Relics of Mine Warfare at the Front of the First World War

Contents

1. THEMATIC PACKAGE

In 2014, it was acentury ago that much of the world was dragged into a bloody military conflict. What began with rising tensions in the Balkans soon threw most of Europe into turmoil. With the participation of major colonial powers, the virus of war soon infected the rest of the world. The First World War had broken out.

The 100th anniversary of the First World War has prompted many people to take action in previous years. Because agreat deal of heritage is linked to that period, the commemoration prompted the Agency for Immovable Heritage to take new initiatives around the inventory and protection of that heritage. In 2002, the project Inventory of the relics from the First World War in the Westhoek was launched as apartnership between the Province of West Flanders and the Flemish Government (Department of Monuments and Landscapes and the Flemish Institute for Immovable Heritage). The focus was on the material traces of the First World War in the Westhoek, such as bunkers, military cemeteries and honorary plots, above- and underground shelters and depots, soup kitchens, war memorials, emergency housing, etc. These were followed by thematic protection packages from 2007 onwards: 162 military cemeteries were protected as monuments. Valuable war memorials were also selected for protection based on their historical and artistic value.

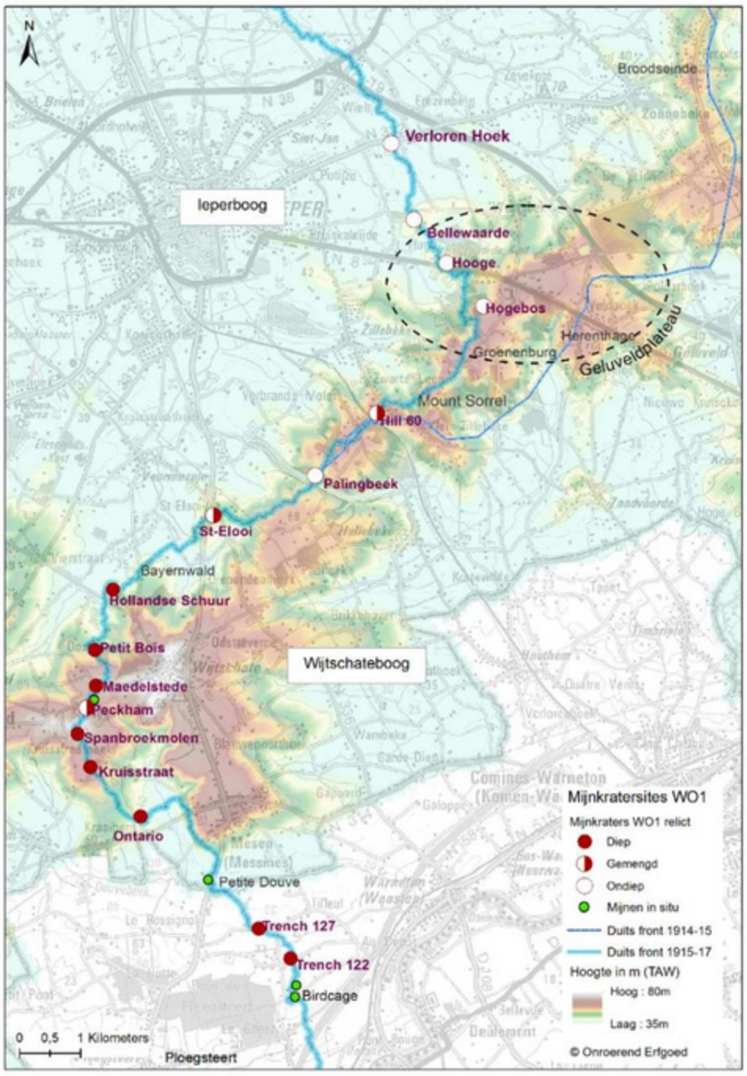
In 2010 the research expanded to include war landscapes and archaeological WW1 heritage. Where were the battlefields of the past and what traces did they leave on the terrain - above ground and underground -behind? The result was the demarcation of 28 lieux de mémoire or landscape memorial sites, parts of the former battlefields where the landscape was the bearer of the war story. Because of this landscape and therefore also spatial component, Onroerend Erfgoed explored the path of spatial anchoring of the heritage of the First World War in spatial plans. The procedure was initiated, starting with the designation of anchoring sites. In order to make them heritage landscapes, Ruimte Vlaanderen started preparing a regional RUP 'Ieperboog-Zuid' that would include a large part of the WW1 heritage. In the meantime, this procedure, based on broad consultation with many stakeholders, has been temporarily halted.

During the research into war landscapes, it appeared that mine craters were one of the few remaining visible landscape relics of the First World War on the surface. They formed the backbone of several lieux de mémoires, including the Wijtschateboog, Bellewaarde hoeve and the Hooge, Drieblotenbos and Hill 62 in the municipalities of Ypres and Heuvelland. Now that the option of spatial anchoring has not led to the expected results, Onroerend Erfgoed has opted to use its own instruments to recognise this specific type of heritage. The aim is to ensure the long-term preservation of the mine craters, even after public interest in the major wave of commemorations of the First World War has waned somewhat. That is why aprotection procedure has been chosen in athematic package. In the meantime, all remains of mine craters from the First World War have been mapped, inventoried and the heritage database has been made publicly available: in https://inventaris.onroerenderfgoed.be/erfgoedobjecten/zoeken (search for typology mine craters and tag First World War)

In the past, some mine crater sites have been protected individually, without a thematic inventory campaign preceding them. The protection of the Spanbroekmolen crater (id 11870), better known as the Pool of Peace, and the Hooge crater

(id 12572) were part of adiverse package of WW1 heritage protections in 1992. Following the protection of the Hill 60 memorial site (id 13040) in 2009, the crater remains were also included in the contours of the protection. The Caterpillar mine crater that was detonated from the same tunnel system, but was not part of the tourist site at the time, was therefore not included in the demarcation of the protected zone. In 2015, the mine crater of 7/6/1917 in Sint-Elooi (id 12618) was protected following the protection of the British bunker located on the site. The two other nearby craters of 27/3/1916 were not part of this protection.

2. DEMINCTED REGION: EAST AND SOUTH OF YPRES



All relics by the underground mine warfare occurs in the area of military operations where a front line was once defined. In the case of the First World War, this is the Westhoek. In concrete terms, we find most mine craters on that part of the front line that held out the longest, particularly between 1914 and 1917, in the *Hill 60* zone between (Zwarteleenstraat in Zillebeke) and Mesen. North of *Hill 60* there are only mine craters to be found on the Geluveld plateau between *Sanctuary Wood* (Guesthouse forests in Zillebeke) and Verloren Hoek (Ypres).

