STERNE BRIDGE, SOWERBY BRIDGE–COPLEY VALLEY REGENERATION PROJECT, SKIRCOAT, WEST YORKSHIRE

Archaeological Photographic Building Recording and Watching Brief

Oxford Archaeology North

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I & H BROWN LTD

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OA North Job No: L10409
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SUMMARY

I and H Brown Ltd commissioned Oxford Archaeology North (OA North) to undertake a programme of archaeological recording during the initial infrastructure works associated with the redevelopment of Copley Valley in Sowerby Bridge, West Yorkshire (centred on NGR SE 075 233). The proposed redevelopment relates to an overall area of 15ha, which lies mainly to the north of, and adjacent to, the river Calder, with the Calder Hebble Navigation Canal defining the northern extent of this area. A portion of the development, which is known as 'The Island' to the west of Sterne Bridge due to its position between the two waterways, and 'The Hub' to the east of the bridge, is to be developed for residential, commercial and leisure purposes.

The development area was formerly occupied by sites of industrial archaeological interest, with Sterne Mill occupying part of The Hub, and Canal Mill occupying the western end of The Island, as well as Milner Royd Mill lying to the south of the river. As a result, planning permission for The Island and The Hub was granted (planning ref: 11/00200/FUL) with an archaeological condition. Consultation with West Yorkshire Archaeological Service (WYAAS) led to the establishment of a targeted watching brief as the first phase of work, during the initial preparatory ground work, and this was undertaken by OA North between September 2011 and February 2012. In addition, WYAAS also requested that Sterne Bridge (NGR SE 04683 23249), which was to be demolished as part of the preparatory works, should be subject to a photographic survey and watching brief prior to, and during, demolition.

Sterne Bridge is historically significant within the area, as part of the Sterne Mill complex. The earliest reference to the mill is within a will of 1732, when it was a corn and fulling mill with two water wheels. However, it is not clear in which year the first bridge was constructed over the river Calder in this position due to the ambiguity of the early historic mapping, although it is suggested that it is the structure on John Eyes' map of 1758. Based on evidence from the wing walls, that project outwards along the north and south bank of the river Calder, and stone abutments that were still extant during the survey, it is apparent that the early bridge was constructed of ashlar sandstone masonry, similar to Sterne Mill, with rubble stone wing walls. Furthermore, it would appear, from the configuration of the earlier remains, that the main span was arched, which would be expected. In 1911, Sterne Mill was occupied by the Standard Wire Company who used it as a wire drawing facility, and replaced the main earlier arched stone bridge in 1914 to meet their requirements for access and transportation. The replacement bridge was significant as an early example of the Hennebique system, i.e. a modern reinforced-concrete method of construction, and probably constructed by the Yorkshire Hennebique Contracting Company Ltd.

The extensive and detailed survey of the structure of Sterne Bridge has provided an in-depth written record of the bridge's construction and phasing. This has been further augmented by the watching brief during the demolition of the bridge, which recorded changes in the surface levels of the bridge deck, including an earlier surface of sandstone cobble setts beneath the modern tarmac road. Differences recorded in the stone, bond and construction type of the surviving abutment and the wing walls may have indicated two separate phases of construction, or the use of different styles for structural or economic purposes. A similar pattern of construction is evident on

another bridge at Mytholmroyd, approximately four miles to the north-west of Sowerby Bridge, where the abutments also appear as rusticated ashlar stone blocks of a regular size and the wing walls are constructed in a much more loose dry-stone style.

There is the potential for further archaeological remains to be disturbed during the proposed redevelopment of the site, which would allude to the early phases and dating of Sterne Mill and its associated bridge, it is recommended that consultation be undertaken with WYAAS as to the requirements to fulfil the remainder of the archaeological condition accompanying the planning permission.

ACKNOWLEDGEMENTS

OA North would like to thank I and H Brown Ltd for commissioning the project and, in particular, Keith Stubbs, for his assistance and co-operation. OA North is also grateful to the staff of the West Yorkshire Archaeological Advisory Service (WYAAS), especially David Hunter, and the Historic Environment Record (HER), West Yorkshire Archive Service (WYAS), Calderdale Central Library, and Sowerby Bridge Library.

The bridge survey was undertaken by Jamie Quartermaine. The historic background was compiled by Alastair Vannan. The watching brief was undertaken by Andrew Bates, Andrew Frudd and Caroline Raynor. The report was compiled by Caroline Raynor and Chris Wild. The illustrations were produced by Mark Tidmarsh. The project was managed by Emily Mercer, who also edited the report.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

1.1.1 I and H Brown Ltd commissioned Oxford Archaeology North (OA North) to undertake a programme of archaeological work during the initial infrastructure works associated with the redevelopment of Copley Valley in Sowerby Bridge, West Yorkshire. The proposed redevelopment relates to an overall area of 15ha, and lies mainly to the north of, and adjacent to, the river Calder with the Calder Hebble Navigation Canal defining the northern extent of this area. A portion of the development, which is known as 'The Island' to the west of Sterne Bridge due to its position between the two waterways, and 'The Hub' to the east of the bridge, is to be developed for residential, commercial and leisure purposes.

1.1.2 The proposed development area was formerly occupied by sites of industrial archaeological interest, with Sterne Mill occupying part of The Hub, and Canal Mill occupying the western end of The Island, as well as Milner Royd Mill lying to the south of the river. As a result, planning permission for The Island and The Hub was granted (planning ref: 11/00200/FUL) with an archaeological condition. Consultation with West Yorkshire Archaeological Service (WYAAS) led to the undertaking of a targeted watching brief during the initial preparatory ground works, which was undertaken by OA North between September 2011 and February 2012 (OA North 2012). In addition, WYAAS also requested that Sterne Bridge, which was to be demolished as part of the preparatory works, should be subject to a photographic survey and watching brief prior to, and during, demolition.

1.1.3 The survey of the bridge commenced on 13th March 2012 and was undertaken using a light weight electrically-powered helicopter (UAV; unmanned aerial vehicle) with a camera attachment. This was followed by an intermittent watching brief until the completion of the demolition work on 19th April 2012. The following report summarises the findings.

1.2 LOCATION, TOPOGRAPHY AND GEOLOGY

1.2.1 Sterne Bridge (NGR SE 04683 23249; Figs 1 and 2) spans the river Calder to the west of the former site of Sterne Mill and a weir, and to the east of the town of Sowerby Bridge, at approximately 70m aOD. This area is situated in the Southern Pennines area of West Yorkshire (Countryside Commission 1998). The surrounding landscape of the local moorland plateau is undulated and rolling, and comprises a mixture of pastoral agricultural land to the south with the urban landscapes of Sowerby Bridge and Halifax to the west and north (*ibid*). The solid geology comprises millstone grit, mudstone, siltstone, and sandstone, and is overlain by clay, silts, and sands that have accumulated within the Calder Valley (British Geological Survey 2011).

2. METHODOLOGY

2.1 INTRODUCTION

2.1.1 The archaeological photographic survey and watching brief were undertaken in order to preserve by record the remains of Sterne Bridge, including the concrete Hennebique structure built in 1914, and remains of the earlier stone bridge. This work was undertaken in accordance with the specifications provided by WYAAS (*Appendix 1*), but was modified to incorporate the variation detailed in the project proposal (*Appendix 2*). All work was carried out in accordance with English Heritage (2006a; 2006b) and IfA guidelines (2008a; 2008b; 2010). The archaeological recording was undertaken in two phases; the first consisted of an archaeological and photographic survey of Sterne Bridge prior to its demolition, complete with detailed photographic record; the second phase of work consisted of an intermittent watching brief during the demolition of the bridge with the aim of identifying any newly-revealed elements or phases of that were not visible whilst it was intact. This took place over four separate visits between 13th March and 19th April 2012.

2.2 ARCHAEOLOGICAL RECORDING

2.2.1 The 'preservation by record' was achieved by the generation of a comprehensive archive. In the case of the initial archaeological photographic survey of the bridge prior to demolition, this was carried out using photogrammetry, which is a long-established technique that has been updated and refined such that it is now an extremely simple and cost-effective means of recording features and landscapes in three dimensions. The data was retrieved using an electrically-powered model helicopter (UAV, unmanned aerial vehicle) carrying a light-weight camera. The majority of the photographic survey was undertaken using digital photographs taken from the helicopter (UAV), by flying it low-level along the line of the bridge, taking a series of semi-rectified photographs of the bridge elevations and their elements (Figs 11 and 13). Similarly, photographs were taken from above the bridge to provide a plan view of the trestles spanning the river Calder (Fig 12). This provided blanket photographic coverage of the bridge.

2.2.2 Survey control was provided by the placement of control targets across the elevations of the bridge, located by means of survey tapes. The images generated were processed using software known as 'Agisoft', which collates the images and provides an accurate visual record of both the plan view and elevations of the targeted structure.

2.2.3 A further series of images were taken using a medium format camera, as specified in the brief provided by WYAAS, which are required to be presented as plates within this report along with the digital images. Due to the large number of images gathered during the recording (ten medium format films, plus replica digital images), of which many represent duplicate images at varying exposures, not all have been presented in this report as plates. Medium

format images are presented using the prefix 'MF' and then the film number and image number (e.g. MF SB01_01), and digital images are prefixed by 'DS', 'IMG' or 'P', denoting different cameras employed on site. The corresponding location of each plate has been presented in Figures 14 (medium format) and 15 (digital images).

2.2.4 All of the features identified during the watching brief were recorded stratigraphically, using a system adapted from that used by the Centre for Archaeology Service of English Heritage, with accompanying graphic documentation (plans, sections, and digital photographs and monochrome print photographs, both of individual contexts and overall site shots from standard view points). Photography was undertaken with 35mm cameras on archivable black-and-white print film, all frames including a visible, graduated metric scale. Digital photography was used extensively throughout the course of the fieldwork for presentation and reference purposes. Photographic records were also maintained on photographic *pro-forma* sheets.

2.3 ARCHIVE

2.3.1 The results of all archaeological work carried out will form the basis for a full archive to professional standards, in accordance with current guidelines (English Heritage 2006a; UKIC 1990). The original record archive of the project will be deposited with West Yorkshire Archive Services. Copies of the report will be sent to the West Yorkshire Historic Environment Record (HER), and the National Monuments Record for reference purposes.

2.3.2 The Arts and Humanities Data Service (AHDS) online database *Online Access to index of Archaeological Investigations* (OASIS) will be completed as part of the archiving phase of the project.

3. HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

3.1 DISCUSSION

3.1.1 Sterne Bridge was associated with Sterne Mill, which was established within the Woodhouse estate in Skircoat, Halifax. The earliest known reference to the mill appears to date to 11th September 1732, in the will of Richard Sterne (Structural Perspectives 2003, 3). Although the mill lay within the Skircoat portion of the Woodhouse estate, the bridge spans the river Calder, which demarcates the boundary between Skircoat to the north, and Norland to the south (*ibid*). Sterne Mills was also recorded by John Watson within a list of mills on the river Calder in 1758 in *History and Antiquities of the Parish of Halifax*, and was described as being a corn and fulling mill with two water wheels (*op cit*, 4).

3.1.2 The mill was also depicted on one of the earliest detailed maps of the area during 1758, when John Eyes surveyed the portion of the river Calder running between Halifax and Brooksmouth (Fig 3). This stylised map showed the mill building and tail race at the northern side of the river, and depicts a linear structure running across the river. As this feature is not labelled, it is unclear whether it represents an early incarnation of Sterne Bridge or if it represents the weir which is located to the east of the bridge. As the weir is "V-shaped" and is commonly depicted as such on other maps, it is quite likely that this linear feature represents the original stone bridge.

3.1.3 A similar depiction of the mill was shown on an anonymous map of 1765 (Fig 4), which showed the river and the course of the Calder and Hebble Navigation canal. Numerous bridges and crossing points were depicted as associated with parallel dashed lines representing track ways leading to and from the rivers edge. No such lines were shown approaching the river Calder at the site of Sterne Mill, although two parallel lines crossing the river adjacent to the mill may represent the presence of the bridge and weir; the key to the map specifically mentioned 'Stern Mill' and 'Stern Dam' although it does not make any mention of the bridge. Indeed, as late as Baines' map of 1822 (Fig 5) it is not clear whether the schematic lines shown traversing the river mark a bridge at the site. Other elements associated with the mill are more clearly identifiable, specifically the weir, tail race, and a schematic water-wheel, as well as the canal bridge to the north.

3.1.4 Documentary sources from the eighteenth and early nineteenth centuries, cited in Structural Perspectives' report of the mill (2003), also omit descriptions of a bridge at the site of Sterne Mill. For example, a letting advertisement in the Leeds Mercury in 1777 described Sterne Mill having six fulling stocks and a corn mill with three pairs of stones, but did not mention the bridge. A gradually revised valuation of Skircoats, which was first undertaken in 1782, recorded details about the mill, such as the erection of a new malt kiln in 1788 and the addition of a cotton mill in 1804 to the existing complex of corn and fulling mills. However, this valuation did not mention a bridge, either.

3.1.5 It has, however, been previously suggested (*op cit*, 9) that a bridge might have been present at the site since at least as early as the eighteenth century. This would seem likely because, as a functioning mill, access to both sides of the river Calder would have been necessary, and the absence of a bridge over the Calder at this point would have acted as a serious impediment to the business.

3.1.6 One of the earliest clear depictions of a bridge at the site appears on the Ordnance Survey (OS) first edition map of 1854 (Fig 6), wherein Hollas Lane is shown running northwards underneath the Halifax to Bradford railway, via Hollas Bridge, and over the river Calder by Sterne Bridge, which is clearly labelled. This was depicted in greater detail on the OS mapping of 1894 (Fig 7), which also showed the key elements associated with Sterne Mill, including Sterne Bridge (the map even notes that it was constructed of stone), the V-shaped weir, the sluice, and three large mill buildings and associated outhouses; various modifications were made to the mill complex during the later nineteenth century, such as the addition of the number two mill in 1874 and the rebuilding of the number one mill (Structural Perspectives 2003, 6). During this time it was used as a corn mill but by 1904 at least part of the mill was occupied by a fruit preserver or jam maker named William Lee Oldfield (*ibid*). However, by the time of the OS map of 1909 the mill was labelled as 'disused' (Fig 8).

3.1.7 The mill was then leased by the Standard Wire Company in 1911 as a wire drawing facility. A conveyance plan was produced in 1911 to such effect (*op cit*, 7; Fig 9), although it does not show Sterne Bridge in any great detail. However, this is the last map produced prior to the major alterations, which saw the stone bridge being dismantled and the construction of the concrete trestle bridge. The bridge was rebuilt to facilitate access requirements for the wire company in 1914 and was likely to have been built by the Yorkshire Hennebique Contracting Company Ltd (*op cit*, 8). Although the line of the roads leading to the bridge appeared to have altered slightly on the OS maps produced after 1914 (Fig 10), the only apparent difference in the depiction of the bridge it that it was shown as being slightly wider than on the preceding plans. The wire company ceased to operate from Sterne Mill in 1999 (*op cit*, 8).

4. FIELDWORK

4.1 INTRODUCTION

4.1.1 Prior to the demolition of Sterne Bridge, a study of the structure, including the remains of the earlier stone bridge (present in the form of northern and southern abutments) and the later concrete structure, was undertaken in order to provide a complete mitigative record. Further to this, an intermittent watching brief was carried out during the demolition process. Figures 11-13 illustrate the numbered elements of the bridge (**1-15**) recorded and discussed in *Section 4.2*, below, the key for which is provided in full in Figures 11 and 12. Figure 11 shows the elevations, together with the direction of the discussion (in a clockwise direction).

4.1.2 The description of the bridge, below, commences by examining the northern access to the bridge (Figs 11-12; **1**), followed by the core visible components of the south-east-facing elevation (Figs 11-12; **2-8**), and a detailed description of the ashlar and rubble stone components on the southern bank (Fig 12; **9-12**). Those additional elements, such as the '1914' datestone, visible octagonal section beam on the north-west elevation and the surfaces of the bridge revealed during the demolition process (**13-16** respectively, Figs 11-13) will be discussed in turn.

4.2 RESULTS

4.2.1 Sterne Bridge is, in the main, a twentieth century concrete trestle bridge with earlier stone abutments and rubble stone wing walls (Figs 11-13; Plates 1-22) that survives on each bank to a varying degree of prominence. This earlier phase of bridge construction is more visible on the southern bank, where the abutment is constructed of ashlar stone and local stone rubble, although much of this has been rebuilt presumably during the insertion of the concrete structure. However, fabric relating to an earlier bridge survives below deck level, on both the north and south banks, although that on the northern side is now heavily obscured by deposited silts.

4.2.2 The bridge has a flat deck, supported on four trestles, and effectively reflects the construction methodology for a timber bridge, albeit using concrete. Concrete was a relatively new engineering material during the early decades of the twentieth century, and many of the first concrete bridges reflect more traditional construction techniques (OA North 2011). Modern concrete bridges have large pre-cast sections transported relatively large distances to the site of construction, or are cast on site. However, transporting large heavy bridge sections was unfeasible at this time, which meant concrete had to be cast into much smaller structural members, principally beams. As these could not easily be jointed like cast iron or steel, construction methodologies reverted to the principles of timber bridge-building, where concrete beams offered a direct, but cheaper and more substantial alternative (*ibid*).

4.2.3 At the northern terminus of the bridge, the upper course of the earlier eastern wing wall was partly visible, which appears to have been remodelled during the replacement of the deck in the early twentieth century. This was evidenced by the two concrete steps leading up onto the deck of the bridge, flanked by the partially demolished remains of the rubble stone wing walls (Figs 11 and 12; Plates 12-16, 24-28; **1** and **2**). At the northern end of the bridge, only the barrel of the original stone abutment was visible (Fig 12; Plate 29: **3** and **4**), although this strongly suggests that the earlier abutment survives below present ground level.

4.2.4 The bridge deck was carried on four trestles (**4**, **4a**-**c**), the northern of which (**4**) was almost entirely buried by silt at the time of the survey (Figs 11-13; Plates 30-59). The northern three trestles (**4**, **4a**-**b**) were of similar design, comprising two octagonal-section posts (**6**; Figs 12-13; Plates 30-35), each with a slightly jowled head to carry the chord of the bridge deck above. The posts were jointed by rectangular-section top and bottom rails (**4a**), with similar section diagonal bracing internally (Fig 13; Plates 30-41).

4.2.5 At its junction with the sill, each brace was housed within a rectangular concrete gusset (Plates 30-41). On the downstream, eastern side of the bridge, the two central trestles (**4a** and **4b**) had an additional sill of similar length, which terminated on an octagonal-section short post. These were jointed to the principal eastern post with an upbrace, the additional length of the trestle forming a cutwater (**5** and **5a**; Figs 12-13; Plates 30-36). The northern trestle (**4**) was mainly submerged within the silt, but had only a single brace against the upstream (western) post (Fig 13; Plate 29). To the east it butted a solid concrete wall, which presumably formed a bypass channel, quite probably into the headrace for the mill (Fig 11).

4.2.6 The southernmost of the four trestles (**4c**; Fig 12; Plates 45-47) had similar octagonal-section posts to those to the north, but was infilled with a solid concrete panel, rather than having braces within an open frame, as noted in trestles **4**, **4a** and **4b**. This reflects the nature of flow under the bridge, with the southern channel forming a higher water bypass to the weir, rather than the faster-flowing, deeper channels to the north, which would have been less structurally stable with an infilled frame.

4.2.7 The deck above was carried on two chords (**7**; Fig 12; Plates 1-23, 30-33), socketed into, and presumably jointed above, each trestle (**4**-**4c**). These chords carried 21 rectangular section cross-beams (**8**; Figs 12 and 13; Plates 30-33 and 60-65), upon which the concrete sheet deck sections were placed. Damage to the beams suggests that they contained substantial steel reinforcing bars (Plates 48-51).

4.2.8 The parapet of the bridge deck (**10**; Figs 11-13) comprised three equal sections measuring *c* 9m in length, jointed above each of the trestles. These sections were jointed with slender square-section posts (**9**-**9c**) rising from the trestle below, and terminating in a pyramidal capstone, projecting above the upper rail of the concrete panel parapet (Plates 1-21, 61-66). The northern post (**9**) was larger than that at the southern end of the bridge (**9a**-**9c**; Plates 24-28), where it did not mark the end of the bridge, but instead continued as a stone

parapet wall, above the wing wall, and as a breeze block infill above the stepped access (**1**; Plates 1-23, 33-35). Each of the beams projected through the face of the bridge and formed corbels to the chamfered sill of the parapet (**10**) above (Plates 1-23).

