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Geophysical survey of land adjacent
to Gelligaer Cemetery, Gelligaer,
Caerphilly

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Abstract

This report details geophysical surveys undertaken over land to the north of the existing cemetery at Gelligaer in advance of its planned extension. The area had previously been the subject of a field assessment by the Glamorgan-Gwent Archaeological Trust. The interpretation of the geophysical survey data is integrated with their results to provide a revised evaluation of the archaeological potential of the site.

The survey covered two fields and lies to the northeast of the two known Roman Forts (the Flavian Gelligaer I to the north and the Trajanic-Hadrianic Gelligaer II to the south).

The southern field produced evidence for multiple generations of ditches, drains and land-drains, reflecting the extreme wetness of the site and all are probably post-medieval in age (on the basis of cartographic and excavation evidence). One extremely wet hollow towards the south of the field is broadly in alignment with NE gate of Gelligaer II and there is a possibility this marks a road.

The northern field contains a similar array of late drains and boundaries. One excavated ditch (GGAT trench 1 cut [1013]) which is not recorded cartographically, traverses the field in a direction parallel to ditches in the southern field that were recorded in the 19th century, so a post-medieval age would appear likely. This ditch cuts the surface interpreted as the road leading NE from Gelligaer I. The geophysical signature of the road was more complex than expected. The road is poorly imaged as enters the survey area, but becomes represented by a strong positive resistivity anomaly for approximately 15m after passing the line of NW-SE ditch, before abruptly becoming marked by only minor resistivity anomalies on a slightly different alignment. The interpretation of this is uncertain, possibly indicating that the terminal section of the well-made road is free-draining, but alternatively just possibly suggesting that the road has been used as a base for a subsequent rectangular structure. A NW-SE ditch appears to have break for the passage of the road and as it lies on the same alignment as Gelligaer I, it is possible it marks the NE limit of the annex that has been postulated to lie NE of the fort. The eastern part of the northern field shows two closely-spaced NE-SW negative linear resistivity anomalies, suggestive of double-ditches, which turn abruptly towards the NW in the southern corner of the field. Their path after the angle is unclear, either passing into the area of the presumed annex or amalgamating and merging with the NW-SE ditch. The line of the anomalies was cut by GGAT trench 4, which revealed no significant archaeological remains. These features are tentatively interpreted as either a previously unknown enclosure (possibly Roman and military) or as part of an enclosure attached to the annex.

In summary, the geophysical data provide little evidence for significant archaeology in the southern field apart from the very tentative road, but the northern field shows several features of significance.

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Methods

Survey rationale and background

The survey was undertaken on behalf of Caerphilly County Borough Council and commissioned by Mr Bob Napper. It was undertaken as a part of a Community Engagement project, coordinated by Victoria Lewis.

The site comprises an area intended for use as an extension to Gelligaer Cemetery, but a field evaluation conducted by the Glamorgan-Gwent Archaeological Trust acting for Caerphilly Council (Dunning 2012) identified features of archaeological interest within the area, including a Roman road towards the west of the site and a scatter of Roman artefacts towards the east. The purpose of this geophysical survey was to attempt to clarify the location and extent of any surviving buried archaeological features.

The majority of the survey was conducted between the 16th and 20th of September 2013 in cool, mostly rather damp, conditions. The ground resistivity survey in the southern field was undertaken later, on 24th-25th October, in a period following very heavy rainfall with much groundwater.

The site lies on a slightly hummocky topography of Devensian diamicts, resting on solid geology comprising the Grovesend Formation (uppermost part of the Carboniferous Coal Measures). The westward limit of the superficial deposits is approximately the western boundary of the survey area. This setting means that both the hummocky topography and the tendency of wet conditions are in stark contrast to the area immediately to the west.

In all cases where a high degree of certainty on the presence/absence of archaeological features is required, or a high level of interpretation of those features, then additional investigations, usually including intrusive testing through trial excavation, may be required. Geophysical survey results should not be relied on, on their own, to provide unambiguous interpretations.

Survey layout

Surveys were laid-out using a Trimble 4700 survey-grade RTK GPS system. For the main phase of survey, a base station was created in the southern field on the first day of the survey. GPS data were logged by a Trimble 4700 receiver for 1 hour and 24 minutes. Data were converted to RINEX format and were (together with RINEX files from the five closest OS passive net stations) backdated using the *RinexDates* utility to permit baseline processing in *Trimble Geomatics Office*. The data files were then post-processed to give a location for the basestation accurate to within a few millimetres.

The location of the base station (STN1: an arbitrary point within the field) was determined as:

N= 197291.04
E= 313546.36
Z= 209.58

The corrected base station was then employed to lay out the survey area using locations marked at 'round-number' 20m intervals of National Grid. The grid pegs were positioned to within 40mm of the correct location reported by the GPS, which should mean they have a

final accuracy to within approximately 50mm of National Grid.

For the second phase of survey, the process was repeated with a second arbitrary base station (the first one having been removed because a second phase of survey was not anticipated at that stage). This second station, STN2, was logged for 12 minutes to give corrected coordinates of:

N= 197286.89
E= 313550.83
Z= 209.18

The stakeout was undertaken using a Trimble 4700 RTK rover unit controlled by a TSCe running Survey Controller v11, with OSTN02 calibration files. The 20m grids were marked by temporary canes and spray paint marks, to avoid leaving a trip hazard.

During the second phase a nail was positioned close to the edge of the road in the corner of the present cemetery, in order to be able to act as a base station location should any further work be required. This nail, STN3, was located at:

N= 197272.47
E= 313490.96
Z= 217.50

The grid locations are shown in Figure 1.

Ground resistivity

The ground resistivity survey was undertaken with a Geoscan RM15 resistivity meter, operating a 'parallel twin electrode' configuration, employing three electrodes with 0.5m probe spacing on a PA5 frame, via an MPX15 multiplexer.

In this configuration, the mobile electrode pairs had a 0.5m spacing (giving the main component of the response from 0.5-0.7m depth), with 0.5m between centres, to give a 0.5m effective traverse interval. Data were collected with 0.5m sample interval (i.e. raw data grid has 0.5 x 0.5m node spacing) on grids, walked either in a zig-zag pattern (for complete grids) or in parallel (for partial grids). To provide an exercise suitable for young children, several of the conventional 20m grids were subdivided into 10m grids,

By using a 0.25m N and 0.25m E initial measuring location, the sampling within the grids is symmetrical, allowing walking in an EW direction as well as the conventional NS one. This facility was employed for acquiring data close to the northern margin of the surveyed area. All other areas were walked in a NS direction.

Data were downloaded from the instrument using Geoscan Research's *Geoplot* software. Data were downloaded and collated separately for the 20m wide and 10m wide grids. Data processing in *Geoplot* was minimal, involving removal of any minor data spikes (due to poor electrode contact in the very tussocky grass) using the 'despike' function'. A high-pass filtered version of the data from the northern field was also prepared, to eliminate some of the natural background variation.

Data from both datasets were then exported from *Geoplot* and imported to Golden Software's *Surfer*. The data were gridded by kriging to a node-spacing of 0.125m for production of the final, less pixelated, image.

