Request for extension of the deadline for fulfilment of obligations under Article 5 of the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction

Denmark

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Executive summary

The only remaining minefield in Denmark is from the Second World War and situated at the Skallingen peninsula at the Danish West coast. It has little impact on the local community and there are no victims since 1946.

With the ratification of the Ottawa Convention in 1998, Denmark committed itself to the obligations in Article 5 that the mined area should be released before 1 March 2009.

At the 9th meeting of the States Parties in 2008, Denmark requested a 22 month extension of its Article 5 deadline until 1 January 2011, during which period Denmark should complete the technical survey, EIA Environmental Impact Assessments and public consultations, proceed with the tendering process in order to undertake all necessary survey and other preparations and develop a release plan for the last mine affected area in Denmark

At the time of the signature, the suspect mined area in Denmark was approximately 300 hectares (3 square kilometres). The threat from the mines was unknown. The mined areas were defined in the old minefield records, and the first step was to make these records fit with the modern map and to define the exact boundary between areas which were cleared and released in 1945-1957 and the area which was not released. After this, the suspect area could be reduced to 186 hectares.

At the time of signing the treaty Denmark did not have a structure suited for dealing with large scale mine clearance. The Danish Coastal Authority under the Danish Ministry of Transport owns the mined area and was appointed to establish an organisation to plan and manage the clearance of the area.

When the mine clearance was initiated in 2005 the affected area of 186 hectares was divided in three sub areas. Area 1 was conducted in 2006 by the British contractor ELS, releasing 19 hectares of beach and dunes. Area 2 was conducted by the Danish consortium Minegruppen from May 2007 to April 2008, releasing another 47 hectares of beach and dunes.

The decision on timing and method for the last area of 120 hectares awaited the technical experience obtained in the two first clearance areas as well as a technical survey of the remaining area. The technical survey was conducted in 2008-2009 and has resulted in a threats assessment for the remaining area based on which clearance criteria could be established.

Areas 1 and 2 have both been cleared using a combination of sifting of large volumes of sand and datalogging metal detection followed by point target excavation of targets identified in the datalog. The process has been monitored by external quality assurance contractors and sample quality control has been conducted in completed areas.

The project was funded by the Danish Government which has also provided the funds for the remaining clearance.

The remaining mined area is 121.2 hectares. Denmark requests an extension of 18 months until July 2012 to address this remaining area. For technical reasons the area is considered consisting of five different terrain types, each of which provides different conditions for the mines:

- 9.2 hectares of dune or dyke.
- 6.6 hectares of marshland covered with dunes.

- 68.3 hectares of frequently flooded low marshland.
- 29.1 hectares of high marshland.
- 8.0 hectares of beach.

The mine threat is different for each of these terrain types and so are the clearance criteria as well as the planned clearance methods.

Area category	Clearance Criteria	Clearance Method
Dike/Dune	Items: All explosive items which are larger or the same size as a detonator mounted on a ZZ-42 fuse Depth: 0-200 cm below surface	Sifting
Marshland covered with dune	Items: All explosive items which are larger or the same size as a detonator mounted on a ZZ-42 fuse. Depth: Danger layer of 90 cm above the estimated1944 surface to 80 cm under the estimated 1944 surface	Sifting
Low marsh	Items: Teller mines Depth: 0-50 cm	Metal detection with geo-mapping and data-logging
High marsh	Items: All mines, UXO and parts of mines and UXO containing metal (all metal indications must be investigated and removed for QC reason) Depth: 0-20 cm	Metal detection
Beach	Items: Teller mines Depth: 0-130 cm	Metal detection with geo-mapping and data logging

The estimation of time frame for the project in order to release the remaining mines affected areas at the peninsula of Skallingen is listed in the table below.

Period	*Process*
August 2008 to December 2009	Technical survey of the area Environmental Impact Assessment. Analysis of recovered mines from the technical survey. Studies of terrain and surface changes between 1944 and 2009.
January 2010 to May 2010	Tender process
May 2010 to July 2010	Mobilisation of operational setup
July 2010 to December 2011	The clearance conditions give the Contractor until the end of 2011 to complete the clearance + additional time for weather down days. Scheduled activities in 2010: • Surface proving (clearance of surface-near AT-mines) of areas which needs vehicle access. • Sifting of dikes and dunes. • Clearance of beach. • Clearance of low marshland.

	Scheduled activities in 2011: • Sifting of dikes and dunes. • Clearance of low marshland. • Clearance of high marshland.
January 2012 to June 2012	Quality Control and buffer time to absorb delays, weather down days etc.
July 2012	Final release of Area 3 at Skallingen

If the mine clearance is completed before the deadline of December 2011, the area will be released earlier than July 2012.

1 Origins of the Article 5 implementation challenge

After the Second World War there were approximately 1.4 million mines in Denmark, mostly along the coasts. Almost all were removed or disarmed in 1945-47. There were also deployed mines in the southern part of western Jutland on the North Sea coast, on a 10 km long peninsula named Skallingen.

2 Nature and extent of the original Article 5 challenge, quantitative aspects

During 1945-47 approx. 99% of the estimated 1.4 million landmines deployed during the Second World War in Denmark were removed. The balance left is located on Skallingen, a peninsular in south west Jutland on the North Sea coast. In 1947 the mine sweeping was ended, due to major difficulties with the clearance and quality control of mainly dunes and salt marsh areas, and a part of the mined area was fenced and left uncleared.

