



Interpretation of archival aerial photographs obtained from the United States National Archives and the Head Office of Geodesy and Cartography for the cemetery in Kaluszyn

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Archive search queries

In order to interpret the area of the Jewish cemetery in Kaluszyn, archival search queries were carried out to find and obtain photogrammetrical and cartographic materials. The US Archives and the Head Office of Geodesy and Cartography (Główny Urząd Geodezji i Kartografii, GUGiK) in Poland were searched.

1939-1945 aerial photographs available in the United States National Archives and Record Administration (NARA), Record Group 373

As part of an order to search for aerial photographs, search queries were performed in the United States National Archives and Records Administration¹ (NARA) for photographs covering the cemetery area in Kaluszyn from 1939 to 1945. The search query concerned group 373 collections.

The collections in group 373 comprise sets of aerial and satellite photographs, as well as cartographic and architectural materials. The search query included 373.3 series consisting of aerial photographs taken in 1935 to 1960 by both German and Allied airmen².

The photographs available in the archives are shared on a public domain basis.

Information from the website of the United States National Archives on public domain, possibility of using and indicating the source:

“The vast majority of the digital images in the Online Catalog are in the public domain. Therefore, no written permission is required to use them. We would appreciate your crediting the National Archives and Records Administration as the original source.”

Based on the results of the search query conducted in the archives, a list of photographs was created for the cemetery and the photographs available were ordered in the archives.

¹ The Archives Address: National Archives at College Park, 8601 Adelphi Road, College Park, MD 20740-6001

² the collection of photographs taken by the Allied airmen consists of 2,863,800 pieces, and by the German airmen — 1,209,520

The obtained photographs

As part of the order, two German (Luftwaffe) aerial photographs were obtained and scanned with EPSON Expression 12000 XL scanner at 600 DPI. The original paper prints available in the archive were scanned.

Technical description of the obtained photographs

1. **Signature: GX 12333**

A series of photographs taken with 506 mm cone Carl Zeiss RB-30 camera. Only the year of the photograph obtained is known: 1944. The obtained images are of very good quality. There is no mist and clouds which may hinder interpretation.



Figure 1. An aerial photograph taken in 1944.

2. GX 8058 SK

Pictures taken with RB 18 camera with 210.77 mm cone focal length. During the invasion of Poland in 1939, except Rb30, cameras marked with Rb 18 symbol were used. They were manufactured by Zeiss Aerotopograph GmbH. These cameras shot images on a perforated superpanchromatic film produced by AGFA company, 20 cm

wide and 10 m long. This allowed to take approximately 50 pictures per reel. Lens cones of 20 cm focal length, available in batch production since 1931, were used most frequently. Cones of 500 mm focal length were available for special purposes from 1935. Other names of these cameras, such as MK HS181810 or Zeiss RMMK 2111, also appear in the literature. Given that the authors of the publication state that they used original 18 x 18 cm photographs (or scanned images), the Rb 18 cameras can be assumed in this case.

For this flight we have copies of German photographs. A method of making prints on paper which may have been produced by Kodak was used here. The obtained photogram is probably a 3. or 4. generation copy — frames of the duplicator used to copy the German photographs can be seen. This did not affect the radiometric quality of the photograph. The exact date the series of photographs was taken is unknown. It may be assumed that the date of taking the photograms is probably the year 1941 or 1942. The photograph was used in the interpretation process.

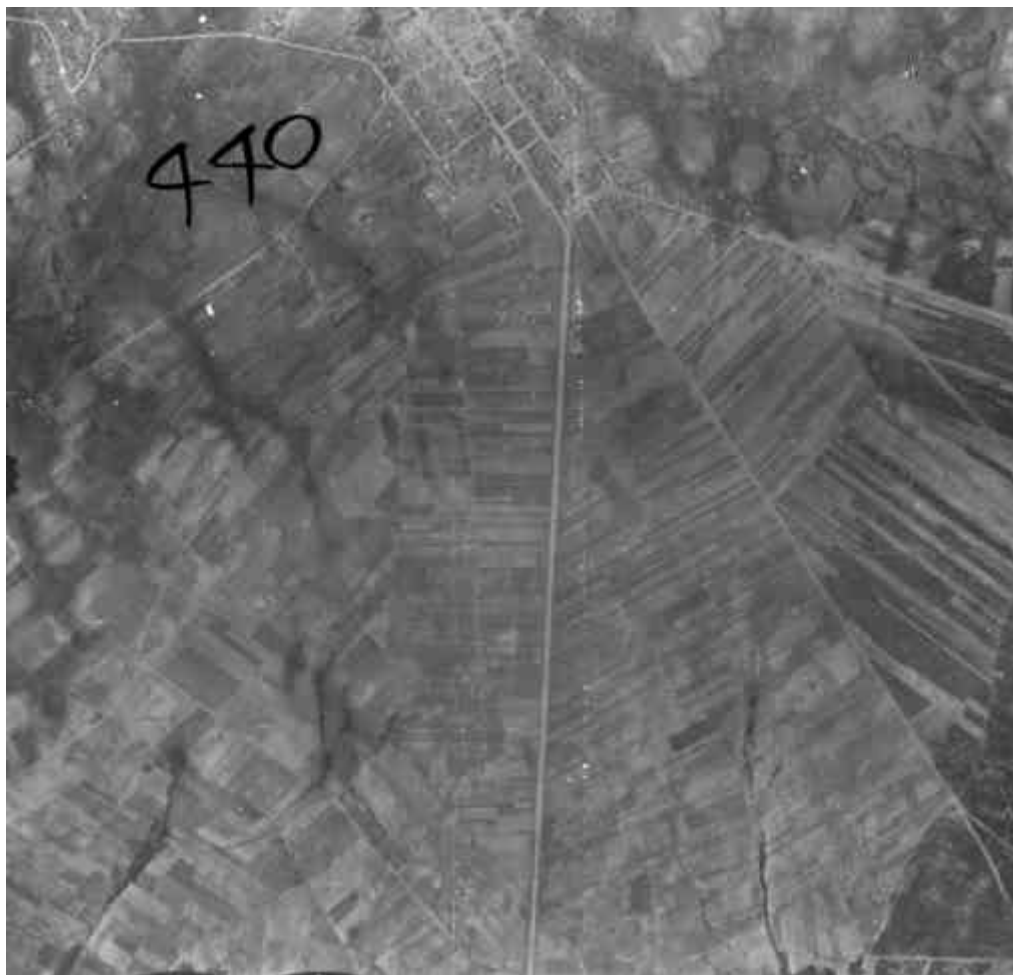


Figure 2. An aerial photograph, probably taken in 1941–1942.

Aerial photographs, orthophotomaps, and laser scanning data from the National Geodetic and Cartographic Resources

An orthophotograph is a product obtained by the geometric processing of an aerial photograph. This process, known as ortorectification, is commonly known as the change of the central projection to the orthogonal projection. An orthophoto is shown in a specific mapping and coordinate system and provides adequate situational accuracy. Unlike an orthophotomap, it does not maintain a prescribed section/sheet breakdown and does not become an end product, but is an intermediate product. An orthophotomap is a collection of mosaicked orthophotographs. In Poland, orthophotomaps collected in the Central Geodetic and Cartographic Resources are made available by the Head Office of Geodesy and Cartography. As part of the performed task, aerial photographs and orthophotomaps from **1947, 1958, 1997, 2010, and 2020** were collected for the cemetery. The selection of photographs was preceded by an analysis of the possible use of available photogrammetrical materials in Polish archives. The parameters of these photogrammetrical materials are presented in Table 1.