Magnetic gradiometry

Magnetic gradiometry was undertaken with a Bartington Grad 601 Dual fluxgate gradiometer. Data were collected at 0.125m intervals on traverses 2m apart (giving effective traverse interval of 1.0m; single density).

Data were downloaded from the instrument, assembled and cleaned using DW Consulting's 'Terrasurveyor Lite v3' software. The grids were assembled, the data clipped and the destriping function employed for data in which there was an imbalance between the two gradiometers. The data were exported from *Terrasurveyor* and interpolated to a 0.125m node-spacing using Golden Software's *Surfer* package to reduce pixilation where required.

Results

The survey results are illustrated in figures 2-7.

The resistivity data are of very good quality, with only minimal striping of the data due to slight imbalance between the electrode pairs.

The magnetic gradiometry data are of reasonable quality, although not all the data striping has been able to be removed by software for grids which impinge on the field boundaries. Much of the northern part of the survey area is characterised by a high background noise, with high amplitude, but extremely localised, anomalies, indicative of ferrous debris. Whilst some modern rubbish was easily visible, local anecdotal evidence suggests that some metallic waste may have been spread on the fields along with composted material from recycling, before the land came into Council ownership.

Within the southern field, the magnetic gradiometer shows two distinct areas. To the west of the large composite curvilinear anomaly there are a large number of irregular positive magnetic anomalies up to 2m across. These are absent to the east of the curvilinear.

The ground resistivity data are presented in Figure 2 (as a raw bitmapped images from *Geoplot*), Figure 3 (as a bitmapped image from *Geoplot* of the processed and high-pass filtered data), Figure 4 (as the interpolated cleaned data from *Surfer*) and, Figure 5 (as the interpolated cleaned and high-pass filtered data from *Surfer*).

The magnetic gradiometer data are presented in Figure 6 (as a bitmapped image from *Terrasurveyor* of the raw, but destriped, data) and Figure 7 (as the interpolated data from *Surfer*).

Interpretation

The resistivity survey shows a very irregular background, reflecting the slightly hummocky drift deposits, with irregular patterns of groundwater distribution. Removal of some of this variable background was the main purpose for the generation of high-pass filtered datasets.

The magnetic gradiometer data show a few marked dipolar anomalies. These are indicated as red dots on

Figure 9. Some may simply be large pieces of ferrous detritus. The pair of such anomalies present in the northern field within the general line of the former field boundary (the red line on Figure 9; the grey-green line on Figure 10 labelled 'f') are strongly suggestive of a former gateway.

One such point anomaly in each field corresponds to the observed location of monitoring boreholes that have steel casings and caps. These are indicated 'a' on Figure 10.

The magnetic gradiometer survey shows numerous linear anomalies, in both fields, all with 'speckled', variable sense components. These anomalies are indicative of small highly magnetic (either showing high ferromagnetism or high magnetic susceptibility) materials in linear arrays. Information from map regression and from the GGAT evaluation trenches suggests that these features are not all of the same type. However, most of these linear anomalies are likely to be due to cut features, either buried ditches or land-drains, that include magnetic materials. Some of the features marked by less-intense anomalies may be ceramic land-drains, but others may be French drains with a component of magnetic material in the fill (one GGAT trench recorded a drain bearing a plastic pipe). The minor examples interpretable as land-drains are marked in green on Figures 9 and 10 (on which they are marked 'c'). These features are variably expressed in the resistivity data, but mostly appear as rather minor negative linear anomalies, shown as black lines on Figure 8.

The major curvilinear features in both fields correspond to the location of land boundaries on pre-1960s maps, and may include debris from former metallic fencing, probably within former ditches. They are shown in the resistivity data by negative resistivity anomalies suggestive of significant ditches. These are marked in grey on Figure 8, red on Figure 9 and grey-green on Figure 10 (where they are marked 'f').

Subsequent to the removal of these field boundaries, two large ditches were dug across the southern field (and are visible on 2001 aerial photography, available via Google Earth). The western ditch closely follows the former field boundary. They are marked in red on Figure 9 and purple on Figure 10, where they are marked 'b'.

A WNW-ESE oriented magnetic anomaly, similar to the 'speckled' texture of the drains/ditches described above but of lower magnitude in the southern field (in brown on Figures 9 and 10, where marked 'd'), corresponds to the southernmost of a series of open drains subdividing the field on the 1st Edition OS mapping. A similar anomaly cuts the northern field, where no ditch/drain appears on OS mapping. This was observed in excavation as shallow ditch (GGAT Trench 1, cut [1013]), with a maximum width of 0.5m, and a maximum depth of 0.35m. The similarity of direction suggests that this ditch may also be post-medieval in age.

Minor lineations within the magnetic dataset (black lines on Figure 9) are suggestive of directions of ploughing, presumably post-dating the late 20th century removal of the former field boundaries. Minor lineations in the resistivity dataset probably indicate disturbance by recent vehicles (not marked on the figures).

Where the resistivity survey suggested earlier archaeological features, they were not resolved by the magnetic survey.

No certain significant archaeological features were observed in the southern field. The low resistivity zone in the SE part of the site (Figure Figure 10 'j'), shows some discrete SW-NE lineations and it is possible this represents, or is associated with, the line of a road from NE gate of Gelligaer II, but this is far from certain.

A variety of complex resistivity anomalies are associated with the line of the road extending NE from NE gate of Gelligaer I. The likely road is only poorly imaged where it enters the survey area from the SW, but rapidly becomes a much stronger positive resistivity anomaly, at approximately the point where it appears to pass through a gap in a NW-SE negative anomaly (suggestive of a ditch at least 2.5m wide, shown in blue on Figure 8 and tan on Figure 10, where it is labelled 'h'). The high resistivity area is marked in dark blue on Figure 8 and in dark grey tone on Figure 10, labelled 'g'. The high resistivity area is associated with a small topographic knoll. It is possible that the high resistivity has been generated by the free-drainage of the road structure from this knoll, but the rectangular outline of the anomaly hints that it is possible there is a structure (approximately 14m x 8m superimposed on the road).

To the SE of the resistivity high, a zone of lowered resistivity arises from the road but skirts to the SE of the road, before passing down-slope to an extant spring. This may be interpreted a zone of groundwater flow, arising from the road surface higher up the slope, by becoming slightly divergent in this area. The bounds of this zone are indicated by green lines on Figure 8.

Down-slope of the high resistivity anomaly, paired anomalies suggest that the course of the road swings from being NE-directed to more ENE (orange lines on Figure 8, pale grey tone on Figure 10).

To the eastern side of the northern field lies a pair of linear negative resistivity anomalies, suggestive of double ditches, each 2-2.5m in width and 1-2m apart, which run SSW up the slope, before swinging around a corner in the SE of the field. Their passage to the west of the corner is unclear. They might turn to become contiguous with the ditch 'h' described above, but equally might turn less sharply to continue WNW (as indicated by the red lines, on Figures 8 and 10, where they are labelled 'i'). The resistivity survey is complex along the SW boundary of the field and discriminating between these possibilities is currently not possible.

Discussion

The high levels of background noise and the strongly magnetic fills/debris associated with the various drains, means that, although there are no clear anomalies due to archaeological features in the magnetic dataset, conditions for determining more subtle archaeological anomalies are poor.

