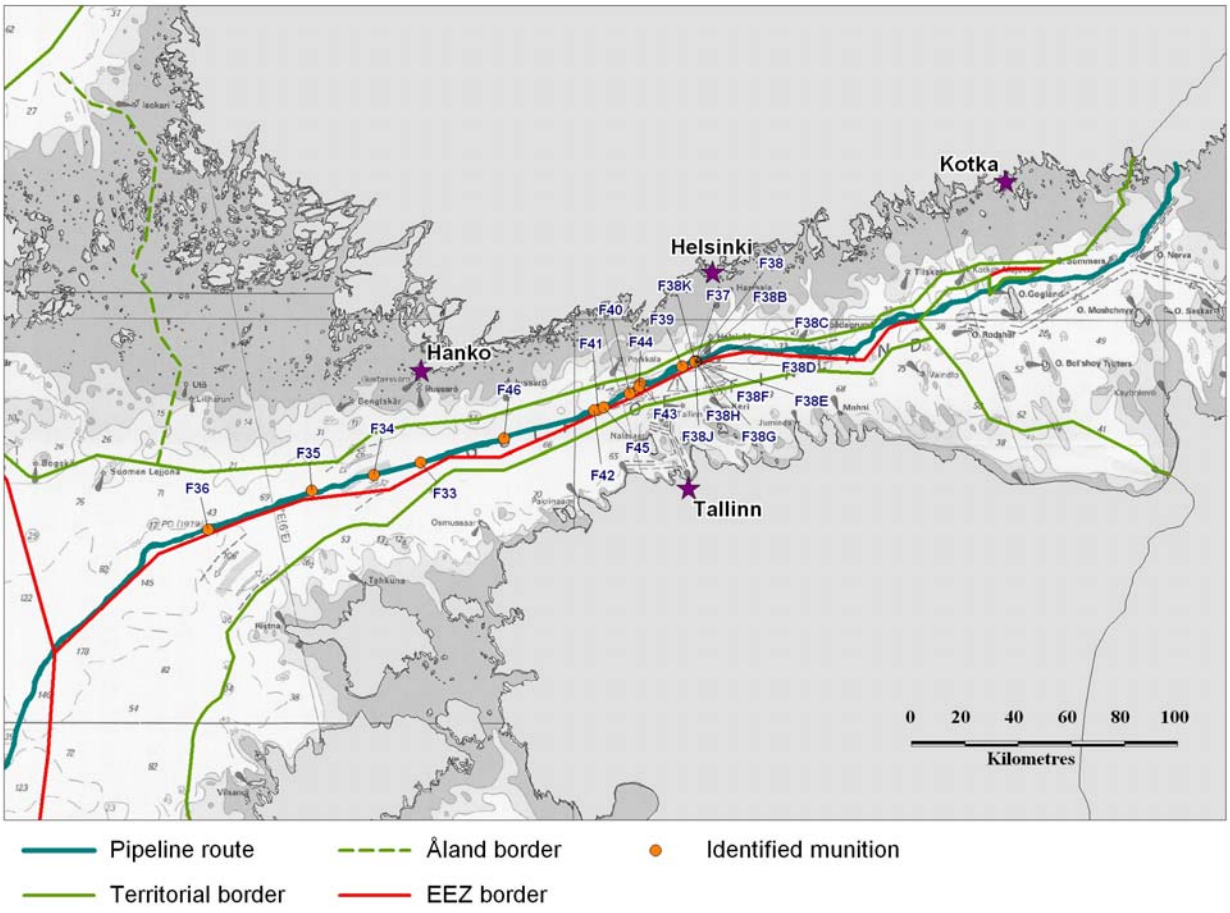

Figure 1. Locations of identified munitions part of munitions clearance phase 2 in the Finnish EEZ where multi-beam echo sounding and ROV visual inspections will be carried out to monitor seabed morphology.

Table 3. The monitoring programme for seabed morphology during munitions clearance in phase 2.

Seabed morphology monitoring					
Project activity	**Parameter**	**Unit**	**Method**	**Location**	**Timing**
Munitions clearance (Phase 2)	Crater / depression	m (depth, radius), m^3 (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

2.2 Water 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) /1/. This assessment has been extended for munitions clearance phase 2 on a munition by munition basis /2/, /3/, /4/, /5/, /6/.

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 through the water column from 1 m below the surface to 5 m above the seabed by a sensor from a support vessel. 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 a 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 via in situ measurements using a combination of 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 in-situ measurements will be conducted over time intervals to allow assessment of the predicted migration of the sediment plume. At the selected location (Figure 2) the following sensoring will be performed:

- Vessel operated automatic sensoring (1 location, VOM4)

The selected methods are described in detail below. A summary of methods and parameters to be analysed are presented in Table 4.

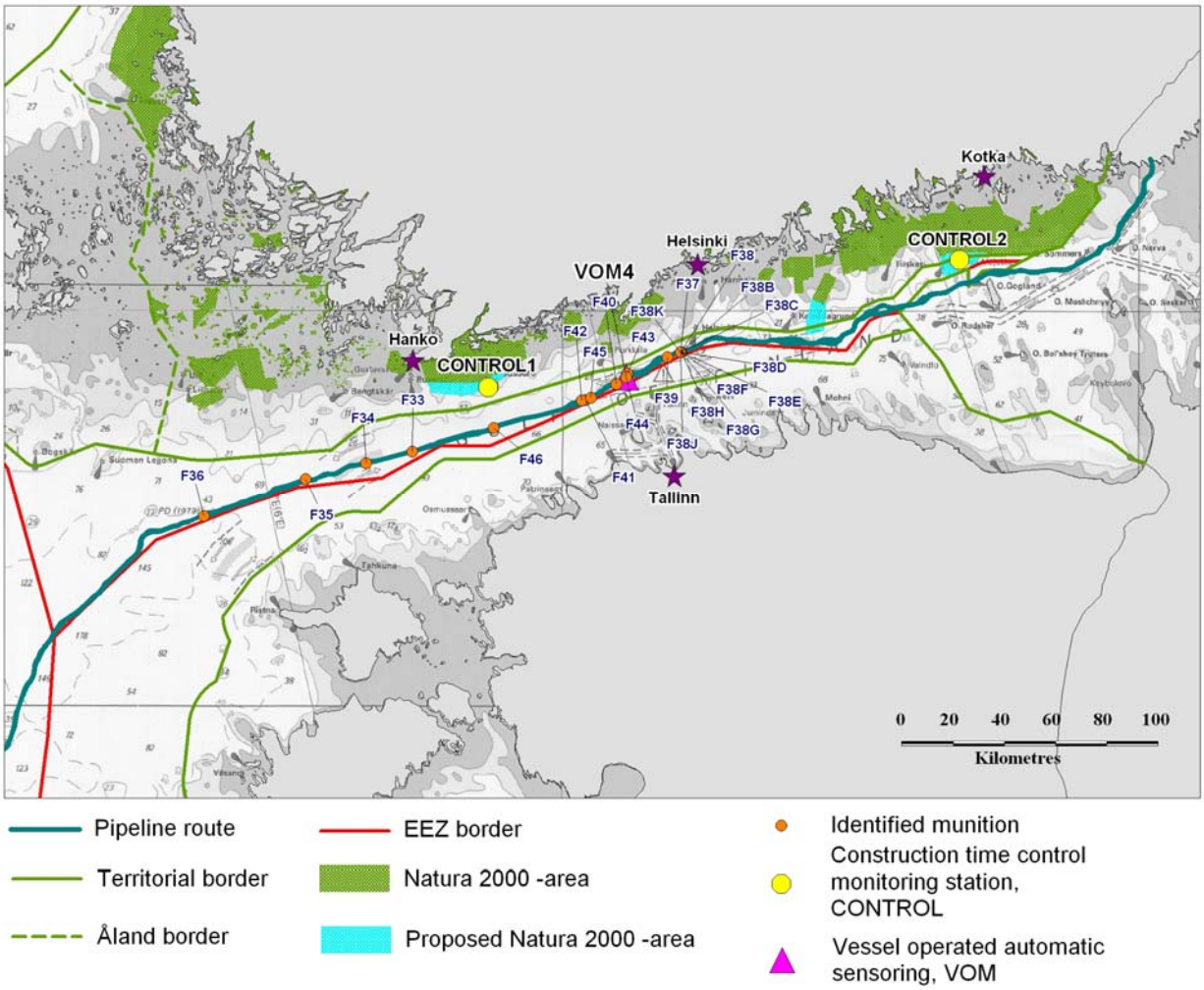

Figure 2. Location (VOM 4) where water quality monitoring will be carried out during the munitions clearance in phase 2 in the Finnish EEZ

Table 4. The monitoring programme for water quality during munitions clearance in phase 2.

