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GEORECTIFYING OBLIQUE PHOTOGRAPHS AT THAMES HOSPITAL

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Georectification

In brief, the georectification of photographs for archaeological purposes involves the correction of camera distortions so that true distances can be measured. Initially, points were calculated manually (e.g. British Archaeological Jobs Resource 2005), and various techniques of photogrammetry produced survey maps from the mid-20th century (Wikipedia 2014). The advent of GIS programmes has enabled the computerisation of increasingly sophisticated methods of rectification (Wikipedia 2013a).

Generally vertical or near-vertical aerial photographs have been selected for rectification. One exception in New Zealand was the oblique photographs of Puketutu Island taken in 1946 and 1958 that were georectified by Ian Lawlor (Lawlor 2006). Recently, hand-held camera shots have been rectified (e.g. Prins and Adams 2012).

The following is an example of the georectification of a set of historic oblique photographs that greatly assisted the interpretation of the archaeological findings from excavations at Thames Hospital.

Thames Hospital Investigations

Between 2007 and 2008, an archaeological team headed by Caroline Phillips and Brent Druskovich undertook investigations at Thames Hospital (Phillips and Druskovich 2009). The project involved examining a series of trenches where new buildings and services were being constructed (Figure 1).

The current Thames Hospital property overlies what was in the late 19th century a hospital, school and more than 30 residential properties. At that time, there were two locations where photographers frequently took pictures overlooking this part of Thames: Irishtown Hill to the north and Edward Street to the east. It was hard to relate the scattered excavation trenches to properties visible in the early photographs, due to the oblique angle the photographs were taken at. However, as the photographs were frequently the only records about

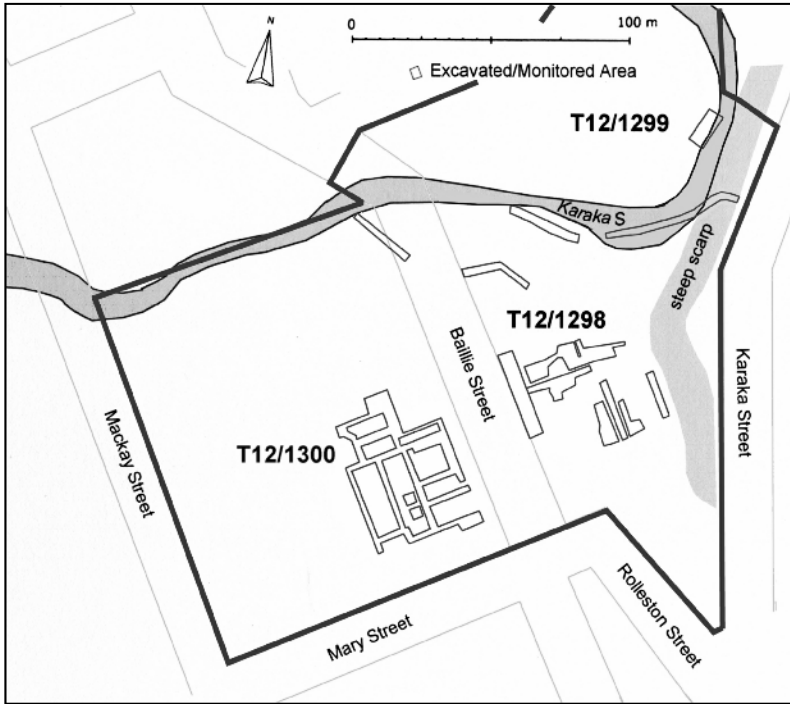


Figure 1: The scattered excavated and monitored trenches, with site record numbers, in the hospital property (shown by heavy black outline). Note that Baillie Street existed until the mid-20th century when it was incorporated into the hospital grounds and built over



Figure 2: Oblique photograph of Thames Hospital and houses 1875

the structures relating to this time, it was necessary to decipher the information they contained.

Dave Rudd was part of the archaeological team and produced the GIS of the excavations using Manifold software. It was decided to use this software to try to rectify these oblique land-based photographs. Accordingly, those from Irishtown Hill dating to 1868, 1870, 1872 and 1875 were georectified, while the views from Edward Street were used to correct or refine the final plans.

The method involved:

1. Viewing the photographs (Figure 2) to find control points in as many different locations as possible that could be linked to the modern survey plan. These were mainly road junctions and were marked A-J.
2. Deriving additional controls from lot boundaries, which were often fences between properties, including the fence around the original hospital site, and Vickery's Battery, both of which had been surveyed and were present in all four photographs.
3. Superimposing and georeferencing the 19th century survey plans onto the modern plan of the hospital property.
4. Tracing the footprints of the buildings, roads, features and controls that were visible in the photographs (Figure 3).