When Denmark signed the Ottawa treaty, the area which remained suspect of being mined was approximately 300 hectares. It covered beach, dunes and marshland at the peninsula of Skallingen. Once the modern map was compared to old marking poles and fix points which could be identified in the terrain as well as minefield records the suspected areas was reduced to 186 hectares.

For operational purposes the suspected mined area at Skallingen was divided into three sub areas – Area 1 (19 hectares), Area 2 (47 hectares) and Area 3 (120 hectares).

3 Nature and extent of the original Article 5 challenge, qualitative aspects

The threat posed by these mines was unknown. The mine types in the minefields were well defined, but their present condition and the depth in which they could be found was unknown. According to information obtained from maps and other records, the mines left were laid in a random distribution and consisted of several types, including both anti-tank and anti personnel mines.

The impact of the minefield was insignificant on the local community. In fact the local population considered the minefield non-existent, as they were convinced that time had destroyed the mines.

4 Methods to identify mined areas

The mined areas were identified through 1944 German mine reports, combined with reports from clearance operations which took place in the area just after the Second World War in 1945-47. Additionally, old marking poles and fix points could be identified in the terrain. All this compiled information could then be compared with modern maps to identify the remaining affected mined area.

5 National demining structure

At the time of signing the treaty Denmark did not have a structure suited for dealing with large scale mine clearance. The Danish Coastal Authority under the Danish Ministry of Transport owns the mined area and was appointed to establish an organisation to plan and manage the clearance of the area.

The organisation was established in 2005 and consists of a project manager, a quality manager and a GIS manager. In addition the project can make use of various experts in coast technical matters from the Coastal Authority and hire external consultants when needed.

This organisation runs commercial tenders for the clearance operations and when operations are ongoing, conducts quality assurance and quality control with the aid of independent quality assurance companies.

6 Nature and extent of progress made, quantitative aspects

When the mine clearance was initiated in 2005 the affected area of 186 hectares was divided in three sub areas. Area 1 was addressed in 2006 by the British contractor Europe Land Solutions, releasing 19 hectares of beach and dunes and resulting in the clearance of 14 anti-personnel mines, 21 anti-tank, 21 mine parts (parts which clearly represent mines not cleared before, such as detonators or explosives) and 11 UXO (British WWII smoke bombs and parts of incendiary bombs). Area 2 was addressed by the Danish consortium Minegruppen from May 2007 to April 2008, releasing another 47 hectares of beach and dunes and resulting in the clearance of 13 anti-personnel mines, 5 anti-tank mines, 129 vital mine parts and 2 UXO (76 mm projectiles still in their canister).

Together the clearance of Area 1 and 2 has resulted in 27 complete AP-mines, 26 complete AT-mines, 150 other vital mine parts and 13 UXO.

In the years between 1947 and 2005 the Danish military has removed thousands of mines from the coast line at Skallingen. The coast line is steadily moving eastwards and as the dunes eroded, the mines came out on the beach where they were collected. Unfortunately the number of mines cleared in this manner is not registered.

During 2008-2009 a technical survey has been conducted to make threats assessment for the remaining Area 3. Based on this threats assessment the clearance criteria for Area 3 have been defined. Annex 1 to this extension request presents information on the technical survey and threats assessment for Area 3.

7 Nature and extent of progress made, qualitative aspects

The areas which were released in 2006 and 2008 are open to the public.

8 Methods and standards used to release areas

The minefields were in 1947 fenced with a buffer to the actual mined area, and some areas which had never been mined but were cut off by the minefields were also registered as restricted areas. The original German mine records could not just be superimposed on the modern map as the old map had some distortions which made this impossible. By systematically finding and GPS registering the fix points and the unambiguous terrain points from the old map in the landscape, the old map could be adjusted to the

modern map. By doing these adjustments, the original 300 hectares of restricted land could be reduced to 186 hectares (which was later adjusted slightly up to 187.2 hectares).

In an area like Skallingen with its dynamic landscape, a minefield has to be considered as three dimensional. In the dunes the old surface in which the mines were placed in 1944, is often several metres under the present surface. Therefore "danger areas" should rather be regarded as "danger volumes". Prior to the clearance work the volumes which could contain mines were identified.

In the dunes, this was done by establishing the level of the surface in 1944 when the mines were laid. This was done by a method where old aerial photographs were made into a 3-D model. The uncertainty of this model gave a "danger-volume" around the models 1944 surface. This volume was excavated by armoured excavators and sifted through a Power Screen allowing the sand to run through but collecting all items larger than a fuse attached with a detonator. The piles of removed items were then gone through by an EOD-operator who removed all mine parts. Afterwards the dunes were re-established.

In the beach, a maximum depth was defined on basis of studies of how beach sand changes its position in an environment like Skallingen. Clearance was conducted by data-logging metal detection followed up with point target excavation of potential mines identified from the data log. After finishing a defined area, the upper sand level was removed to a depth corresponding with the metal-detectors capacity, and the whole drill was repeated until the correct level was reached in the beach.

These methods have been the same in Area 1 and Area 2. All explosive items were destroyed as they were found or collected in a central demolition site at Skallingen.

Denmark has developed standards for clearance in Skallingen based on the International Mine Action Standards (IMAS). The mine clearance standards for the two first areas were adapted to the environment in which the clearance took place. Based on the experience from Area 1, the standards were altered slightly for Area 2. Likewise, the Standards for Area 3 have been reviewed and reformulated so they address the situation in the new area of operation while remaining IMAS compliant.

9 Methods and standards of controlling and assuring quality

The mine clearance is subject to an extensive quality management system which assures that the work is conducted within the framework of IMAS, the project specific technical guidelines and in accordance with the Danish legislation (especially restrictions on handling and storage of explosives as well as the specific Danish Health and Safety regulations).