Water quality monitoring					
Project activity	**Parameter**	**Unit**	**Method**	**Location**	**Timing / frequency**
Munitions clearance (Phase 2)	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	1 location based on a large charge size (VOM 4)	Once before and two times directly after detonation
	Water samples for oxygen, 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	VOM 4	After detonation

As all Natura 2000 areas are in excess of 10 km from the closest munitions clearance site (see Appendix 1) no reference station in these areas will be established to monitor sedimentation during the munitions clearance.

Vessel operated automatic sensoring during munitions clearance will be carried out at one location. The location has been selected for monitoring based on the sediment type at the munition site (soft sediment), the charge weight of the munition (large charge size) and the relative proximity of the munition to the Estonian EEZ border (Figure 2):

- VOM 4 – In location of munition F44 (R-08-200957) with 300 kg charge weight close to KP 242

The selected munition lies at the depth of 70 m. The seabed at the munition site is clay/ soft clay, which will result in sediment dispersion during the detonation.

Vessel operated automatic sensoring at this location will be carried out with multi parameter sonde that will measure vertical turbidity, temperature, conductivity and depth. This automatic sonde is lowered from a 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 sensoring 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 a detonation is a reference measurement and represents natural background level of turbidity.

Data from vessel operated automatic sensoring will be shown as transect figures. Data is presented as a function of distance from a detonation site, 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.

Water sampling from VOM 4 station will be carried out in order to calibrate the results (turbidity, suspended solids and conductivity) of the automatic sensoring. In addition oxygen concentration, phosphate (PO_4) and total phosphorus, nitrate-nitrite (NO_3-NO_2), ammonium (NH_4) and total nitrogen as well as total concentrations of metals (As, Cd, Cr, Co, Cu, Hg, Ni, Pb, Zn) will be analysed. 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 5 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 the sampling site (VOM 4) water samples will be taken in intervals of ten meters from 1 m below the surface to 1 m above the seabed. In addition, 4 to 6 samples will be taken according to the sensoring 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 sensoring data. All samples will be analyzed by an accredited laboratory with normal laboratory methods using quantification limits presented in Table 5. The monitoring programme for munitions clearance in phase 2 for water quality is presented in Table 4.

Table 5. Water analyses 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_4, 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_3+NO_2, 0,40 µm	Yes	µg/l	5		SFS-EN ISO 11905	100 ml	15
Nitrogen, NH_4, 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

The assessment results of sediment spreading for the detonation of munition F44 (R-08-200957) to be monitored are shown in Table 6.

Table 6. Assessed sediment dispersion from the clearance of the munition F44 at VOM 4 station /3/

Calculated spreading of suspended sediment and contaminations									
Sampling point	**Munition location**	**Munitions number / ID**	**Charge**	**Water Depth**	**Sediment / Seabed Type**	**Radius crater**	**Released sediment**	**Concentration > 10 mg/l for max. 18 hrs.**	
								Extent	**Area**
	KP		**kg**	**m**		**m**	**tonnes**	**km**	**km^2**
VOM 4	**242**	R-08-200957	300	70	Clay/ soft clay	7.0	583	4.3	2.9

2.3 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) /1/ 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/, /3/, /4/, /5/, /6/.

To verify the assessment, the pressure wave and the resulting acoustic pulse will be measured to document peak pulse and attenuation over distance at three selected locations: NOISE2, NOISE3 and NOISE4. These locations have been selected based on cables in the vicinity of munitions as follows:

- NOISE2 - during the detonation of F37 (R-08-2767), F38 (R-08-450077), F38B-F38H (R-08-001-FAB to R-08-007-FAB), F38J (R-08-009-FAB) and F38K (R-08-010-FAB), with a charge size of 46 kg each. The munitions F37, F38, F38B-F38F, F38H and F38J will be lifted and shifted to a predefined clearance area and detonated at least about 120 m away from the cable EE-SF2. The munitions F38G (buried) and F38K will be cleared in-situ 85 m and 103 m away from the cable EE-SF2. One blast wave sensor will be located in midwater near the cable during each detonation.

- NOISE3 - during the detonation of F40 (08-R-90) with a charge size of 115 kg. The munition is located 530 m away from cable FEC1. One blast wave sensor will be located in midwater near the cable.

- NOISE4 - during the detonation of F43 (R-08-44066) and F44 (R-08-200957) with a charge size of 300 kg each. The munition F43 is located 530 m and the munition F44 590 m away from cable UESF2. One blast wave sensor will be located in midwater near the cable during both detonations.

The locations of NOISE 2-4 are shown in Figure 3. 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 7.

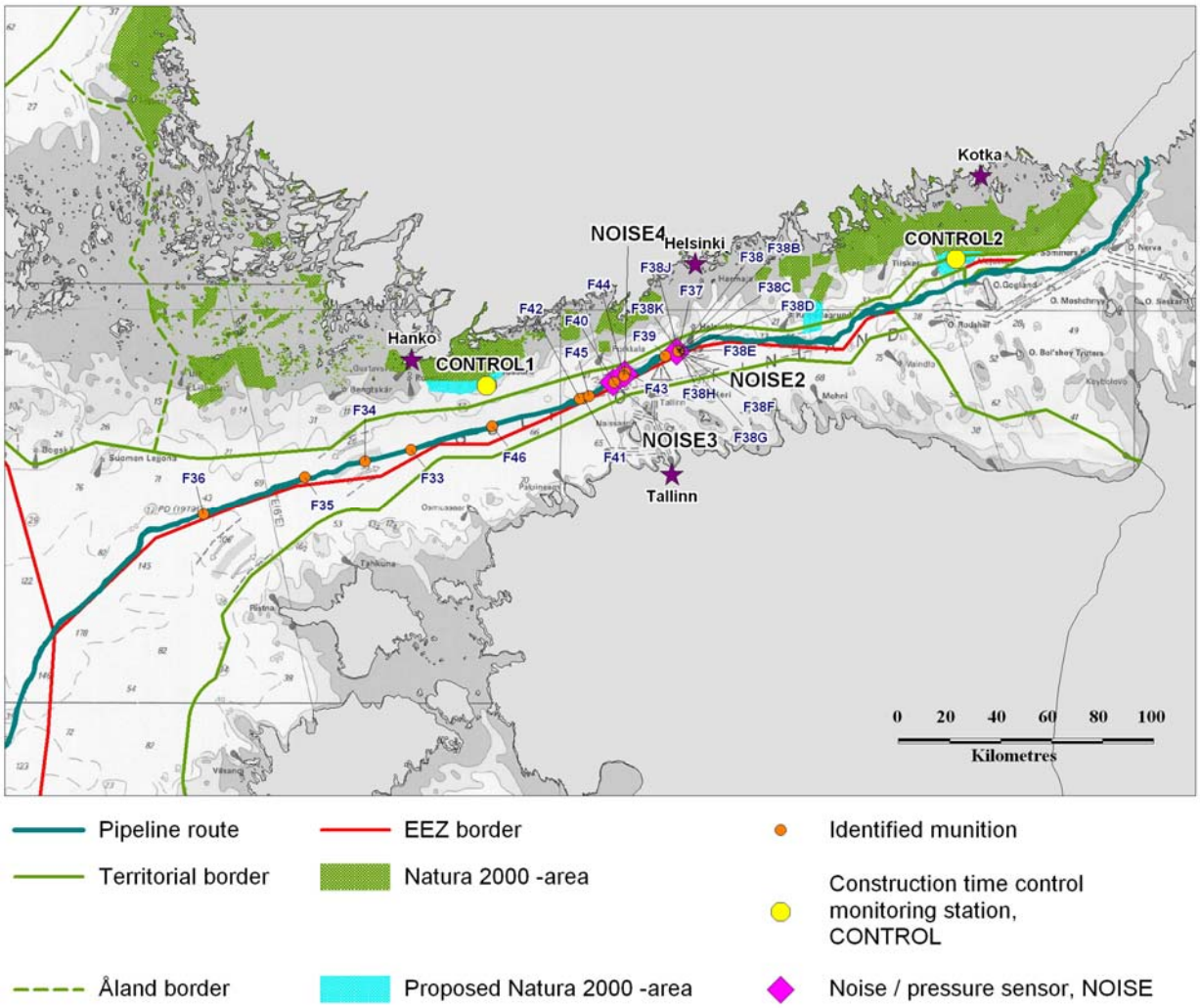

Figure 3. Locations where pressure wave monitoring (NOISE 2-4) will be carried out during the munitions clearance in phase 2.