Table 1. Obtained aerial photographs and orthophotomaps from the Head Office of Geodesy and Cartography (pl. GUGiK).

No	The date the photograph was taken	Picture/ortho type	Technical specifications
1	1947	Panchromatic	Camera: Wild RC5 Recording format: TIFF Scan Resolution: 1200 DPI
2	1958	Panchromatic	Camera: Wild RC5 Recording format: TIFF Scan Resolution: 2400 DPI
3	1997	Panchromatic	Recording format: GeoTIFF Pixel: 50 cm
4	01.08.2010	IR	Recording format: GeoTIFF Pixel: 25 cm
5	19.07.2020	Colourful	Recording format: GeoTIFF Pixel: 25 cm

Laser scanning data

The laser scanning product is a collection of points in the spatial coordinate system (X, Y, Z), the so-called point cloud. These are the points of reflection from the surface of the land and objects "protruding" above that surface, such as buildings, trees, power line cables. The most common use of laser scanning is the construction of a numerical model of the terrain — Digital Terrain Model (DTM), or Digital Elevation Model (DEM), which represents the physical surface of the terrain with its morphological forms. In this case, the points resulting from the reflection from objects "protruding" above the surface of the terrain must be removed. The survey used a point cloud of the density of 4 points per square meter, acquired in April 2015. It has been processed in RVTools and QGIS software, which has resulted in the following products covering the areas of research:

- a numerical land model which represents the terrain without high and low vegetation;
- shaded maps;
- visualisations based on Principle Component Analysis (PCA);
- sky view factor;
- topographical openness;
- local dominance.

The above products, resulting from the processing of the digital elevation model, contain valuable information about the analysed area. Historical or archaeological research uses shaded maps, slope maps, exposure maps and visibility maps most frequently. Appropriate parameters for such processing, selected according to the characteristics of the surface, highlight the characteristics of the terrain, which are particularly useful in analysing the activities carried out in the area under consideration. The processing of DTM has been treated as supporting material in this paper.

Summary

The archive materials described in this chapter in the form of aerial photographs and maps will allow the interpretation and analysis of the cemetery area. As part of the order being performed, the current spatial data set, available for the development area, was also acquired and described. This material will help refer the results of analyses and interpretations of archival materials to the current terrain situation. **This is of great importance for planning field studies, both non-invasive and invasive ones, as well as for future memorialising.**

Research methodology

To define the boundaries of the cemetery and for the sake of interpretation, archival and current data relating to the surrounding area will be used. Archival data in the form of aerial photographs taken during the second World War and topographical maps are the main material for recreating the boundaries of the cemetery and for analysing the historical coverage of the area.

In some cases, laser scanning data showing the terrain may be a very useful source of information.

Current data in the form of aerial photographs will be used to reference (georeference) archival data and will allow visualization of the selected archival objects on the current background.

QGIS software was used for practical interpretation and analysis of the terrain. In the first stage of the works, vector layers were acquired, showing the cemetery border and the terrain objects and damage seen in the 1942 and 1944 photographs: the building, fence, inner roads, tree/bushes, and terrain damage. The vector layers created allowed the creation of graphic attachments. All the data obtained from the interpretation have been written to the National Spatial Reference System: system 2000, zone 7 (UTM 34N for survey). This helped generate geodetic coordinates of the selected objects. These coordinates will allow to map the identified objects in the area in the aerial photographs taken in 1942 and 1944.

Interpretation of an aerial photograph taken in 1942 and 1944

The entire cemetery was recorded in the photograph from December 1944 and its interpretation is possible. There is no snow on the ground. The 1942 photographs were probably taken in spring. Their quality is good. First, all physical damage to photo emulsion, which may affect the interpretation results, has been identified. The obtained photographs are original paper prints stored in the archive for more than 80 years. The materials shall be made available to all interested parties. In the photographs used (see Figure 3), we have, among other things, the following cases:

- a) emulsion scratches (indicated by arrows),
- b) emulsion chips (outlined with circles).



Figure 3. Physical damage to the 1942 aerial photo emulsion.

Despite the physical damage indicated, the picture quality is good.

Black and white aerial photographs show the recorded area of the terrain in shades of grey between extreme tones of white and black. The grey tones in the photograms are so-called direct distinguishing features which help identify objects. **The tone** of the object is closely related to the rays reflected from the object and recorded on the film. The object perpendicular to the light source will reflect the most rays and will be the brightest in the photograph, regardless of the colour it physically has. The tone of the object in the image is also affected by the nature of the surface itself. The smoother the surface, the brighter the tone in the picture. In contrast, the tones in the photograph defining vegetation are dependent on a phenological factor, e.g. green grass is photographed in a dark grey tone and dried grass — in a light tone.

Other direct distinguishing features include the shape, size, and shadow of individual objects.

The shape in aerial photographs is most often used to distinguish natural objects from man-made objects. The latter are characterized by a regular geometric shape. The exterior appearance of a building, in some cases, even allows it sometimes to recognize its purpose (to distinguish between residential and industrial buildings).

Shadows are divided into cast shadows and self shadows. When reading, orient the picture with respect to the light source. A cast shadow is a shadow cast by objects on the surface of the ground or on other objects. A self shadow is the shaded part of the photographed object. Based on shadows, you can calculate the height of an item. Remember that the shadow cast onto the dips increases, while it decreases in case of rising terrain. Also note that when the sun is low above the horizon (e.g. in the morning), the shadows will be longer, causing the object to deform.

Cemetery fence

The interpretation process began with an analysis of the topographic archival map in the scale of 1:25000 (Figure 4). The map was probably released in 1939 by the Polish Military Geographical Institute. The map shows the cemetery and the funeral house (Figure 4). The contours of the cemetery's border are close to the border shown in the aerial photographs taken in 1942 and 1944 (Figure 5).



Figure 4. A fragment of a topographic map with the cemetery highlighted. The arrow indicates the symbol (black square) representing a building — probably the funeral house.

The initial location of the cemetery on the topographical map allowed the exact location of the object in the aerial photographs. In order to determine the border of the

cemetery, data from the Land and Property Register was also used. The Land and Property Register, or the real estate cadastre, is a public register of spatial data on land, buildings, and premises, as well as data on property owners. The current **course of the land boundaries does not coincide with the boundaries of the cemetery** as seen in the 1942 and 1944 photographs (Figure 5 and Figure 6). The cemetery's border interpretation was also facilitated by the wall of the cemetery, which survived in 1942. The wall is visible as a light line and a dark (almost black) shadow. If the wall was perpendicular to the light source, the shadow is visible as dark tones blocking objects on the other side of the wall (not illuminated by the light source). In 1942, there was, among others, a wall on the north and south border (Figure 6).

The determined boundary allows **the area of the cemetery** from 1942 to be calculated — 38.218 m² (3.82 ha).