4.2.9 The principal element for the earlier stone bridge survives in the form of stone abutments (**12**) and associated wing walls (**11**) on the north and south banks (Figs 11 and 12). The original stone bridge was most likely a multiple span deck bridge, and the footings for the piers may still survive on the river bed. On the southern side of the present bridge a seven-course high, dressed sandstone abutment (**12**; Plates 66-69) was incorporated into the present bridge structure, and represents the southern abutment of the earlier stone bridge. It comprised rusticated blocks, typically 2'6" x 1' (0.76 x 0.3m), and was pointed in a hard cement mortar, obscuring the original, almost certainly lime-based, mortar beneath. The abutment was truncated by the replacement bridge, and has no evidence for the springing of the original arch, the later bridge having a flat deck, at a lower level. It is, therefore, highly probable that the springer for the arch was more than one course higher, as the present deck was placed only half a course above the extant remains of the pier; the impost of the earlier bridge would have been structurally advantageous had it been feasible to incorporate it into the new structure.

4.2.10 The weir, to the immediate east of the bridge (Figs 1 and 2), extended up to the southern trestle and abutment, where it was partially concrete-capped. A metal support extended from the concrete weir, tying it into the southern abutment (**12**).

4.2.11 To the rear of the dressed face of the abutment (**12**; Figs 11-12), the wing wall (**11**; Figs 11-12) is of dry stone rubble construction, butting up to the rear face of the abutment (**12**; Plates 66-69). It was built of roughly-squared sandstone blocks, built to course with double-faced construction and a loose rubble core, and was battered slightly for greater strength (Plates 79-80). The wing walls splayed out on both the eastern and western faces, suggesting that access to the bridge was required from both directions, although the splay was more exaggerated on the west side (Plates 79-80), suggesting that this had formed the principal access. Much of the stone parapet wall represents a rebuild associated with the earlier bridge, but the southern part of the extant western wing wall appears to extend in its original form to parapet height, where it had edge-set copings of similar proportions to those used in the wall faces (Plates 56-59). At its very southern extent it retained three dressed and chamfered capstones, with two relatively well-dressed stones beneath (Plate 56), forming the end of the surviving wall, possibly suggesting that the parapet wall at the terminus of the wing wall was dressed, and that the bridge therefore almost certainly had some ornamentation.

4.2.12 This wing wall parapet represented a rebuild of the original construction, which contained several rebuilds therein. The majority of the wall was of drystone construction, but was erected above a concrete deck, which was contemporary with the 1914 remodelling of the bridge (Plates 66 and 69). This appears to have represented a flattening of the bridge deck, with the wing wall rising sharply to the south, but levelling above the inserted deck, presumably

where an earlier arch was replaced with the flat deck. However, unlike in the original construction, the copings were of a more rounded style. On both the eastern and western wing walls, sections of much later repair were also undertaken, using slightly better-dressed stone, bonded in a cement mortar.

4.2.13 On both the east- and west-facing elevations of the concrete parapet walls (**10**) there is a rectangular concrete datestone (Fig 12) inscribed 'A.D. 1914' (Plates 1-11, 17-23). The deck of the bridge (**15**) had also been resurfaced with asphalt (**14**), presumably in the late twentieth century (Fig 11; Plates 83 and 84).

4.2.14 ***Watching Brief:*** between 13th March and 19th April 2012 an intermittent watching brief was conducted with the aim of examining Sterne Bridge during the demolition process, and recording any features of interest that may be revealed.

4.2.15 The demolition of the bridge was undertaken using a tracked mechanical excavator fitted alternately with pneumatic breaker, and a grab-and-sheer attachment, which was utilised to carefully cut back discrete sections of the concrete bridge deck, parapet, trestles and associated piers (Plates 85 and 86). Prior to the commencement of the demolition work, pontoons were installed beneath the bridge deck to limit contamination of the river Calder and damage to the nearby weir.

4.2.16 The first stage of work involved stripping the modern concrete surface from the bridge deck, which revealed an earlier stone cobbled sett bridge surface (Plates 87 and 88). This had originally been revealed during structural testing prior to the demolition work as part of a series of make-up and bedding layers (Plate 88). The lowest surface revealed was the iron reinforced concrete (Hennibique) structure, which formed the core part of the structure remodelled in 1914. Directly above this was a 0.05m thick layer of black gritty sand, which acted as bedding for the original sandstone cobble sett surface. The cobbles were all fairly uniform, measuring 0.35m x 0.18m, with the surface measuring 0.19m thick. The setts were sealed by a 0.1m thick layer of crushed yellow sandstone that acted as a bedding for the 0.8m thick modern tarmac surface.

4.2.17 Demolition work then focused on the centre of the bridge deck with the concrete bridge parapets being knocked inwards onto the deck. This was followed by removal of the concrete and earlier surfaces on the central and southern deck down to a level that exposed east/west-orientated rectangular-section concrete cross beams (Plate 86). This process was then repeated from the northern bank until the exposed skeleton of the bridge was left standing with the metal work of the trestle, deck and braces. This permitted the removal of the central section in its entirety, breaking the span of the bridge.

4.2.18 The mechanical excavator was situated first over the southern wing wall and then over the northern wing wall to remove the remaining sections of the bridge, leaving the sandstone abutment and remnants of the wing wall on both sides of the river exposed. The wing wall parapet was also removed at this time in order to allow access for the demolition process.

4.2.19 The whole process was undertaken without the presence of coffer dams and, therefore, there was no opportunity to examine the river bed for the remains of the earlier bridge structure. Following the complete removal of the bridge span, the surviving but incomplete elements of the northern and southern stone abutments, and the southern wing wall were left *in situ*.

4.2.20 The partial removal of the upper parapet section of the wing wall on the southern side of the bridge (Plate 89) did not provide any new information about the construction techniques or phasing of the bridge, but confirmed previous observations from during the initial bridge recording (discussed above). Where the seven-course high, dressed sandstone abutment of the earlier stone bridge (Plate 90) had been retained and incorporated into the present concrete bridge structure, the masonry comprised rusticated blocks measuring typically 2'6" x 1' (0.76 x 0.3m). Demolition of the parapet wing wall showed that it was constructed of roughly-hewn sandstone blocks laid in an irregular pattern, with no mortar bond.

4.2.21 On the northern side of the river Calder, the remnants of the north abutment, along with a number of elements of the concrete bridge constructed in 1914, were still visible following the completion of the main demolition process. The earlier stone bridge abutment was partially obscured by a combination of concrete and river silt, although the surviving upper four courses of ashlar sandstone masonry were clearly visible. A 3.5m wide section of the stone abutment was visible, with each row comprising nine courses of rusticated stone work with an average measurement of 0.34 x 0.35m. The stone work was pointed with a hard white-cream lime mortar. The depth and thickness of the abutment remains unknown.

4.2.22 Left exposed on the eastern and western side of the stone abutment were two surviving concrete octagonal-section posts, which were part of the 1914 rebuild of the bridge, and are discussed in greater detail in section *4.2.4*. Abutting the western side of the west octagonal-section post was a further mass-pour of concrete, which probably post-dates the 1914 modifications to the bridge.

4.2.23 On the southern side of the river, the remaining elements of the bridge following demolition were more prominent and clearly visible (Plate 90), largely because of the survival of the lower section of the wing wall, and because this area of the bank had not been subjected to sheet piling. There was no surviving evidence for the later 1914 concrete construction phase on the southern side of the bridge (this having been completely removed during the demolition process). However, there were two distinct stone construction types that may have exhibited two separate phases, although it is more likely that the abutment and the remains of the wing wall were contemporary but constructed in different styles, either for structural or economic reasons.

4.2.24 The surviving original element was approximately 2.15m tall and a seven-course high, dressed sandstone abutment (Plates 90 and 92), which was incorporated into the later bridge structure. It comprised rusticated blocks, typically 2'6" x 1' (0.76 x 0.3m), and was pointed in a hard cement mortar, obscuring the original, almost certainly lime-based mortar beneath. The

abutment was truncated by the replacement bridge, and there is no evidence for the springing of the original arch. To the east and west of the surviving abutment (Plate 92) were the lower sections of the wing wall, the upper section having been demolished to facilitate access during the main phase of works. Although the western wing wall appeared to be an early structure in that it was constructed in a more rudimentary drystone and rubble-wall style, it was probably contemporary with both the surviving abutments, and may have been rebuilt or repaired on more that one occasion.

5. CONCLUSION

5.1 DISCUSSION

5.1.1 The mitigative recording of Sterne Bridge was part of a larger, overarching, programme of archaeological work required for the the Sowerby Bridge-Copley Valley Regeneration Project. Historic mapping showed the bridge to have been a significant part of a larger complex of contemporary industrial processing structures established at Sterne and Canal Mills during the eighteenth and nineteenth centuries. It was positioned at a key crossing point, providing direct access across the valley floor for personnel working in the mills, as well as a direct route for the movement of goods.

5.1.2 The photographic recording of the structure of Sterne Bridge provided a record of its construction and phasing. This was further augmented by the watching brief during demolition, which served to highlight changes in the surface levels of the bridge deck, including locally-acquired made ground deposits on the surface of bridge, as well as an earlier surface of sandstone cobble setts later covered by the modern tarmac road.

5.1.3 The difference in the stone, bond and construction type of the surviving abutment and the wing walls may be indicative of two separate phases of construction. However, it is probably more likely that the two structures were built at the same time, but in a different style for structural or economic purposes. This is borne out by the identification of not too dissimilar patterns of construction such as at a bridge situated at Mytholmroyd, approximately four miles to the north-west of Sowerby Bridge, where the abutments also appear as rusticated ashlar stone blocks of a regular size, with the wing walls constructed in a much more loose drystone style. At the end of the remedial work for the Sowerby Bridge-Copley Valley Regeneration Project, the northern and southern abutments were left *in situ*.

5.1.4 The bridge is likely to have been constructed in order to facilitate access to and from Sterne Mill. Due to problems with accuracy with the very early historic maps, it is not possible to ascertain a definitive date for the construction of the bridge. However, it is probable that the linear feature shown spanning the river on John Eyes' map of 1758 (Fig 3) is Sterne Bridge in its earliest form. The stone abutments, the rubble stone wing walls and the partially-demolished sandstone walls of the surrounding mill structures indicate that the earliest version of the bridge was constructed solely from sandstone. The interface between the northern section of the southern wing wall, where the concrete bridge deck adjoins, definitely indicates that this element of the stone bridge was heavily reworked in order to accommodate the new lower, flat, concrete form constructed in 1914.

5.1.5 As late as 1967, there were no industrial structures shown on OS mapping extending much to the north-west of Sterne Bridge, although by 1971 the Sterne Mill buildings had been extended to cover a large portion of this part of

the development area. Given the obvious modernity of the bonded brickwork that was disturbed by the pre-piling trenching, it is likely that it derives from the buildings erected during the 1970s.

5.2 RECOMMENDATIONS

5.2.1 Whilst the abutments remain *in situ*, any additional work, including the proposed shoring of the river bank to the west of the weir, will have an impact upon the standing remains, including those visible at present and any earlier phasing that has potentially been obscured by the reworking of the abutments and wing walls in 1914. Furthermore, the current project brief (*Appendix 1*) requests that any further work within this area be subject to an archaeological watching brief in order to create a full mitigative record of the bridge during the development process.

5.2.2 The potential exists for further archaeological remains associated with the early phases and dating of Sterne Mill and its associated bridge, to be disturbed during the actual redevelopment of the site. It is recommended that consultation be undertaken with WYAAS as to the requirements to fulfil the remainder of the archaeological condition accompanying the planning permission.

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7. ILLUSTRATIONS

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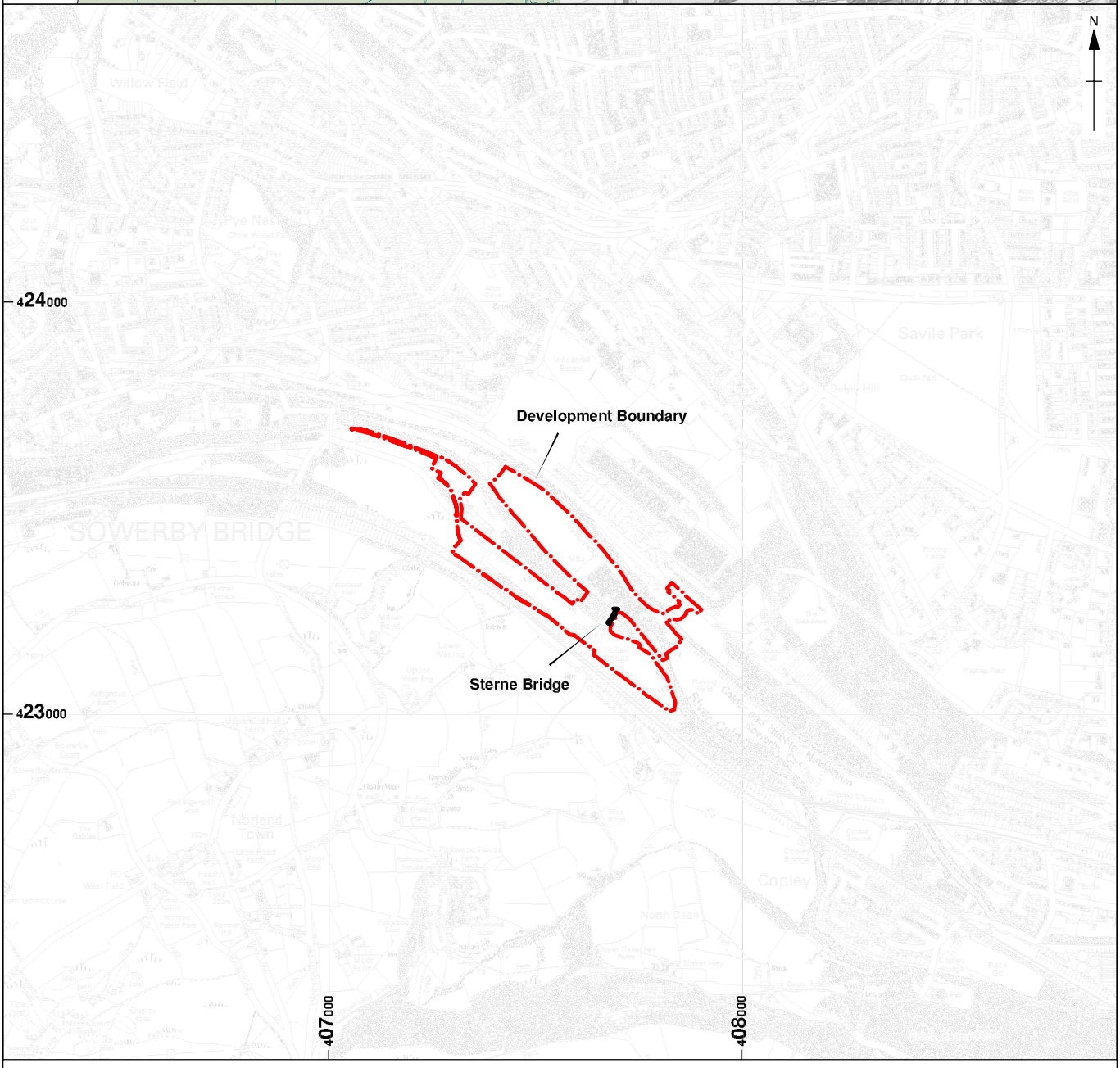

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Figure 1: Site location

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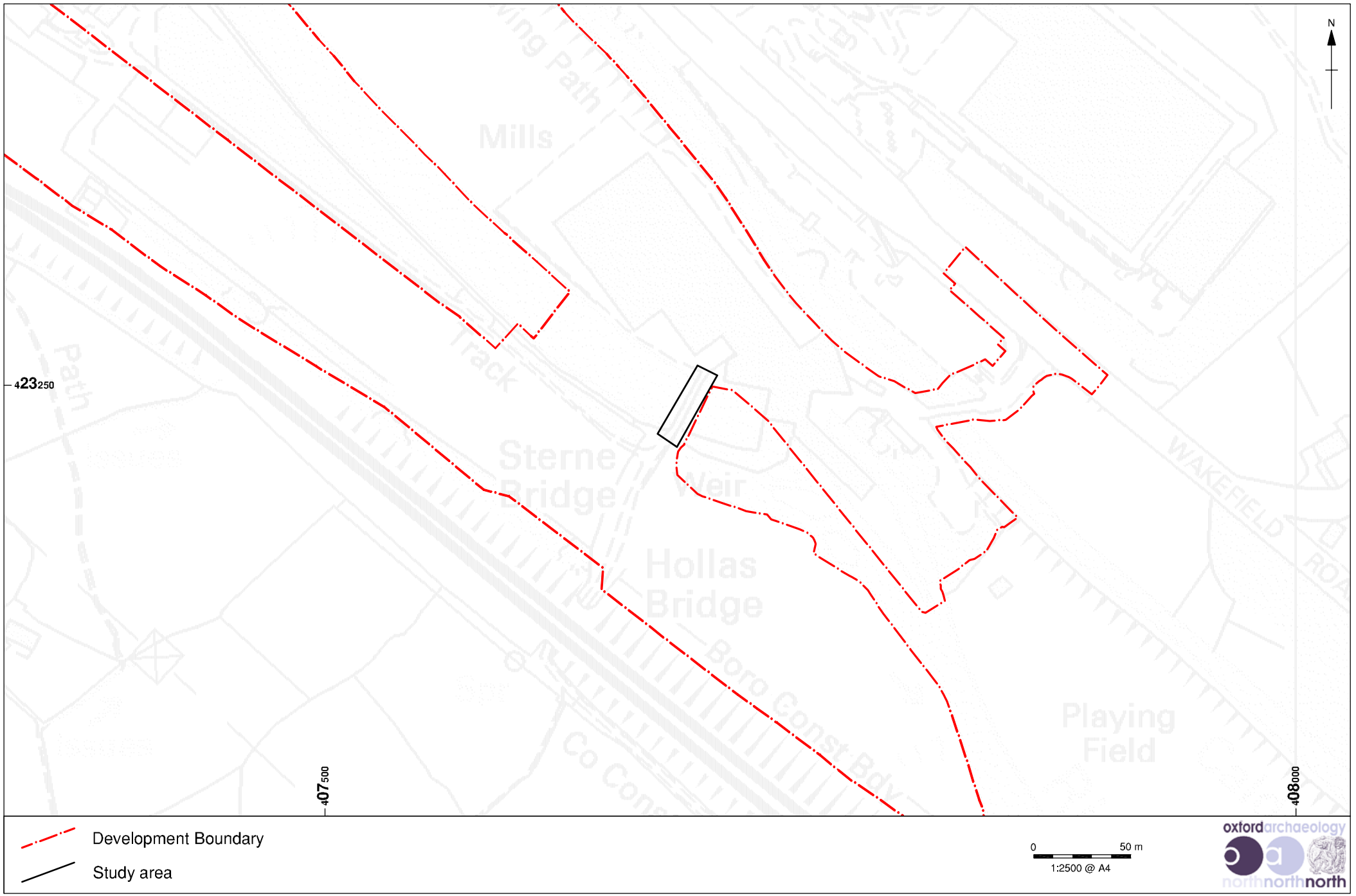