Table 7. The monitoring programme for pressure waves from munitions clearance.

Underwater noise Monitoring					
Project activity	**Parameter**	**Unit**	**Method**	**Location**	**Timing**
Munitions clearance (Phase 2)	Pressure wave	psi (pressure), s (time)	Pressure wave sensor close to the seabed	3 locations (Noise 2-4)	During detonation
	Pressure wave	psi (pressure), s (time)	Pressure wave sensor on the PAM buoy	Each detonation site	During detonation

2.4 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) /1/. 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/, /3/, /4/, /5/, /6/.

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 1.

Cultural Heritage

As shown in Appendix 1, 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 4):

- S-13-32852 (0.48 km from the munition F35, R-13-31989 with a charge size of 250 kg)
- R-09-10009 (0.40 km from the munition F41, R-09-1000149 with a charge size of 300 kg)
- S-09-3025 (0.50 km from the munition F41, R-09-1000149 with a charge size of 300 kg)
- S-09-49489 and S-09-49490 (remains of a wreck) (0.73 and 0.77 km from the munition F45, R-09-1116855 with a charge size of 60 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 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 4 and the monitoring programme for cultural heritage sites in Table 10.

In addition to the survey of these two wrecks, a bone sample will be taken from the object S-07-2744 as requested by the Finnish National Board of Antiquities. The object is assessed to be a skeletal remain of a whale. The skeletal remains are located 350 m from the detonation site of

munition F3 (R-07-004) that was demolished as part of phase 1 clearance campaign in December 2009.

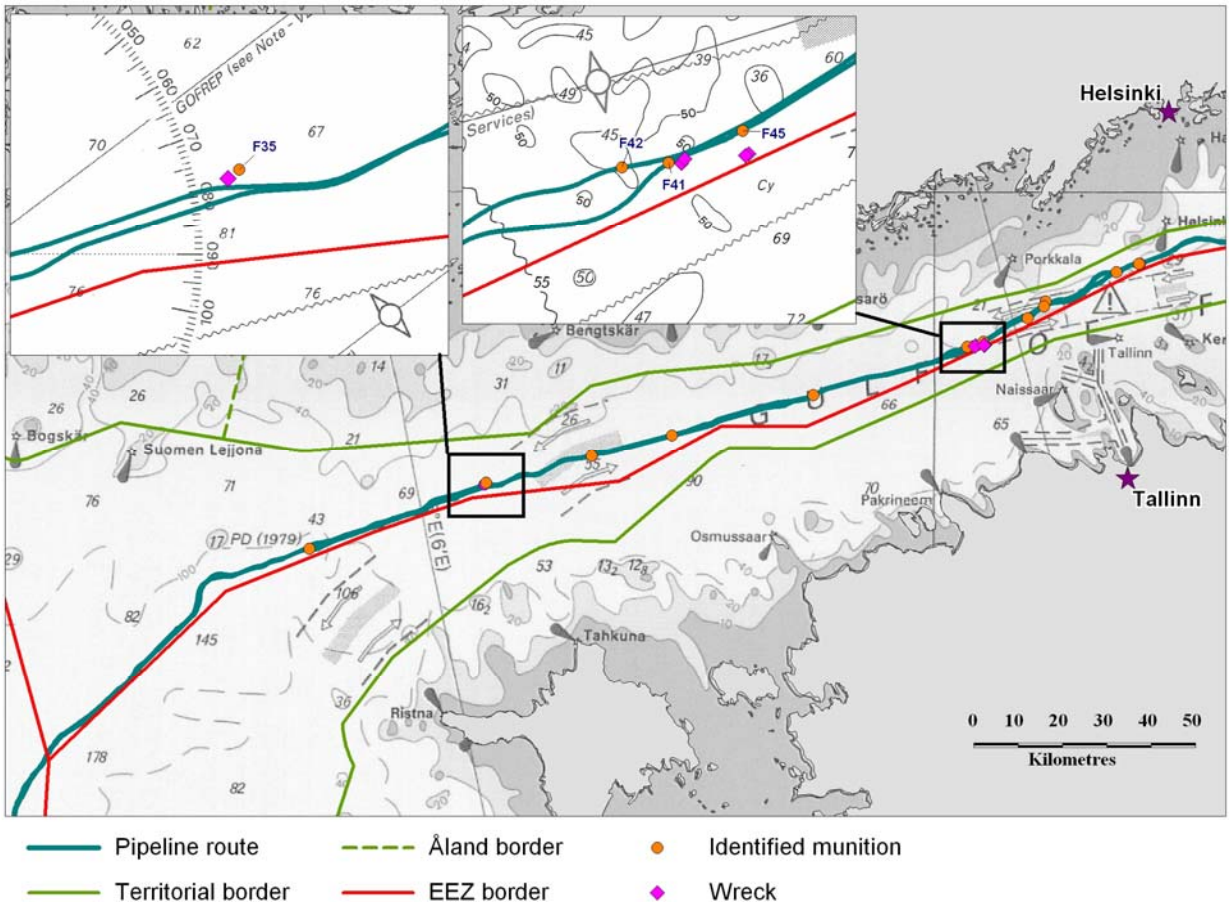

Figure 4. Identified cultural heritage sites (wrecks) to be monitored by ROV visual inspection prior to and after the detonation of munitions in phase 2.

Barrels

Appendix 3A shows the distances of all barrels from individual munitions and Appendix 3B the expected displacements of all barrels due to munitions clearance on a munition by munition basis. As presented in Appendix 1 munitions clearance is anticipated to cause no release of content from barrels having an environmental risk class 2 or 3[1].

[1] Classification of the environmental risk class of barrels according to the condition and exposure of the content to the sea water:

- Class 0: barrels in which the content is and has been fully exposed to sea water

The monitoring of barrels will concentrate on barrels classified as environmental risk class 2 or 3 that have been identified within 1.0 km from the munitions that need 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. Moreover, 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 0.2 m) /2/. The barrels to be inspected are listed in Table 8 and shown in Figure 5.

Table 8. Barrels to be monitored via ROV visual inspection prior to and after detonation

Munition ID	Barrels with risk class 2 or 3	Environmental risk class	Distance to munition [km]
R-11-200030 (F33)	R-11-26172	2	0.89
	R-11-3362	3	0.08
R-13-31989 (F35)	R-13-33554	2	1.0
R-08-90 (F40)	R-09-327236	3	0.22
R-09-1116855 (F45)	R-09-48737	3	0.12
R-10-3227 (F46)	R-10-52996	3	0.72
	R-10-53214	3	0.56
	R-10-53215	3	0.52
	R-10-54053	2	0.12

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 10.