The Contractor is organisationally accredited after evaluation of the contractor's prequalification application, proposal and Standard Operating Procedures. Likewise, the contractor's equipment is accredited when it has proven its capabilities in tests at Skallingen.

The Danish Coastal Authority (KDI) outlines in the tender documents the demand for quality management which is required from the contractor. Also, KDI has contracted external quality auditors (Orbicon in Area 1 and Bureau Veritas in Area 2 and 3).

KDI and the external auditor monitor the mine clearance and check the extensive amount of recorded data following from this type of mine clearance.

Finally quality control samples are made in completed areas.

10 Exclusion of civilians from mined areas

During the 2005 summer, an eight kilometre long IMAS compliant fence was erected to replace and compliment an old fence and sign postings. A total of approximately 300 hectares was fenced off from the public. This includes a buffer zone due to the inconsistency in the available mapping information. Of the approx. 300 hectare, 95 hectare is beach, which is deemed to be mine polluted due to the eroding coastline. As areas have been released, the fence has been adjusted.

11 Resources made available to support progress made to date

The Danish National Political Agreement in 2005 granted 86 million DKK for the release of Area 1 and 2 on Skallingen. During 2006 a further 32 million DKK were allocated. This has fully financed the clearance of Area 1 and 2 as well as the technical survey of Area 3.

For clearance of Area 3, the Danish Government has granted 98 million DKK.

12 Circumstances that impeded compliance for 10 years

- Some delay occurred in the process of identifying the correct authority with competence to administrate the task of having Skallingen cleared from mines.

- Skallingen is protected by international directives and conventions due to its environmental value and any activities which could disturb or deteriorate its high natural qualities had to proceed in accordance with these regulations.

    - Based on an impact analysis, the environmental authorities in Denmark approved the mine clearance project Area 1 and 2, provided that a number of restrictions and recommendations were followed. These concerned reestablishment of dunes, precautions to prevent sand loss from the beach, measures to keep dune- and beach sand separated, restrictions in use of access roads etc.

    - The most serious challenge to the operational planning consists of a ban on vehicles and use of explosives in the southern part of the area of operation, from 1st of April to 1st of August. Mine clearance in the affected area been brought to a halt from April to August every year to avoid disturbance of colonies of protected rare breeding birds. These months are the most productive mine clearance months due to the weather conditions and because a large part of the area is under water in the remaining part of the year.

    - Planning clearance of Area 3 required further investigation of the area, the condition of the mines and the environmental influence of the area. This included the carrying out of an Environmental Impact Assessment to receive permission from the Environmental Authorities for technical survey and subsequent clearance of the area.

13 Humanitarian, economic, social and environmental implications

There are no humanitarian implications of the minefield.

The social and economic impact of the minefield is insignificant, although it should be noted that the release of Areas 1 and 2 has made these now safe areas accessible to the population.

The environmental impact of the minefield is in some ways positive. Restrictions on access have minimized human disturbance to the area for about 60 years, resulting in rare and on a European scale threatened birds breeding in colonies in the mined area.

However, since a new fence was erected in 2005, domestic animals have not grazed the area. The missing grazing is changing the vegetation in a detrimental way, because the salt meadows and dunes are overgrowing with high and lush plants unsuitable for the rare birds, which were the reason for international designation as a nature protection area.

It is the Danish Coastal Authority's view that the standards and guidelines for the upcoming operation will allow mine clearance to a high quality without causing irreparable damages to the nature or wildlife of the area.

14 The remaining Article 5 challenge, quantitative aspects

The remaining mined area is 121.2 hectares. For technical reasons the area is considered consisting of five different terrain types, each of which provides different conditions for the mines:

- 9.2 hectares of dune or dyke.
- 6.6 hectares of original marshland (at the time of mining the area) later covered with dunes.
- 68.3 hectares of low marshland with surface lower than 2 m (Danish Vertical Reference of 1990).
- 29.1 hectares of high marshland with surface higher than 2 m (Danish Vertical Reference of 1990).
- 8.0 hectares of beach.

15 The remaining Article 5 challenge, qualitative aspects

The mine threat is different for each of the terrain types. This leads to five different sets of clearance criteria and different clearance methods.

Area category	Clearance Criteria	Clearance Method
Dike/Dune	Items: All explosive items which are larger or the same size as a detonator mounted on a ZZ-42 fuse Depth: 0-200 cm below surface	Sifting
Marshland covered with dune	Items: All explosive items which are larger or the same size as a detonator mounted on a ZZ-42 fuse. Depth: Danger layer of 90 cm above the estimated1944 surface to 80 cm under the estimated 1944 surface	Sifting

Low marsh	Items: Teller mines Depth: 0-50 cm	Metal detection with geo-mapping and data-logging
High marsh	Items: All mines, UXO and parts of mines and UXO containing metal (all metal indications must be investigated and removed for QC reason) Depth: 0-20 cm	Metal detection
Beach	Items: Teller mines Depth: 0-130 cm	Metal detection with geo-mapping and data logging

16 Amount of time requested

Date of entry into force	1 March 1999
Date ten years after entry into force	1 March 2009
Extended deadline (first request)	1 January 2011
Proposed end date of second extension period	1 July 2012

17 Detailed work plan

The estimated time frame for the project in order to release the remaining mine affected areas on the peninsula of Skallingen is listed in the table below.

