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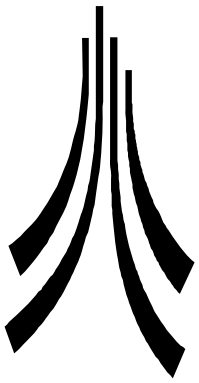

October 2000

CARLTON ALUM WORKS
CARLTON BANK
CARLTON-IN-CLEVELAND
NORTH YORKSHIRE

Archaeological Excavation: Final Report

Commissioned by: North Yorkshire Moors National Park Authority

Carlton Alum Works
Carlton
North Yorkshire

Archaeological Excavation Final Report

Report no 1999-2000/101/AUA8743

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Banks Reclamation Ltd and C G Robinson Plant Hire are thanked for their assistance, and in particular for the skill of their drivers.

The excavation was initially directed by Denise Drury and supervised by Iain Hedley; Nigel Cavanagh, Peter Owen, Mike Parsons, and Dale Robertson were excavation assistants throughout. The final stage of the excavation was directed by Ian Hedley. The survey during the excavation was completed by Ian Miller, assisted by Mark Tidmarsh. The report was written by Iain Hedley and Ian Miller, the drawings were created by Graham Suggett and Neil Wearing. The project was managed by Jamie Quartermaine, who also undertook the aerial photography, and the report was edited by Rachel Newman.

SUMMARY

An excavation of the Carlton Alum Works, Carlton-in-Cleveland, North Yorkshire (NZ 520027), was undertaken by the Lancaster University Archaeological Unit (LUAU) in advance of a land reclamation scheme to stabilise the spoil tips, which cascade down the steep hillside of Carlton Bank. This was the third stage of a multi-phased project which has involved topographic survey, field evaluation (LUAU 1996), a geophysical survey and geochemical analysis.

The fieldwork involved an initial surface survey of the excavation area and immediate locality, a series of evaluation trenches which were subsequently incorporated into the extent of the open-area excavation, and then the main mitigation excavation of the site. Following on from the excavation, a watching brief of the landscaping works was undertaken to enhance the results of the earlier phases of the work. The fieldwork was carried out in accordance with the project brief and design, in September 1997, and was monitored throughout by Mr G Lee (North York Moors National Park Authority). The project was funded by English Partnerships.

The North York Moors are of considerable national importance in the history of the British alum industry, producing the vast majority of the entire national output of alum from the early seventeenth century until 1847. The earliest successful working of alum was in the Guisborough area at the beginning of the seventeenth century; the Carlton works was established at the end of the seventeenth century (1680), along with a series of other sites on the North York Moors coast, and it continued in use up to 1774. Subsequent to the closure of the alum works there was some limited jet extraction in the nineteenth century. Most of the coastal sites continued in operation into the nineteenth century and subsequently have been adversely affected by coastal erosion; consequently the Carlton works is of particular importance because it is relatively well-preserved and because the remains have not been extensively overlain by nineteenth century workings

The Carlton Alum Works survived as a large quarry and spoil tip, together with the buried remains of calcination and steeping processes. The excavation identified a series of steeping pits, a large circular cistern, and a series of liqour troughs which linked the pits and provided an outlet to the alum processing house at the base of the hill.

Given the findings of the combined investigations at Carlton Bank, a decision was made to publish the results in a monograph dedicated to the alum industry, the compilation of which is due to be completed in 2001.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1 The Carlton Alum Works lies on the northern scarp of the Cleveland Hills above and to the south of the village of Carlton-in-Cleveland, North Yorkshire (NZ 520027). In 1995, a land reclamation scheme was proposed with the aim of stabilising the existing slope by the removal of the calcined shale tip from the hillside. Under the proposed scheme, the material from the tip was to be removed from the site and the slope graded to a stable angle of repose (Plate 1). This would involve the removal of much of the spoil tip and was likely to disturb some features associated with the alum works immediately behind it. As a consequence the North York Moors National Park Authority required that a mitigation strategy of evaluation and recording of archaeological deposits be undertaken in advance of, and during, the reclamation works.

1.1.2 Following the results of geotechnical analysis (Foundation & Exploration Services Ltd 1995) and a watching brief of geological test pits (Cleveland County Archaeology Section 1996), Lancaster University Archaeological Unit (LUAU) was commissioned to conduct a topographical survey and archaeological evaluation in 1996. The evaluation revealed that many of the features identified during the topographical survey were of relatively recent origin. However, one trench, situated in the western part of the site, revealed several features which were not visible from surface inspection, including decayed timber, stone walls and yellow puddled clay; these were interpreted as remains relating to the alum works. The presence of previously unrecorded below ground features prompted the need for further archaeological work on the site prior to the commencement of the reclamation scheme. The results of this phase of work were documented in a report (LUAU 1996) submitted to the client.

1.1.3 An additional programme of evaluation work, involving geophysical survey, detailed recording of a section of the erosion scar, palaeoenvironmental and geochemical analysis of the spoil tip, was undertaken between December 1996 and July 1997 and the results were presented in a second report (LUAU 1997a). An additional topographic survey was undertaken immediately prior to the commencement of the excavation (LUAU 1997b).

1.2 SITE DESCRIPTION

1.2.1 The alum works at Carlton Bank, North Yorkshire, survived as a large quarry and spoil tip, together with the buried remains of calcination and steeping processes. The site (NZ 520 027) lies on the north-facing scarp of the North York Moors, at the north-westernmost point of the Cleveland Hills (Fig 1), an area of Jurassic rocks which dip very gently to the south. The crest of the scarp is formed by Lower Deltaic Sandstone, beneath which there lies a considerable thickness of 'Alum Shales'. These in turn overlie thin Dogger limestone which is on top of further shales containing a seam of jet. The alum quarry is cut into the steep scarp face from the north, within the Alum Shales, and extends south to the edge of the Lower Deltaic Sandstone, with shallower lobes extending south-east to north-west below the strike of the outcrop. The outcrop of a jet seam, just below the floor level of the quarry, is marked by an horizontal line of nineteenth century workings along the hillside.

1.2.2 The crest of the scarp lies at *c*400m OD, and the base is at *c*200m OD; the floor of the main quarry is at 320m OD. The vegetation cover consists of heather moorland on the flatter areas, giving way to rough grass on the steeper slopes, with bracken and some scrub towards the base of the scarp. There is extensive bare ground on the sides of the quarry (due to the unstable and steep surface of weathered shale) and on the tips to the north of the quarry (due to the instability of weathered shale, coupled with the acid and infertile nature of the component calcined shale). The tips and the slope below them have been affected by land slippage, which in part prompted the programme of landscaping.

1.3 ARCHAEOLOGICAL BACKGROUND

1.3.1 The North York Moors are of considerable national importance in the history of the British alum industry, and produced the vast majority of the entire national output of alum from the early seventeenth century until 1847. The earliest successful working of alum was in the Guisborough area at the beginning of the seventeenth century. The Carlton works were established at the end of the seventeenth century (1680), along with a series of other sites on the North York Moors coast, extending from Ravenscar in the south to Saltburn in the north (with some inland works near Whitby), and south-westward to Osmotherly following the northern scarp of the Cleveland Hills (Gould 1993, 8). The industry continued on Carlton Bank up to 1774. Subsequent to the closure of the alum works there was some limited jet extraction in the nineteenth century.

1.3.2 The North Yorkshire alum industry has received much archaeological interest in recent years, largely from local groups. Much work has been published on the technology and chemistry of the industry, principally by the Cleveland Industrial Archaeology Society. Excavation and survey has been undertaken at Boulby (Chapman 1975; 1994), Loftus (Marshall 1993), Saltwick (Marshall 1994), and Ravenscar (Marshall 1992). Research by David Pybus at Sandsend is continuing (D Pybus, pers comm); however, all of these sites are coastal and research has largely been initiated by the threat of destruction from erosion.

1.4 PREVIOUS WORK AT CARLTON BANK

1.4.1 No archaeological research had been undertaken at the Carlton Bank alum works prior to the commencement of the current project. However, the site was assessed under the English Heritage Monuments Protection Programme (Gould 1993). The assessment concluded that there was insufficient evidence, based on surface inspection alone, to recommend its protection by statutory means (scheduling). It was stressed, however, that any surviving buried remains could potentially be of national importance and that appropriate conservation and management measures should be undertaken in the light of a development threat.

1.4.2 A contour survey of the quarry, tips, and surrounding area was undertaken in 1995-6, as part of a geotechnical report for the reclamation scheme (Foundation & Exploration Services 1995). This survey accurately depicted the overall forms of the quarry and tips, but smaller-scale archaeological features were not picked up by the coarse survey point grid employed.

1.4.3 Geological test pits were dug in March 1996, and were recorded as a watching brief by Cleveland Archaeology (Cleveland County Archaeology Section 1996). Despite the competent recording of the sections, this information contributed little to the overall understanding of the site, since the 'footprint' of each trench was small relative to the anticipated plan size of many alum working features. On the available information it was impossible to determine whether some pits were wholly within large archaeological features.

1.4.4 ***Phase I:*** a field evaluation was then undertaken by LUAU at the request of the North York Moors National Park Authority, and a report was submitted in July 1996 (LUAU 1996). The evaluation comprised a topographical survey to record the character of the relatively small-scale features that were not recorded by the earlier contour survey, and a programme of trial trenching was undertaken to test a sample of the features identified. Whilst many of these proved to be relatively recent, some, more deeply stratified, features were found to be associated with the alum works.

1.4.5 ***Phase II:*** a further phase of work was commissioned by the North York Moors National Park Authority in 1997 (LUAU 1997a). This comprised a geophysical survey, the detailed recording of a section of both bank and spoil tip revealed in a deep erosion scar (Fig 6), palaeoenvironmental investigation of a waterlogged deposit at the base of the slope, and geochemical analysis of the spoil tip. This programme revealed the potential for other subsurface features immediately above the edge of the spoil tip, and also that the tip had been carefully engineered, with the spoil deposited in horizontal layers, rather than being tipped over the edge of the slope in a more casual fashion.

1.4.6 ***Phase III:*** following the results of earlier work at the site, the North York Moors National Park Authority requested that a programme of mitigation recording of the sub-surface features be undertaken in advance of and during the reclamation works. This involved a programme of detailed surface survey (LUAU 1997b), mitigation excavation, and a watching brief during the reclamation programme.

2. FIELDWORK METHODOLOGY

2.1 PROJECT DESIGN

2.1.1 The survey and excavation methodologies followed an agreed strategy, outlined in the project design (*Appendix 1*) which was offered in response to a verbal brief by Mr G Lee, Archaeologist for the North York Moors National Park Authority. Any subsequent modification to that original strategy was undertaken in consultation with, and with the agreement of, Mr G Lee.

2.1.2 The results of the topographic survey have been presented in an earlier report (LUAU 1997b) and this report presents results of the excavation only.

2.2 EXCAVATION METHODOLOGY

2.2.1 A phased approach to the excavation was taken, with the site divided into excavation areas. This was in part dictated by the requirements of spoil management and the need to allow machine access across the site, thus the central part of the site remained unexcavated until the later stages of the excavation. This allowed open-area excavations to be conducted simultaneously in the eastern and western parts of the site. Towards the final stage of the excavations these areas were linked by the part-excavation of the central area forming one large open-area excavation (Fig 3).

2.2.2 All excavation areas were machine-cut in the first instance, and all overburden was removed mechanically, under archaeological supervision. Following the results of the evaluation and initial machine stripping, it was found that the entire site was covered by a substantial deposit of redeposited grey shale intermixed with occasional calcined shale lenses. This deposit post-dated the abandonment of the alum works and was removed using a mechanical excavator fitted with a 2m toothless ditching bucket.

2.2.3 Instability was encountered during initial machine stripping in the eastern part of the site, where a number of large voids appeared. The collapsing of the voids was in part caused by the high ground pressure of the JCB wheels. The area was abandoned on safety grounds, and partially backfilled. During the later stages of the excavation a 360° mechanical excavator fitted with a 0.90m toothless bucket was employed, which allowed the eastern part to be re-excavated safely. Machine excavation continued to the point at which archaeologically significant deposits were reached. Thereafter, all significant archaeological features were uncovered in plan, cleaned and recorded, and, where appropriate, were further excavated by hand or by machine.

2.2.4 The sides of the excavation areas were stepped or battered at a depth of 1.2m to prevent collapse. Several trench edges were cleaned by hand and recorded as drawn sections at a scale of 1:20.

2.2.5 All elements of the work were, as a matter of course, recorded in accordance with current English Heritage guidelines (*MAP2*) and the best practices formulated by English Heritage's Centre for Archaeology, and the Institute of Field Archaeologists. All excavation, by whatever method, was recorded by the compilation of *pro forma* context and object records, and the production of accurately scaled section drawings (at scales of 1:20 and 1:10), as well as a comprehensive photographic record. Features were recorded in plan using a total station, from which plots were generated, and

details manually draughted. On completion of the fieldwork the site was partially backfilled and made safe.

2.3 GEOCHEMICAL AND OTHER SAMPLING METHODOLOGIES

2.3.1 Samples of calcined shale were taken from the fills of two steeping pits and the basal 'slam' deposit of a cistern or settling tank during the excavation, in accordance with appropriate professional standards, to enable geochemical analysis. The sampling programme was designed to supplement the pilot geochemical analysis of the spoil tip undertaken during Phase II (LUAU 1997a). Preliminary analysis, however, indicated a low potential for the attainment of reliable results due to post-abandonment disturbance, and full analysis was subsequently not undertaken.

2.3.2 Timbers uncovered during the excavation were cleaned and recorded *in situ*, but not methodically sampled due to poor preservation. However, one substantially intact segment of timber post from the fill of a steeping pit was recovered and has been subject to basic analysis to enable species identification. The potential for dendrochronological dating of the timber was considered to be fairly low because of the poor preservation and thus was subsequently not undertaken.

2.4 FINDS METHODOLOGY

2.4.1 The finds recovery and sampling programmes were undertaken in accordance with best practice (current IFA guidelines) and subject to expert advice. However, the artefactual sterility of most excavated layers within the site generated little need to formulate detailed sampling strategies for any artefact group.

2.4.2 All finds have been washed, marked, sorted, recorded, and catalogued to LUAU basic level, with brief descriptions, dimensions, etc detailed on standard *pro forma* record sheets.