- 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 propably 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

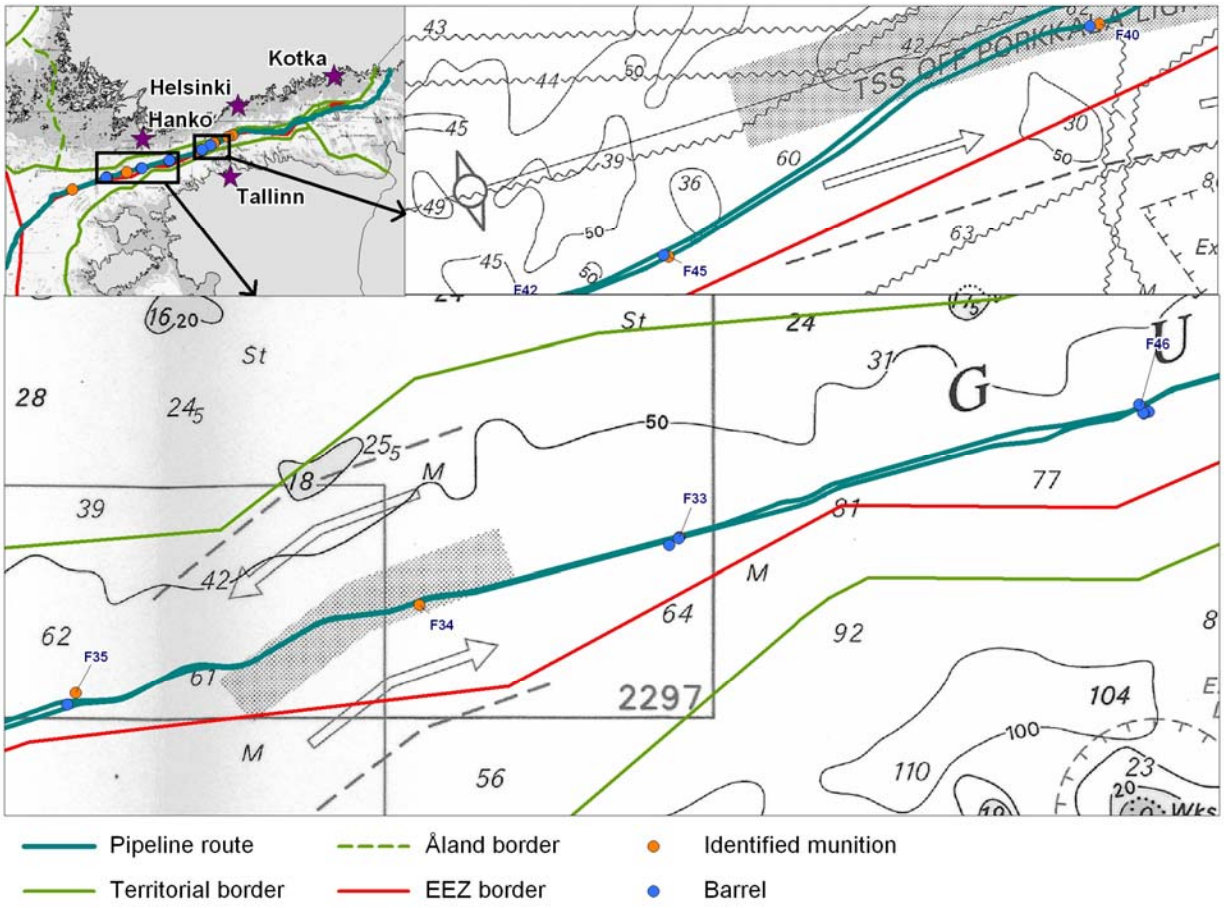

Figure 5. Barrels classified as environmental risk class 2 or 3 that are located within 1 km from the munitions. These barrels will be monitored by ROV visual inspection prior to and after the detonation.

Cables

As shown in Appendix 1, the pressure waves from munitions clearance are anticipated to cause no impact on the existing infrastructure (cables). Therefore the monitoring of the identified cables will only be performed during the clearance of those munitions that are located within 1.0 km from them. The cables to be inspected are listed in Table 9 and shown in Figure 6.

Table 9. 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-12-51010 (F34)	115	UCCBF St. Petersburg - Kaliningrad (owner: Russian military)	0.63
R-08-2767 (F37)	46	EE-SF2 Finland - Estonia (owner: TeliaSonera)	~ 0.12
R-08-450077 (F38)	46		~ 0.12
R-08-001-FAB (F38B)	46		~ 0.12
R-08-002-FAB (F38C)	46		~ 0.12
R-08-003-FAB (F38D)	46		~ 0.12
R-08-004-FAB (F38E)	46		~ 0.12
R-08-005-FAB (F38F)	46		~ 0.12
R-08-006-FAB (F38G)	46		0.085
R-08-007-FAB (F38H)	46		~ 0.12
R-08-009-FAB (F38J)	46		~ 0.12
R-08-0010-FAB (F38K)	46		0.10
R-08-2767 (F37)	46	Pangea Seg 3 Helsinki – Tallinn (owner: Linx Telecoms)	~ 0.87
R-08-450077 (F38)	46		~ 0.87
R-08-001-FAB (F38B)	46		~ 0.87
R-08-002-FAB (F38C)	46		~ 0.87
R-08-003-FAB (F38D)	46		~ 0.87
R-08-004-FAB (F38E)	46		~ 0.87
R-08-005-FAB (F38F)	46		~ 0.87
R-08-006-FAB (F38G)	46		0.78
R-08-007-FAB (F38H)	46		~ 0.87
R-08-009-FAB (F38J)	46		~ 0.87
R-08-0010-FAB (F38K)	46		0.63
08-R-90 (F40)	115	FEC1 Porkkala - Kakumäe (owner: Elisa)	0.53
R-08-44066 (F43)	300	UESF2 Helsinki - Hanko (owner: Telenor)	0.53
R-08-200957 (F44)	300		0.59

The 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 operator 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 10.