The sites are therefore only found east and south of Ypres. In the northern part front in the Belgian sector the conditions were very different from those in the Ypres Salient. Because the defence in the northern front zone was based on military inundations, the front lines there were far apart. Moreover, the geological conditions and the flat relief were so different from those in the south that undermining was unnecessary and even impossible.

There are concrete indications that defensive undermining systems were built in the canal zone north of Ypres, but only on the German side. Photos show that deep mine shafts were probably dug east of the Ypres-Yser Canal, but we have not been able to determine their exact position.

Furthermore, mine warfare never extended to that sector. Depth explosions never occurred there.

3. EVALUATION OF THE MINE CRATER SITES

Mine crater sites are recognizable by their mostly circular depressions in the landscape, often filled with groundwater. At first glance they look like ponds, but their creation is clearly due to man. Another striking feature is that they lie in aline. Anyone familiar with the history of the First World War will recognize the front line of the period 1914/15-1917.

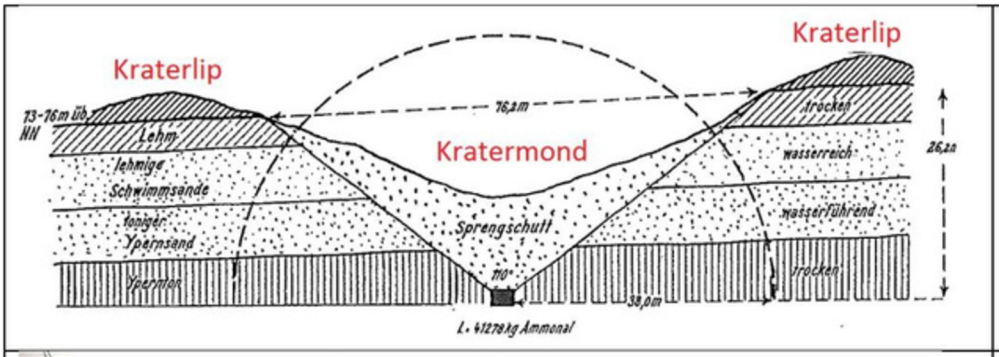
3.1 Terminology of the underground war

Characteristic of mines from the First World War is the use of alarge charge of explosives that are detonated in an underground chamber and from adistance. The explosives usually consisted of several types of explosives, such as guncotton, gunpowder or ammonal, depending on what was available at the time. There was no linear relationship between the size of the explosive charge and the size of the crater, but in general it was true that larger quantities achieved agreater effect. However, other factors also played arole: the depth of the explosive charge and the composition of the geological layers in the subsurface. Sandbags around the mine chamber buffered the operation of the mine. In order to prevent the force of the explosion from moving laterally in the tunnel system, athick wall of sandbags ensured that the released energy was transferred upwards as much as possible. The intention was ultimately to blow up the bulwark above the mine.

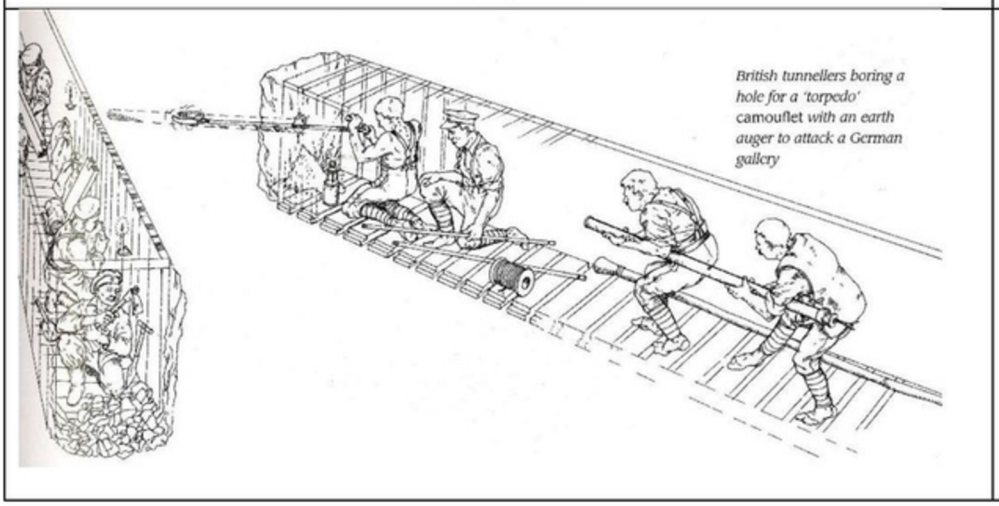
Depending on the depth and the nature of the explosives placed, we speak of different types of mines. Shallow mines were placed at alesser depth (5 to 15 m) and generally consisted of less powerful charges. It is difficult to say where exactly the boundary lies to be allowed to speak of deep mines. In this file we use we atechnological criterion, which determined the difference: depending on whether the tunnellers or miners succeeded in penetrating through water-bearing layers to the tertiary Ypresian clay layers and placing the charge of explosives there, we speak of deep mines. According to the chronology of mine warfare, the first deep mines did not explode until June 1917, but there are indications that this happened earlier, namely in Sint-Elooi in March 1916 (British) and in May 1917 at Bellewaarde farm (cf. the Allenheim crater, German).

A special type of mines were the so-called camouflets (quetschungen). This type was used to destroy the enemy's tunnels underground. Camouflets usually had little or no above-ground effect. Rarely did this type cause acrater on the surface.

A mine explosion leaves traces in the form of acrater, or more correctly according to the terminology of anatomy, acrater mouth and alip. The mouth consists of aconical pit with a wide base at the surface and anarrow bottom at depth. The thrown up earth falls around the base, usually forming a ring-shaped crater lip on top of the ground level.



Anatomy of acrater, here the example of the Spanbroekmolen deep mine in Wijtschate.
by
Source: REICHSARCHIV 1939: *Die Kriegsführung im Frühjahr 1917.*
Bearbeitet im Reichsarchiv,
Der Weltkrieg 1914 bis 1918: Die militarischen Operationen zu Lande 12,
Berlin, attachment



The use of a*camouflage*
in undergrounAdn tunnel combat. With these light rod-like charges, miners torpedoed the tunnels of their opponents.

This type had only subsurface effect and usually did not canudse craters on the surface.
Source: BARTON P., DOYLE P. and VANDEWALLE J. 2004 (ed. 2010): *Beneath Flanders Fields,* Stroud, 115.

3.1. Evaluation of mine crater preservation

According to a large count of different types of craters on Belgian territory, 301 craters were created during the First World War as a result of various mine explosions (Stichelbaut 2016, 71). Based on trench maps from the period 1914-18 we counted 260 historical mine craters for Flanders. Of these, about 43 craters still exist today, leaving Hill 60 out of consideration. A precise count of the number of remaining craters has become impossible there, because the crater volumes can no longer be distinguished from each other.