3. DOCUMENTARY BACKGROUND

3.1 HISTORICAL EVIDENCE

3.1.1 The Carlton Alum Works were established in the Manor or Lordship of Carlton in the late seventeenth century, though the precise date of its foundation is uncertain. Indeed, few documentary sources have survived from the period of operation, although it is traditionally assumed that it began life in 1680 (Pickles 1975; Morrison 198l), immediately following the end of the Crown monopoly in 1679. At this time Carlton formed part of the Estate of the Earl of Elgin, but an assignment (a transfer of claim, right, interest, or property) between the Hon Robert and James Bruce (Elgin?) and Christopher Prissick of London, merchant, dated 1695, transferred the Manor to the Prissicks. The document does not include a reference to an alum works, but no other industries are mentioned in the text. In the previous year, Christopher Prissick held the land in lease. The Prissicks appear to have been resident in Carlton from at least the early seventeenth century when an earlier Christopher Prissick was recorded in the Quarter Sessions in 1606, having been fined £100 '*for the bringing in of a boy for which he did beat*' (Cook 1996). The last will and testament of the father of the later Chistopher, John Prissick Senior, yeoman, who died in 1694, lists disposable goods and chattels but does not mention Christopher, his son and heir, nor his estate, which may imply that they may have passed to him in his lifetime.

3.1.2 The second son, John Prissick Junior, appears to have been a tanner and maltster (Cook 1996), following in the footsteps of his father. The tanning process required relatively low-cost and predictable supplies of alum, which was used to increase the suppleness of leather, and this reliance may have encouraged the Prissick interest in alum production. It is likely that soon after they acquired the Manor of Carlton, if not earlier, an alum works was established, thus reducing their reliance on existing producers.

3.1.3 The works were certainly in operation in the early eighteenth century as it is specifically mentioned in the inventory of Christopher Prissick, made after his death in 1718. The inventory lists 26 barrows, 14 picks and hacks, 12 crow irons or gravelocks, six stone hammers, and five rock hammers. This number of tools suggests that at maximum working capacity, the total labour force could have been as large as 60 men, who would have been largely employed in the quarrying of shale and barrowing it to the roasting clamps (Cook 1996). The inventory of 1718 also lists eight horses, including at least one Galloway (pack pony), a foal, and an ox for use at the works (ibid). That the alum works was flourishing at the time of Christopher Prissick's death is reflected in the inventory of his goods, and that he had been engaged in the construction of a new Manor house at Carlton. It would seem that during this early period John Prissick Junior was the manager of the works, and following his death in 1731, the management became the responsibility of his son, George Prissick of Mulgrave Hall, Lythe.

3.1.4 The fortune of the works fluctuated with the price of alum throughout the eighteenth century. Following the collapse of the alum price to £10 per ton during the early 1730s, an agreement between four of the major works was reached in 1736, which proposed limiting the combined output of alum to 1500 tons *per annum* (Pickles 1975). Under this arrangement, the Carlton works was restricted to producing 240 tons of alum *per annum* (ibid), although it has been suggested that during this period the

works were actually laid idle and Codrington John Prissick was paid £400 annual compensation (Marshall 1995, 41; Morrison 1981, 18). The price soon began to rise, however, and the restrictions on production output were lifted.

3.1.5 By the 1740s, the Prissick family appears to have withdrawn from their involvement in the Carlton estate when they entered into a lease and release concerning the entire Carlton Estate in 1743 (Cook 1996). The release was tripartite between Goddrington Prissick and his wife, George Prissick, and Thomas Allaly in the first part, and Messrs Porrat, Porrat and Hess. The latter may have been venture capitalists seeking an investment opportunity, although it may be significant that Hess was a mercer (dealer in textiles). The works are stated as belonging to Goddrington Prissick, although it is probable that Bunting and Sutton leased the management. The alum house at this time included a range of buildings including carpenter's, plumber's, smith's and cooper's shops, kelp houses, warehouses, and clerkhouses, in addition to the various pans and pits. The document also records that the alum works included '*a newly built house for the labourer on the top of the hill near the alum rock and the newly built summer house*', in addition to the pits, receptors and cisterns (Cook 1996).

3.1.6 In 1765, the price of alum reached an all time high of £26 per ton (Morrison 1981, 19), which led to an industry-wide increase in production as new works were established to take maximum advantage of the high price, and in 1768 4,500 tons were produced in Yorkshire. Demand did not keep pace with supply, however, and by early 1774 the price had fallen to £13 per ton (*ibid*). The serious financial problems that this caused to the industry led to the closure of several works, and those at Carlton may have been laid idle. It was during this decade that other inland alum works in the vicinity of Carlton were closed altogether, such as Ayton Banks in 1770, and Thimbleby in 1774.

3.1.7 The date of the final abandonment of the works is uncertain, though it may not have worked again after the slump in the alum price during the 1770s. In 1780, the Prissick family finally sold their interest in the Carlton Estate to John Sutton of Stockton for a sum of £2,450 (Cook 1996). Little is known of his background, or whether he was connected to the Messrs Bunting and Sutton of 1743; the name is common in south Durham and it is possible that the two were unrelated. The articles of agreement were drawn up on 13th May 1779 and enacted on 1st August 1780. The agreement included '*allom [sic] pans, cisterns, coolers and all other impliments* [sic], *utensils and things whether fixed or not fixed belonging to the said premises*' (*ibid*). No mention is made of the alum works or the alum rock though they may not have been considered as separate items. There is no indication from the document, however, to confirm that the works were a going concern. That individual items are listed may suggest that these particular elements were of value and could be sold on.

3.1.8 Following the slump in the 1770s, the production of alum was concentrated in a few surviving North Yorkshire coastal sites, such as Boulby, Loftus, Sandsend, and Kettleness (Pickles forthcoming). In the mid-nineteenth century, a new process was developed in which freshly calcined shale (normally colliery waste) was treated with hot concentrated sulphuric acid. These works were sited on or near the coalfields, and rapidly made the older Yorkshire technology redundant, the last works in the North York Moors area being those at Kettleness and Boulby, which closed in 1871 (*op cit*).

4. EXCAVATION RESULTS

4.1 INTRODUCTION

4.1.1 The results of the excavation are discussed with reference to four broad phases: the preparation of the site for the construction of the alum works, the period of operation, the post-abandonment period, and more recent activity. This report is concerned predominantly with the alum works itself, and whilst the subsequent history of the site is of interest in a local context, the later phases are dealt with in less detail; a full account can be found within the project archive.

4.1.2 The main components uncovered in the western part of the site were the remains of six rectangular steeping pits used in the lixivation or steeping process, and a central raw liquor trough, which carried the alum liquor eastwards to a storage cistern (Fig 3). Whilst not investigated during the excavation, the earlier evaluation proved the survival of archaeological remains within the quarry, and geophysical survey also revealed the presence of a rectangular structure within the entrance to the quarry (LUAU 1997a).

4.1.3 A plan of the site depicting the components of the complex referred to in the following text is shown in Figure 3, and context numbers are given in parentheses.

4.2 PHASE I: PREPARATION OF THE SITE

4.2.1 The earliest activity was observed in the western part of the site, and related to preparation of the area in advance of the construction of the alum works. The recording of the erosion gully during the preliminary evaluation (LUAU 1996) clearly showed undisturbed bedded shale (162) to be overlain by a natural deposit of yellow clay, which was sealed by a fossil soil. This had subsequently been covered by a suite of steeply tipped layers of earth, shale, and fragmented sandstone, although significantly these did not include any calcination waste. The appearance of several crown holes across the area permitted further examination of the primary deposits, which confirmed the sequence recorded in the erosion gully. The excavation demonstrated that the steeping pits had been built directly on top of the yellow clay deposit, which was further used extensively during Phase II both as a bonding medium, and for keeping the various structures within the alum works watertight. The complete absence of the fossil soil across the southern part of the site indicated extensive truncation, presumably by the creation of a terrace across the hillside in advance of construction. Such preparations will have been necessary to allow the structures, at least in the southern part of the site, to be slotted into place. This has also been found at Saltwick Nab (Marshall 1994, 10), where available space for construction was similarly restricted.

4.3 PHASE II: CONSTRUCTION AND OPERATION OF THE ALUM WORKS (*C*1680 – *C*1774)

4.3.1 ***Northern steeping pits*:** only the westernmost of the steeping pits (Pit 1)/(104) on the north side of the trough was excavated in detail (Fig 4). The eastern pit (Pit 5)/(139) initially lay partly beyond the site boundary, but was found on further examination to survive only on the western side. It is clear, however, from the form of construction and surviving plan that the pits were contemporary and were built as a unit. The

steeping pits had a maximum internal length of 11.08m, a maximum width of 4.89m, which tapered to 4.68m at the southern end, and a maximum depth of 1.06m. They were orientated broadly from north to south, with the shorter wall bordering the trough (Plate 8).

4.3.2 The floor (106) of Steeping Pit 1, which sloped noticeably southward towards the trough end, was laid directly over puddled clay and consisted of squared sandstone paving slabs arranged in rows parallel to the shorter walls of the pit (Plate 8, to rear). A number of notches had been cut in the paving stones, at least some of these whilst the floor was in place. Their dimensions and distribution appeared to be random and at least some of these contained the remains of rotted timber posts. The floor of Steeping Pit 5 was not fully revealed, although the sample area excavated was seen to comprise squared sandstone paving slabs (143) of an identical arrangement to those in Steeping Pit 1.

4.3.3 The build of the pits was impressive, consisting of unbonded, well-dressed and coursed sandstone blocks, with chevron dressing. The walls overlapped the paved floor and it is probable that they were erected after the floor was laid. The walls were backed throughout by a deposit of watertight puddled clay, which also had the benefit of securing the blocks in place, since no 'bonding' appears to have been used in any of the structures within the alum works. The overall plan appears less impressive, however, with both the angles of the corners and wall lengths unequal. The east wall of Steeping Pit 1, for instance, was found to be 0.3m longer than its western counterpart, whilst the angles of the southern corners differed by as much as 10°; this produced a slightly trapezoidal plan. The pit was drained from a round timber pipe in the centre of the bottom course of the south wall, which led through the wall, connecting with a pipe in the bottom of the trough. A fragment of sandstone was found immediately in front of the pipe (Plate 9), which would have been used to prevent blockage when the pit was drained.

4.3.4 The wall tops had been covered with timber planks (192), of which a few lengths had survived in place. The planks were laid perpendicular to the line of the wall and were secured by a central joist, which was set into the puddled clay core of the wall to prevent movement. The planking is likely to have been laid to allow wheelbarrow access and a working surface around the steeping pits.

4.3.5 ***Southern steeping pits:*** on the south side of the trough, the steeping pits were of slightly different construction (Plate 10). Once again the westernmost (Pit 2)/(102) of the two survived only partially along the south and west sides (Fig 4), whilst the eastern pit (Pit 6)/(170) had also suffered a small amount of damage on the east side. The surviving evidence, however, was sufficient to confirm that the pits were of the same construction and had again been built as a pair. Only the remains of Steeping Pit 2 were comprehensively examined.

4.3.6 The pits were oriented broadly north to south with the shorter north wall bordering the trough, thus mirroring their northern counterparts. The internal dimensions of Steeping Pit 2 were 10.89m in length, with a maximum width of 4.6m, which tapered down to 4.3m at the northern end, where the depth was up to 1m. The pits were therefore slightly shorter and narrower than their counterparts to the north of the trough, and were built on a slightly different alignment. The build was broadly similar, though generally the stonework appeared to be in poorer condition. Voiding in the north-east corner revealed the same underlying sequence of bedded shale overlain by a layer of puddled clay, which in turn was overlain by the floor of the pit.

The floor itself, however, comprised horizontally laid timber planks (105) rather than stone paving.

4.3.7 A round timber pipe set in puddled clay was recorded in the centre of the bottom course of the north wall. This led through the wall and connected with a pipe in the bottom of the trough. A fragment of rough sandstone had again been placed immediately in front of the pipe to prevent blockage when the pit was drained (Plate 10).

4.3.8 ***Western steeping pits:*** two further steeping pits (Pits 3 and 4)/(135 and 137) were uncovered beyond the west end of the trough (Fig 4). In this instance the pits were positioned end-to-end, there being no attempt to continue the trough westwards between them. In addition, they were off-set to the south and separated from the eastern pits by a 2m wide baulk of shale. In the north, this at least partly comprised calcined shale, steeping residue, and disturbed natural shale. In the south, however, a significant area of undisturbed bedded shale was exposed at the surface suggesting that, at least in this area, the natural shale had been quarried out to allow the insertion of the pits. The pits measured approximately 10.9m in length by 4.8m in width by up to 1m in depth, and were oriented broadly north-south. The build of the pits was identical to the pits on the north side of the trough - though with noticeably square corners - with well-dressed and coursed masonry and paved sandstone floor surfaces (150 and 159). Crown hole damage in Steeping Pit 3 (135) revealed that the paved floor butted the walls, suggesting that the walls may have been built first. Square settings had been cut into the upper courses of the pit walls, similar to those noted in the northern steeping pits, but of a greater depth and width. Whilst these settings may similarly have been constructed to allow wheelbarrow access and a working surface around the steeping pit, it is possible that they facilitated box-sectioned timber pipes, which delivered a water supply (Plate 11). Drainage holes in the bottom course of the steeping pit walls, with blocking stones, are likely to have connected the pits to the north and south pipes in the bottom of the trough, respectively, though the full extent of this relationship was not tested.

4.3.9 ***The trough*****:** in the western part of the site a raw alum liquor trough (103) ran broadly east-west, with steeping pits bordering the north and south sides, respectively (Fig 4). The walls of the trough, which were approximately 1.3m high and positioned up to 1.4m apart, were of well-dressed and coursed sandstone, and were separated from the internal walls of the steeping pits by a core of watertight puddled clay. Whilst the north wall of the trough ran in a broadly straight line, the southern counterpart meandered noticeably, resulting in its width tapering from 1.4m in the east to only 0.8m at its western terminus. This is more likely, however, to be the result of post-abandonment disturbance than an original design feature. At least three phases of rebuilding were detected in the upper courses of the south wall, the most obvious of these being the insertion of an additional line of edge-laid stones (161) within the clay core. The precise function of these stones remains unclear, although the absence of timber planking on the top of this wall may suggest that 161 represents crude coping stones.

