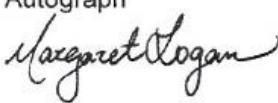






Herøya Industripark - Porsgrunn

Historical Research on the Possible Presence of Unexploded Ordnance

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1 RELEVANT DOCUMENTS

[1]

2 VERSION HISTORY

Revision	Date	Changelog	Revised by
Rev. 00	29/06/2018	Concept	SC
Rev. 01	10/07/2018- 13/07/2018	Concept	AV
Rev. 02	25/07/2018	Editing, additions to text	ML
Rev. 03	26/07/2018	Editing, additions to text	ML
Rev. 04	27/07/2018	Additions to text, GIS information	ML
Rev. 05	31/07/2018	Editing, GIS info	ML, DJ
Rev. 06	02/08/2018	Editing, GIS info	ML
Rev. 07	03/08/2018	Editing, GIS info	ML
Rev. 08	10/08/2018	Editing	ML
Rev. 09	13/08/2018	Final Editing	ML
Rev. 10	17/08/2018	Editing after receiving comments from client	ML
Rev. 11	17/10/2018	Editing after receiving comments from client	ML

Table 01. The document's version history (*ADEDE*).

3 ABBREVIATIONS AND DEFINITIONS

Item	Meaning
AA	Anti-Aircraft
A/C	Aircraft
BG	Bombardment/Bomb Group. Refers to bomber aircraft. Can also include, in parentheses, whether the group was classified as Light (L), Medium (M), Heavy (H), or Very Heavy (VH)
EO	Explosive Ordnance

EOD	Explosive Ordnance Disposal
FT	Feet
Gardening	Designation for aerial minelaying policy adopted by the British to hinder the movement of German shipping in European waters during WWII. Such minelaying was usually undertaken at night by bombers.
GIS	Geographical Information System
Gp	Group
GP	General Purpose
HE	High Explosive
H/P	Height/Pressure
Lbs/LB	Pounds
MC	Medium Capacity
NATO	North Atlantic Treaty Organization
Nordag	<i>Nordische Aluminium Aktiengesellschaft</i>
NEQ	Net Explosive Quantity
NIL	None, zero
RAF	Royal Air Force
SNMCMG1	Standing NATO Mine Counter Measures Group 1
Sqn	Squadron
TNA	The National Archives
TOT	Total
UK	United Kingdom
USA	United States of America
USAAF	United States of America Air Force
UXO	Unexploded Ordnance

Table 02. Table of abbreviations and definitions (ADEDE).

4 INTRODUCTION

4.1 PROJECT DESCRIPTION

Herøya Industrial park A/S (*Herøya Industripark*), located on a peninsula near the city of Porsgrunn in southern Norway, has contacted ADEDE with reference to conducting historical research on the Gunneklevfjord, which is located directly next to Herøya Industrial Park. The aim is to list all possible types of unexploded ordnance (henceforth UXO) that could be expected within the project area, and to delineate the areas in which these types of UXO could be expected to be found. The industrial park plans to carry out invasive works (including capping and dredging), and the presence of UXO in the proposed project area must be established before works can begin. Due to the proposed project area's location, there exists the possibility of the presence of UXO. Herøya Industrial Park is known to have been bombed during the Second World War. Adhering to a preventative safety policy, ADEDE has been contracted to conduct historical research and to deliver a site-specific risk analysis map, concerning the possibility of discovering UXO in the process of the works. The focus of the research is the Gunneklevfjord.

4.2 METHODOLOGY

The main goal of the historical research is to determine the risk of finding UXO during the future works in the project area. The parties involved are thus given a base to determine their further policy on this issue. The study of historical accounts results in a number of technical details that are important for further risk analysis of the UXO problem, such as types, calibres, nationality, and amounts of the UXO suspected to be present. Apart from many other historical sources, aerial photographs and maps are also analysed and interpreted, in order to limit the risk area to its true extent. All sources used are cited in footnotes and the 'Sources' chapter at the end of the report.

A geographical information system (GIS) was used to georeference any geographical information mentioned in the textual sources, and any charts or aerial photographs which were encountered during the investigation. Due to the nature of the source data, a degree of inaccuracy needs to be considered when using the delivered georeferenced data.

4.3 DISCLAIMER

It should be further noted that certain incidents occurring throughout history were either never recorded in historical sources, or recorded incompletely or incorrectly. Sources have been lost, deliberately destroyed, or are, due to still being considered 'secret', inaccessible to historians and researchers. All these problems are inherent to historical research and are

insurmountable. Although the available sources were consulted and analysed with scientific caution, ADEDE cannot be held liable for the completeness and accuracy of the sources used, or the conclusions that were drawn from them since we are dealing with UXO's in unknown quantity.

5 PROJECT AREA

The project area, the Gunneklevfjord, is located in the territory of the municipality of Porsgrunn in Southern Norway. The project area is a body of water with an area of ca. 754 hectares (see Figure 1). The fjord is bordered to the west by the peninsula Herøya, where the industrial site itself is situated. This peninsula is roughly 1775 hectares of which ca. 1500 hectares is covered by the industrial park. To the east of the fjord is the mainland. The peninsula is located at the mouth of the Telemarksvassdraget, and the body of water to the west of the peninsula is the Frierfjord. The Porsgrunselva or Skienselva is a river that begins in Skien and runs through Porsgrunn to the mouth of the river at the Frierfjord. In the south, the Gunneklevfjord connects to the Frierfjord by a canal.

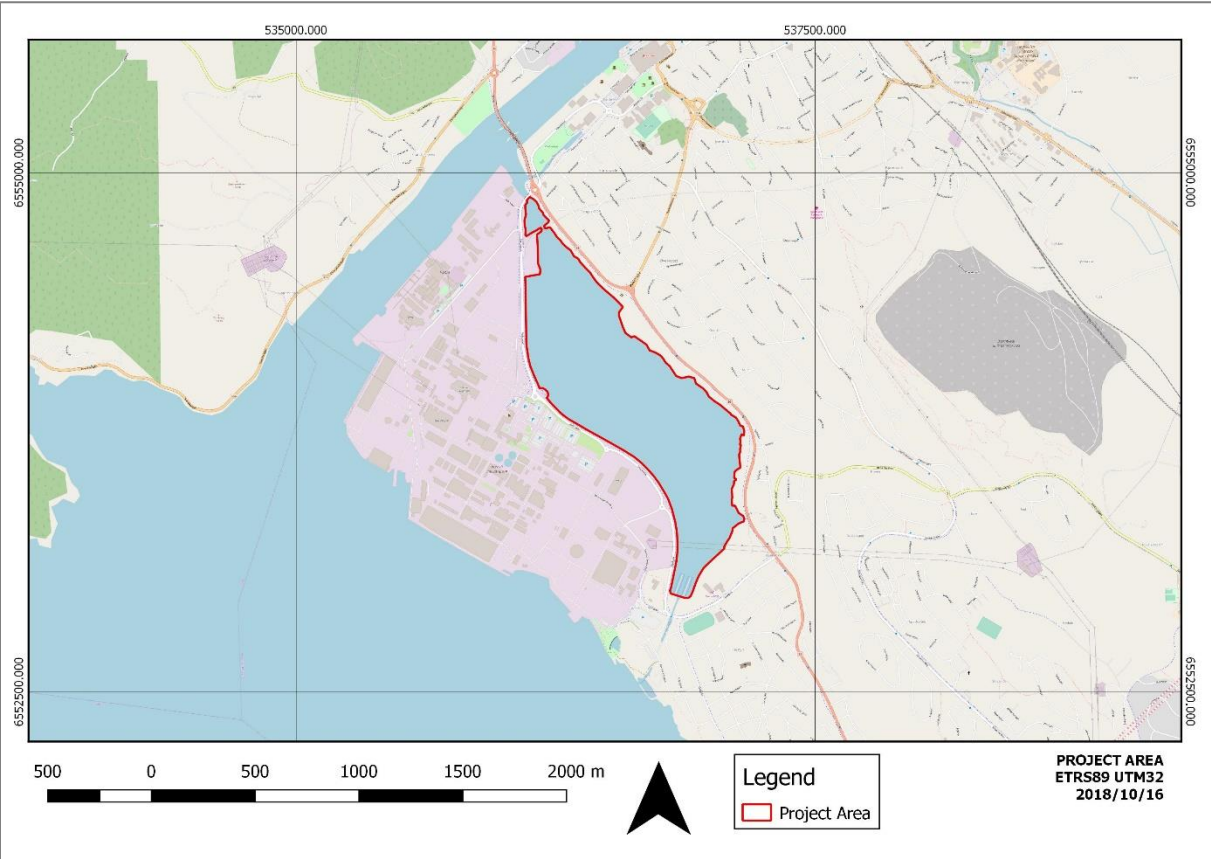


Figure 1: Map of project area (red border), the Gunneklevfjord near Porsgrunn, Norway (ADEDE)

The focus of the historical research is the Gunneklevfjord, however, the surrounding areas will also pose a risk concerning possible UXO. The project area as well as the surrounding area have been delineated into three different potential risk zones: a red zone, an orange zone, and a yellow zone (see Figure 2).

- The red zone is the Gunneklevfjord, the project area.
- The orange zone is the area immediately surrounding the Gunneklevfjord, including the peninsula with Herøya Industrial Park, Klevstrand, and a small coverage of the sea on the western side.
- A wider area encompassing part of the Frierfjorden as well as the Porsgrunnselva/Skienselva leading north to Menstad. This area is not within the project area itself, but could pose a risk if future activities in the area are increased.

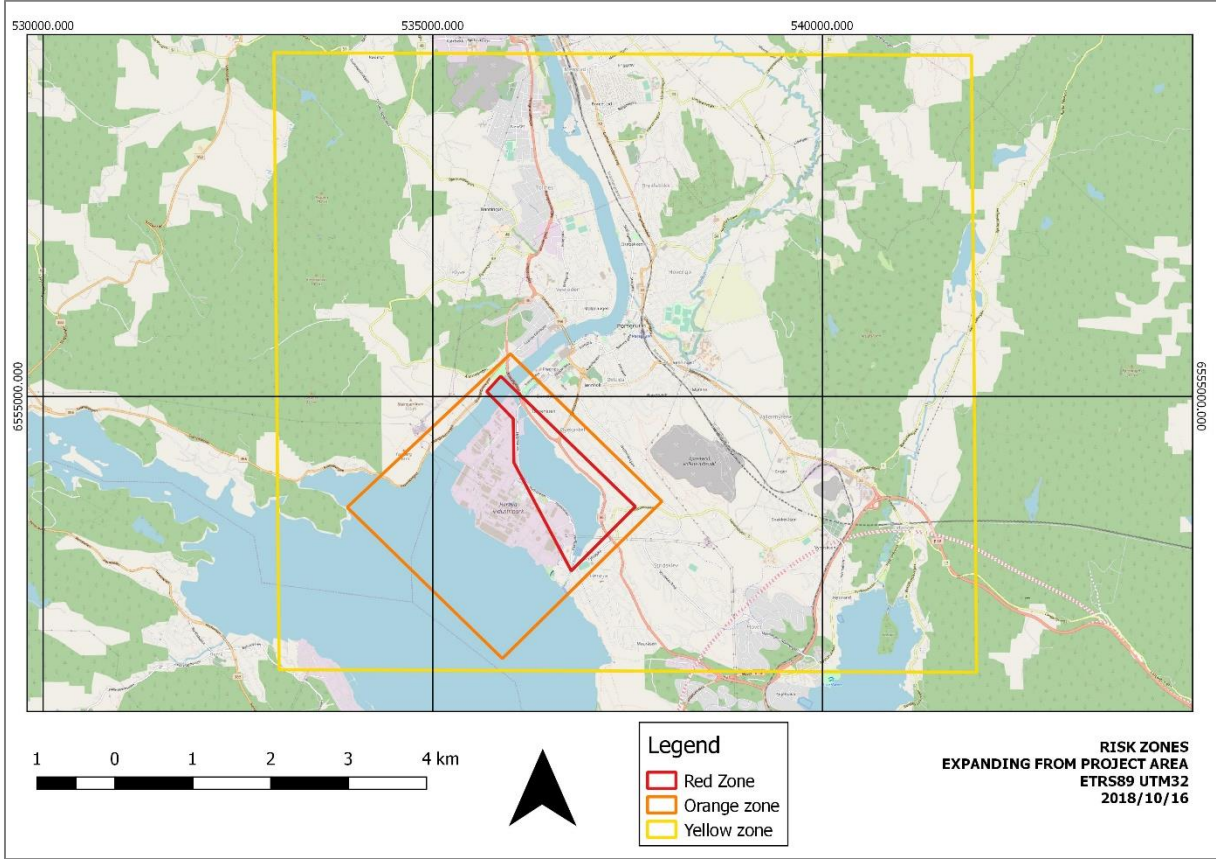


Figure 2: Areas delineating risk zones should the future works expand further than the current project area of the Gunneklevfjord. (ADEDE)

6 BACKGROUND OF PROJECT AREA¹

Originally, the peninsula of Herøya was predestined for agricultural activities, which took place there until 1928, when the grounds were acquired by Norsk Hydro in order to install a fertilizer factory on the island. By the summer of 1929, the factory (Eidanger Salpeterfabrikker) and an associated port were built. The core business on the island became the production of calcium nitrate, phosphate, and other fertilizer substances.

During the construction of the new factory and port, the northern part of the island was connected with the mainland via a bridge, one that serves as a road. Through the first decennia of the 20th century, the fertilizer factory saw rapid expansion with the development of complex fertilizers such as NPK which contains nitrogen, phosphorous, and potassium.

When the Germans invaded and occupied Norway in 1940, they quickly noticed the industrial potential and advantageous position of Herøya. The occupying force developed plans to install aluminium and magnesium plants at the peninsula. "At the Hydro plant at Herøya, work began on the construction of large aluminum plant."² In 1941, a partnership was formed between Norsk Hydro and the German company Nordag (*Nordische Aluminium Aktiengesellschaft AG*), which represented the German aviation ministry and the *Luftwaffe*. In the spring of 1941, the construction of the "*Lettmetallfabrik*" at Herøya started. In 1943, the battle for air sovereignty over Europe was in no way resolved and Herøya thus represented a direct threat to the Allied invasion plans. Herøya therefore found itself on Allied bomb lists as a possible target.

During construction works, they were interrupted by heavy bombings from Allied troops. After the irreparable damage of the bombing of 24 July, 1943, the German occupiers abandoned the plans for the Herøya peninsula. During the remainder of the war, no construction works took place there. It would only be after the armistice and the recovery of Norway that Norsk Hydro would again invest in projects on Herøya.

7 BOMBING OF HERØYA 24 JULY 1943

Between the 24th and the 30th of July, 1943, the USAAF³ performed an aerial bombardment as part of the Combined Bomber Offensive. This week, one of the most intensive periods of US bombing operations up to that time, would come to be known as "Blitz Week." The week

¹ <https://www.hydro.com/en/press-room/hydros-new-automotive-line/history/> & <https://eng.Herøya-industripark.no/> & <https://eng.Herøya-industripark.no/about-hip/facts-and-figures> & <https://hydro.com/en/about-hydro/Our-history/>

² <https://www.hydro.com/en/press-room/hydros-new-automotive-line/history/>

³ USAAF: United States Army Air Forces

of relentless aerial attacks included US raids in various strategic locations, including Trondheim, Hamburg, Kiel, and Herøya.

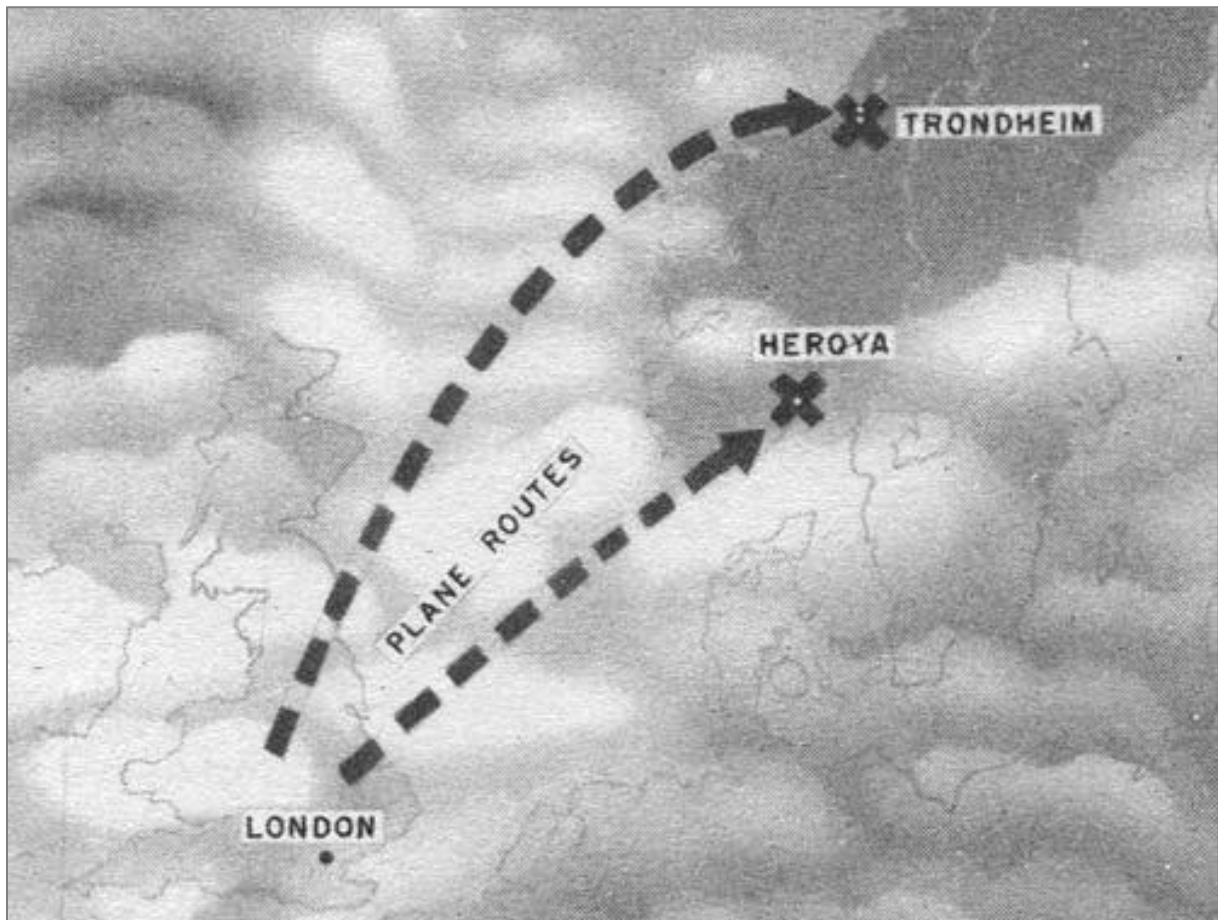


Figure 3: Weather chart from Mission of 24 July 1943, the bombardment of Herøya-Trondheim.⁴

The Eighth Air Force's target on 24 July 1943 was the "Nordisk Aluminum [sic] Factory" in Herøya. Some sources call this operation Mission No. 75⁵, and other sources designate it Combat Mission No. 52⁶. On July 24th, after flying over dense stratocumulus clouds to within a few miles of the targets, the bombers broke into the clear and found their principal targets, Herøya and Trondheim, un-obscured. Primary targets were well-covered by bombings and accuracy was excellent.