On the 16 km long front between Ypres and Messines there are 14 locations where traces of the underground war can still be seen today. Originally there were 20:

- At 5 sites, traces of underground mine warfare have completely disappeared.
  This mainly concerns sites where light mines exploded in an early stage of mine warfare (Broodseinde, Herenthage, Groenenburg, Mount Sorrel, Bayernwald). None of the earliest undermining left any traces. This is not surprising, because these were small and shallowly placed charges. This shows how much the first undermining was finger practice.
- 1 site was mined but abandoned before the operations were carried out (Petite Douve in Mesen). The explosives are probably still in situ.
- Of the 14 remaining mine crater sites, there are:
  - o 5 where only light mines exploded (Verloren Hoek, Bellewaarde, Hooge, Hogebos or Sanctuary Wood, Palingbeek or Bluff)

- o 6 where only the craters of deep mines remained (Hollandse Schuur, Petit Bois, Maedelstede, Spanbroekmolen or Pool of Peace, Kruisstraat, Ontario)

- o 3 sites with traces of light and deep mines *(Hill 60,* Sint-Elooi, *Peckham)*

The preserved crater sites are located for the sector south of Ypres on the front line of 1914-1917. After the shift of the front in the spring of 1915 east of Ypres (second battle), the undermining operations developed there on new sites. In any case, it is characteristic that undermining occurred in places where the front had been stable for at least afew months and no man's land was relatively narrow. The preparations required quite some time for the excavation work, the construction of ashaft, underground galleries, the supply of materials, the removal of the excavated earth and the placement of the explosive charge.

Compared to the sites east of Ypres, far fewer mines exploded in the Wijtschate Salient. All forces were spared to ensure that preparations for the mine battle went well. Only at Bayernwald, Petit Bois and Peckham shallow mines exploded at an early stage. Deep mine craters are clearly better preserved than the craters of shallow mines. Two of the 19 craters of deep mines were filled in, most recently in Wijtschate in 1972 on the Kruisstraat. With the exception of one place, all craters of shallow mines in the Wijtschate arch have disappeared. The less extensive craters of shallow mines could easily be filled in. This happened on afairly large scale, especially in agricultural areas, during the first post-war years.

Anyone who wants to see craters from shallow mines today should go to the crater sites east of Ypres. The mine crater field at Bellewaarde is the best preserved. After the war, the owner had the badly damaged terrain reforested, so that the relief remained untouched. The preservation of relief relics appears to be better under forest in general. This also applies to the craters in Sanctuary Wood and the Palingbeek, although the crater site of the Palingbeek domain was used for the controlled explosion of ammunition in the post-war years. In the case of Sanctuary Wood , the former forestation was restored, but the relief was left largely untouched.

3.2. Shafts and tunnels: the archaeological heritage at mine craters

Not visible are the underground structures that were irrevocably connected to mine craters: shafts and tunnels. Along the front there were two separate circuits, each on one side of no man's land. The German underground system was defensive in concept, because their troops in the Westhoek were often on the higher positions. And since that gave amilitary-tactical advantage, they chose to remain on those positions. Defending was therefore sufficient. For the siege of the higher positions, the British used an offensive approach, with atunnel system that went under the enemy's positions.

The entire tunnel system consisted of an entrance, listening posts, underground galleries, ending in a chamber for the charge of explosives. The entrance or the shaft house was often built into a trench. This could be located in the front trenches close to the front or -in the case of deep tunnel systems - up to 300m behind the front. The work on the shaft and tunnel system had to be done with the greatest care out of sight of the enemy. Camouflage was therefore important.

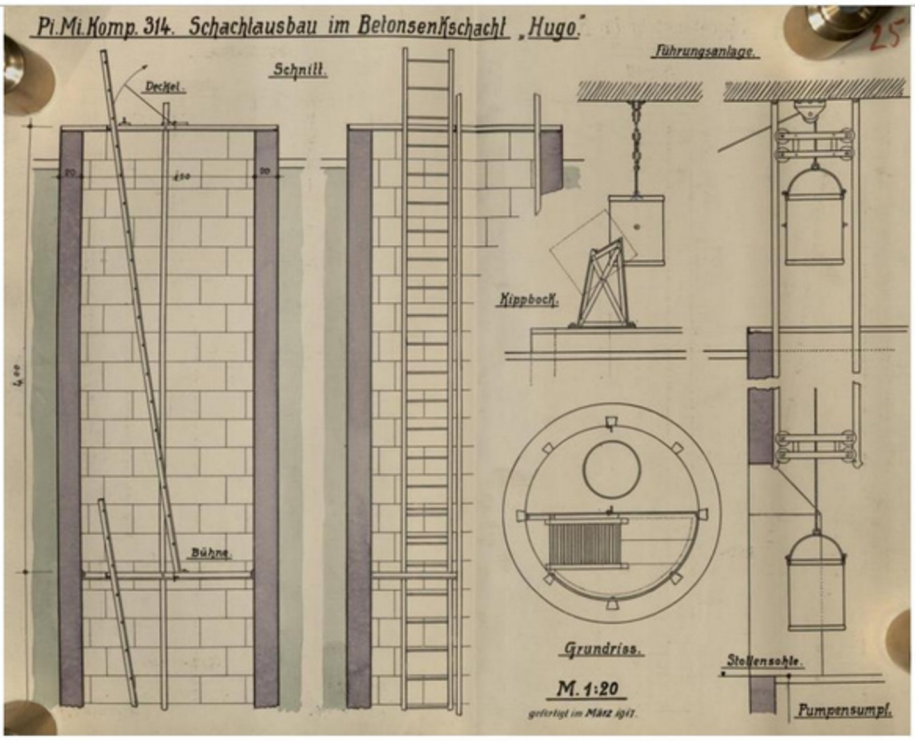
Because patrols crossed no man's land during (usually night-time) raids in search of the entrance to tunnels, the shaft houses were built into abunker or in alower area behind the front.

From the shaft house ashaft departed, diagonally (stairs) or vertically, into the depths. The materials consisted of wood or concrete (blocks) and steel. The oldest systems with wooden (stairs) shafts were constructed to alimited depth, i.e. above the difficult to penetrate, water-saturated sand layers. The depth of these layers differs from site to site, depending on the local geological conditions. In order to penetrate the water-saturated layers, concrete shafts were necessary that could withstand the enormous pressure of the groundwater. These shafts were 'sunk' into the ground with the aid of steel rings (zinc shafts). This type of shaft was first designed by British mining engineers. By applying this technique, they succeeded in penetrating the tertiary clay layers in the ground and undermining strongholds at the front from agreat depth (30 to 40 m).

At the end of the shaft began the tunnel or gallery (horizontal). These galleries were often equipped with listening posts (defensive) to locate and sabotage any enemy actions underground. In an offensive system, an underground gallery ended in aroom that was packed with ahuge load of explosives. The gallery walls were usually built of wood.