4.3.10 The remains of two parallel and abutting box-section timber pipes (96)/(152) were uncovered in the base of the trough, set into a masonry-edged slot (132); (Plate 5). These pipes were aligned from west to east and formed the main channel for the conveyance of the raw liquor to the cistern. Leading from the steeping pit drainage holes on their respective north and south sides, further wooden pipes were revealed,

which joined the central pipes at right angles. Masonry-edged slot 132 comprised roughly cut blocks of sandstone, set into a deposit of puddled clay (133), and formed a solid foundation for the wooden pipes.

4.3.11 The complete excavation of the central part of the site found that all evidence of the trough had been removed in that area. In the eastern part of the site, however, the trough was once again uncovered and was found to continue the east-west orientation for a further 7m. At this point, its line turned abruptly to the north-east and continued for a further *c*20m (Plate 6). The walls of the trough were less well built in this area, comprising a mix of dressed and undressed buff sandstone blocks, measuring between 0.14m and 0.5m across. Although this section of the trough was not fully tested below the upper course, it is clear from a test pit at the north-east end that some attempt at coursing was made. Once again, the construction was drystone with puddled clay backing the walls and floor. The north-east end of the trough terminated at the remains of a bridge (Plate 7), which appeared to be a later addition and consequently is described in Phase III (below, section 4.4.5).

4.3.12 ***The cistern*:** the well-preserved remains of a large raw liquor cistern (183), measuring 5.2m (internal diameter) and 2.5m deep, were uncovered to the north of the trough, some 20m from the excavated steeping pits. (Fig 3). The cistern, which was circular in plan, comprised walls of well-dressed and coursed sandstone blocks (Plate 12), measuring up to 0.75m by 0.25m, with puddled clay backing (198), which extended to the south to form a platform flush with the brim of the cistern. The fill was partially excavated by machine to the floor of the cistern, which consisted of squared sandstone paving, sealed by a pink clay deposit (186) and subsequent backfilled materials (Fig 5). Test pits excavated around the north side of the cistern revealed a uniform deposit of redeposited grey/green shale, which clearly post-dated the construction of the cistern and is likely to have been banked against the outer face in order to counteract the pressure of the stored liquor on the drystone walls of the structure. The exterior of the cistern was not investigated, though it is most likely that the puddled clay was applied to the surface prior to the deposition of this material. Although the relationship between the clay and the grey/green shale was not tested, it would seem probable that the clay overlay a continuation of this deposit on the south side of the cistern.

4.3.13 Two short parallel sections of wall (182), 0.48m apart and at least 1.4m in length (Plate 13), led from the south edge of the cistern to the remains of a second pit-like structure (181), located immediately to the south (Fig 5). This sub-circular structure, although significantly disturbed, was seen to measure 4.7m by 4.2 m. The fill included several fragments of well-dressed and coursed sandstone masonry along the south-east side, mixed with lenses of calcinated clay and redeposited puddled clay. Its function cannot be determined with certainty, though it possibly represents the remains of a second, smaller cistern. The connecting walls may be the remains of a sluice or spillway between the two structures.

4.3.14 Although the clay surface situated between the cistern and the trough would appear to be an ideal medium for preserving evidence of contemporary features or activity, no such evidence was observed. Indeed, it seems highly likely that the contemporary surface was covered either with timbers, such as those covering the pit walls, or with stone paving that had subsequently been completely removed.

4.3.15 A comparison of the relative heights of the steeping pits and liquor trough with the cistern gives an indication of the gradient between the two processual stages. The top

course of the walls of structures (181) and (183) were situated at heights of 307.7m and 308.0m OD respectively. The base of the northern end of Steeping Pit 1, for instance, was situated at a height of 309.7m OD, leaving a height differential between the pit and the cistern of *c*2m over a distance of *c*23m, although the trough at the southern end of the pit was situated less than a metre higher than the cistern (183). These relative heights indicate that the liquor trough had a gentle downward gradient from the steeping pits to the cistern, although sufficient to allow the natural flow of liquor between the two groups of features.

4.3.16 ***Process residues:*** evidence for the operation of the works was largely confined to process residues in the form of fill deposits within the steeping pits and cistern. Whilst all of these deposits were tested, only the fills (107-117 and 125/126) of Steeping Pit 1, situated on the north side of the trough, were fully excavated. These were found to consist of mixed green and yellow shale to a maximum depth of 0.75m (Plate 14). The poorly-preserved remains of rotted timber posts were found within, each resting at angles of between 20º and 45º against both the east and west walls. It is thought that they may have been used to flatten out the top surface of the shale when the pit was filled (A Rout pers comm). In addition, several randomly spaced vertical timbers were recorded in the fill (Plate 15), and these may have been coincident with notches cut into the paved floor. Their function is far from clear, although it is possible that they may have been employed as supports for horizontal planks placed across the steeping pit to allow the alum workers access to the main body of the shale during steeping. This pattern of deposition was also encountered in a test pit excavated into fill 142 of Steeping Pit 5, situated immediately on the east side, although in this instance the deposit was 1m in depth.

4.3.17 The fills (118-124) of Steeping Pit 2, which were only partially excavated, consisted of calcined shale that varied in colour from golden yellow to pink. Several fragments of timber were disseminated throughout the fill, including a number of vertical timbers. The fill (160) of Steeping Pit 4 consisted of a uniform deposit of yellow shale, whilst the fill (149) of Steeping Pit 3 was sectioned on the short axis and found to consist of alternating bands of greenish and red calcined shale which sloped in to the mid point of the pit at approximately 30° (Plate 16). This suggests that the barrows laden with calcined shale were tipped from the long walls progressively towards the centre until the pit had been filled.

4.3.18 The basal deposit in the cistern was tested by machine and found to consist of an homogeneous pink clay (186) to a depth of 0.6m. The clay, or 'slam', is likely to have resulted from the settling of minute particles of shale in the raw alum liquor.

4.3.19 The spoil tip on the north side of the site graphically illustrated the volume of material that passed through the works during its life. A profile of deposition was exposed in the erosion gully on the north side of the site (Fig 6), and was recorded in an earlier phase of the project (LUAU 1997a). Natural glacial drift and fossil soil were overlain by a suite of tipped layers of earth, shale and sandstone, which probably represent material from opening the quarry and construction of the works. These layers were in turn overlain by a major suite of tipped layers, dominated by red calcined shale, which were deposited in horizontal units. The general lie of the stratigraphy within these layers did not conform to the hillslope, nor to the steeper northward dip that would be produced by the progressive northward extension of a platform tip. This mode of deposition was unexpected but may be explained by the use of the tip as a working surface, or merely as an attempt to promote stability within the tip.

4.4 PHASE III: POST-ABANDONMENT OF THE ALUM WORKS

4.4.1 Following the closure of the works it would appear that much of the central area of the site was robbed of stone, resulting in significant damage to Steeping Pits 5 and 6, and possibly the complete removal of other steeping pits and structures to the east. Machine excavation to a depth of 4m in this central area failed to encounter any structural remains. Further evidence of stone robbing was found in Steeping Pits 2 and 6 which clearly showed that parts of the walls had been dismantled, resulting in a spread of clay extending into Steeping Pit 6. The stratigraphy revealed in the erosion gully also indicates that a significant cut was made into the spoil tip at this time. The cut began immediately below the topsoil layer, a little to the north of the presumed line of the north wall of Steeping Pit 5, cutting both the spoil tip and the waste generated during the initial construction phase.

4.4.2 It is likely that any structures built above ground level were also removed at this time. The abundance of dressed stone mixed with calcined shale encountered above the ground level of the works on the south side of the cistern may have resulted from the dismantling of the structures and the emptying of the steeping residues. The presence of pantile fragments in the fill of the cistern suggests that buildings, although not encountered within the excavation area but probably situated close to the works, may also have been demolished or dismantled at this time. Similarly, a layer of timber planks (184) located within the fill may indicate a former structure, perhaps a roof over the cistern, although no supporting evidence may be offered for this hypothesis. The absence of redeposited grey shale in the cistern suggests that it had been deliberately filled in following the abandonment of the works.

4.4.3 It is possible, however, that this phase did not consist entirely of the removal and demolition of structures; the bridge at the eastern end of the site appeared to be of a later date. This structure led from the hillside over the course of the trough to the spoil tip on the north side of the site (Fig 3). The abutment walls comprised well-dressed and coursed sandstone masonry surviving to four complete courses, the individual blocks measuring up to 0.23m x 0.3m x 0.83m, and dressed in the chevron style. A single springer stone at the south-east corner suggested that the bridge had a rounded arch with a span approximately 1.2m wide. The bridge measured 3.04m wide and, although incomplete, would have stood at least 2m above the floor of the trough. The walls were erected on a foundation course of roughly cut sandstone blocks, which in turn overlay puddled clay, forming a continuation of the clay in the bottom of the trough. Packing behind the abutment walls comprised irregular sandstone fragments, brown clay, shale, and fragments of pantile. The latter inclusions are of interest as they indicate the construction of the bridge post-dated the demolition of at least one roofed structure in the vicinity, thus suggesting that the bridge was a later addition to the site. The reasons for its construction are likely to be associated with the transportation of stone from the quarry and abandoned alum works, although its presence does suggest that the trough was still in use, perhaps for drainage purposes.

4.4.4 At the time of excavation, the bridge was in a ruinous condition. The precise date of its collapse is uncertain, although it is believed to have been intact until at least September 1971 (G Lee, pers comm).

4.5 PHASE IV: LATER ACTIVITY

4.5.1 Although the alum works were abandoned in the late eighteenth century, sporadic industrial activity continued at the site into the twentieth century. In the later nineteenth century the jet shales, situated beneath the alum shale, were extensively worked across the whole of Carlton Bank. This has resulted in the characteristic line of small spoil tips, oxidised from the combustion of bitumen, running horizontally along the hillside west of the site and in the larger finger-like tips to the east. The jet was mined by a system of drifts and connecting tunnels, the tops of which were no more than 10m below the base of the alum works. It is the presence of these mining features that is responsible for the numerous voids encountered during the excavation, caused by roof falls progressively working up to the surface. Where these voids, or crown holes, have occurred within the site, significant damage has been inflicted on the archaeological remains.

4.5.2 It is believed that stone extraction and dressing was also undertaken during the nineteenth and twentieth centuries, a practice which in more recent times was continued by the present landowner. This activity has left little trace except perhaps the trackways within, and leading to, the site. The earliest date for this activity is likely to be the construction of the alum works but it may have begun again following the abandonment of alum processing, significantly, a time when much dressed stone was removed from the site.

4.5.3 Subsequent to the abandonment of the site, a substantial deposit of natural grey shale, washed down from the quarry, covered the entire site. It is probable that for a time the trough would have continued to drain the site until such time as it became choked with shale. This, coupled with the height of the spoil tip above the working surface of the works, effectively turned the site into a pond, within which successive periods of deposition of waterborne shale took place. The sections exposed within the excavation area, and also in the erosion gully, revealed that this deposit consisted of alternating bands of coarse shale and clay. This suggests initial deposition of heavier grains of shale, followed by gradual deposition of finer particles in still water. The overspill from the pond and the later drainage of the site is likely to have caused the erosion of the gully, which formed such a prominent feature of the spoil tip (Plate 3).

4.5.4 During the Second World War the site was once again utilised, this time for two Bren gun emplacements, which formed prominent circular depressions in the modern ground surface. Originally it was thought that these features may have marked the location of two cisterns but trial excavation proved that they were entirely within the redeposited shale.

4.6 THE FINDS

4.6.1 In total, 31 fragments were recovered from the site during the course of the excavation. The bulk of this small assemblage was retrieved from post-abandonment contexts, and yielded little information pertaining to the alum works. The lack of pottery and other indicators of domestic occupation are perhaps not that surprising given the industrial nature of the site, but is nevertheless disappointing as it has precluded an avenue for establishing the secure chronological development of the site.

4.6.2 Numerically, dark green bottle glass (22 fragments) of a nineteenth century date, probably from the same vessel, dominated the assemblage, together with two fragments of window glass, a single sherd of pottery of the same date, and two fragments of pantile (a sample of that present on the site). The presence of pantile and

window glass does suggest the presence of roofed structures in the general vicinity, if not in the works itself. All these artefacts were produced from post-abandonment contexts.

4.6.3 Artefacts produced from earlier deposits (Phase II) comprised a single fragment of fine eighteenth century bottle glass, a small quantity of iron nails, and two wooden paddles. The bottle glass fragment appeared to have had a specialist function, perhaps used for taking chemical samples, which may tentatively suggest a laboratory building situated close to the site. The nails were produced from the timber launder (47) located on top of the south trough wall (177), and are likely to have originated from the construction of the feature.

4.6.4 The wooden paddles do arouse some interest. Historically, the only trees believed to be suitable for use in the alum industry were those species, such as Scots Pine, which had a high enough resin content to withstand the action of the sulphuric acid generated during the steeping process. The paddles, however, have been identified as an oak (J Huntley pers comm).

5. DISCUSSION

5.1 The preliminary archaeological evaluation of the site (LUAU 1996) identified the *in situ* remains of the steeping pits, thus demonstrating a potential for the survival of further structural components. During the early stages of the subsequent excavation, it became clear that the level of survival was remarkable, and that the remains were of national importance. Consequently, every effort was made to minimise the damage during both the excavation and reclamation programmes in order to allow the preservation of the remains *in situ*. It must be stressed, however, that only the part of the alum complex that was considered to be directly under threat of disturbance from the landscaping scheme was subjected to archaeological recording, and that significant components of the site are likely to be preserved outside of the study area. Thus, a considerable body of potential evidence relating to the form and development of the alum works may remain a topic for future study. Nevertheless, the significant remains revealed during the excavation provide valuable evidence of the technological process employed at Carlton, and demonstrate a stage of the development of the alum industry during the later seventeenth and eighteenth centuries.

5.2 Whilst the quarry was located to the south-west of the steeping pits and beyond the area subject to formal excavation, the result of the initial evaluation proved that considerable remains survive within this area, including evidence of the alum clamps. This was further confirmed by the results of the geophysical investigation (LUAU 1997a), which suggested that at least one rectangular structure existed within the entrance to the quarry. The precise nature and function of this putative structure is unknown, although it may relate to the documented '*newly built house for the labourer on the top of the hill near the alum rock*' (Cook 1996). Situated on the hillside to the south-east of the quarry are the remains of a reservoir used to supply water for the alum works, which survives as a distinct earthwork. This reservoir was supplied from a spring, known as Raik's Well, which was diverted from its natural easterly course to flow northwards over the escarpment and into the reservoir (*op cit*).