Figure 2: Study boundary of Sterne Bridge

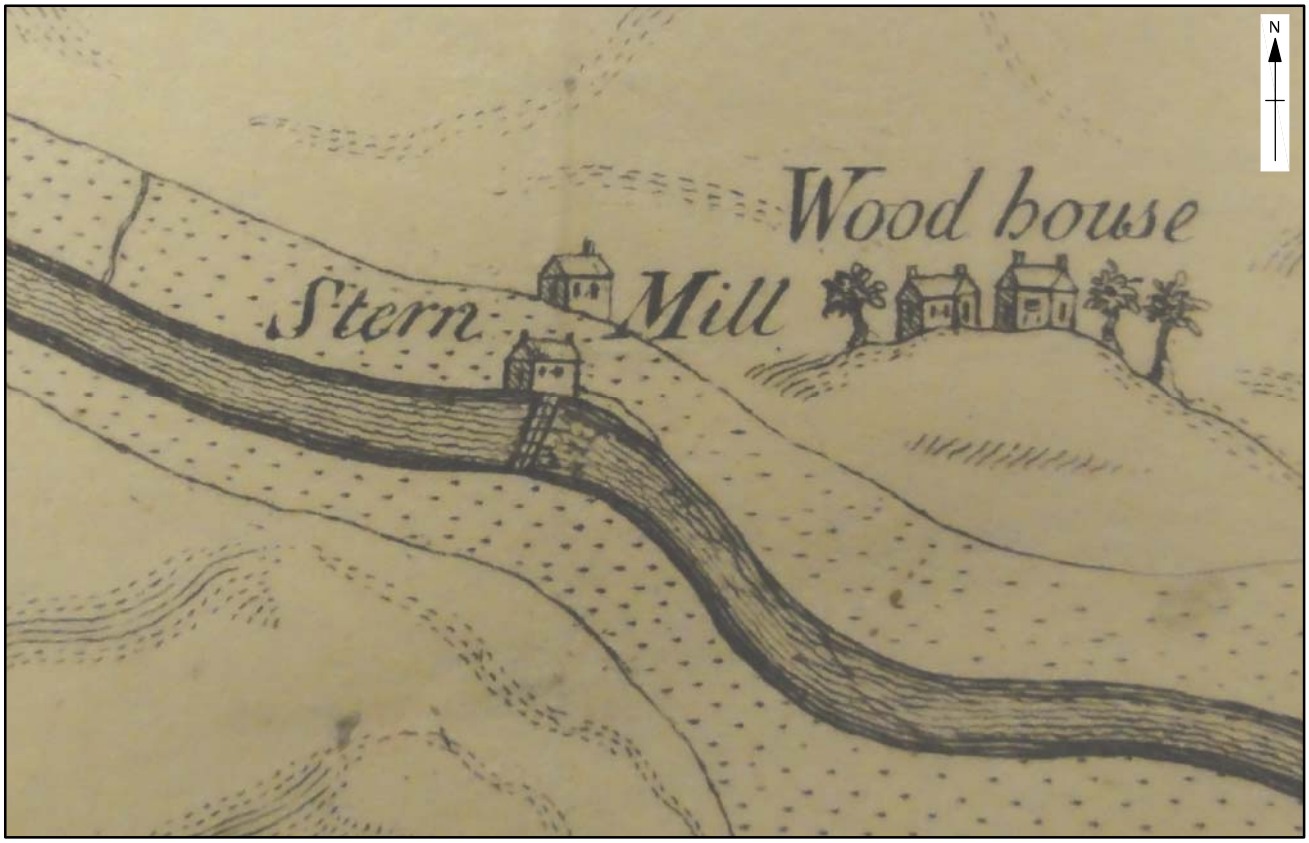

Figure 3: Extract from John Eye's map, 1758

Figure 4: Extract from an anonymous map, 1765

Not to Scale

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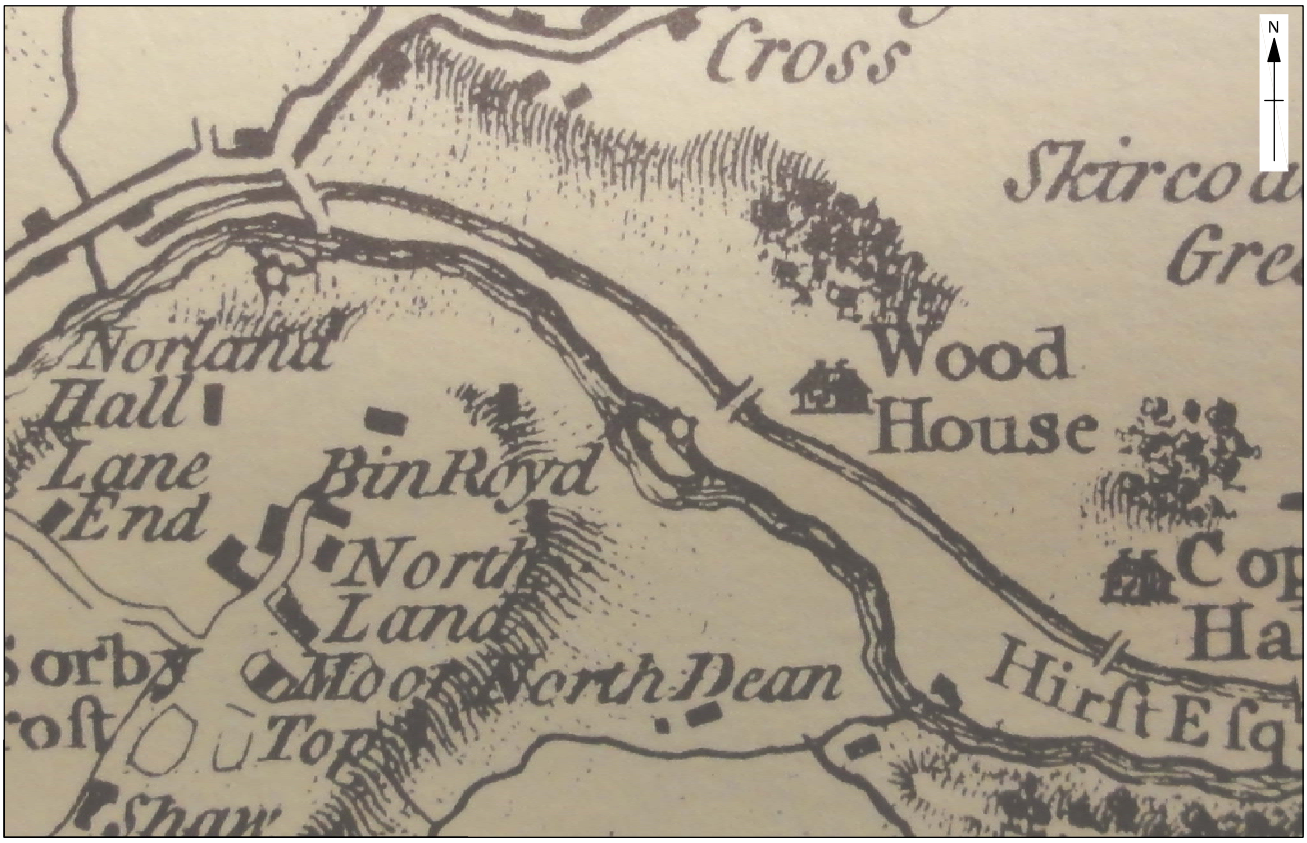

Figure 5: Extract from Baines' map, 1822 (not to scale)

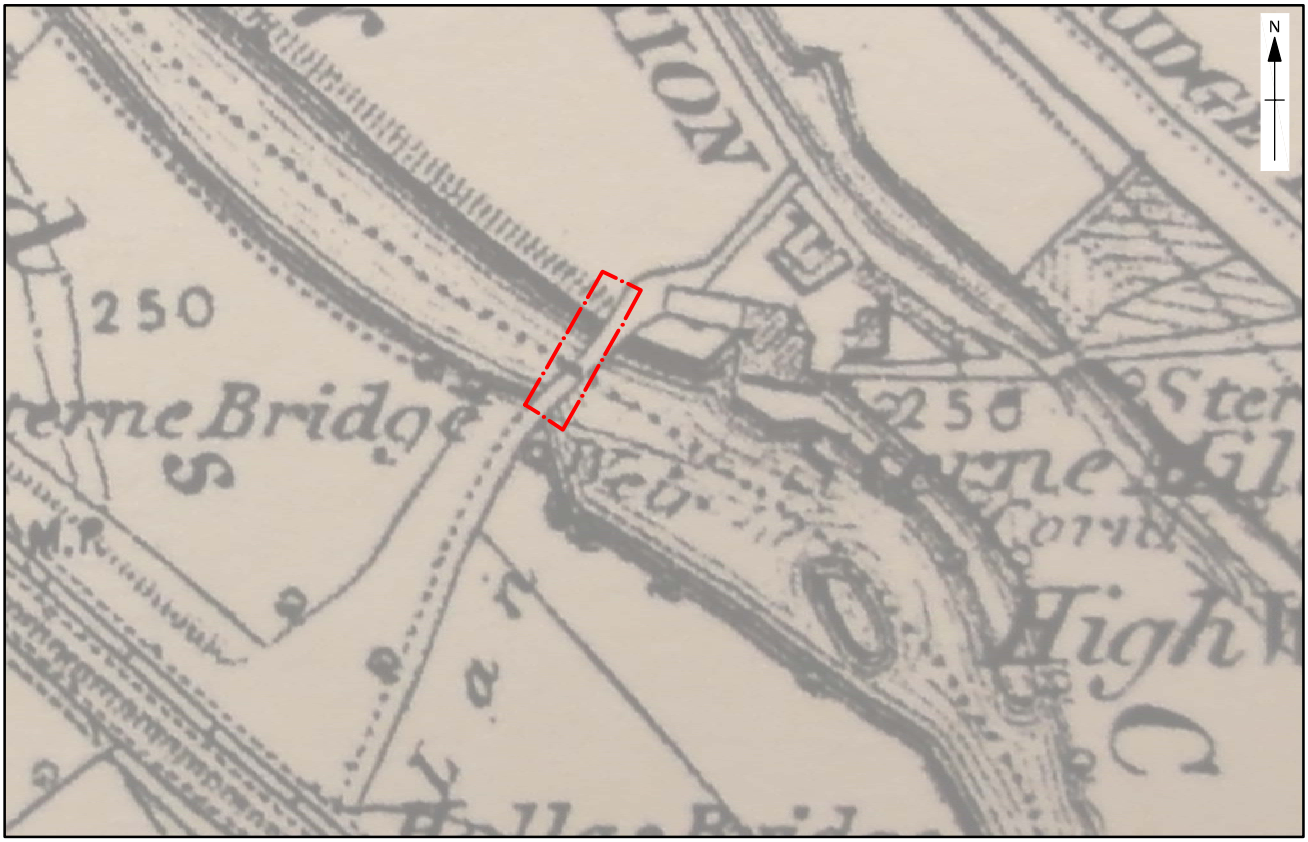

Figure 6: Extract from the First Edition Ordnance Survey 6": 1 mile map, 1854

Sterne Bridge Study Boundary

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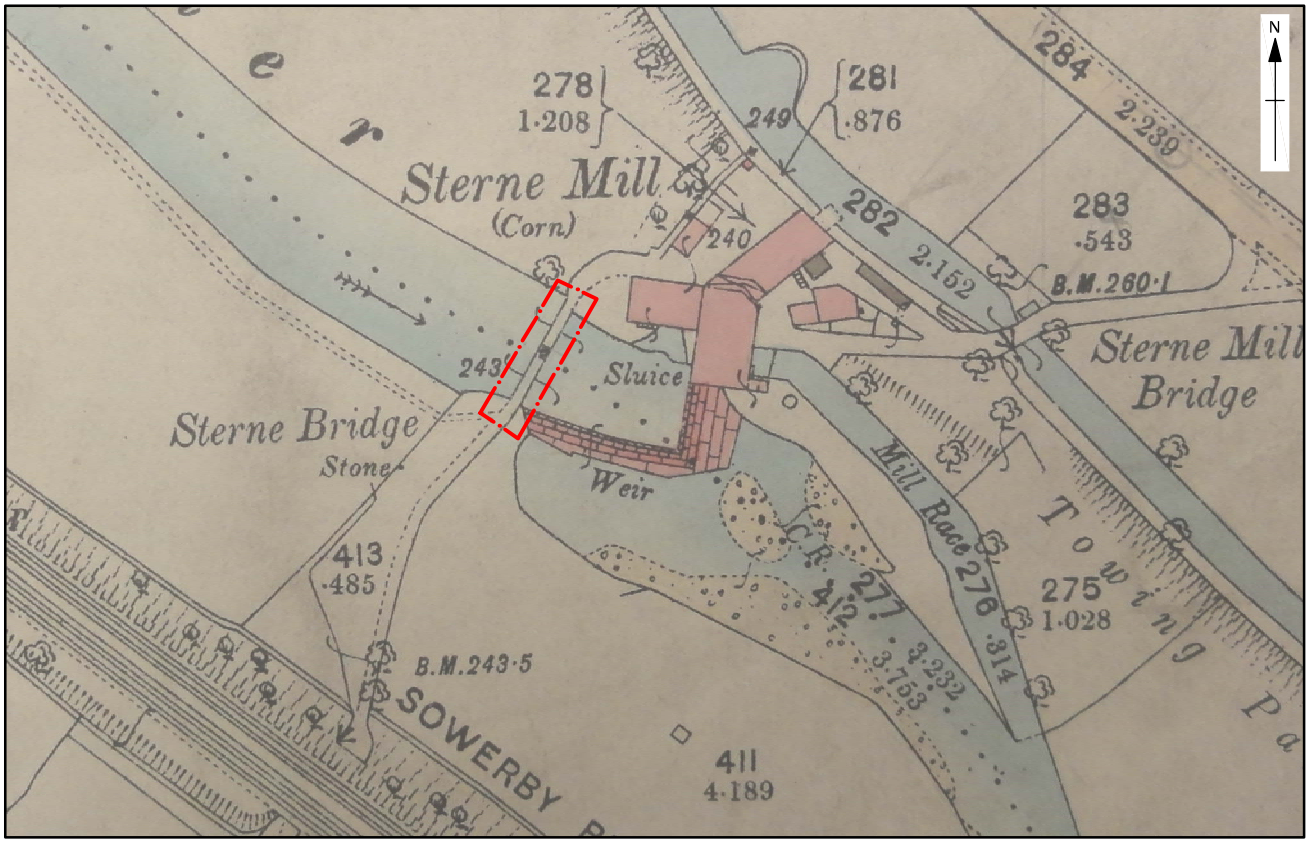

Figure 7: Extract from the First Edition Ordnance Survey 25": 1 mile map, 1894

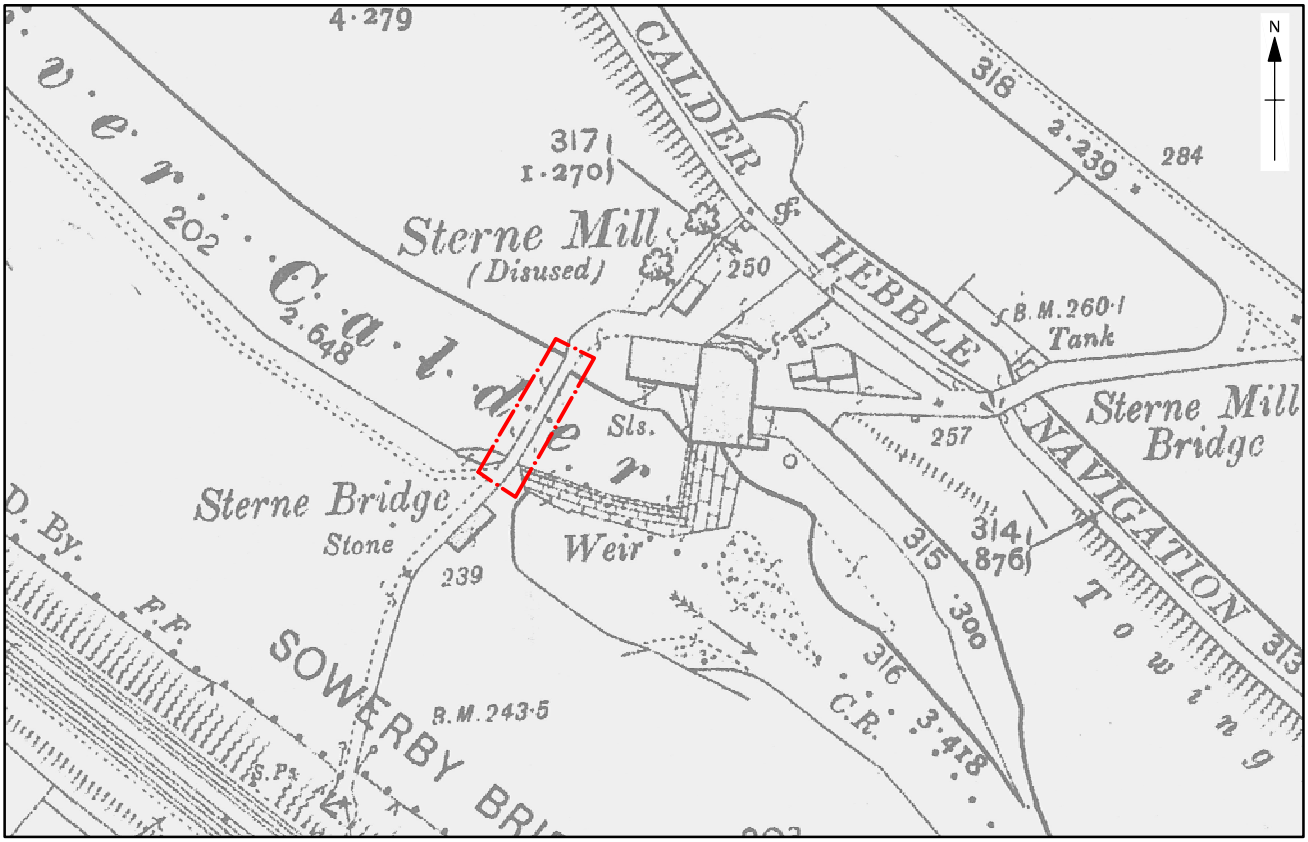

Figure 8: Extract from the Second Edition Ordnance Survey 25": 1 mile map, 1909

Sterne Bridge Study Boundary

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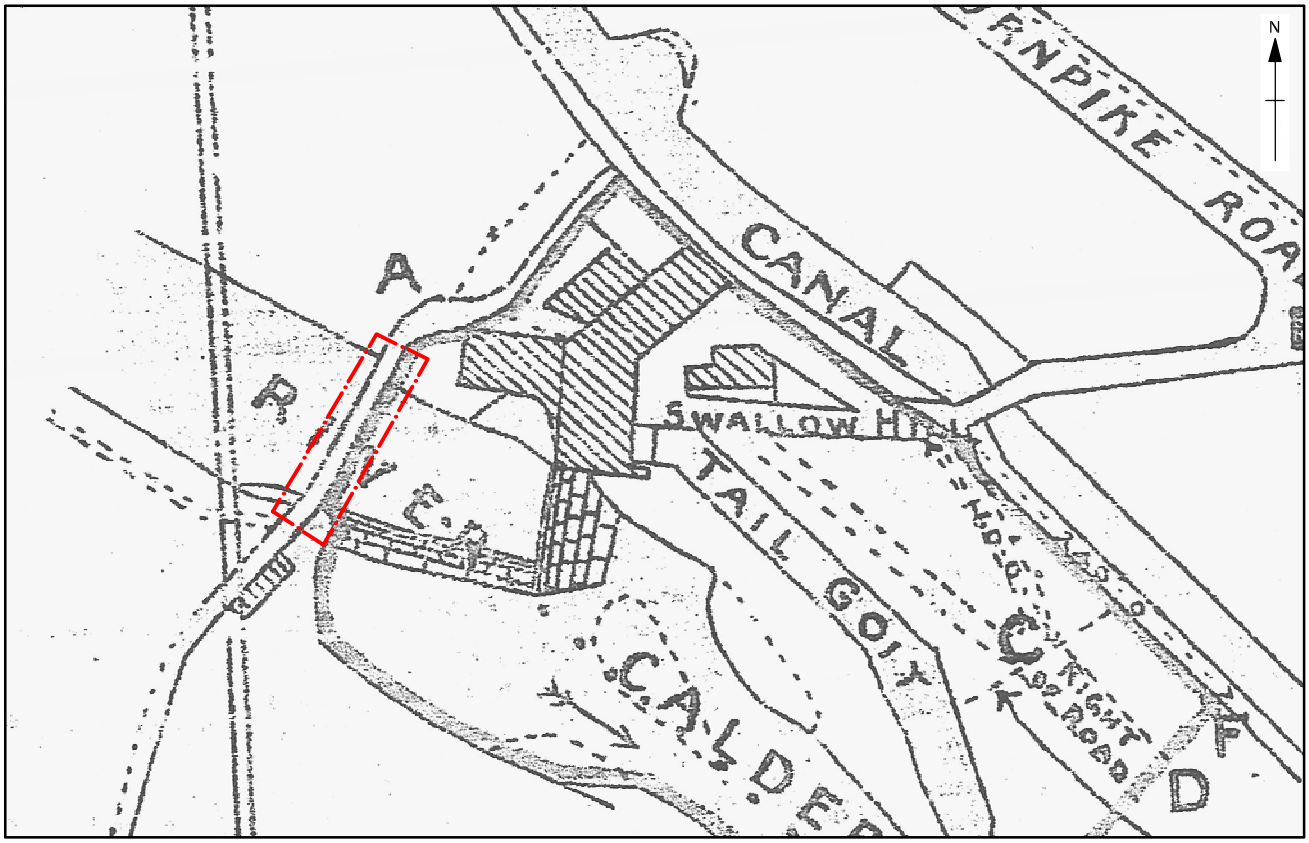