These issues meant that the magnetic gradiometer was, rather unexpectedly, not able to produce a dataset capable of determining the location of subtle archaeological features.

The ground resistivity meter was employed mainly as a child- and volunteer- 'friendly' technique for the 'Community Engagement' aspect of the project, but has actually produced a more useful dataset, even if that dataset is difficult to interpret. Unfortunately, because of time constraints, that dataset was only

produced initially for part of the northern field and a second phase of work was subsequently undertaken to produce a ground resistivity survey of an 80m-wide swath across the southern field.

The anomalies revealed by the ground resistivity survey include, mainly, a variety of linear negative features. These are interpretable as representing the location of buried ditches and drains.

The GGAT field evaluation (Dunning 2012) provides a means of interpreting some of the geophysical anomalies, for several of the anomalies were intersected by the trenches. The GGAT field evidence is not always easy to use, for no locations for features within trenches are given, and even for the more interesting trenches, only unlocated partial plans were presented. The evidence available from the evaluation trenches is:

Trench 1 – this contains a surface interpreted as a Roman road, with an adjacent 'roadside structure'. The road was cut by a pit (not imaged by the geophysics) and by a ditch or drain 0.5m wide and 0.35m deep (of unknown age). The latter feature is identifiable as that shown on Figure 10 as 'e'. The intersection of this cut with the road provides a close location for Trench 1. The GGAT report does not illustrate where in the trench these features were actually found (the 'Plan of Trench 1', Figure 2, and the 'Plan of Trench 1', Figure 3, actually only illustrate an unlocated 6m section of the 20m long trench). However, the minimum difference in location between the trench as illustrated and a location encompassing the intersection of the road and ditch would be that the illustrated trench location is 3.5m SW of its true location.

Trench 2 – this contained the continuation of the road surface seen in trench 1. There are no independent features to locate the trench position, but a possible EW negative anomaly across the area of the 'road' suggests the trench lay 3-4m N or NE of its planned location.

Trench 3 – this contained no features. It lies immediately to the SE of the line of the possible track and a possible land-drain.

Trench 4 – this contained no observed features, apart from a crude cobble surface believed to be an extension to that in the field gate to the south. This trench should cover the line of possible ditches 'i', but these were not observed (though it should be noted that the apparent natural was only examined to a maximum depth of 0.48m below surface, Dunning 2012 p. 6).

Trench 5 – this contained no observed features. It lies just outside the area of the current geophysical survey.

Trench 6 – this trench is recorded as having intersected two modern land drains (aligned NW-SE) and a modern rubbish pit. As with the other trenches, the report contains information as to the location of these features within the trench. Map regression shows the trench lies immediately NE of, or possibly overlaps with, the former field boundary. It also intersects a drain or ditch mapped on early OS mapping (feature 'd' on Figure 10). This ditch is barely visible on the magnetic survey, but other modern more magnetic land-drains, much closer to N-S are much clearer. Although the field boundary disappears from the OS 1:2500 between the 1972 (possibly as late 1986 according to the 1:10000 map) and 1991 editions, a Google Earth image of 2001 shows two

freshly dug drainage ditches, one of which lies approximately on the line of the earlier boundary.

Trench 7 – this contained some Roman artefactual material (pottery and tile according to the report stratigraphic text, but a column base is also mentioned as a find in other sections of the report). The report also describes one and possibly two post holes, one of which still contained remnants of a post – but as with other trenches these features are not located. The location suggests that the W end of the trench was located immediately E of the eastern of the two ditches visible on the 2001 aerial photography.

Trench 8 – this is described as intersecting a cut for a modern plastic pipe running NW-SE. The magnetic survey raises the possibility of the trench intersecting either of two features, at either end of the trench depending on the precise location, but the resistivity survey also hints at a possible more central drain.

In summary, the southern field shows evidence for a post-medieval field boundary, two major modern cuts (one approximately coincident with the earlier field boundary), a post-medieval open ditch or drain and at least four modern land drains (at least one of which was shown by excavation to contain a plastic pipe). These features all reflect the very wet nature of this field, particularly towards its southern part. An area of somewhat elevated resistivity, with a complexly rectilinear outline, lies close to Trench 7 (which yielded Roman pottery and a column fragment). However, the elevated resistivity (area of pale grey tone on Figure 10) appears closely aligned with the post-medieval ditches – and is therefore more likely to be associated with former associated field-banks than with a Roman structure.

The sole possible geophysical evidence for Roman activity in the southern field is the linear resistivity low running SW-NE across the southern part of the field (Figure 10 'j'). This area shows several slight SW-NE lineations and approximately lies on the line of any potential route extending from NE gate of the later fort. The anomaly does not necessarily indicate an archaeological feature, but the location is somewhat suggestive.

The northern field similarly shows a variety of post-medieval land boundaries and drains. A curvilinear ditch-like feature apparently corresponds to the old field boundary that appears on 19th and 20th century maps. Anomalies that resemble those of the modern land-drains in the southern field also occur and lie to the NE of the field boundary. A long ditch or drain (excavated in GGAT trench 1 as cut [1013]) runs NW-SE across the upper part of the field, in a direction similar to that of the open drain in the southern field which was shown on 19th century mapping (features shown as Figure 10 'e').

Features likely to be of Roman origin include a ditch (Figure 10 'h'), through which a road (Figure 10 'g') passes in a narrow break. The nature of the resistivity anomaly associated with the road changes abruptly at this point, as does its direction. This suggests that the ditch marks the NE limit of a significant enclosure, probably that of the annex postulated (Young 2003) to lie NE of Gelligaer I. A very strongly elevated resistivity on the line of the road may possibly indicate a superimposed structure rather than road itself. If this is the case, the length of walling found in excavation (GGAT Trench 1, context 1008) may belong to it, rather than to a roadside structure as postulated.

An apparent length and corner of a double-ditched feature (Figure 10 'i') are suggestive of further Roman military structures. It is not clear however, whether they form a southern corner to an enclosure on an oblique alignment to Gelligaer I, or whether they form one side of an enclosure, perhaps an outer annex, in association with the ditch ('h').

References

- DUNNING, R. 2012. Gelligaer Cemetery, Gelligaer, Caerphilly. An archaeological field evaluation report. Unpublished GGAT report number 2012/057
- YOUNG, T.P. 2003. Geophysical survey of the Flavian fort and adjacent areas, Gelligaer [ST 133972]. *Geoarch Report 2003/17*. 4pp. + 6 figs.

Figure Captions

Figure 1. Layout of survey grids, with respect to key modern features and the 2012 excavation trenches (locations as given in Dunning 2012).

Figure 2. Raw ground resistivity data as a bitmapped images from *Geoplot*:

(a) northern field, greyscale 60 ohm measured resistance (black) to 180 ohm (white).

(b) southern field, greyscale 50 ohm measured resistance (black) to 170 ohm (white).

Figure 3. Cleaned high-pass filtered ground resistivity data for the northern field as a bitmapped image from *Geoplot*, greyscale -30 ohm measured resistance (black) to +30 ohm (white).

Figure 4. Interpolated cleaned ground resistivity data as image from *Surfer*, greyscale 60 ohm measured resistance (black) to 180 ohm (white).

Figure 5. Interpolated cleaned high-pass filtered ground resistivity data as a bitmapped image from *Surfer*, greyscale -15 ohm measured resistance (black) to +15 ohm (white).