In total 179 B-17s and 1 YB-40 were dispatched. The US Air Force attacked Herøya in five waves: between 13:17h and 14:14h, 167 aircrafts were able to drop their bombs, over 1500 in total (414 tons⁷) on the factory⁸. Some aircrafts had to return due to cloud coverage or losing

⁴ http://saltofamerica.com/contents/displayArticle.aspx?18_411

⁵ <http://www.8thafhs.org/combat1943.htm>

⁶ <http://www.303rdbg.com/missionreports/052.pdf>

⁷ Watson, P.

⁸ Bowman, M.

contact with the GP formation. "Each aircraft [of Combat Mission No. 52] carried ten 500-lb bombs... They flew with full cloud cover until just before they reached the target [Nordisk Aluminum (sic) Factory]... Each Group decided to make separate bomb runs. A hole appeared in the clouds just before the 303rd BG(H) reached the target, which allowed a perfect bomb run... 'There was a pillar of smoke up to 6,000 feet before we got there. The ships that went ahead of us really bombed the hell out of it. The target was so smoky we had to make two passes in order to see it. Our bombs landed right smack on it.'"⁹ The mission succeeded completely destroyed the factory, 55 people lost their lives during the attack, and over one hundred were injured.

⁹ <http://www.303rdbg.com/missionreports/052.pdf>

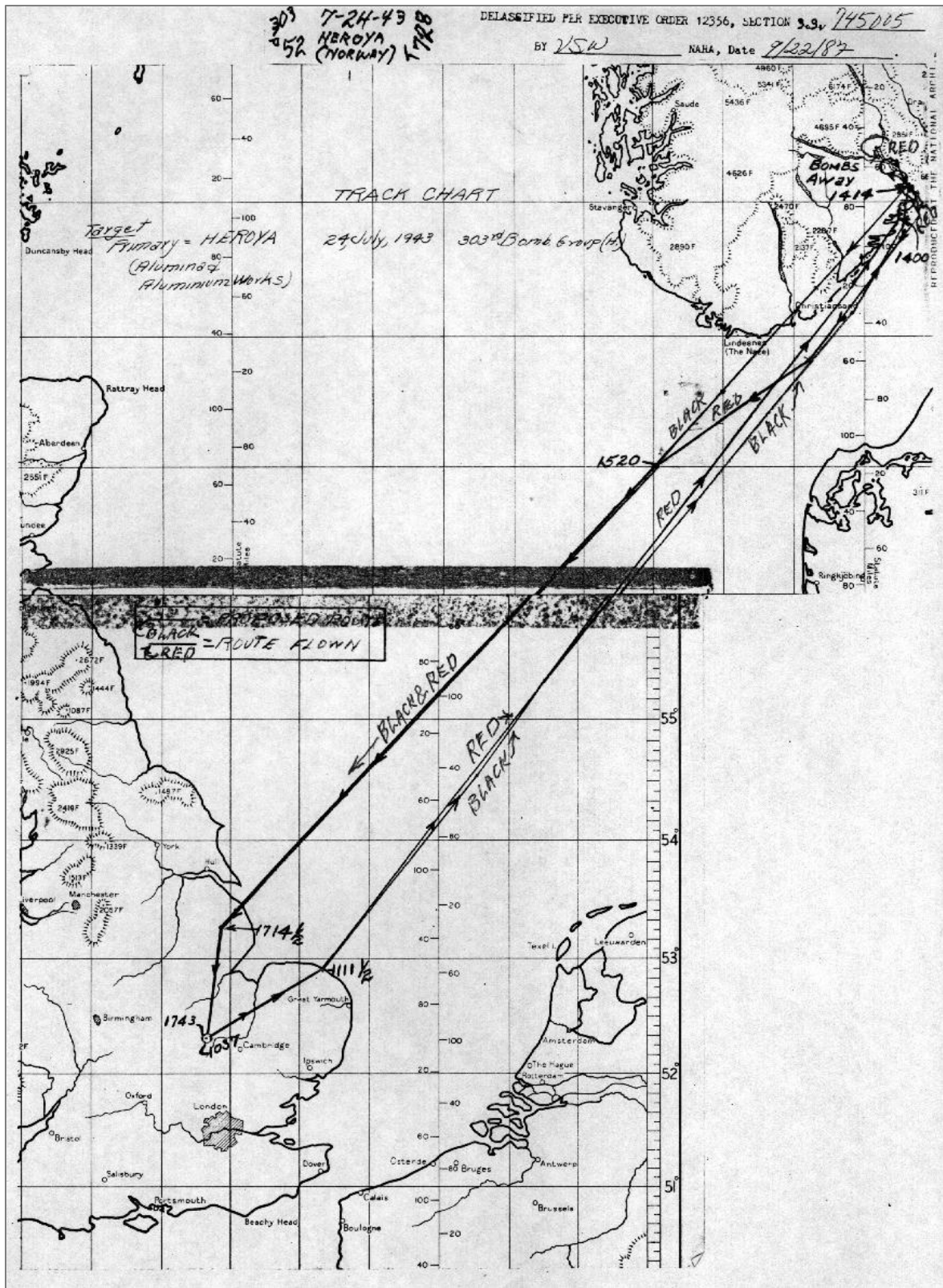


Figure 4: Route of bombers flown from base to the plant at Herøya¹⁰

¹⁰ http://www.scharch.org/Rich_Scharch/missions/052_map_1943-07-24.jpg

7.1 UNITED STATES OF AMERICA AIR FORCE INTERPRETATION REPORTS (USAAF OR AAF)

This section concerns the reports issued by the USAAF on the operations and subsequent damage of the bombings of 24 July 1943. The first source is an operations narrative (A.P.O. 634) for the mission issued by VIII Bomber Command. Two more reports were created immediately after the bombing for the purpose of immediate interpretation (Immediate Interpretation Reports Nos. SA-407 and K-1629), using aerial photographs taken the day after the attack (25 July 1943). Four further reports were released, on 3 August (Report No. K-1629), 19 August (Report No. 345), 2 October (Report No. 406), 1943, and 9 February 1944 (Report No. KS-465). For these later reports, more aerial photos were taken several months after the attack and studied so as to determine the extent of the damage from the attack, as well as monitor any reconstruction.

These reports are extremely thorough, and go into great detail describing how many aircraft participated in dropping bombs, how many bombs were dropped, how many bursts were recorded in what location both within and without the target area, as well as meticulous accounts of observed damages to structures and buildings.

The Operations Narrative states that 180 aircraft were dispatched to Herøya, and 167 actually participated in the attack. "BOMBING RESULTS: 167 aircraft dropped 1657 x 500 GP fused 1/10 sec. nose and 1/40 sec. tail at 1317 to 1414 hrs. from 15000 to 17000 ft. The attack was very successful. Strike attack photos show a very heavy concentration of bomb bursts within the target area..."¹¹

¹¹ USAAF Operations Narrative

9. CONFIDENTIAL

HEADQUARTERS
VIII BOMBER COMMAND
A.P.O. 634

Bomber Command Narrative of Operations
Day Operation - 24 July, 1943
Mission No. 75

TARGETS: Magnesium, Aluminium and Nitrate Works at Heroya, Norway.
U-Boat Workshops and Harbor Installations at Trondheim, Norway.

For the first time, 309 B-17s were dispatched to attack three targets in occupied Norway. The mission-longest ever undertaken by B-17s of this command - was very successful as targets at Heroya and Trondheim were bombed with excellent results by 203 a/c. The third target was found to be cloud covered and no bombs were dropped. No fighter support was scheduled, and e/a opposition was weak. From the three operations only 1 a/c is missing, and this a/c which was damaged by flak and landed safely in Sweden.

Unit		Number of A/C				Claims	Personnel Casualties		
		(Dispatched)	(Attacking)	Abortive+	Lost)		(Killed)	(Wounded)	(Missing)
HEROYA		A.	B.						
91	22	14	8	0	0	0-0-0	0	0	0
92	15 ^x	15 ^x	0	0	0	4-0-0	0	0	0
303	20	19	1	0	0	0-0-0	0	0	0
305	19	18	1	0	0	2-0-0	0	0	0
306	21	20	1	0	0	3-2-0	0	3	0
351	21	21	0	0	0	0-0-0	0	0	0
379	21	21	0	0	0	0-0-0	0	0	0
381	21	20	0	1	1	0-0-0	0	0	10
384	20	19	1	0	0	0-0-0	0	0	0
	180 ^x	167 ^x	12	1	1	9-2-0	0	3	10

Figure 5: USAAF Bomber Command Narrative of Operations for 24 July 1943, Mission No. 75.
Note the total amount of attacking aircraft: 167.¹²

In one of the immediate interpretation reports (No. SA-407) from the USAAF, it states once again that there were 167 aircraft from Bomber Command, and they dropped 1657 x 500 lb G.P. bombs on Herøya.¹³ When describing the damage, the report specifically mentions the Gunneklevfjord: "Six of ten bursts seen in the wooded area south west of Porsgrunn. Twentynine bursts seen in the Gunneklev Fjord [sic] are shown on the bomb plot... A concentration of about forty bomb bursts in a wooded and sparsely settled area south east of the Gunneklev Fjord."¹⁴ (see Figure 6) The Gunneklevfjord is mentioned again in Report No. 345: "After the raid, Gunneklevfjord was covered with fish killed by bombs which dropped in the water."¹⁵

¹² USAAF Operations Narrative

¹³ USAAF Interpretation Report SA-407

¹⁴ USAAF Interpretation Report SA-407

¹⁵ USAAF Interpretation Report No. 345



Figure 6: "Attack on the Magnesium, Aluminium, and Nitrate Works at Herøya: 24.7.43: Approximate bomb plot of target area."¹⁶

¹⁶ USAAF Interpretation Report SA-407

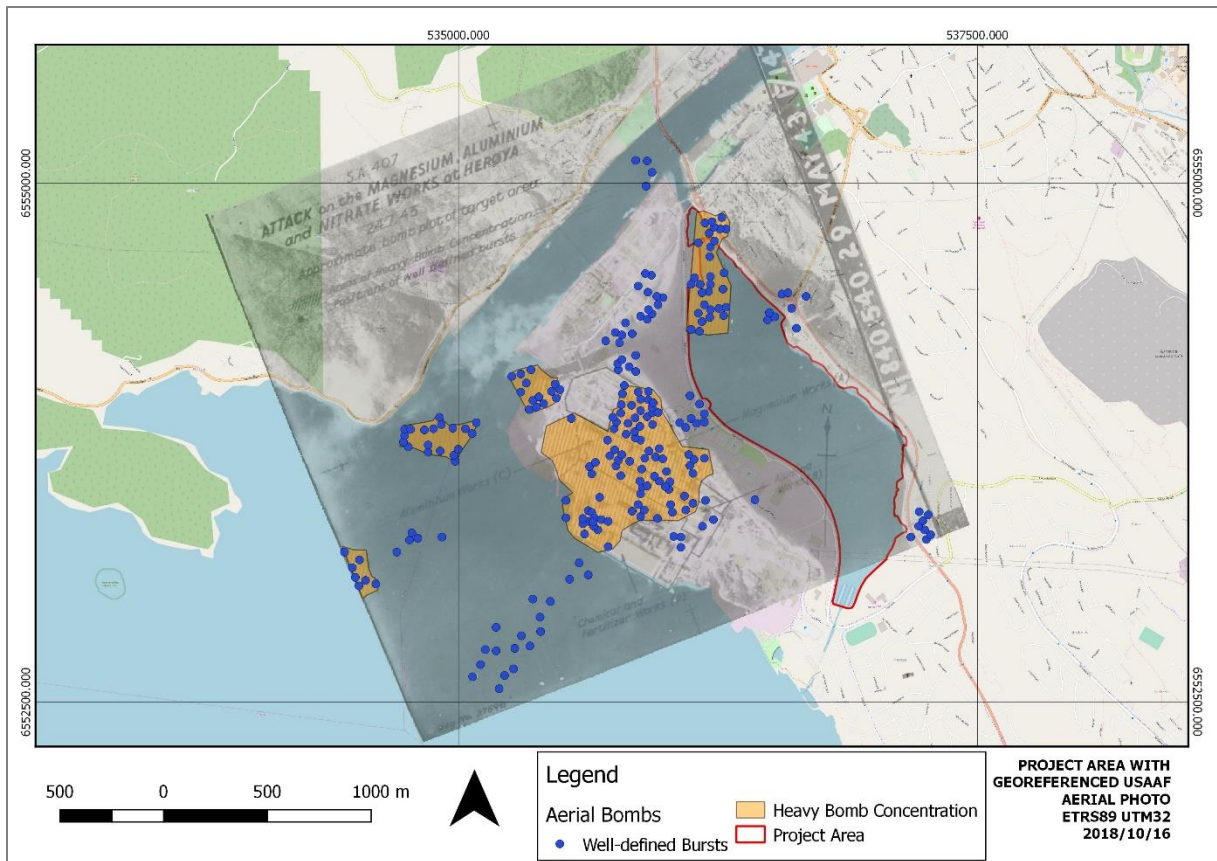


Figure 7: Map of project area with aerial photo from Figure 6 georeferenced and superimposed. Note the blue dots of well-defined bursts and orange areas of heavy bomb concentration (ADEDE and USAAF Interpretation Reports)

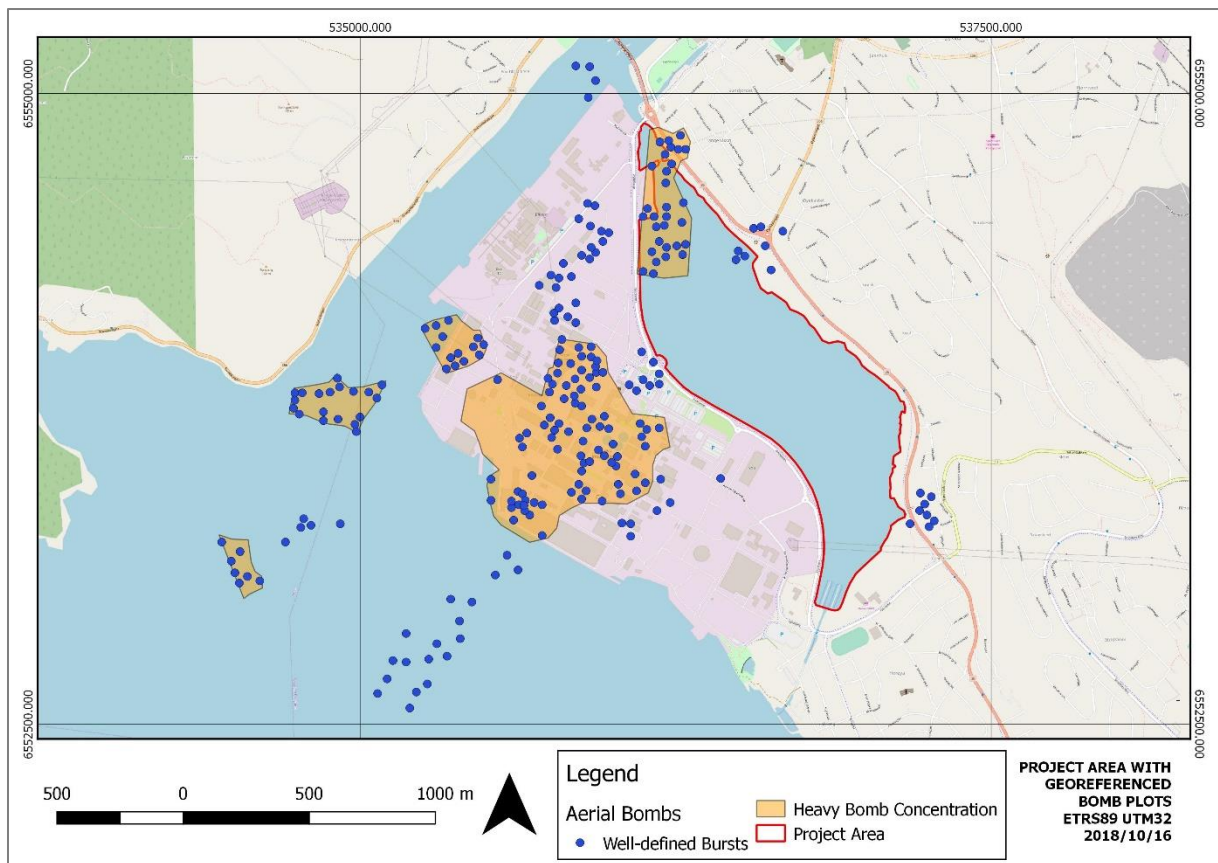


Figure 8: Project area with bomb plots (well-defined bursts and heavy bomb concentration) from Figure 5. Note the amount of bombs inside project area. (ADEDE and USAAF Interpretation Report)

The aerial photo from the USAAF Interpretation Report No. SA-407 (shown in Figure 6) was georeferenced and then superimposed over a current map of the project area. The bomb bursts and areas of heavy concentration were traced over so as to be easier to read (see Figures 7 and 8). If the blue dots (each showing a “well-defined burst”) in the Gunneklevfjord are counted, then a total of 25 well-defined bursts landed in the fjord itself. Even if each blue dot would only represent a single bomb, that would add to a total 12,500 pounds of explosives (each bomb being 500 lbs). However, that is not taking into account the fact that the Gunneklevfjord used to be larger (see Figures 9 and 10 for comparison). The peninsula was expanded in the meanwhile since WWII. Observing the aerial photo from Figure 6, and counting the number of dots that fall into the former fjord, the number rises from 25 to 42. If each dot is still only one bomb, that would amount to 21,000 pounds of explosives (see Figure 10).