Period	*Process*
August 2008 to December 2009	Technical survey of the area Environmental Impact Assessment. Analysis of recovered mines from the technical survey. Studies of terrain and surface changes between 1944 and 2009.
January 2010 to May 2010	Tender process
May 2010 to July 2010	Mobilisation of operational setup
July 2010 to December 2011	The clearance conditions give the Contractor until the end of 2011 to complete the clearance + additional time for weather down days. Scheduled activities in 2010: • Surface proving (clearance of surface-near AT-mines) of areas which needs vehicle access. • Sifting of dikes and dunes. • Clearance of beach. • Clearance of low marshland. Scheduled activities in 2011: • Sifting of dikes and dunes. • Clearance of low marshland. • Clearance of high marshland.
January 2012 to June 2012	Quality Control and buffer time to absorb delays, weather down days etc.

July 2012	Final release of Area 3 at Skallingen

The Contractor undertaking Area 3 has in their initial time schedule planned to complete the clearance in April 2011, which is 8 months before the deadline given by the Danish Coastal Authority in the tender. If the mine clearance is completed before the deadline of December 2011, the area will be released earlier than July 2012. The Contractor's time schedule is attached as Annex 2 to this extension request.

Based on an impact analysis, the environmental authorities in Denmark have approved the mine clearance project provided that a number of restrictions and recommendations are followed. This concerns reestablishment of dunes, precautions to prevent sand loss from the beach, measures to keep dune- and beach sand separated, restrictions in use of access roads etc. The most serious challenge to the operational planning consists of a ban on vehicles and use of explosives in the southern part of the area of operation, from 1st of April to 1st of August each year. This means that if the contractor experiences delays in areas which are under this restriction this can significantly impact the completion date. A few weeks behind schedule can mean six months delay in completion of the work.

The weather conditions have large influence on the operational progress. Flooding blocks the access road to the site and prevents operations in the low marshland.

The number of weather down days is unpredictable. During the work in Area 1 and 2 in the mild winters of 2006/2007/2008, the Contractors had less than one week of down days each year. However, if clearance had been in progress this winter (2009/2010), operations would have been suspended from Christmas until mid March because of the amount of snow and the low temperatures which would have impeded work with metal detectors and excavation of mines. With the proposed extension there is room for up to six months delay without breaking the deadline.

18 Institutional, human resources and material capacity

Mine clearance of Area 3 will be conducted by the Danish Consortium Damasec J. Jensen Group, consisting of the two companies Damasec and J. Jensen.

The Damasec J. Jensen Group task organisation is:

- Admin and support team
- Health, Safety, Environment, Quality and Risk (HSE-Q-R) team
- Geographical Information System (GIS) unit
    - GIS admin team
    - GIS field team
- Survey/Clearance unit
    - Data logging team
    - Manual demining team
- Mechanical Clearance unit
    - 2 x Sifting team
    - Dozer team
    - Support team
- Medic unit
- Camp unit
    - Admin camp team

- Field camp team

The mechanical key equipment will be Excavators, Power Screen Sifters and Dozers.
The detection equipment will be Ebinger Large Loop detectors, Ceia metal detectors, geo mapping and data-logging Vallon Magnetometers.

Technical Survey, Threats Assessment and Clearance Criteria of Skallingen Area 3.

The Danish Coastal Authority has in 2008 and 2009 conducted technical survey of the mine problem in Area 3 of Skallingen. The technical survey consisted of a number of activities which together with the experience from the clearance of Area 1 and Area 2 has given the basis of the threats assessment. Based on the threats assessment the clearance criteria were formulated.

1 Technical Survey

The technical survey consisted of the following elements:

1. Datalog from a sample lane in the marsh, conducted with a Wide Area Detection System (based on Ebinger large loop technology).
2. Sample clearance of approximately 15,000 m2, conducted with handheld detectors.
3. Analysis of the data received and recovered items, conducted by KDI
4. Analysis of a number of the recovered items, conducted by the TNO laboratory in Holland.
5. Analysis of magnetism of a number of ZZ-42 fuses at the Navy research laboratory at Lynetten, Copenhagen
6. Analysis of a the metal composition of number of ZZ-42 fuses and Stockmine bodies at Aalborg Portland.
7. Samples of marshland surface soil in order to determine the thickness of the marsh black soil layer.

2 Mine Threat

The mine threat is a product of:

- The type of mines present
- The quantity of mines
- The mines distribution
- The depth of the mines
- The quality of the mines i.e. their functionality

2.1 Mine Types

The mine types are well known from the German minefield records and confirmed by previous clearance and the technical survey.
Area 3 contains parts of two German minefields, originally named Minefield I and Minefield III.

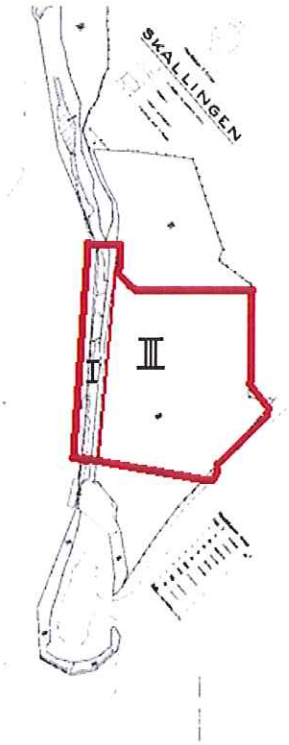


Figure 1, Original minefields included in Area 3.

Minefield I was covering the entire front dune to the west in the minefield system "Minensperre Skallingen". What is left from Minefield I in the Area 3 is the dike/dune west of the road going through the Phase 3 area. Minefield I contained the following mine types.