Figure 6. Raw (but destriped) magnetic gradiometer data as a bitmapped image from *Terrasurveyor*, greyscale -4nT (black) to +4nT (white).

Figure 7. Interpolated magnetic gradiometer data as an image from *Surfer*, greyscale -3nT (black) to +3nT (white).

Figure 8. Summary interpretation of the ground resistivity data. For explanation see text.

Figure 9. Summary interpretation of the magnetic gradiometer data. For explanation see text.

Figure 10. Summary interpretation of major features. Outline of early fort after Young (2003).

The earlier Roman fort and its possible annex are shown in yellow tone, the later Roman fort in pink tone, with their ditches in brown. The grey tone presents the known or predicted courses of the associated Roman roads.

The outline of the present area of investigation is shown by a dashed line. Point anomalies shown in red and lettered 'a' correspond to the monitoring boreholes. The linear anomalies 'b' shown in purple correspond to two large ditches visible a open features on 2001 aerial photography. Linear anomalies indicated in green and as 'c' are interpretable as land drains, probably of recent date. Linear anomaly 'd' in brown corresponds to a ditch present on the OS 1st edition mapping of the 1870s. A parallel anomaly, also in brown labelled 'e' cut the Roman road in GGAT Trench 1, and is probably also a late (post-medieval?) drainage ditch. The major curvilinear anomalies 'f' are post medieval field boundaries, removed during the 20th century.

Earlier archaeology includes the Roman road, in grey labelled 'g', for which the major resistivity anomaly stops just N of GGAT trench 2, but its line continues, towards the NE as a much lesser resistivity anomaly. A negative linear resistivity anomaly, in blue, labelled 'h', apparently continues either side of the road, but does not cut it (it passes between GGAT trenches 1 and 2). This ditch is parallel to the early Roman fort alignment and might potentially be associated with the NE side of the possible annex.

The parallel negative resistivity anomalies shown in red, labelled 'i', are problematic. Their N-S course to the east is fairly clear on the resistivity survey, but they were not identified in GGAT Trench 4 which lies directly across them. Their SE corner is well imaged by the resistivity data, but their westwards course is less certain – they may either pass WNW as shown, or have a tighter corner and actually link with anomaly 'h' instead. In the first case they potentially form a corner of an unknown Roman enclosure (perhaps a temporary camp?), and in the second case they might form part of a second, outer annex.

A downslope-directed resistivity low 'j', presumably reflecting an underlying hollow, may possibly suggest the line of a road extending NE of the later fort – although it may simply be a natural topographic low on a coincidental alignment.

A complex area of slightly elevated resistivity, labelled 'k' and shown in grey tone, has a somewhat rectilinear outline, but this appears closely related to the orientation of adjacent ditches – and so probably is related to banks alongside the post-medieval ditches.

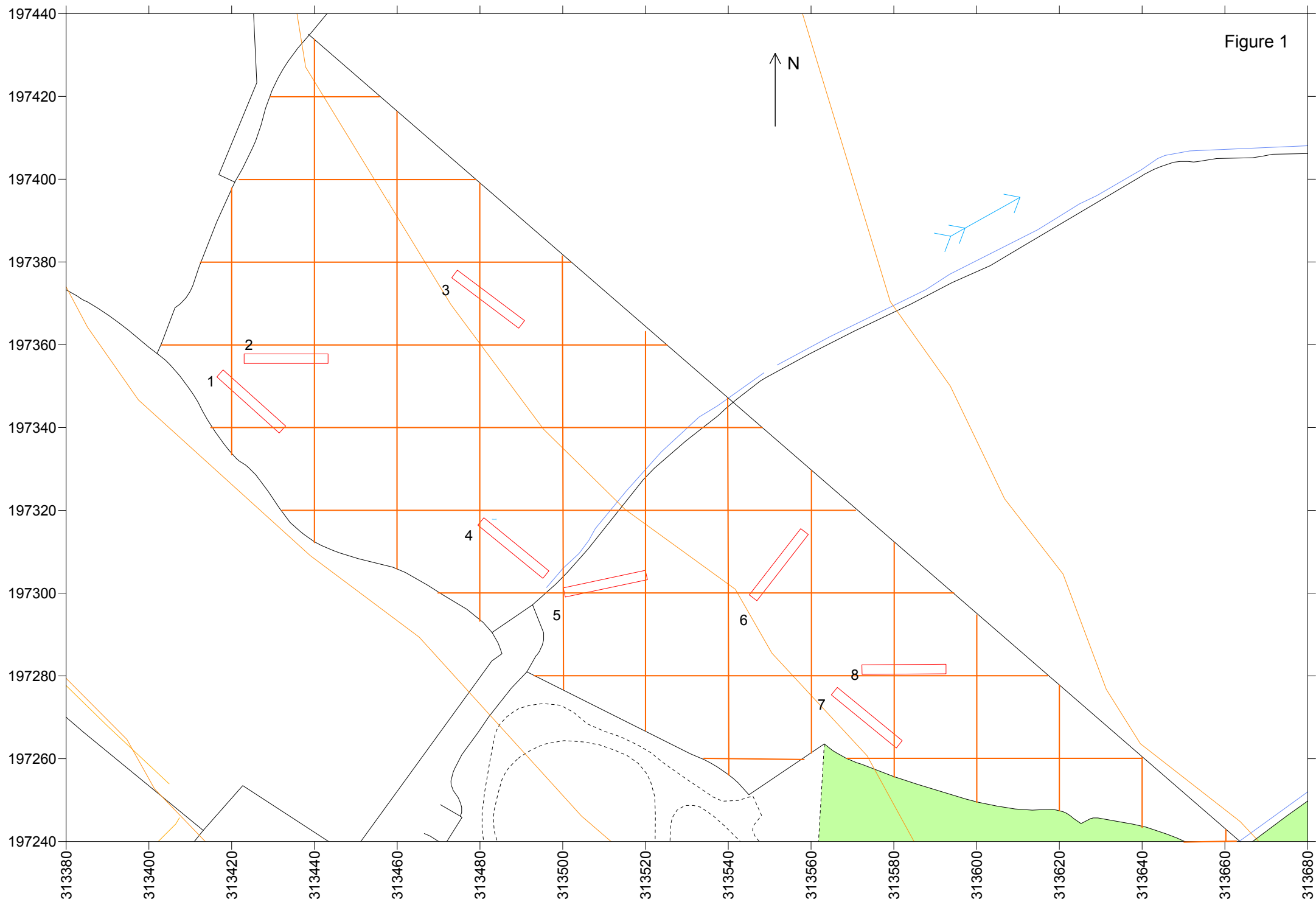
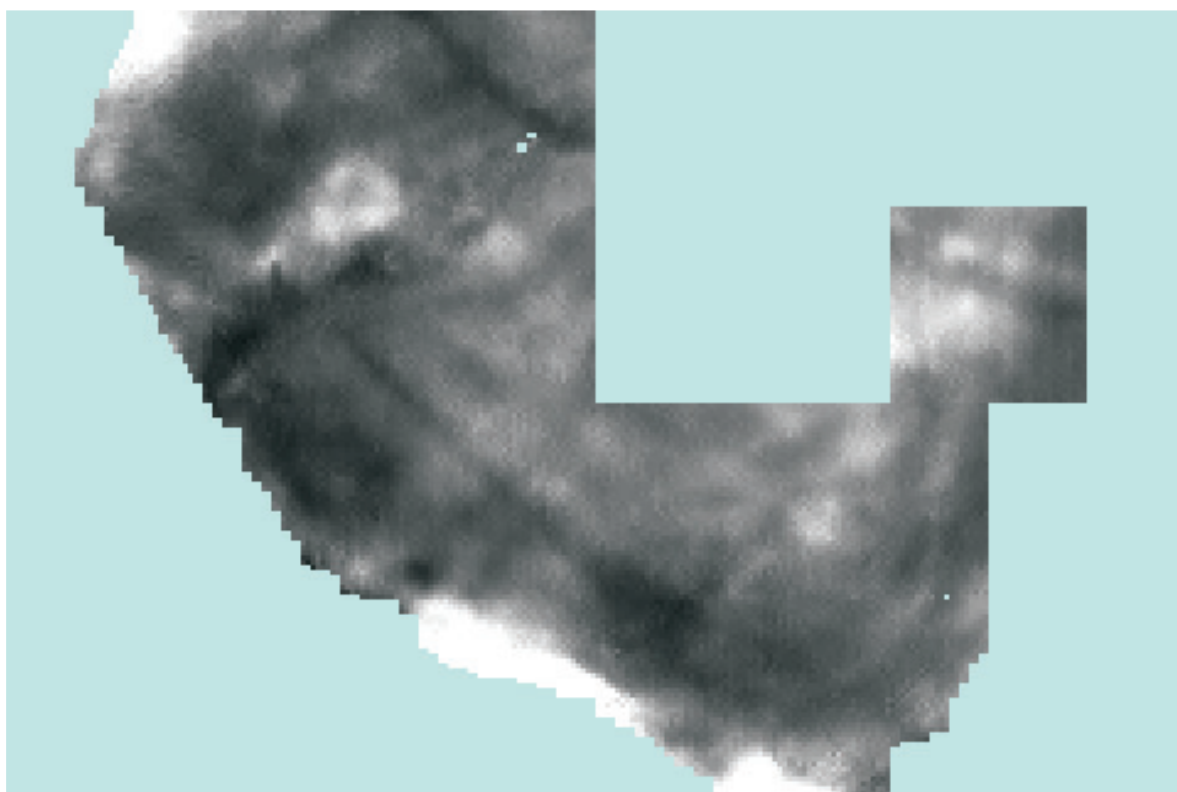