5.3 The six steeping pits, the arrangement of which provided some interesting processual evidence, dominated the western part of the excavated area. It was clear from the form of construction and the surviving plan that Steeping Pits 1 and 5, located to the north of the liquor trough, were of a single build and thereby contemporary. Similarly, the two pits to the south of the trough (Steeping Pits 2 and 6) were likewise the result of a single construction event, and whilst it was impossible to ascertain with complete confidence which bank was built first, it is likely that all four pits were broadly contemporary. It can, however, be argued that the noted slight differences in the size and alignment of the two banks of steeping pits indicate different phases of construction, supported by the recorded rebuilding of the south wall of the liquor trough. This rebuilding, though, appeared to be restricted to the upper courses of the trough, and did not constitute evidence of a complete remodelling, which may have been required with the insertion of additional steeping pits. The noted differences of alignment between the two banks of steeping pits, moreover, may purely be an indication of the crude survey methods of the original laying out or, perhaps more likely, the result of the forces created by the post-abandonment hillwash. The use of timber planks to create the floor surface of Steeping Pit 2 remains curious, although

their absence from the northern, and subsequent western pits, may be ascribed to availability and ensuing cost of materials.

5.4 It has been noted that the central part of the site contained no archaeological structures, and that all traces of the liquor trough had been completely removed. It may therefore be quite possible that two further steeping pits formerly existed in this area, one to the north and one to the south of the central trough, which have subsequently disappeared without trace. Thus, the initial design may have incorporated three pits on one side of the trough, followed by a second bank of three on the opposite side, and thereby utilising a three stage process (Rout 1997, 17).

5.5 The bank of two steeping pits along the western edge of the site (Steeping Pits 3 and 4) was positioned beyond the western terminus of the liquor trough, and they were separated from the other pits by a 2m thick baulk of material that incorporated calcinated shale and steeping residues. This has been taken as a clear indication that the western steeping pits were a later addition to the alum works, and their incorporation may suggest the adoption of a four-stage counter-current extraction process in line with Colwall's account in the late eighteenth century (*ibid*). Such modifications may be seen as attempts to improve the efficiency of the works, and suggest that business was sufficiently profitable to justify the necessary expenditure. It is of interest, however, that these two later steeping pits were of an identical build to the pits on the north side of the trough, and of very similar dimensions. Whilst it is impossible to ascertain the exact inception date of these later pits, it may be concluded that no modifications to their design were implemented.

5.6 Writing in the nineteenth century, Watson (1854, 48-9) details an eyewitness account of the steeping pits at the Guisborough alum works, which provides an interesting comparator:

> '*After having fixed on a suitable site for your intended number of pits, observing to let the floor have a proper descent, and that it is quite even you are to provide a sufficient quantity of clay....the ramming ought to be 6 inches thick at the bottom and sides....The pits ought to contain 60 cubic yards of mine, and run about these divisions, viz, 18 yards in length, 5 yards in breadth, and 24 inches in main depth, to hold that quantity; but as the pits are rarely filled to the top, allowance ought to be made for 2 inches more in depth; and a pit this length should have 12 inches descent, so that the deep end of the pit should be 32 inches, and the shallow end 20 inches. Deep pits were formed at a still early date, but were found by experience not to steep the mine so efficiently. The walls are two 10 inch parpin walls, with an intermediate 6 inch ramming* [of clay] *and the bottoms flagged with the hardest stone on a 6 inch ramming. Cisterns similarly built*.'

In broad terms, the construction of the Carlton works conforms to Watson's (1854) account, although there are some variations that require comment as they may be taken as evidence for the gradual evolution of the alum process. An interesting element of Watson's account is his assertion that deep pits were formed at an earlier date, and that they were found to be less efficient. The steeping pits at Carlton are indeed deeper than those at the later Guisborough works as described by Watson and, in terms of total volume, the Guisborough steeping pits were around 40 cubic metres compared to the *c*56 cubic metres capacity of those at Carlton. This should be compared with Colwall's 1678 account of typical steeping pit dimensions being about

ten yards by five yards wide and five feet deep, giving a volume of 64 cubic metres (Morrison 1981, 5); such pits would be shorter, but over 0.5m deeper than those at Carlton. From these figures it could be argued that Carlton falls within the mid range of the development of steeping pit design and chronologically between the two. It is worth emphasising, moreover, that Colwall's observations were made at a similar date to the construction of the Carlton alum works, which hints at Carlton playing an important role in the technological advances of the industry.

5.7 The degree of drop in the level of the floor of the steeping pits referred to by Watson (1854) represents a further variation; at Guisborough, the drop was noted to be 12", but only 6" was recorded at Carlton. Again, this difference may be accounted for in the evolution towards a more efficient design in the nineteenth century, although the degree to which subsidence from subsequent jet working has affected the floors at Carlton is not known.

5.8 Watson does not mention any tapering in the width of the steeping pits. The recorded measurements of the pits at Carlton do demonstrate a slight tapering in the width towards the drain end, although whether this was entirely intentional or merely the result of subsidence is unclear. It is of note, however, that this tapering was not identified in the later western steeping pits, which were not drained via the end walls. In several of the steeping pits, large, roughly worked stones were found immediately in front of the drainpipe. It is unlikely that these were intended to function purely as drain plugs as they could not have provided a tight seal; they were perhaps intended to prevent blockage, and the seal was formed using a wooden plug on the trough side of the steeping pit.

5.9 From the steeping pits, the raw alum was transferred to the cistern via the liquor trough (Fig 3). The westernmost 8.6m of the trough was seen to be well-preserved, whilst in the eastern part of the excavation a further *c*28m of trough was again present, although poorly preserved. The eastern end of the trough terminated at the bridge, beyond which there was no evidence for its existence. Similarly, a 13.6m section of liquor trough across the centre of the site was not surviving. The missing sections of the trough are probably the result of extensive robbing, or by disturbance associated with the nineteenth century jet workings. Although no distinct robber trenches were identified, it is feasible that such evidence had been completely masked by the substantial hillwash in subsequent years. The apparent absence of the liquor trough eastwards from the bridge to the alum house, however, is more difficult to explain as extensive surveys of the hillside have failed to find any trace of such a structure. By projecting the line of the western end of the trough (103), it may be postulated that it would contour around the slope to the east and into the area affected by the later jet workings. The direction of the trough, however, changed abruptly on its approach towards the bridge (Fig 3), for reasons that remain unclear. The section leading to the bridge could then be explained in terms of the outflow of waste, perhaps from flushing out the pits and the water supply system, which must have become frequently blocked with shale. Moreover, it may be possible that the trough was never constructed beyond the cistern and that the liquor was transferred to barrels and transported to the alum house at the base of the bank via packhorse or cart. Whilst this would significantly increase the overheads involved, Christopher Prissick's inventory of 1718 attests the presence of pack animals (Cook 1996).

5.10 The excavation uncovered the remains of a single circular cistern, with a volume in the region of 13 cubic metres, although the identification of the collapsed, and possibly

robbed, structure on the south side of the surviving cistern as a further, perhaps smaller, cistern is tempting (Fig 3). Indeed, parallels for a stone channel connecting the two structures exist at Boulby (Chapman 1975, 32), where it was seen to connect two cisterns.

5.11 An important component of the alum complex that was not located within the area studied was the alum house, where the 'raw' alum liquor was purified and converted into the finished product by the addition of potash or ammonia, and crystallised. Since these processes used large amounts of fuel, and relatively small amounts of 'raw' alum, the alum house was normally sited downhill from the quarry, where transport of fuel and other imported materials was easier. It is shown on the 1st edition Ordnance Survey map as having been *c*1km to the north-west at the base of the scarp (Fig 2), and there is a prominent earthwork in that locale which may mark the site (LUAU 1998). Any investigation of the alum house is likely to produce important evidence, such as the presence or absence of the liquor trough, and as such remains a priority for future study.

5.12 The reasons for the closure of the Carlton Alum Works in *c*1774 are likely to be financial, resulting from the instability in the price of alum, and particularly the slump of the 1770s. Other inland alum works in the vicinity of Carlton ceased production around the same time, leaving a predominance of coastal sites that had a competitive advantage. It is worthy of note that some of these other inland works, such as Ayton Banks (1765–*c*1770) and Thimbleby (1752-1774) (Pickles forthcoming), were short-lived enterprises established during the mid-eighteenth century, and it may be reasonable to suggest that their inception was stimulated by the successes of the then established Carlton works.

5.13 The presence of the large gully in the central part of the site gives some indication of the significant natural erosion that has affected the site since the abandonment of the alum works. The hillwash from the quarry is thought to be largely responsible for the blocking of the water management system, thus allowing run-off from the quarry to pond within the site, as indicated by the succession of waterborne deposits that were exposed within the excavation area. The significant cut identified in the section of the erosion scar, which is located opposite the mouth of the quarry, post-dated the abandonment of the works, and may be attributed to stone robbing activity. This cut will potentially have weakened the integrity of the spoil heap and allowed subsequent overspill from the quarry to result in the creation of the present-day erosion scar. The processes of natural scouring from the hillwash is likely to have been responsible for the destruction of the easternmost steeping pits and the erosion of the unstable spoil tip.

5.14 In general terms, the form of the Carlton works does not appear to have altered significantly for perhaps the majority of its existence, and it therefore serves as an example of the technology employed in the later seventeenth century as well as much of the eighteenth century. Whilst evidence of expansion was revealed in the clear phasing of the construction of steeping pits, the new pits appeared largely to conform to the standard for the site. Whilst some differences in contemporary accounts of other works were noted, the form of the works conforms generally to the layout of other contemporary works. This perhaps illustrates the conservatism of the design of alum works during the early phase of the industry. That the form of the works remained largely unchanged during the greater period of operation may, however, be expected since innovation within the industry was largely confined to the workings of the alum

house, where the raw alum liquor was processed into a usable product and later into a series of products. Indeed the basic principle of the alum works persisted relatively unchanged until the final collapse of the industry in North East Yorkshire in the 1870s, when new coalfield-based methods of alum production were developed that no longer required the steeping process.

6. CONCLUSION

6.1 The Carlton Alum Works is almost certainly one of the best surviving sites on the North York Moors, and is additionally rare in that its period of use was limited to approximately 100 years from the late seventeenth- to the later eighteenth-century. Therefore, whilst it is not one of the earliest alum-working sites, it has not been affected by the major changes to working practices that evolved during the nineteenth century, which have become the most visible remains on many of the surviving sites, particularly those along the coast. In recent years, moreover, the research into alum works has largely concentrated on the alum houses (Marshall 1992; Marshall 1995). Fieldwork projects have largely been confined to observation at a number of coastal sites, in many cases driven by a need to record in advance of coastal erosion, such as at Boulby (Chapman 1975). This has resulted in an imbalance of knowledge that heavily favours the coastal sites, many of which belong to a period late in the development of the industry.

6.2 The excavation at Carlton has thus provided an unusual opportunity to record earlier practices of alum working, in the context of a whole site, rather than a partially destroyed site. Moreover, unlike many of the coastal sites which are unsuitable for long term preservation, Carlton provides a realistic opportunity for preservation. Despite the disturbance caused by the nineteenth century jet mining and the recent reclamation scheme, the overall integrity of the site has been largely retained. The site is also very accessible to the public and, as an important example of the industry, has considerable interpretation and display potential.

6.3 Given the important results of the combined archaeological investigations at Carlton Bank, and the considerable local and regional interest that the site generated, it was expected at an early stage that the results would be published in an appropriate journal, such as *Industrial Archaeology Review*. It was also proposed that the results be presented as a small illustrated 'Shire'-style publication, or indeed, in a form used by the National Park Authority itself. Following further discussions with Mr G Lee, however, it has been decided to instigate a more general publication that will consider all aspects of the North Yorkshire alum industry, in which the Carlton excavation will form an entire chapter. The compilation of this proposed monograph is currently under way, and is due to be published in 2001.

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APPENDIX 1
INITIAL PROJECT DESIGN

Lancaster University Archaeological Unit

August 1997

CARLTON BANK
ALUM WORKS
NORTH YORKSHIRE

ARCHAEOLOGICAL EXCAVATION AND RECORDING

INITIAL PROJECT DESIGN

This project design is presented in accordance with current English Heritage guidelines, as specified in Management of Archaeological Projects*, 2nd edition, 1991.*

Proposals

The following project design is offered in response to discussions with Mr G Lee of the North Yorks Moors National Park for mitigation archaeological recording in advance of the stabilisation of the spoil tip of the former Alum Works at Carlton Bank, North Yorkshire.

1. BACKGROUND

1.1 Site Description

1.1.1 The alum works at Carlton Bank, North Yorkshire, survives as a large quarry, with associated features which may be a legacy of the calcining and initial steeping of the alum shale, together with a large spoil tip, over the scarp slope at the north-westernmost point of the Cleveland hills. The spoil tip has become increasingly unstable and subject to slumping in the last few years; therefore the decision has been taken by the North Yorks Moors National Park that stabilisation work should be undertaken, necessitating the removal of almost all of the spoil tip.

1.1.2 The site (NZ 520 027) lies on the north-facing scarp of the North York Moors, an area of Jurassic rocks dipping very gently to the south. The crest of the scarp is formed by Lower Deltaic Sandstone, beneath which lies a considerable thickness of 'Alum Shales'. These in turn overlie the thin Dogger limestone, over further shales containing a seam of jet. The alum quarry is cut into the steep scarp face from the north, within the Alum Shales, and extends south to the edge of the Lower Deltaic Sandstone, with shallower lobes extending south-east and south-west below the strike of this outcrop. The outcrop of a jet seam, just below the floor level of the quarry, is marked by a horizontal line of workings along the hillside.

1.1.3 The crest of the scarp lies at *c* 400m OD, and the base at *c* 200m OD; the floor of the main quarry lies at 320m OD. The vegetation cover consists of heather moorland on the flatter areas, giving way to rough grass on the steeper slopes, with bracken and some scrub towards the base of the scarp. There is extensive bare ground on the sides of the quarry (due to the unstable and steep surface of weathered shale) and on the tips to the north of the quarry (due to the instability of weathered shale), coupled with the acid and infertile nature of the calcined shale of which these tips are composed. The tips and the slope below them have been affected by landslipping.