Figure 9: A conveyance plan of Sterne Mills produced in 1911

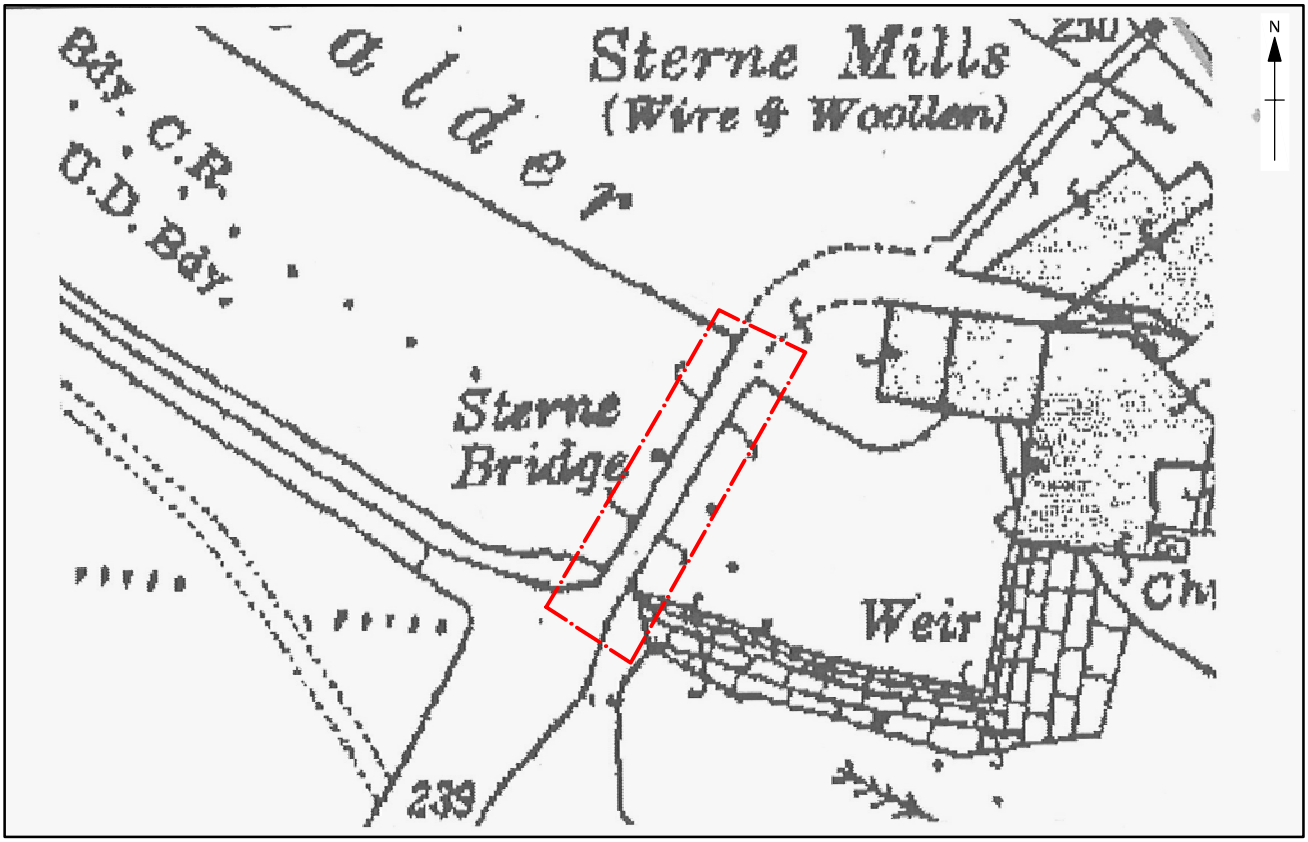

Figure 10: Extract from the Third Edition Ordnance Survey 25": 1 mile map, 1919

Sterne Bridge Study Boundary

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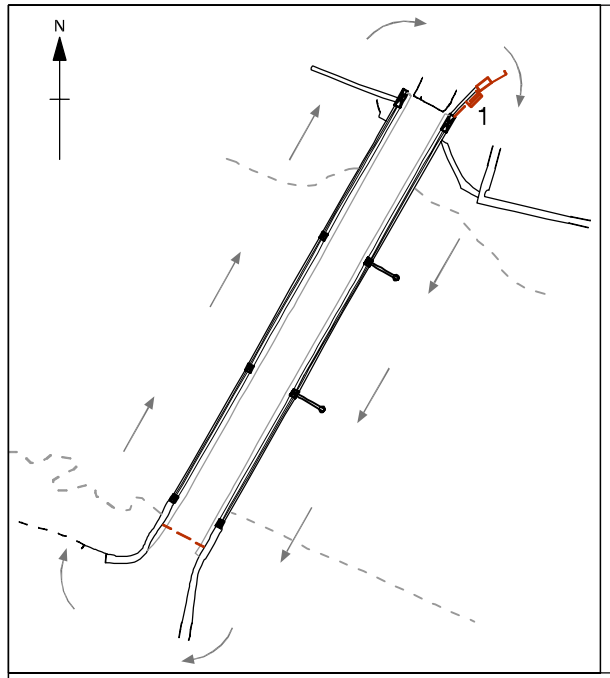
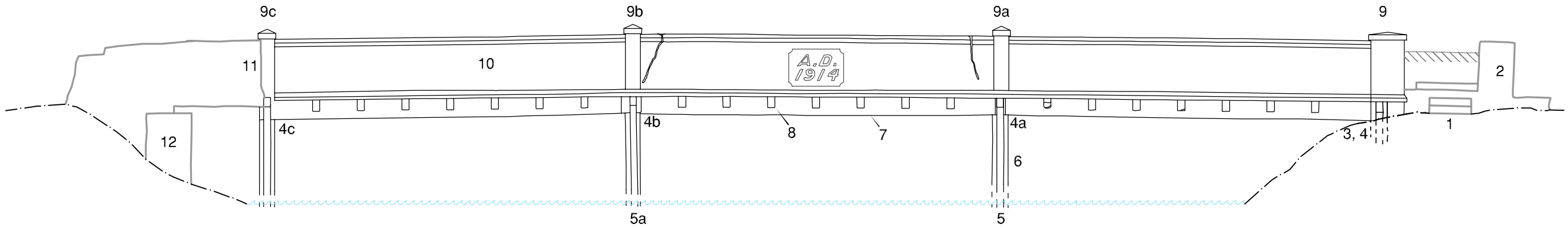
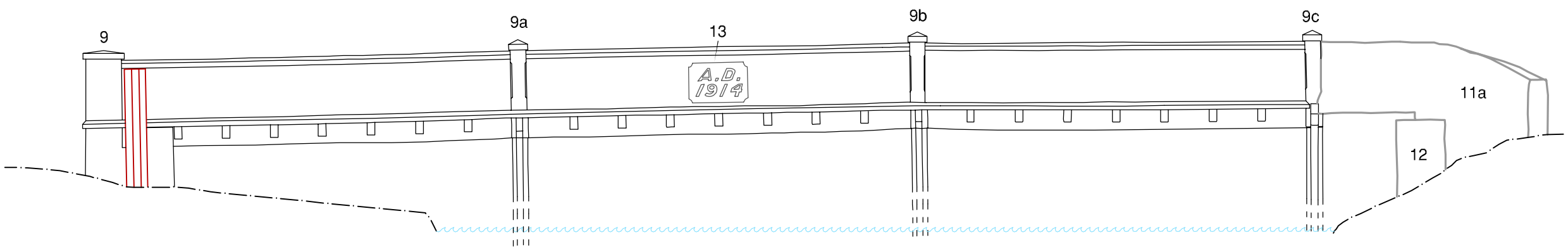


KEY

1 - Stepped access
2 - Remains of north-eastern wing wall
3 - Barrel of earlier stone abutment
4 - Northern trestle
4a - North central trestle
4b - South central trestle
4c - South trestle
5 - North cut water
5a - South cut water
6 - Elements of trestle (see Fig 5 for detail)
7 - Bridge chord and deck
8 - Rectangular section cross-beam (21 in total)
9-9c - Vertical square section paired posts with pyrimidal capstones
10 - Concrete parapet
11-11a - Rebuilt rubble stone wing wall on south bank
12 - Earlier ashlar sandstone abutment
13 - Plaque showing date of rebuild
14 - Tarmacadam road surface
15 - Earlier cobbled road surface



South-east-facing elevation



North-west-facing elevation

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Figure 11: Elevations of Sterne Bridge

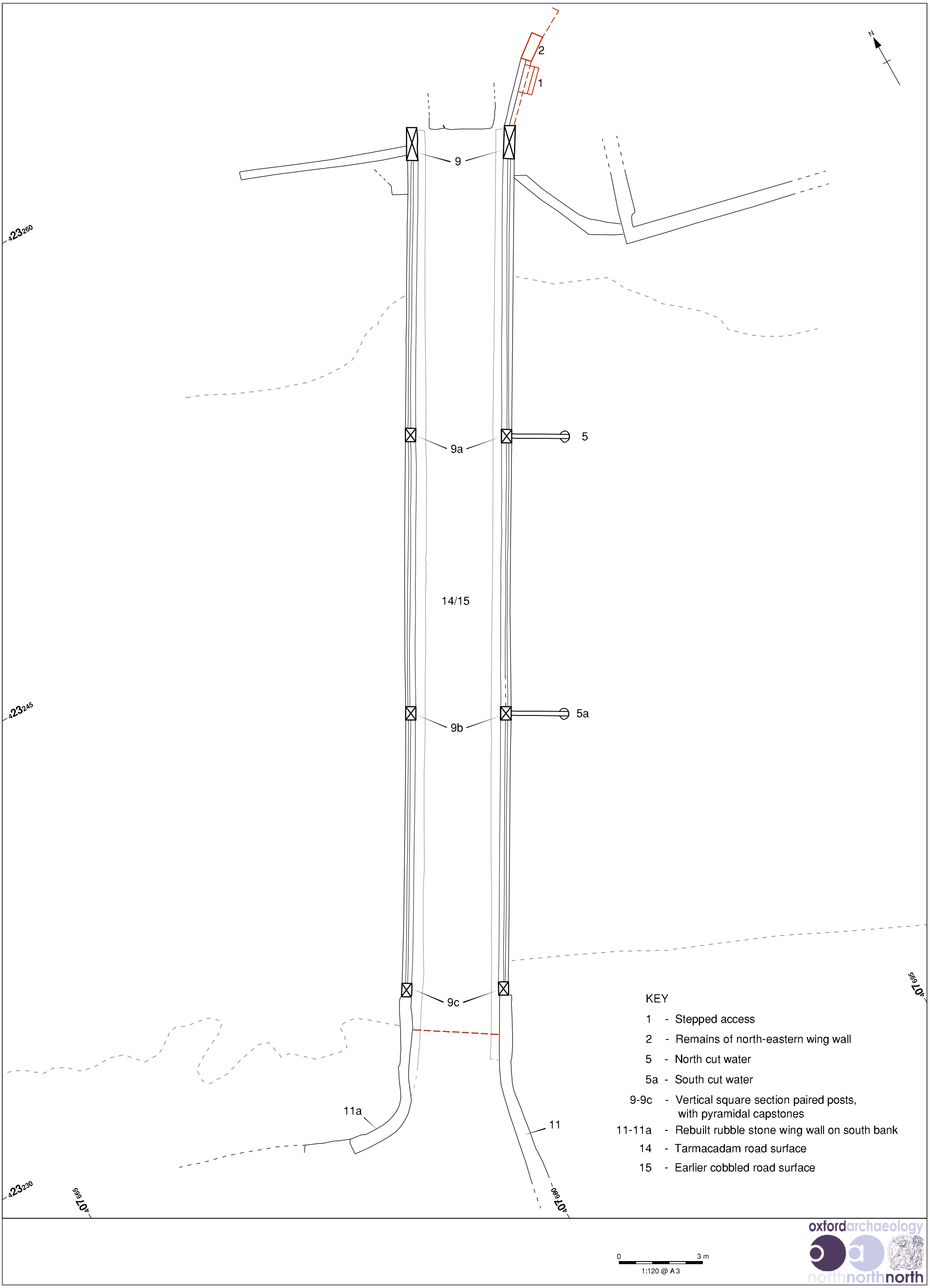

Figure 12: Plan of Sterne Bridge

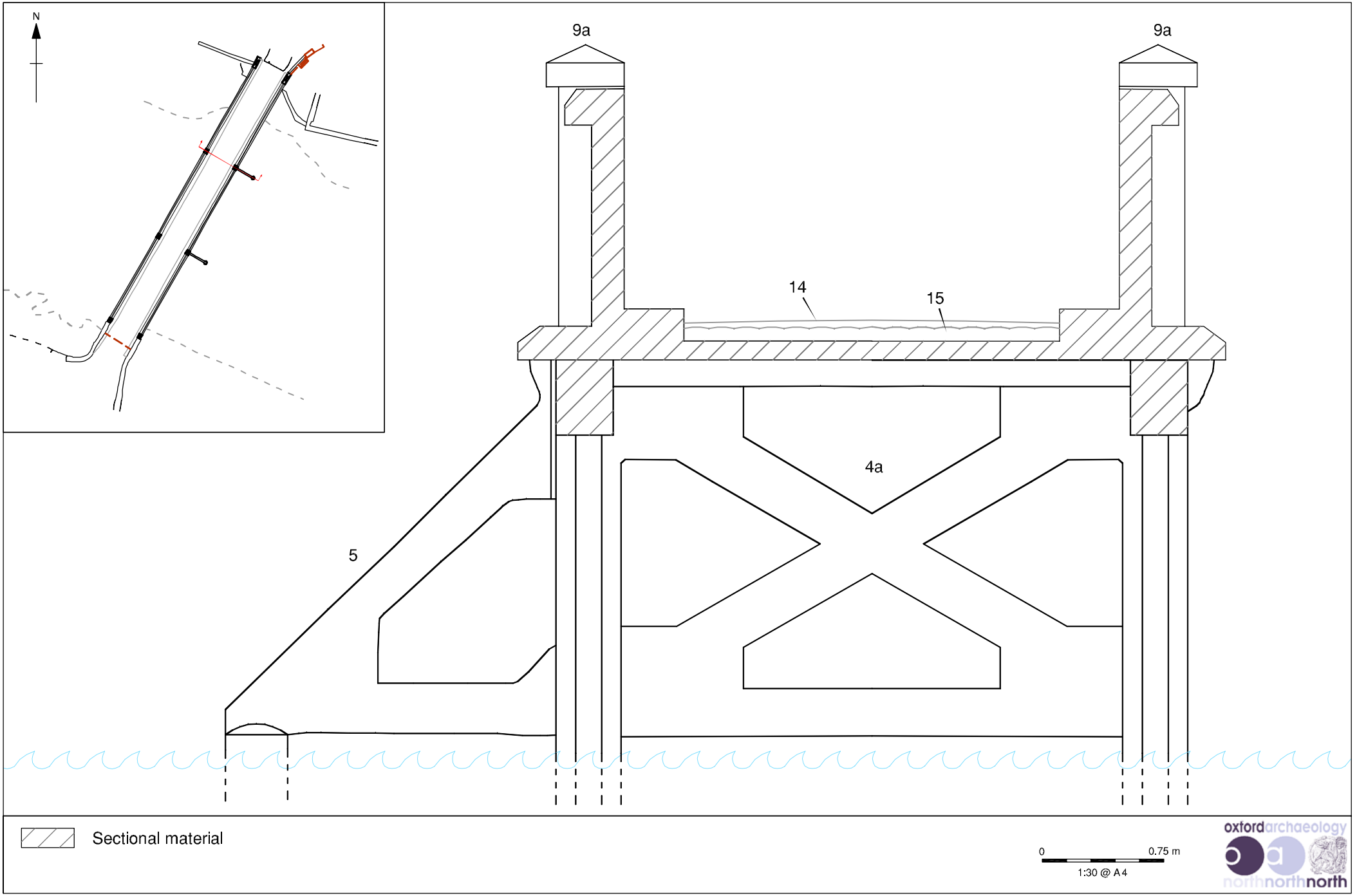

Figure 13: North-west-facing cross-section through the bridge and the northern central trestle

Photograph location	Film Number	Shot Number	Plate Number
01	SB05	- 04	
		- 05	
02	SB05	- 09	(Plate 26)
		- 10	(Plate 27)
		- 11	(Plate 28)
		- 15	
03	SB05	- 04	
		- 05	
		- 07	
		- 08	
		- 12	
		- 13	
		- 14	
04	SB05	- 01	(Plate 16)
		- 02	(Plate 24)
		- 03	(Plate 25)
05	SB04	- 05	(Plate 18)
		- 06	
		- 07	
06	SB04	- 04	(Plate 17)
		- 08	(Plate 13)
		- 09	(Plate 14)
		- 10	
		- 11	
		- 15	(Plate 15)
07	SB03	- 01	(Plate 30)
		- 02	(Plate 31)
		- 03	(Plate 32)
08	SB04	- 01	
		- 02	
		- 03	
09	SB01	- 09	
		- 10	(Plate 09)
		- 11	
10	SB08	- 02	
		- 03	
		- 04	
		- 05	
11	SB06	- 08	(Plate 61)
		- 09	(Plate 62)
		- 15	(Plate 65)
12	SB06	- 04	(Plate 60)
		- 10	(Plate 63)
		- 11	(Plate 64)
13	SB01	- 01	(Plate 02)
		- 02	(Plate 03)
		- 03	(Plate 04)
		- 04	(Plate 05)
		- 06	(Plate 06)
		- 07	(Plate 07)
		- 08	(Plate 08)
14	SB01	- 12	(Plate 10)
		- 13	(Plate 11)
	SB08	- 08	
		- 09	
15	SB04	- 12	(Plate 19)
		- 13	
		- 14	
		- 09	
16	SB09	- 10	
		- 11	
17	SB03	- 10	
		- 11	
18	SB09	- 02	
		- 03	
		- 04	
		- 05	
19	SB03	- 04	(Plate 33)
		- 05	(Plate 34)
		- 06	(Plate 35)
20	SB03	- 07	(Plate 70)
		- 08	(Plate 71)
		- 09	
21	SB02	- 11	(Plate 53)
		- 12	(Plate 54)
		- 13	(Plate 55)
22	SB02	- 14	
		- 15	
		- 16	
23	SB02	- 08	(Plate 50)
		- 09	(Plate 51)
		- 10	(Plate 52)
24	SB03	- 07	(Plate 70)
		- 08	(Plate 71)
		- 09	
25	SB02	- 02	(Plate 57)
		- 03	(Plate 58)
		- 04	(Plate 59)
26	SB02	- 05	
		- 06	
		- 07	
27	SB06	- 01	(Plate 73)
		- 02	(Plate 74)
		- 03	(Plate 75)
28	SB06	- 05	(Plate 76)
		- 06	(Plate 77)
		- 07	(Plate 78)
29	SB07	- 01	(Plate 20)
		- 02	
		- 03	
		- 04	(Plate 21)
		- 05	
		- 06	(Plate 22)
		- 07	
		- 08	(Plate 23)