Figure 2

(a)



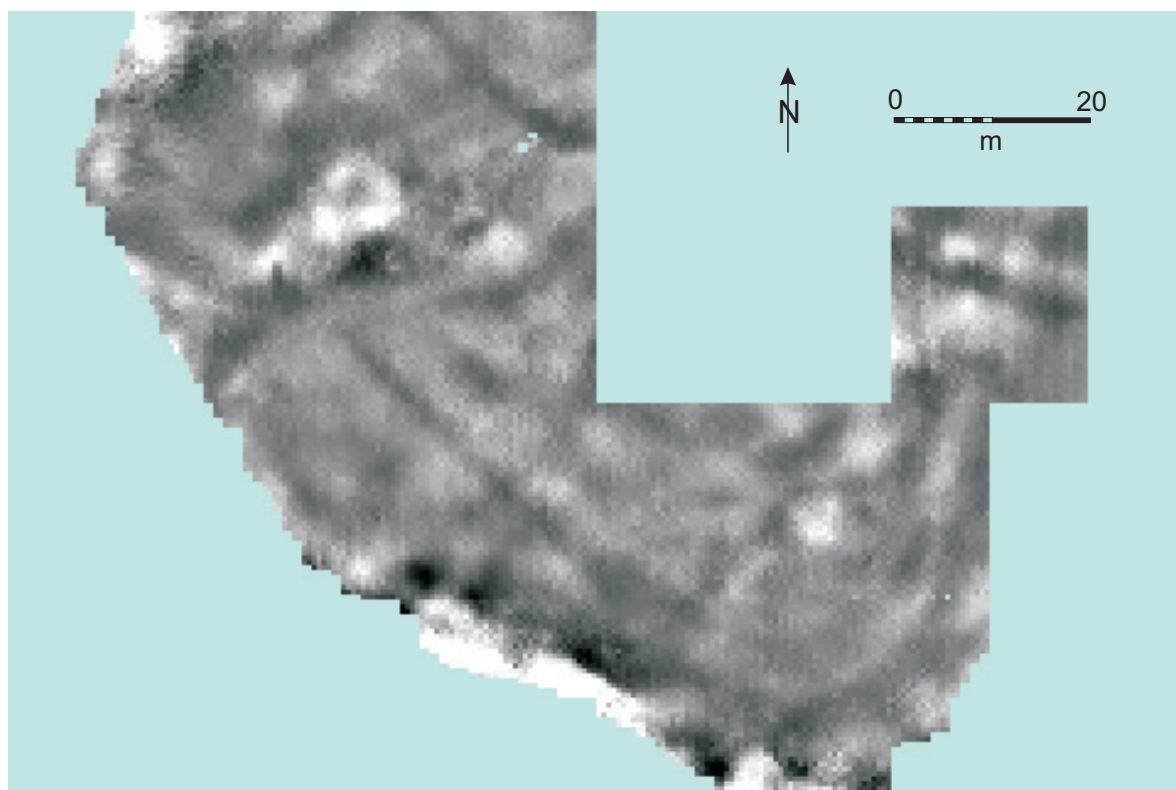
(b)