1.2 Background History

1.2.1 Alum working in the area began in earnest in the seventeenth century. Alum shale was extracted by quarrying, often on a very large scale in comparison to other industries during the early post-medieval period. The broken shale was then calcined (roasted) in large heaps ('clamps'), mixed with a small amount of brushwood and/or coal; the clamps sometimes had permanent clay bases containing flues. Calcining took several months, and consisted of a slow burning to oxidise the pyrites to iron sulphate, which in turn reacted with the shale to form aluminium sulphate and iron oxide.

1.2.2 The aluminium sulphate, being soluble, was then leached out of the shale in a series of 'steeping tanks', lined with clay, stone, wood, or lead. Calcined shale was placed in these tanks, water added, and the mixture stirred and allowed to settle. A series of tanks was used, to produce a progressively stronger solution. The leached shale, still a distinctive red colour, was then dumped. All these processes took place within or very close to the quarry, due to the bulk of shale involved.

1.2.3 The 'raw' alum liquor produced was led into storage cisterns near the steeping tanks, and then fed by a culvert or 'liquor trough' to an 'alum house' where it was purified, converted into alum by the addition of potash or ammonia, and crystallised. Since these processes used large amounts of fuel, and relatively small amounts of alum (which was in liquid form), the alum house was sited downhill from the quarry, where transport of fuel and other imported materials was easier.

1.2.4 Until the sixteenth century, alum for use in Britain was imported from the Mediterranean, where a Papal monopoly existed. Sixteenth century attempts to develop home production, largely in southern England, were unsuccessful.

1.2.5 Technical success was achieved at the start of the seventeenth century, in the Guisborough area, under a Crown monopoly. By the middle of the century the industry was commercially viable, and it was returned to private ownership in 1679; many new works (including Carlton Bank) were opened, though most of these were short-lived. The British industry was concentrated almost exclusively on the North York Moors.

1.2.6 Following a slump in the 1770s, many works closed and production was concentrated in the few surviving works, still in North Yorkshire. In the mid-nineteenth century, a new process was developed in which freshly calcined shale (normally colliery waste) was treated with hot concentrated sulphuric acid. These works were sited on or near the coalfields, and rapidly made the older Yorkshire technology redundant, the last works in the North York Moors area closing in 1871.

1.2.7 The Carlton Bank alum works is recorded as having operated from *c*1680 to 1774, though the earliest record of its form is the mid-nineteenth century 1st edition Ordnance Survey (OS) map. This indicates the quarry which forms the present evaluation area, and an alum house *c*1 km to the north-west, at the base of the slope. No detailed modern study of the site is known to have been undertaken until the evaluation in advance of this stabilisation work, and the North Yorkshire Record Office reports that it has no documents or pre-OS maps relating to the site. The site is however recorded as 'Alum Works' on a county map of 1771 though no detail is depicted.

1.3 Previous Work

1.3.1 A contour survey of the quarry, tips, and surrounding area was undertaken in 1995-6, as part of a geotechnical report for the proposed reclamation scheme (Foundation and Exploration Services 1995). This survey accurately depicted the overall forms of the quarry and tips, but smaller-scale archaeological features were not picked up by the contour interval (5m) employed.

1.3.2 Geological test pits were dug in March 1996, and were recorded as a watching brief by Cleveland Archaeology (Cleveland County Archaeological Section 1996). Despite competent recording of the sections, this information contributed little to the overall understanding of the site, since the 'footprint' of each trench was small relative to the anticipated plan size of many alum-working features, and on the available information it was impossible to determine whether some of the test pits were wholly within large archaeological features.

1.3.3 A field evaluation was undertaken by the Lancaster University Archaeological Unit (LUAU 1996), which comprised a topographical survey to record the suite of relatively small-scale features not recorded by the contour survey, and a programme of trial trenching to test a sample of the features identified. Whilst many of these proved to be relatively recent, some, more deeply buried, were associated with the alum works.

1.3.4 A further phase of work (LUAU 1997) comprised a sample geophysical survey, the detailed recording of a section of both bank and spoil tip revealed in an erosion scar, palaeoenvironmental investigation of a waterlogged deposit at the base of the slope, and sample geochemical analysis. This programme revealed potential other subsurface features immediately above the edge of the spoil tip, and that also the tip had been carefully engineered, with the spoil deposited in horizontal layers, rather than being tipped over the edge of the slope in a more casual fashion.

1.4 Circumstances of Project

1.4.1 A land reclamation scheme has been put forward, to stabilise the present slope by the removal of the calcined shale tip from the hillside. This material will be removed from the site and the slope graded to a stable angle of repose. This will necessarily remove the entirety of the spoil tips and also disturb some of the features associated with alum working immediately beyond. A scheme for ensuring that the slope remains well-drained will also be enacted, which will also affect some of the culverts identified in the topographical survey, which are probably associated with launders leading the alum liquor down to the alum house at the base of the slope. Therefore a mitigation policy for recording deposits in advance of and during the reclamation works has been requested by the North Yorks Moors National Park Archaeologist.

1.4.2 LUAU has considerable experience of the evaluation and excavation of sites of all periods, having undertaken a great number of small and large scale projects during the past 17 years. Evaluations and mitigation programmes have been undertaken within the planning process, to fulfil the requirements of clients and planning authorities, to very rigorous timetables. The survey and evaluation of the alum works at Carlton Bank has been undertaken by LUAU, and members of staff were involved with the English Heritage Monuments Protection Programme on the alum industry. LUAU has the professional expertise and resource to undertake the project detailed below to a high level of quality and efficiency. LUAU and all its members of staff operate subject to the Institute of Field Archaeologists' (IFA) Code of Conduct.

2. AIMS AND OBJECTIVES

2.1 The alum industry, along with working of jet, has had, perhaps, the most marked effect of any industry on the North Yorkshire moors area, which was for some three hundred years the focus of the industry. Alum shales outcrop along the scarp slopes of the moors, and are particularly prominent on the north-

facing slope overlooking the Tees valley, and along the coast, between Kettleness in the north and Ravenscar in the south. These coastal works are the better known, and are some of the earliest, but also the longest lived workings. The inland sites are less common, which is unfortunate, as much information on the coastal sites has been lost to the sea, both as a deliberate policy of waste disposal, and through natural erosion of the coastline, whereas the inland sites survive largely intact.

2.2 The Carlton Bank alum works is probably one of the best surviving sites on the North Yorks moors and is additionally rare in that its period of use was limited to approximately one hundred years from the late seventeenth- to the later eighteenth-century. Therefore, whilst it is not one of the earliest alum working sites, it has not been affected by the major changes to working practices which evolved during the nineteenth century, which have left the most visible remains on many of the surviving sites, particularly those along the coast. It thus provides an unusual opportunity to record earlier practices of alum working, in the context of the whole site, rather than of a partially destroyed site.

2.3 The English Heritage Monuments Protection Programme on the alum industry (Gould 1993) considered the site to be of potential national importance if good survival of below ground features was verified. The evaluations undertaken to date have done much to confirm this view. The mitigation recording is therefore essential to add as much information as is feasible in the context of the reclamation scheme.

2.4 The primary pragmatic objectives of the excavation programme are driven by the inherent needs of recording in advance of and during the reclamation scheme. The objectives must be to define the extent, character and condition of the archaeological deposits to be affected by the scheme, as well as to advise of methods to avoid damage to those areas peripheral to the scheme. In addition, if possible, the function and date of those remains should be confirmed. Features should, wherever possible, be placed in the context of the alum process, in an attempt to understand better the late seventeenth-eighteenth century methods of production. Key elements of the stratigraphy will be examined in some detail, in an attempt to define an occupational sequence and if possible, an absolute chronology.

2.5 The programme will investigate and record the presence of artefacts revealed during the works programme. It will examine the range and character of the artefactual evidence within both an industrial and regional context.

2.6 An archive for the project to the specification provided in Appendices 3 and 6 of MAP2, prepared during the excavation programme, and supplemented as necessary during any phase of analysis will be prepared to professional standards for deposition in an appropriate repository. Following analysis, a text suitable for publication in an appropriate journal will be prepared.

3. METHODS STATEMENT

3.1 Programme

3.1.1 The following programme has been designed, in discussion with the North Yorks Moors National Park Archaeologist, Mr G Lee, to provide a suitable level of archaeological observation, excavation and recording prior to the stabilisation works on the site. It has been based in large part on the results of the 1996/97 evaluatory work by LUAU.

3.1.2 It is important, given the circumstances, that the programme of work should follow a series of stages, with a review of progress between each, allowing a flexible approach to the investigation of the archaeological deposits on the site.

3.1.3 The required stages to fulfil the aims of the project are:

a) *Survey Recording:* survey recording in advance of the reclamation scheme is required in two parts of the site. Firstly, those parts of an apparent culvert and perhaps also launder currently eroding from the central erosion gully should be cleaned and surveyed. In addition, those features recorded in the topographical survey (LUAU 1996) which will be removed by the reclamation scheme should be subject to more detailed survey recording prior to excavation.

b) *Machine Clearance:* the area immediately beyond the spoil tip which will be affected by the reclamation scheme should be subject to some archaeological recording in advance of the site works commencing. Firstly, a machine-cut trench should be dug to the south of Trench G (LUAU 1996) to establish whether the stone feature there is a culvert or a tank. Following this, and dependent on the results of this work, two areas should be subject to machine clearance to establish the presence or absence of archaeological features, revealed by surface traces or the geophysical survey. These areas

should be centred on the site of Trench D (LUAU 1996) to the west of the central erosion gully, where a possible launders were revealed. The full extent of these features should be uncovered in this exercise, and the possibility of associated features should be confirmed or discounted. Secondly, the area to the east of the central erosion gully should be stripped to test for possible features highlighted by the geophysical survey, the possible settling tank revealed in the section of the erosion scar, and the other possible tank revealed by the topographical survey.

Machine clearance should be limited to the area to be affected by the reclamation scheme. Overburden will be cleared to a level just above the anticipated depth of the important archaeological deposits. The efficiency with which this is achieved is critical to the success of the excavation, and should be under the supervision of a qualified archaeologist, to allow identification of key areas of material. This process will commence on either side of the erosion gully at the southern limits of the available area moving northwards.

c) *Excavation:* an area of approximately 1450sqm will be excavated, centring on those areas of prime archaeological interest revealed during the removal of the overburden. Manual excavation techniques will be employed to clean, define and sample features forming key elements of the site. The aim of this phase of the project is to excavate all elements of the site to establish function, date and the internal sequence.

d) *Watching brief:* during the removal of the spoil tip, a permanent presence watching brief will be maintained to record the infrastructure of the tip and any associated archaeological features (such as culverts and launders, and also perhaps settling tanks or even calcining bases) revealed during the process. This process should be subject to regular review and discussion between the contractors, LUAU, and the North Yorks Moors National Park archaeologist to ensure an adequate level of recording is maintained. It is possible that this may also trigger more detailed recording strategies, should material of importance and/or complexity be identified during this process.

e) *Site Archive/Review:* following fieldwork, the results should be collated and the site archive completed as soon as appropriate. The whole programme should then be reviewed with the North Yorks Moors National Park archaeologist as a formal assessment of the results, to agree the scope of any further work deemed necessary (assessment, analysis, synthesis) to complete the project.

f) *Analysis/Report:* a provisional programme of post-excavation analysis is proposed, on the basis of the anticipated recovery of material from the excavation; however, the extent of the programme can only be reliably assessed on completion of the fieldwork. The proposed programme anticipates analysis of the site stratigraphy and also analysis of the artefactual evidence leading to the production of a summary report for the client and for dissemination to the general public.

3.2 Methods

3.2.1 The site is not unique in the region, although few such sites have been subject to detailed recording. It will not be practical to excavate every feature in its entirety, and a rigorous sampling strategy will be applied.

3.2.2 *Survey Recording:* in earlier phases of work use has been made of the existing survey control installed by Foundation and Exploration Services, Basingstoke, during the borehole investigations. LUAU still hold co-ordinate information supplied by Foundation and it is proposed that this be used again unless either the main contractor wishes to install their own control in which case LUAU will tie into this, or the Foundation control no longer survives. The existing control is in the form of capped borehole tubes, which will be extended to incorporate stations outside of the sphere of reclamation activity in order to preserve control integrity for the duration of the project. It is proposed that survey control be extended by closed traverse to an accuracy of +/- 0.01m in plan and 0.005m in height. If the original survey control does not survive a local grid will be established until the main contractor installs their own control, at which point LUAU will tie into this.

3.2.3 *Survey detail:* as the current proposals for land reclamation would involve the destruction of areas located below the 311m contour level which are known to have archaeological potential, a LUAU Level 3 survey is recommended. Level 3 survey *(Mitigation)* is a comprehensive record of the archaeological features in relation to the surface topography. It incorporates an interpretative hachure survey alongside a full computer generated model of the ground surface enacted when a full survey is needed in conjunction with excavations or in cases where detailed survey of fragile upstanding earthworks is the only appropriate mitigative measure.

3.2.4 The Level 3 mitigation survey is designed to record the archaeological site as fully as current technology will allow in advance of its destruction. It is applied selectively to sites of particular importance and which have a good survival of surface features.

3.2.5 This will be achieved by means of its in-house total station facility, linked to a portable data logger with full micro-computer data transfer capability. The aim of the survey is to provide accurate, three-dimensional co-ordinates, with respect to the previously established control. In many cases only a relatively limited amount of additional data is required to upgrade the Level 2 survey to the full surface modelled Level 3 and therefore this can be an economic recording option.

3.2.6 The resulting data is modelled on CAD which maintains the original accuracy of the survey data and allows flexibility of drawing output at any scale. The drawing file will record the contour detail at different height separations and the final survey drawings can therefore be tailored to meet any requirements of the client.

3.2.7 In the case of the putative culvert within the central erosion gully, the features will be subject to hand-cleaning, as far as health and safety considerations will allow, before being subject to the methodology outlined above. Where material of great importance is revealed, the survey will be enhanced by hand-drawing of selected elements at a sale of 1:20. This information can be digitised to give greater detail to the CAD-generated drawings, if required.