Prevent
At present, 125 locations of British or German mine shafts are known. Since achance discovery of two trench maps from 1916-1917 with indications of the locations of shafts in the Hauptstaatsarchiv of Stuttgart, knowledge about the locations of German mine shafts in particular has increased considerably. Most of these shafts are not (anymore) on the surface, with the exception of the German shafts Dietrich in the Wijtschate forest, Bayernwald in Wijtschate and Hermann in Mesen.

Almost a year after the British, the German troops only began their system of Tiefensicherungen, the underground protection of their front sectors at great depth (30 to 40 m), from June 1916.



Left Construction plan of a German concrete zinc shaft 'Hugo' in Mesen, March 1917.

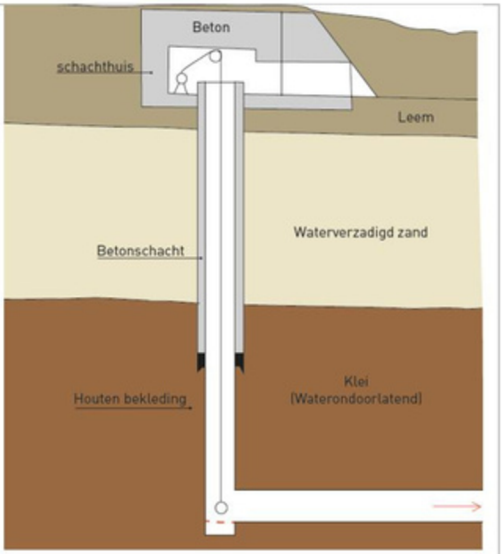
The location of this shaft is known.

Source:

Hauptstaatsarchiv
Stuttgart, M201 Active Pioniertruppen: Linien Bataillon und Kompanien: Kriegstagebücher und Anlagen, volume 125: Pionier-(Mineur)-Kompanie 314: book 239.

Below: KRANZ W. 1935: Mineurkampf und Kriegsgeologie im Wytschaetebogen, *Vierteljahrschriftershefte für Pioniere,* 2/3, 166-181.

Edited by Immovable Heritage, Nele Van Gemert.



View of aBritish shaft with steel rings at 'Lancashire farm' in Ypres. Source: BARTON P., DOYLE P. and VANDEWALLE J. 2004 (ed. 2010): *Beneath Flanders Fields,* stroud, 82.

4. DEVELOPMENT OF MINE WAR DURING THE FIRST WORLD WAR IN FLANDERS

4.1. Mine warfare: some key points

At the outbreak of the First World War, no army was prepared for an underground war. The laying of mines was actually an old siege technique, which was taken out of the closet again in 1914. Just as fortresses were besieged in times long past, at the beginning of the 20th century positions at the front were bombarded with similar techniques. It says alot about the character of the warfare that had led to acomplete standstill and astalemate.

By November 1914 it was clear that the war on the Western Front had come to astandstill. What had been awar of movement up until then had degenerated into a hopeless, static trench war. Troops were dug in on either side of no man's land. If no opening was found at the front above ground, they might try underground. The idea came over from France and the first mines exploded at the front in the Westhoek where French troops were defending the Allied lines. From their positions they dug a tunnel under the first German line. At the end of the tunnel they packed together a large quantity of explosives (gunpowder, guncotton, ammonal) which were detonated remotely via electrical wires. Anyone above in the lines was torn to pieces, crushed by the blast wave or buried under earth and rubble. Where the explosives exploded, acrater was left behind.

The first mine exploded on 29 December 1914 at asite east of Ypres (Hill 60). German counter-actions soon followed. This was also typical of mine warfare: every action provoked counter-actions and new mine explosions. If amine exploded somewhere, this was immediately the starting signal for even more explosions on the same site. In February 1915, mine explosions followed at other locations on the front of the first battle of Ypres: Sint-Elooi (Ypres, 3February 1915), Broodseinde (Zonnebeke, February 1915), Herenthage (Ypres, 19 February 1915) and Groenenburgbos (Ypres, 21 February

By mid-1916, mine warfare had spread to adozen other locations east and south of Ypres.

4.2. Mine warfare escalates

Technological developments were the basis for the expansion of the underground war. While the oldest mines consisted of at most a few hundred kilos of explosives, the British experimented with a charge of 2.2 tons in July 1915. In March 1916 this was increased to 14 tons. Just over ayear later, the tunnellers placed explosive charges of up to 43 tons.

Parallel to the increase in explosive charges, the war dug deeper into the ground. From the original superficially excavated tunnels, the undermining evolved into very deep constructions of over 30 to 40m. In short, mine warfare escalated. The turning point came in March 1916 with the simultaneous explosion of six mines near Sint-Elooi, which caused the front in that sector to retreat for ashort time. But it was especially the size, power and depth of these British mines that worried German observers. They made it painfully clear how much the German troops had fallen behind in this technical arms race.

4.3. The Mine Battle: Preparations (August 1915-June 1917)

A problem in the Ypres subsoil was the presence of water-saturated sand layers on top of clay layers. Wooden shafts and tunnels collapsed under the pressure of the accumulated groundwater. Until military engineers found atechnique to penetrate these unstable, wet layers of loose sand using steel zinc shafts. This made it possible to tunnel deeper than ever before. The British tunnelling companies were the first to use this new technique. In this way they got deep underground past the German lines unnoticed, for the first time in August 1915 at Hill 60. But instead of immediately playing out this advantage, they saw the possibilities of acoordinated action over abroad sector of the front.

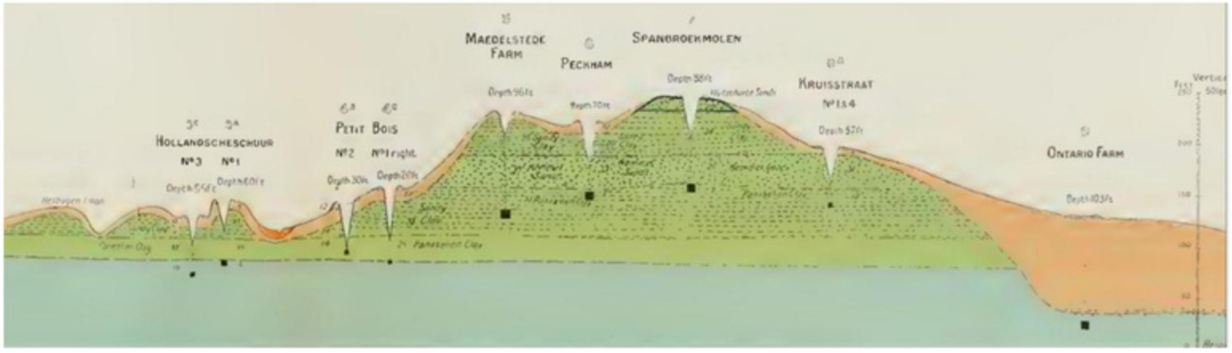
The driving force behind the idea of the mine battle was the flamboyant businessman, engineer, millionaire and parliamentarian John Norton Griffiths. On the British side, he was one of the first to see the significance of undermining on adeadlocked front. He advocated the creation of specialized troops (tunnelling companies), but only gained the support of the highest commanders after the Germans set off mines under the front in France in December 1914. In March 1915, he visited Hill 60 and witnessed the simultaneous explosion of five British mines. He was one of the few who saw the possibility of using deep, offensive undermining to blow up an entire sector of the German front in one go. He set his sights on the Wijtschate-Mesen ridge. But he lacked the knowledge of the terrain to translate that idea into aconcrete plan. The general staff therefore left the operationalization of the plan to others from mid-1915 onwards. The key figure was Captain Cropper (250th tunnelling company) who developed a scheme for undermining the ridge that targeted five strongpoints on the front: Hollandse Schuur, Petit Bois, Peckham, Spanbroekmolen and Kruisstraat.