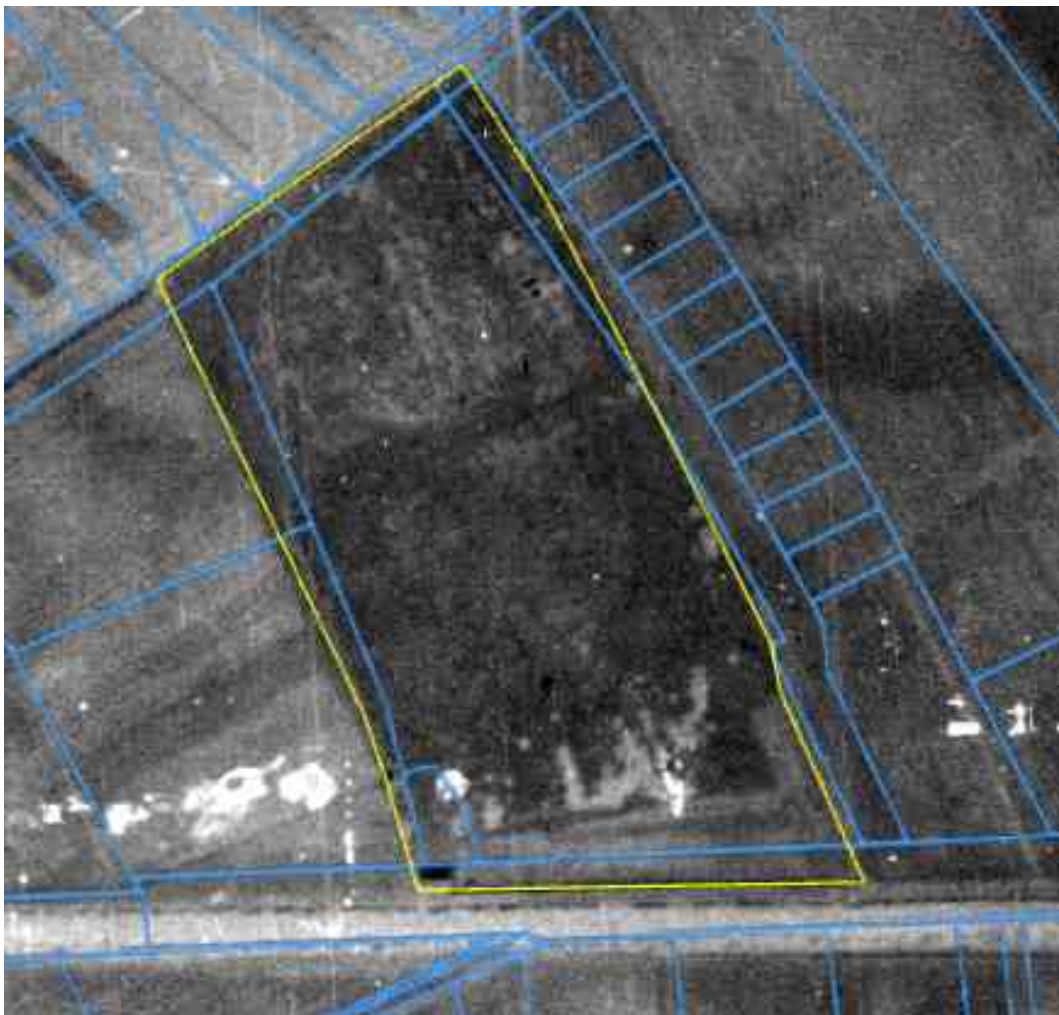


Figure 5. Aerial photograph from 1942. The blue lines are the current boundaries of the land cadastre. The cemetery border from 1942 was marked in yellow.

If the wall was located parallel to the light source, the shadow was minimal, which made it easier to interpret and determine its course — the border of the cemetery. In the photograph taken in 1944, fragments of the wall (eastern and western boundaries) are visible. These are probably residues which could be interpreted due to different lighting on the terrain than in the 1942 photograph (Figure 7). It may be suspected that these parts of the wall could have been dismantled/destroyed during the occupation.

The quality of the photographs allows to define the exact course of the border.

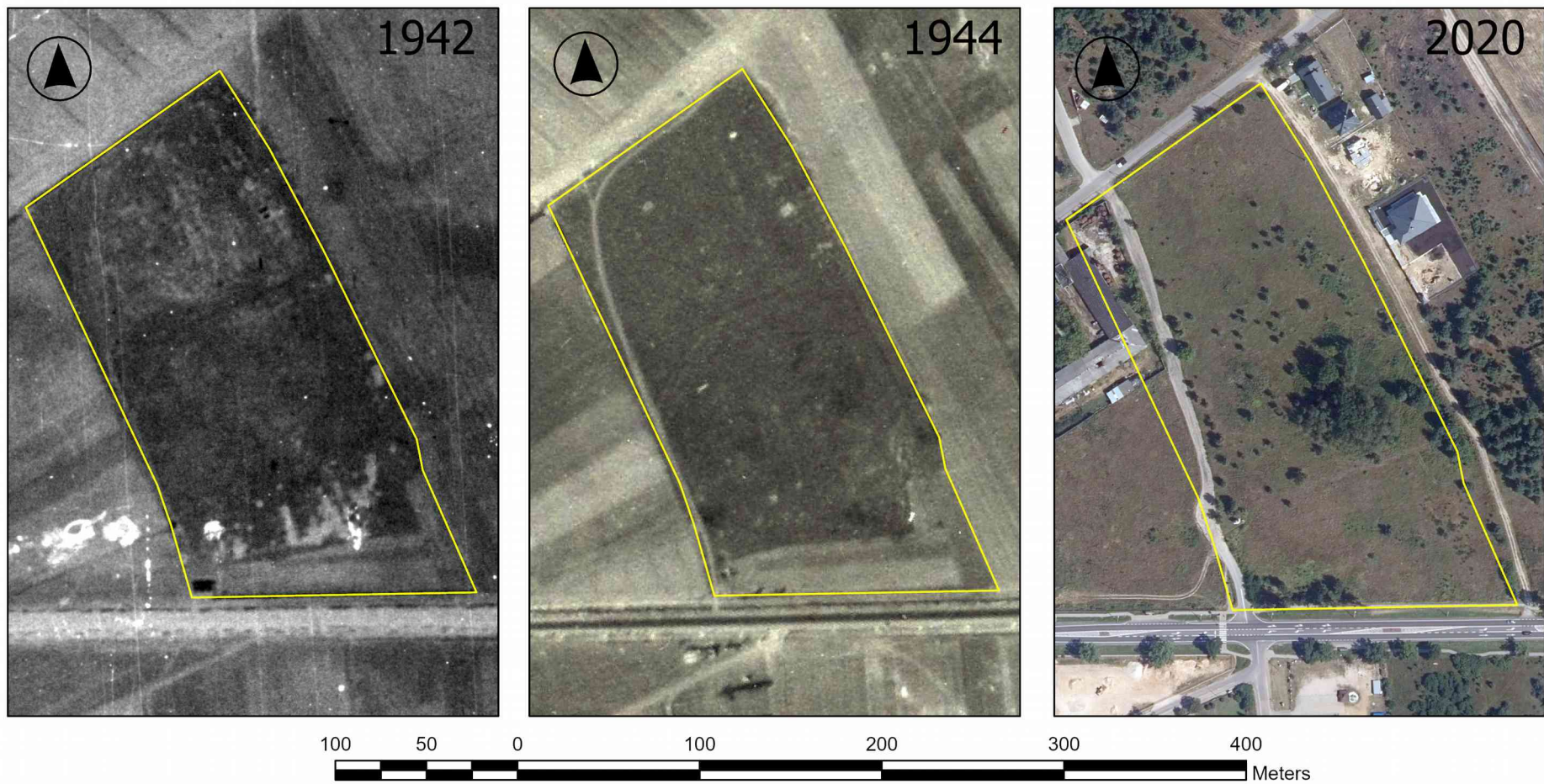


Figure 6. From left: an aerial photo taken in 1942, middle — a photo taken in 1944, on the right — 2020. Border outline defined on the basis of the 1942 and 1944 photos (yellow colour).