3.2.8 *Machine Clearance:* a machine-cut trench will be excavated to establish the presence or absence of a stone culvert between Trenches F and G to the immediate east of the reclamation scheme. In addition, two areas, one on either side of the central erosion gully, will be stripped to allow the recording of features within the area affected by the reclamation scheme identified from the topographical survey, geophysical survey, and trial trenching (Trench D). This would be undertaken under the supervision of a fully qualified archaeologist, who would ensure that the overburden was stripped efficiently and that no important archaeological deposits were disturbed during this process. The archaeologist would lead a team who would identify archaeological material as they manually cleaned the site following the machine.

3.2.9 The overburden stripping will be undertaken by a JCB, using a 2m toothless ditching bucket. The machine will remove the topsoil across the area, an action that is critical to the success of the excavation, as the removal must be judged exactly so that neither too much overburden remains on completion of the task, nor should any deposits of archaeological significance be disturbed during this task. Features identified will be cleaned and planned with respect to the survey control framework which will have been established over the site using total station equipment.

3.2.10 *Excavation methodology:* the excavations will concentrate on defining all elements of the alum works within the area to be affected by the stabilisation works. These include possible tanks and culverts already identified by earlier phases of work. The programme will investigate all features associated with this and an attempt will be made to establish an overall chronology for the site, as this may allow an analysis of the development of the works. Any features of archaeological significance belonging to periods either preceding or succeeding that believed to be the core activity on the site will be treated appropriately.

3.2.11 The excavation will use a variety of techniques, from rapid cleaning to delicate excavation, to suit differing conditions. Following removal of the overburden, the core areas will be subject to manual excavation; the aim of this work will be to explore all features stratigraphically and to produce a clear plan of the complex.

3.2.12 The deposits encountered during the excavations will be sampled according to the appropriate professional standards to enable palaeoenvironmental and/or geochemical analysis if proven beneficial. To maximise the available resources, all features will be cleaned and a sample will be excavated, but they will not necessarily be excavated to their full extent if sufficient information can otherwise be retrieved to establish their date, function and stratified relationship. Layers and features will be cleaned and excavated by an appropriate technique.

3.2.13 All elements of the work will, as a matter of course, be recorded in accordance with current English Heritage guidelines (*MAP2*) and the best practices formulated by English Heritage's Central Archaeology Service. All excavation, by whatever method, will be recorded by the compilation of context records, of object records for any finds and a photographic record. The archaeological record will take a form which will allow the flexibility of database capture and manipulation, should the results warrant this treatment, or be an acceptable paper record (copies of standard LUAU recording forms are

attached to this project design). Accurately scaled plans and section drawings (probably at scales of 1:20 and/or 1:10) will be generated with respect to a 5m grid that will be established over the core areas by total station and will be tied into the survey control framework. Most emphasis will be placed on identified dated deposits, particularly structural data and artefact recovery, although information relating to the continued use of the site through time will not be neglected. Three-dimensional recording of selected finds' classes will be undertaken using a data-logging total station, should the site warrant this treatment.

3.2.14 Finds recovery and sampling programmes will be in accordance with best practice (current IFA guidelines) and subject to expert advice. Any palaeoenvironmental and/or geochemical sampling will be undertaken with advice from specialists. The Unit has close contact with Ancient Monuments Laboratory staff at the Universities of Durham and York and, in addition, employs in-house finds and palaeoecology specialists, who are readily available for consultation. Finds storage during fieldwork and any site archive preparation will follow professional guidelines (UKIC). Emergency access to conservation facilities is maintained by the Unit with the Department of Archaeology, the University of Durham, and the English Heritage contract worker at York Archaeological Trust, and, in addition, employs artefact and palaeoecology specialists with considerable expertise in the investigation, excavation, and finds management of sites of all periods and types, who are readily available for consultation.

3.2.15 It should be noted that in a site such as this where little information is available, any discard policy should be formulated with care, and with advice from the Local Planning Authority and the local Museums Service. Such liaison should be formulated prior to fieldwork.

3.2.16 *Watching Brief:* a permanent programme of field observation will accurately record the location, extent, and character of any surviving archaeological features within the reclamation area. This work will comprise the observation (and where appropriate the supervision) of the process of excavation for works or construction purposes, the systematic examination of any subsoil horizons exposed during the course of works, and the accurate recording of all archaeological features and horizons, and artefacts, identified during observation.

3.2.17 During this phase of work, recording will comprise a full description and preliminary classification of features or materials revealed, and their accurate location (either on plan and/or section, and as grid co-ordinates where appropriate, using a data logging total station linked to a portable computer. All archaeological information collected in the course of fieldwork (including finds) will be recorded in standardised form, as described above (3.2.13), and will include accurate national grid references. Features will be planned accurately at appropriate scales, and where possible, a running section through the spoil tip will be maintained as it is removed. A photographic record will be undertaken simultaneously.

3.2.18 It is assumed that LUAU will have the authority to stop works for up to one hour to enable the recording of particularly important deposits, if necessary. Field recording will therefore also include a continual process of analysis, evaluation, and interpretation of the data, in order to establish the necessity for any further more detailed recording that may prove essential.

3.2.19 In the event of archaeological features or evidence of particular significance being identified, it may be necessary to undertake more detailed recording and/or excavation, utilising additional archaeological support (LUAU rapid response team). Such additional work as is considered necessary would be undertaken only after consultation with the North Yorks Moors National Park Archaeologist and the contractors. The recording techniques and procedures employed by LUAU for such detailed recording represent current best practice (as described above, 3.2.13).

3.2.20 *Archive:* the results of the programme of fieldwork detailed above will form the basis of a full site archive to professional standards, in accordance with current English Heritage guidelines (*MAP*2, *Appendix 3*). This archive represents the collation and indexing of all the data and material gathered during the course of the fieldwork. It will include summary processing of any features, finds, or other data recovered. The deposition of a properly ordered and indexed project archive in an appropriate repository is considered an essential and integral element of all archaeological projects by the IFA in that organisation's Code of Conduct. LUAU conforms to best practice in the preparation of project archives for long-term storage. The expense of preparing such an archive is part of the project cost but only represents a very small proportion of the total. This archive (including excavated material) will be prepared in accordance with UKIC *Guidelines for the preparation of excavation archives for long-term storage*, and the Museums' and Galleries' Commission *Standards in the museum care of archaeological collections*. It can be provided in the English Heritage Central Archaeology Service format, both as a

printed document and on computer disks as ASCII files. It is intended that archive records should be deposited with the North Yorks Moors National Park**,** and a further copy can be made available for deposition in the National Archaeological Record (RCHME). Discussions should also take place at this stage as to the need for conservation for long-term storage. This should involve a representative from the County Museums Service. The actual details of the arrangements for the deposition/loan of the material from the site (artefacts, ecofacts and samples) will be agreed with the site owner and the North Yorks Moors National Park archaeologist, dependent on the quantity and quality of the material recovered. The receiving institution should be a registered museum, approved by the Museums and Galleries Commission. LUAU would make the appropriate arrangements with the designated museum at the outset of the project, for the proper labelling, packaging, and accessioning of all material recovered.

3.2.21 *Assessment/Review:* assessment of the level (if any) of post-excavation analysis, as recommended by MAP2, will be undertaken by means of a formal review, involving LUAU and the North Yorks Moors National Park Archaeologist. This will agree the scope and timetable for any such analysis, as well as the length and outline content of a publication text.

3.2.22 *Analysis:* an appropriate programme of analysis should be undertaken to prepare a research archive, should the results warrant this, as detailed in Appendix 6 of *Management of Archaeological Projects.* This will involve the compilation of an archive report, detailing the stratigraphic history of the site, and a full text recording the significance of the structural, artefactual and environmental evidence. This will include analysis of the geochemical/environmental samples and report preparation, and the production of reports on any finds material. It is not possible to provide a totally accurate estimate of costs until the results of the assessment are known, but a best estimate of costs has been submitted on the basis of the results of the evaluation.

3.2.23 The results of the programme of works detailed above should be placed in the public domain by a number of routes. Firstly, a synthesised report of the results of the work should be compiled, which should be published in an appropriate manner. In addition, the completed project archive (site and research archive) should be copied on to microform and disseminated (as detailed above). A synthesis of the work should be placed in the North Yorkshire Sites and Monuments Record.

3.2.24 The precise nature and scale of the published report can only be established after the fieldwork has been undertaken, although it is certain that there will be sufficiently important material to warrant the publication of an article in an appropriate journal.

3.3 Other Matters

3.3.1 *Health and safety:* full regard will, of course, be given to all constraints during the excavations and watching brief, as well as to all Health and Safety considerations. The Unit Health and Safety Statement conforms to all the provisions of the SCAUM (Standing Conference of Unit Managers) Health and Safety manual, as well as the Lancaster University Health and Safety Statement. Risk assessments are undertaken as a matter of course for all projects, The Unit Safety Policy Statement will be provided to the client, if required. The location of services will be investigated from the statutory services and as a matter of course, a U-Scan device is used prior to the commencement of excavation. LUAU will work within the health and safety plan (reclamation phase) produced by the main contractor as a requirement of the Construction (Design and Management) Regulations 1994. It will contribute to this plan by providing risk assessments and a method statement covering its staff whilst working on the watching brief and recording programme. LUAU personnel will observe all restrictions regarding access to potentially unstable areas which should be identified and clearly marked by the main contractor. Work carried out in observing or recording features within the erosion gullies during the reclamation work will be guided by advice from the main contractors regarding the stability of the slopes. It is envisaged that these areas will be reduced in horizontal spits with the opportunity of recording any features revealed being accommodated by the contractor if in there judgement it is safe to do so.

3.3.2 *Insurance:* the insurance in respect of claims for personal injury to or the death of any person under a contract of service with the unit and arising out of an in the course of such person's employment shall comply with the employers' liability (Compulsory Insurance) Act 1969 and any statutory orders made there under. For all other claims to cover the liability of LUAU in respect of personal injury or damage to property by negligence of LUAU or any of its employees. there applies the insurance cover of £1m for any one occurrence or series of occurrences arising out of one event.

3.3.3 *Access:* there is currently unimpeded access for both machines and pedestrians. It is anticipated that the lead contractor involved with the stabilisation will have responsibility for the security of the site. Areas for parking a site cabin and portaloos, if these cannot be shared with the site contractor, as well as car parking, will need to be set aside for the duration of the excavations and watching brief.

3.3.4 *Presentation:* in the interests of health and safety, it is recommended that there should be no public access during the excavations, as well as the watching brief. No statements will be made to any third parties without the express consent of the client.

3.3.5 *Working Hours:* survey and excavation will be undertaken on the basis of a five day week, within daylight hours only. The watching brief will take place to the contractor's timetable.

3.3.6 *Reinstatement:* the level of reinstatement depends on the timing of the excavation in comparison to the timetable for stabilisation. At this stage, it is not anticipated that reinstatement will be required, and spoil will therefore be temporarily dumped on the top of the spoil tip to the north of the excavations. The trench across the putative culvert to the immediate east of the reclamation area will be rapidly backfilled if required.

3.3.7 *Equipment:* the following plant will be required on site:

a) The necessary plant (JCB) for the removal of overburden in association with the excavation of features at the top of the slope will be provided by LUAU.

b) Subject to agreement with the contractors and the North Yorks Moors National Park Archaeologist, it may be possible to share the contractor's site accommodation, but should this not be possible, Mobac or Rollalong-type accommodation for the provision of office space and mess huts will be hired by LUAU, if proven necessary. At present, the allocation for site accommodation has been expressed as a contingency sum.

3.3.8 Pr*oject Monitoring:* monitoring meetings will be established with the North Yorks Moors National Park Archaeologist at the outset of the project and at the critical review stages of the programme, although there will be additional site meetings as required.

3.3.9 *Archive Deposition:* the full archive will be deposited with the North Yorks Moors National Park within eight months of completion of the project, following any programme of processing/analysis agreed with the North Yorks Moors National Park Archaeologist.

3.3.10 *Publication:* the physical publication of the results of this work is beyond the remit of this project design, but hopefully will be subject to discussion at the completion of fieldwork; however, it is certain that there will be sufficiently important material to warrant the publication of an article in an appropriate journal. The costs set out below include the preparation of a summary account of the excavations suitable for publication.

4. WORK TIMETABLE

4.1 The preliminary survey work, particularly that on the central erosion gully, should take place before the contractor starts his site preparation. The other survey work and excavations can take place whilst the contractor is undertaking preliminary work on the site, but sufficient time must be allowed for the completion of this work prior to the commencement of the removal of the spoil tip. At present, there is no detailed timetable for this work. It is estimated that the post-excavation programme will be completed within six months of the fieldwork, allowing for other internal Unit work programmes to be met. Deposition of the archive will be scheduled for three months after the post-excavation programme is completed**.**

4.2 Project Timetabling

4.2.1 The internal project timetable is approximately as follows:

i survey/CAD production	-	*erosion gully*	*3 days*
	-	*top of slope*	*6 days*
ii machine clearance	-	*culvert*	*1 day*
	-	*excavations*	*3 days*

iii excavation of features below 311.0m contour	*2.5 weeks*
iv watching brief	*9 weeks*
v archive/Review	*1 week*
vi analysis/Report (estimate)	*3 weeks*

5. RESOURCES AND PROGRAMMING

5.1 The following resource base will be necessary to achieve the survey, excavations, and watching brief as detailed above. The basic costs assume that the excavations will not identify complex and extensive stratigraphy.

5.2 The post-excavation programme will be subject to the results of the excavation and the attached costs do not anticipate the discovery of particularly complex stratigraphy or extensive analysis of environmental samples. A contingency has been allowed for the analysis of geochemical samples.

5.3 The project will be under the guidance of Rachel Newman, BA (Unit Deputy Director), to whom all correspondence should be addressed, although day-to-day management may be undertaken by an appointed LUAU Project Manager. Rachel is a native of the North East and has extensive experience of the archaeology of the region. She has a detailed knowledge of the North Yorks moors and has studied the alum industry of the area (particularly the coastal sites).

5.4 The site director will be Denise Drury (LUAU Project Officer), who has considerable experience of the excavation of industrial sites. The watching brief will be undertaken by Iain Hedley (LUAU Project Supervisor), who has worked for several years on the English Heritage Monuments Protection Programme of industrial sites, and undertook the evaluation of Carlton Bank in 1996

5.5 Christine Howard-Davis would undertake the necessary finds analysis. She has many years' experience of the identification and analysis of artefact of all periods. If proven necessary, a consultant(s) of suitable status would advise on details of the industry identified during this programme of work (David Pybus of Sandsend; David Cranstone of Newcastle).