Mine types in Minefield I	Fuse	Original % of mines laid in Minefield I
Teller mine 35	T-Mi.Zdr.35	55 of 31511 0,2 %
Teller mine 42	T-Mi.Zdr.42	1193 of 31511 4 %
(Teller mine 43)	(T-Mi.Zdr.42 or T-Mi.Zdr.43)	35 of 31511 0,1 %
Holz mine 42	Z.Z.42	2015 of 31511 6 %
Schütz mine 42	Z.Z.42	13183 of 31511 48 %
Stock mine	Z.Z.42	15029 of 31511 42 %

Table 1, Minetypes of German Minefield I.

The Teller mine 43 was only used to close a well defined path north of the present area and is therefore not present in Area 3. In Area 1 & 2 there has been found Teller mine 42, Holz mine 42, Schütz mine 42 and Stock mine in the old Minefield I, north of Area 3.
The area east of the road in Area 3 all belongs to Minefield III. This minefield originally contained the following mines:

Mine type in Minefield III	Fuse	Original % of mines laid in Minefield III
Teller mine 42	T-Mi.Zdr.42	156 of 7782 2 %
Holz mine 42	Z.Z.42	1128 of 7782 14 %
Schütz mine 42	Z.Z.42	4447 of 7782 57 %
Stock mine	Z.Z.42	2051 of 7782 26 %

Table 2, Minetypes of German Minefield III.

All mine types of Minefield III were found during the technical survey.

2.2 Mine Quantity

The quantity of mines is unknown. The number of mines laid in each minefield is well documented, but the post war clearance has only documented the total number of mines cleared without reference to which minefield they belonged to. Estimates are therefore based on the experience from the clearance in 2006-2008 and technical survey in 2008.

	Original minefield			Clearance 2006-2008		
	Area	Mines laid	Mine density	Area	Mines cleared	Mine density
Minefield I	758500 m2	31511	1 mine per 24 m2	130000 m2 (dune)	181	1 mine per 718 m2
Minefield III	2004000 m2	7782	1 mine per 258 m2	15000 m2	19	1 mine per 789 m2

Table 3, Mine density.

Both Area 1 and 2 were situated inside the old Minefield I, covering areas of dunes and beach.

In Area 1 the cleared area covered approximately 170,000 m2 of which the 30,000 m2 were dunes. Except from one mine which had just come out of the dune, only mine parts were found in the beach. In the dunes 34 complete mines were cleared (21 T-42 mines, 11 Schütz mines, and 2 Stock mines) i.e. one mine per 900 m2. Some mine parts found during sifting of sand would also represent mines which had not been cleared earlier. In the dunes these could have been broken by the process of excavating and sifting sand. This number could mean up to 30 more mines and a mine density of one mine per 500 m2.

In Area 2 the clearance figures were 12 Stock mines (containing explosives or fuse), 1 Schütz mine and 5 Holz mines, all except 1 found in the dunes. In addition 129 vital mine parts were found. Dunes covered approximately 100,000 m2. It gives a mine density of approximately one mine per 700 m2.
The mine density of Area 1 and 2 are quite similar around one mine per 700 m2, which must also be expected in the Minefield 1 area west of the road in Area 3.

The experience from Area 1 & 2 was also that complete mines were very rare in the beach.
The mine density in the area east of the road (old Minefield III area) can only be based on the sample clearance conducted in 2008, which was part of the technical survey. The aim of the survey was to recover as many mines from the low marshland as possible for further analysis. The survey therefore only took place in the low marshland. The methodology was to run a number of survey lanes randomly until contact with a mine and then search a larger area around the first mine. Furthermore a number of metal indications from an earlier WADS detection were identified and investigated. The areas searched may therefore not give a correct picture of the mine density in the rest of the minefield. It would be likely that a mine missed during the 1945 clearance would indicate some kind of systematic error at this local spot. However, this is the best indication of the mine density that is available at the moment. On 15,000 m2 19 mines were recovered i.e. one mine per 800 m2.

2.3. Mine Distribution

The mine distribution is unknown. Minefield records describe the numbers and types of mines laid inside the minefield perimeter, but in a random distribution. Furthermore It is not recorded how many mines were cleared in each section in 1945-1947 and it is not clear which clearance methodology and procedures were used in different sections of the minefield.

2.4 Mine Depth

The depth of the mines depends on the surface changes since 1944. This development has been different for the different terrain types at Skallingen. In general it is appropriate to distinguish between five terrain types in Area 3.

Area type	Estimated depth of mines
Dike/ Dune	The dike running along the west side of the dirt road through the mined area is constructed 80 years ago. To the south it has integrated with the dune, while the rest is clearly separated from the dune by a gully along the west side. The western perimeter of the minefield runs in this gully. The surface development is well documented in a differential model showing the surface changes from 1961 to present with an uncertainty of 60 cm. The surface changes of this period are less than 100 cm. The surface change from 1944 (when the mines were laid) to 1961 is not documented, but there is no reason to believe that it has differed in any way from the later period. If the uncertainty of 1944-1961 is estimated to 40 cm, the mines should be within 200 cm from the surface (60 cm model uncertainty 1961-2010 + maximum 100 cm change in surface according to the model + 40 cm uncertainty 1944-1961).
Low Marshland (<2 m DVR90)	Studies of the marshland have shown that the sediment accumulation is only 2-3mm per year. Therefore, the total sediment deposit since WWII is up to 20 cm. In the low marshland the mines found during the technical survey were all between 5 cm and 20 cm from the surface.
High Marshland (>2 m DVR90)	Also in the high marshland, the sediment accumulation can be identified to less than 20 cm. indicating that the mines can be expected within 20 cm from the surface.