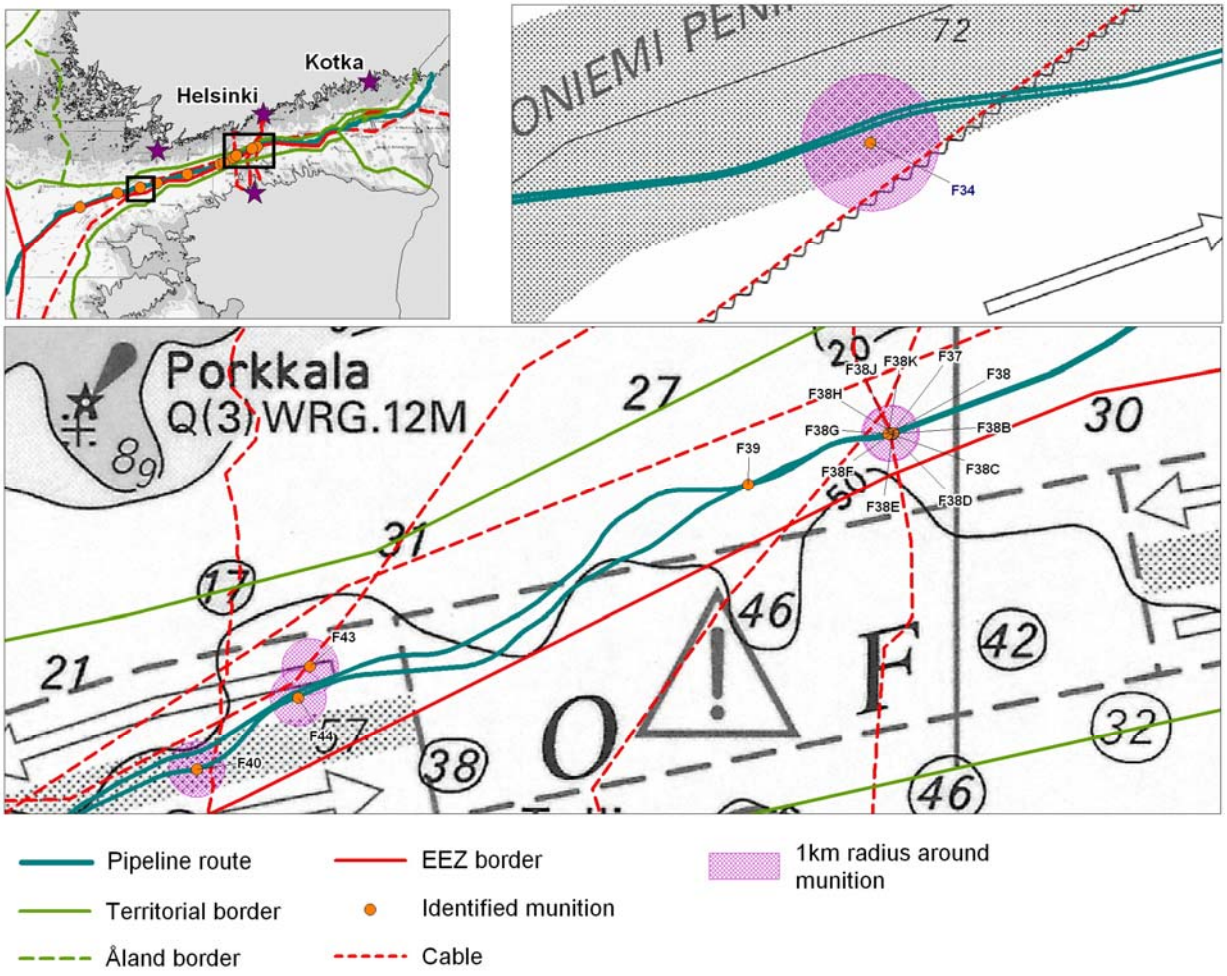

Figure 6. Cables located within 1 km from munitions that will be monitored by ROV visual inspection prior to and after detonation. The purple circles with a 1 km radius around the munitions show the cable inspection areas.

Table 10. The munitions clearance monitoring programme for cultural heritage, barrels and existing infrastructure.

Cultural Heritage, Barrels and Existing Infrastructure Monitoring					
Project activity	**Parameter**	**Unit**	**Method**	**Location**	**Timing**
Munitions clearance (Phase 2)	Integrity of cultural heritage sites	Intact / damage	Visual inspection by ROV	All wrecks (4) within 1.0 km from munitions	Prior to and after detonation
	Integrity of barrels	Intact / damage and displacement	Visual inspection by ROV	All barrels (9) 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 (5) 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 shall 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.

2.5 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) /1/. This assessment has been extended on a munition by munition basis for munitions clearance phase 2 to consider the impact of the pressure wave resulting from the clearance of individual munitions on fish, marine mammals and seabirds /2/, /3/, /4/, /5/, /6/.

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 1 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 2000 m and the injury range from 80 m to 260 m for detonations in phase 2. 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 detonations involves the measures presented below:

1. Observations to determine, to the extent practicable, whether marine mammals, fish shoals or seabirds are in 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 in the injury/safety zone, the detonation will be delayed.

2. The displacement activities in the injury/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 7.

    - **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.

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 11.

Table 11. The munitions clearance monitoring programme for marine mammals, seabirds and fish shoals.

Marine mammals, seabirds and fish monitoring					
Project activity	**Parameter**	**Unit**	**Method**	**Location**	**Timing**
Munitions clearance (phase 2)	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

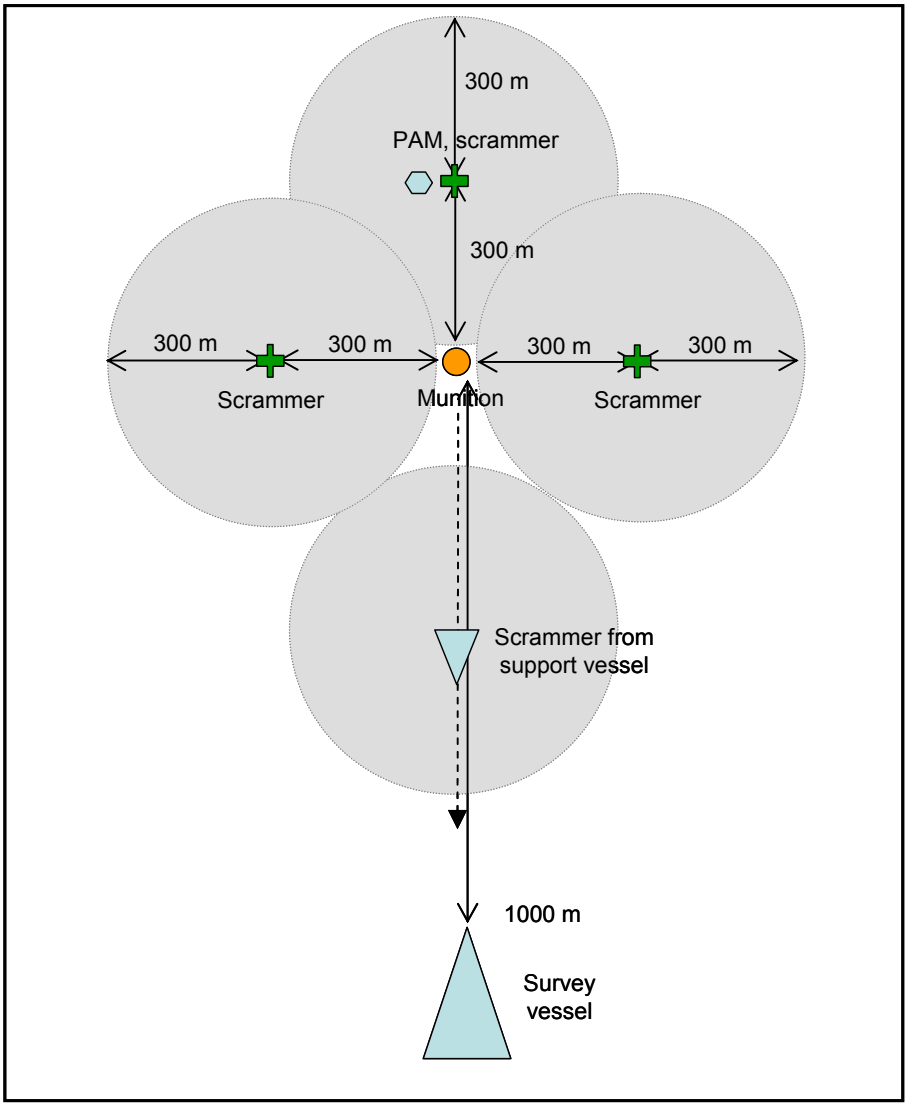

Figure 7. Standard layout of the environmental mitigation equipment prior to the detonation. View is from above.

Reporting of Observations

Qualified MMOs onboard will have 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.

2.6 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) /1/. This assessment has been extended for all construction activities in the report “Nord Stream Construction and the Impact to Ship Traffic” /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. The preliminary safety zone during the pre-detonation and post-detonation inspection surveys will be a radial distance of 1 km from the cleared munition and during the detonation phase 2 km from the cleared munition.

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.

2.7 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) /1/.

To mitigate the adverse impacts on commercial fishing vessels a safety zone will be established around each munitions clearance site during the clearance works. The preliminary safety zone during the pre-detonation and post-detonation inspection surveys will be a radial distance of 1 km from the cleared munition and during the detonation phase 2 km from the cleared munition. 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.

3 Reporting of Monitoring Results

As presented in Ch. 8 of the environmental monitoring programme for Finland, 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 monitoring results for munitions clearance in phase 2 in the Finnish EEZ will be included into the annual monitoring report (see Ch. 8) The annual report presents a summary of the monitoring results and impacts from munitions clearance for all monitored parameters.

Furthermore, a separate monitoring report for munitions clearance in phase 2 will be prepared in the Finnish and Swedish languages within 3 months after the finalization of the activity and a hard copy of the report will be delivered to the competent authorities. Unexpected events and chance finds will be reported immediately according to the procedure that has been agreed upon with relevant authorities.

4 References

/1/ Nord Stream and Ramboll, 2009, Environmental impact assessment report, Natural gas pipeline through the Baltic Sea, Environmental impact assessment in the exclusive economic zone of Finland.