06 SB00 - 00 (Plate 00) = Photographs taken at bridge level and above

07 SB00 - 00 (Plate 00) = Photographs taken beneath bridge level

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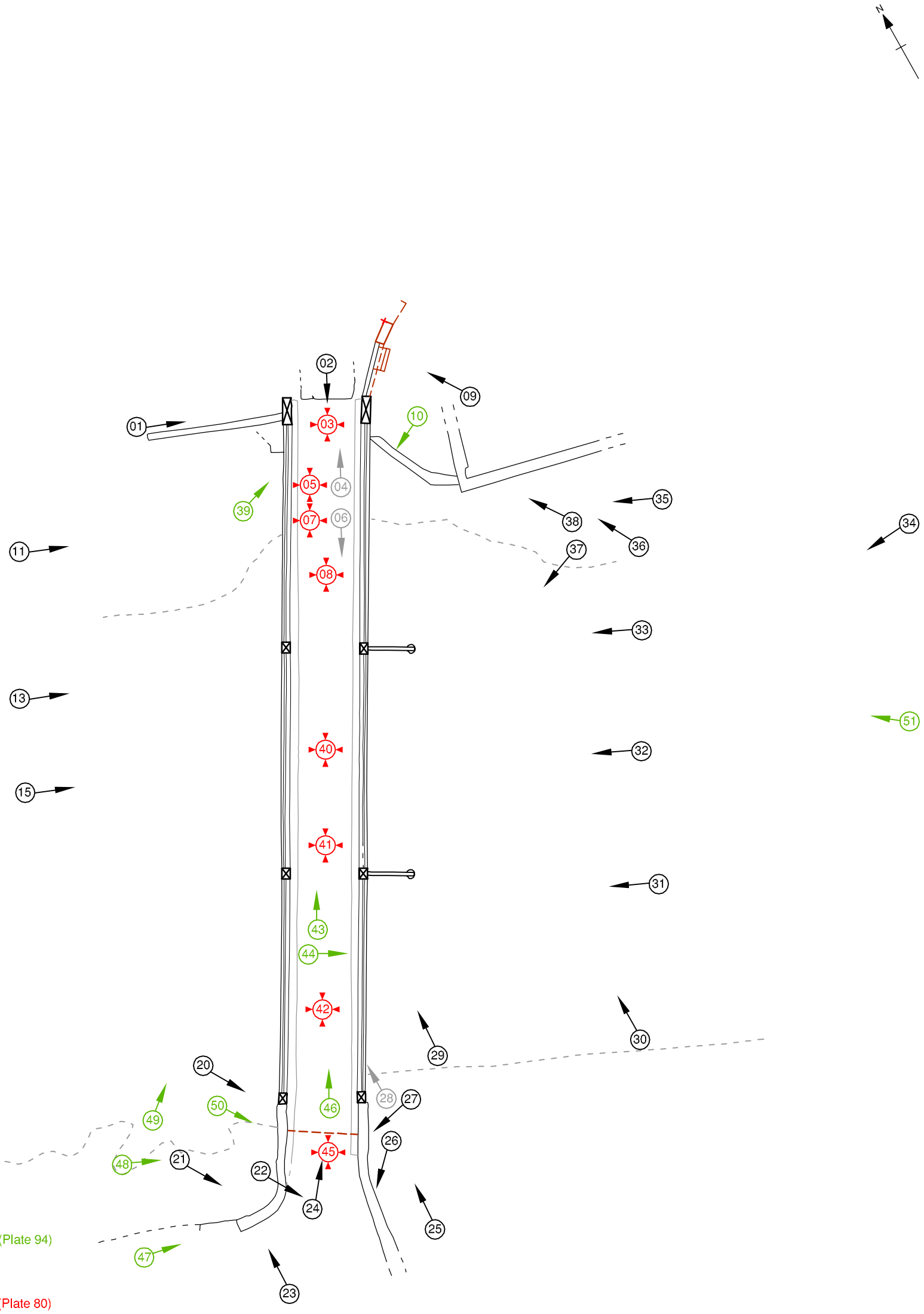
Figure 14: Medium format photograph location plan

Photograph location	Shot Number	Plate Number
01	2446	
	2438	
02	2361	(Plate 84)
	2362	
	2364	
	2365	
03	0475	
04	2439	
	2442	(Plate 29)
	2443	
05	0483	
06	2396	(Plate 36)
07	0476	
08	0477	(Plate 82)
09	2444	
	2445	
10	8733	(Plate 90)
11	2430	
	2428	
	2429	
12	2431	
13	2382	
	2383	
	2384	
14	2432	
	2437	
15	2381	
	2385	
	2386	
	2387	
16	2433	
17	2434	
18	2435	
19	2428	
	2436	
20	2406	(Plate 69)
21	2402	
	2403	
	2423	(Plate 56)
	2423	(Plate 68)
22	2401	
23	2398	
24	2397	(Plate 83)
25	2417	(Plate 72)
26	2409	
27	2407	(Plate 66)
	2408	(Plate 67)
28	2421	
29	2415	(Plate 48)
	2416	
30	2420	(Plate 49)
	2422	
31	0490	(Plate 40)
	0491	
	0492	
32	0489	(Plate 39)
	0493	(Plate 41)
	0494	
	0498	(Plate 42)
	0506	(Plate 44)
	0510	(Plate 46)
	0512	(Plate 47)
33	0488	
	0495	
	0499	(Plate 43)
	0500	
	0501	
	0511	
34	2372	
35	0503	
	0504	
	0505	
	0508	
36	0496	
	0497	
37	0507	(Plate 95)
38	0486	(Plate 37)
	0487	(Plate 38)
39	8743	(Plate 94)
40	0481	
	0482	
41	0478	(Plate 80)
42	0479	(Plate 79)
43	3611	(Plate 87)
44	3619	(Plate 88)
45	0480	
46	0744	(Plate 86)
47	0745	(Plate 89)
48	8757	(Plate 92)
49	8751	(Plate 93)
50	8754	(Plate 91)
51	0740	(Plate 85)



20 2406 - (Plate 69) = Photographs taken at bridge level and above

04 2442 - (Plate 29) = Photographs taken beneath bridge level

08 0477 - (Plate 82) = Aerial Photographs of the bridge

10 8733 - (Plate 90) = Photographs taken following main demolition phase

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Figure 15: Digital photograph location plan

PLATES

Plate 1: North-west-facing elevation of Sterne Bridge (IMG_2383)

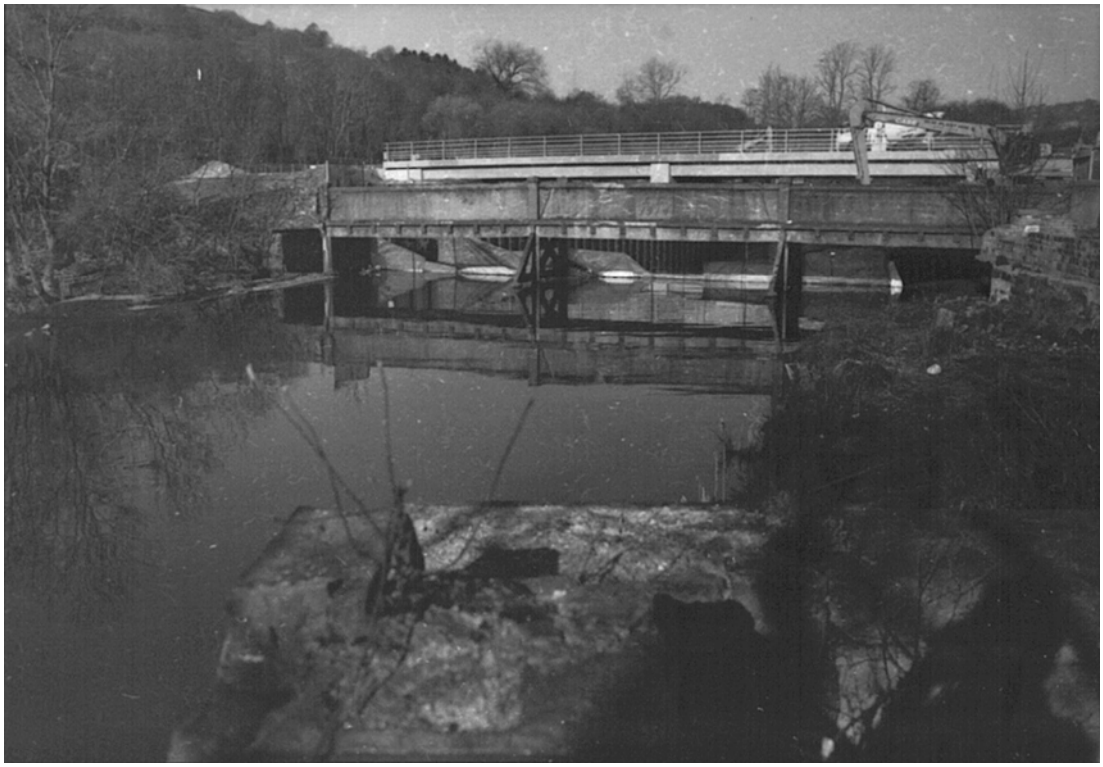

Plate 2: South-east-facing elevation of Sterne Bridge (MF SB01_01)

Plate 3: South-east-facing elevation of Sterne Bridge (MF SB01_02)

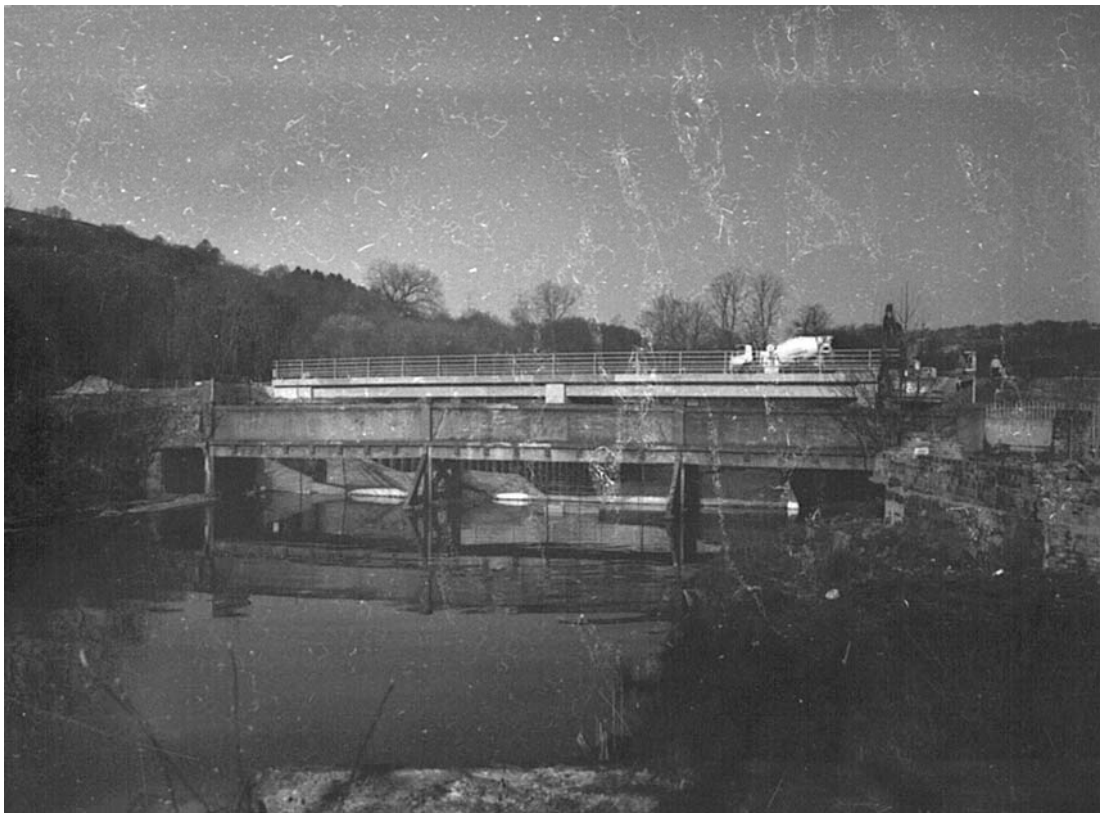

Plate 4: South-east-facing elevation of Sterne Bridge (MF SB01_03)

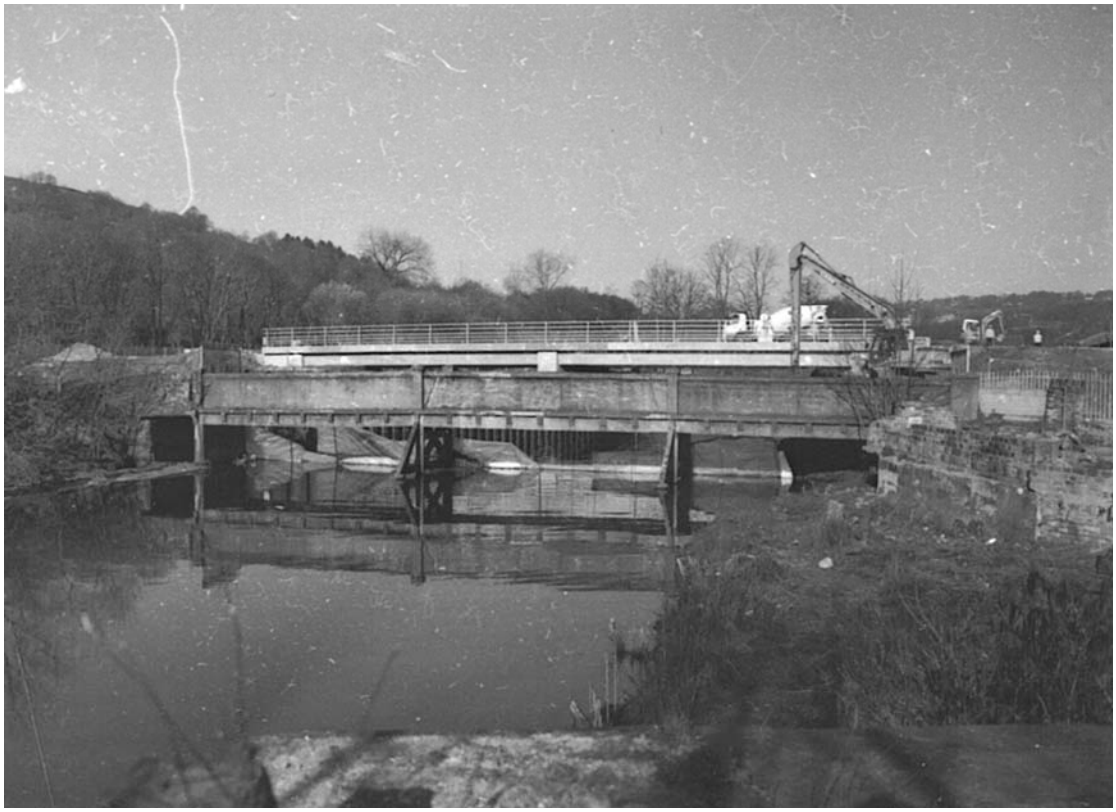

Plate 5: South-east-facing elevation of Sterne Bridge (MF SB01_04)

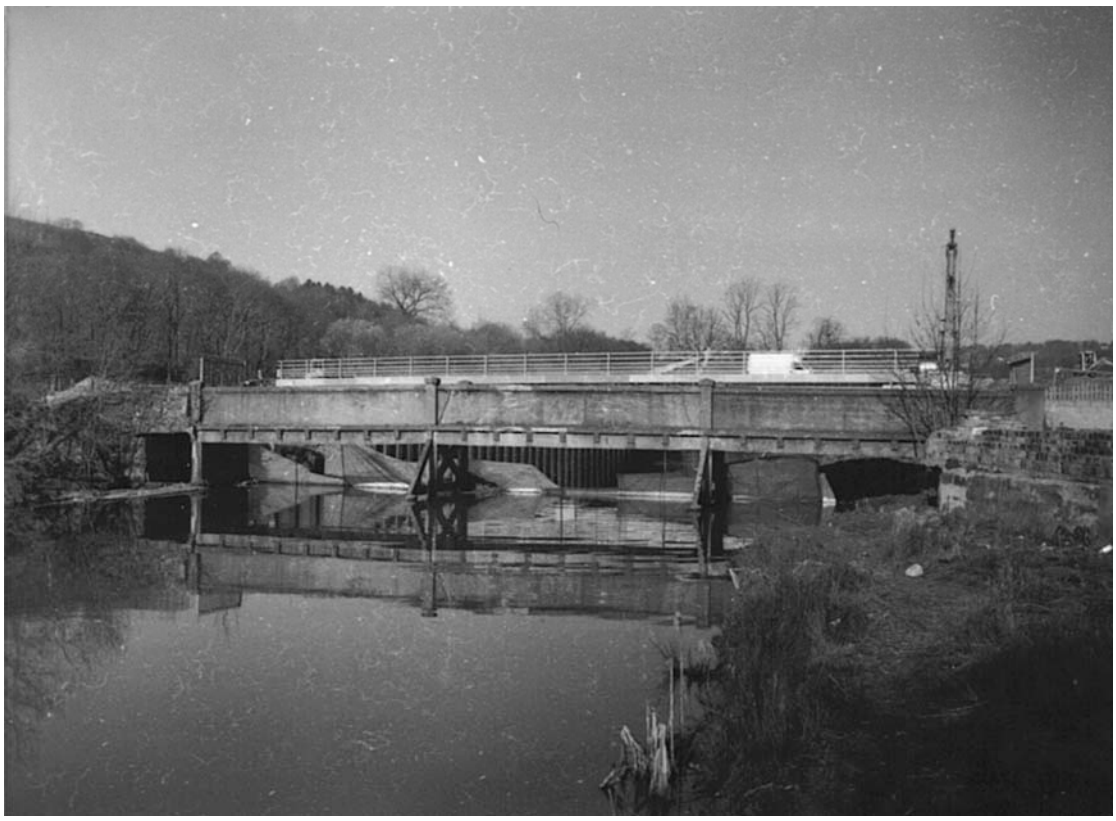

Plate 6: South-east-facing elevation of Sterne Bridge (MF SB01_06)

Plate 7: South-east-facing elevation of Sterne Bridge (MF SB01_07)

Plate 8: South-east-facing elevation of Sterne Bridge (MF SB01_08)

Plate 9: South-east-facing elevation of Sterne Bridge (MF SB01_10)

Plate 10: South-east-facing elevation of Sterne Bridge (MF SB01_12)

Plate 11: South-east-facing elevation of Sterne Bridge (MF SB01_13)

Plate 12: Stepped access **(1)** (IMG_2445)

Plate 13: Stepped access **(1)** and vertical sandstone pillar **(2)** (MF SB04_08)

Plate 14: Stepped access **(1)** and vertical sandstone pillar **(2)** (MF SB04_09)

Plate 15: Stepped access **(1)** and vertical sandstone pillar **(2)** (MF SB04_15)

Plate 16: Stepped access **(1)** and vertical sandstone pillar **(2)** (MF SB05_01)

Plate 17: South-facing view across the river Calder, showing the south-east-facing bridge elevation (MF SB04_04)

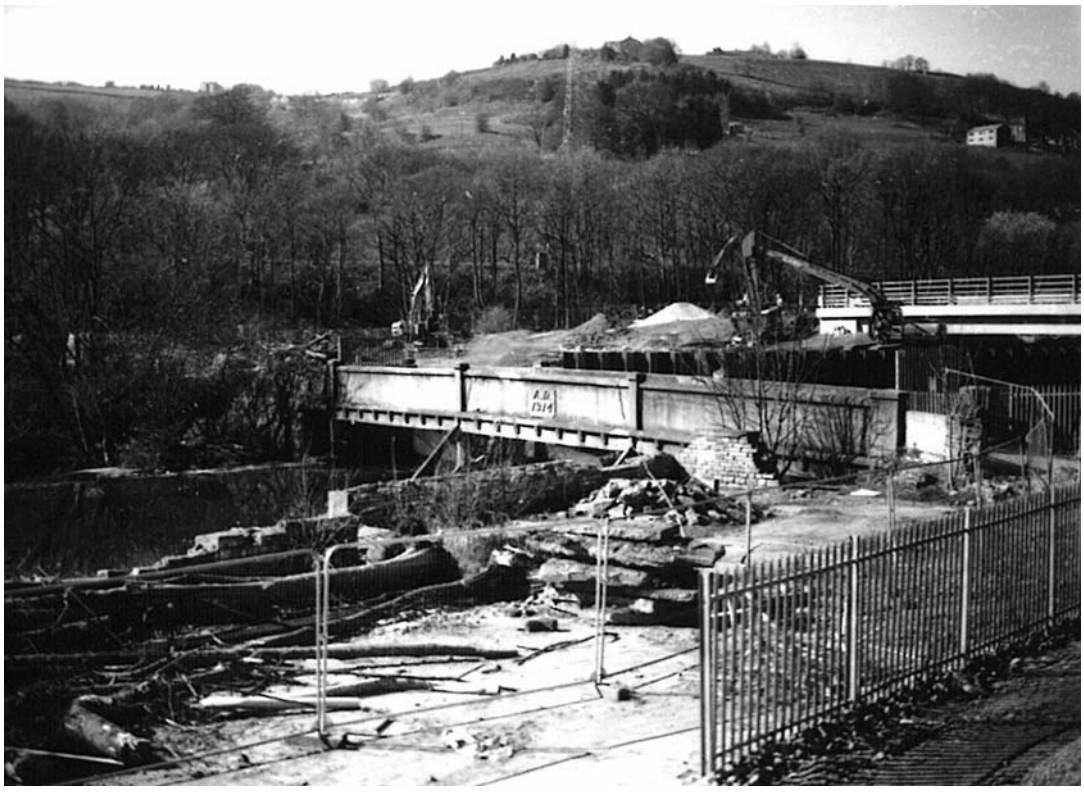

Plate 18: General view across the river Calder showing the south-east-facing bridge elevation (MF SB04_05)