The work was carried out by the Royal Engineers' tunnelling companies under the supervision of the Inspector of Mines Harvey. On the German side were the Pionierkompanien under the command of Otto Füsslein, commander of the Mineure of the Fourth Army.

4.4. Wijtschateboog (Messines Ridge)

The deep mines that had already been placed were deliberately not detonated yet, pending the placement of more mines at other locations along the front line. The choice was made for the Wijtschate salient south of Ypres. There, abulge had formed on the front around the Wijtschate-Mesen ridge. Before an allied offensive could succeed, this salient had to be straightened out first. The plan was to begin this action with the simultaneous explosion of 19 deep mines, a matter of surprising the enemy and then clearing the terrain with amassive infantry attack. In this respect, the plan for the mine battle differed fundamentally from all previous undermining operations, which had until then been limited to local actions on isolated pieces of the front sector.

The plan was adjusted afew times. First, the execution was planned for 1916, but due to the successive offensives in France, the operation on the Ypres front was postponed until the summer of 1917. As a result, the plan changed over the years. Until the decision to postpone was taken (July 1916), the timetable for the tunnel works was very tight. Afterwards, there was time to further expand the plan, to tap new locations (such as Maedelstede or Ontario farm) or to expand existing ones with multiple explosive charges (such as Kruisstraat).



Source:Work in the Field Under the Engineer-in-Chief, BEF 1922: *Geological Work on the Western Front. The Work of the Royal Engineers in the European War, 1914–19,* Chatham: The of Engineers [online] https://ia902602.us.archive.org/26/items/ workinfieldunder00inst/ workinfieldunder00inst.

4.5. The Mine Battle Offensive at Messines (7 –14 June 1917)

The placement of the deep mines became arace against time, which succeeded until just afew days before the execution date, despite some sabotage actions. On 7June 1917 in the early morning, the explosion of so many powerful explosive charges offered aspectacular spectacle. The German front literally and figuratively collapsed. The meticulous preparation on the Allied side made the mine battle a short-lived military success. The British, Irish, Australians and New Zealanders then succeeded in conquering the Wijtschate-Mesen ridge in one week.

The mine battle was the prelude to alarge-scale offensive around Ypres (third battle). The intention was to first straighten the Wijtschate Salient and in asecond phase to break through the entire front between Ypres and the French border. The ultimate objective was to eliminate the German submarine bases at Ostend and Zeebrugge. But they would never be achieved. The Third Battle of Ypres died in November 1917 at

Passendale. After a five-month battle, the front had advanced 8km at the cost of hundreds of thousands of casualties. Once again, the war entered aphase of complete standstill.

The failure was due to poor timing between the phases of the Allied offensive, the harsh weather conditions and above all the underestimated resilience of the German troops. The Allies were forced to give up the territorial gains that had been achieved with so much bloodshed in the autumn of 1917, barely six months later.

5. HERITAGE VALUES AND CRITERIA

5.1.Heritage values

5.1.1. Historical value

Mine craters have historical value as witnesses to the underground mine warfare as it was fought on the front in the Westhoek during the period 1914-1918.
The First World War was characterised by its static nature: a four-year bloody conflict that had come to acomplete standstill. No breakthrough could be achieved above ground, so attempts were made underground. Historically, the technique of undermining fitted in with the tradition of sieging fortresses, as had often been applied in times long past. Due to the static nature of trench warfare, the technique of undermining fitted in with the military strategy of the First World War. Moreover, it was away of “feeding the offensive spirit of the men” in so-called quiet periods, as the spirit of the times prescribed to military commanders. Moreover, some sectors served as adiversionary manoeuvre for larger offensives elsewhere on the western front, which also fitted in with the tactics of trench warfare. In order to prevent the enemy from moving troops to the offensive, they were ‘kept busy’ with smaller-scale offensives.

Often these diversionary manoeuvres were initiated by an intense bombardment or -to make the surprise even greater - by mine explosions. For example, German troops exploded several mines in February 1916 as adiversion for the impending offensive in Verdun (Bellewaarde, Palingbeek), or in September 1915 at the moment that an offensive in the French Loos began (Bellewaarde, Sanctuary Wood).
Where many mine craters have been preserved on one site, they are reminders of the deadly underground cat-and-mouse game between troops on both sides of the front. They are the material witnesses of the intensity of the warfare at the front. Places where mines exploded had an even worse reputation than other sectors at the front. This not only made the warfare more intense, but also more dangerous and unpredictable. The enemy could strike at any moment unexpectedly and 'invisibly' to the man in the trenches.

A characteristic of sites with shallow undermining is that they never led to abreakthrough at the front, at best to asmall shift. The military commanders decided to undermine front sectors, not with the prospect of afundamental change, but to maintain the balance of power. If one began to undermine, the other had to follow, otherwise the other side could gain an advantage from the imbalance created. In this way, mine warfare reinforced the character of the attritional warfare that the First World War was in fact and contributed to ahopeless stalemate.

The mine crater sites are part of a **historical line**, more specifically the front line of the First World War. All sites developed at places on the front where the situation was difficult to break through, often where the front was consequently stuck for a long time. Mine crater sites occur in the Ypres Salient on the front line of the Second Battle (April 1915- July 1917) and in the Wijtschate Salient on the front line of the first and second battle (November 1914-June 1917). An exception are the mine craters in Sanctuary Wood. They were created shortly after the second battle in September 1915, but an offensive in June 1916 shifted the front lines in favour of the German troops, causing the mine craters to lie well behind the front line. They are now the oldest preserved, individually recognisable mine craters of the Ypres Salient.

