

LIME KILNS, FELL END,
RAVENSTONEDALE, CUMBRIA

MONUMENTS AT RISK SURVEY



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EXECUTIVE SUMMARY

In February 2018, Ed Dennison Archaeological Services Ltd (EDAS) were commissioned by Mr Miles Johnson, Senior Historic Environment Officer of the Yorkshire Dales National Park Authority (YDNPA) to undertake an archaeological survey of two lime kilns at Fell End, near Studfold Farm between Sedbergh and Kirkby Stephen, in Cumbria (NGRs SD 73170 99927 and SD 73186 99869). The kilns are set on the eastern slope of the valley below Fell End Clouds, at an elevation of c.317m AOD. The kilns are in moderate to poor structural condition and are currently deemed to be 'at risk', and the work was required to provide a pre-intervention level of survey prior to undertaking repair and/or a management scheme. The work involved the collation of a small amount of existing documentary material, coupled with a detailed drawn and photographic survey. A specification for consolidation has also been produced as a separate document. The project was funded by YDNPA, as part of the Yorkshire Dales Industrial Monuments Management Scheme (YDIMMS).

The kilns fall on the cusp of the two previous major studies of surviving lime kilns in the region (within the Central Pennines, and Westmorland and Cumberland), and conform to many of the typical patterns noted within these study areas. They are sited in an area where limestone is the prominent surface geology - there is no clearly associated quarry, and so limestone was probably obtained from surface crags and nearby outcropping.

Both kilns have a draw arch which faces north-west, and one makes use of firebricks in the draw eye, manufactured at a colliery brickworks in County Durham; the same colliery may also have provided the fuel to fire the kilns. The bowl of one kiln is of markedly larger volume than the other, and the kiln structure incorporates two external passages or vents connected to the bowl which were designed to increase air flow through it; these are very rare surviving features which have been noted at only one other field kiln in the region. The smaller kiln was probably built in the late 18th or early 19th century, and was probably used to provide lime to improve land in the valley bottom which had been enclosed at an earlier date. The larger more sophisticated kiln may be slightly later in date although its purpose remains less certain - it may have been built to supplement or replace the smaller kiln and/or have been used to supply the local estate or provide lime for sale on a commercial basis.

1 INTRODUCTION

Reasons and Circumstances of the Project

- 1.1 In February 2018, Ed Dennison Archaeological Services Ltd (EDAS) were commissioned by Mr Miles Johnson, Senior Historic Environment Officer of the Yorkshire Dales National Park Authority (YDNPA), to undertake an archaeological survey of two lime kilns at Fell End near Studfold Farm, between Sedbergh and Kirkby Stephen, in Cumbria (NGRs SD 73170 99927 and SD 73186 99869). The kilns are in moderate to poor structural condition and are currently deemed to be 'at risk' by the YDNPA, and the work is required to provide a pre-intervention level of survey prior to undertaking repair and/or management schemes.
- 1.2 The work involved the collation of a small amount of existing documentary material, coupled with detailed drawn and photographic survey. The results were used to prepare an appropriate report and a separate specification for repair and consolidation. The extent of the project was defined by discussions between the YDNPA and EDAS. The project was funded by YDNPA, as part of the Yorkshire Dales Industrial Monuments Management Scheme (YDIMMS), an Historic England funded programme designed to help conserve some of the most significant industrial heritage of the National Park.

Site Location and Summary Description

- 1.3 The Fell End lime kilns are situated some 70m to the east of the unclassified Fell End Lane, which runs broadly parallel to the A683 Sedbergh to Kirkby Stephen road at this point (see figures 1 and 2). The kilns are set on the eastern slope of the valley, below Fell End Clouds, at an elevation of c.317m AOD and in good weather are clearly visible from the main A683 road, particularly when travelling in the direction of Kirkby Stephen (see plate 1). The nearest farms are Studfold, 330m to the north-west, and Cold Keld, 345m to the south-west, although the kilns themselves lie within open access land, defined by the Countryside and Rights of Way (CROW) Act 2000. Both kilns are marked on the 1862 Ordnance Survey 6" to 1 mile map (sheet 36) and appear to have been in use at that date (see figure 3).
- 1.4 The two Fell End lime kilns are not designated as Listed Buildings of Special Architectural or Historic Interest, and they are not Scheduled Monuments or otherwise protected. However, they fall within the Yorkshire Dales National Park and are listed on their Historic Environment Record (MYD 633307 and 63308). They are also listed on Historic England's Pastscape website (monuments 966306 and 966307) (www.pastscape.org.uk). The kilns fall within the eastern limit of an extensive survey of surviving lime kilns undertaken in Westmorland and Cumberland by Dr David Johnson (Johnson 2013); David Johnson very kindly made his original notes available and answered a number of queries.