Marshland covered by dune	The differential model indicates with the uncertainty of +/-60 cm how the surface has changed between 1944-2006. Like the rest of the marshland this area must have remained stabile until the retreat of the beach caused sudden build up of dunes. According to the differential model the 1944 surface is between 0 and 260 cm below the present surface. Where the black soil layer under the sand dune can be identified, it will give a good indication of the mines depth immediately under this layer. Because of the uncertainty of the differential model (60 cm), the mines can be positioned anywhere in a "risk layer" from 80 cm below the estimated 1944 surface to 90 cm above the estimated 1944 surface. (80 cm = uncertainty of model + clearance depth from 1944 surface) (90 cm = Uncertainty of model + size of stockmine above 1944 surface)
Beach	The mines position in the beach depends only on the shifting of materials caused by the dynamics of the sea. Based on the experience from Phase 1 & 2, mine parts can be found down to 130 cm below the beach surface.

Table 4, Mine depths

2.5 Mine Functionality

The present quality and functionality of the mines depends on the mine type combined with the conditions under which they have rested for the last 65 years.
The mines functionality is in the following understood as the mines ability to work as designed, meaning if it can be brought to detonation by an external action which can occur under normal activities at Skallingen. What is regarded as an unfunctional mine can therefore still contain functioning explosives which can be activated by some kind of extreme action. In this respect, the unfunctioning mine is not a mine but rather an UXO although it is safer than most UXO.

Already in reports from the first clearance in 1945-47 it was mentioned that many mines had become inactive. Again in 1964 a number of detonators and percussion caps from Skallingen were tested. The conclusion was that a high number of mines did not function. In addition the low marshland inside the suspect area has been grassed by hundreds of cattle every year between 1975 and 2005, without a single accident, clearly indicating poor functionality of the mines.

The main charges consist of either TNT, TNT/aluminium, Amatol or Picric acid. Picric acid has a tendency to disintegrate while the TNT based explosives remain almost unchanged. However the Ammonium-Nitrate from the Amatol charges dissolves and leave the charges with only TNT.
With the assistance of the TNO Defence Laboratory in Holland, KDI has analyzed a number of ZZ-42 fuse bodies, detonators and percussion caps recovered from different environments on Skallingen. The majority of the ZZ-42 fuses have lost their functionality due to corrosion at the top of the striker outside the fuse body, preventing it to move, and from a kind of solid plug over the percussion cap, consisting of a mixture of dust, oil and rust. These malfunctions are found on fuses from all the different environments at Skallingen and will prevent more than 90% of the fuses to function mechanically.

Analysis of the detonators shows that exposed to salt water they will after a while loose their functionality. According to TNO it takes three years of exposure to salt water before the chemical reaction has made them inactive. It is of course necessary that the water gets access to the open end of the detonator. This seems to be the case with Holz-42, Schütz-42 and Stockmines if they are in a

water soaked environment like the beach or the low marshland. The Teller mines however seems to keep the fuses and detonators in a much better condition.

TNO tested the functionality of 5 percussion caps from low marshland on Skallingen and found none of them viable. KDI has furthermore tested 15 percussion caps recovered from ZZ-42 fuses from different environments at Skallingen. KDI found none of these functional either.

Functionality of each specific mine type

T-35 Anti Tank Mine
Only few T-35 were laid and none were found in Area 1 or 2. The findings from T-42 mines found in Area 1 (see below) would expectedly be the same for T-35, but it is unknown if the T-35 cover offers the same protection against the environment as the T-42

Picture 1: T-35 mine. This picture is not from the new clearance project on Skallingen

T-42 Anti Tank Mine
21 T-42 mines were cleared in the dunes in Area 1, In Area 2 no T-42 mines were found. One T-42 was found in the low marshland of Area 3 during the technical survey in 2008. Many T-Mi.Zdr.42 fuses without detonators were found in the dunes. These were left behind during the clearance in 1945-47. Of 22 T-42 mines found, 4 were disarmed and examined and 3 were opened for a visual inspection before demolition. In addition 4 T-Mi-Zdr-42 fuses found separated from their mines were cut open. (3 of the examined mines and the additional 4 fuses were cut open with an abrasive water cutting system, while the other 4 mines just had their lid taken off.) Fuse and percussion cap Of the 7 examined mines, the fuse well was found perfectly sealed and dry with no corrosion in 2 of them. 4 had a slightly corroded metal surface inside the mine and on the fuse, while the last one suffered some deformity of metal parts by corrosion Of the11 fuses, the mechanic parts in 2 could not be examined. Of the 9 remaining the mechanical parts worked in 7.

From a visual examination, 1 of the 7 percussion caps in the fuses was clearly ineffective while the 6 other looked intact.