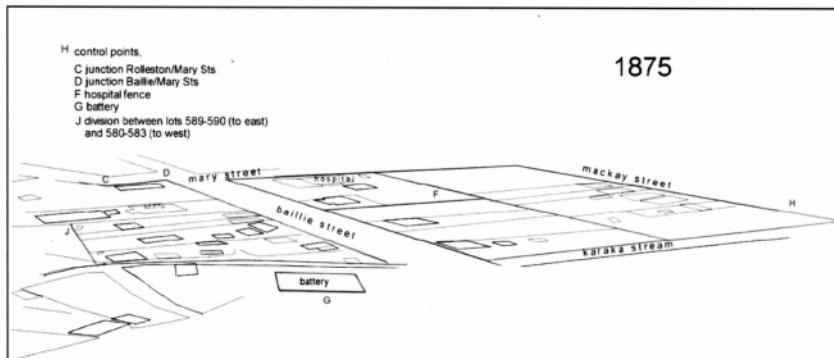


Figure 3: Tracing of building footprints, features and control points marked C-J.

5. Superimposing the tracings into the GIS using a series of different registration distortions in Manifold software, notably a restricted polynomial numeric method (Figure 4).

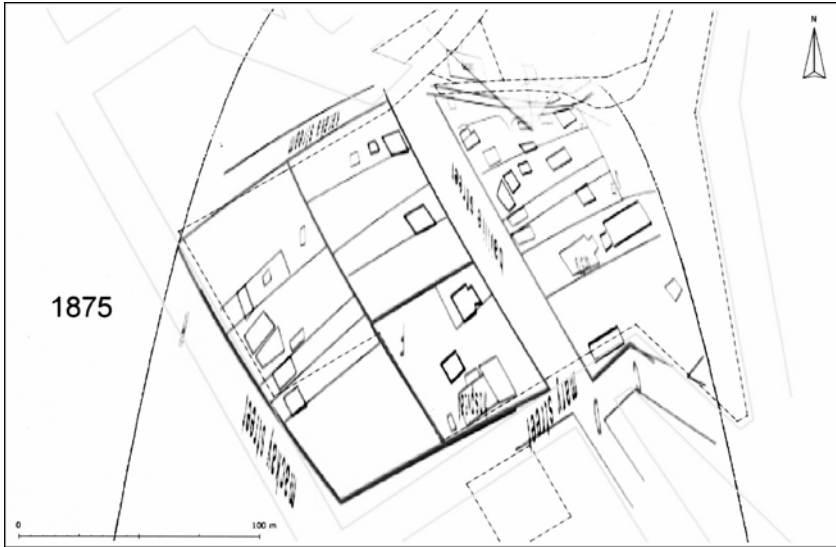


Figure 4: Distortion of tracings and superimposition into GIS

6. Retracing the distorted image with adjustments made by using known points, and property boundaries. The buildings were then redrawn to create the final plan (Figure 5).
7. Overlaying the final plan on the archaeologically investigated areas to determine which properties and structures were being investigated.

This process was repeated for all four photographs, and combined plans were made focusing on the main areas excavated (Figure 6).

Accuracy and Limitations

In two instances the frontages of buildings close to the road were surveyed in 1889 and these could be compared to the georectified position. The result was that the georectified original Thames Hospital building was found to be 3m too close to the road, while the Reitmann family home was 2m too close to the road and a further 2m too close to its northern boundary.

The Reitmann house was also too narrow, due to neighbouring houses and trees obscuring it in the photographs; it should have been 8m wide rather than 5m as shown in the georectified plans.

Both the hospital and Reitmann's house were relatively central to the original photographs and an increased error would be expected on the margins.

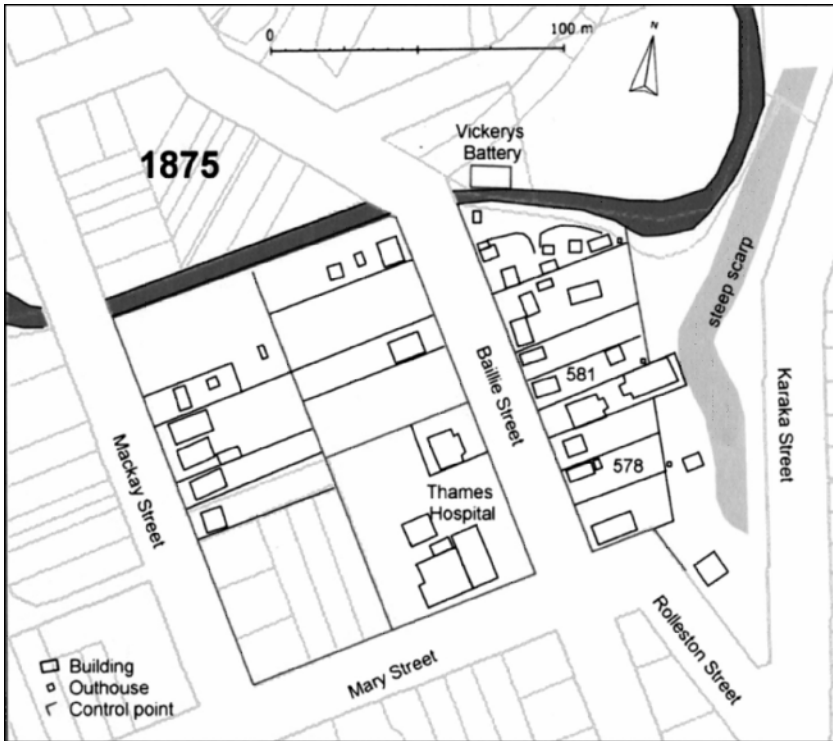


Figure 5. Adjusted distorted image and redrawing of buildings. The main areas of the archaeological investigation were in the vicinity of the original Thames Hospital, as well as Thames High School and Reitmann's property at Lots 581 and 578 on Baillie Street

Difficulties were encountered in the tracing process, due to the acute angle of the photographs, as well as larger buildings and vegetation that obscured the base of some smaller buildings and structures.