Aims and Objectives of the Project

- 1.5 The aims and objectives of the project were:
 - to produce a detailed measured archaeological survey of the two kilns, to inform the production of a specification for detailed consolidation.

Survey Methodologies

- 1.6 The archaeological recording equates to a Level 3 analytical survey, as defined by Historic England (Historic England 2016, 26). Three elements of work were involved. The field element of the project was undertaken on 22nd June 2018.

Collation of Documentary Material

- 1.7 The YDNPA did not require any new documentary research to be undertaken, although existing readily-available material held by the YDNPA HER was provided, and this was incorporated into the project. Relevant secondary sources on lime kilns within the Yorkshire Dales and adjoining areas, such as those written by David Johnson (2010 & 2013), were also consulted.

Archaeological Building Survey

- 1.8 A 1:50 scale plan of each lime kiln (including the loading ramp areas) was produced using traditional hand-measurement techniques; Shaun Richardson of EDAS was aided by volunteer Steve Douglas in undertaking the survey. The plans show the lower and upper levels of each kiln, one superimposed on the other - some measurements for the upper levels of each kiln had to be estimated, as parts were too structurally unsound to safely access. The resulting plans include details of the interior of the draw arches, and also record features such as sockets, recesses, evidence for repair or rebuilding etc. The plans were not tied into the Ordnance Survey grid nor were they levelled into an Ordnance Survey datum. Sufficient notes were also taken in the field to produce a detailed written description of each kiln.
- 1.9 All drawings were produced according to the guidelines established by Historic England (2016). The final product arising from the survey was two hand-drawn wet ink plans. Smaller scale plans were used to put the survey area into context.

Photographic Survey

- 1.10 A detailed photographic record was made of both kilns. External and internal elevations of the structural elements were taken both parallel to the elevation (within the constraints of the site) as well as from other vantage points to include oblique general views of the structures and showing them in their settings. Close-up photographs were also taken of significant detail, as appropriate. These photographs were suitable to show not only the structures' present appearance but also for use in drawing up the specification for conservation works. Other photographs were taken to illustrate specific well-preserved site elements, details of specific areas of erosion or decay etc, as well as their general landscape context.
- 1.11 The colour photographs were produced using a digital camera with 12 mega-pixel resolution. Historic England photographic guidelines were followed (Historic England 2016, 19-21) and each photograph was provided with a scale (subject to access). All photographs were clearly numbered and labelled with the subject, orientation, date taken and photographer's name, and have been cross-referenced to digital files etc in a photographic catalogue.

Survey Products

Archaeological Survey Report

- 1.12 A single EDAS archive archaeological survey report for the kilns was produced, based on the results of the documentary research and field survey. The report is a standard A4 typed and bound document, which assembles and summarises the available evidence for the kilns in an ordered form, synthesises the data, comments on the quality and reliability of the evidence, and how it might need to be supplemented by further site work or desk-based research. One draft copy of the report was made available for discussion with the YDNPA on completion.

Specification for Repair and Consolidation

- 1.13 Using the results of the above survey report, a single stand-alone specification for the consolidation and/or repair of the two lime kilns was produced.
- 1.14 This specification identifies all work necessary to protect, secure and consolidate the structures to withstand natural erosion and a low level of agricultural grazing and visitor activity. The concept of 'consolidate as found' was followed wherever possible, rather than restoration and rebuilding. However, it was accepted that some limited rebuilding might be required to secure the structural integrity of the structures and if so, appropriate justification was made. It was anticipated that the proposed works, unless specified otherwise, would require the use of traditional methods of building, using traditional materials, and would be reversible. No demolition was required. In general, and where appropriate, the specification provided for the protection of the structures, rubble clearance, repointing and rough racking, replacement, resetting and/or rebuilding, the treatment of any exposed metal work and timber, vegetation management, the removal of modern spoil and rubbish dumps, and site reinstatement.
- 1.15 The consolidation specification was produced as a separate document, which will be used by the YDNPA to commission repairs at some point in the future.

Archaeological Survey Archive

- 1.16 An archive of material, comprising paper, magnetic and plastic media, relating to the project has been ordered and indexed according to the standards set by Historic England. This was deposited with the YDNPA HER at the end of the project (EDAS site code FEK 18).

2 SURVEY DESCRIPTIONS

Introduction

- 2.1 The two kilns are described below in a logical manner, starting with location and setting, plan form, elevations and any surviving internal detailing. For the purposes of description only, the northern of the pair is referred to as Kiln 1, and the southern as Kiln 2 (see figure 2). Both kilns are set on north-west/south-east alignments but, again for the purposes of description, they are assumed to be aligned east-west.
- 2.2 Throughout the text, the digital photographs are referenced using square brackets and italic type, the number before the stroke representing the film number and the number after indicating the image e.g. [2/1]. Appendix 1 provides a catalogue of all

the photographs taken during the project, and a selection have been used to illustrate this report. Finally, in the following text, 'modern' is taken to mean dating to after c.1945.