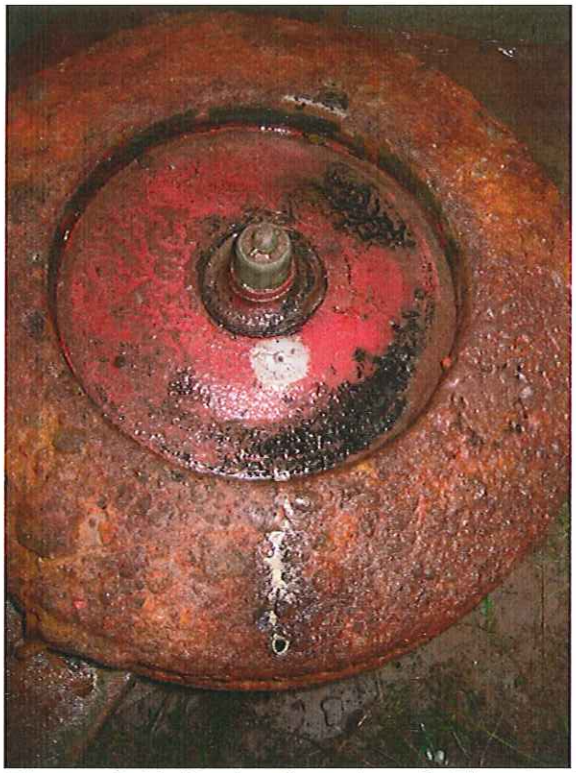
Detonator
The detonators in the 4 disarmed mines seemed from a visual inspection to be in good condition, but could have been inactive because of moisture. The degree of corrosion described above gives an indication of the humidity which the detonator has been exposed to. One of these four was actually tested by TNO, who found it functional.

Mine body and main charge
The metal covering the explosives was corroded but intact at the 22 T-mines found
The main charges were TNT in good condition on the examined mines. All demolished mines exploded when subjected to an external charge.

To raise the trigger weight above 100 kg, a spring is placed between the pressure plate and the fuse. This spring was in good condition in the 7 opened mines.

Conclusion
The mechanics of the fuses are generally working, some percussion caps might still work, some detonators are still working and the main explosive charge works. The T-42 mine shall therefore be considered fully functional.
The T-42 mines examined would probably still need above 100 kg pressure to function, but that might be different in the more corroded mines.

Picture 2: T-42 mine found in Area 1.



Picture 3: T-42 mine from Area 1. The mine has been opened with an abrasive water cutter, hence the water and sand on the fuse.

Picture 4: T-Mi.Zdr.42 fuse recovered from a T-42 mine in Area 1. The damages on the fuse body are made in the water cutting process.

Picture 5: T-42 found during the technical survey in Area 3 marshland.

Picture 6: The inside of the T-42 found during the technical survey in Area 3 marshland. The fluid is oil from the attempt to loosen the fuse from the fuse well. When opened, the inside seemed unaffected by the wet environment in which the mine had been for 60 years.

Holz-42 Anti Tank Mine
The most common AT-mine in the areas concerned. No items were identified as Holz 42 in Area 1 while five were found in Area 2 and one during the Technical survey of Area 3. The Holz-42 mine body is made of wood and will eventually decay. The Holz-mines are made in better wood quality than the Schütz-mines and some of those found during this project has remained recognisable box-shaped, while other were found in pieces. The TNT or Amatol blocks inside are found in good condition. ZZ-42 fuse

The ZZ-42 fuse springs and firing pins are soaked in oil and function well. The upper part of the strikers and the safety pins are corroded which in most cases makes the fuse safer as it prevents the safety pins from being pulled out and it locks the hammer in its top position. However if the corrosion makes the top of the striker break, the striker can strike the percussion cap why the fuse should be treated with caution as long as the detonator is still mounted. There will often be a kind of solid material over the percussion cap blocking the striker and preventing ignition even if the percussion cap should function.
The mines utilising the ZZ-42 fuse do not protect the fuse and detonator against moisture like the T-mines do. Therefore the percussion caps and detonators are more likely not to function. When the open end of the detonator gets in contact with water, a chemically change of the picric acid occurs which after a while makes the detonator un-functional.

Picture 7: Holz-42 mine in Area 3 marshland.

Picture 8: Holz-42 mine in Area 3 marshland, opened.

Schütz-42 Anti Personnel Mine
The Schütz 42 is very likely to be found. In Area 1 and 2 only six complete Schütz 42 mines were found, but remains from more than 50

other were identified. In the marshland of Area 3 the technical survey found 14 complete Schütz mines.

The Schütz mines which were found in the dunes of Area 1 were in poor condition. The wood had decayed and most of the explosives were only recognised as yellowish colouring of the sand (picric acid). The fuses incl. detonators were visually in better condition.

The Schütz mines found further south, in Area 2 had poor mine bodies, but perfect TNT blocks inside. This was also the case in the technical survey of Area 3.

The Schütz-42 gives poor protection for its ZZ-42 fuse which is exposed to the surrounding environment. The risk of a Schütz-42 with both functioning fuse, percussion cap and detonator is extremely small. Due to the decomposition of detonators in contact with water, there is no risk of functioning Schütz mines in the frequently flooded marshland. (see also the description of the ZZ-42 fuse above under the Holz42 description)

Picture 9: Schütz-42 mine from Area 3 marshland.

Stock Anti Personnel Fragmentation Mine
Very likely to be found in the concerned areas. Area 1 and 2 seventeen stock mines with explosives and more than five hundred empty stock mines were recovered. Empty stock mines were left behind during the clearance in 1945-47. The stock mine body is robust but disintegrates when corrosion expands the metal fragments. The stock mine does not protect the fuse top (safety pin) against moisture, while the lower part with the detonator is better protected by a collar sealing the hole where the fuse is inserted in the mine. The mine body is still open at the bottom why the functionality of the igniters and detonators most likely are destroyed if the mine has been exposed to rain and salt water for a longer period. (see also the description of the ZZ-42 fuse above under the Holz42 description)

Picture 10: Stockmine form the dunes in Area 1.

Picture 11: Main charge, ZZ-42 fuse and detonator from Stockmine found in the dunes.