Challenges with georectifying the images using this particular software included barrel distortion, perspective and lack of reference points, so the precise locations of buildings were impossible to discern (Rudd *pers. comm.* 2009).

Since this time the technology has improved, so that given enough control points, the sophisticated rubbersheeting used by modern GIS software could be used to overcome some of these limitations (ArcGIS 2012, Wikipedia 2013b). Rubbersheeting allows an image to be stretched in various directions, conforming to numerous control points as long as they are available (Rudd *pers. comm.* 2014).

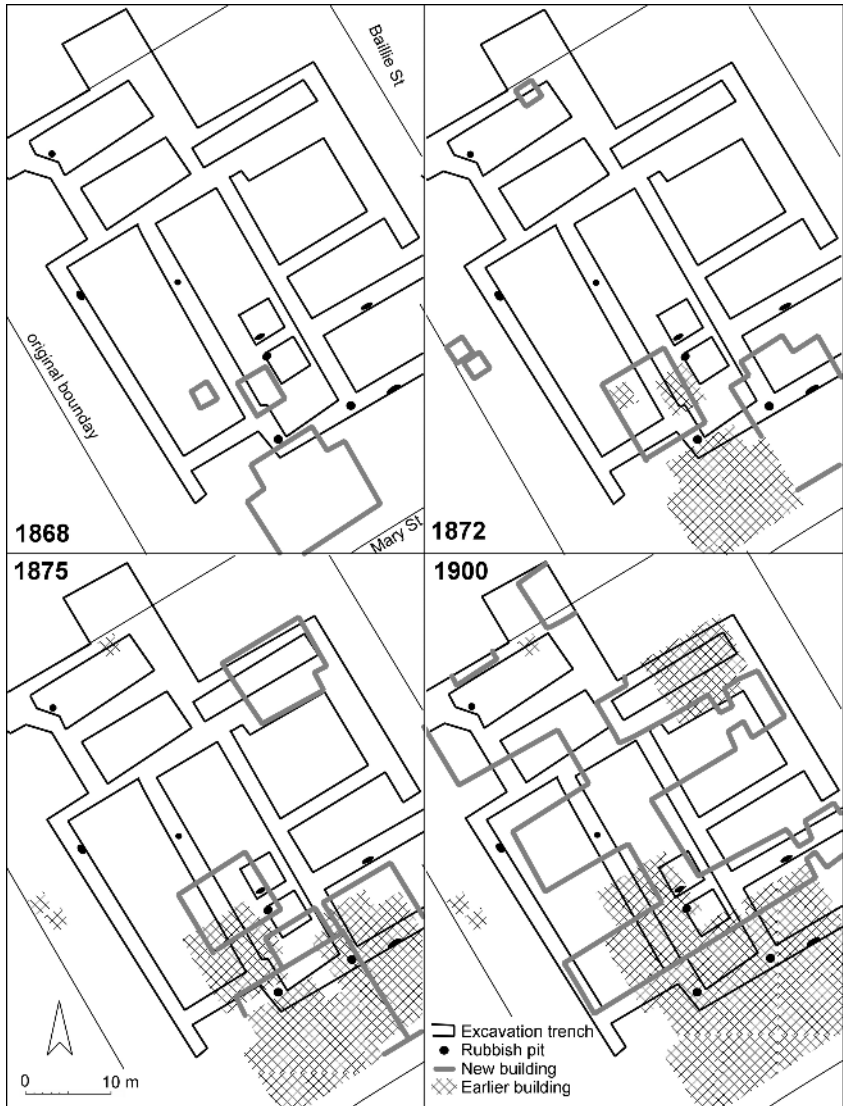


Figure 6: Detail of the site of the old Thames Hospital, showing the 1868, 1872 and 1875 georectified buildings overlaid on the rubbish pits found in the investigated trenches. Note the 1900 hospital footprint is shown as the fourth phase of construction

Summary

Despite the issues encountered by using the Manifold restricted polynomial numeric method, the location of historic buildings not shown on survey plans could be estimated within a few metres.

Consequently, in the Thames Hospital archaeological investigations, georectification of the oblique land-based photographs enabled the identification of post alignments to particular structures and the dating of some of the rubbish pits in cases where they underlay subsequent buildings. It was therefore a very valuable technique that was fundamental to the interpretation of the archaeological results.

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