/2/ Witteveen+Bos and Nord Stream, 2010, Nord Stream munitions clearance in Finnish EEZ, Environmental impacts on munition by munition basis, Phase 2, G-PE-EIA-REP-000-MCLFP2EN-A

/3/ Witteveen+Bos and Nord Stream, 2010, Nord Stream Munitions clearance in Finnish EEZ Environmental impacts of munitions F43-F46, G-PE-EIA-REP-000-MCLF4NEN-B

/4/ Witteveen+Bos and Nord Stream, 2010, Nord Stream Munitions clearance in the Finnish EEZ, Environmental impacts of munitions F37-F38, G-PE-EIA-REP-000-MCLF3738-A

/5/ Witteveen+Bos and Nord Stream, 2010, Nord Stream Munitions clearance in Finnish EEZ, Environmental impacts of munitions F38B-F38I, G-PE-EIA-REP-000-MCLF38BI-A

/6/ Witteveen+Bos and Nord Stream, 2010, Nord Stream Munitions clearance in Finnish EEZ, Environmental impacts of munitions F38G-J-K,G-PE-EIA-REP-000-MCLF38GK-A

/7/ Nord Stream AG, 2009, Nord Stream Construction and the Impact to Ship Traffic

5 Revision Record

Rev.	Date	Description	Prepared	Checked	Approved		
			Nord Stream				
B	2010-08-30	Issue for use	TSA	JKU	SBO		
A	2010-04-19	Issue for use	TSA	JKU	SBO		
02	2010-02-08	Issue for consultation	TSA/TKU	JKU	SBO		
01	2010-01-22	Issue for consultation	TSA/TKU	JKU	SBO		

Appendix 1 Summary of the impacts from munitions clearance on a munition by munition basis - phase 2 /2/, /3/, /4/, /5/, /6/

MU1	MU2	MU3	MU4	MU7	MU8	MU9	MU10	MU11	MU12	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
NSP ID and Approx. KP (C16-5) Sequence in order of increasing KP		Munitions ID	Charge	Distances to nearest munition	Water Depth	Sediment / Seabed Type	Munition Discription	Radius crater	Released sediment	MF1 Safe range for mammals and fish	MF2 Injury range for mammals prob. fish mortality 25-75%	MF3 Lethal range for mammals prob. fish mortality 75-100%	I1 Distance	I2 Peak pressure	I3 Owner Cable	I4 From / to	I5 Status	I6 Impact assessment	C1 Distance	C2 Peak pressure	C3 ID	C4 Description	C5 Impact assessment	B1 Nearest distance	B2 Peak pressure	B3 Barrel ID	B4 Description	B5 Barrel risk catagory	B5 Estimated horizontal displacement	B7 Impact assesment			Firing danger area	Restricted area			
West or East	KP		kg	m	m			m	tonnes	m	m	m	km	MPa					km	MPa				km	MPa				m		km	Area ID	km	km	km	St.	km
F37	218.153	R-08-2767	46	183	70	Clay / Soft clay	Russian air-dropped bomb type FAB 100	3.9	103	1300	170	25	0.12	1.32	TeliaSonera (EE-SF2)	Finland - Estonia	Assumed exposed	No impact																					
F38	218.153	R-08-450077	46		70			3.9	103				0.87	0.14	Linx telecommunications	Helsinki to Tallinn																					
F38B	218.016 - 218.135	R-08-001-FAB	46	183	70.0			3.9	103				0.87	0.14																							
F38C		R-08-002-FAB	46					3.9	103				0.05	3.23	TeliaSonera (EE-SF2)	Finland - Estonia																					
F38D		R-08-003-FAB	46					3.9	103				For F38B+C+D+E+F 0.12	1.32	TeliaSonera (EE-SF2)	Finland - Estonia															16.93		5.63	16.83	1.43		1.10
F38E		R-08-004-FAB	46					3.9	103				0.87	0.14	Linx telecoms	Helsinki to Tallinn																					
F38F		R-08-005-FAB	46					3.9	103																												
F38G		R-08-006-FAB	46	90				3.9	103				0.085	1.90	TeliaSonera (EE-SF2)	Finland - Estonia															16.83		5.53	16.73	1.30		1.20
F38H		R-08-007-FAB	46	183				3.9	103				0.78	0.16	Linx telecoms	Helsinki to Tallinn																					
F38J		R-08-009-FAB	46					3.9	103				For F38H+J 0.12	1.32	TeliaSonera (EE-SF2)	Finland - Estonia															16.93		5.63	16.83	1.43		1.10
F38K		R-08-010-FAB	46	189				3.9	103				0.87	0.14	Linx telecoms	Helsinki to Tallinn																					
F39	223.737	R-08-1000069	20	5404	54.0	Coarse sediment	Medium sized artillery grenade	3.2	55	1200	160	20	0.103	1.53	TeliaSonera (EE-SF2)	Finland - Estonia																					
F43	241.750	R-08-44066	300	274	70.0	Clay / Soft clay	German EMC	7.0	583	2000	260	35	0.63	0.20	Linx telecoms	Helsinki to Tallinn																					
F44	241.946	R-08-2000957	300		70.0	Clay / Soft clay	German EMC	7.0	583																													
F40	246.670	08-R-90	115	154	69.0	Soft clay	Russian contact mine Type M08	5.4	270	1600	210	30	0.53	0.46	Telenor Sweden: UESF2	Helsinki (FIN) - Hanko (FIN)	Assumed to be buried	No impact																					
F45	258.120	R-09-1116855	60	735 to F21	65.0	Clay with coarse sediment	German WBF	3.7	89	1400	180	25	0.59	0.41																							
F41	260.554	R-09-1000149	300	1431	60	Glacial till, coarse sediment with boulders	German EMC2 mine	5.6	291	2000	260	35	0.53	0.35	Elisa (FEC1)	Porkkala - Kakumae	Assumed exposed		0.73	0.20	S-09-49489	Remains of vessel very broken up.	No impact	0.22	0.92	R-09-327236	200 lt barrel with cap hole on the side	3	0.8	No impact								
F42	261.973	R-09-1000202	40		56	Coarse sediment	German contact mine Type UMB	3.5	72	1300	170	25							0.77	0.19	S-09-49490			0.12	1.54	R-09-48737	101 lt container, top closed, quite corroded but apparently undamaged	3	1.2		19.30	FI0100901	5.60	9.80	7.50			1.04
F46	298.420	R-10-3227	200	21 km to F23	85.0	Fine sediment	Depth charge or part of torpedo	6.3	414	1800	230	30							0.40	0.63	R-9-10009	Steel wreck in several sections	No impact							19.30	FI0100899	5.60	9.80	7.50			1.06
F33	331.836	R-11-200030	4*0.454	142	79	Clay with coarse sediment	Sweep obstructor Ru MZ26 (MK3)	1.7	8	600	80	10	3.74	0.02	Russian military	St. Petersburg - Kalmingrad	Assumed exposed	No impact	0.49	0.50	S-09-3025	Battleship	No impact							19.90		4.80	9.60	6.10		L19 (FMR)	1.54
F34	350.515	R-12-51010	115	8479	80	Very soft clay	M08-39, Russian moored contact mine	5.4	270	1600	210	30	0.63	0.38										0.72	0.29	R-10-52996	60 lt container, both ends closed, fairly good condition	3	0.2	No impact	21.80	FI0100902	8.60	12.80	6.00			5.70
F35	375.664	R-13-31989	250	9090	70	Very soft clay	Munitions, corroded type FMB sea mine in anchor chair	6.7	498	1900	250	30							0.56	0.38	R-10-53214	200 lt container, not barrel, both ends closed, fairly good condition		0.52	0.41	R-10-53215	200 lt barrel, both ends closed, quite corroded but apparently undamaged	3	0.3									
F36	418.557	R-14-35290	250	42675	90	Very soft clay	Munition, torpedo head	6.7	498										0.12	2.19	R-10-54053	30 lt container, both ends closed, fairly good condition	2	1.6											
																			0.89	0.07	R-11-26172	200lt barrel in fairly good condition, cap hole open	2	0.0											
																			0.09	0.85	R-11-3362	200lt oil barrel in good condition, probably open cap	3	0.7											
																			0.48	0.53	S-13-32852	Steel hulled vessel with wooden superstructure from 20th century.	No impact	1.89	0.10	R-13-200024	Poor visibility; could be a whole 200 lt barrel or just part of a barrel.	2	0.0	No impact	27.4 24.1		10.80	14.80	4.51		LL12 (HELCOM)	3.45
																								1.34	0.15	R-13-300298	35 lt container, possibly with cap hole; label visible but not readible.	3	0.0		32.70	FI0200090	inside	24.70	14.50		6.39
																								1.01	0.21	R-13-33554	200 lt barrel in fairly good condition, cap hole open.	2	0.1		36.00	FI0200164/ FI0200090	2.50	30.90	14.60		LL13 (FMR)	3.05
																								1.26	0.16	R-13-33834	50 lt container with cap hole; slightly punctured and contracted, but in fairly good condition.	3	0.0									
																								1.19	0.17	R-13-34125	200 lt barrel, both ends closed; quite corroded, but apparently undamaged.	3	0.1									
																			4.41	0.05	S-14-3569		No impact							41.90	FI0200164/ FI0200090	1.87	30.00	3.52		BY27 (HELCOM Sweden)	47.00