General Historical Background

- 2.3 The manor of Ravenstonedale was granted by Torphin to the Gilbertine Priory of Watton (East Yorkshire) in the 12th century. At the Dissolution, it was bought by Sir Thomas Wharton, and descended with the Wharton family until, following the death of the Duke of Wharton in 1728, the manor was sold to Robert Lowther of Maulds Meaburn, from whom it descended to the Earls of Lonsdale (<https://www.cumbriacountyhistory.org.uk/township/ravenstonedale>).
- 2.4 The parish of Ravenstonedale is relatively small, covering 16,406 acres, with more than half lying over 1,000 feet above sea level. At the beginning of the 19th century, descriptions of the nearby parishes of Asby, Crosby Ravensworth, Orton and Kirkby Stephen stress that agricultural prices were rising, land was being enclosed, pared and burnt, and crops were being sown. Although most of the land was still pasture or meadow, a considerable amount was arable. Oats were the main crop, but potatoes, wheat, turnips, rape, barley, rye and peas and beans were becoming common. However, by contrast, Ravenstonedale was described as having mainly small farms, engaged in dairying and stock raising (Duxbury 1994, 202-203).
- 2.5 Almost half a century later, in 1851, there were 117 farms in Ravenstonedale, with an average size of just over 50 acres; only ten farms were over 100 acres. In neighbouring parishes, the average farm size was over 50 acres and there were a number of farms of 500 acres and more (Duxbury 1985, 224). Duxbury (1994, 211) states that there were no enclosures in the parish since an 'improvement' of 1579. An Enclosure Bill was proposed by Lord Lowther in the later 18th century, but it was successfully killed off by a counter-petition to Parliament in 1767, signed by every one of the 101 landowners in the parish apart from Lord Lowther himself (Searle 1995, 259-260). Although during the 19th century the economy of the area was predominantly agricultural, quarrying and lime burning were also undertaken, with some limited lead mining at Fell End Clouds (<https://www.cumbriacountyhistory.org.uk/township/ravenstonedale>).

The Northern Kiln (Kiln 1) (YDNPA HER MYD 63308)

Historical Background

- 2.6 A private letter of January 1997 suggests that the kiln was built in about 1850, although no further information is provided (www.pastscape.org.uk). The kiln is marked on the Ordnance Survey 1862 6" to 1 mile map as a 'Limekiln', then falling within the parish and township of Ravenstonedale (see figure 3 top). It is located in an area of unenclosed land off Fell End Lane, opposite the east end of an enclosed trackway which leads from Fell End Lane directly to the A683 Sedburgh to Kirkby Stephen road and Studfold Farm to the west. A trackway ran to the base of the kiln from Fell End Lane, but none is shown leading to the upper part, nor are there any quarries depicted which are obviously linked with the kiln; there is a 'Quarry' to the east, but this is c.135m from the kiln. A curving retaining wall runs south-east for a short distance from the south side of the kiln.
- 2.7 The kiln is similarly depicted on the more detailed Ordnance Survey 1898 edition; by this date, the retaining wall is angled rather than curving and it may have been

extended slightly further to the south-east (see figure 3 bottom). The late Helga Frankland of Needle House in Uldale was certain that the kiln was fired up by her grandfather (believed to be a Professor of Chemistry) between 1910 and 1912 to make lime to apply on their land (David Johnson, *pers. comm.*). There had been little change by 1914 in terms of map depiction, and the kiln continued to be marked on maps until at least 1954. It was previously examined and described by David Johnson as part of his survey of lime kilns in Westmorland (Ravenstonedale 21).

Survey Description (see figure 4)