Further, the bomb plots show a distinct line of attack running northwest-southeast, across the fjord. We can assume that bombings did not stop on one side of the fjord and continue on the

other. The northern area of the Gunnekelevfjord, between the high concentrations of bomb bursts, can be attributed with a high expectation of unexploded aerial bombs.

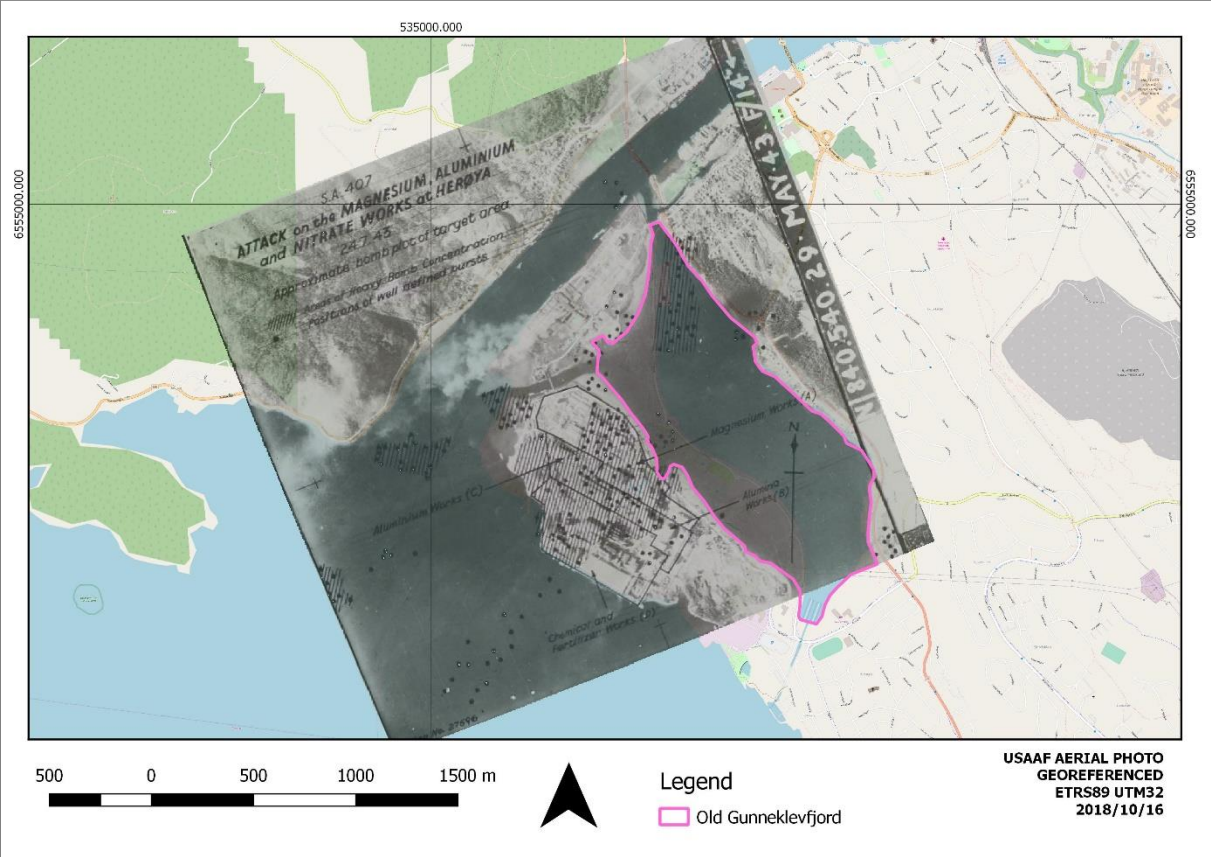


Figure 9: Map showing georeferenced aerial photo from USAAF Interpretation Report, with former outline of Gunnekelevfjord shown in pink. (ADEDE and USAAF Interpretation Report SA-407)

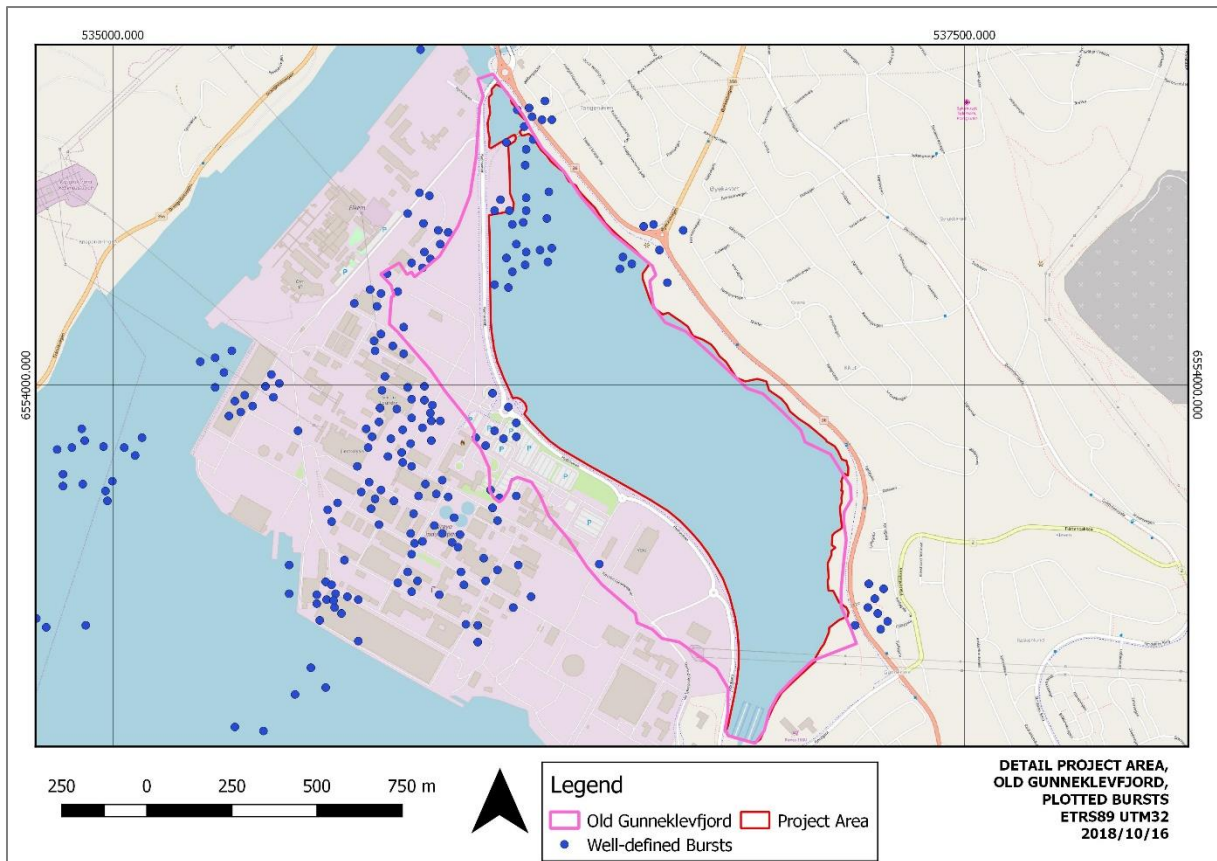


Figure 10: Detail map showing the project area in red, the old Gunneklevfjord in pink, and the plotted bombs from the USAAF report picture. (ADEDE and USAAF Interpretation Report)



Figure 11: Aerial photograph of July 24th attack on Herøya. Note the two deployed bombs in the lower left-hand corner.¹⁷

¹⁷ <https://www.fold3.com/image/1/47649462>

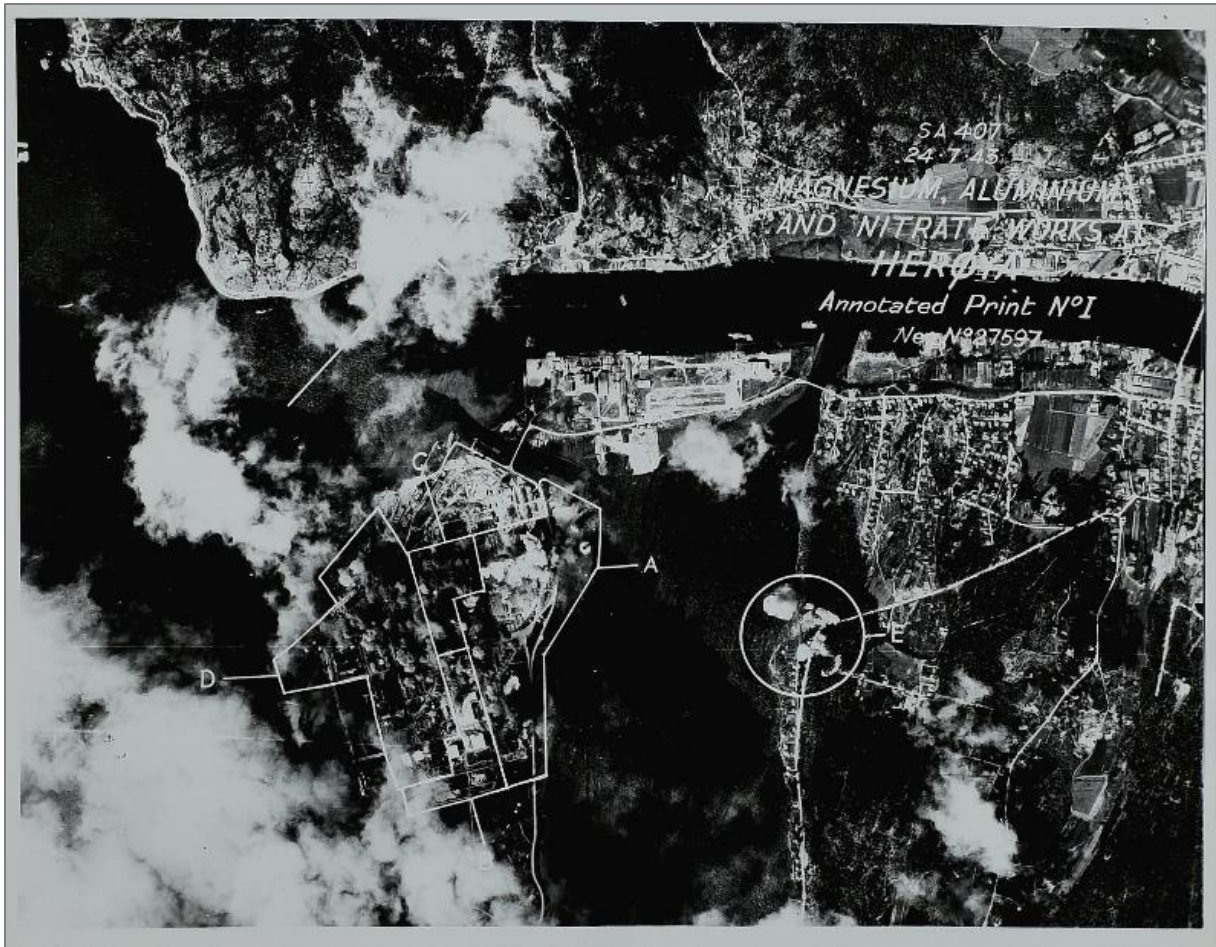


Figure 12: Image of targets (industrial plants) on the island of Herøya on July 24, on an aerial photograph taken five months after attack for purposes of reconnaissance.¹⁸

In Report No. 406, issued 2 October 1943, it states that "... two plots recording the explosions of the bombs.

It can be concluded from these reports alone that UXO can be highly expected within the project area of the Gunneklevfjord, as well as on the peninsula of Herøya. There is evidence that munition fell directly into the fjord itself. At least 42 "well-defined bursts" were recorded in the former Gunneklevfjord alone, not including the likelihood of bombs having dropped into the fjord itself with no visible burst.

7.2 EIDANGER RAPPORT

Eidanger Potassium Nitrate Factory (Eidanger Salpeterfabriker) issued a comprehensive report after the attack on 24 July. Eidanger Salpeterfabriker was located on the peninsula of Herøya. This report included physical descriptions of the company, such as the products, terrain, neighboring companies, susceptibility to air attack, dangers posed by fire, etc.

¹⁸ USAAF Interpretation Report

Emergency procedures in case of air raids were also described: necessary equipment, air raid shelter locations, leaders and telephone operators, alarms and regulations.

The report goes on to describe the attack on 24 July 1943, including flight paths of the bomber aircraft, direction and number of the bomber aircraft, a timeline of the air raid, and includes estimates of the number and types of bombs dropped. A large portion of the Eidanger Salpeterfabriker report is based on eye-witness accounts. The report states this fact, as well as a disclaimer concerning the reliability of such accounts:

“Der er innsamlet opplysninger fra folk der har iaktatt en større eller mindre del av angrepet fra punkter der tildels har ligget utenfor fareområdet. De aller fleste har vært helt sikre i sine angivelser. De forskjellige personere opplysninger er allikevel høist varierende og for en stor del tilsynelatende motstridende. Dette har sin årsak i at:

- 1) Den menneskelige hukommelse er skrøpelig,*
- 2) Foreteelsen var uvertet og uvant. Opmerksomheten blev derfor så sterkt festet ved enkelte detaljer at andre helt unddrog sig opmerksomhet.*
- 3) Det hele kom så plutselig at vedkommende ikke i forveien hadde fått tid til å orientere sig i terrenget. Retningsangivelsene er derfor usikre. Etter angrepet har vedkommende hatt helt andre tanker enn å få eksakt fastlagt hvad som virkelig er hendt.*
- 4) Angrepet har foregitt fra stor høyde. De forskjellige iakttagere tror derfor at flyene har passert ‘rett over der hvor vedkommende stod.’*

En helt sikker rekonstruksjon av angrepet har det derfor ikke vært mulig å foreta. Der er allikevel satt op et sannsynlig forløp, ifølge forklaringene. Dette forløp sannsynliggjøres av de bombenedslag som viser bombene fallretning.

Efter dette har der vært to innflyvninger tett på hverandre. Så har der vært et lenger opphold, hvorefter der kom ennu to innflyvninger. Tidspunktene for den late, 3dje og 4de innflyvning er avmerket i kommandocentralens journal, mens tidspunktet for 2. innflyvning ikke er fått med. Journalføreren mener også at han ikke rakk å få med ett av angrepene. Kommandocentralene journal angir følgende klokkeslett:¹⁹

¹⁹ Rapport fra Eidanger Salpeterfabrik, pg 59

journal, mens tidspunktet for 2. innflyvning ikke er fått med. Journalføreren mener også at han ikke rekk å få med ett av angrepene. Kommandocentralens journal angir følgende klokkeslett:

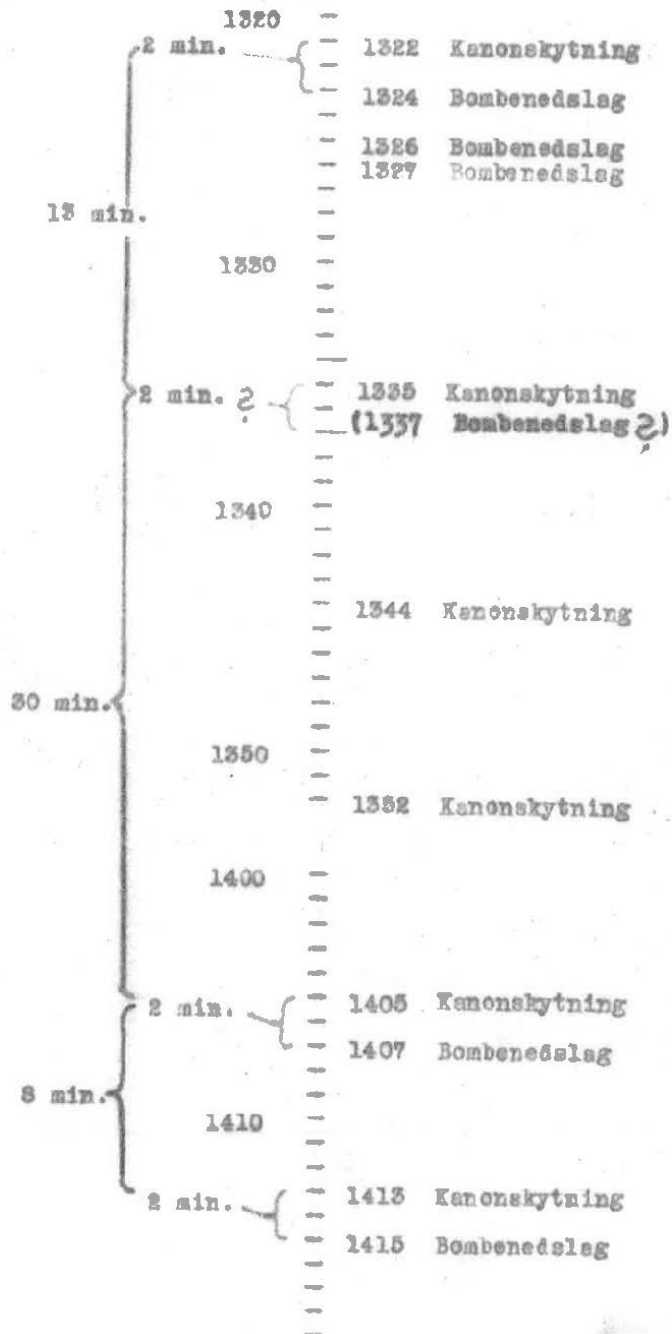


Figure 13: Excerpt from Eidanger Salpeterfabrik report, showing the estimated timeline of the 24/07/1943 attack. Rapport fra Eidanger Salpeterfabrik

The times given (see Figure 13) very closely match those reported in the Operations Narrative issued by Bomber Command. However, the estimated number of aircraft given in the report does not match the number of aircraft reported by USAAF. The Eidanger report states: *“Der har hver gang antagelig vært anvendt tre sveit a 18 fly, tilsammen 54 fly.”*²⁰ The reports from USAAF state in multiple instances that 167 aircraft participated in the 24 July bombing of Herøya. There is a difference of over 100 aircraft. However, as stated in the report itself, human memory of traumatic, dangerous events cannot be expected to perfectly reflect the actual events.