Legend to Appendix 1 /2/, /3/, /4/, /5/, /6/

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 2 Summary of the sediment spreading due to munitions clearance on a munition by munition basis - phase 2 /2/, /3/, /4/, /5/, /6/

Munitions									Spreading of suspended sediment								Spreading of contaminations																Distance to FIN / EST-EEZ boundary
MU1	MU2	MU3	MU4	MU7	MU8	MU9	MU12	MU13	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14	SC15	SC16	
NSP ID and approx. KP (C16) Sequence in order of increasing KP		Munitions ID	Charge	Distances to nearest munition	Water Depth	Sediment / Seabed Type	Released sediment		Concentration > 10 mg/l for max. 18 hrs.				Maximum concentration > 3 mg/l				Maximum concentration > PNEC for SUM16PAH				Maximum concentration > PNEC for Cu				Maximum concentration > threshold concentration for Dioxins				Maximum concentration > threshold concentration for Phosphorous				
									Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ		Gulf of Finland		Into Estonian EEZ		
									Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	Extent	Area	
	KP		kg	m	m		tonnes		km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km	km²	km
F37	218.153	R-08-2767	46	183	70.0	Clay / Soft clay	103		0.6	0.4	0.0	0.0	1.2	1.2	0.0	0.0	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.26
F38	218.153	R-08-450077	46		70.0	Sand and gravel	103		0.6	0.4	0.0	0.0	1.2	1.2	0.0	0.0	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.26
F38B	218.016 - 218.135	R-08-001-FAB	46	183	70.0	Clay / Soft clay	103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.10
F38C		R-08-002-FAB	46				103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	
F38D		R-08-003-FAB	46				103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	
F38E		R-08-004-FAB	46				103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	
F38F		R-08-005-FAB	46				103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	
F38G		R-08-006-FAB	46	90			103		0.6	0.4	0.0	0.0	1.2	1.2	0.0	0.0	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.20
F38H		R-08-007-FAB	46	183			103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.10
F38J		R-08-009-FAB	46				103		0.6	0.4	0.0	0.0	1.2	1.2	0.1	0.1	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	
F38K		R-08-010-FAB	46	189			103		0.6	0.4	0.0	0.0	1.2	1.2	0.0	0.0	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.26
F39	223.737	R-08-1000069	20	5404	54.0	Coarse sediment	55		0.4	0.2	0.0	0.0	0.8	0.6	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.96
F43	241.750	R-08-44066	300	274	70.0	Clay / Soft clay	583		4.3	2.9	1.9	1.3	8.6	8.6	6.2	6.2	6.5	4.3	4.1	2.7	2.5	1.7	0.1	0.1	0.0	0.0	0	0	0.0	0.0	0	0	2.40
F44	241.946	R-08-2000957	300		70.0	Clay / Soft clay	583		4.3	2.9	2.1	1.4	8.6	8.6	6.4	6.4	6.5	4.3	4.2	2.8	2.5	1.7	0.3	0.2	0.0	0.0	0	0	0.0	0.0	0	0	2.22
F40	246.670	08-R-90	115	154	69.0	Soft clay	270		1.6	1.3	0.0	0.0	3.3	5.3	1.6	2.6	2.0	1.1	0.3	0.2	0.9	0.3	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.66
F45	258.120	R-09-1116855	60	735 to F21	65.0	Clay with coarse sediment	89		0.5	0.3	0.0	0.0	1.0	1.0	0.0	0.0	0.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.04
F41	260.554	R-09-1000149	300	1431	80.0	Glacial Till, coarse sediment with bouders	291		3.1	4.8	2.0	3.2	6.2	14.4	5.1	11.9	3.0	2.0	1.9	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.06
F42	261.973	R-09-1000202	40		56.0	Coarse sediment	72		0.4	0.2	0.0	0.0	0.8	0.6	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	1.54
F46	298.420	R-10-3227	200	21 km to F23	85.0	Fine sediment	414		3.1	2.1	0.0	0.0	6.2	6.2	0.5	0.5	4.7	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0	0	5.7
F33	331.836	R-11-200030	4*0.454	142	79.0	Clay with coarse sediment	8		0.4	0.1	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0	0	0	3.45
F34	350.515	R-12-51010	115	8479	80.0	Very soft clay	270		1.6	1.3	0	0	3.3	5.3	0	0	2.0	1.1	0	0	0.9	0.3	0	0	0.0	0.0	0	0	0.0	0.0	0	0	6.39
F35	375.664	R-13-31989	250	9090	70.0	Very soft clay	498		3.1	4.8	0.1	0.1	6.2	14.5	3.2	7.4	3.0	2.0	0	0	1.8	0.7	0	0	0.0	0.0	0	0	0.0	0.0	0	0	3.05
F36	418.557	R-14-35290	250	42675	90.0	Very soft clay	498		3.1	4.8	0	0	6.2	14.5	0.0	0.0	3.0	2.0	0	0	1.8	0.7	0	0	0.0	0.0	0	0	0.0	0.0	0	0	47.00

Appendix 3A Distances between barrels and munitions in [km] on a munition by munition basis /2/, /3/, /4/, /5/, /6/