- 2.8 The kiln is placed c.50m to the south-east of Fell End Lane, at an elevation of c.315m AOD. It is terraced into the natural slope of the hillside, hard against a drystone wall field boundary. This drystone wall, in its existing form, is later than the kiln; to the east, it curves onto the upper part of the kiln before terminating, whereas to the west, it butts the kiln. A number of trackways, clearly of several different phases, leave Fell End Lane to ascend the valley side, and that shown in 1862, running to the base of the kiln, remains visible [1/107]. As previously noted, there is no obvious large quarry associated with the kiln, although the volume of outcropping limestone in the Fell End Clouds area may have made such a feature un-necessary, and there appear to be numerous small workings in the area to the east and south-east.
- 2.9 All three external elevations of the kiln are built of roughly coursed and squared limestone, largely laid without mortar, and with large limestone quoins to the north-west and south-east corners (see plate 1). All three elevations have a pronounced batter from base to top - the north and south elevations slope inwards by a maximum of 0.40m, whereas the west elevation slopes inwards by a maximum of 0.75m. Rather than being the result of collapse or slumping, the batter is a specific design feature intended to provide greater structural stability.
- 2.10 The north elevation of the kiln is difficult to view clearly as it faces into the enclosed field to the north, to which there was no access, and because it was partly obscured by nettles at the time of the survey [1/154]. The south elevation stands up to c.2.6m high at the west end. There are a number of holes in the elevation where stones have fallen out or been removed, but otherwise the elevation appears to stand to close to its original height [1/148-1/150] (see plate 2).
- 2.11 The west elevation forms the main elevation of the kiln, the kiln itself facing to the north-west (see plate 1). The elevation is 4.50m wide across the base, tapering to 3.45m across the top. The draw arch itself is 1.60m wide and is placed slightly to the north of centre, standing to a maximum of c.1.30m high. It has a broad, segmental head of thin, mortared limestone rubble voussoirs [1/101, 1/151-1/153] (see plate 3). Internally, the draw arch of the kiln is 1.60m wide by 2.95m deep; the roof over is of sandstone, with limestone to the side walls. At the time of the survey, the interior was partly filled with soil and rubble, and so it was not possible to tell if it was provided with a floor surface, such as, for example, flagstones. There is a single, low, flat-headed draw opening in the east wall, 0.5m wide. The jambs of the draw opening are formed by large limestone blocks, but the deteriorating head is built from firebricks [1/105, 1/106] (see plate 4). There is no visible evidence in the draw opening for a grate, iron bars or any similar structural features. Almost immediately above the draw opening, the face of the east wall is corbelled out markedly; it appears to contain a small, single poking hole above the draw hole.

- 2.12 The firebricks of the draw opening appear to be neatly handmade, with a yellowish fabric, and average dimensions of 225mm by 110mm by 60mm. Some *ex situ* examples bear the impressed mark 'F & L' [1/156, 1/157] (see plate 5). This denotes Ferens and Love, the company which owned Cornsay Colliery in County Durham. The company was formed in 1857 when Robin Ferens married Sarah Love, and they acquired a number of collieries. Probably principal amongst these was Cornsay, which was sunk in 1863 and opened in 1868, and worked until the 1950s. As well as producing coal, a superb fireclay was mined at the site and a large brick, tile and sanitary pipe works was built adjacent to the colliery, although fireclay production is apparently not listed at the site until 1896 (<http://www.brocross.com/Bricks/Penmorfa/Pages/england8.htm>; <http://www.dmm.org.uk/colliery/c030.htm>; <https://www.thenorthernecho.co.uk/history/15046381.does-anyone-have-any-ferens-love-bricks-readers-respond/>). Given that the kiln was already present by 1862, before the colliery was sunk or indeed producing fireclay, the bricks lining the draw opening must represent a later rebuilding or alteration; it is possible that they date from the 1910-12 usage by Helga Frankland's grandfather, as the kiln would probably have required considerable work to get it back into working order (David Johnson, *pers. comm.*).
- 2.13 The upper level of the kiln was accessed via the charging ramp to the east. The earth ramp approaches the kiln from the south-east for some 11m, and then angles sharply to the north-west [1/097] (see plate 6). The southern approach of the ramp is supported on a collapsing limestone rubble retaining wall, standing up to 1.0m in height (see plate 9); the ramp is shown in 1862, and was possibly extended between 1862 and 1898 - it clearly butts the main body of the kiln itself. There are also the remains of a former fence line crossing the charging ramp, presumably to prevent stock falling into the bowl.
- 2.14 Below and to the south-west of the charging ramp retaining wall, there is a sub-rectangular depression, possibly a platform, slightly terraced into the natural slope here although it still has a prominent fall from east to west; it measures c.8.0m by 5.0m [1/099] (see plate 7). It has been suggested that this, and 'a pair of hollows' perhaps mark the position of former kilns robbed to make the extant ones (www.pastscape.org.uk). This seems unlikely in the case of the platform, which appears too regular to be a quarry and so might mark the position of a short-lived structure or storage area associated with the kiln. Some kilns were provided with an adjacent lime shed (usually a drystone structure formerly equipped with a single pitch roof) in which to store quicklime (Johnson 2010, 259), although no such feature is shown on any historic maps at Fell End.
- 2.15 The mouth of the kiln bowl remains visible, although the majority has been backfilled with soil and some debris including barbed wire. The bowl is slightly oval in plan, measuring c.2.20m across. The bowl lining is of sandstone rubble, which displays some evidence for burning [1/098] (see plate 8). In October 2005, it was noted by David Johnson that there was a 0.30m wide ledge running around the interior of the bowl, set 1.10m below the top (David Johnson, field notes), but this was not visible at the time of the current survey.