5.6 Environmental Samples (if proven necessary)

Environmental Archaeology Unit, York University.

5.7 Geochemical Analysis (if proven necessary)

Andrew Millard, University of Durham.

5.8 Conservation (if proven necessary)

Jenny Jones, University of Durham.

APPENDIX 2
CONTEXT LIST

CONTEXT	AREA	DESCRIPTION
001	1	Initial machine clearance
002	1	Grey shale deposits in possible gulley
003	1	Mixed red shale deposits and clay 'tip'
004	1	Yellow deposit/dump of clay
005	1	Mixed deposit of silted clay and burnt shale
006	1	Buff-red burnt shale deposit
007	1	Buff-red burnt shale deposit with clay inclusions
008	1	Grey shale/clay deposit
009	1	Bank material – circular feature
010	1	Similar to 1 in centre of circular feature
011	1	Cut for gunpowder emplacement?
012	2	Possible silt trap
013	2	Silt deposit
014	2	Machine clearance surface
015	2	Silt trap? Patch of yellow sand stone
016	3	Grey silt in gully
017	3	Yellow shale
018	2	Void with timber lining
019	2	Void with timber lining
020	3	Grey dump
021	3	Timber lined void
022	3	Bands of red and grey shale below 1
023	3	Grey shale and clay
024	3	Lose grey material around stone
025	3	As 003
026	3	As 004
027	3	As 005
028	3	Grey shale
029	3	Grey shale
030	3	Dump
031	3	Dump
032	2	Timber planking
033	2	Timber pipe in wall
034	2	Puddled clay core

CONTEXT AREA DESCRIPTION

035	2	Stone wall/north wall of trough
036	2	Deposit of water borne grey clay
037	2	Pipe trench
038	2	Settling pit wall
039	2	Timber post hole? (pipe)
040	2	Timber on wall 38
041	2	Timber pipe?/post hole?
042	2	Timber pipe?/post hole?
043	2	Timber pipe?/post hole?
044	2	Timber pipe?/post hole?
045	2	Wall South of trough
046	2	As 34
047	2	Timber pipe/overlying 45/46
048	2	Timber pipe/plank
049	2	Slumped stone/possibly end of trough
050	2	Pipe in south facing section
051	2	Pipe/timber
052	2	Wall
053	2	Timber planking on 52
054	2	Pipe/plank
055	2	Pipe close
056	2	Isolated pipe/post
057	2	Very firm clayey shale
058	-	Void
059	-	Void
060	-	Void
061	3	Grey shale
062	3	Grey shale
063	3	Pale brown shale
064	3	Grey shale
065	3	Stone wall on north side of trough
066	3	Stone tumble from 65
067	3	Yellow clay
068	3	Section 2
069	3	Section 2
070	3	Section 2
071	3	Section 2

CONTEXT	AREA	DESCRIPTION
072	3	Section 2

073	3	Section 2
074	3	Section 2
075	3	Section 2
076	3	Section 2
077	3	Section 2
078	3	Section 2
079	3	Dark brownish-yellow clay
080	3	Clay lensing
081	2	Waste shale deposit (section 4)
082	2	Coarse waste shale deposit (section 4)
083	2	Silty clay shale deposit (section 4)
084	2	Burnt shale waste deposit (section 4)
085	2	Clay/shale deposit (section 4)
086	2	Silty/shale deposit (section 4)
087	2	Silty/shale deposit (section 4)
088	2	North wall of steeping pit, south of trough
089	2	East wall of steeping pit, south of trough
090	2	Yellow clay deposit packing 89
091	2	Projecting timber in face of 88
092	2	Timber drainage channel along side 56
093	2	Indeterminate timber structure adjacent to 52
094	2	Indeterminate timber structure adjacent to 52
095	2	Small posthole/stake hole in base of settling pit
096	2	Timber lined channel running along bas of the trough
097	2	Timber pipe running into 98 then into 96
098	2	Timber channel running from 97 to 96
099	2	Timber (?) pipe running into 96
100	2	Timber walkway over trough at northern end of settling pit
101	2	Remains of timber post against wall (north) of settling pit
102	2	Steeping pit 2, west end of site
103	2	Trough running east-west between steeping pits 1 and 2
104	2	Steeping pit 1, west end of site
105	2	Wooden floor of steeping pit 2
106	2	Stone floor of steeping pit 1
107	2	Fill of 104, pink and grey shale
108	2	Fill of 104, dark grey silty shale

CONTEXT	AREA	DESCRIPTION
109	2	Fill of 104, grey clay deposit
110	2	Fill of 104, red shale

111	2	Fill of 104, grey and yellow shale
112	2	Fill of 104, red laminated shale
113	2	Fill of 104, Pink shale
114	2	Fill of 104, grey silty shale
115	2	Fill of 104, grey and green shale
116	2	Fill of 104, grey clay laminated deposit
117	2	Fill of 104, grey shale laminated deposit
118	2	Fill of 102, pink shale (same as 113)
119	2	Fill of 102, red shale (same as 110)
120	2	Fill of 102, pink and grey shale (same as 107)
121	2	Fill of 102, pink shale
122	2	Fill of 102, yellow, gold and rust shale
123	2	Fill of 102, yellow and grey shale
124	2	Fill of 102, grey shale crust
125	2	Fill of 104, grey and yellow shale
126	2	Fill of 104, yellow, gold and rust shale
127	2	Fill of trough – light grey shale
128	2	Fill of trough – buff shale
129	2	Fill of trough – yellow/brown shale
130	2	Timber lined channel on north side of settling pit
131	1	Bridge at east end of excavation
132	2	Stone floor of the trough (103)
133	2	Buff and grey clay underlying stone floor of trough
134	2	Timber plank to north fo pit 3
135	2	Third stone steeping pit
136	2	Timber cut along west side of pit 3
137	2	Forth stone steeping pit
138	2	Clay underlying wooden floor of pit 2
139	2	Fifth stone steeping pit
140	2	West wall of steeping pit 5 (139)
141	2	South wall of steeping pit 5 (139)
142	2	Fill of steeping pit 5 (139)
143	2	Paved stone floor of steeping pit 5 (139)
144	2	North wall of steeping pit 3 (135)
145	2	East wall of steeping pit 3 (135)

CONTEXT	AREA	DESCRIPTION
146	2	South wall of steeping pit 3 (135)
147	2	West wall of steeping pit 3 (135)
148	2	Timber planks overlying 136

149	2	Fill of 135
150	2	Paved stone floor of 135
151	2	Plug in east wall of 135
152	2	Timber pipe draining pits1, 3 and 5
153	2	Timber pipe linking 99 and 152
154	2	West wall of steeping pit 1 (104)
155	2	North wall of steeping pit 1 (104)
156	2	West wall of steeping pit 4 (137)
157	2	North wall of steeping pit 4 (137)
158	2	East wall of steeping pit 4 (137)
159	2	Stone paved floor of steeping pit 4 (137)
160	2	Fill of steeping pit 4 (137)
161	2	Line of rough sandstone blocks over 146 and 157
162	2	Bedded shale
163	2	South wall of steeping pit 2 (102)
164	2	Timber planks over 163
165	2	Timber joist under 164
166	2	Timber pipe
167	2	Structure on south side of 166
168	2	Structure? South of south west corner of 102
169	2	Timber pipe south west of 168
170	2	Steeping pit 6
171	2	North wall of steeping pit 6
172	2	South wall of steeping pit 6
173	2	Fill of steeping pit 6
174	2	Timber floor of steeping pit 6
175	4	Erosion feature
176	3	Eastern section of trough
177	3	South trough wall
178	3	Fill of 176
179	3	Timber pipe
180	1	Puddled clay at base of trough near 131
181	3	Circular feature south of cistern 1 (183)
182	3	‘Channel’ connecting 181 and 183

CONTEXT	AREA	DESCRIPTION
183	3	Cistern 1
184	3	Uppermost fill of 183
185	3	Timber below 184
186	3	Pink clay beneath 185

187	3	Stone floor of 183
188	3	Grey/green shale north of 183
189	2	Inner south wall of steeping pit 1 (104)
190	2	Group context for fill of 104
191	2	Group context for all puddled clay deposits in area 2
192	2	Group context for all timber planks and joists in area 2
193	2	Calcinated shale to north of area 2
194	2	Calcinated shale to south of area 2
195	2	Group context for fill of pit 2 (102)
196	All	Group context for all post-abandonment deposited clay
197	3	Group context for fill of cistern 1 (183)
198	3	Group context for puddled clay deposits in area 3
199	3	Fill of 181

ILLUSTRATIONS

Fig 1 : Location Map

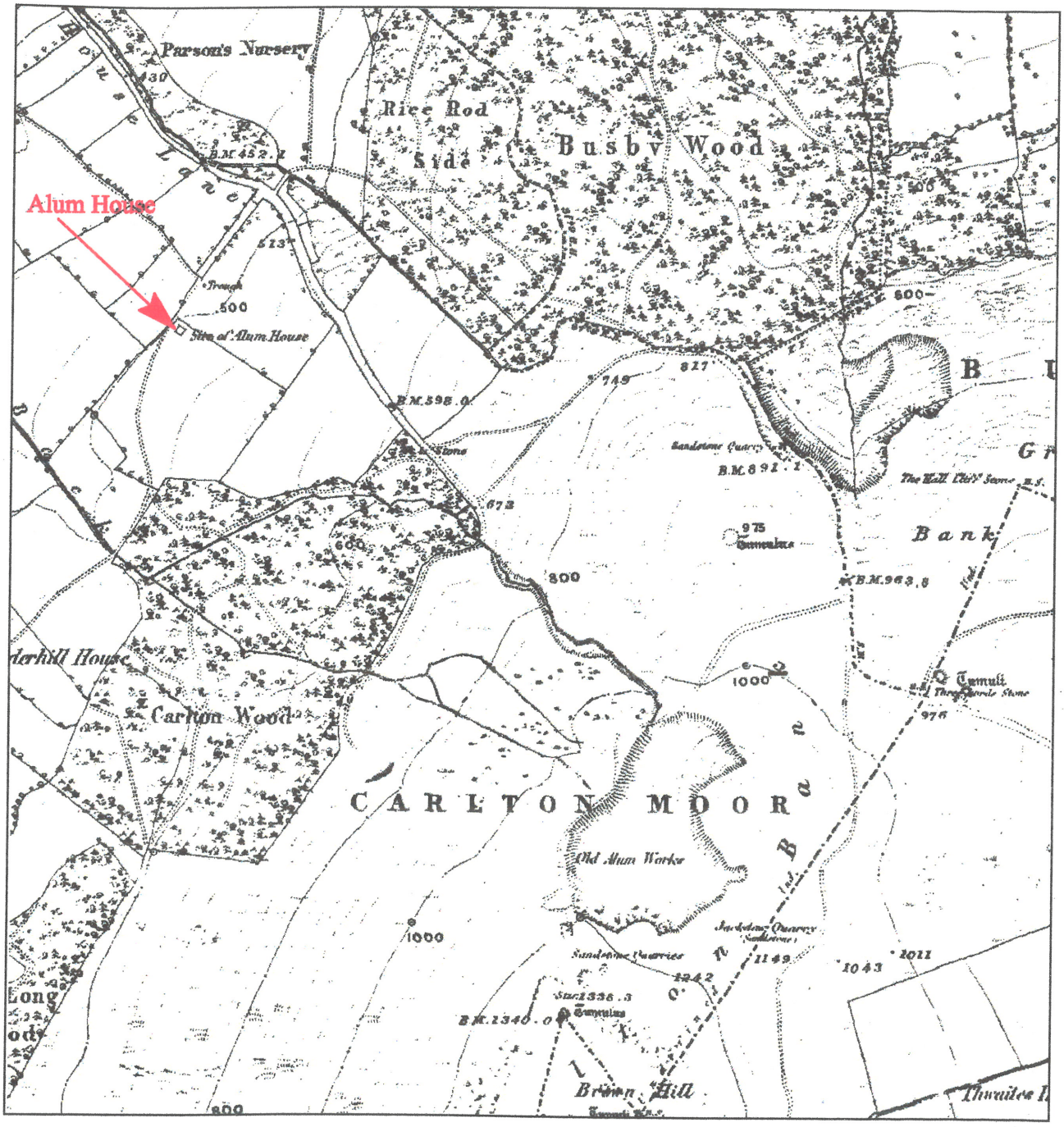

Fig 2 OS 1st edition map (1857)