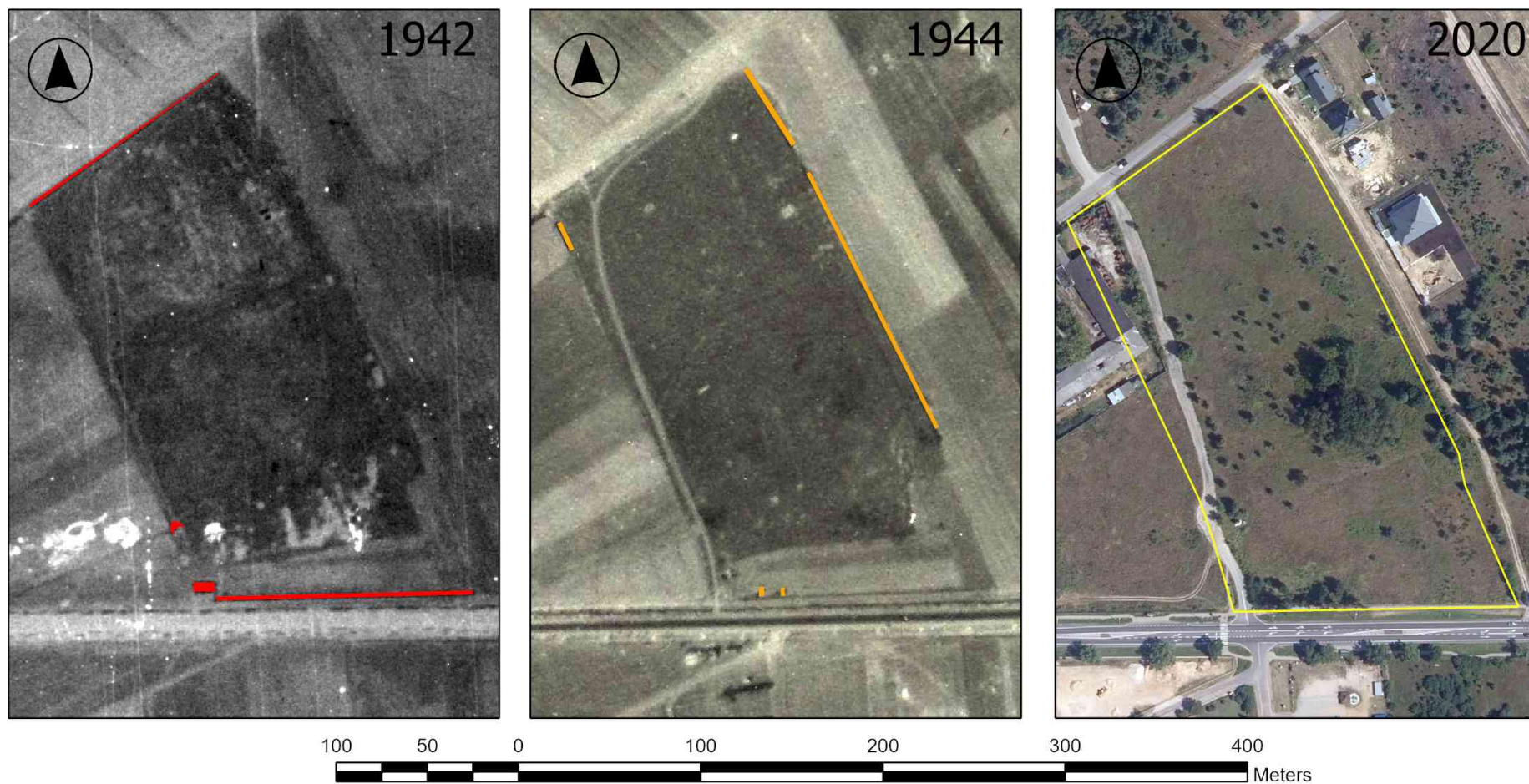


Figure 7. From left: an aerial photo taken in 1942, middle — a photo taken in 1944, on the right — 2020. Cemetery wall/fence shadows (red colour — 1942, orange — 1944). On the right, a 2020 photograph with a border set based on the photograph taken in 1942 and 1944.

Entry gate and funeral house

The next step was to mark the entrance to the cemetery. Probably the entry gate was situated at Warszawska Street. The remaining parts of the cemetery can only be reached along the dirt roads, which would make it much more difficult for the cemetery to function. Therefore, it was assumed that the main gate was in the vicinity of the funeral house.

Next to the entrance there was a building (probably the funeral house), which **is visible only in the 1942 photograph**. The house had a gable roof with one side pointing toward the sun rays, which influenced the light grey/almost white tones (a very strong reflection — glare) — Figure 8. The approximate size of the funeral house is 10 by 5 meters, which gives **an area of approximately 50 square meters**. The funeral house was the opening fragment of the southern cemetery fence.