The Southern Kiln (Kiln 2) (YDNPA HER MYD 63307)

Historical Background

- 2.16 As with the northern kiln, a private letter of January 1997 suggests that the kiln was built in about 1850, although no further information is provided

(www.pastscape.org.uk). The kiln is marked on the Ordnance Survey 1862 6" to 1 mile map as a 'Limekiln', then falling within the township of Ravenstonedale and placed c.55m south-east of Kiln 1 (see figure 3 top). It is located in an area of unenclosed land off Fell End Lane, opposite the east end of an enclosed trackway which leads from Fell End Lane directly to the A683 Sedbergh to Kirkby Stephen road and Studfold Farm to the west. A trackway, branching off another running south-west from Fell End Lane, ran close to the base of the kiln, although its main destination was an area of isolated enclosures just below Fell End Clouds. No trackway is shown leading to the upper part of the kiln; a small quarry is marked c.117m to the east, but the two are not obviously associated.

- 2.17 The kiln is similarly depicted on the more detailed Ordnance Survey 1898 edition, when the walls of the kiln are shown extending back some distance from the mouth of the bowl (see figure 3 bottom). Furthermore, a short branch or spur runs from the adjacent trackway to the north-east to the base of the kiln itself. There had been little change by 1914, although a small area of quarrying may be indicated to the immediate north-east of the kiln itself. The lime kiln continued to be marked on maps as late as 1954, with the quarry to the east named as 'Old Quarry'. The kiln was previously examined and described by David Johnson as part of his survey of lime kilns in Westmorland (Ravenstonedale 22).

Survey Description (see figure 4)

- 2.18 The southern kiln is located c.55m to the south-east of the northern kiln, and some 90m south-east of Fell End Lane, at an elevation of c.320m AOD. It is terraced into the natural slope of the hillside [1/155, 1/158, 1/159] (see plate 9). A number of trackways, clearly of several different phases, leave Fell End Lane to ascend the valley side; that shown in 1862, running to the north-west of the base of the kiln, remains visible [1/145-1/147]. The quarry shown to the east in 1862 is not a prominent feature, and there is no obvious large quarry associated with the kiln, although the volume of outcropping limestone in the Fell End Clouds area may have made such a feature unnecessary (www.pastscape.org.uk); there also appear to be numerous small workings in the area to the east and south-east.
- 2.19 All three external elevations of the kiln are built of roughly coursed and squared limestone, largely laid without mortar, and with large limestone quoins to the north-west and south-east corners. All three elevations have a pronounced batter from base to top - the north and south elevations slope inwards by a maximum of 0.50m, whereas as the west elevation slopes inwards by a maximum of 0.60m. As with Kiln 1, the batter is a specific design feature to provide greater structural stability.
- 2.20 The north elevation of the kiln stands up to c.3m high at the west end [1/108] (see plate 10). There are a number of holes in the elevation where stones have fallen out, and some of the upper parts are missing. However, approximately half way along its length, there is an opening, 0.30m square with a stone lintel, set towards the base of the elevation [1/109]. This opening leads into a narrow level passage or flue with a flagstone roof, which extends for a distance of 2.80m through the body of the kiln [1/143], angling to the west at its southern end to emerge as a narrow slit-like feature in the east side of the kiln's bowl (see below) (see plate 11). This passage must be original, as it would have been impossible to insert it into the kiln's structure at a later date. The south elevation of the kiln stands up to c.3m high at the west end [1/132-1/135] (see plate 12). It too has, approximately half way along its length, an opening, 0.25m square with a stone lintel, set towards the base of the elevation [1/136]. This opening leads into a narrow, level, slightly

curvilinear passage or flue with a flagstone roof, which extends c.3.40m through the body of the kiln, angling to the west at its northern end to emerge in the aforementioned narrow slit-like feature in the east side of the kiln's bowl [1/138]; the precise arrangement as to how the two flues joined could not be seen. Again, this passage must be original.

- 2.21 The west elevation forms the main elevation of the kiln, the kiln itself facing to the north-west. The elevation is 5.20m wide across the base, tapering to 4.30m across the top (see plate 9). The draw arch itself is 2.15m wide, standing to a maximum of c.2.0m high, and appears to have a low opening to the south. It has a broad head of mortared limestone and sandstone rubble voussoirs [1/122, 1/123, 1/139-1/142] (see plate 13), forming rather more like what Johnson (2010, 253; 2013, 206) describes as a Romanesque arch than a segmental arch. Internally, the walls of the draw arch taper inwards, decreasing in width to 1.60m to the point where the interior has collapsed, exposing the bowl; the depth from the west face of the kiln to the collapse is c.2.20m, and the barrel-vault over is of sandstone. There are small recesses 0.40m square by 0.30m deep, with stone lintels to the north and south internal walls of the draw arch [1/124, 1/125]. At the time of the survey, the interior of the draw arch was choked with rubble, and so it was not possible to tell if there was any floor of, for example, flagstones. The base of the west wall of the bowl has largely collapsed, removing any visible evidence for the draw opening, although it was corbelled out above it.
- 2.22 The upper level of the kiln was accessed via the charging ramp to the east, which survives as a slight earthwork running along the northern side of the area between the top of the kiln's walls [1/110-1/115] (see plate 14). The earth ramp approaches the kiln from the east for c.6m, meeting what appears to be the remains of a stone cross-wall, partially visible in plan and as an earthwork [1/116], beyond which lies the mouth of the bowl. The bowl is slightly sub-circular in plan, measuring c.3m across. The majority of the interior remains visible, and is lined with limestone rubble which displays no evidence for burning [1/126-1/129] (see plate 15). Originally, limestone would never have been used as the inner lining, and so it was probably either heat-resistant flagstone or laminated sandstone which has been subsequently stripped out (David Johnson, *pers. comm.*). The narrow, slit-like, feature referred to above, with which the internal passages communicate, is visible in the east side of the bowl [1/130, 1/131], situated approximately half way down its height (see plate 16); unfortunately, it was not possible to access the interior of the bowl to investigate this feature closely.