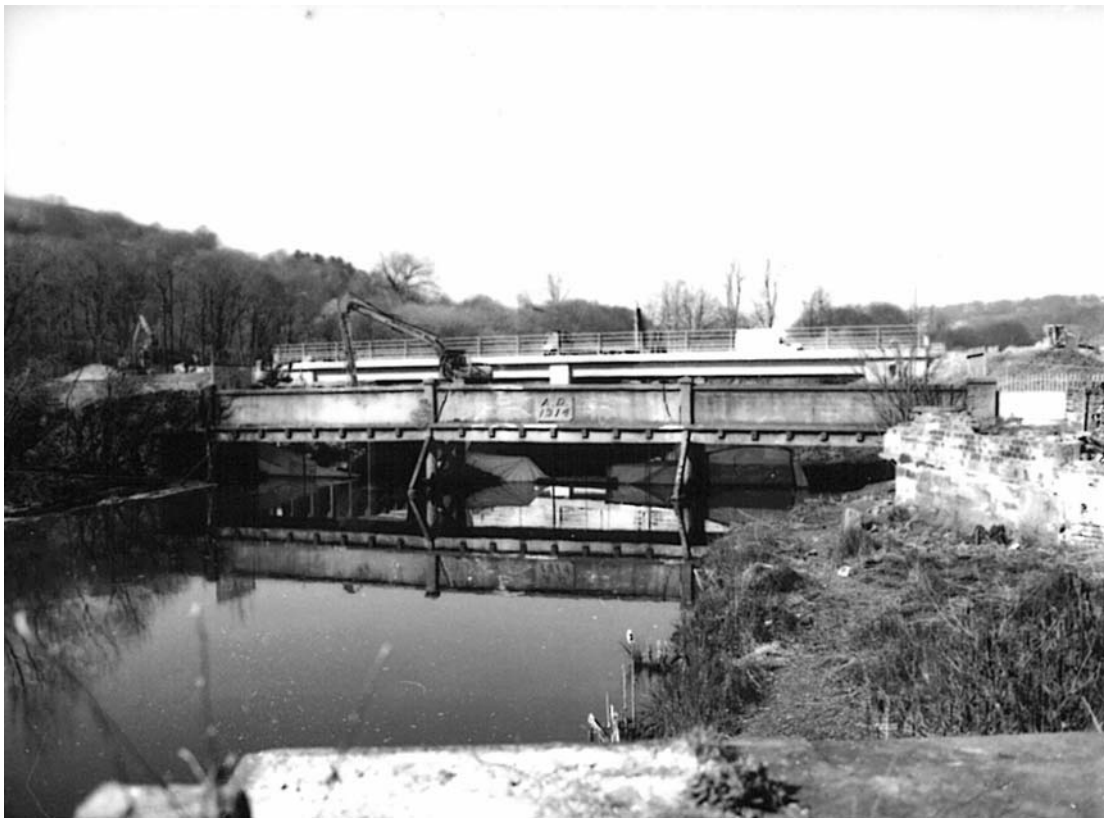

Plate 19: West-facing view across the river Calder showing the south-east-facing elevation of Sterne Bridge (MF SB04_12)

Plate 20: View from the replacement bridge showing the north-west-facing elevation of Sterne Bridge (MF SB07_01)

Plate 21: View from the replacement bridge showing the north-west-facing elevation of Sterne Bridge (MF SB07_04)

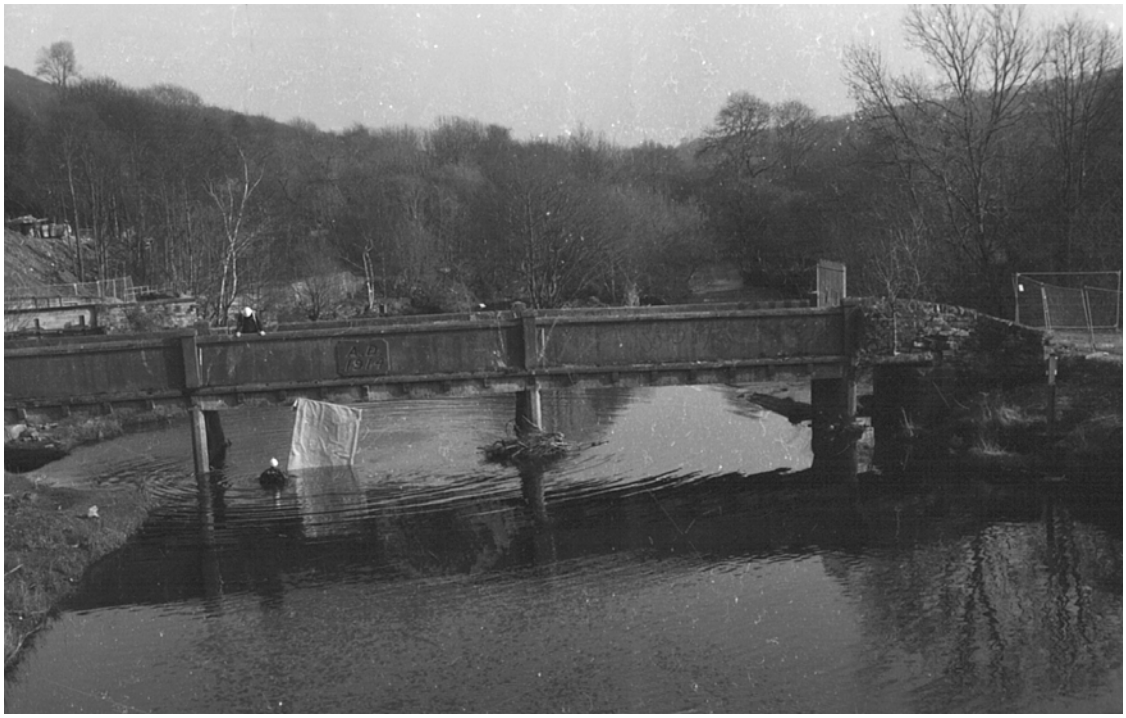

Plate 22: View from the replacement bridge showing the north-west-facing elevation of Sterne Bridge (MF SB07_06)

Plate 23: View from the new bridge showing the north-west-facing elevation of Sterne Bridge (MF SB07_08)

Plate 24: Blocked stepped access **(1)** and surviving section of eastern wing wall **(2)** (MF SB05_02)

Plate 25: Blocked stepped access **(1)** and surviving section of eastern wing wall **(2)** (MF SB05_03)

Plate 26: Blocked stepped access **(1)** and surviving section of eastern wing wall **(2)** (MF SB05_09)

Plate 27: Blocked stepped access **(1)** and surviving section of eastern wing wall **(2)** (MF SB05_10)

Plate 28: Blocked stepped access **(1)** and surviving section of eastern wing wall **(2)** (MF SB05_11)

Plate 29: Remainder of earlier bridge barrel **(3)** behind single trestle **(4)** (IMG_2442)

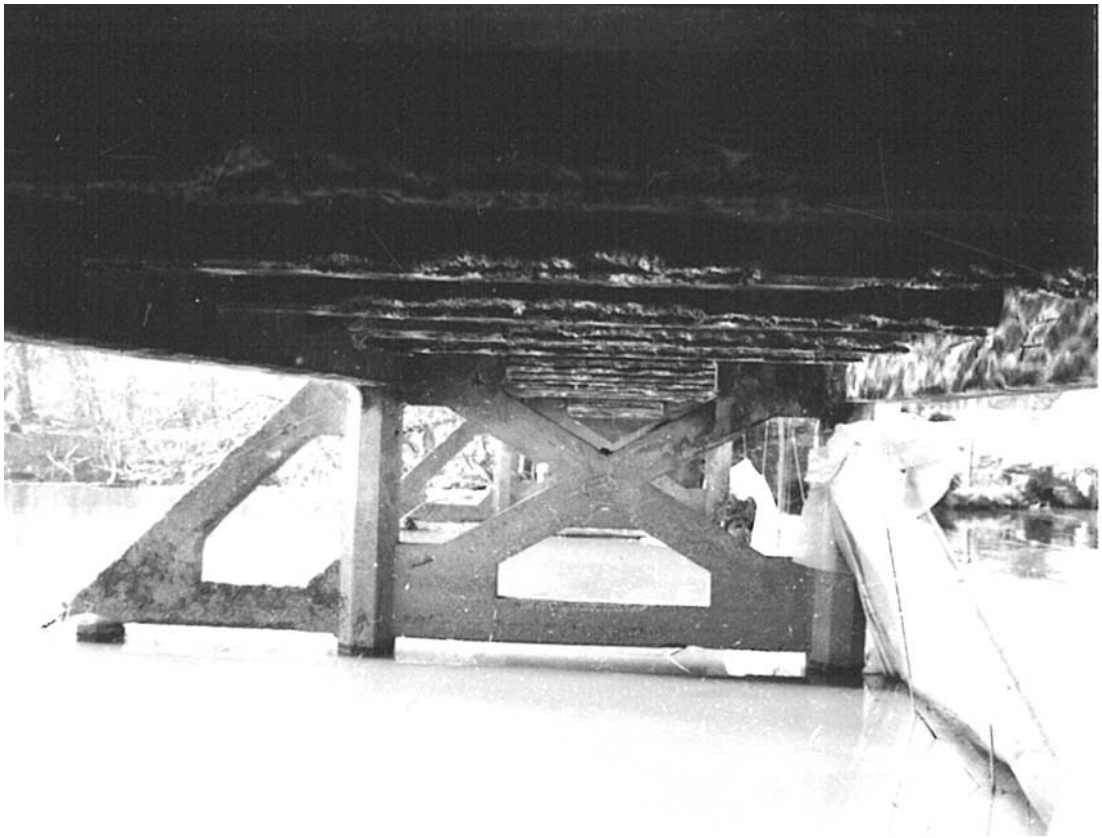

Plate 30: View from the north bank looking south, showing trestles **(4a)** and **(4b)** and cut-waters **(5)** and **(5a)** (MF SB03_01)

Plate 31: View from the north bank looking south, showing trestles **(4a)** and **(4b)** and cut-waters **(5)** and **(5a)** (MF SB03_02)

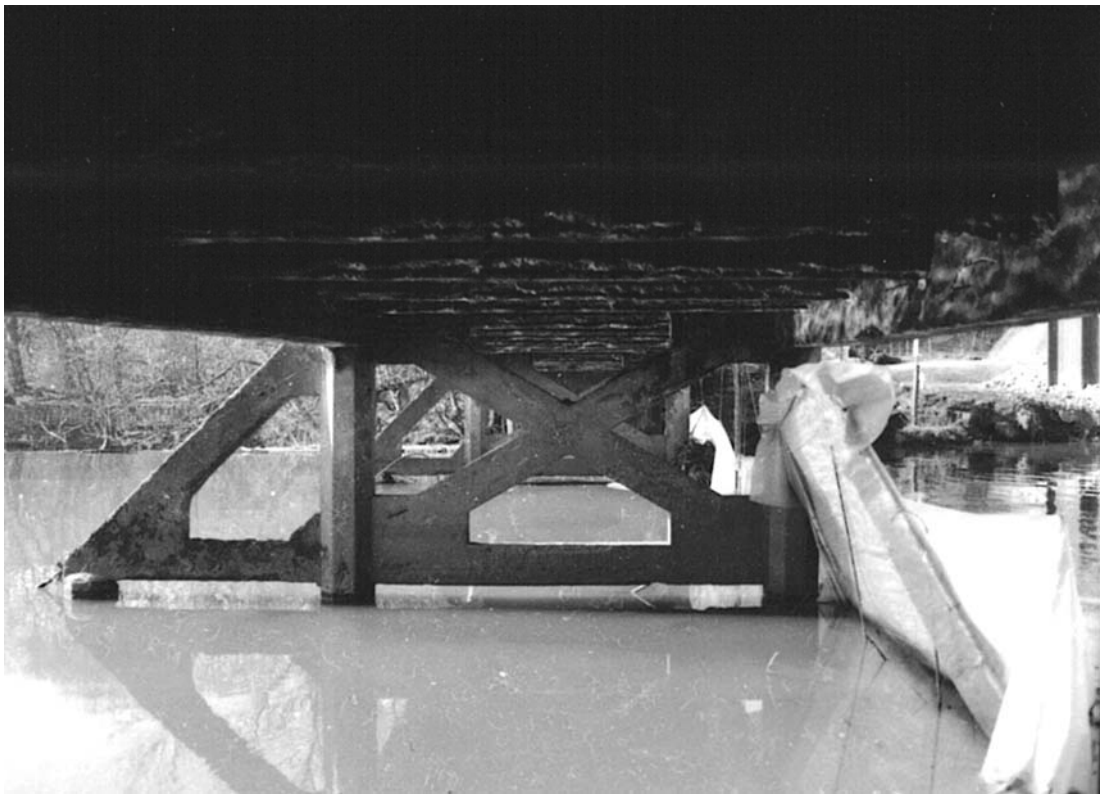

Plate 32: View from the north bank looking south, showing trestles **(4a)** and **(4b)** and cut-waters **(5)** and **(5a)** (MF SB03_03)

Plate 33: North-facing view showing south-east-facing bridge elevation, trestles **(4a)** and **(4b)**, and cut-waters **(5)** and **(5a)** (MF SB03_04)

Plate 34: North-facing view showing south-east-facing bridge elevation, trestles **(4a)** and **(4b)**, and cut-waters **(5)** and **(5a)** (MF SB03_05)

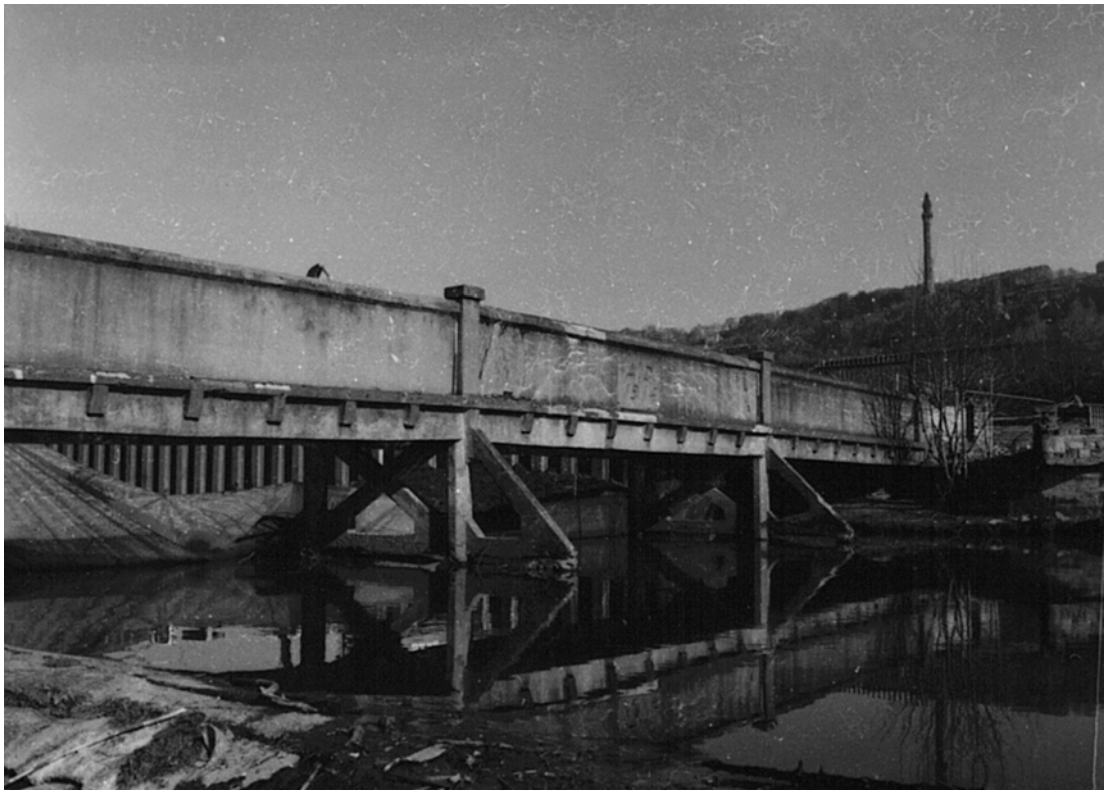

Plate 35: North-facing view showing south-east-facing bridge elevation, trestles **(4a)** and **(4b)**, and cut-waters **(5)** and **(5a)** (MF SB03_06)

Plate 36: View from the north bank looking south, showing trestles **(4a)** and **(4b)** (IMG_2396)

Plate 37: View from the north bank showing south-east-facing elevation and trestle **(4a)**, and cut-water **(5)** (DSC00486)

Plate 38: View from the north bank showing south-east-facing elevation and trestle **(4a)**, and cut-water **(5)** (DSC00487)

Plate 39: South-east-facing bridge elevation and trestles **(4a)** and **(4b)**; also showing cut-waters **(5)** and **(5a)** (DSC00489)

Plate 40: South-east-facing bridge elevation and trestles **(4a)** and **(4b)**; also showing cut-waters **(5)** and **(5a)** (DSC00490)

Plate 41: South-east-facing bridge elevation and trestles **(4a)** and **(4b)**; also showing cut-waters **(5)** and **(5a)** (DSC00493)

Plate 42: South-east-facing bridge elevation and trestle **(4b)**; also showing cut-water **(5a)** (DSC00498)

Plate 43: South-east-facing bridge elevation and trestle **(4b)**; also showing elevation view of cut-water **(5a)** (DSC00499)

Plate 44: South-east facing bridge elevation showing trestles **(4a)** and **(4b)**; also showing cut-waters **(5)** and **(5b)** (DSC00506)

Plate 45: South-east facing bridge elevation showing trestles **(4a) (4b)** and **(4c)**; also showing cut-waters **(5)** and **(5b)** (DSC00507)

Plate 46: South-east facing bridge elevation showing trestles **(4a) (4b)** and **(4c)**; also showing cut-waters **(5)** and **(5b)** (DSC00510)

Plate 47: South-east facing bridge elevation showing trestles **(4a) (4b)** and **(4c)**; also showing cut waters **(5)** and **(5b)** (DSC00512)

Plate 48: North-facing view beneath bridge showing trestles with diagonal internal bracing **(4b)** and **(4a)** and cut waters **(5a)** and **(5)** (IMG_2415)

Plate 49: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, and cut-waters **(5a)** and **(5)** (IMG_2420)

Plate 50: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, and cut-waters **(5a)** and **(5)** (MF SB02_08)

Plate 51: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, and cut-waters **(5a)** and **(5)** (MF SB02_09)

Plate 52: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, and cut-waters **(5a)** and **(5)** (MF SB02_10)