Figure 14: Map from report issued by Eidanger Salpeterfabrik, showing recorded locations of bomb hits and UXO

²⁰ Rapport fra Eidanger Salpeterfabrik, pg 61

Bombtreff på E.S. interesseområdet avmerket på kart 310 stk.			
--	--	--	i bygninger 85 .
--	--	--	utenom bygninger 225 "
Bombtreff på N.L. interesseområde avmerket på kart 270 stk.			
.	.	.	i bygninger 66 .
.	.	.	utenom . 204 .

Figure 15: Detail from Figure 14, map legend. Provided by HIIP Eiendom A/S

The pink map shown in Figure 14 depicts the peninsula of Herøya with “bombtreff” (bomb hits) plotted. Figure 15 is a detail from the map legend of Figure 14. The legend lists bomb hits on Eidanger Salpeterfabrik (“E.S.”) as well as Norsk Lettmetall (“N.L.”), and lists bomb hits found in buildings (“i bygninger”) and outside of buildings (“utenom bygninger”). Tallying these numbers, the report states that at least 580 bombs fell on these two factories.

The Eidanger report also describes how German bomb disposal teams were quick to begin clearance operations after the attack. The section mentions how the bomb disposal squad searched for duds (unexploded ordnance) and safely detonated them. “Blindgjengere blev med en gang de blev opdaget avmerket med dertil bestemte skilt. Disse skilt var gjort ferdige tidligere og blev opbevart i kommandocentralen. Merkningen blev utført i en avstand av 200 meter fra nedslagsstedet.”²¹ Some of the bombs, on the recommendation of the bomb disposal team, were left in the ground and marked with a sign, for a safer demolition after two years.

The Eidanger report created lists and maps to record the location of each crater and unexploded ordnance. In total, the lists in the report tally roughly 314 bomb craters, 40 bomb hits, and nine UXO.²² Of these, specifically in the area of “Gunneklev”, the report lists 54 instances of observed craters, three UXO, and 17 bomb hits.

There is an attempt within the report to estimate the number of bombs dropped during the attack, including how many actually detonated and how many fell without detonating. “På selve Herøya, innenfor begge selskaper fabrikkområde, er der falt ca. 600 bomber. I distriktene omkring er der falt anslagsvis 200 bomber, på Roligheten og i Friersfjorden og i Gunneklevfjorden minst 200 a 500. Man må derfor ante at der anslagsvis er kastet 1000 a

²¹ Rapport fra Eidanger Salpeterfabrik, pg 86

²² Rapport fra Eidanger Salpeterfabrik, Appendix 22

1500 bomber. Bombene størrelse skal, ifølge eksperters utsagn, ha ligget mellom 100 kg og 250 kg. med noen få på 500 kg. Settes middelvekten til 200 kg blir bombevekten 200 a 300 tonn.”²³ Several maps were drawn up and bombs were plotted on these maps and included in the report.

It must be noted that these numbers cannot be used to determine an exact number of UXO to expect in the project area. There doesn't appear to be a clear distinction of what qualifies as a crater and what as a “bomb strike.” Additionally, locating bomb craters in water can only be done on impact or in very shallow water. The numbers in the report which were obtained by counting craters thus underestimate the number of bombs to be found in the water. These numbers are informational only, used to help create the risk analysis of the proposed project area. However, it can be definitively concluded from the Eidanger Salpeterfabrik report that UXO can be expected on the peninsula of Herøya, and UXO can be highly suspected within the project area of the Gunneklevfjord. More than one witness claims to have seen bombs drop directly into the Gunneklevfjord: *“Han merket de at det falt bomber i Gunneklevfjorden og skjønte de at han stod i den farlige sone... Da falt bombene i Gunneklev.”*²⁴

²³ Rapport fra Eidanger Salpeterfabrik, pg 61

²⁴ Rapport fra Eidanger Salpeterfabrik, Appedix 18

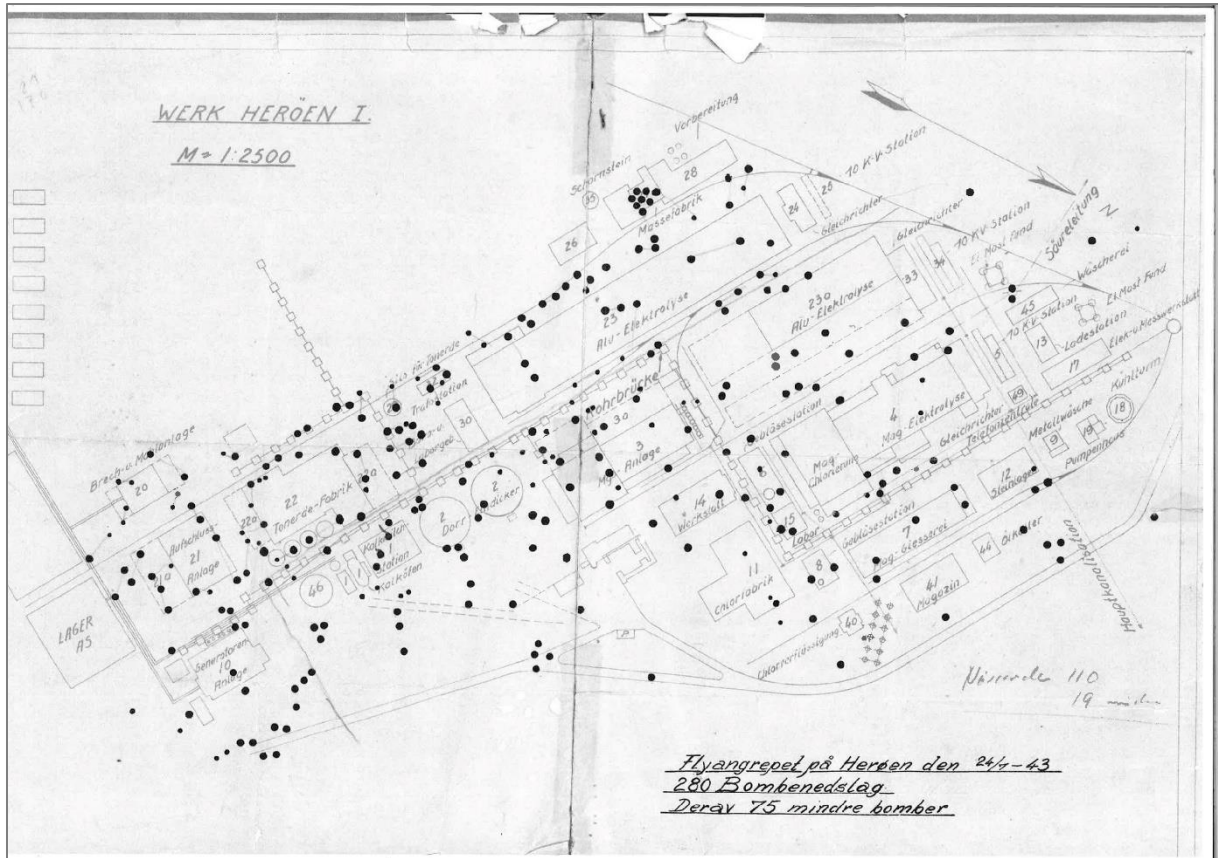


Figure 16: Map included in the report issued by Eidanger Salpeterfabrik, showing recording instances of bomb hits on the factory Nordisk Lettmetall A/S.

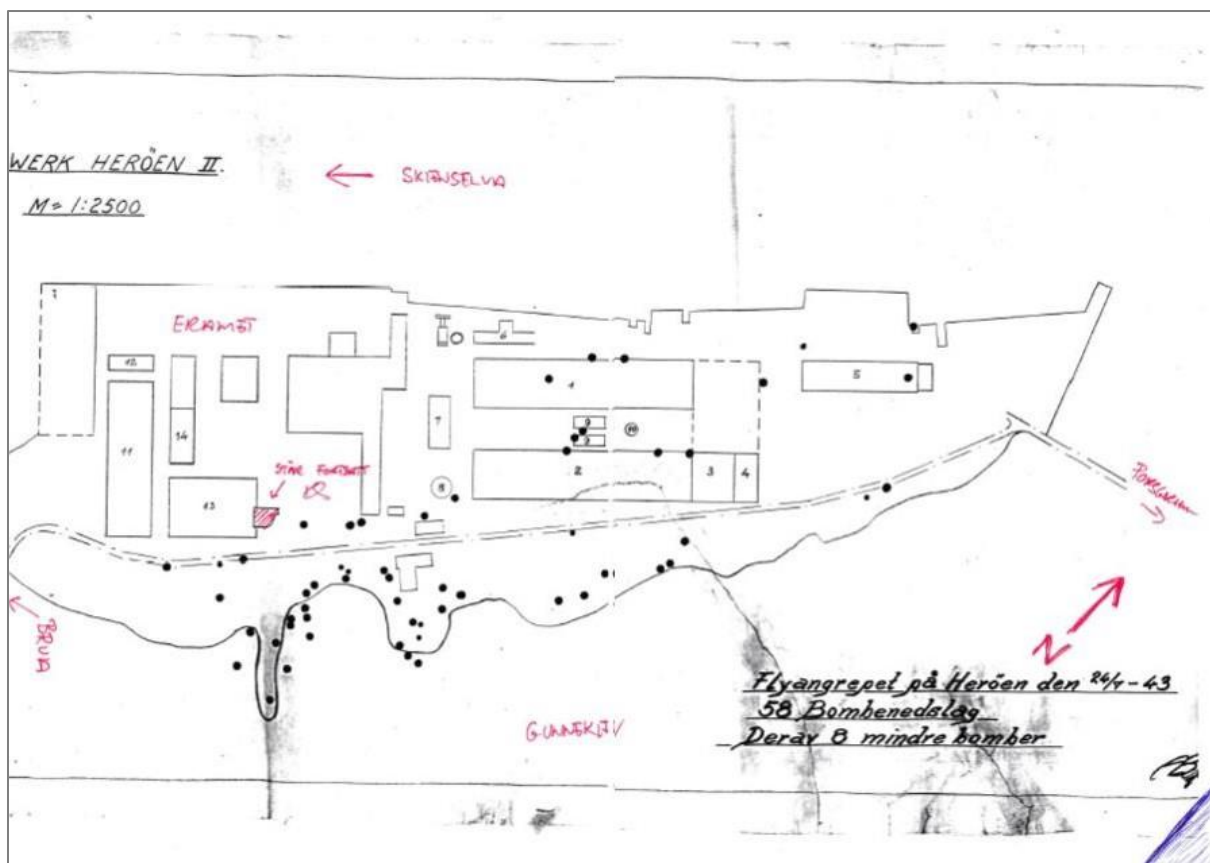


Figure 17: Map provided by HIP Eiendom A/S, showing a portion of the peninsula with recorded locations of bomb hits.

7.3 LANDSLIDE AT GUNNEKLEVFJORD

One specific consequence of the 24 July attack was a landslide on the southern shoreline of the Gunneklevfjord. During the attack, a number of bombs were dropped on the southern end of the fjord where homes had been constructed on clay. The impact of the bombings began to cause soil liquefaction, thus prompting a landslide of soil, house rubble, and possible UXOs into the fjord itself.

“50 bombs of 500 Lbs [sic] weight fell over an area of 50 000 sq. m, causing an artificial clay-slide, in its effect completely similar to a natural one... The houses were completely wasted by the disturbance in the ground... The movement of the ground principally took place during the raid, but a certain movement in the underground was also to be observed several weeks afterwards.”²⁵

Interpretation Report No. K-1629 issued by the USAAF, describing the damage of the bombing of 24 July, also includes a description of this landslide: “About 3 houses have been destroyed on the E. bank of Gunneklev Fjord. At the head of the Fjord and S.E. of Herøya Peninsula

²⁵ http://www.ngu.no/filearchive/NGUPublikasjoner/NGUUnr_167_Holmsen_26_28.pdf

several more houses were destroyed or damaged and a concentration of bombs caused a landslide of unconsolidated material. The greatest movement was more than 100' to the W. in the direction of the Fjord and involved about 10 acres."²⁶

The Eidanger Salpeterfabrik report also mentions the landslide at Gunnekevfjord, in the appendices listing damage and bomb craters in the area of Gunnekev: "*Terrenget er sunket ned langs fjellsiden ca 8 m.*"²⁷ In addition to this, in a sketch of the Gunnekevfjord included in the report, the cluster of bombs in the southeast is clearly depicted. There is also a hatched area with the note "*Utraset område*".²⁸

²⁶ USAAF Interpretation Report No. K-1629

²⁷ Rapport fra Eidanger Salpeterfabrik, pg 1 of appendices

²⁸ Rapport fra Eidanger Salpeterfabrik, Appendix 3

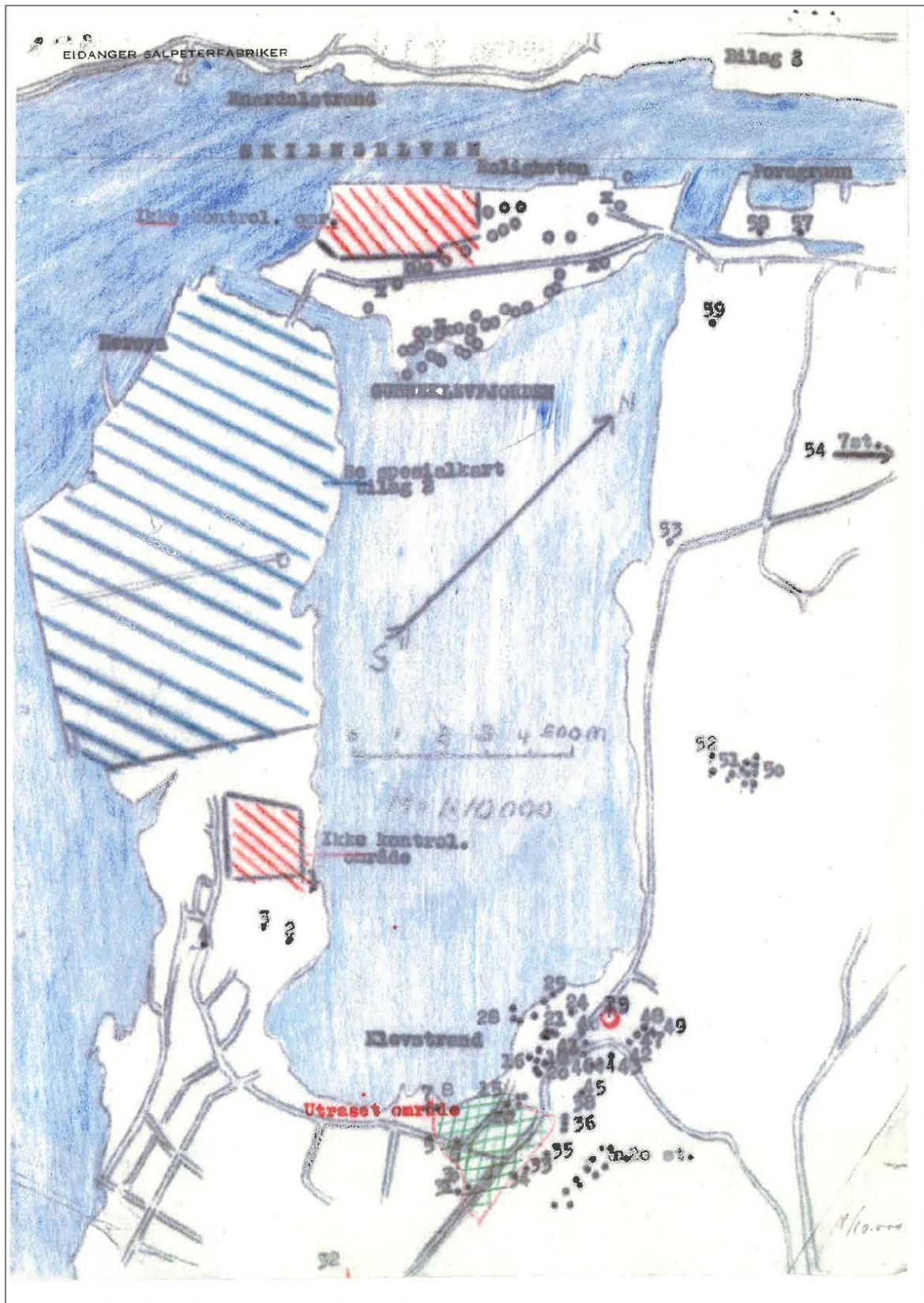


Figure 18: Sketch included in the report issued by Eidanger Salpeterfabrik. Note the hatched area in the south of the fjord, with the words "Utraset område". This was probably the location of the landslide. *Rapport fra Eidanger Salpeterfabrik*