Object	Risk	F33	F34	F35	F36	F37	F38	F39	F40	F41	F42	Phase 1	Phase 2
		R-11-200030	R-12-51010	R-13-31989	R-14-35290	R-08-2767	R-08-450077	R-08-1000069	08-R-90	R-09-1000149	R-09-1000202		
R-08-42893	0								0.43			phase 1	phase 2
R-08-42894	1								0.46			phase 1	phase 2
R-09-23	0									1.32		phase 1	phase 2
R-09-326635	0									1.78	0.41	phase 1	phase 2
R-09-326883	1										1.97	phase 1	phase 2
R-09-326892	0										1.94	phase 1	phase 2
R-09-327236	3								0.22			phase 1	phase 2
R-09-48197	0								1.24			phase 1	phase 2
R-09-48198	0								1.29			phase 1	phase 2
R-09-49716	1										1.95	phase 1	phase 2
R-09-49719	1										1.96	phase 1	phase 2
R-09-49727A	1										1.86	phase 1	phase 2
R-09-49727B	1										1.85	phase 1	phase 2
R-09-49736	1										1.97	phase 1	phase 2
R-09-49740	0										1.57	phase 1	phase 2
R-09-49742	0										1.92	phase 1	phase 2
R-09-49750	1										1.80	phase 1	phase 2
R-09-TO-260005	1									1.17	0.30	phase 1	phase 2
R-11-200019	1	1.31										phase 1	phase 2
R-11-25199	0											phase 1	phase 2
R-11-25605	0	0.69										phase 1	phase 2
R-11-25606	0	0.70										phase 1	phase 2
R-11-25607	0	0.69										phase 1	phase 2
R-11-26172	2	0.90										phase 1	phase 2
R-11-3297	0	0.73										phase 1	phase 2
RPS-11-3662	0											phase 1	phase 2
RPS-11-3800	0											phase 1	phase 2
09-R-20	1									0.93	0.50		phase 2
09-R-75	1									0.91	0.53		phase 2
R-09-1000150	0									0.11	1.51		phase 2
R-09-3028	1									0.45	1.88		phase 2
R-11-25210	1												phase 2
R-11-25340	1												phase 2
R-11-25379	0	1.34											phase 2
R-11-25392	0												phase 2
R-11-25542	3												phase 2
R-11-25550	0												phase 2
R-11-25619	0												phase 2
R-11-25620	0												phase 2
R-11-25766	0												phase 2
R-11-26016	0	1.08											phase 2
R-11-26103	0												phase 2
R-11-26233	0												phase 2
R-11-26446	0												phase 2
R-11-26595	2												phase 2
R-11-26625	0												phase 2
R-11-27265	0	1.57											phase 2
R-11-27459	3												phase 2
R-11-27654	0												phase 2
R-11-27663	0												phase 2
R-11-27664	0												phase 2
R-11-27669	0												phase 2
R-11-27948	0												phase 2
R-11-27957	0												phase 2
R-11-28439	0												phase 2
R-11-28439	0												phase 2
R-11-28449	0												phase 2
R-11-300854	0												phase 2
R-11-3372	0												phase 2
R-11-38338	0												phase 2
RPS-11-3915	0												phase 2
RPS-11-4060	0												phase 2
R-13-200014	0			1.90									phase 2
R-13-200024	2			1.89									phase 2
R-13-300298	3			1.34									phase 2
R-13-300353	0			1.65									phase 2
R-13-300380	0			1.34									phase 2
R-13-33149	1			1.78									phase 2
R-13-33554	2			1.01									phase 2
R-13-33831	0			1.68									phase 2
R-13-33834	3			1.26									phase 2
R-13-34125	3			1.19									phase 2
R-13-34573	0			1.89									phase 2
R-13-34670	0			2.00									phase 2
R-13-3546	0			1.69									phase 2
R-08-5108	0					0.08	0.05						phase 2
R-11-130120	1	0.10											phase 2
R-11-25240	0												phase 2
R-11-25568	0	0.55											phase 2
R-11-25884	0	0.78											phase 2
R-11-25958	0												phase 2
R-11-26505	0	0.26											phase 2
R-11-27380	0	0.93											phase 2
R-11-27682	0	0.79											phase 2
R-11-300658	0	0.10											phase 2
R-11-300707	0	0.62											phase 2
R-11-300713	0	0.81											phase 2
R-11-300839	0	0.79											phase 2
R-11-3304	0												phase 2
R-11-3362	3	0.09											phase 2
R-13-200016	1			0.56									phase 2
R-13-200016	1			0.56									phase 2
R-13-300199	0			0.97									phase 2
R-13-32134	0			0.37									phase 2
R-13-33347	0			0.48									phase 2
R-13-33349G	0			0.64									phase 2
R-13-33349G	0			0.63									phase 2
R-13-33350	0			0.69									phase 2
14-S-42	1				0.89								phase 2

Appendix 3B Expected displacements of barrels in [m] due to munitions clearance on a munition by munition basis /2/, /3/, /4/, /5/, /6/

Object	Risk	F33 R-11-200030	F34 R-12-51010	F35 R-13-31989	F36 R-14-35290	F37 R-08-2767	F38 R-08-450077	F39 R-08-1000069	F40 08-R-90	F41 R-09-1000149	F42 R-09-1000202	Phase 1	Phase 2
R-08-42893	0								0.28			phase 1	phase 2
R-08-42894	1								0.25			phase 1	phase 2
R-09-23	0									0.05		phase 1	phase 2
R-09-326635	0									0.03	0.21	phase 1	phase 2
R-09-326883	1										0.01	phase 1	phase 2
R-09-326892	0										0.01	phase 1	phase 2
R-09-327236	3								0.76			phase 1	phase 2
R-09-48197	0								0.03			phase 1	phase 2
R-09-48198	0								0.03			phase 1	phase 2
R-09-49716	1										0.01	phase 1	phase 2
R-09-49719	1										0.01	phase 1	phase 2
R-09-49727A	1										0.01	phase 1	phase 2
R-09-49727B	1										0.01	phase 1	phase 2
R-09-49736	1										0.01	phase 1	phase 2
R-09-49740	0										0.01	phase 1	phase 2
R-09-49742	0										0.01	phase 1	phase 2
R-09-49750	1										0.01	phase 1	phase 2
R-09-TO-260005	1									0.06	0.37	phase 1	phase 2
R-11-200019	1	0.00										phase 1	phase 2
R-11-25199	0											phase 1	phase 2
R-11-25605	0	0.01										phase 1	phase 2
R-11-25606	0	0.01										phase 1	phase 2
R-11-25607	0	0.01										phase 1	phase 2
R-11-26172	2	0.01										phase 1	phase 2
R-11-3297	0	0.01										phase 1	phase 2
RPS-11-3662	0											phase 1	phase 2
RPS-11-3800	0											phase 1	phase 2
09-R-20	1									0.10	0.14		phase 2
09-R-75	1									0.11	0.13		phase 2
R-09-1000150	0									1.91	0.01		phase 2
R-09-3028	1									0.40	0.01		phase 2
R-11-25210	1												phase 2
R-11-25340	1												phase 2
R-11-25379	0	0.00											phase 2
R-11-25392	0												phase 2
R-11-25542	3												phase 2
R-11-25550	0												phase 2
R-11-25619	0												phase 2
R-11-25620	0												phase 2
R-11-25766	0												phase 2
R-11-26016	0	0.01											phase 2
R-11-26103	0												phase 2
R-11-26233	0												phase 2
R-11-26446	0												phase 2
R-11-26595	2												phase 2
R-11-26625	0												phase 2
R-11-27265	0	0.00											phase 2
R-11-27459	3												phase 2
R-11-27654	0												phase 2
R-11-27663	0												phase 2
R-11-27664	0												phase 2
R-11-27669	0												phase 2
R-11-27948	0												phase 2
R-11-27957	0												phase 2
R-11-28439	0												phase 2
R-11-28439	0												phase 2
R-11-28449	0												phase 2
R-11-300854	0												phase 2
R-11-3372	0												phase 2
R-11-38338	0												phase 2
RPS-11-3915	0												phase 2
RPS-11-4060	0												phase 2
R-13-200014	0			0.02									phase 2
R-13-200024	2			0.02									phase 2
R-13-300298	3			0.04									phase 2
R-13-300353	0			0.03									phase 2
R-13-300380	0			0.04									phase 2
R-13-33149	1			0.02									phase 2
R-13-33554	2			0.08									phase 2
R-13-33831	0			0.03									phase 2
R-13-33834	3			0.05									phase 2
R-13-34125	3			0.05									phase 2
R-13-34573	0			0.02									phase 2
R-13-34670	0			0.02									phase 2
R-13-3546	0			0.03									phase 2
R-08-5108	0					1.59	2.14						phase 2
R-11-130120	1	0.62											phase 2
R-11-25240	0												phase 2
R-11-25568	0	0.02											phase 2
R-11-25884	0	0.01											phase 2
R-11-25958	0												phase 2
R-11-26505	0	0.12											phase 2
R-11-27380	0	0.01											phase 2
R-11-27682	0	0.01											phase 2
R-11-300658	0	0.65											phase 2
R-11-300707	0	0.02											phase 2
R-11-300713	0	0.01											phase 2
R-11-300839	0	0.01											phase 2
R-11-3304	0												phase 2
R-11-3362	3	0.69											phase 2
R-13-200016	1			0.25									phase 2
R-13-200016	1			0.25									phase 2
R-13-300199	0			0.08									phase 2
R-13-32134	0			0.49									phase 2
R-13-33347	0			0.32									phase 2
R-13-33349G	0			0.20									phase 2
R-13-33349G	0			0.20									phase 2
R-13-33350	0			0.17									phase 2
14-S-42	1				0.10								phase 2