3 DISCUSSION AND CONCLUSIONS

- 3.1 The two recorded kilns fall on the cusp of the two major studies of surviving lime kilns in the region (within the Central Pennines, and Westmorland and Cumberland), previously undertaken by Johnson (2010 & 2013), and so comparisons with the results of these studies in both areas are relevant. Johnson suggests that the widespread use of agricultural lime in Westmorland and Cumberland appears to have had a later genesis than in the former West Riding of Yorkshire, probably due to the relatively smaller number of landed estates, the lesser proportion of land under monastic control, and the prevalence of small-scale yeoman farmers, coupled with often difficult access to affordable fuel supplies (Johnson 2013, 192-193). Nevertheless, although widespread lime burning may have started earlier in the West Riding, within the Central Pennines as a whole, there was a burgeoning of lime kiln numbers during the 18th century, many of them associated with the period of Parliamentary enclosure (Johnson 2010, 234).

- 3.2 The addition of lime to fields was a means of improving soil quality, and thus agricultural productivity, whatever crop was being grown. It is important to note that lime was not used as a fertiliser *per se*, but rather as a catalyst to render fertilisers that were used to be more effective. For example, in heavy clay soils, lime breaks up the solid clumps and increases oxygen content and soil temperature, which leads to improved drainage, easier ploughing, easier and deeper root penetration, and increases populations of worms, fungi and bacteria, all of which result in enhanced plant growth. Adding lime also decreases soil acidity levels and increases pH, again by putting nutrients back into the soil. In practise, lime was spread as a top dressing or mixed into the soil, but rates and frequency of application varied considerably - it was important not to spread too much lime as this may well 'sour' or 'burn' the soil (Johnson 2016, 49-51).
- 3.3 The Fell End lime kilns conform to many of the typical patterns noted by Johnson's earlier surveys. They are sited below Fell End Clouds, where limestone is clearly and prominently the dominant surface geology. In both the Central Pennines and Westmorland areas, there was a strong correlation between the siting of kilns and where limestone is the dominant surface geology. However, even in the Central Pennines, where 79% of kilns were sited on limestone, this was not always the case, with access to fuel (usually coal), and proximity to a large building site or to newly enclosed moorland also sometimes being important (Johnson 2010, 240; Johnson 2013, 200). Although the Fell End lime kilns are sited on limestone, there is no clearly associated quarry; again, this characteristic is shared by over 43% of lime kilns in the Central Pennines, where crags, scree, slopes, stream beds, pits and hushes were all exploited for stone (Johnson 2013, 201).
- 3.4 The lime kilns also share several structural characteristics with those previously recorded. Both have a draw arch which faces north-west. In both the Central Pennines and Westmorland areas, it was found that the majority of kilns had draw arches which faced between north-west and south-east, into the prevailing wind directions in the region (Johnson 2010, 244-245; Johnson 2013, 204). The use of firebricks, as in the draw hole of Kiln 1, was more common in Westmorland than in the Central Pennines, with many taken from bowl linings having identifiable manufacturer's marks (Johnson 2013, 207). In terms of their size, the bowl of Kiln 2 is significantly larger than that of Kiln 1. Although it is not possible to make exact calculations of their volume, a rough estimate would be that the bowl volume of Kiln 1 is approximately nine cubic metres, whereas that of Kiln 2 is c.17 cubic metres. This places Kiln 2 above the average volume of 12 cubic metres for lime kilns surveyed in Westmorland, where ten estate or commercial 'selling' kilns were also larger than this average (Johnson 2013, 205).
- 3.5 Kiln 2 does, however, preserve a very rare feature. The passages or flues leading from the longer north and south elevations to the narrow opening in the east side of the bowl are highly unusual, and only one other field kiln with a comparable arrangement (at Great Asby in Cumbria) has been noted in either the Yorkshire Dales or the Westmorland/east Cumberland region. A more complex variation of the same arrangement has also been recorded at a commercial kiln between Masham and Bedale in North Yorkshire. These flues were designed to increase air flow through the central part of the bowl where the calcining process took place i.e. above the cooling zone and below the pre-heating and drying zone, and they may well have been built into the kiln's structure because the lime burners knew (or hypothesised) that a bowl of this height and volume would not draw well (David Johnson, *pers. comm.*).