0 20
m

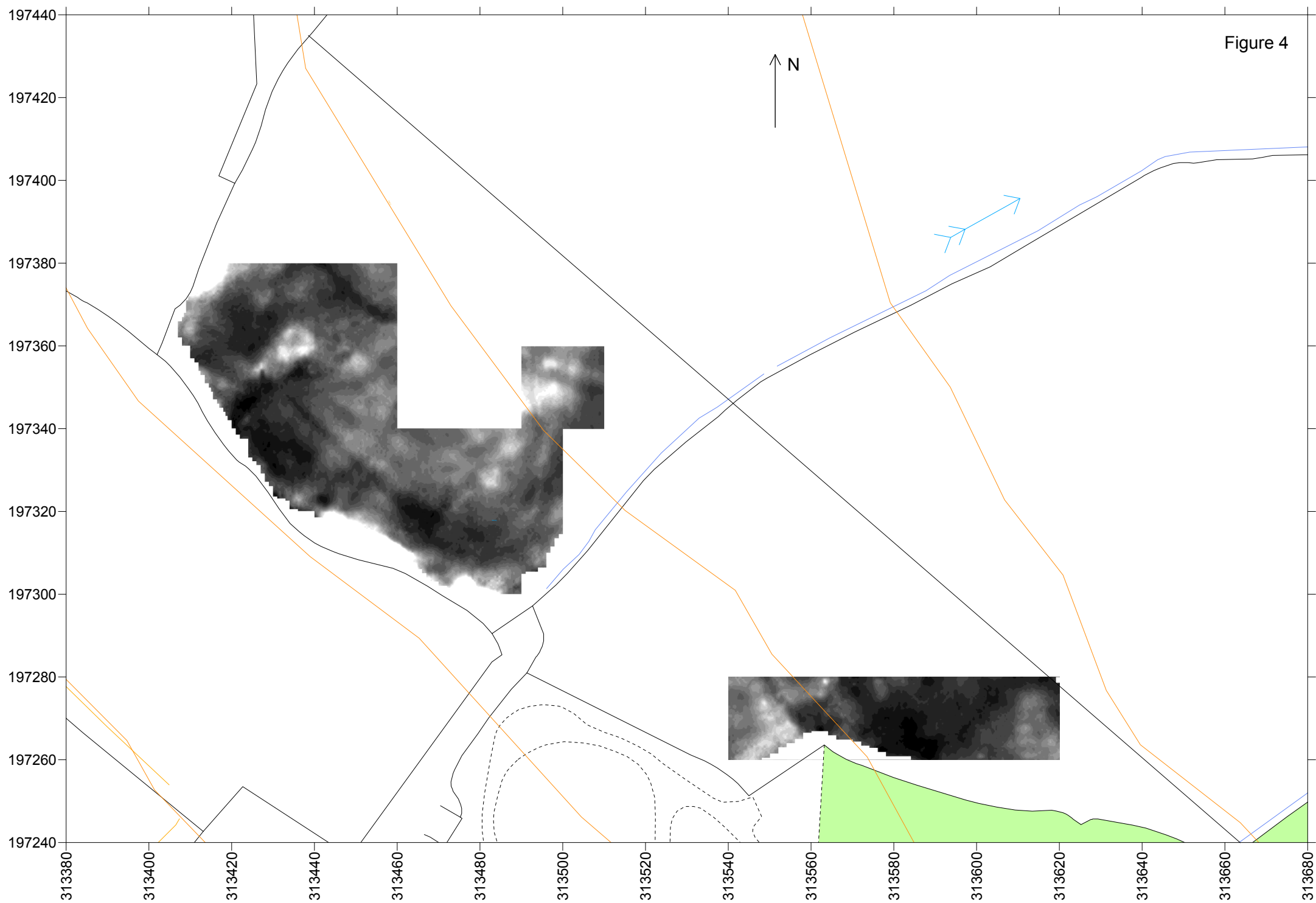
Figure 3

(a)



(b)