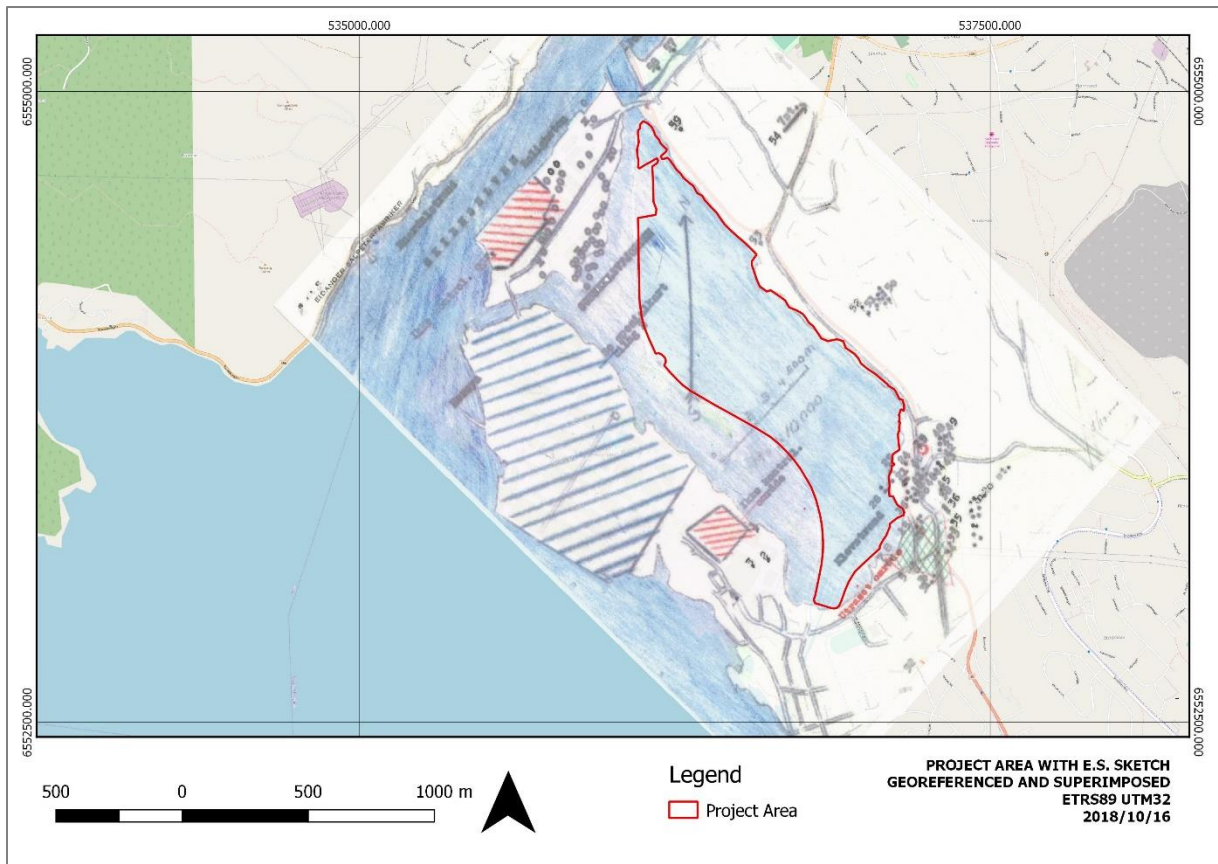


Figure 19: Sketch from Figure 18 georeferenced and superimposed over project area. (*ADEDE and Eidanger Salpeterfabrik*)

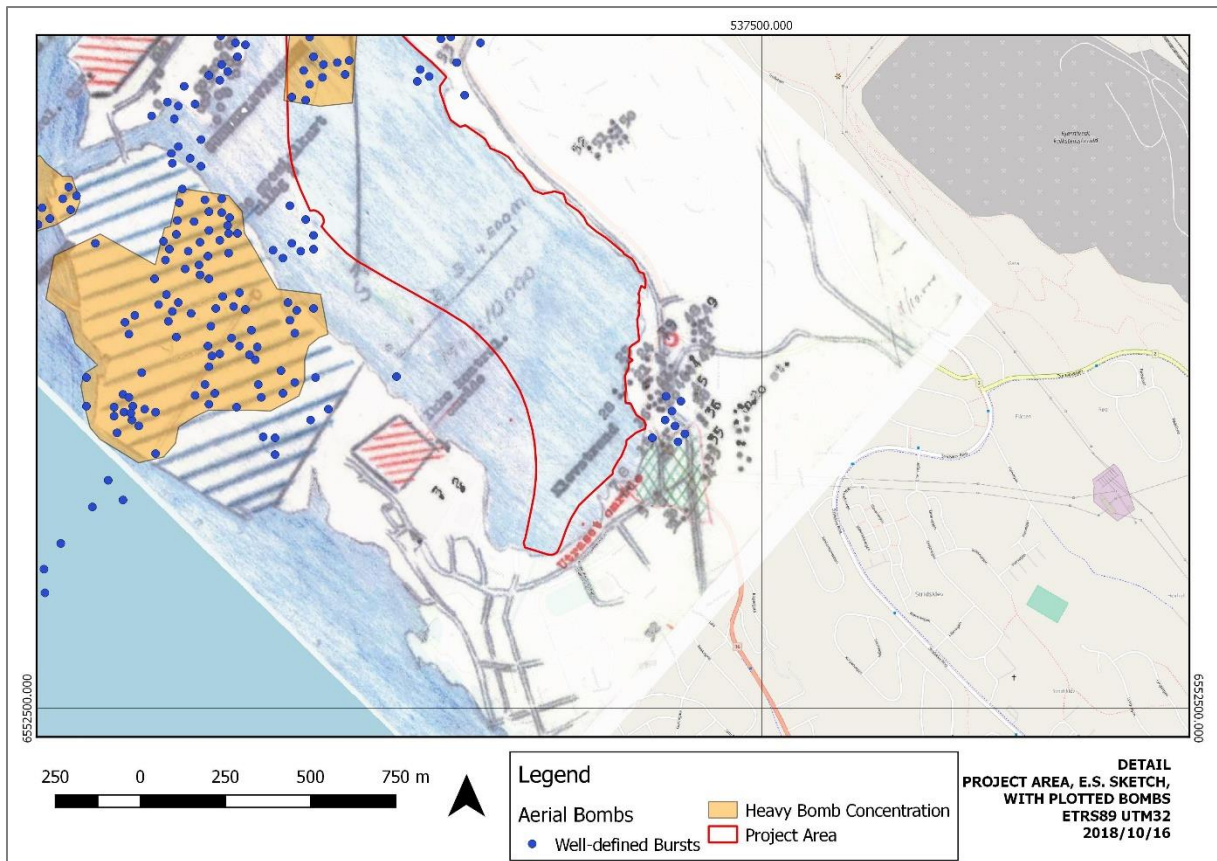


Figure 20: Detail of Figure 19, with the plotted bombs from the USAAF report superimposed.
(ADEDE, USAAF Interpretation Report, Eidanger Salpeterfabrik)

It can be concluded that there exists the possibility of UXO having ended up in the southern part of the Gunneklevfjord. More than one source refers to the considerable landslide, a landslide directly caused by the bombing of 24 July 1943. Since no methodical clearance of the Gunneklevfjord has yet been performed, the risk of encountering unexploded ordnance in the fjord is high.



Figure 21: Photo of Gunneklevfjord after the landslide (11 August 1943). Caption reads: "The lowermost area of the landslide at Gunneklevfjorden"²⁹

7.4 SUMMARY OF ATTACK

After the smoke cleared, it became apparent that the attack had been even more successful than the Allied forces had initially thought. By means of aerial photographs, the Allies saw that more bombs than expected had hit their intended targets. "... instead of 230 bombs bursting within the target area and 50 direct hits, actual figures proved on later investigation to be 580 bursting within the area and 151 direct hits."³⁰

The report issued by *Eidanger Salpeterfabriker* mentioned above included descriptions of bombs being dropped and the locations: "*Man må derfor ante at der anslagsvis er kastet 1000 a 1500 bomber.*"³¹ The reports issued by the USAAF state that no less than 1657 bombs were dropped on the target of Herøya.

In the original report from 1943 270 bomb craters were registered. On the Werk I map a total of 280 registered bomb craters appear. Bilag 22 described a total of 310 bomb craters from nearby and IVO the factory³². A total of 298 craters were registered, UXO has been found in crater number 150b, 167 and 193, 1 UXO was Blown in place (BIP) ivo Mast to cableway and there were suspected UXO craters at number 118b and 290. Bilag 22 furthermore described Bomb craters at Gunneklev and Porsgrunn with a total of 52 registered craters³³. In this area crater number 32 was suspected for UXO while number 29 was UXO. 7 more craters were lying more east which brings the total on 59 craters. On Werk II 58 bomb craters are registered.

²⁹ http://www.ngu.no/filearchive/NGUPublikasjoner/NGUnr_167_Holmsen_26_28.pdf

³⁰ <https://www.ibiblio.org/hyperwar/AAF/II/AAF-II-20.html>

³¹ Rapport fra Eidanger Salpeterfabrik, pg 61

³² Pg. 206-217

³³ Pg. 202-205

Those combined make up for 707 registered craters. This means that on a total of 1567 bombs that have been dropped, 950 have not been registered.

Target area	Reg craters	UXO	Suspect UXO
1657 bombs dropped			
ES	310	4*	2
NL (Werk I) **	280	UNK	UNK
NL (Werk II) **	58	UNK	UNK
Surrounding area	59	1	1
Total UXO		5	3
Total craters	707		

* 1 UXO ivo cableway mast was disposed of by controlled demolition

** UXO's not registered on Werk I & II

The destruction caused by the aerial attack was so complete that work at the plant was disrupted for 3.5 months and the Germans eventually abandoned the aluminium and magnesium plants (Nordisk Lettmetall).

8 ANTI-AIRCRAFT BATTERIES

Due to several sources referring to the presence of anti-aircraft batteries near the proposed project area, there exists a risk of encountering artillery UXO. Before the 24 July attack on Herøya, Germans had established anti-aircraft batteries in five different locations in the vicinity of the Gunneklevfjord³⁴: at Hydros Kasino and at Roligheten, both on the peninsula of Herøya; at Flakvarpåsen, Torsberg; at a football stadium in Tollnes, located north of Porsgrunn; and finally across the Frierfjord at Rafnesgård, Herre.³⁵

³⁴ <http://www.porsgrunn.folkebibl.no/bok/historie/Okkupasjonsaarene/01-01.html>

³⁵ HIP Eiendom A/S

The batteries at Hydros Kasino as well as on the northern end of Herøya peninsula at Roligheten boasted 8.8 cm cannons. The battery at Pors football stadium in Tollnes had four 8.8 cm cannons at Rafnesgård, Herre.

All five of these batteries were active during the 24 July attack. After the attack of Blitz Week, a number of these anti-aircraft cannons were relocated to other sites in Norway where the Germans had a greater need for them.

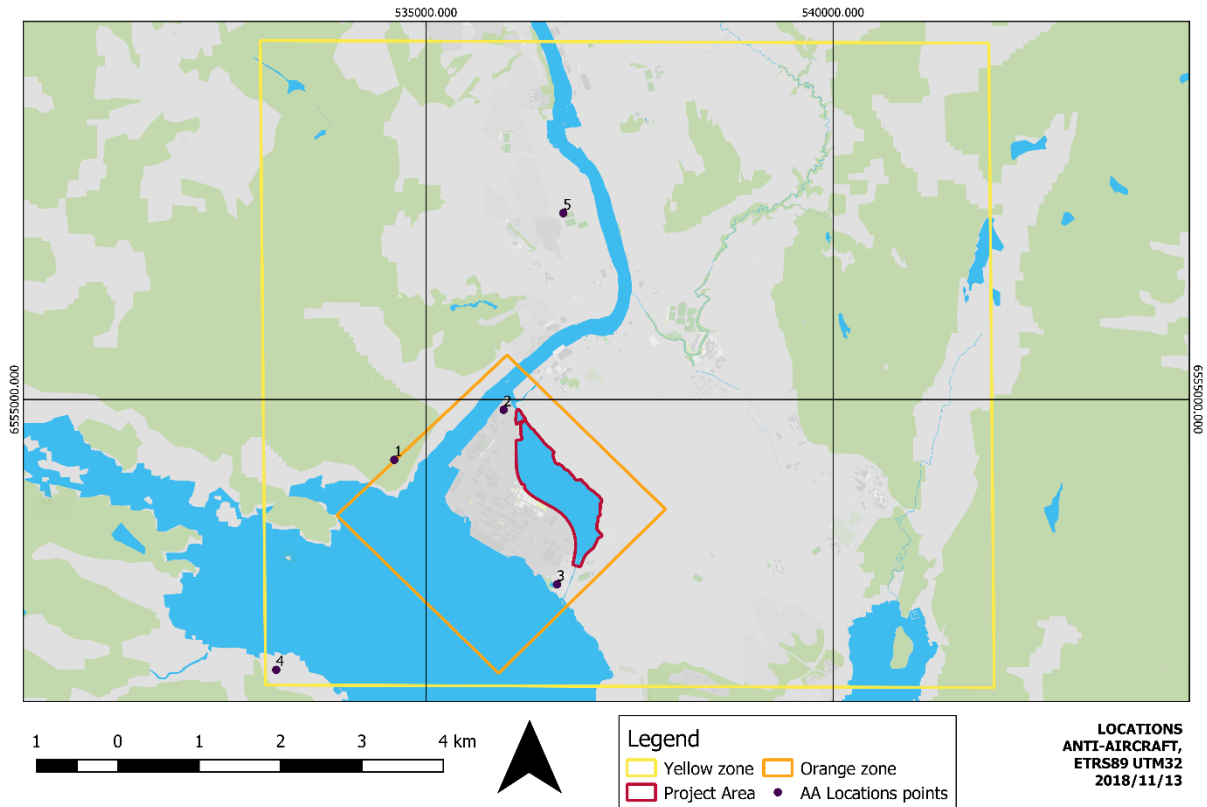


Figure 22: Locations of anti-aircraft artillery. 1: Torsberg, 2: Roligheten, 3: Hydro Kasino, 4: Herre, 5: Tollnes (*ADEDE and HP Eiendom A/S*)

As can be seen in Figure 22, three of the locations (1, 2, and 3) fall inside the orange zone, in the close vicinity of the project area of the Gunneklevfjord. The two locations at Herre and Tollnes are located within the yellow zone. While not adding to the risk analysis of the current project area, should any future works expand, these two anti-aircraft locations should certainly be taken into account. However, the anti-aircraft locations at Roligheten and at Hydro Kasino are located within 500 meters of the Gunneklevfjord.



Figure 23: Caption read: "German anti-aircraft, emplaced in the eastern area before the attack of 24/7/1943"³⁶

In Figure 23, a photograph shows German anti-aircraft artillery on the island of Herøya. In the background, one can see a building with distinct windows to the left, and towers or chimneys to the right.

The following source described the attack of 24 July, specifically mentioning anti-aircraft batteries: "The air raid alarm was sounded at Herøya at 1244 hours, some 20 minutes before the first bomb fell... It is believed that the first wave obliterated the Flak [sic] batteries; certainly none remained intact after the fact."³⁷ Another source lists out three specific locations of the anti-aircraft batteries listed above: "*I tiden før bombingene av Herøya den 24. juli 1943 hadde tyskerne satt opp luftvernartilleri på følgende steder: Ved Hydros Kasino på Herøya og på fabrikkområdet nordre ende mot Rolighetssundet.... De hadde også et batteri på Flakvarpåsene ved Torsberg i Solum for å beskytte transformatorstasjonen der. Alle disse*

³⁶ Norsk Industriarbeidermuseum

³⁷ USAAF Interpretation Report 1943

*batteriene var i aktivitet bombeangrepet på Herøya i juli 1943. Senere ble alt antiluftskytset trukket bort til andre steder, der tyskerne mente denne beskyttelsen trengtes bedre.*³⁸

There exists the possibility of encountering artillery UXO in the project area, especially in the vicinity of two of the historical locations of anti-aircraft artillery. Should the works expand from the Gunneklevfjord to the peninsula itself, the risk of encountering UXO would increase.

9 MENSTAD (PORSGRUNN HARBOUR AIR ATTACKS)

Sources refer to at least two specific air raids in the vicinity of the Gunneklevfjord in the spring of 1945. Near the end of WWII, Germany was evacuating Norway, and Porsgrunn, due to its location, was being used as a main port of departure. This made it a tempting target for raid by the Allies.

On Friday, March 30, 1945, aircraft armed with rockets attacked ships docked in the fjord located in Menstad, which was located just north of Porsgrunn³⁹. 44 Mosquitoes, along with Mustang escorts, created the strike force. This was a strafing attack, meaning low-flying aircraft attack ground targets using automatic weapons—in this case, rockets. One German vessel and four Norwegian vessels were successfully sunk, and “buildings in use by the Germans to store chemicals are also badly damaged.”⁴⁰ In the book ‘*Flyalarm: Luftkrigen over Norge 1939-1945*’, the ships are described as being hit by rocket after rocket: “*De fire skipene som lå ved Menstad ble truffet av det ene raketten etter den andre som slo seg gjennom skipssiden over og under vammilijnen.*”⁴¹ John McNab Milsom refers to the presence of anti-aircraft fire: “Porsgrunn Harbour, flack, three thousand [ton] ship was hit, and we lost a Mossy [Mosquito].”⁴²

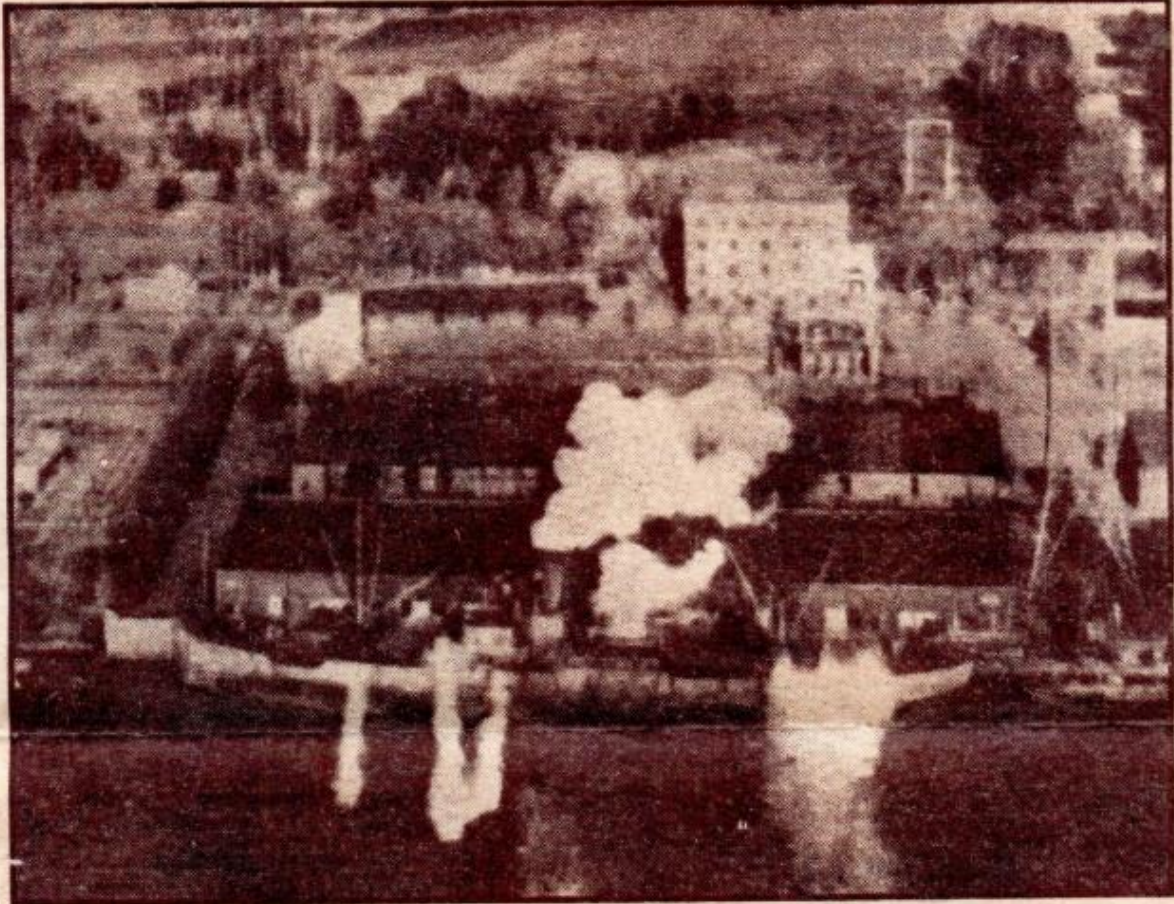
³⁸ <http://www.porsgrunn.folkebibl.no/bok/historie/Okkupasjonsaarene/04-03.html>

³⁹ Hafsten, B., Larsstuvold, U., Olsen, B., Stenersen, S.