- 3.6 The placing of both kilns on open or unenclosed moorland is typical of just over a quarter of the surveyed lime kilns in Westmorland, with 47% on the edge of or within enclosed improved grassland or arable land (Johnson 2013, 207); in the Central Pennines, only 7% were sited on moorland, and of these many were set close to the limit of the enclosed pasture (Johnson 2010, 251-252). On the 1862 Ordnance Survey 6" to 1 mile map, Kiln 1 lies right on the edge of enclosed land, with Kiln 2 on unenclosed moorland but close to the enclosed land (see figure 3). Given that no large scale enclosure took place in Ravenstonedale after 1570 (Duxbury 1994, 211), it is assumed that the majority of the relatively narrow strip of enclosures in the valley bottom to the north-west of the kilns are therefore early in date, and are associated with small farm holdings here. Yet some of the individual enclosures to the east of Fell End Lane must be more recent than the late 16th century, whilst others apparently fell into disuse during the early 19th century; the small group of enclosures to the north-east of the kilns, known as Harry Hope's Land, is believed to have been last farmed during the 1820s (Frankland 2008, 7).
- 3.7 On balance, it is considered that both kilns are likely to be late 18th or early 19th century in date. Kiln 1 may have been built first to provide lime to improve land previously enclosed in the valley, and a string of lime kilns exist in the area to the east of the A683, many close to the enclosed land in the valley bottom (Johnson 2010; Johnson 2013, 197). The precise purpose of Kiln 2 remains less certain, although the fact that it has a significantly larger capacity and is of a more sophisticated construction (e.g. the flues), might imply that it is slightly later in date. Whether it might have been used to supplement or replace Kiln 1 and/or perhaps have been used as an estate or commercial lime-selling kiln is presently uncertain; further detailed documentary research may be able to clarify this.

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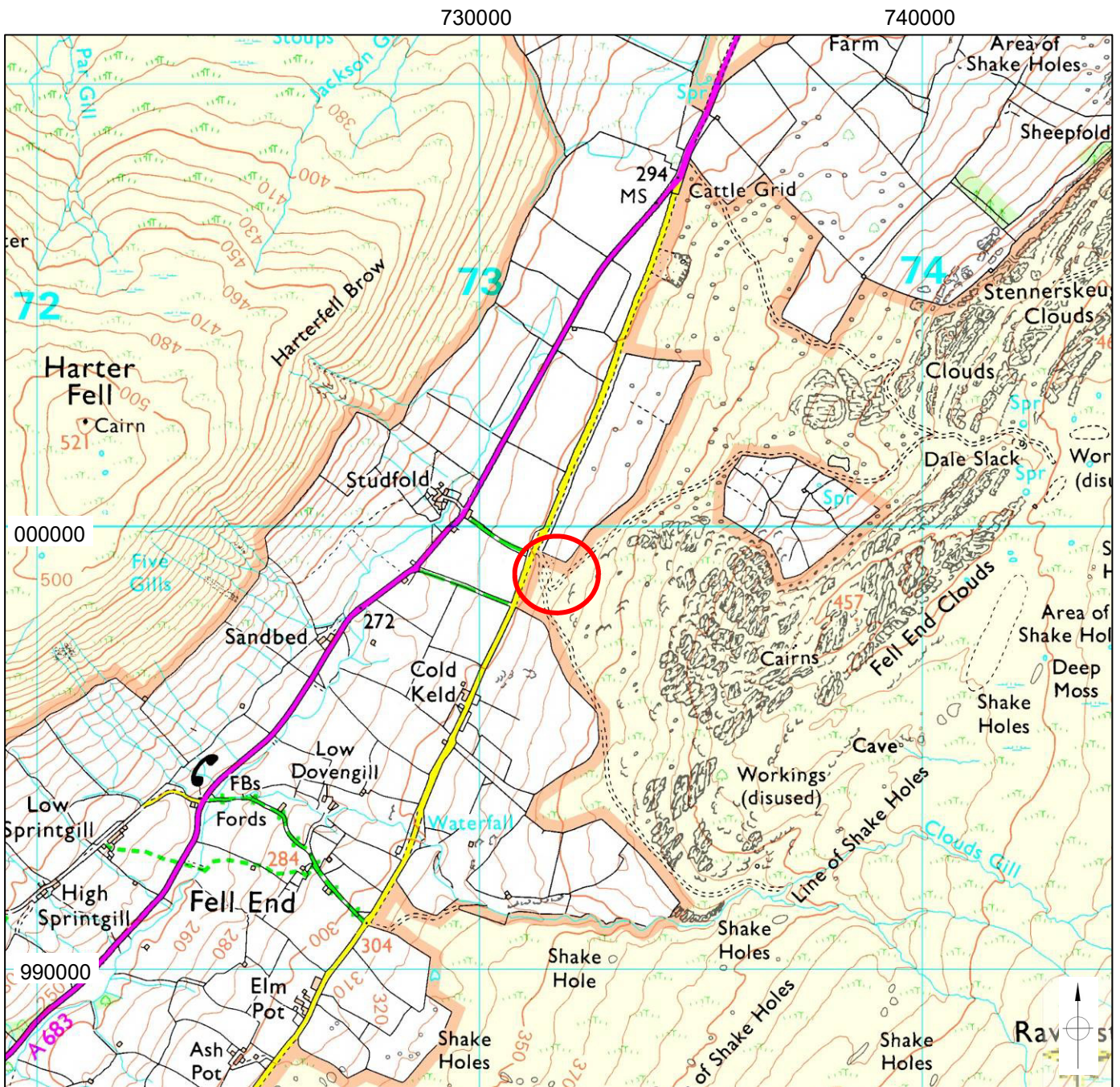
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5 ACKNOWLEDGEMENTS