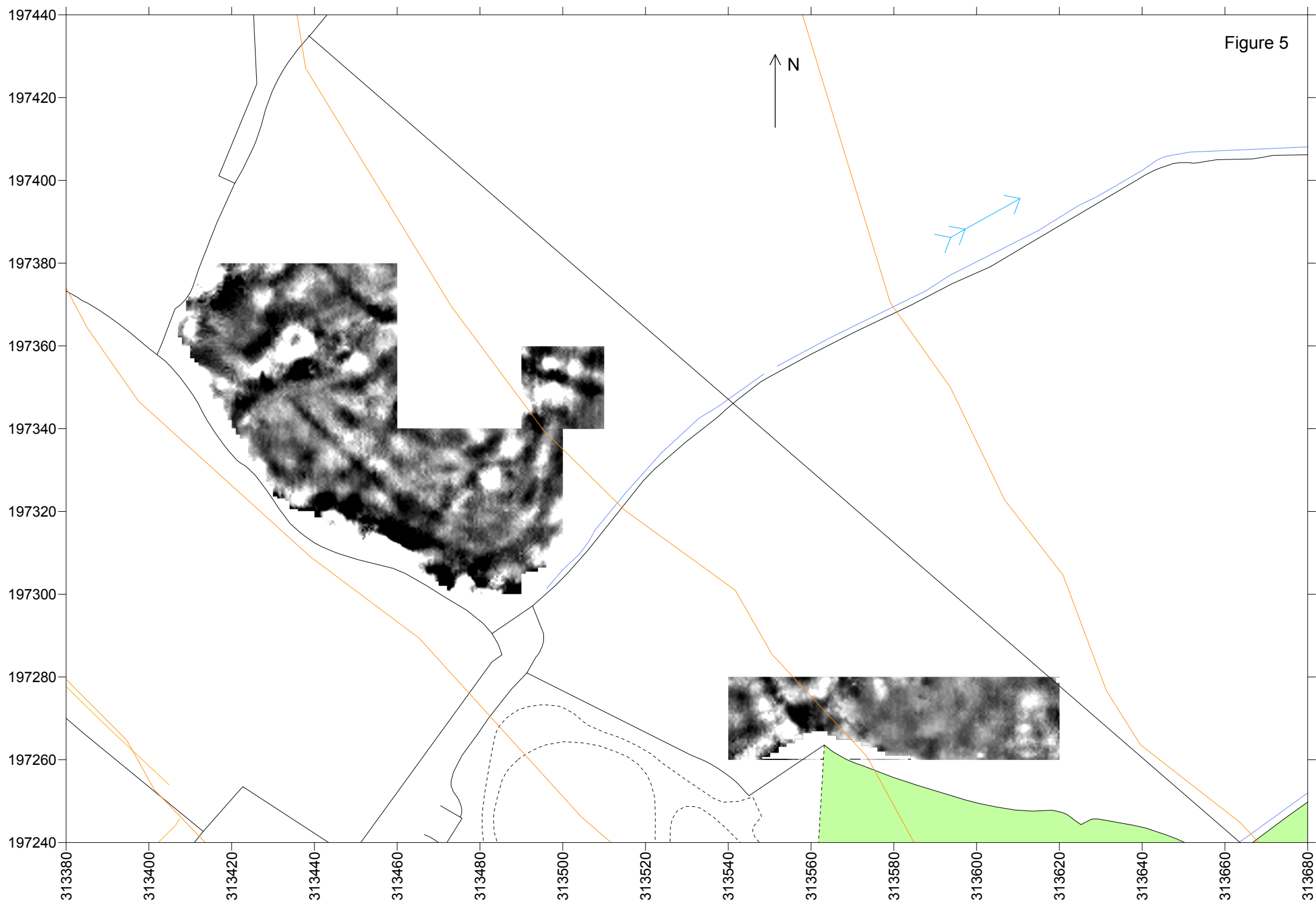
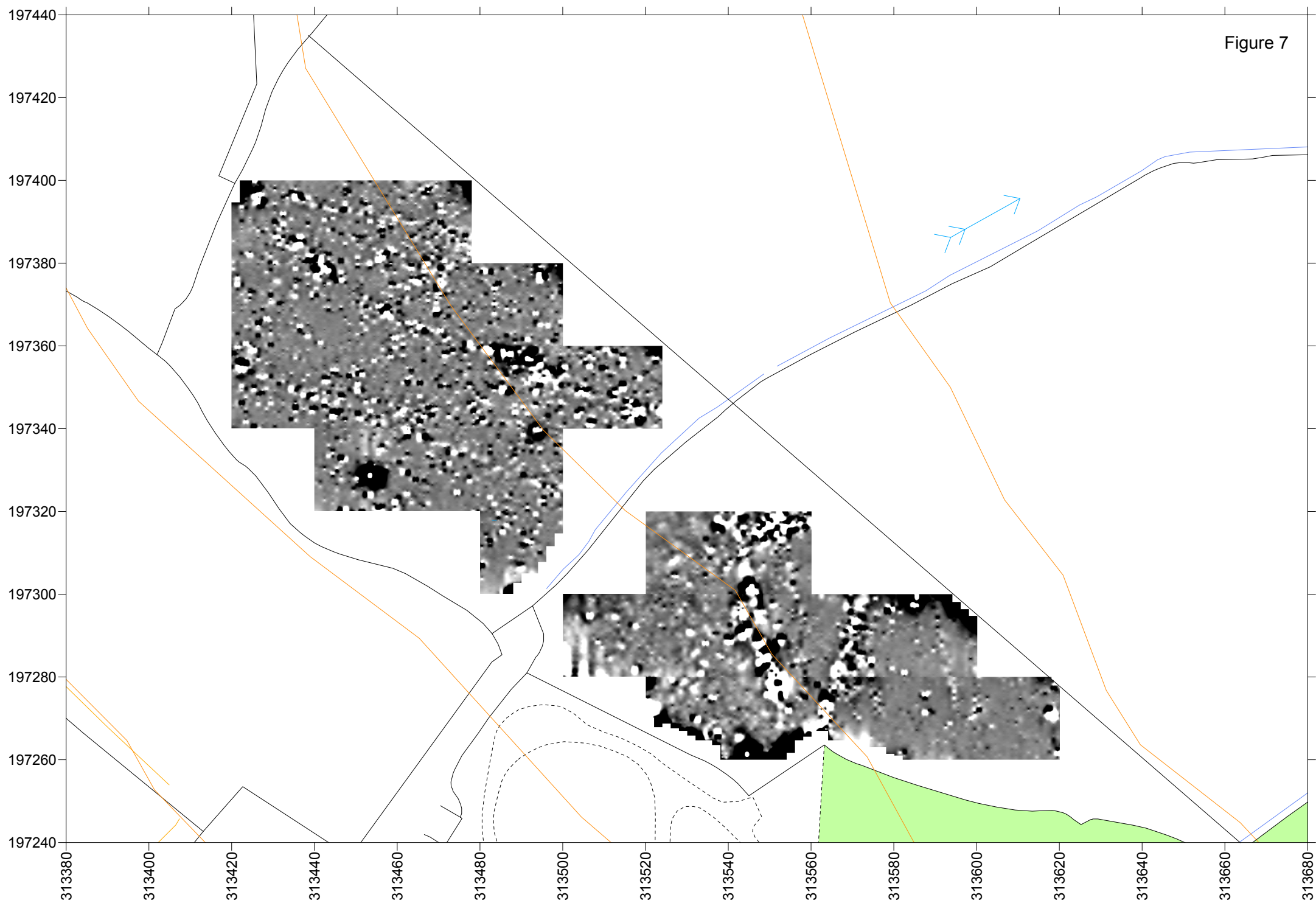
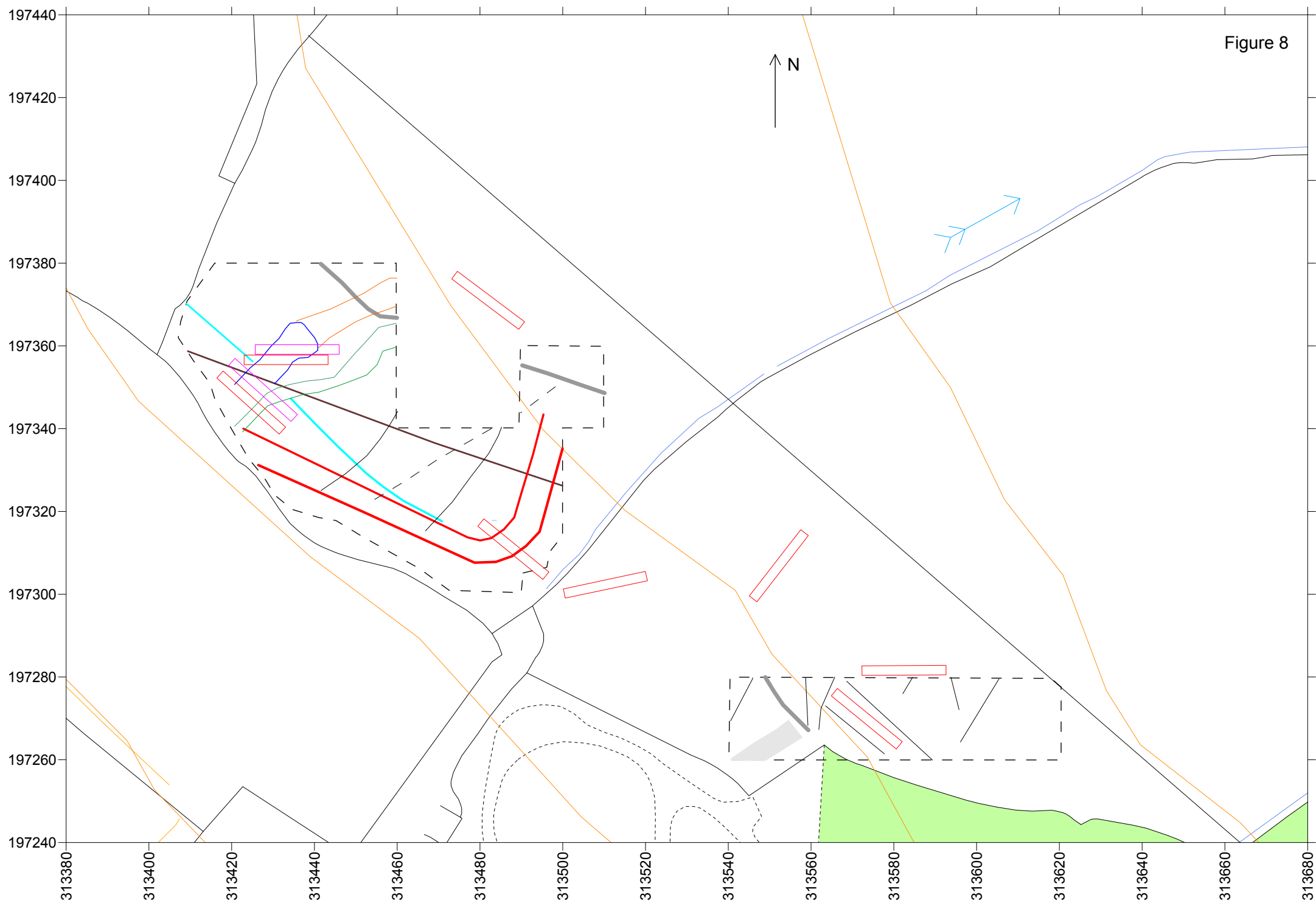