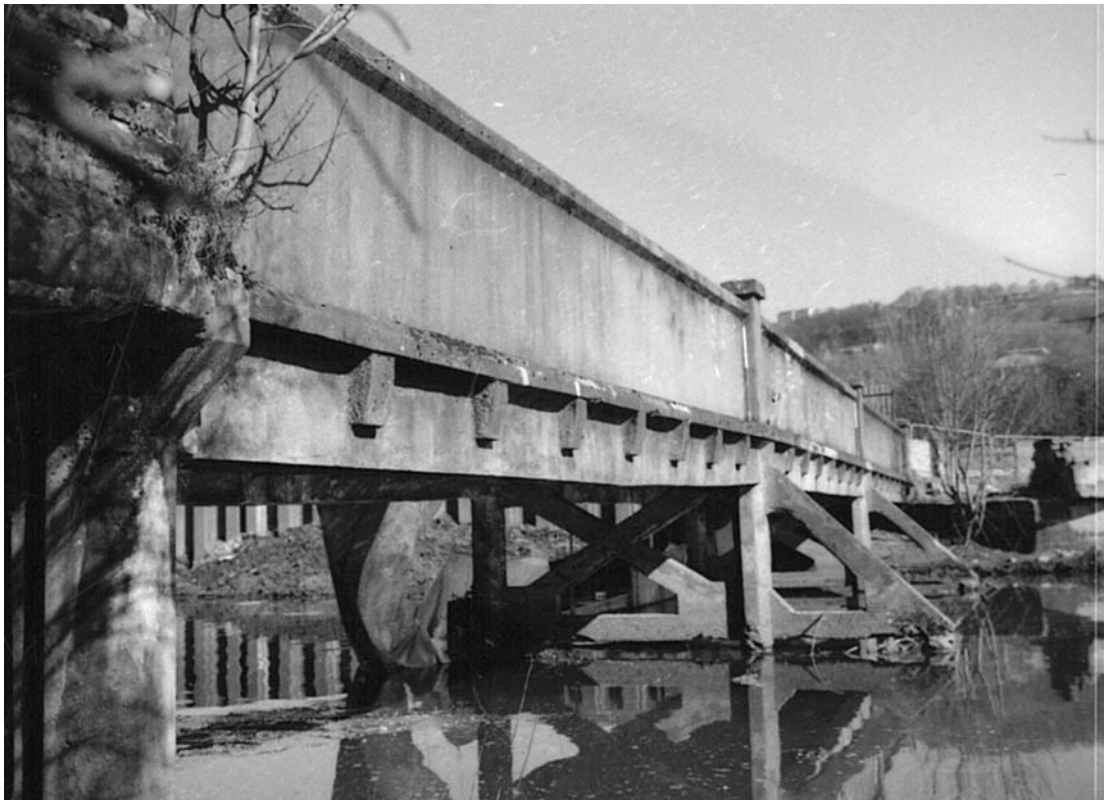

Plate 53: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, and cut-waters **(5a)** and **(5)** (MF SB02_11)

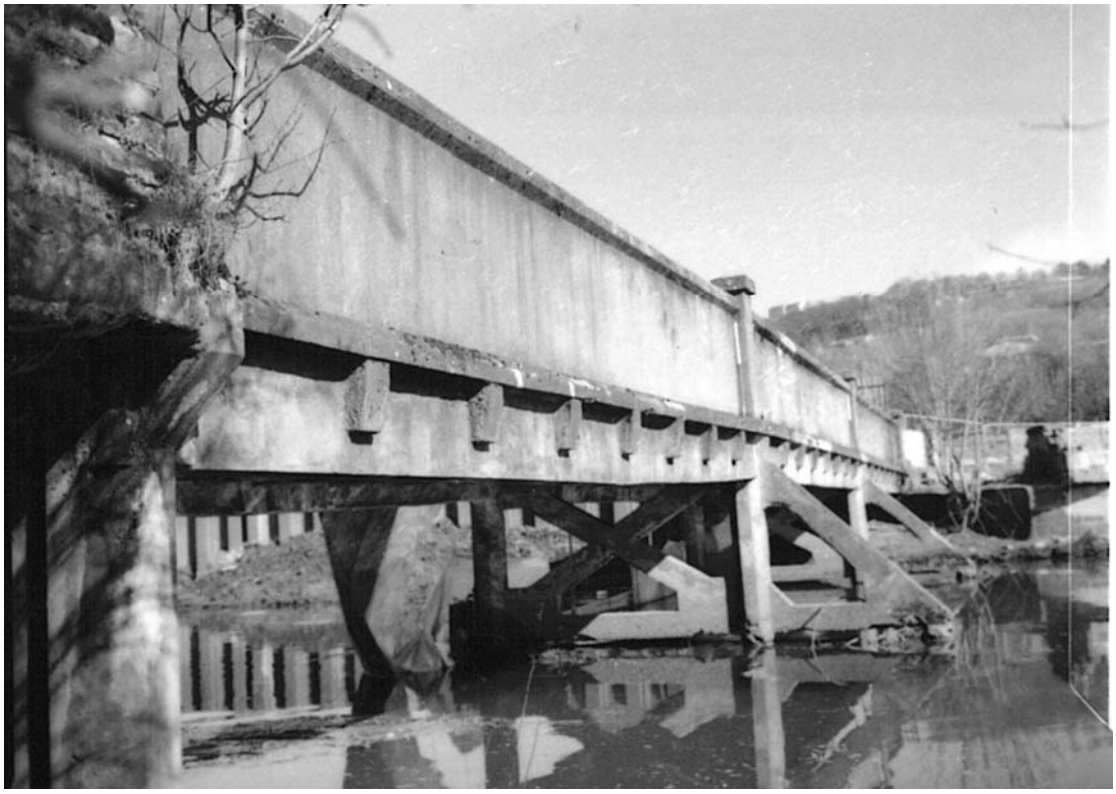

Plate 54: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, cut waters **(5a)** and **(5)**, chord **(7)**, and parapet **(10)** (MF SB02_12)

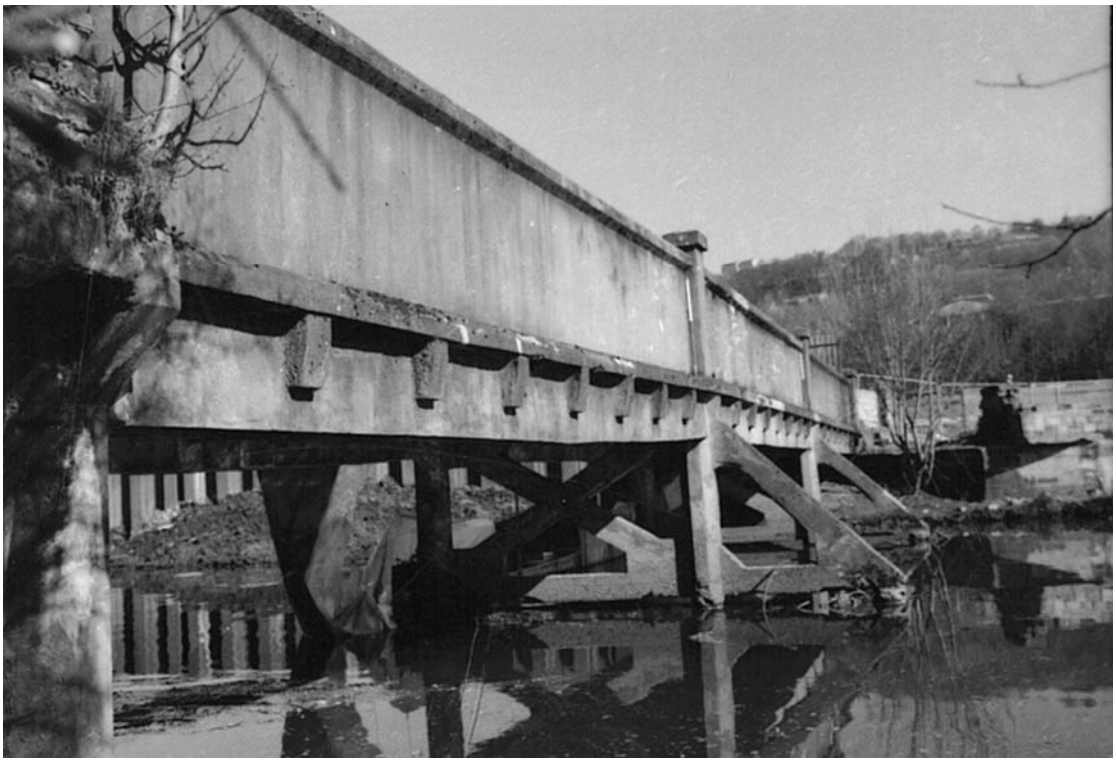

Plate 55: North-facing view showing trestles with diagonal internal bracing **(4b)** and **(4a)**, and cut-waters **(5a)** and **(5)** (MF SB02_13)

Plate 56: East-facing view showing southern trestle **(4c)**, parapet **(10)**, and western rubble wing wall **(11a)** (IMG_2423)

Plate 57: East-facing view showing southern trestle **(4c)** and western rubble wing wall **(11a)** (MF SB02_02)

Plate 58: East-facing view showing southern trestle **(4c)** and western rubble wing wall **(11a)** (MF SB02_03)

Plate 59: East-facing view showing southern trestle **(4c)** and western rubble wing wall **(11a)** (MF SB02_04)

Plate 60: West-facing view showing parapet and parapet sill **(10)** and over cross beams **(8)** (MF SB06_04)

Plate 61: South-facing view showing parapet and parapet sill **(10)** over cross beams **(8)** with vertical pillars **(9A - 9C)** (MF SB06_08)

Plate 62: South-facing view showing parapet and parapet sill **(10)** over cross beams **(8)** (MF SB06_09)

Plate 63: West-facing view showing parapet and parapet sill **(10)** over cross beams **(8)** with vertical pillar **(9a)** (MF SB06_10)

Plate 64: West-facing view showing parapet and parapet sill **(10)** over cross beams **(8)** with vertical pillar **(9a)** (MF SB06_11)

Plate 65: South-facing view showing parapet and parapet sill **(10)** over cross beams **(8)** with vertical pillars **(9a-9c)** and date stone **(13)** (MF SB06_15)

Plate 66: Interface between the south-east wing wall **(11)**, stone abutment **(12)** and the later concrete parapet wall of bridge (IMG_2407)

Plate 67: Interface between the south-east wing wall **(11)**, stone abutment **(12)** and the later concrete parapet wall of bridge with chamfered cross beam **(8)** (IMG_2408)

Plate 68: Interface between the south-east wing wall **(11)** and stone abutment **(12)** (IMG_2424)

Plate 69: East-facing shot showing a close-up of the ashlar sandstone southern abutment **(12)** (IMG_2406)

Plate 70: View from the edge of the weir showing wing wall **(11)**, abutment **(12)** and trestle **(4c)** (MF SB03_07)

Plate 71: View from the edge of the weir showing wing wall **(11)**, abutment **(12)** and trestle **(4c)** (MF SB03_08)

Plate 72: South-eastern wing wall **(11)** showing truncation and root damage (IMG_2417)

Plate 73: South-western wing wall **(11)** and sandstone abutment **(12)** (MF SB06_01)

Plate 74: South-western wing wall **(11)** and sandstone abutment **(12)** (MF SB06_02)

Plate 75: South-western wing wall **(11)** and sandstone abutment **(12)** (MF SB06_03)

Plate 76: South-western wing wall **(11)** and sandstone abutment **(12)** (MF SB06_05)

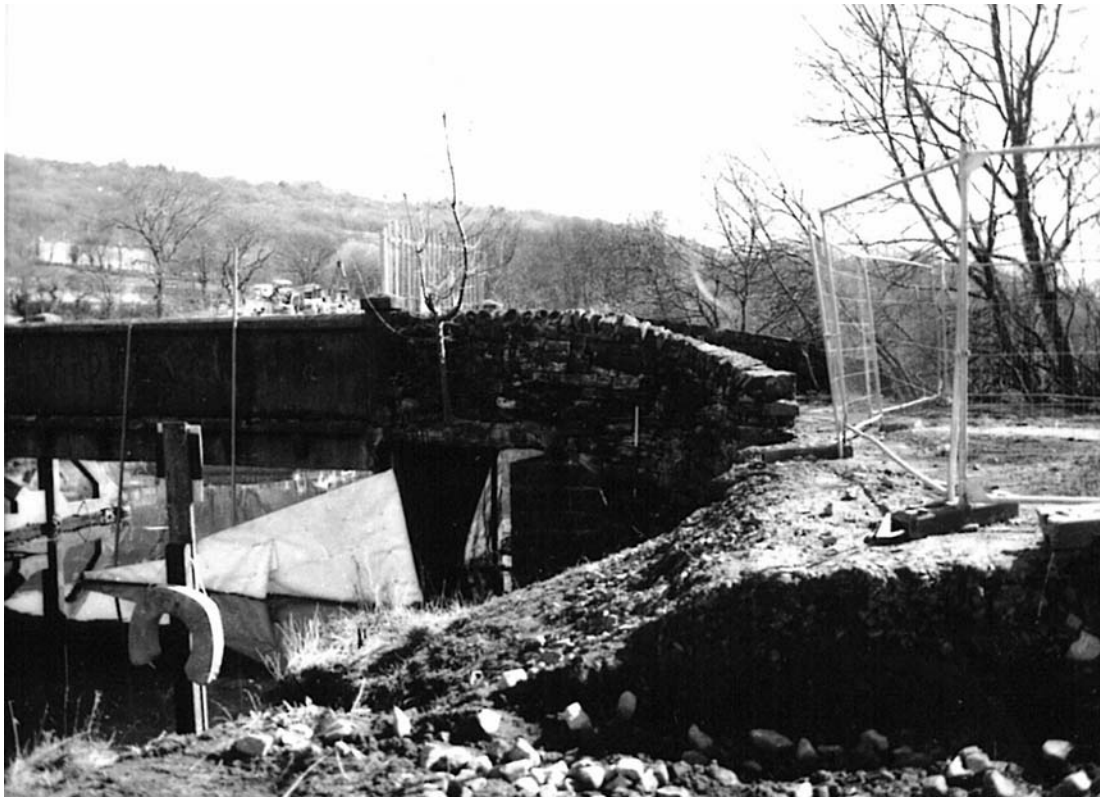

Plate 77: South-western wing wall **(11)** and sandstone abutment **(12)** (MF SB06_06)

Plate 78: South-western wing wall **(11)** and sandstone abutment **(12)** (MF SB06_07)

Plate 79: Aerial view showing southern bank and wing walls **(11)** (DSC00479)

Plate 80: Aerial view showing bridge deck **(14)** and southern wing walls **(11)** and the weir pictured to the south-east (DSC00478)

Plate 81: Aerial view showing bridge deck **(14)** flanked by parapet walls **(10)** (DSC00475)

Plate 82: Aerial view showing bridge deck **(14)** flanked by parapet walls **(10)** with projecting cut-waters **(5)** and **(5a)** on the south-eastern side (DSC00477)

Plate 83: View to north bank showing modern bridge deck **(14)** flanked by stone parapet wing walls (**11)** (IMG_2397)

Plate 84: View across the bridge to the southern bank, showing the bridge deck **(14)** flanked by concrete parapet walls **(10)** (IMG_2361)

Plate 85: Sterne Bridge during the demolition process, with central section of concrete parapet **(10)** removed (P3020740.JPG)

Plate 86: North-east-facing view across the bridge deck ,showing reinforcing in the deck and parapet walls (P3020744.JPG)

Plate 87: Cobble sett surface **(15)** exposed during the course of demolition (100_3611.JPG)

Plate 88: Bedding and made-ground layers between the cobble setts **(15)** and modern surface **(14)** on the bridge deck (100_3619. JPG)

Plate 89: East-facing view across the demolished parapet and wing walls **(11)** (P3020745.JPG)

Plate 90: South-facing view across the river Calder showing southern abutment after the completion of the demolition process (IMP_8733)

Plate 91: Close-up of interface between southern abutment **(12)** and remains of rubble wing wall **(11)** after main phase of demolition (IMG_8754)

Plate 92: Interface between southern abutment **(12)** and remains of rubble wing wall **(11)** after main phase of demolition (IMG_8757)

Plate 93: North-facing view showing the remains of the northern abutment **(3)** following the main phase of demolition (IMG_8751)

Plate 94: South-east-facing view showing the remains of the northern abutment **(3)** and octagonal section pillars on the east and west sides (IMG_8743)

APPENDIX 1: PROJECT BRIEF

Specification For Archaeological Photographic Building Recording and Watching Brief at Sterne Bridge, Copley Valley, Sowerby Bridge
Planning Permission 11/00200/FUL
(404683 423249)

Specification prepared at the request of Steve Emily Mercer Oxford Archaeology North on behalf of Calderdale district Council.

1 Summary

1.1 A record (photographic survey and watching brief) is required to document the present Sterne Bridge prior to its demolition. Both demolition and construction of a new bridge should be subject of a watching brief to record any evidence of an earlier bridge on the site during construction (planning permission 11/01154/FU). This specification for the necessary work has been prepared by the West Yorkshire Archaeology Advisory Service (WYAAS), the curators of the West Yorkshire Historic Environment Record.

NOTE: The requirements detailed in paragraphs 6.1.1 to 6.1.5 inclusive, 8.3 and 8.4 are to be met by the archaeological contractor **prior** to the commencement of fieldwork by completing and returning the attached form to the WY Archaeology Advisory Service.

2 Site Location and Description

2.1 Location

(Grid ref. **404683 423249**) Sterne Bridge is located on the river Hebble to the south Wakefield Road (A6026). The Calder and Hebble Navigation, Sowerby Cut, lies 75m to the north and is also bridged at this location. The northern part of the Sterne Bridge is in the township of Skircoat while the southern lies in Norland. Due to it's close associated with the Sterne's and Sterne Mill the bridge will be consider to lie in Skircoat for the purposes of this project.

2.2 Description

The bridge is a concrete trestle bridge c. 35m long with stone abutments. The parapet has been reinforced with a external sprayed concrete coating. The bridge deck is support by the two abutments and two concrete trestles set equidistant from the abutments with a wide central span between. The trestles appear to rest on piles driven in to the river bed. It is assumed the bridge is constructed using a contemporary reinforced concrete system (see Archaeological Interest below).

3 Planning Background

The site developers, through DPP (The Exchange 3 New York Street Manchester M1 4HN Contact Richard Wilshaw Tel: 0161 238 9877) have obtained planning consent (Planning Application No. **11/00200/FUL**) for the provision of new infrastructure as part of a mixed use development in the Copley Valley. The WYAAS (as Calderdale's archaeological advisor) has prepared this specification in order to allow the owners to meet the terms of an archaeological condition which has been placed on the consent.

4 Archaeological Interest

4.1 Historical Background

A bridge is first recorded at Sterne Mills on a plan of the Calder and Hebble Navigation of 1765 although it is far from clear on Jefferys' map of 1775. The bridge provided a minor crossing of the Hebble which would have been of some importance in the functioning of the local economy. The present bridge's stone abutments may relate to this structure. It seems likely the bridge is closely associated with the adjacent Sterne Mill. A mill is first recorded in the will of Richard Sterne dating from 1732 when it is named as Woodhouse Mill, at this date the mill is assumed to have been used for grinding corn. After a checkered history as a fulling then textile mill the site was leased by the Standard Wire Company in 1911. That the bridge

was replaced soon after this in 1914 illustrate that Sterne Bridge was closely associated with the fortunes of the adjacent mill and may show increased investment in the site after a period of dilapidation and, perhaps, the changing needs of the new tenant.
The use of concrete for bridges and other structures began in the late 19th century. Several systems of reinforced concrete were common in the early 20th century including Hennebrique, Coignet and Considere. Hennebrique is the most common system employed in the UK although it is not currently known which system was used in the construction of Sterne Bridge.

4.2 Impact of proposed development
The approved application calls for the demolition of the bridge.

5 Aims of the Project
5.1 The aim of the proposed work is to identify and objectively record by means of photographs the historical form of the present bridge and abutments. Any earlier remains disturbed by demolition or new construction will be recorded during an archaeological watching brief to achieve 'preservation by record'. This record will be placed in the public domain by depositing it with the WY Historic Environment Record (Registry of Deeds, Newstead Road, Wakefield WF1 2DE).

6 Recording Methodology

6.1 General Instructions
6.1.1 Health and Safety
The archaeologist on site will naturally operate with due regard for Health and Safety regulations. Prior to the commencement of any work on site (and preferably prior to submission of the tender) the archaeological contractor may wish to carry out a Risk Assessment in accordance with the Health and Safety at Work Regulations. The archaeological contractor should identify any contaminants which constitute potential Health and Safety hazards (e.g. chemical drums) and make arrangements with the client for decontamination/making safe as necessary and appropriate. The WY Archaeology Advisory Service and its officers cannot be held responsible for any accidents or injuries which may occur to outside contractors engaged to undertake this survey while attempting to conform to this specification.