⁴⁰ <http://www.robbiereid.co.uk/rhdiary.html>

⁴¹ Hafsten, B., Larsstuvold, U., Olsen, B., Stenersen, S.

⁴² <http://www.thememoryproject.com/stories/3402:john-mcnab-milsom/>



A force of Mosquitos of R.A.F. Coastal Command struck at enemy shipping in Porsgrunn Harbour, Norway, used by the Germans for evacuating troops to Germany. Four merchantmen were left well ablaze. The picture shows strikes on one of them.

Figure 24: Newspaper clipping about the raid on 30 March. Caption reads: "A force of Mosquitos of R.A.F. Coastal Command struck at enemy shipping in Porsgrunn [sic] Harbour, Norway, used by the Germans for evacuating troops to Germany. Four merchantmen were left well ablaze. The picture shows strikes on one of them."⁴³⁴⁴

⁴³ <http://themoryproject.com/stories/3402:john-mcnab-milsom/>. Note:

⁴⁴ Note: The attack was actually at Menstad



Figure 25: Smoking Mosquito 'T' as a hit on a factory at Porsgrunn on 30 March (IWM⁴⁵)

⁴⁵ Note: This is actually at Menstad

10 PORSGRUNN HARBOUR

A second raid occurred soon thereafter on 11 April 1945. The “Banff Strike Wing”, comprised of 4 squadrons (143rd, 235th, 248th, and 333rd), were also headed for ships docked in the fjord north of Porsgrunn and Herøya (much like the targets of the earlier attack). This was also a strafing attack. “*De fire skipene i Skienselven nord for Porsgrunn hadde sett fullastet ut, og ligget slik til at det ville være lett å angripe dem.*”⁴⁶ Three Norwegian freighters were sunk, as well as a German trading vessel. However, German forces returned fire, shooting down at least one bomber.⁴⁷



Figure 26: Caption of photo reads “*Porsgrunn 11. april, Banff Strike Wings siste store angrepstokt mot mål i Norge.*”⁴⁸

10.1 SUMMARY

While the targets for these strafing attacks were not located within Gunneklevfjord, it is important to note the distinct probability of encountering UXO in the river between Porsgrunn and Menstad. During these two attacks, a lot of ammunition, specifically rockets, were expended. “[The Mosquito FB.Mk VI was] fitted with eight 76.2-mm (3-in) rocket projectiles

⁴⁶ Hafsten, B., Larsstuvold, U., Olsen, B., Stenersen, S.

⁴⁷ <http://www.wlb-stuttgart.de/seekrieg/45-04.htm>

⁴⁸ Hafsten, B., Larsstuvold, U., Olsen, B., Stenersen, S.

under the wings. In addition to a nose armament of four 20-mm and four 7.7-mm (0.303-in) guns, the Mosquito FB.Mk VI could also carry a pair of short-finned 227-kg (500-lb) bombs in the rear of the bomb bay.”⁴⁹ With large ships being hit by “one rocket after another”⁵⁰, and a total of nine ships being successfully sunk (and three more crippled)⁵¹, this could mean potentially hundreds of kilos of UXO deposited in the river of Skien. While the location falls into the yellow zone described in the beginning of the report (see Chapter 5), and not specifically the project area, should the works ever expand into these rivers, the possibility of discovering UXO here remains high.

11 MINE-LAYING OPERATIONS NEAR PROJECT AREA

Throughout the Second World War, Allied forces carried out systematic and thorough mine-laying operations. Mine-laying is the dropping of mines from aircraft onto deliberate locations in water, such as strategic ports, harbours, shipping channels, etc. These mines were designed to sink to the seabed and were detonated via “non-contact magnetic detonation”. “The aircraft mine is cylindrical shaped [sic], approximately 17 inches in diameter and 9ft long including the wood or metal fairing. The weight averaged 1,500 lbs (680 kg) of which 750 lbs (340 kg) of explosive [sic] (Amatol or Minol).”⁵² This is relevant to the project area because there is one source that mentions Porsgrunn as a mine-laying target, and two more sources that indicate targets in the vicinity.

During WWII, many of the locations for mine-laying would have been along the Atlantic Coast, the North Sea, and the Baltic Sea. The Admiralty decided on the positions where mines were to be dropped, basing these decisions on several factors such as sea routes and enemy shipping practices. Areas where broad mine-laying was to occur were split into sections, each section labelled with its own codename. The codename for mine-laying in general was “gardening.” Following this theme, different geographical sections were named using flowers, fruits, and vegetables as codenames, such as Onions, Sweet Pea, Nectarines, etc. The codename for Porsgrunn was *Polyanthus VI* (see Figure 25). If Porsgrunn was assigned a mine-laying codename by the Allies, it would be safer to assume that mines could be expected in and near the project area.

The *Oslofjord* in Norway contained some of the most important ports (thus tempting targets for mine-laying), and these were connected via railway. The Skagerrak strait features deep waters, while “suitable mining grounds” are as close as possible to individual ports and strategic fjords. Due to the precision required, there existed the possibility for mines to be

⁴⁹ Bishop, C.

⁵⁰ Hafsten, B., Larsstuvold, U., Olsen, B., Stenersen, S.

⁵¹ Hafsten, B., Larsstuvold, U., Olsen, B., Stenersen, S.

⁵² <https://tailendcharlietedchurch.wordpress.com/operations/gardening-mine-laying/>

deposited off-target (in deeper water or even on land). Thus, if a minefield is known to have been in close proximity to the Gunneklevfjord, there exists the possibility that mines could be found within the project area. Certainly if the project area is expanded into the Frierfjord, then the possibility of coming across mines rises from possible to probable.

APPENDIX 3

CODE NAME	POSITION	AREA	FIRST MINED	AGENT
Anemones	Le Havre	5	11. 9. 40	Coastal
Juniper	Antwerp	4	14. 10. 40	Coastal
Scallops	Le Havre	5	8. 12. 40	Coastal
Vineleaf	Dieppe	5	9. 1. 41	Coastal
Nectarines	Frisian Islands	4	30. 3. 41	Coastal
Prawns	Calais	5	8. 4. 41	Bomber
Gorse	Quiberon Bay	6	13. 4. 41	Bomber
Greengages	Cherbourg	5	3. 5. 41	Coastal
Rosemary	Heligoland Bight	4	11. 6. 41	Bomber
Hawthorn	Jutland Coast	4	11. 6. 41	Bomber
Geranium	Swinemunde	1	29. 9. 41	Bomber
Willow	Sassnitz	1	20. 10. 41	Bomber
Privet	Danzig	1	1. 5. 42	Bomber
Trefoil	Netherlands Coast 52°38'N to 52°52'N	4	23. 7. 42	Bomber
Silverthorn	Kattegat	2	8. 8. 42	Bomber
Spinach	Gdynia	1	16. 8. 42	Bomber
Tangerine	Pillau	1	20. 8. 42	Bomber
Pollock	Bornholm I.	1	20. 8. 42	Bomber
Elderberry	Bayonne	6	18. 9. 42	Bomber
Turbot	Ostende	5	8. 10. 42	Coastal
Furze	St. Jean de Luz	6	16. 10. 42	Bomber
Hyacinth	St. Malo	5	3. 2. 44	Bomber
Upas Tree	Morlaix	5	3. 2. 44	Bomber
Sultana I	Chenal du Four	6	23. 3. 44	Bomber
Sultana II	Passage de Fromvoer	6	3. 5. 44	Bomber
Cypress II	Gravelines to Dunkirk	5	28. 5. 44	Bomber
Iris II	W. Scheldt	4	30. 5. 44	Bomber
Iris V	Hook of Holland	4	31. 5. 44	Bomber
Hostile Air	Guernsey	5	18. 6. 44	Bomber
Hostile Ozone	Alderney	5	23. 6. 44	Bomber
Onions II	Drams Fjord	3	28. 10. 44	Bomber
Onions III	Moss	3	11. 11. 44	Bomber
Onions IV	Horten	3	11. 11. 44	Bomber
Polyanthus VI	Porsgrund	3	28. 12. 44	Bomber
Polyanthus VII	Sandefjord	3	28. 12. 44	Bomber
Polyanthus IV	Arendal	3	25. 2. 45	Bomber
Polyanthus V	Tromsøund	3	25. 2. 45	Bomber
Polyanthus VI A	Laurvik	3	25. 2. 45	Bomber
Polyanthus I	Kristiansand (S)	3	2. 3. 45	Bomber

Figure 27: The National Archives, assigned codenames for mine-laying targets in WWII (*The National Archives*)

In the National Archives, in the Bomber Command logs of Night Operations of WWII, there are three instances of mine-laying operations which are relevant to our project area. Those are:

-An operation on the night of 28/29 December 1944. The targets listed in the National Archives were Kattegat, Oslo, and “Skagerrak.”⁵³

-An operation on the night of 31 December 1944/1 January 1945. The targets listed for this mission were Kattegat, Frederikstad, and “Skagerrak.”⁵⁴

-An operation on the night of 24/25 February 1945. The targets listed for this mission were Kattegat, Oslo, Porsgrund (an old name for Porsgrunn), and Sandefjord.⁵⁵

The first two listed missions, while they do not list Porsgrunn, the Frierfjord, or the Gunneklevfjord specifically, have targets close enough to the project area that they merit mention. A risk analysis for the prospect of mines must include any possibility of mines. As mentioned above, there existed the possibility for mines to be deposited off-target.

The first mission, on night of 28/29 December 1944, seven Halifax aircraft successfully “mined” the Skagerak (spelled “Skagerrak” in the Archives). The Skagerak is the large body of water south of Norway. Each Halifax would have boasted four A-MK VII mines, for a total of 28 mines.⁵⁶ There exists the possibility, however low, that any number of these mines could have ended up in the Frierfjord. The second mission, which took place on the night of 31 December 1944/1 January 1945, also listed Skagerak as a target. This time there were eight Halifax aircraft, each carrying the same four A-MK VII mines. This comes to a total of 32 mines for the second mission.⁵⁷

The third mission, listing “Porsgrund” as a target, is especially pertinent. The Archives show that on the night of 24/25 February, 1945, 10 Lancasters were dispatched to lay mines at “Porsgrund” and Sandefjord, and two of these aircraft aborted, leaving eight to carry out the mission (see Figure 32). Each of these aircraft were able to carry six ground mines (A Mk I-IV and A Mk VI). A total of 48 mines were laid on the mission. What amount of mines were laid in Porsgrunn vs. Sandefjord is not mentioned. However, in the name of safety, there exists the possibility that all 48 mines were laid in the vicinity of Porsgrunn.

⁵³ The National Archives: AIR 24/209

⁵⁴ The National Archives: AIR 24/209

⁵⁵ The National Archives: AIR 24/209

⁵⁶ The National Archives: AIR 24/209

⁵⁷ The National Archives: AIR 24/209



Figure 28: Aerial mines being loaded.⁵⁸

⁵⁸ <https://www.lancaster-ed559.co.uk/raf-gardening-operations-during-the-second-world-war.html>

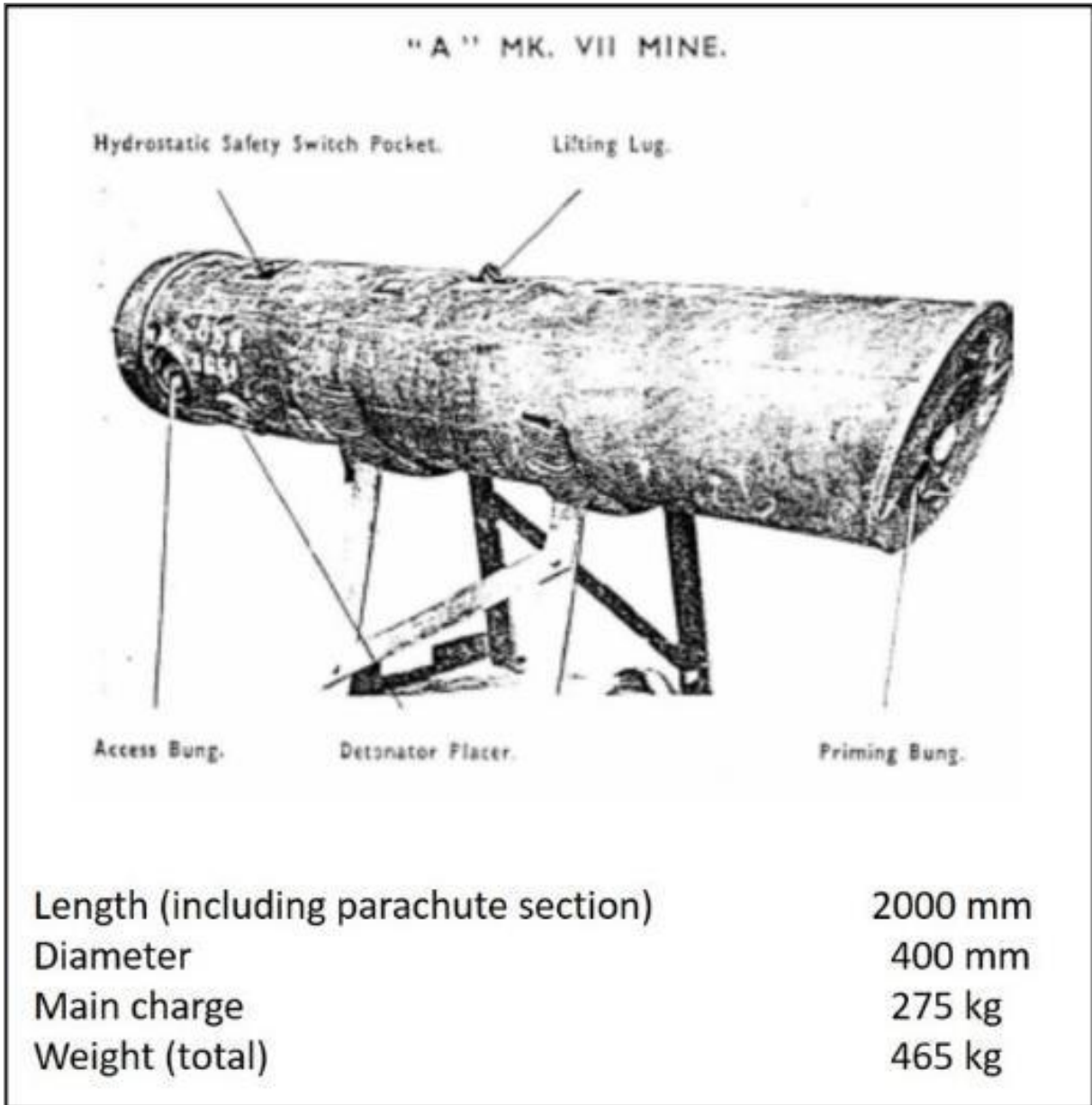


Figure 29: A Mk VII mine⁵⁹

⁵⁹ ww2images

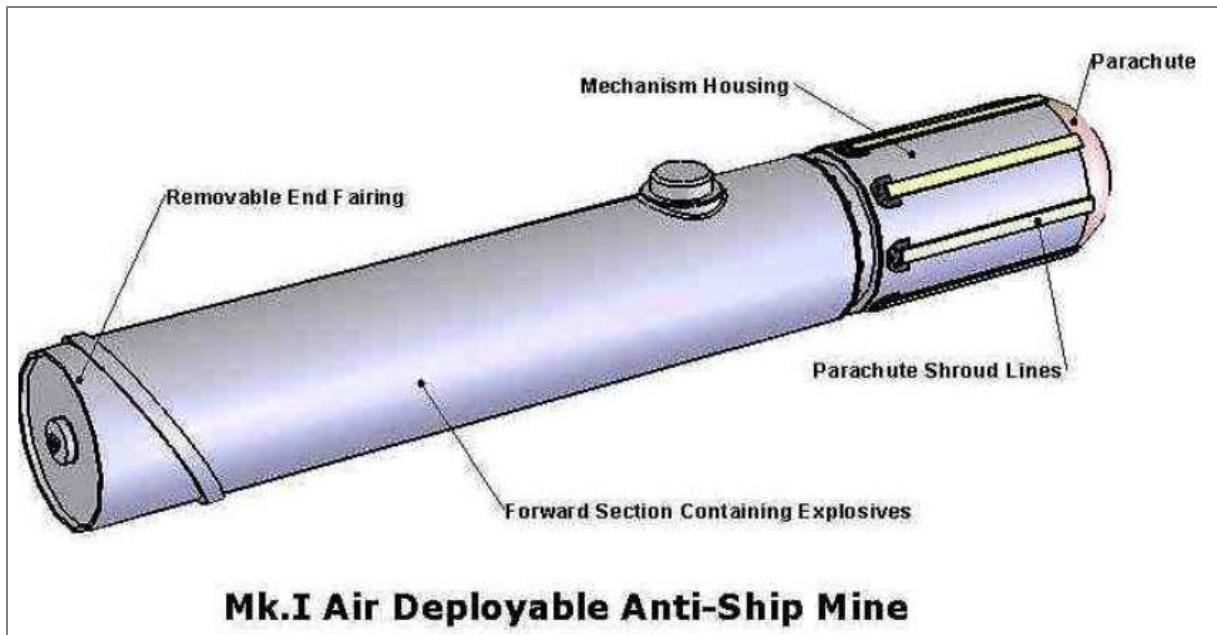


Figure 30: MK I Air-Deployable Anti-ship mine⁶⁰



Figure 31: Loading mines into aircraft⁶¹

⁶⁰ ww2images
⁶¹ ww2images

Target	Group	A/C Desp.	Type of A/C	Succ. A (including missing)	Succ. B
<u>MIDDLAYING</u>					
Kattegat	1	10	Lancasters	9	
Oslo	3	6	Lancasters	4	
Oslo	5	9	Lancasters	9	
Forsgrund } Sandefjord }	6	10	Lancasters	8	
TOTAL		35		30	

Figure 32: Excerpt from The National Archives, AIR 24/209 (*The National Archives*)

12 POST-WWII HERØYA

Herøya Industripark has reported several instances of discovered UXO in the meantime since the Second World War:

- On the 4th of January 2013 parts of a (detonated) bomb were discovered when digging at “crossroad C/20” (see Figures 33, 34 and 35). This confirms that the position of “crater 103”, as described in the report released by *Eidanger Salpeterfabriker* is fairly accurate.
- On the 25th of July, 1943, German AA projectile splints were recovered from a beach (Figure 35).
- On the 14th of September 1982 an Impeller from the fuse of a US bomb was found.
- In 1982/83, the industrial park reported the discovery of parts of US 500 lb bomb, as well as splints. These were found in a storage at Herøya during a clean-up.