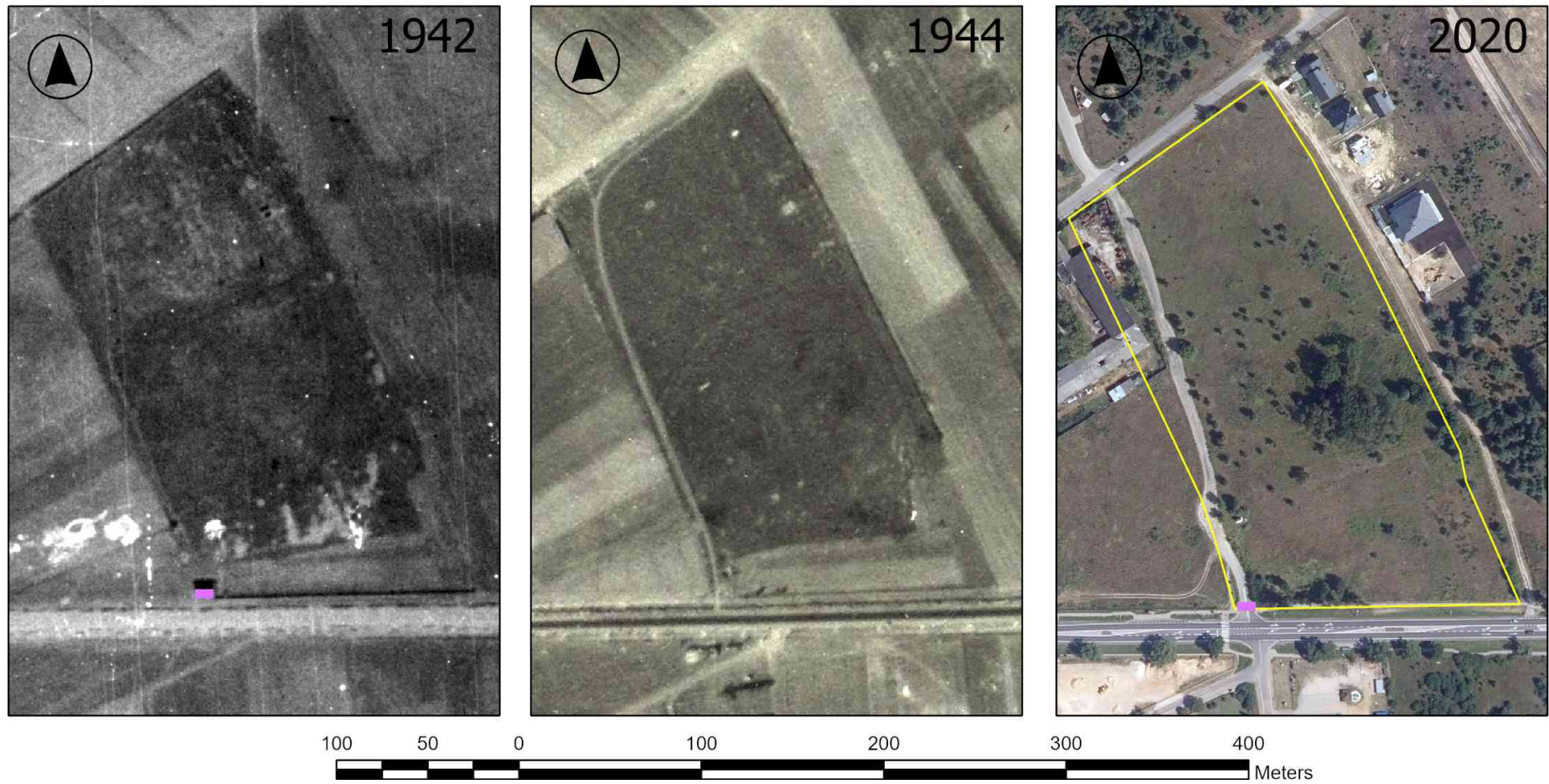


Figure 8. From the left: the 1942 aerial photograph and a rectangle showing the location of the funeral house; in the middle: the 1944 photo (the funeral house is invisible); on the right: the funeral house and border course (from 1942) in the 2020 photograph.

Roads and paths

There is only one main path in the cemetery, which runs parallel to the western border of the cemetery. These are in the form of bright and irregular bands in the photographs taken in 1942, 1944 and 1947 (Figure 9). Paths and roads are important in the topography of cemeteries. They allow to observe the main roads or areas, which are often attended by the cemetery visitors. The path course has changed and looked different on all the material collected (1942–1947).

The course of the path seen in the photographs of 1947 became the current western border of the cemetery, which resulted in reducing its area.

The change in the western course of the border caused the cemetery to decrease by about 0.3 ha (3,200 m²). In subsequent years, buildings were built on this territory.

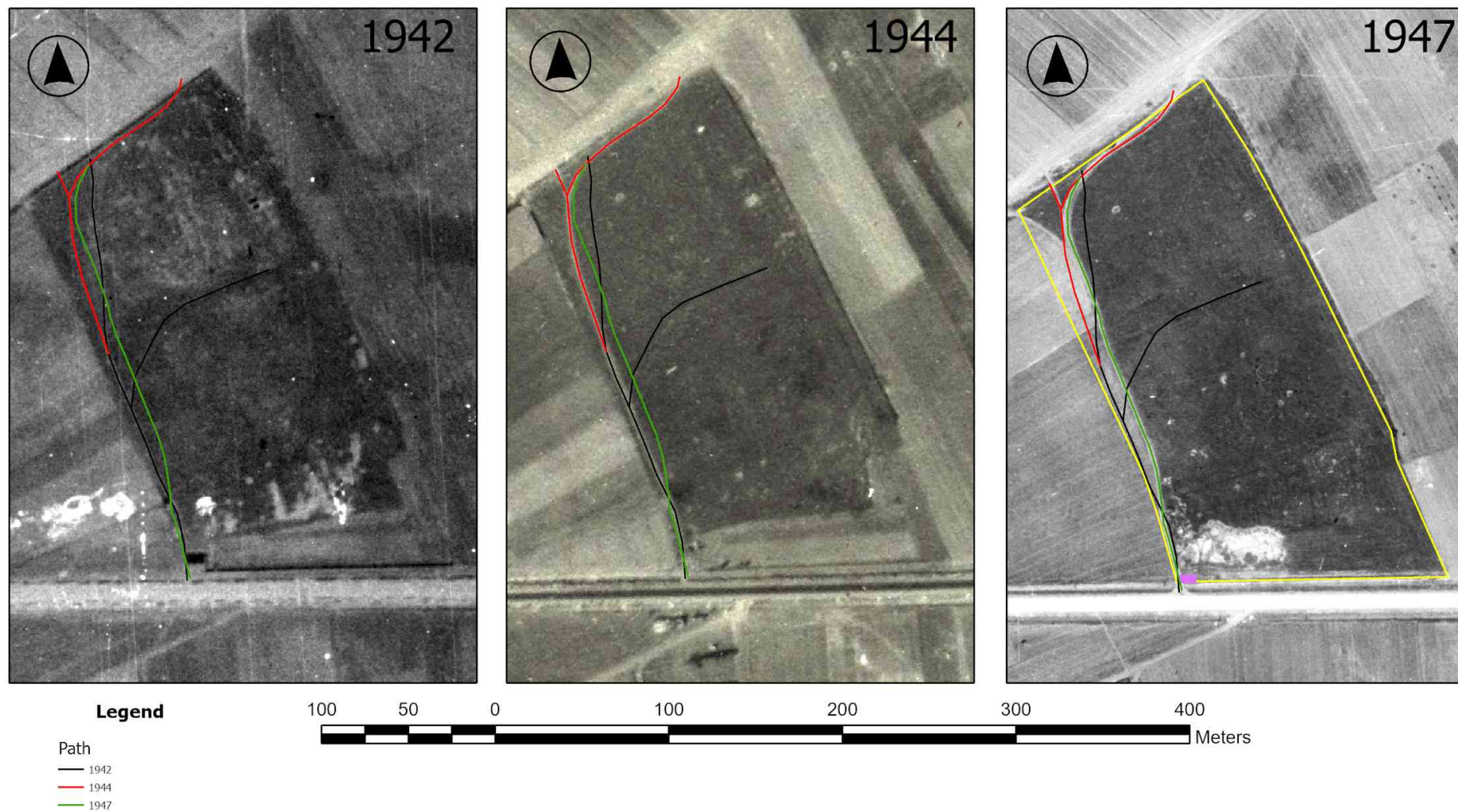


Figure 9. From left: an aerial photo taken in 1942, middle: a photo taken in 1944; on the right: a photo taken in 1947. The course of paths and roads located in the cemetery.

Other objects

Four groups of objects can also be identified in the picture.

- The first is an object casting a shadow. **This can be a structure that rises above the ground** due to the apparent cast shadow (a yellow rectangle in Figure 10). It is located in the vicinity of the road/path which was previously described. This may be an ohel (an obelisk) or its residues. Ohels were usually small masonry or wooden tombstones, most often cuboid in shape. Unfortunately, there is currently a road along the border of the cemetery. However, it is possible that the residues of this object are still in the ground. This object is clearly visible in the 1942 photograph. In 1944, it is less visible. In 1947, the area around the site is heavily dug up. This object is located by the main road, visible in 1942.
- In the southern part of the cemetery there is an area covered by low vegetation. It is similar to a meadow with cut grass. This area is characterized by a granular structure in both 1942 and 1944. In 1947, there are clear lanes in connection with the agro-technical process performed on the ground (possibly mowing). This area is distinguished by its structure and a relatively regular shape from the rest of the cemetery area.
- The northern part of the cemetery has a characteristic grainy structure with apparent irregular field anomalies. The anomaly should be described (in 1942) as minor damage (light grey tones) to the topsoil layer (the ellipse in Figure 10). Vegetation is not growing in these areas (grey tone, dark grey). This damage is no longer visible in the 1944 photographs. This area is already homogeneous in 1944 and is covered by low vegetation (possibly grass or a mown meadow). The reason for the damage observed in 1942 cannot be explicitly described.
- Further damage is located in the southern part of the cemetery and is adjacent to the south side with the low vegetation described above (Figure 10 — on the left). This damage (only visible in the 1942 photograph) can be excavations that reach more than a few centimetres deep. In the 1944 photograph, this area is covered by low vegetation (light grey tones) with darker spots (probably slight dampness due to an earlier

land damage). **The ground damage has a characteristic shape of longitudinal belts with a regular arrangement** (continuity). This may indicate that there are excavations starting from the southern fence and running in a northern direction. It can be assumed that there were burials and executions in these places. This area should be examined using geophysical research (GPR or/and conductometry) and archaeological surveys.