The mine craters of the Wijtschate Arch are in particular the remains of the **mine battle** that erupted on 7 June 1917 with the simultaneous explosion of 19 deep mines. The plan of the mine battle was gradually adjusted, but several sites belonged to the original plan of undermining the German front from the beginning, namely Hollandse Schuur, Petit Bois, Peckham, Spanbroekmolen, Kruisstraat.

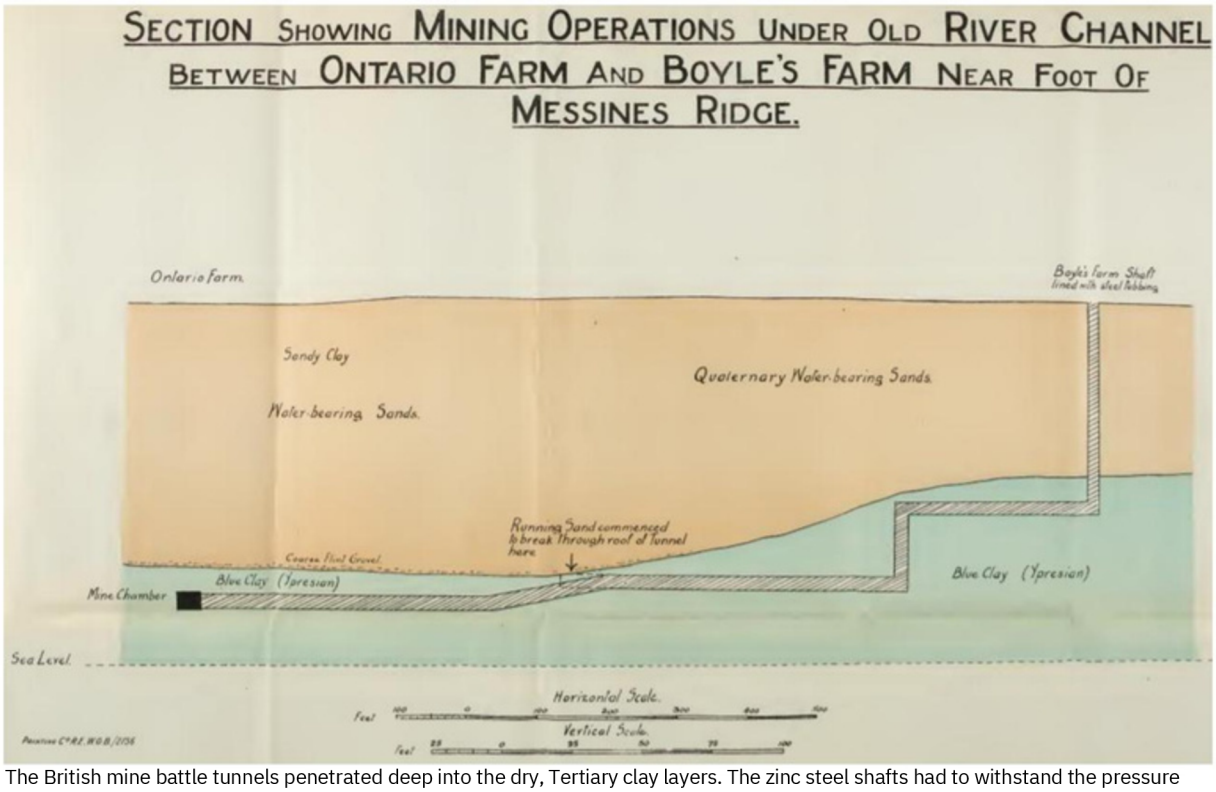
This is where the tunneling started earliest and where the British had to keep the finished systems secret and operational the longest. It is no coincidence that these sites were located at the westernmost positions of the Wijtschate Salient. The efforts to straighten the front were greatest here. The mine crater sites are part of the battlefield of the Third Battle of Ypres (June- November 2017) and, together with the other relics, mark the historical front line from which the Allied offensive started. What is special about the mine battle is that it achieved a limited breakthrough in time and space on the front in the Westhoek, in contrast to previous initiatives of undermining elsewhere on the Western Front. The scale of the action was also unprecedented in the military history of that time.

5.1.2. Technical value

Even though undermining is atraditional form of warfare, the underground war in the Westhoek evolved and saw **technical innovations**. These mine craters are the result of the placement of deep mines, large quantities of explosives such as ammonal, which were buried at great depths in the subsoil.
Technically, this only became possible after the difficult to reach tertiary clay layers in the subsurface could be drilled using steel zinc shafts. This technical innovation is typical for mine craters that are the result of the explosion of deep mines. The first experiments with deep zinc shafts in the Wijtschate arch date from December 1915.

The use of this type of weapon is characteristic of the technicality of warfare at the beginning of the 20th century. The arsenal of weapons became larger, more varied and more specifically adapted to the type of warfare, making full use of technological innovations. Engineers played an important role in the refinements in underground warfare, as evidenced by the deployment of certain troops, in particular the royal engineers and the *mine companies* at the front in Flanders. One of the technical experiments took place in March 1916 at *Petit Bois*: . The object of the experiment was the technique of clay-kicking: men lay on aslanted stool. With both legs forward, they pushed a shovel into the head of the tunnel passage and dug it out. In this way they covered about 3m per day in the narrow, suffocating underground galleries. In an attempt to speed up the excavation of the tunnel systems, Norton-Griffiths (see 4.3) insisted on the use of aboring machine, similar to the excavation of London Underground tunnels. Part by part was carried into the tunnels and mounted there. But in the Ypres clay layers the experiment went completely wrong.

Within ashort time the machine was completely stuck and deviated from the intended drilling direction. The incident was exemplary for the difficult geological conditions in which the tunnelling in the Wijtschate arch took place.



The British mine battle tunnels penetrated deep into the dry, Tertiary clay layers. The zinc steel shafts had to withstand the pressure of the water-bearing sand layers. Source: Work in the Field Under the Engineer-in-Chief, BEF 1922: *Geological Work on the Western Front. The Work of the Royal Engineers in the European War, 1914–19,* Chatham: The Secretary, Royal [online] Institution or Engineers https://ia902602.us.archive.org/26/items/workinfieldunder00inst/workinfieldunder00inst.pdf (accessed March 10, 2017): KING WBR 1919: Geological Work on the Western Front, The Geographical Journal, 54/4, 201- 215.

5.1.3. Spatial-structural value

Mine craters can provide spatial structure for the location of buildings, the development of an inhabited site or the post-war reconstruction of the street pattern. This value is very striking in the mine craters of Hollandse Schuur. Anyone who looks at a topographic map of Ypres-Heuvelland with knowledge of the facts will recognise the front line of the First World War in the coherence between the mine crater sites. During the period of 1914-18, the presence of these battle lines determined the division of space, because for four years they formed an unbridgeable border between two geopolitical power blocs. During that period, the front line was therefore certainly spatially structuring for the war landscape of yesteryear. After the Armistice, this delimitation of space came to an end: through the reconstruction of the pre-war landscape, the former front was 'erased' and made as invisible as possible. Both sides along the no-man's land were reconnected through the restoration of the landscape. As aresult, the mine crater sites now form, as it were, an abstract (because they can only be read on the map), but on the ground they are no longer observable line structure. The sites are independent places with a shared history, the connections of which have since disappeared.