The above described leads to the following conclusion on the functionality of the mines in different terrain types:

	T-35 and T-42	Holz-42	Schütz-42	Stock mine
Dike/dune	Could function	Unlikely to function	Unlikely to function	Unlikely to function
Low marsh	Could function	Not functioning	Not functioning	Not functioning
High marsh	Could function	Unlikely to function	Unlikely to function	Unlikely to function
Marsh covered by dunes	Could function	Unlikely to function	Unlikely to function	Unlikely to function
Beach	Could function	Not functioning	Not functioning	Not functioning

Table 5, Mine functionalities in different environments.

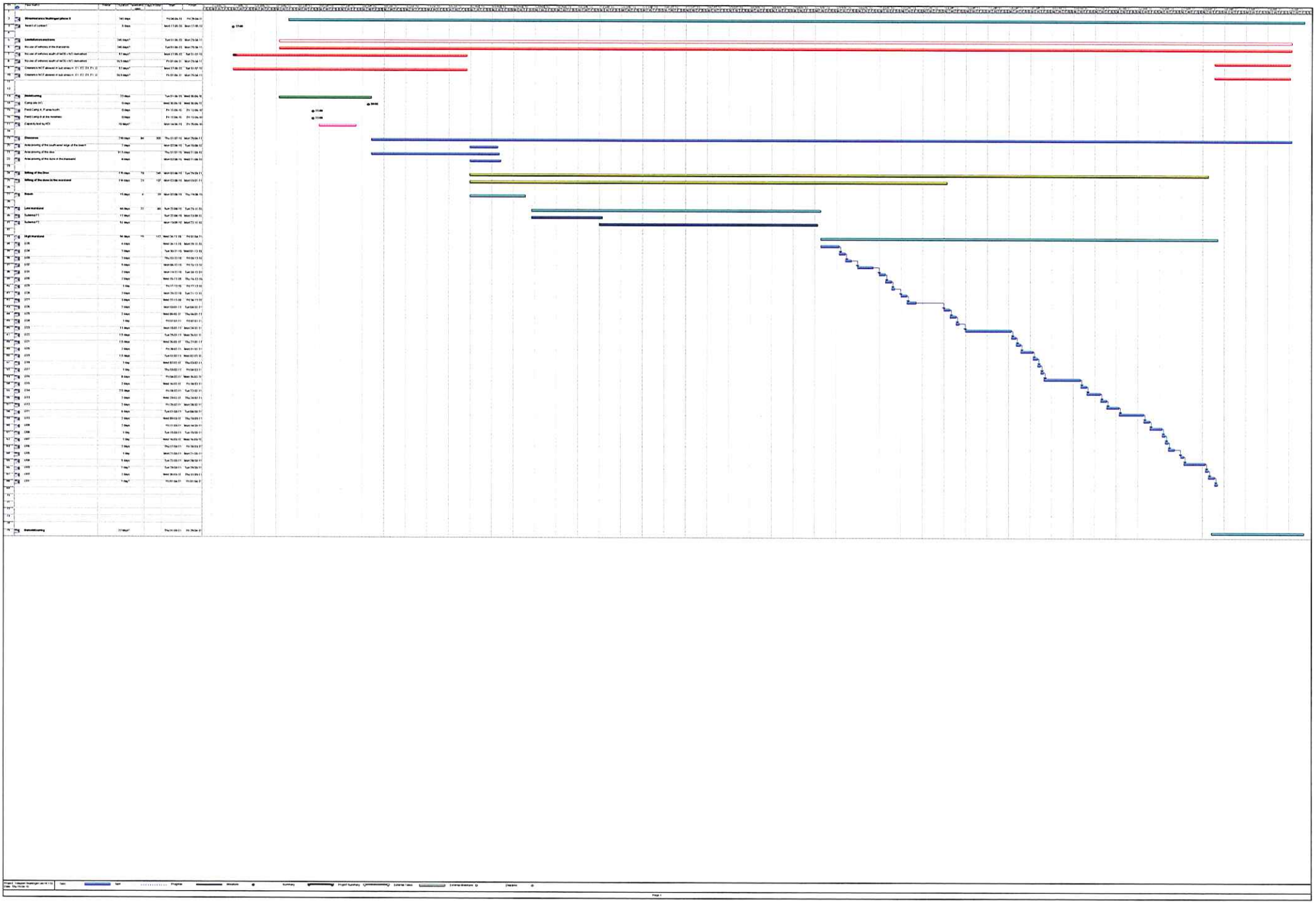
3 Clearance Criteria and Clearance Method

The above described threats assessment leads to the following clearance criteria:

Area category	Minimum Clearance Requirement	Clearance Method
Dike/Dune	Items: All explosive items which are larger or the same size as a detonator mounted on a ZZ-42 fuse Depth: 0-200 cm below surface	Sifting
Marshland covered with dune	Items: All explosive items which are larger or the same size as a detonator mounted on a ZZ-42 fuse. Depth: Danger layer of 90 cm above the estimated1944 surface to 80 cm under the estimated 1944 surface	Sifting
Low marsh	Items: Teller mines Depth: 0-50 cm	Metal detection with geo-mapping and data-logging
High marsh	Items: All mines, UXO and parts of mines and UXO containing metal (all metal indications must be investigated and removed for QC reason) Depth: 0-20 cm	Metal detection
Beach	Items: Teller mines Depth: 0-130 cm	Metal detection with geo-mapping and data logging

Table 6, Clearance criteria and clearance method.

Any other mine, UXO or part of mine which is detected will be cleared although it is not defined in the minimum clearance criteria.



Map 11: All Areas

Mål: 1:7000 Projekt: Skallingen Rev.:	Tegn. nr. 11 Nr. Gr.
Godkendt: mje	