These findings only emphasise the fact that there is a high risk for UXO in the close vicinity of the proposed project area.

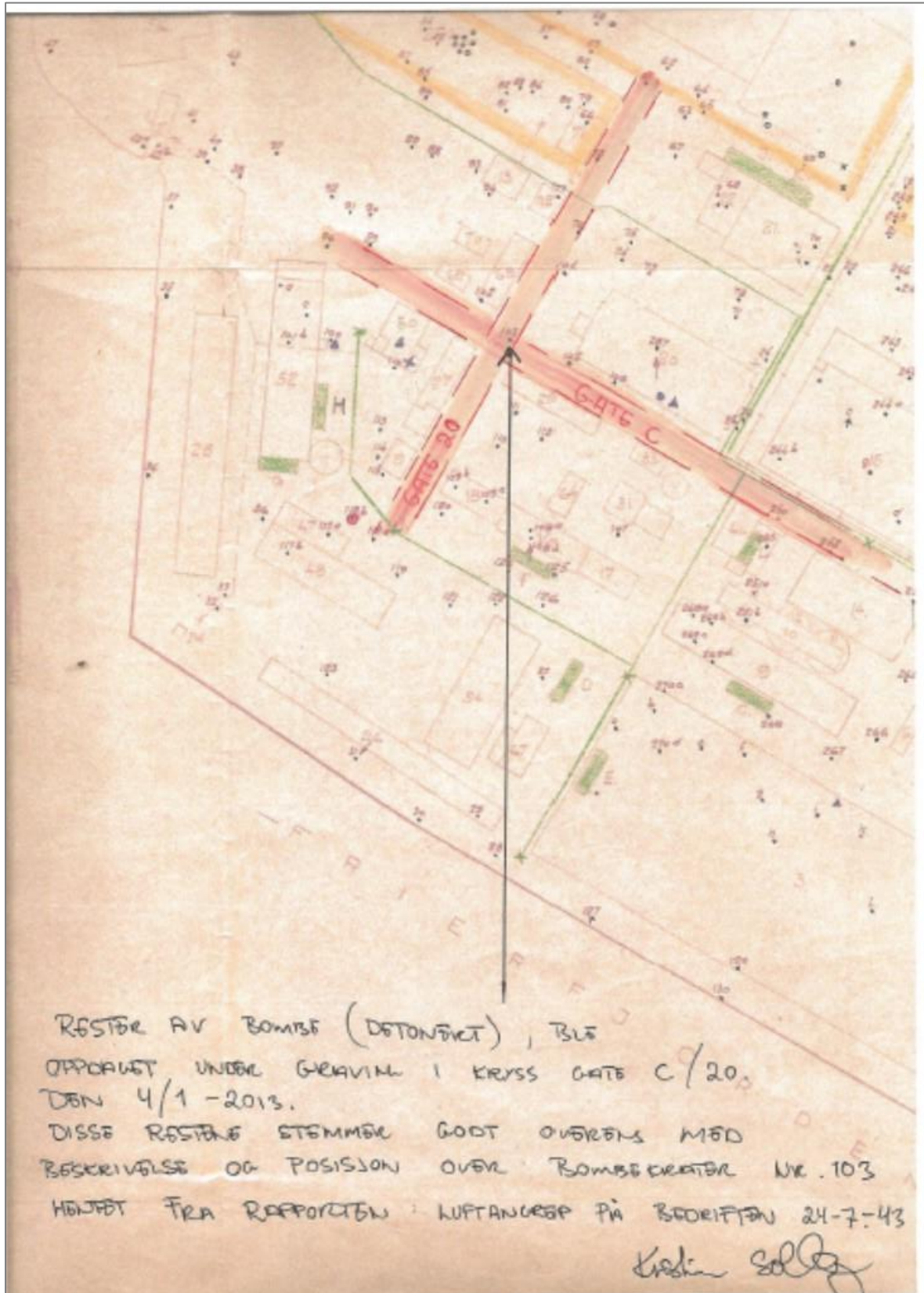


Figure 33: Appendix to report from Eidanger Salpeterfabriker, describing the location of discovered UXO after the 24 July attack⁶²

⁶² HIP Eiendom A/S



Figure 34: Photo of a detonated bomb recovered at Herøya. The bomb resembles a US M43 500lb bomb.⁶³

⁶³ HIP Eiendom A/S



Figure 35: Report of bomb discovered on the 4th January 2013⁶⁴

⁶⁴ HIP Eiendom A/S

Bombesplint fra 24/7 - 43

Sagen nr. 1913	Sag nr. 21	Føl. gnr. 111
		Sodafabrikken i Næstved
Påse og Bombesplint, FT Museum		

Ren. nr. 291
1-5

Kort beskrivelse af gjenstandene

1. Diameterfor ca. 6 x 11 x 3 cm = ca. 2100 cm³
Vægt: ca. 1,6 kg.
Splinten ble fundet ved opgravning efter bombingen 24/7 - 43; Kærtofer, bag 111. Den stammer fra en 500 lb. bombe.
2. Stor bombesplint mærket: Bombesplint fra luftangrebet 26.7.1943. Fundet under anlægsarbejde på logarhus 1-1966. Vægt ca. 45 kg
3. Liten bombesplint fra bombe som ble fundet i Sodafabrikken 12.11.1974, deltaget 13.11.1974 på Kærtofer (ca. 1970-1975)

9/583

Dette bør gøres med gjenstanden:

4. Gennemskåret fra tysk luftværnsbatteri på Tårn: Splinter ble fundet på Tårn, Berørten, Stuen på Hydrostaten (ved Tårn) dagen efter bombingen - splinterens diameter ca. 10 x 7 x 2 cm, vægt ca. 1 kg. Kræfter ca. 10 cm

Bemærkning:

5. Propel fra amerikansk bombe for udløsning af stribing. Fundet på Heega eller bombingen 24 juli 1943

11.9.82.50

Figure 36: Report describing the discovery of bomb splints the day after the attack on 24 July.⁶⁵

⁶⁵ HIP Eiendom A/S

13 CONCLUSION

In order to be able to compare the chances of finding the several sorts of UXO discussed in this research, a classification from *Very Low* to *Very High* is used:

Risk	Definition
Very Low	No indications of the use of this munition in the wide area of the project site were found.
Low	This type of munition can only sporadically have ended up in or around the project area.
Low Average	Uncommonly used munition / possibly ended up in the project area.
Average	Commonly used munition / possibly ended up in the project area.
High Average	Very commonly used munition / probably ended up in the project area.
High	Munition which has – with certainty – ended up in the project area, and is possibly still present.
Very High	Munition which is – with certainty – still present in the project area.

Table 03. Risk matrix (ADEDE).

These classifications are also taken into consideration when formulating recommendations. Commonly, a very low score will result in a written ‘free of explosives’ certificate. When only low scores are attributed, additional security measures will also be discouraged. A classification between Low Average and High Average will in most cases result in a more differentiated classification, while a High or Very High risk will result in a clear recommendation for additional measures. In a Risk Analysis for UXO, the ammunition is divided into six categories: Aerial bombs, artillery, mines, torpedoes, depth charges, and grenades/small arms ammunition.

13.1 AERIAL BOMBS

Very High RA in north of project area as well as one small area in south, High RA over rest of project area

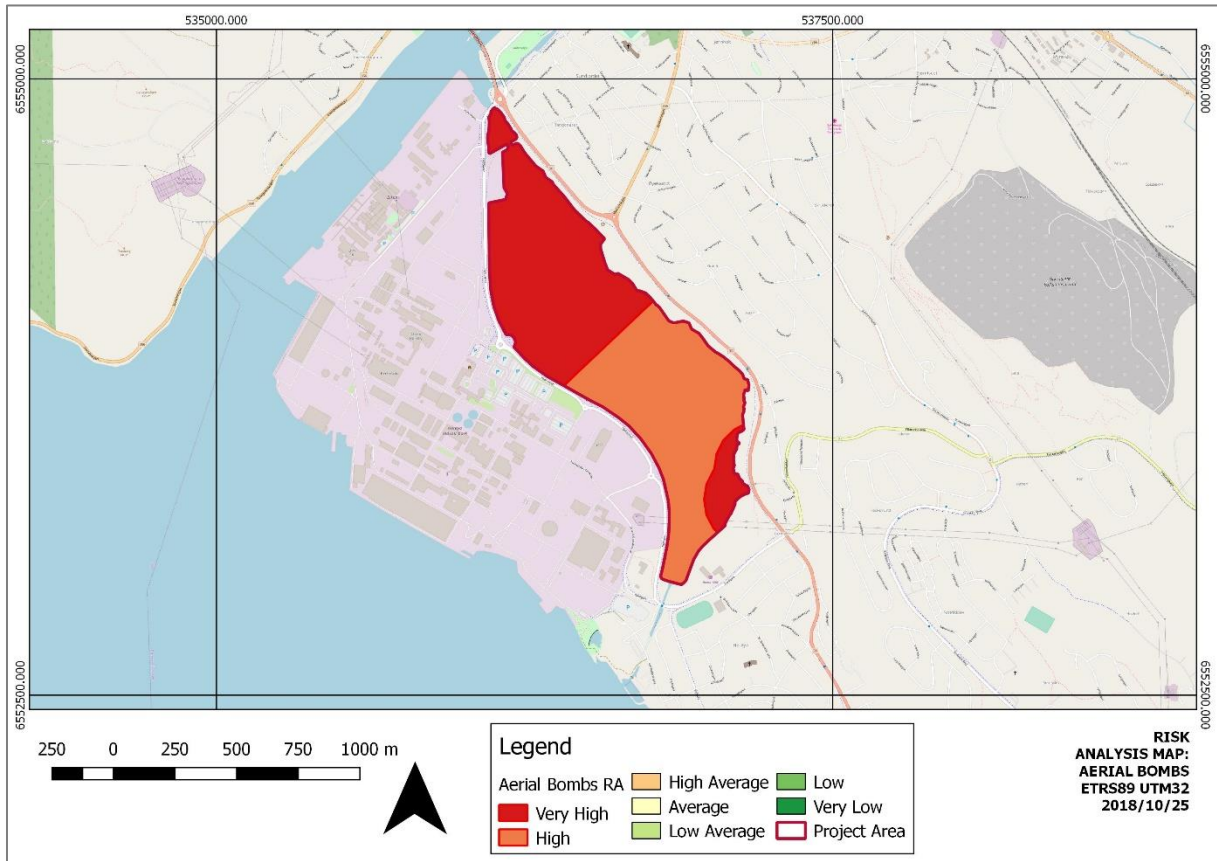


Figure 37: Risk Analysis map showing risk attribution for aerial bombs in the project area (ADEDE)

There are several references and sources with detailed descriptions of aerial bombings on or in the vicinity of the project area during the Second World War. The attack on 24 July alone, as stated in the interpretation reports from the USAAF, accounted for 1657 X 500GP of explosive tonnage.⁶⁶ The report issued by *Eidanger Salpeterfabriker* gives an estimate of between 1000 and 1500 aerial bombs dropped.⁶⁷ This number can be assumed to be too low, as the report used lists of reported bomb craters to achieve estimates: locating bomb craters in water can only be done on impact or in very shallow water. Also to be taken into account is the landslide which occurred in the southern part of the Gunneklevfjord, possibility depositing UXO directly into the proposed project area.

⁶⁶ <http://www.americanairmuseum.com/mission/1694>

⁶⁷ Rapport fra Eidanger Salpeterfabrik, pg 61

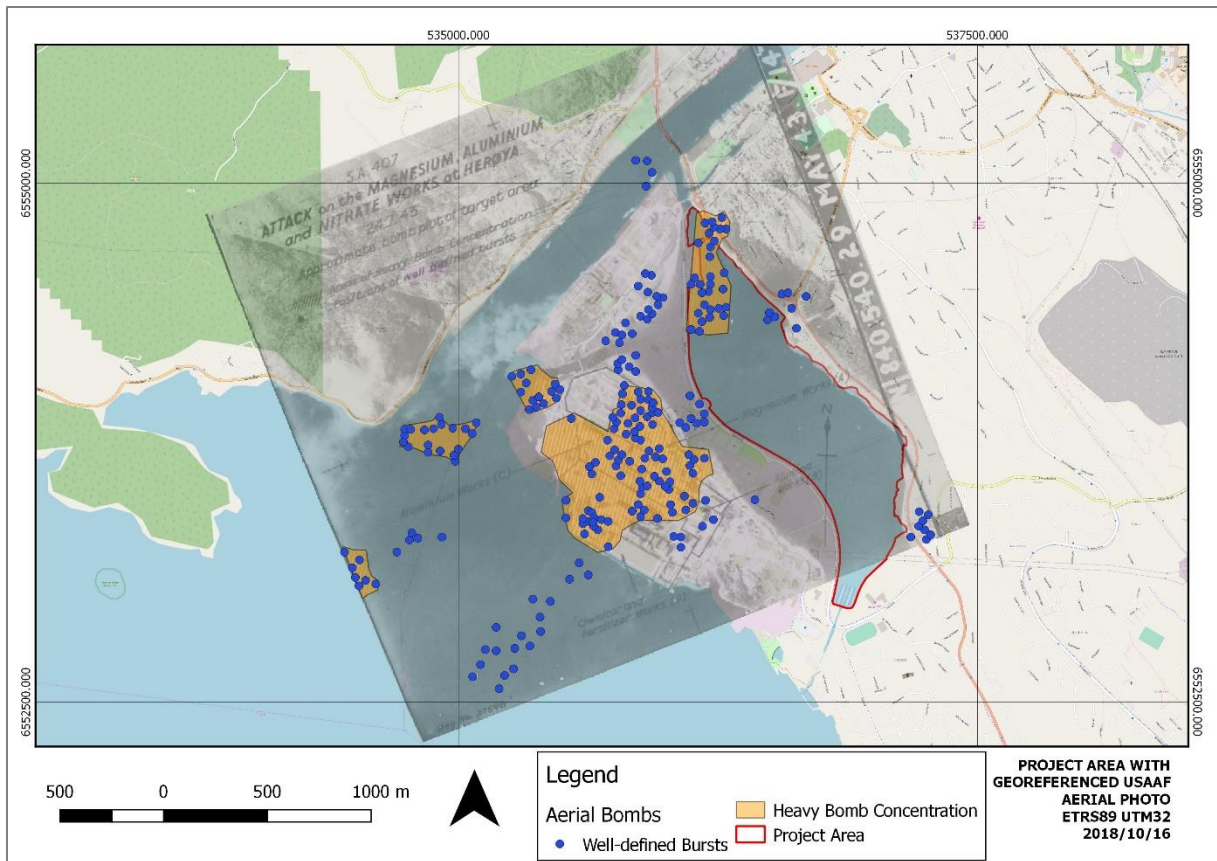


Figure 38: Georeferenced aerial photo of plotted bomb bursts and concentrations. USAAF and ADEDE

Due to the very high likelihood of encountering unexploded aerial bombs, the project area of the Gunneklevfjord was split into three separate risk zones: Very High risk was attributed to the northern part of the body of water; Very High risk was also attributed to a smaller area in the south, in proximity to the recorded landslide; and a High risk attribution was assigned to the rest of the project area.

13.2 ARTILLERY

High RA within buffer areas of 500m from former anti-aircraft locations, High Average RA within buffer areas of 1000m from former anti-aircraft locations, and Average RA over rest of project area.

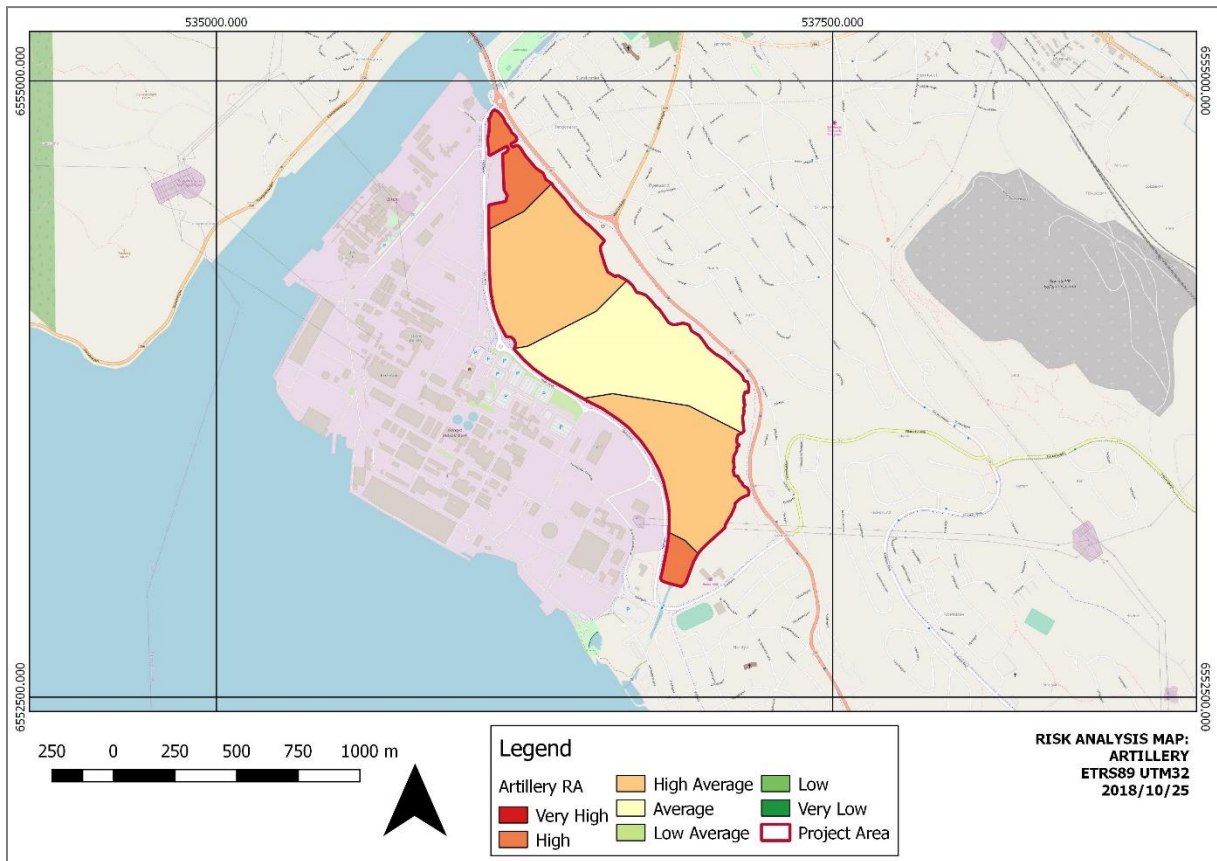


Figure 39: Risk Analysis map showing risk attribution for artillery in the project area (ADEDE)

Before the 24 July attack on Herøya, Germans built anti-aircraft batteries in five different locations in the vicinity of the Gunneklevfjord⁶⁸, two of which were located on the Herøya peninsula, one at Hydros Kasino and one at Roligheten. Buffers of 500m and 1000m were created around these two locations, and parts of these areas fall within the project area of the Gunneklevfjord. Different levels of risk attributions were assigned to these buffer areas.