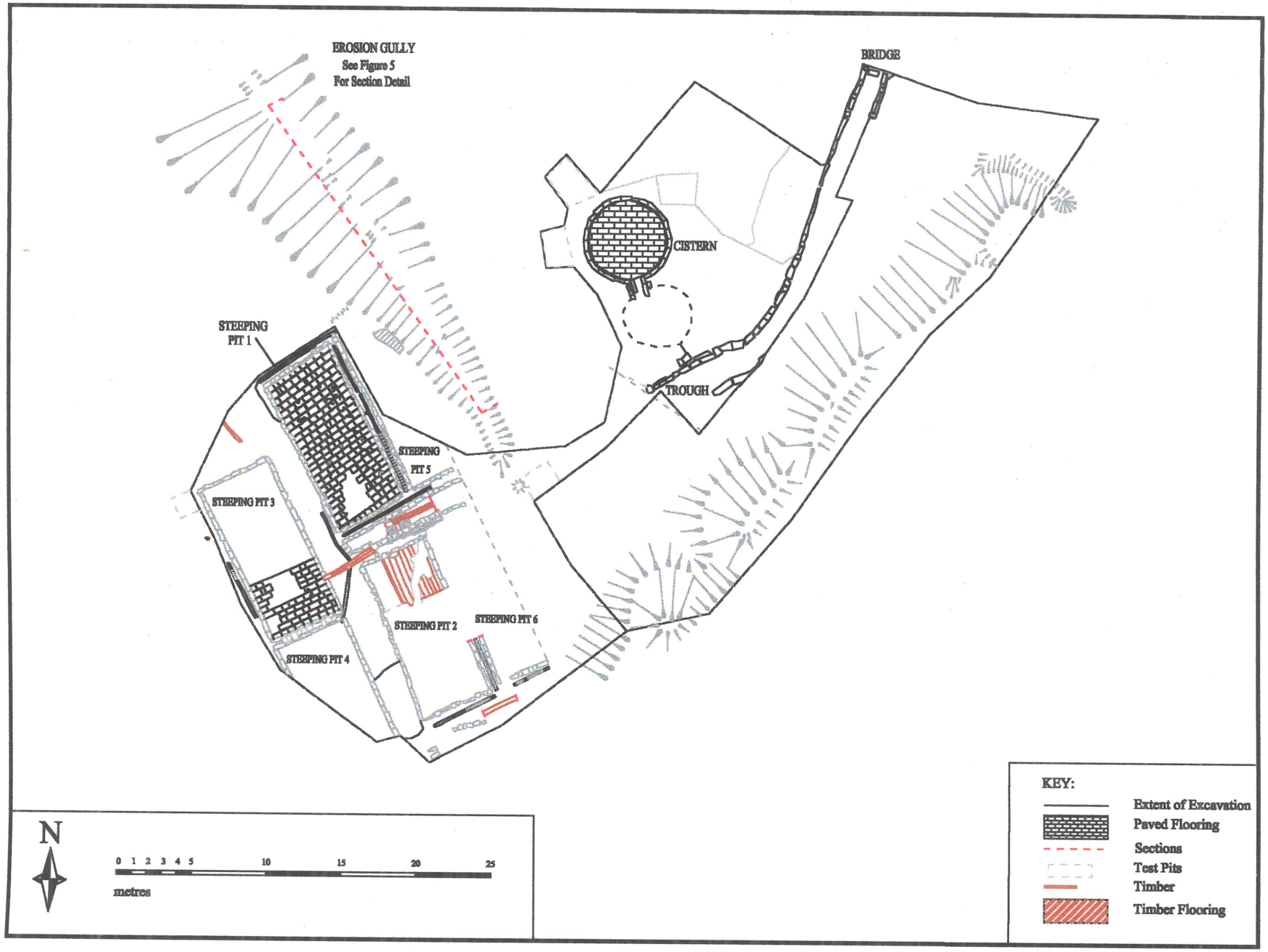

Fig 3 Carlton Bank: area of excavation

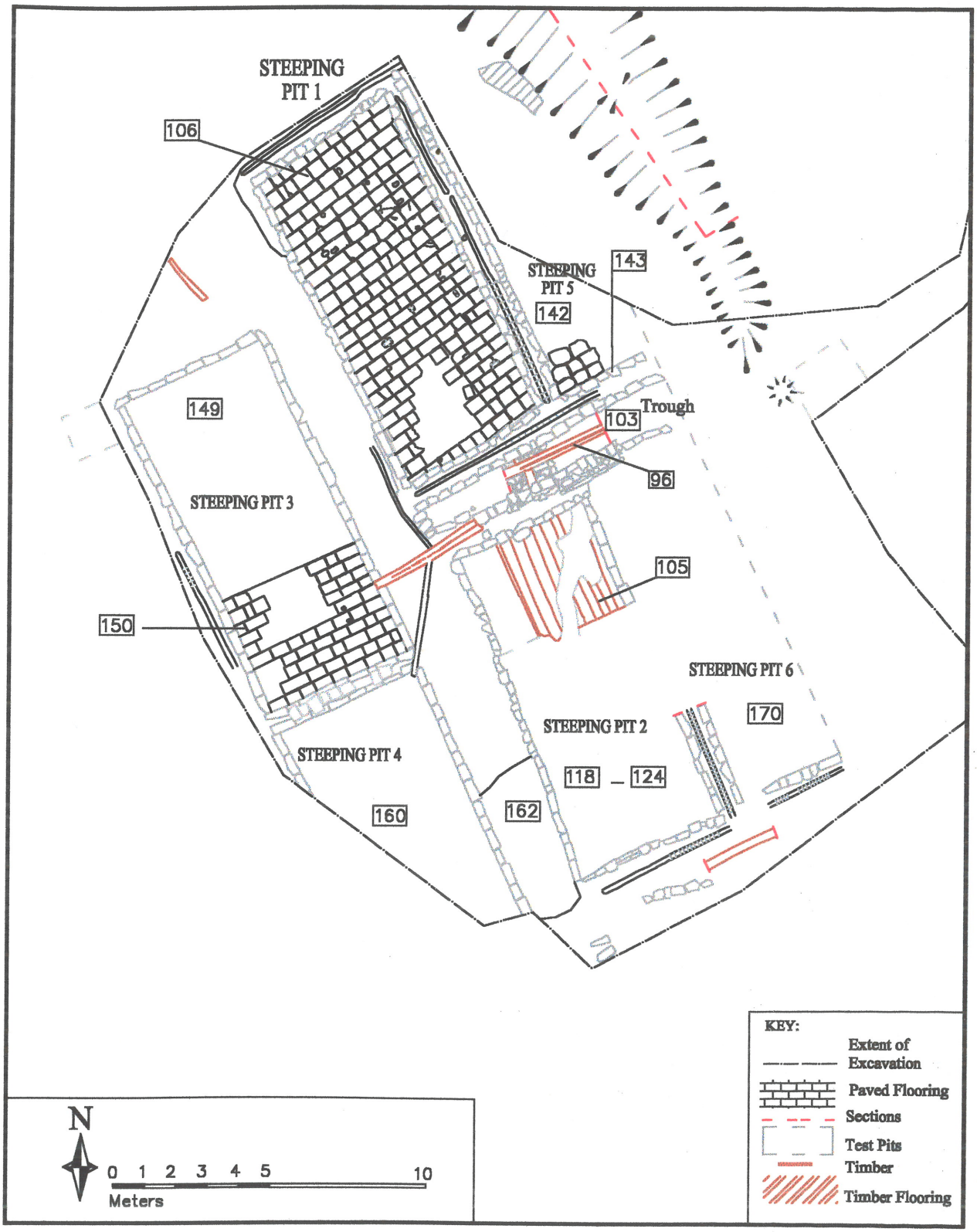

Fig 4 Carlton Bank: detail of steeping pits

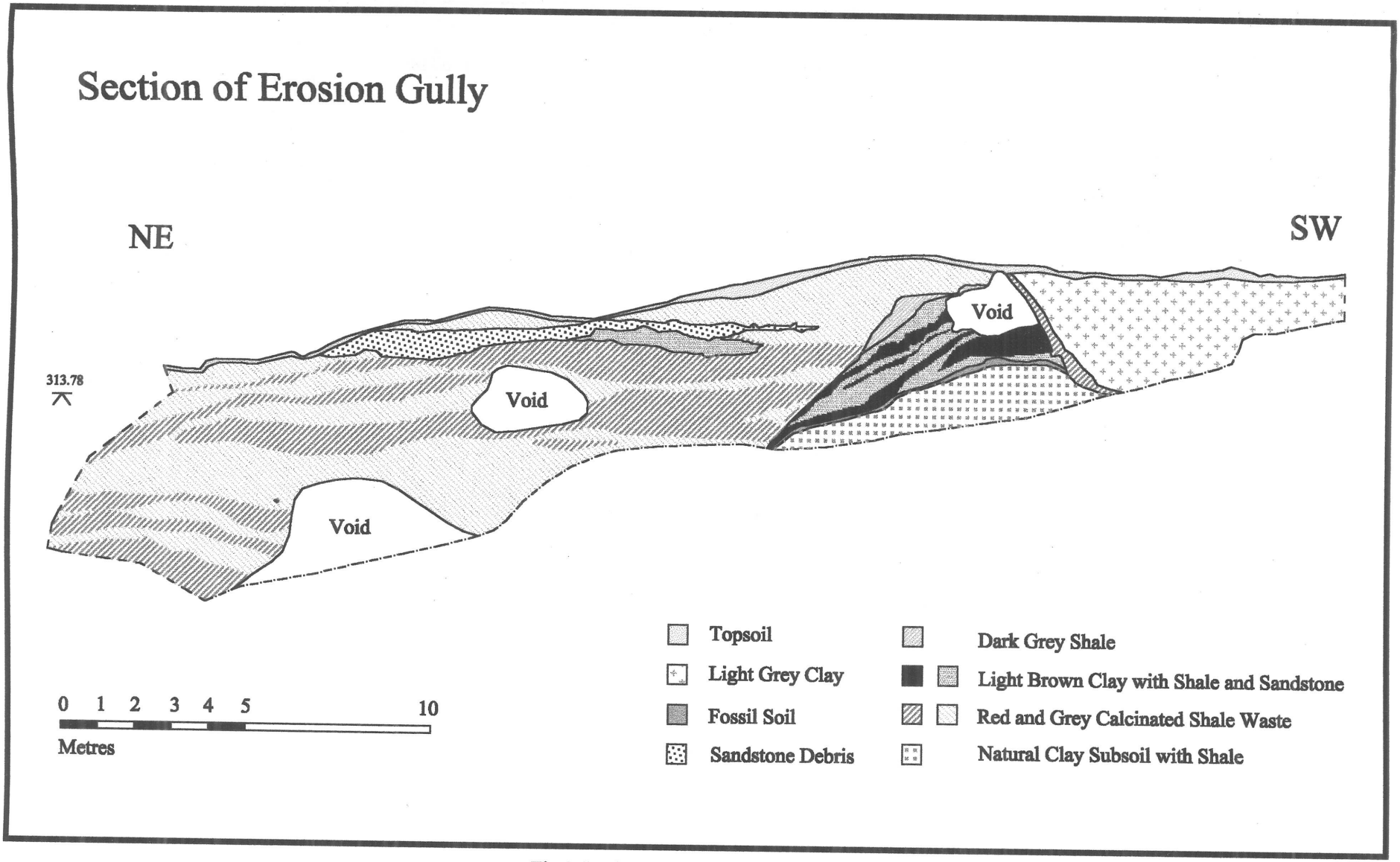

Fig 5 Section through erosion gully

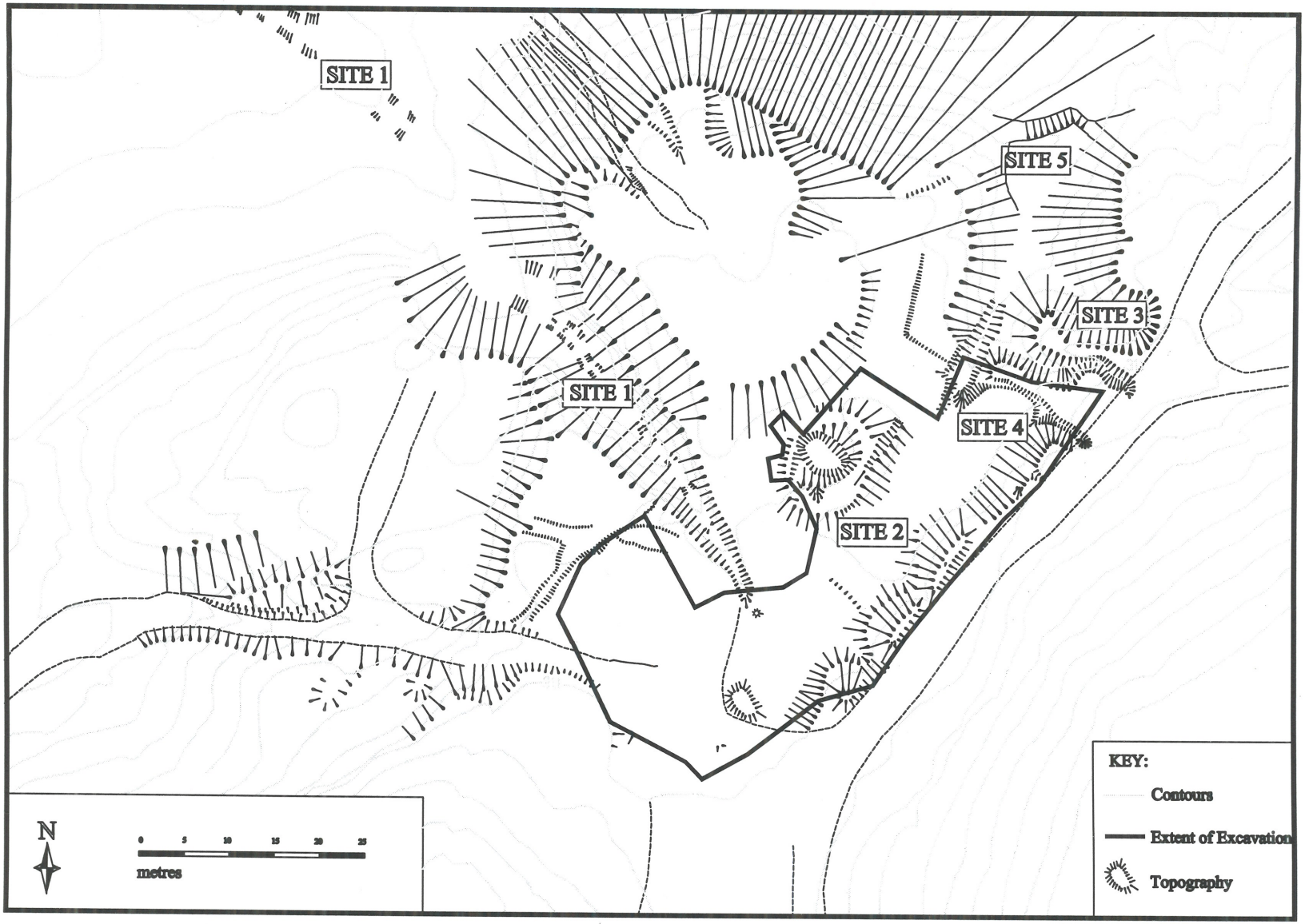

Fig 6 Contour and hachure survey (see LUAU 1997a for details)

PLATES

Plate 1 Landscaping of spoil heap

Plate 2 Scarp slope looking east

Plate 3 Erosion gully

Plate 4 Machine stripping of site

Plate 5 Liquor trough 103 between steeping pits

Plate 6 East end of liquor trough 103

Plate 7 The Bridge

Plate 8 Northern steeping pits during excavation

Plate 9 Steeping pit drain showing stone plug

Plate 10 Southern steeping pits during excavation

Plate 11 Channel into Steeping Pit 3

Plate 12 Cistern during excavation

Plate 13 Section across south edge of cistern wall, showing wall 182

Plate 14 Shale fill within Steeping Pit 1

Plate 15 Remains of vertical timbers with Steeping Pit 1

Plate 16 Fill of Steeping Pit 3