Summary

It is proposed that field reconnaissance should be carried out in the form of geophysical studies and exploratory surveys. The sites selected for accurate field analysis:

- the fence fragments seen in the 1942 photographs,
- the funeral house visible in 1942 (fragments of which can currently be covered by the road),
- the construction rising above the ground (search for residues in the road belt),
- **damage, which may indicate places of execution.**

The last mentioned place relating to possible executions should be examined in the first stage of the investigation. The site is accessible and not overgrown, which favours geophysical research and archaeological surveys in the second stage.

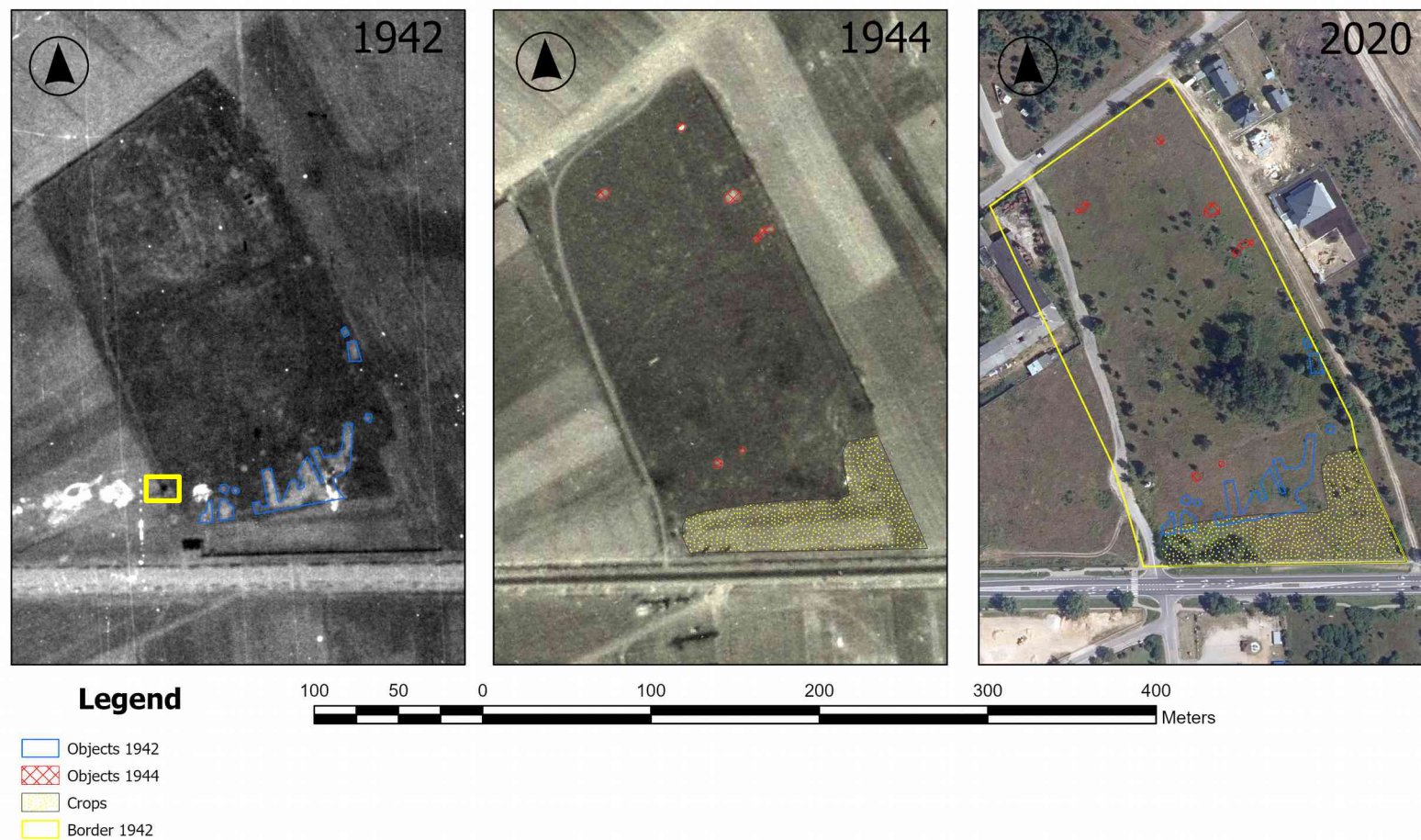
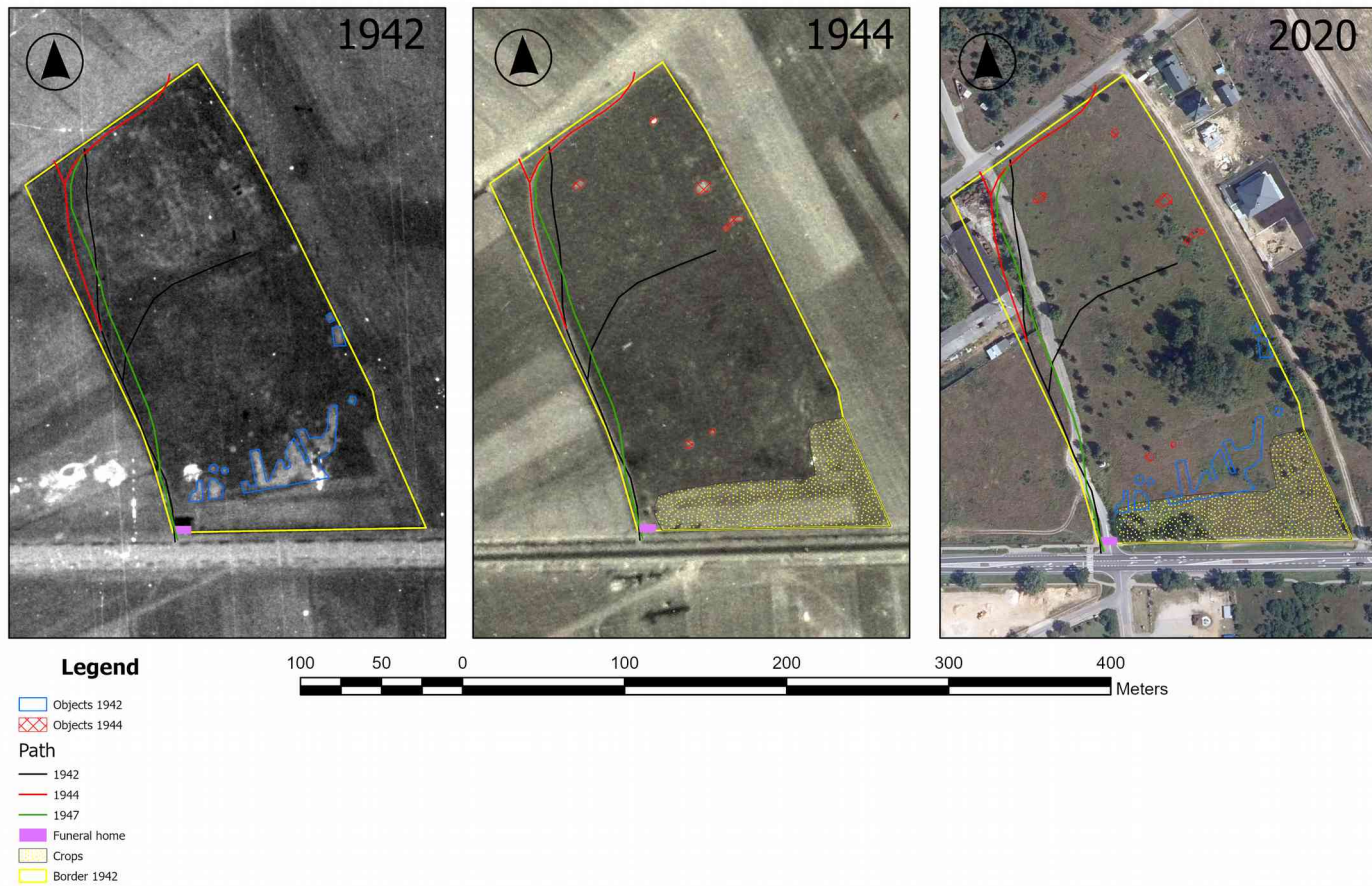