The buffer of 500m from the anti-aircraft locations was given a risk attribution of High, while the larger buffer of 1000m was given a risk attribution of High Average. The part of the project area which the buffers did not cover was given a risk attribution of Average.

⁶⁸ <http://www.porsgrunn.folkebibl.no/bok/historie/Okkupasjonsaarene/01-01.html>

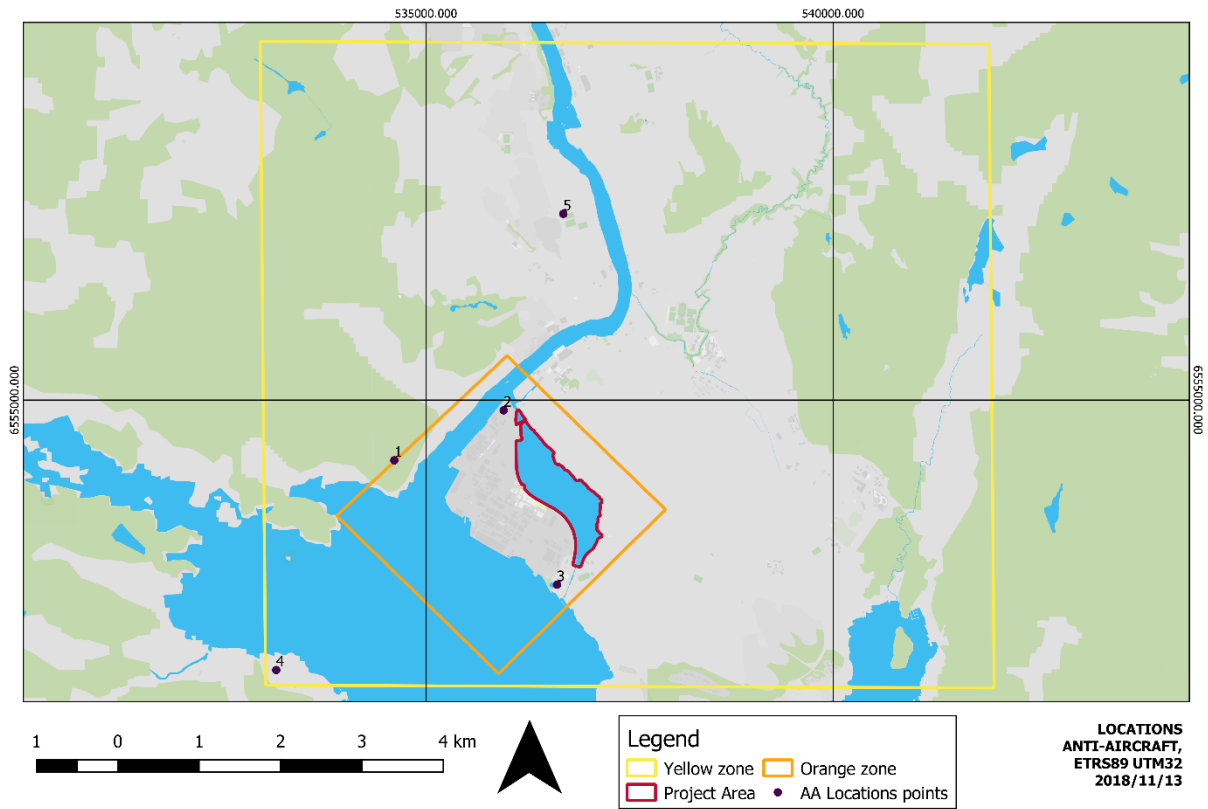


Figure 40: Locations of anti-aircraft artillery. 1: Torsberg, 2: Roligheten, 3: Hydro Kasino, 4: Herre, 5: Tollnes (ADEDE and HP Eiendom A/S)

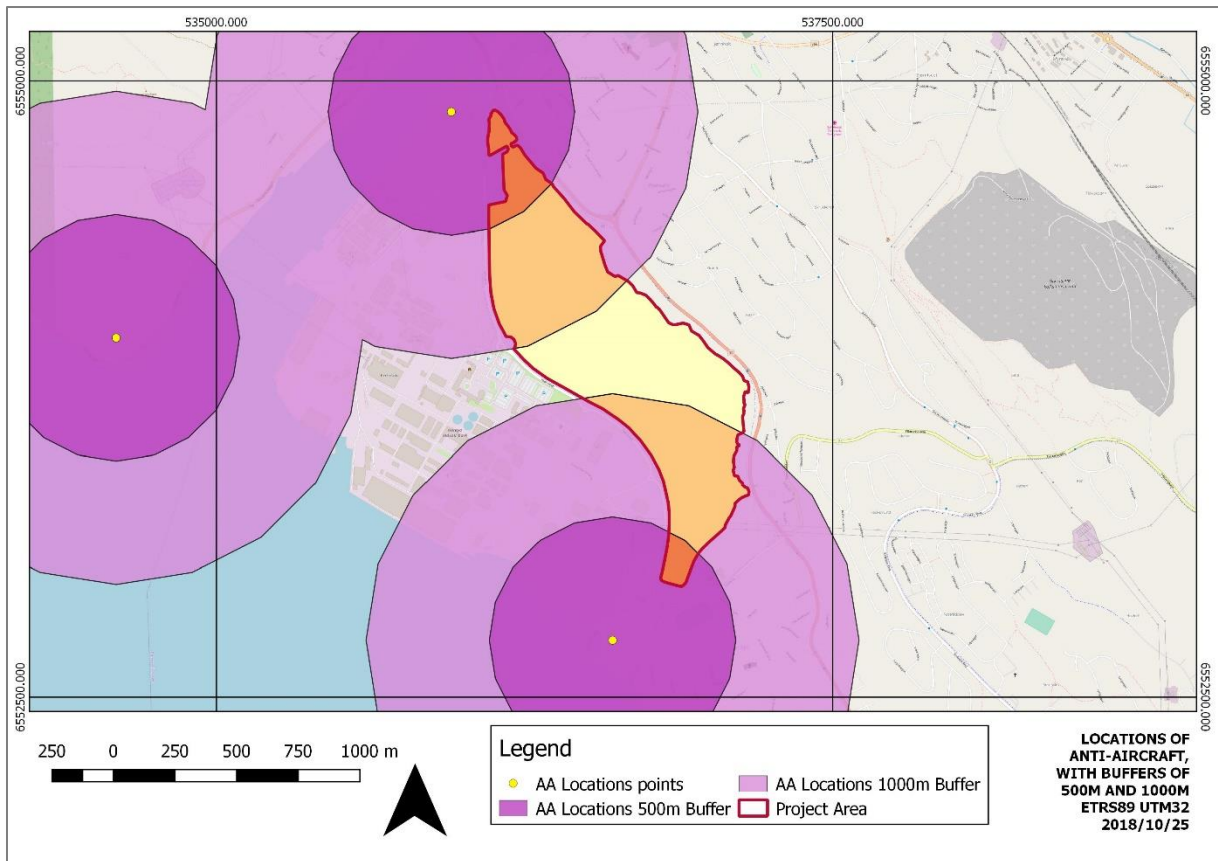


Figure 41: Map showing anti-aircraft locations with buffers of 500m and 1000m. (ADEDE)

13.3 MINES

High RA over project area

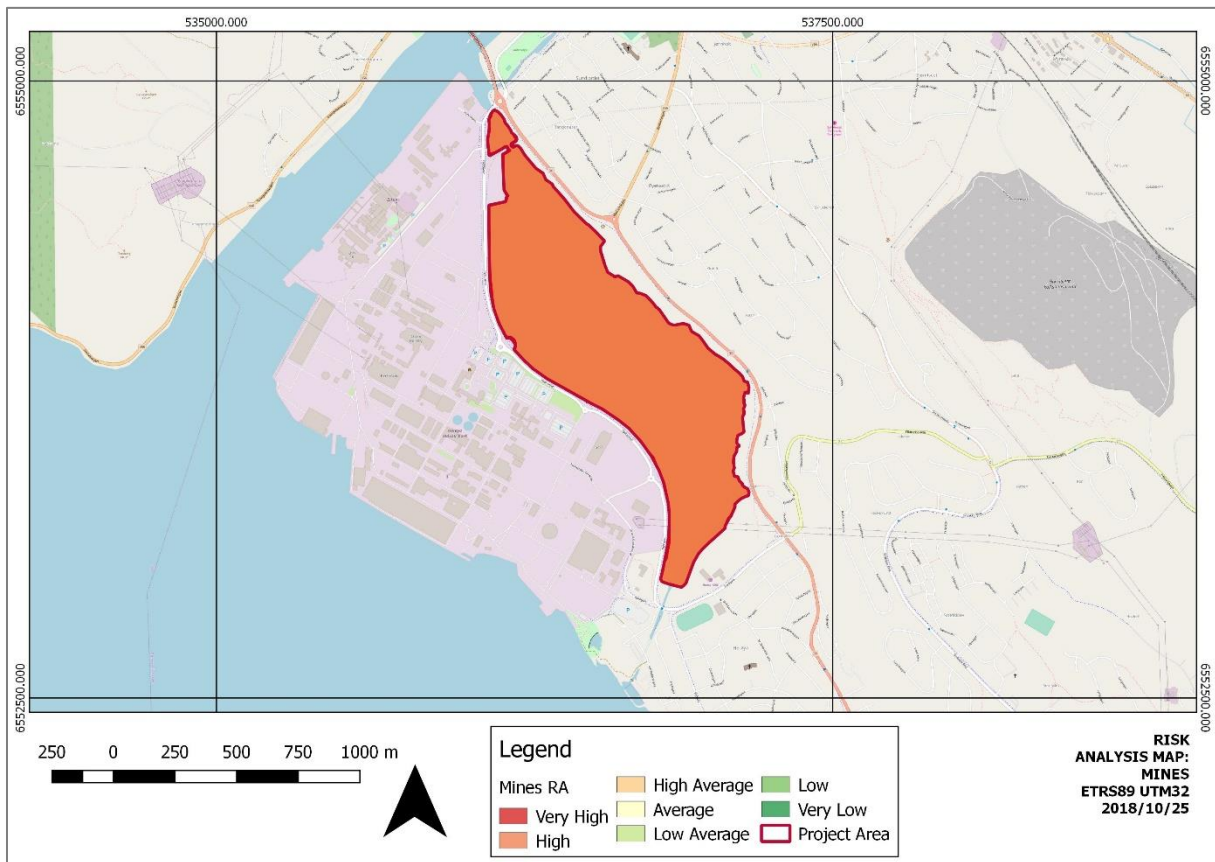


Figure 42: Risk Analysis map showing risk attribution for mines in the project area (ADEDE)

Not only was Porsgrunn assigned a unique target codename (Polyanthus VI) for identification in the Allies' "gardening" operations, but three logged missions of minelaying in the vicinity are relevant to the project area.

One mission specifically targeted "Porsgrund" and Sandefjord, on the night of 24/25 February, 1945. Eight Lancasters carried out the mission. Each of these aircraft were able to carry six ground mines (A Mk I-IV and A Mk VI). A total of 48 mines were laid on the mission, and because the exact portion of these 48 mines laid in Porsgrunn vs. Sandefjord is not specified, there exists the possibility that all 48 mines were laid in the vicinity of Porsgrunn.

In addition, while the other two relevant missions did not target Porsgrunn specifically, the targets were close in proximity to our project area, and there existed the possibility for mines to be deposited off-target (namely, perhaps within the project area). Thus the number of mines in the project area could possibly be higher than 48.

Therefore, the entirety of the project area of the Gunneklevfjord has been assigned a High risk attribution.

13.4 TORPEDOES

Not Applicable.

No risk attribution was assigned to this type of ammunition, because after historical research was conducted, no evidence was found to suspect the presence of torpedoes in the proposed project area.

13.5 DEPTH CHARGES

Not Applicable

No risk attribution was assigned to this type of ammunition, because after historical research was conducted, no evidence was found to suspect the presence of depth charges in the proposed project area.

13.6 GRENADES AND SMALL ARMS AMMUNITION

Not Applicable

No risk attribution was assigned to this type of ammunition, because after historical research was conducted, no evidence was found to suspect the presence of grenades nor small arms ammunition in the proposed project area.

14 RECOMMENDATIONS

Based on the historical evidence, it is highly recommended to take further safety steps in order to secure any works in the proposed project area of the Gunneklevfjord. There exists the possibility of unexploded ordnance within the proposed project area, both on land as well as on the seafloor, and, when detected, they should be safely removed.

It is generally known that an average of about 5-10% of used ordnance does not explode on impact. These can still be found and pose a real threat today. Shortly after the war some of these remaining unexploded items were removed by de-miners on the peninsula of Herøya.

Some were also excavated during ground works. It has already been documented that UXO has been discovered on the peninsula of *Herøya Industripark* in the meantime since the Second World War. However, removal of ordnance in the project area of the Gunneklevfjord (namely, the seabed) has neither been systematically attempted nor documented.

As a consequence, no works should be performed before the risk areas have been declared free of explosives. The risk of encountering UXO in the project area and in the immediate vicinity is high, thus further detection and safety measures are absolutely necessary before the works can begin.

ADEDE recommends and offers to execute a Project Risk Assessment (PRA), in combination with an inventory of tested detection techniques. This is a practical assessment which evaluates the specific risks of UXO within the project area, taking into account all of the planned future works and the impact of these works. Using this information, ADEDE recommends the testing of different detection methods on-site, in order to determine which method would be best employed. After establishing which technique should be utilised where, the client is provided with a map of the project area, divided into risk zones, describing which detection methods are advised and what safety measures are recommended.

The PRA comprises several components, including determining location-specific conditions, analysis of future works and impact, the identification of influencing factors, and an assessment of the possible risks. First, conditions of the site such as vulnerable infrastructure, soil contamination, relevant post-war developments, and other environmental factors are considered. Then the specific future works and their impact(s) are mapped out (ex: probing, excavating, dredging, demolition work, etc.). Evaluating these works as they relate to the environs, a report of influence and/or hazard factors can be identified. The risk assessment must also evaluate the specific UXO suspected on-site and determine possible risk factors.

This comprehensive assessment is then used to determine applicable detection techniques. Detection techniques (such as magnetometry, metal detecting, layer-wise excavation, or ground-penetrating RADAR) are tested on-site. Depending on what type of UXO is suspected and what the future works will be, different equipment and techniques are tested in different areas. All of the factors assessed in the PRA affect which technique and method is best employed, and in which area. The situation on-site might call for a combination of two or more detection techniques. Without testing the equipment on the site itself, it would be impossible to determine which method is most suited for effectively and comprehensively detecting UXO in the project area.

The PRA together with the detection tests are then evaluated to create a map of the proposed project area, divided into different risk zones. Risk zones take into account location-specific conditions, planned works, and the result of the equipment testing. Advice is given as to what method and technique would be best suited for each risk zone in the project area.

This combination of applied analysis with on-site testing provides the client with specific, project-based solutions to safely carry out the future works.

15 SOURCES

15.1 ARCHIVAL SOURCES

The Archives at HIP Eiendom

Report issued by *Eidanger Salpeterfabriker*

“Rapport fra Eidanger Salpeterfabriker: Luftangrep på Bedriften 24-7-43”

- Bomb pieces found at intersection C/20 4/1-2013
 - E-post 2003-01-11 fra Arne Sandvik Geotek AS Posisjon av bomberester funnet v B69
 - Excerpt from report on ammunition components found at Herøya
- Piece of shrapnel from a 500 lbs bomb found in building 111
- Large piece of shrapnel found in store I – 1966. Weight 45 kg
- Small piece of shrapnel found at Soldatfabrikken, detonated at Kjørholt, 13.11.1974

Date of report 9/5-83

- Excerpt from report on ammunition components found at Herøya
- Shrapnel from German FLAK found at Hydrostranda 25.7.1943
- Impeller from US bomb fuse found at Herøya 24.7.1943

Date of report 14/9-82

The National Archives: Administrative and Operations Branches

- Mission No. 75: Herøya, magnesium, aluminium and nitrate works; Bergen, port area and Trondheim, U-boat workshops and harbour installations, 24 July: **AIR 40/424**
- Operation 132: Oslo/Kjeller airfield and repair depot, 18 Nov: **AIR 40/482**
- Operation 131: Oslo/Kjeller airfield, Knaben/Saeter molybdenum mine and Rjukan power plant and nitrate works, 16 Nov: **AIR 40/481**

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- Bomber Command Night Operations: Mine-laying operation with Porsgrunn as target, 28/29 December 1944: **AIR 24/209**
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