The mine craters point-mark the former front line of the First World War. In this way, they make the war landscape legible, but they no longer structure the space. For this reason, we use the spatial-structuring value exclusively at the level of an individual site in the individual protection files.

5.1.4. Cultural value

As amaterial witness to aglobal conflict that had the front region in its grip for years and destroyed hundreds of thousands of lives. The First World War was an international event par excellence, with the Westhoek as the battlefield where men from all over the world fought. The memory of the First World War still has broad social and international support. The tranquil character of the mine craters, especially those that look like apeaceful pond, invite us to commemorate the events and the consequences of awar. This value is not equally present at all sites. We find it most pronounced at the Pool of Peace, which in the seclusion of the site by the reflecting water encourages reflections on war and peace. The design contributes to the introverted character of this site. Other mine crater sites are also included in larger commemorative sites dedicated to the First World War (Palingbeek). Occasionally, information panels provide information about the history and commemorative value of the site. The mine crater sites continue to be visited by tourists every year, especially from the Anglo-Saxon world. The mine battle in the Wijtschate arc (known as the Messines Ridge) involved many troops from Great Britain, Australia, New Zealand, Canada and Ireland. The battle of Messines Ridge is recorded in their national history as asuccessful military offensive. From amilitary-tactical perspective, it is true that the mine battle was an allied success at the front, afeat of technical ingenuity that the British military also liked to boast about in their war propaganda at home and internationally. In one week (7-14 June 1917), the troops achieved all their set objectives. But that success was short-lived and, like every sortie, claimed many victims. If you look at the offensive in a slightly broader perspective, you will notice that the mine battle was followed by the disastrous battle of Passchendaele (September 1917). The mine battle formed the first phase, Passchendaele the second phase of amajor allied offensive around Ypres (third battle). But it ended in ahopeless trial of strength in the mud, with many victims and untold human suffering. Although it was already clear in October that the military objectives would not be achieved, the high command under the leadership of Douglas Haig remained stubborn. The offensive had to and would continue. Six months after the offensive, the British simply gave up their hard-won positions.

The explosions caused by the buried mines killed (mostly German) men who were occupying the front trenches at the time. Many were buried under metres of earth. Their bodies were rarely found. But men also died in the underground war that preceded it: during fights in the tunnels, or in accidents during the excavation work. For these people, the mine craters have become their final resting place.

5.1.5. Archaeological value

After their formation, mine craters formed ideal locations for constructions, such as shelters or new beginnings of underground galleries. In turn, craters were built into the front lines as reinforcements. They are therefore also potential sites for archaeological remains from the First World War.

Together with the development of war tourism after 1918, atradition of excavations and collecting war objects arose in the Westhoek, such as remains of exploded war material, pieces of military equipment, weapons, utensils from daily life at the front, etc. During soil interventions, pieces invariably came to light, but gradually they were also searched for purposefully because awhole trade in them developed. Characteristic of these searches is the attention for the object, not for the context. Since the full-fledged development of professional First World War archaeology from the 1990s onwards, the emphasis has come to lie much more on the archaeological context. To this day, clandestine excavations are a problem, because they disrupt the context value of archaeological sites.

5.2 Selection criteria

5.2.1. Rarity

Mine craters are rare landscape relics of the First World War. Relics of the former war landscape are rarely found on the surface anyway. The location of the battlefields of 1914-18 is well known through intensive research, but most traces of the war are preserved underground or can be found as spatial carriers in the landscape itself (lieux de mémoires). Well-preserved landscape relics of the First World War that are still visible on the terrain are rare. After the war, the front zone was littered with millions of shell craters and remains of military infrastructure. During the reconversion of a war landscape into a liveable agricultural environment, most of the war remnants were removed: land was levelled, agricultural areas were deepened, trenches were dismantled, and plots were made ready for use. The mine craters are one of the few relics of the former war landscape that are recognisable in situ on the terrain.

Research on historical-topographical maps shows that at least 260 historical mine craters were mapped during the First World War. According to an optimistic count, about forty of these have been preserved. The rarity of this type of relics justifies the decision to protect as many mine crater sites as possible. Moreover, it is difficult to distinguish between the sites of the mine battle, since together they formed part of the entire front sectors in the Wijtschate arc that had to make abreakthrough at the front possible in 1917. Each site marks the former front line without distinction.

The craters with bunkers are rare . They were only found in the Hooge and Sanctuary Wood (Gasthuisbossen). At Sint-Elooi and Spanbroekmolen abunker can be found on the crater rim of the deep mine. However, many historical mine craters were built into fortifications. Most of these wooden and sandbag reinforced shelters were intended as temporary constructions and have not survived the ravages of time.

High crater at Ypres, March 1918, Adrian Hill, Imperial War Museum, IWM ART 590, ©IWM Non-commercial license

Also rare are shallow mine craters on deep mine sites in the Wijtschate Arch. On one site, namely at Peckham, a remnant of a shallow mine crater occurs. On other sites, mines were never placed at limited depth or the craters disappeared during the leveling of the terrain in the post-war period (e.g. Petit Bois, Hollandse Schuur). There, only the largest and deepest craters have been preserved.

Post-war levelling works are responsible for the fact that many traces of the underground war have been wiped away. Locations where craters have remained untouched (e.g. Bellewaarde) are very exceptional.

Rare photo of the Ontario crater (Katteputstraat 2, Heuvelland), which now only exists as alocation, but no longer has arecognizable shape as acrater. Source King 1919, 207.

5.2.2. Recognizability

Mine craters are recognizable by their circular crater. Where tertiary clay layers provide a difficult permeable subsoil, the craters are filled with groundwater up to arelatively short distance below ground level. This is the case for all mine crater sites in the Wijtschate arch. They are often reused as cattle drinking pools, fish ponds or ornamental ponds. Some

Mine craters have taken the form of elongated 'depressions', caused by the explosion of several mines located close together (Palingbeek, Hooge, Sanctuary Wood). Elongated mine craters are usually more difficult to recognize in the field, especially if they are shallow. Grassland or forest contributes to the good preservation of the crater lip around the crater.

The original shape of some mine craters has been affected, particularly when the adjacent plots were cultivated up to the crater wall. In exceptional cases, part of the crater was filled in (Maedelstede). The recognisability of the craters may also have been affected by their reuse as explosion pits for the controlled detonation of cleared ammunition in the post-war period, which was the case for the craters in the Palingbeek. The recognisability is generally high, with the exception of the craters on the Ontario farm (Wijtschate) and Verloren Hoek (Ypres) sites. At these locations, respectively, a pond and acattle drinking pool are located exactly where amine left acrater in the landscape during the First World War. However, their recognisability as amine crater has been affected to such an extent that protection is difficult to justify.