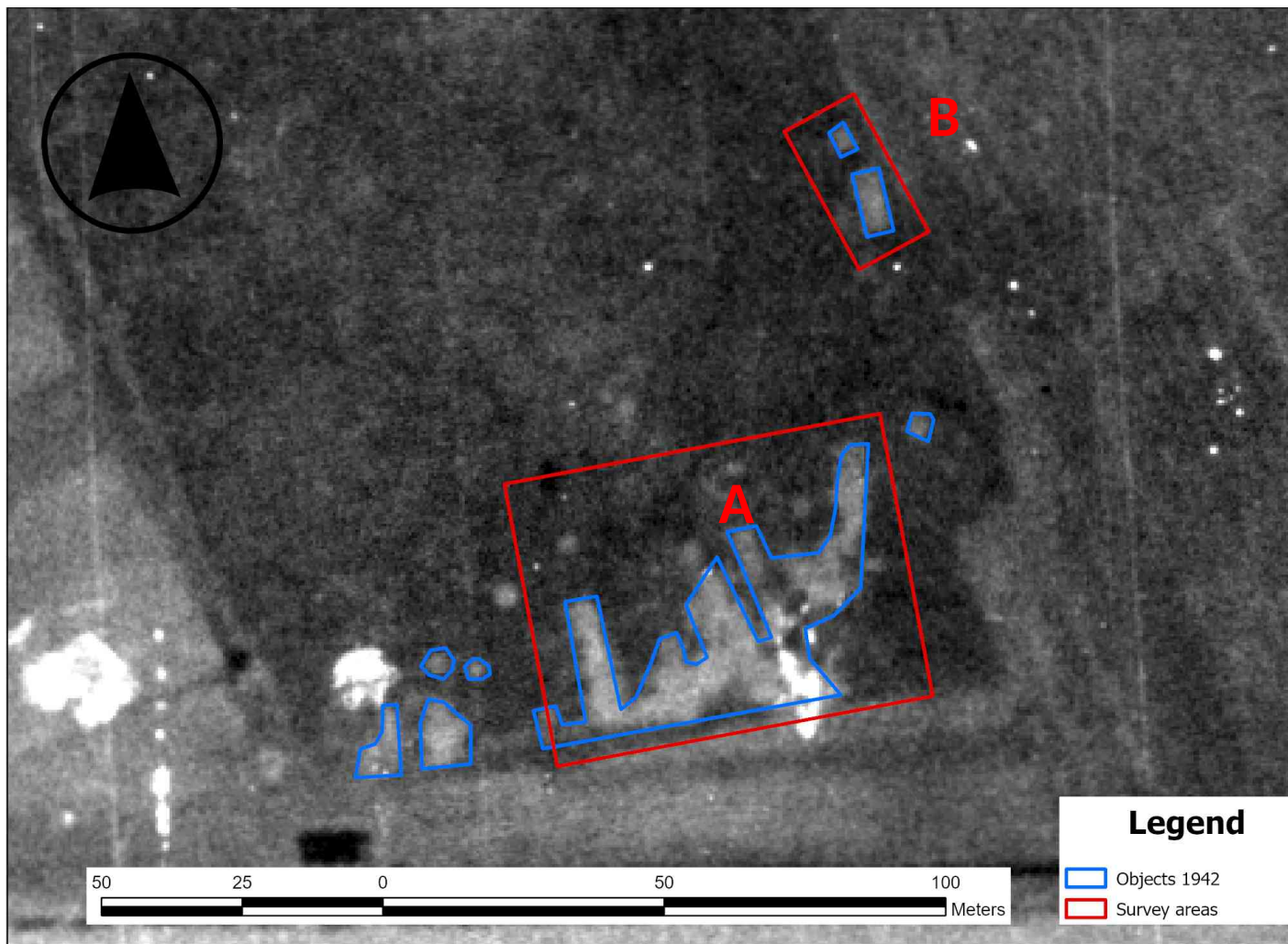
Figure 10. From the right: the 1942 photograph with visible ground damage (blue colour), a yellow rectangle — the object (ohel), a red ellipse marks unrecognised damage; middle: a photograph taken in 1944: the area filled with the yellow texture is probably a meadow, the red areas mark the damage in the ground; on the left: the orthophotomap of 2020 and the damage identified in the photos taken in 1942 and 1944.