6.1.2 Confirmation of adherence to specification
Prior to the commencement of any work, the archaeological contractor must confirm in writing adherence to this specification (using the attached form), or state in writing (with reasons) any specific proposals to vary the specification. Should the contractor wish to vary the specification, then written confirmation of the agreement of the WYAAS to any variations is required prior to work commencing. Unauthorised variations are made at the sole risk of the contractor (see para. 8.3, below). Modifications presented in the form of a re-written project brief will not be considered by the WYAAS.

6.1.3 Confirmation of timetable and contractor's qualifications
Prior to the commencement of work on site, the archaeological contractor should provide the WYAAS in writing with a projected timetable for the site work, and with details regarding staff structure and numbers. *Curriculum vitae* of key project members (the project manager, site supervisor, photographer, any proposed specialists *etc.*), along with details of any specialist sub-contractors, should also be supplied to the WYAAS if the contractor has not previously done so. All project staff provided by the archaeological contractor must be suitably qualified and experienced for their roles. In particular, staff involved in building recording should have proven expertise in the recording and analysis of agricultural buildings.

6.1.4 Site preparation
No additional site preparation is considered necessary.

6.1.5 Documentary research
Prior to the commencement of work on site, the archaeological contractor should undertake a rapid map-regression exercise based on the readily-available map and photographic evidence

held by the relevant Local History Library (contact Sowerby Bridge Library, Hollins Mill Lane Sowerby Bridge Halifax HX6 2QG Tel: 01422 831627; sowerby_bridge.library@calderdale.gov.uk) and the West Yorkshire Archive Service (WYAS, Calderdale Central Library, Northgate House, Northgate, Halifax, HX1, 1UN Tel: 01422 392636; calderdale@wyjs.org.uk). In addition an assessment of Sterne Mills by Structural Perspectives is held by the West Yorkshire Historic environment Record at this office. This work is intended to inform the archaeological recording by providing background information with regard to function and phasing. Please note that this exercise is not intended to be a formal desk-based assessment, and should not represent a disproportionate percentage of the time allowed for the project overall.

6.2 Written Record

The archaeologist on site should carefully examine all parts of the bridge prior to the commencement of the photographic recording, in order to identify all features relevant to its original use and construction and to obtain an overview of its development. As part of this exercise, the archaeologist on site should produce written observations (e.g. on phasing;) sufficient to permit the preparation of a report on the structure.

6.3 Photographic Record

6.3.1 External photographs

An external photographic record should be made of all elevations of the bridge, from vantage points as nearly parallel to the elevation being photographed as is possible within the constraints of the site. The contractor should ensure that all visible elements of each elevation are recorded photographically; this may require photographs from a number of vantage points. A general photographic record should also be made which includes a number of oblique general views of the bridge from all sides, showing it as a whole in its setting. In addition, a 35mm general colour-slide survey of the bridge should also be provided (using a variety of wide-angle, medium and long-distance lenses). While it is not necessary to duplicate every black-and white shot, the colour record should be sufficiently comprehensive to provide a good picture of the form and general appearance of the group and of the individual structures.

6.3.3 Detail photographs

In addition, detailed record shots should be made of all features of archaeological and architectural interest identified during the process of appraisal. Typically, items of interest would include:

- All original structural elements, such as trusses and construction system (reinforcement bars)
- Abutments
- Date plaque

But this list should not be treated as exhaustive. The archaeologist on site should also identify and note:

- any significant changes in construction material – this is intended to include significant changes in stone/brick type and size
- evidence for phasing, and for historical additions or alterations to the bridge.

N.B. Detail photographs must be taken at medium-to-close range and be framed in such a way as to ensure that the element being photographed clearly constitutes the principal feature of the photograph.

6.3.4 Equipment

General photographs should be taken with a Large Format monorail camera (5” x 4” or 10” x 8”), or with a Medium Format camera that has perspective control, using a tripod. The contractor must have proven expertise in this type of work. Any detail photographs of structural elements should if possible be taken with a camera with perspective control. Other

detail photographs may be taken with either a Medium Format or a 35mm camera. All detail photographs must contain a graduated photographic scale of appropriate dimensions (measuring tapes and surveying staffs are not considered to be acceptable scales in this context). A 2-metre ranging-rod, discretely positioned, should be included in a selection of general shots, sufficient to independently establish the scale of all elements of the structure.

6.3.5 Digital photography

As an alternative to our requirement for colour slide photography, good quality digital photography may be supplied as an alternative, using cameras with a minimum resolution of 4 megapixels. Note that conventional black and white print photography is still required and constitutes the permanent record. Digital images will only be acceptable as an alternative to colour slide photography if each image is supplied in three file formats (as a RAW data file, a DNG file and as a JPEG file). The contractor must include metadata embedded in the DNG file. The metadata must include the following: the commonly used name for the site being photographed, the relevant centred OS grid coordinates for the site to at least six figures, the relevant township name, the date of photograph, the subject of the photograph, the direction of shot and the name of the organisation taking the photograph. Images are to be supplied to WYAAS on gold CDs by the archaeological contractor accompanying the hard copy of the report.

6.3.6 Film stock

All record photographs to be in monochrome, using conventional (not chromogenic) silver-based film only, such as Illford FP4 or HP5, or Delta 400 Pro that is replacing HP5 in certain film sizes (such as 220). Dye-based films such as Ilford XP2 and Kodak T40CN are unacceptable due to poor archiving qualities.

6.3.7 Printing

6.3.7a Record photographs should be printed at a minimum of 5" x 7". In addition, a small selection of photographs (the best of the exterior setting shots and interior shots) should be printed at 10" x 8". Bracketed shots of identical viewpoints need not be reproduced, but all viewpoints must be represented within the report.

6.3.7b Prints may be executed digitally from scanned versions of the film negatives, and may be manipulated to improve print quality (but **not** in a manner which alters detail or perspective). All digital prints must be made on paper and with inks which are certified against fading or other deterioration for a period of 75 years or more when used in combination. If digital printing is employed, the contractor must supply details of the paper/inks used in writing to the WYAAS, with supporting documentation indicating their archival stability/durability. Written confirmation that the materials are acceptable must have been received from the WYAAS prior to the commencement of work on site.

6.3.8 Documentation

A photographic register detailing (as a minimum) location, direction and subject of shot must accompany the photographic record; a separate photographic register should be supplied for any colour slides and digital photography. Position and direction of each photograph and slide should be noted on a scaled copy of the building plan (minimum acceptable scale 1:100), which should also be marked with a north pointer. Separate plans should be annotated for each floor of each building.

6.4 Structural Watching Brief

Subsequent to the commencement of work on site, a watching brief should be maintained by the contracting archaeologist to record any pertinent historic structural or functional detail which exposed during the demolition and renewal of the bridge. Particular note should be made of the abutments and any evidence of historic piling, bridge footings in the riverbed or evidence of a ford. This record should be obtained by means of notes, drawings and photographs as appropriate, to the standards outlined elsewhere in this specification. This detail should then be incorporated into the completed record.

7. Post-Recording Work and Report Preparation

7.1 After completion of fieldwork Prior to the commencement of demolition, the archaeological contractor should arrange a meeting at the offices of the WY Archaeology Advisory Service to present a draft of the photo-location plan, and photographic contact prints adequately referenced to this plan (material supplied will be returned to the contractor). **N.B**. if full-sized prints or digital versions of contact sheets are supplied for this purpose, they must be accompanied by a sample of the processed negatives. If appropriate, the WY Archaeology Advisory Service will then confirm to Calderdale Council's Planning Services that fieldwork has been satisfactorily completed and that other work on site may commence (A separate belowground watching brief will be held to record any buried archaeological material disturbed during construction and infrastructure works). Please note that as of the 1st April 2011, the WYAAS will charge the archaeological contractor a fee for each fieldwork verification meeting.

7.2 Report Preparation

7.2.1 Report format and content

- an executive summary including dates of fieldwork, name of commissioning body, and a brief summary of the results including details of any significant finds
- an introduction outlining the reasons for the survey
- a brief architectural description of the bridge correlated to the drawn and photographic record, presented in a logical manner, starting with setting, then progressing to all sides of the structure in sequence and correlated/fully referenced to the photographic record.
- Results of watching brief and observations of any earlier bridge structure encountered

The architectural description should be fully cross-referenced to the photographic record, sufficient to illustrate the major features of the site and the major points raised. It is not envisaged that the report is likely to be published, but it should be produced with sufficient care and attention to detail to be of academic use to future researchers. A copy of this specification and a quantified index to the field archive should also be bound into the back of the report. The cover sheet should include a centred eight-figure OS grid reference and the name of the township in which the site is located (Skircoat).

7.2.2 Report Illustrations

Illustrations should include:

- a location map at a scale sufficient to allow clear identification of the structure in relation to Sterne Mills
- an overall keyed plan of the site showing the bridge and other topographic features
- a complete set of site drawings at a legible scale, on which position and direction of each photograph has been noted
- any relevant historic map editions, with the position and extent of the site clearly indicated
- any additional illustrations pertinent to the site produced during the structural watching brief
- a complete set of good-quality laser copies of all photographs. All photographs should be accompanied by detailed captions clearly locating and identifying any pertinent features.

The latter should be bound into the report, appropriately labelled (numbered, and captioned in full) and fully referenced within the report. When captioning, contractors should identify the individual photographs by means of a running sequence of numbers (e.g. Plate no. 1; Plate no. 2), and it is this numbering system which should be used in cross-referencing throughout the report and on the photographic plans. However, the relevant original film and frame number should be included in brackets at the end of each caption.

7.3 Report deposition

7.3.1 General considerations

7.3.1a The report should be supplied to the client and to the National Monuments Record (English Heritage, Kemble Drive, Swindon SN2 2GZ – for the attention of Mike Evans, Head of Archives) and an identical copy (but including the photographic prints and colour slides) supplied to the West Yorkshire HER. The finished report should be supplied within eight weeks of completion of all fieldwork, unless otherwise agreed with the WYAAS. The report will become publicly accessible once deposited with the WYAAS, unless confidentiality is explicitly requested, in which case it will become publicly accessible six months after deposit. Any comments made by WYAAS in response to the submission of an unsatisfactory report will be taken into account and will result in the reissue of a suitably edited report to all parties, within a timescale which has been agreed with WYAAS.

7.3.1b The West Yorkshire HER supports the Online Access to Index of Archaeological Investigations (OASIS) project. The overall aim of the OASIS project is to provide an online index to the mass of archaeological grey literature that has been produced as a result of the advent of large-scale developer funded fieldwork. The archaeological contractor must therefore complete the online OASIS form at http://ads.ahds.ac.uk/project/oasis/. Contractors are advised to contact the West Yorkshire HER officer prior to completing the form. Once a report has become a public document by submission to or incorporation into the HER, the West Yorkshire HER may place the information on a web-site. Please ensure that you and your client agree to this procedure in writing as part of the process of submitting the report to the case officer at the West Yorkshire HER.

7.3.1c With the permission of the client, the archaeological contractor are encouraged to consider the deposition of a copy of the report for this site with the appropriate Local History Library.

7.3.2 Deposition with WYAAS (the West Yorkshire Historic Environment Record)

The report copy supplied to the WY Archaeology Advisory Service should also be accompanied by both the photographic negatives and a complete set of labelled photographic prints (mounted in KENRO display pockets or similar, and arranged in such a way that labelling is readily visible) bound in a form which will fit readily into a standard filing cabinet suspension file (not using hard-backed ring-binders). Labelling should be on the *back* of the print in pencil giving film and frame number only (taking care not to damage the print) and on applied printed labels stuck on the front of the relevant photographic sleeve and which should include:

- film and frame number
- date recorded and photographer's name
- name and address of building
- national grid reference
- specific subject of photograph.

Negatives should be supplied in archivally stable mounts (KENRO display pockets or similar), and each page of negatives should be clearly labelled with the following:

- Township name (Skircoat)
- Site name and address
- Date of photographs (month/year)
- Name of archaeological contractor
- Film number

Colour slides should be mounted, and the mounts suitably marked with – 'Skircoat" (the Township name) with 'Sterne Bridge' under, at the top of the slide; grid reference at the bottom; date of photograph at the right hand side of the mount; subject of photograph at the left hand side of the mount. Subject labelling may take the form of a numbered reference to

the relevant photographic register. The slides should be supplied to the WY Archaeology Advisory Service in an appropriate, archivally stable slide hanger (for storage in a filing cabinet). In all other respects, standards for archive compilation and transfer should conform to those outlined in *Archaeological Archives – a guide to best practice in creation, compilation, transfer and curation* (Archaeological Archives Forum, 2007).

7.3.3 **Copyright** - Please note that by depositing this report, the contractor gives permission for the material presented within the document to be used by the WYAAS, in perpetuity, although The Contractor retains the right to be identified as the author of all project documentation and reports as specified in the *Copyright, Designs and Patents Act* 1988 (chapter IV, section 79). The permission will allow the WYAAS to reproduce material, including for non-commercial use by third parties, with the copyright owner suitably acknowledged

7.4 Summary for publication
The attached summary sheet should be completed and submitted to the WYAAS for inclusion in the summary of archaeological work in West Yorkshire published on the WYAAS website.

7.5 Preparation and deposition of the building recording archive
After the completion of all recording and post-recording work, a fully indexed field archive should be compiled consisting of all primary written documents and drawings, and a set of suitably labelled photographic contact sheets (only). Standards for archive compilation and transfer should conform to those outlined in Archaeological Archives – a guide to best practice in creation, compilation, transfer and curation (Archaeological Archives Forum, 2007). The field archive should be deposited with the Calderdale Office of the West Yorkshire Archive Service (WYAS, Calderdale Central Library, Northgate House, Northgate, Halifax, HX1, 1UN), and should be accompanied by a copy of the full report as detailed above. Deposition of the archive should be confirmed in writing to the WY Archaeology Advisory Service.

8 General considerations

8.1 Technical queries
Any technical queries arising from this specification should be addressed to the WYAAS without delay.

8.2 Authorised alterations to specification by contractor
It should be noted that this specification is based upon records available in the West Yorkshire Historic Environment Record and on a brief examination of the site by the WYAAS. Archaeological contractors submitting tenders should carry out an inspection of the site prior to submission. If, on first visiting the site or at any time during the course of the recording exercise, it appears in the archaeologist's professional judgement that

> i) a part or the whole of the site is not amenable to recording as detailed above, and/or
> ii) an alternative approach may be more appropriate or likely to produce more informative results, and/or
> iii) any features which should be recorded, as having a bearing on the interpretation of the structure, have been omitted from the specification,

then it is expected that the archaeologist will contact the WYAAS as a matter of urgency. If contractors have not yet been appointed, any variations which the WYAAS considers to be justifiable on archaeological grounds will be incorporated into a revised specification, which will then be re-issued to the developer for redistribution to the tendering contractors. If an appointment has already been made and site work is ongoing, the WYAAS will resolve the matter in liaison with the developer and the Local Planning Authority.

8.3 Unauthorised alterations to specification by contractor
It is the archaeological contractor's responsibility to ensure that they have obtained the WYAAS's consent in writing to any variation of the specification prior to the commencement of

on-site work or (where applicable) prior to the finalisation of the tender. Unauthorised variations may result in the WYAAS being unable to recommend discharge of the archaeological recording condition to the Local Planning Authority and are made solely at the risk of the contractor.

8.4 Monitoring
This exercise will be monitored as necessary and practicable by the WYAAS in its role as 'curator' of the county's archaeology. The WYAAS should receive at least one week's notice in writing of the intention to start fieldwork. A copy of the contractor's Risk Assessment should accompany this notification.

8.5 Valid period of specification
This specification is valid for a period of one year from date of issue. After that time it may need to be revised to take into account new discoveries, changes in policy or the introduction of new working practices or techniques.
Any queries relating to this specification should be addressed to the WYAAS without delay.

David Hunter **February 2012**

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APPENDIX 2: PROJECT PROPOSAL

1. INTRODUCTION

1.1 BACKGROUND

1.1.1 The West Yorkshire Archaeological Advisory Service (WYAAS) has issued a brief for a photographic survey of Sterne Bridge, Sowerby Bridge (February 2012 – Planning Permission 11/00200/FUL), which is required to provide a mitigative record of the bridge in advance of its demolition.

1.2 OXFORD ARCHAEOLOGY NORTH

1.2.1 Oxford Archaeology North has considerable experience of sites of all periods, having undertaken a great number of small and large-scale projects throughout Northern England during the past 30 years. One of the foremost specialists in building recording, OA North has been undertaking detailed fabric survey of buildings since 1984 and has particular and considerable experience of the investigation, recording and analysis of standing ancient monuments, historic buildings and other elements of the industrial heritage of the area, including a large number of mill complexes throughout the region. These include the large nineteenth-century Burley Mill, Leeds and the major complex of Murray Mills in Manchester. OA North has also been involved in the major fabric survey of Backbarrow Ironworks, which included the detail survey of the pug mill there and its hydro-electric turbine station. OA North undertook a detailed survey of the water-powered Howk bobbin mill at Caldbeck, which entailed the production of a detailed record of the mill race, wheel pit and drive train of the mill. Recent projects of relevance include a Level 3 and 4 building recording of the sixteenth-century Grade II* Two Lions public in Penrith, Level 3 building recording and excavations at Clitheroe Castle, and building recording and excavations at the Grade I listed fourteenth-century Ordsall Hall in Salford, the latter by laser scanning.

1.3.2 OA North has developed recording and analytical techniques over the years in order to improve the efficiency and quality of the surveys. This culminates with the use of 3d Laser scanning, which provides accurate, very detailed 3d modelling by very economic means and the model can then be used for the creation of 2d drawings as required. OA North also has the capacity to undertake detailed and rapid recording by photogrammetry using multiple oblique photographs. OA North has the professional expertise and resources to undertake the project detailed below to a high level of quality and efficiency. OA North is an Institute for Archaeologists (IfA) **registered organisation, registration number 17**, and all its members of staff operate subject to the IfA Code of Conduct (1994).

2. STAFFING PROPOSALS

2.1 The project will be under the direct management of **Jamie Quartermaine BA Surv Dip MIfA** (OA North Senior Project Manager) to whom all correspondence should be addressed.

2.2 **Alastair Vannan** (OA North Project Officer) will undertake the documentary study and will prepare the historical assessment.

2.3 The project will be directed by **Chris Wild BSc** (OA North Project Officer). Chris has extensive of experience in the recording and analysis of historic buildings throughout Northern England.

3. METHOD STATEMENT FOR PHOTOGRAPHIC SURVEY

3.1 The project will be undertaken in accordance with the defined project specification (WYAAS 2012), albeit with a proposed variation defined below.

3.2 ***Photogrammetric Recording Variation:*** the specification requires the production of face on views of the bridge using a medium / large format camera. However, this would entail setting up in the river, and is not possible within conventional health and safety constraints. As an alternative photographs can and will be taken with a shift lens to allow for the fact that the photographs will need to be taken from the river bank; however, with such an oblique perspective such techniques would inevitably have a reduced accuracy. The alternative is to implement, in addition to the medium format photography, a process of digital photogrammetric recording techniques which can achieve high levels of accuracy and, as a by product, the production of a 3d model of the bridge.

3.3 Photogrammetry is a long established technique which has been updated and refined such that it is now an extremely simple and cost effective means of recording features and landscapes in three dimensions. It is proposed to take a series of face on and aerial digital photographs from a small electrically powered model helicopter (UAV) which has the ability to carry a light weight camera. By flying the helicopter at low level along the line of the bridge a series of semi-rectified photographs would be taken of the bridge elevations, and similarly a series of photographs can be taken from vertically above the bridge.

3.4 The advantage of the UAV is that it can take photographs from multiple positions and can provide blanket photographic coverage of the bridge. Survey control is introduced to the photographs by the placement of survey control targets across the elevations of the bridge which are located by means of survey tapes.

3.5 The photogrammetric processing is undertaken using Agisoft software which provides detailed modelling using the overlap of up to 30 photographs, and creates a very detailed DTM (Digital Terrain Model) across the site. The photographs are then digitally draped over the model to create an accurate three dimensional model of the ground surface. Because the data is formed as a three dimensional model, it can be used to create accurate elevations of the bridge and also a ground plan. The latter will be used as the basis for creating the photographic plan. The two dimensional images are used to generate accurate plans or elevations which would be reproduced in CAD.