Figure 6







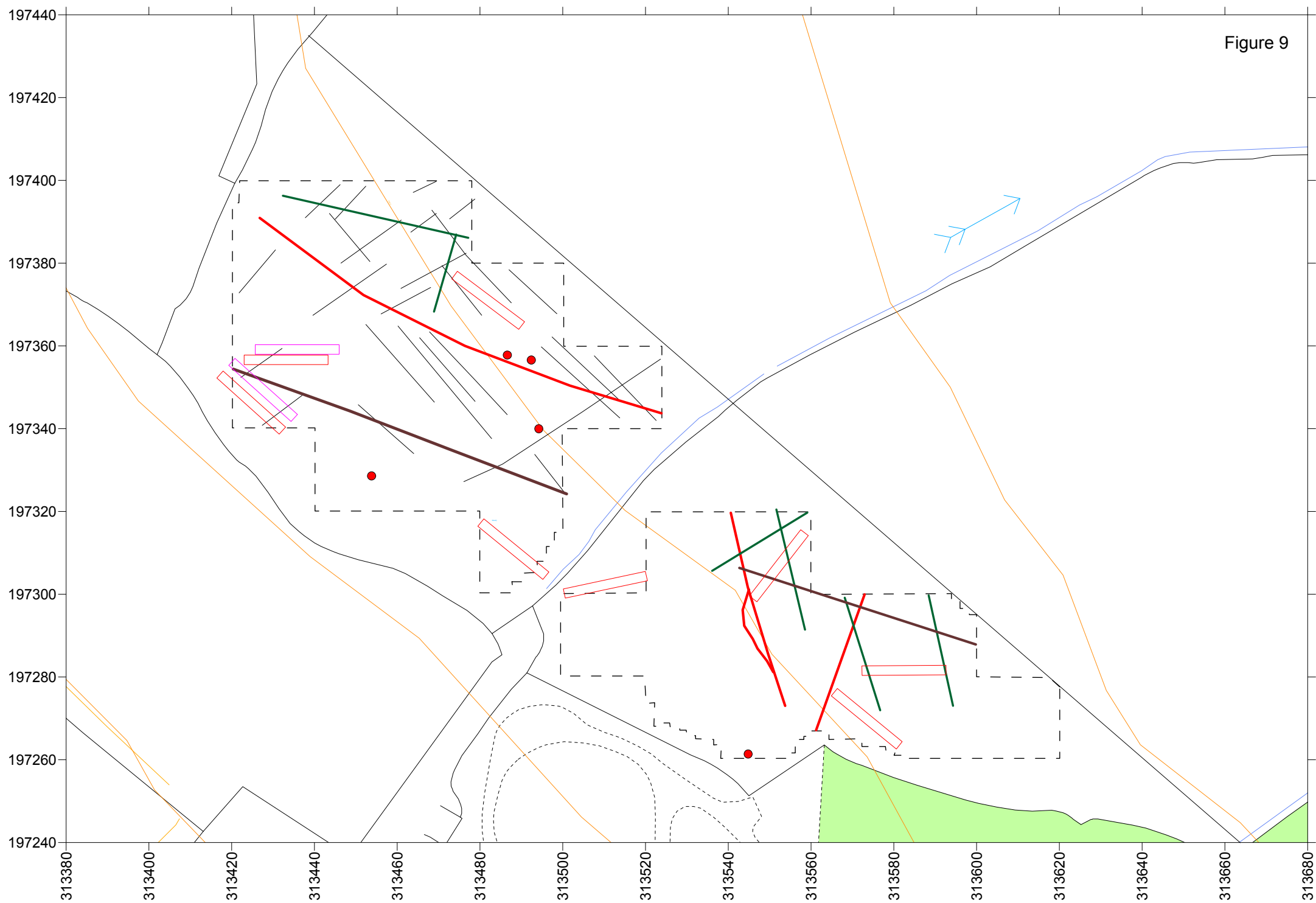
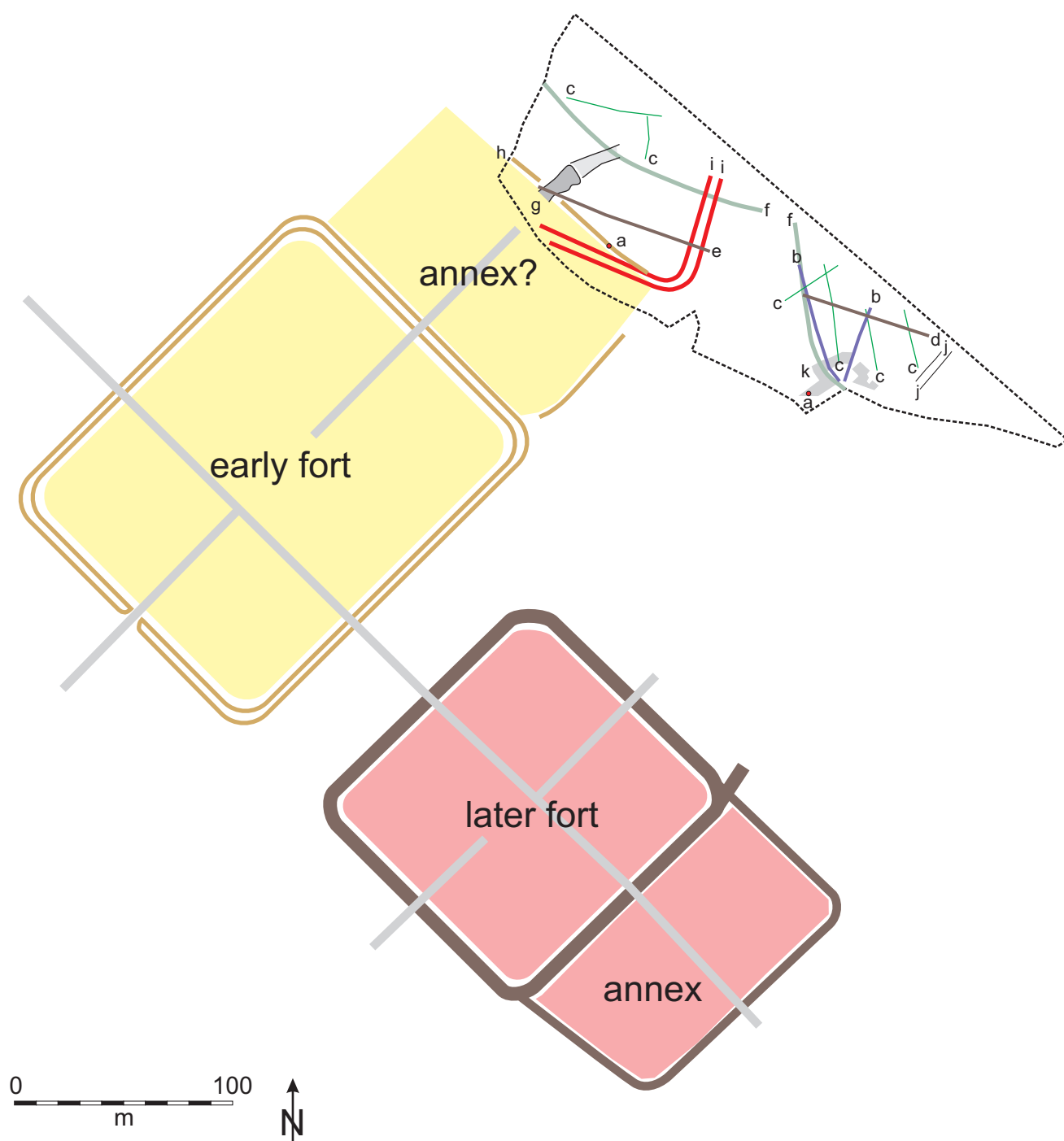


Figure 10



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