These relics are eligible for inventory, because the remains -even though they are hardly recognizable - still indicate the locations of the mine craters. In the whole of the mine crater sites that are part of a line, they remain relevant.
On rare occasions the location of various craters illustrates the position of the various troops at the front (e.g. Peckham, Palingbeek, Bellewaarde).

5.2.3 Representativeness

The differences in size of the mine craters are representative of different phases in the underground war. During the first phase, the lighter, shallower mine craters exploded placed mines (1914-17). The placement of deep mines shows that the engineers had introduced a new phase in the underground war. These two phases are difficult to distinguish precisely, because they partly overlapped (1916-17). The Commonwealth troops were the first to succeed in placing deep mines.
This innovation was related to the possibility of 'sinking' shafts deep underground behind the front line into the dry clay layers. The diameters of the craters of deep mines vary between 40 and 100 m: the smallest is at Hollandse Schuur, the largest at Spanbroekmolen and Peckham. They are significantly larger than those of lighter mines that exploded before June 1917. At only afew sites do craters from shallow and deep mines occur together (Peckham, Hill 60): they are representative of this evolution in underground warfare. Virtually no above-ground traces of the German deep-lying defence system have been preserved.

A thought about the dimensions of mine craters: before 1922, British military engineers made alist of the craters of the 19 deep mines in the Wijtschate arc drawn up. They collected data on the length of the galleries, the depth of the shaft, the size of the explosive charge, the dimensions of the craters, etc. If we compare the historical with the current dimensions of the mine craters, we find striking differences. The current dimensions are systematically larger than the historical ones. It is possible that crater walls have eroded or collapsed over the years, and in some places have been filled with rubble. This could explain the differences. But it is more likely that different measuring points were chosen for the measurements. Comparing dimensions is a tricky business because it is unclear where exactly the measuring points are located: at the highest point of the crater lip, the inside of the crater wall, the lowest point on the outside of the crater lip, the water surface. For the measurements we used the highest opposite points on the crater lip, because these reference points contained the best guarantees for comparability.

5.2.4. Ensemble value

Historically, mine craters form an ensemble with the underground heritage consisting of shafts, underground tunnels or galleries, and above ground with possible fortifications, a higher position (hilltop, rampart, mill relic) or a farm that served as a strong hold at the front during the war. Because craters offered shelter, they were the ideal location for the implantation of bunkers or shelters. Where this connection between crater and bunker(s) is clear, we speak of a high ensemble value.

The mine craters in the Wijtschate arch in particular used to form a line together. The mutual coherence between the sites is mainly visible on the map or from the air. Only exceptionally is this coherence also visible on the ground (Peckham -Spanbroekmolen). In the other cases the distance is too great or intermediate elements (buildings, forest, rows of trees) obstruct the view of the coherence.

5.2.5. Context value

Characteristic of mine crater sites is the relationship with height differences and relief shapes in the landscape. In places at the front where even minimal height differences made the assault on the enemy's lines difficult, the war often went underground.
The spatial context therefore largely determined whether or not mining took place. Relief shapes can therefore be found on most mine crater sites. This applies in particular to sites on the flank of the Wijtschate-Mesen ridge (structural relief element).
The context value is greater if the spatial coherence between elements shows similarities with that in which the war landscape unfolded. Where these height differences can be observed from the public space (e.g. from the public road), the landscape context contributes to the experience value of the relics: visibility of the mine crater from the public road, observable relief
differences. On sites where more recent, post-war buildings have been developed, the contextual value has generally been affected, because these building volumes have sometimes spatially restricted or limited the site, making the connection with the surroundings less clear.

At some locations (Hill 60, Palingbeek) even more above-ground traces of the original war landscape have been preserved, in the form of shell craters or bomb impacts. Even though vegetation has taken over the place or erosion has slightly blurred the differences in level, the terrain is very uneven. These contexts where one can still see more of the traces of the war landscape are exceptional. Because they usually disappeared under thick layers of supplied or levelled earth. In the case of Hill 60, the traces were spared, because the place was developed as atourist attraction after the war. In the case of the Palingbeek, it is the (steep) canal banks that remained outside the 'colonisation zeal' of agriculture and forestry.

6. ACCOUNTABILITY OF PROTECTION THE DELIMINATIO BY THE PERIMETER

The perimeter of the protection is demarcated in such away that it includes the crater and the crater lip, to the extent that it has been preserved. The demarcation was done on the basis of the digital terrain model of Informatie Vlaanderen/Agiv, taking into account the microrelief on the terrain. Connecting building volumes are excluded from the perimeter. The archaeological heritage is not included in the protection perimeter. Even though knowledge about the location of these tunnel systems has increased significantly during the research, we do not know

only indicative of their location. Furthermore, information on their state of preservation, a necessary condition for in situ protection, is usually lacking. In the best case, the location of the tunnel system is known approximately from sketches and annotations on trench maps. The archaeological exploration of such structures so deep below ground level is far from easy, as some past experiences have shown (Barton 2004). Chance finds or deliberate explorations of the underground heritage of mine warfare show that shaft and tunnel systems still exist, but so far it has proven impossible to penetrate galleries at great depths. There are known cases of collapses in underground structures. Farmers in the region are familiar with the phenomenon of ground subsidence or crown holes that suddenly appear from one day to the next. They are caused by the collapse of, for example, a tunnel or other underground structure at aspecific location. The overlying earth sinks into the tunnel and causes a hole on the surface. For safety reasons, that hole is then closed.

The maintenance of such structures in situ is therefore highly problematic. At some locations, the degradation of the tunnel system is clear, for example in the Palingbeek. There, several collapses have already occurred on the site. Asimilar problem occurs with deep dugouts, underground shelters, sometimes very extensive and complex, but usually less deep than the tunnel galleries for undermining. Even there, past experiences with, for example, the Bremen Redoubt have shown that preserving and opening up this type of heritage to the public is particularly difficult. In amanagement vision for this type of heritage, a responsible and substantiated ex situ reconstruction is chosen, as has been achieved in the Memorial Museum Passchendaele in Zonnebeke. Another option to safeguard the archaeological heritage of mine warfare is to use aplanning instrument by, for example, choosing to keep the zone above tunnel and shaft systems as free of construction as possible. The safety argument is an important consideration in this (the risk of collapse, cracks in buildings, subsidence), but safeguarding these deep-lying structures in the long term can also be one. Nothing prevents a municipality or permit issuer from taking into account the presence of mine shafts and tunnel systems when issuing a permit or when drawing up a(municipal) spatial implementation plan.

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