Graphics

Annex A. Comprehensive Map

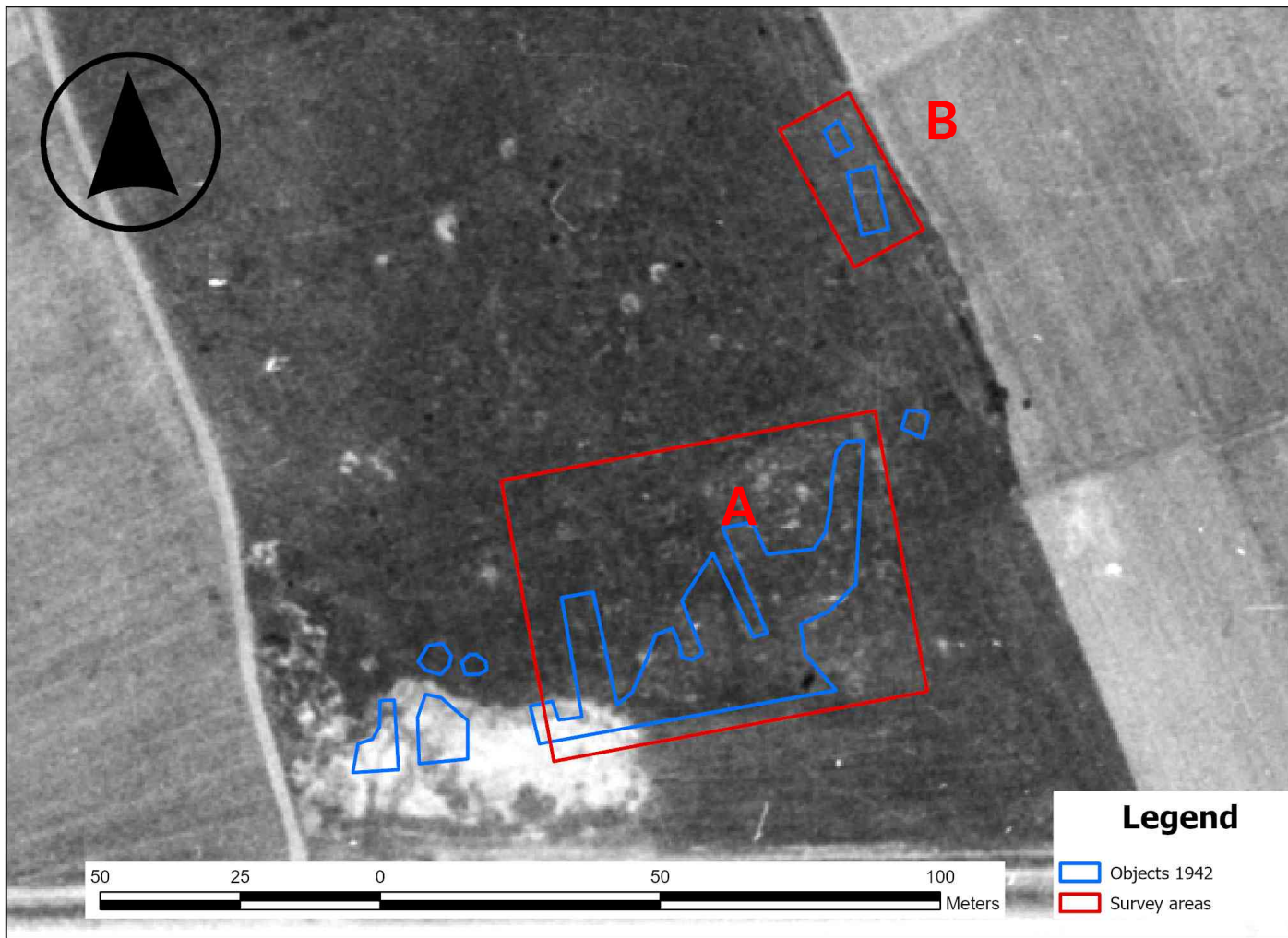


Annex B. Proposed geophysical measurement areas (GPR)



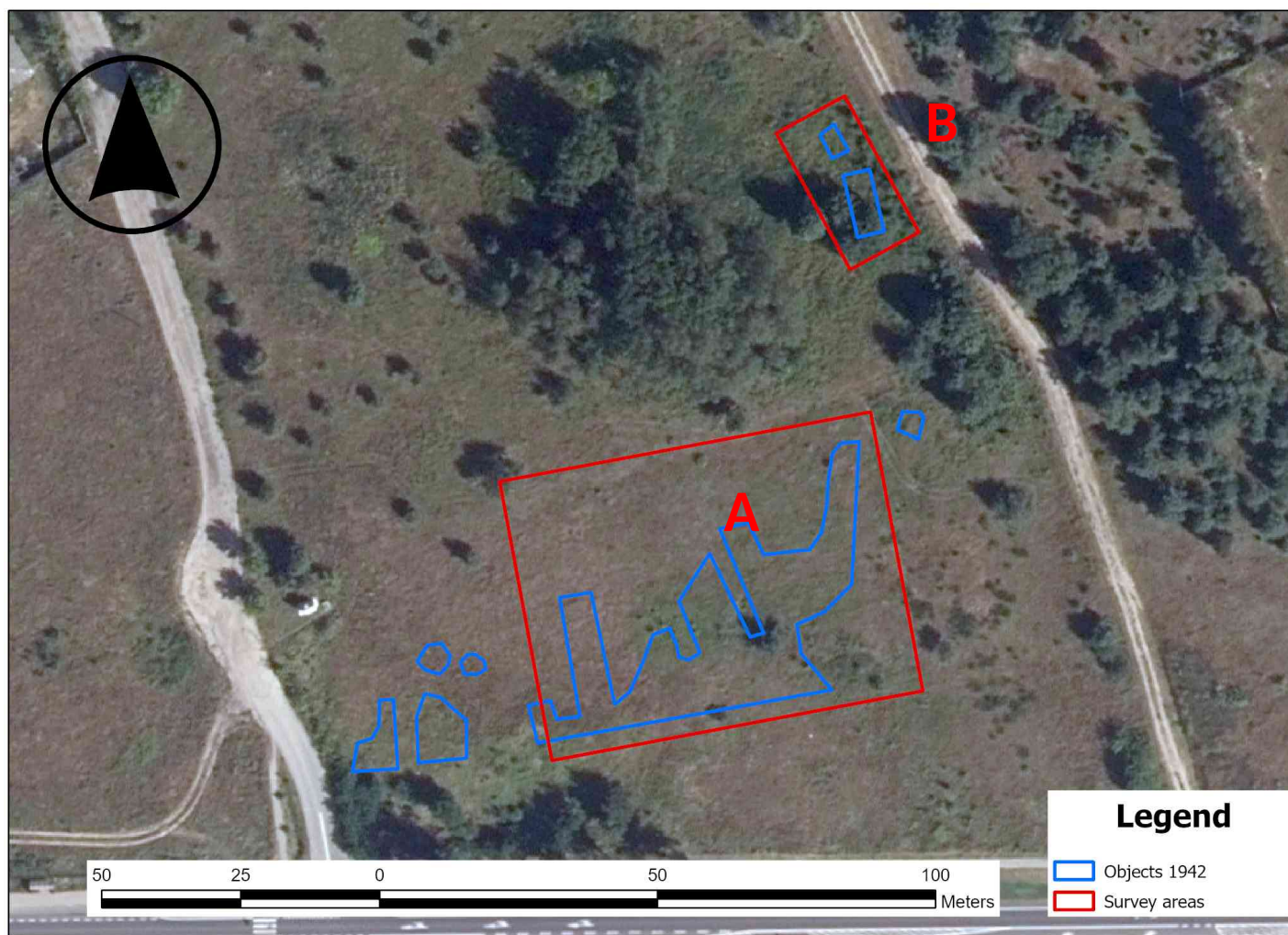
(photo taken in 1942 was used as a background)

Annex C. Proposed geophysical measurement areas (GPR)



(photo taken in 1947 was used as a background)

Annex D. Proposed geophysical measurement areas (GPR)



(photo taken in 2020 was used as a background)

Comment on designated areas for geophysical studies

Two areas (**A** and **B**) have been selected to be subjected to geophysical research. Due to the interference (which took place around 1947) in the land damage, which was determined on the basis of an aerial photograph taken in 1942, it was decided to reduce area **A** where geophysical research was proposed. The damage of 1947 (which may even have led to the movement of suspected burial sites) is shown in Annex C. The damage is superficial and can be seen in the photo (Annex C) in the form of light grey tones. Only the south-west corner of the geophysical survey area (**A**) covers the damage of 1947. The designated area (Annex D) is currently covered with low vegetation, which has a positive effect on the possibility of conducting geophysical research.

Area **B** is smaller than area **A**, but the shape of the damage seen in 1942 in this area shows that there may be burial sites here. There is currently low vegetation (bushes) in the field and trees may be present nearby. Proper management of the measurement profiles and taking into account the current field situation in the measurement results will allow complete geophysical measurements to be made in area B.

Table of points to be used for demarcating areas A and B

(UTM 34 North coordinate system)

N o	X coord	Y coord
0	692737.44	486490.40
1	692804,16	486502.91
2	692794.76	486553.08
3	692728.04	486540.57
4	692791.10	486578.69
5	692803.44	486585.40
6	692790.12	486609.91
7	692777.78	486603.19

A stake-out (survey) draft