5.1 The archaeological surveys were commissioned by Mr Miles Johnson, Senior Historic Environment Officer of the Yorkshire Dales National Park Authority (YDNPA). The on-site survey work was undertaken by Shaun Richardson with the assistance of volunteer Steve Douglas. Permission for access was given by Mr Ed Hewetson, agent for the owners, and Mr Ernest Leach, Chair of the Fell End Grazing Association. The final report and other drawings were produced by Shaun Richardson and Ed Dennison, with the latter taking responsibility for any errors or inconsistencies.



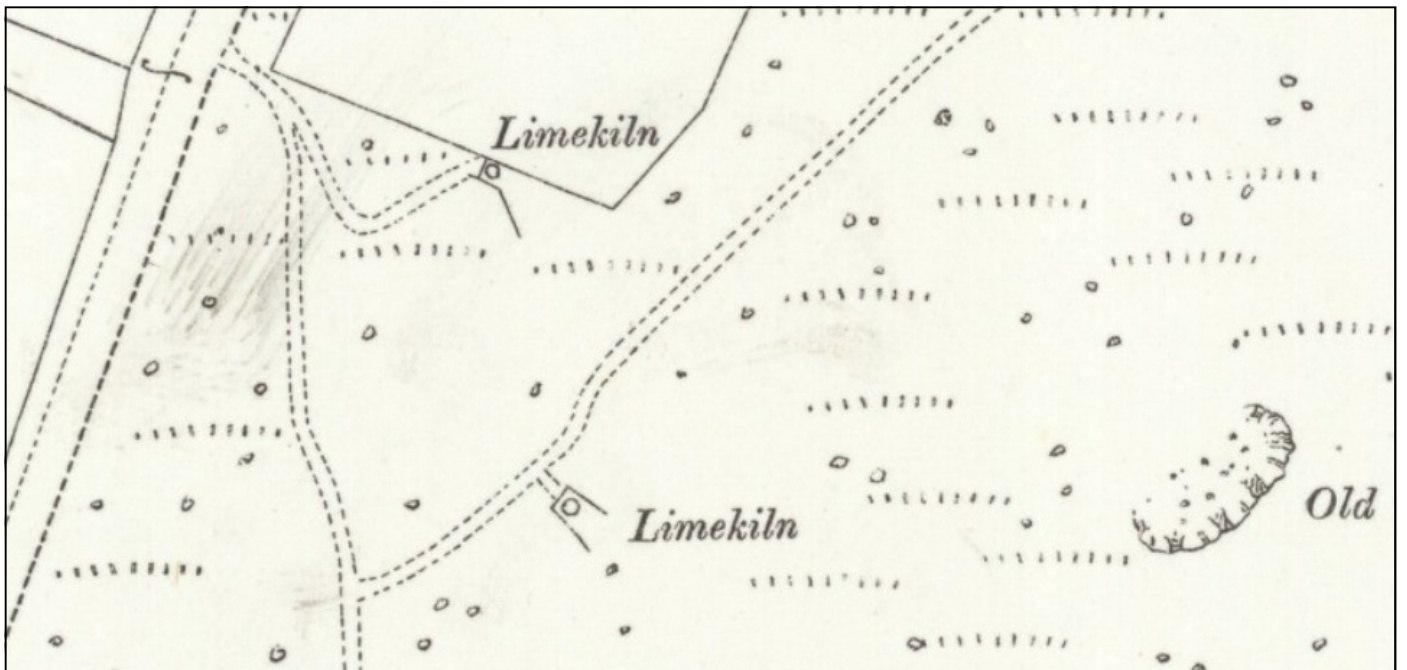
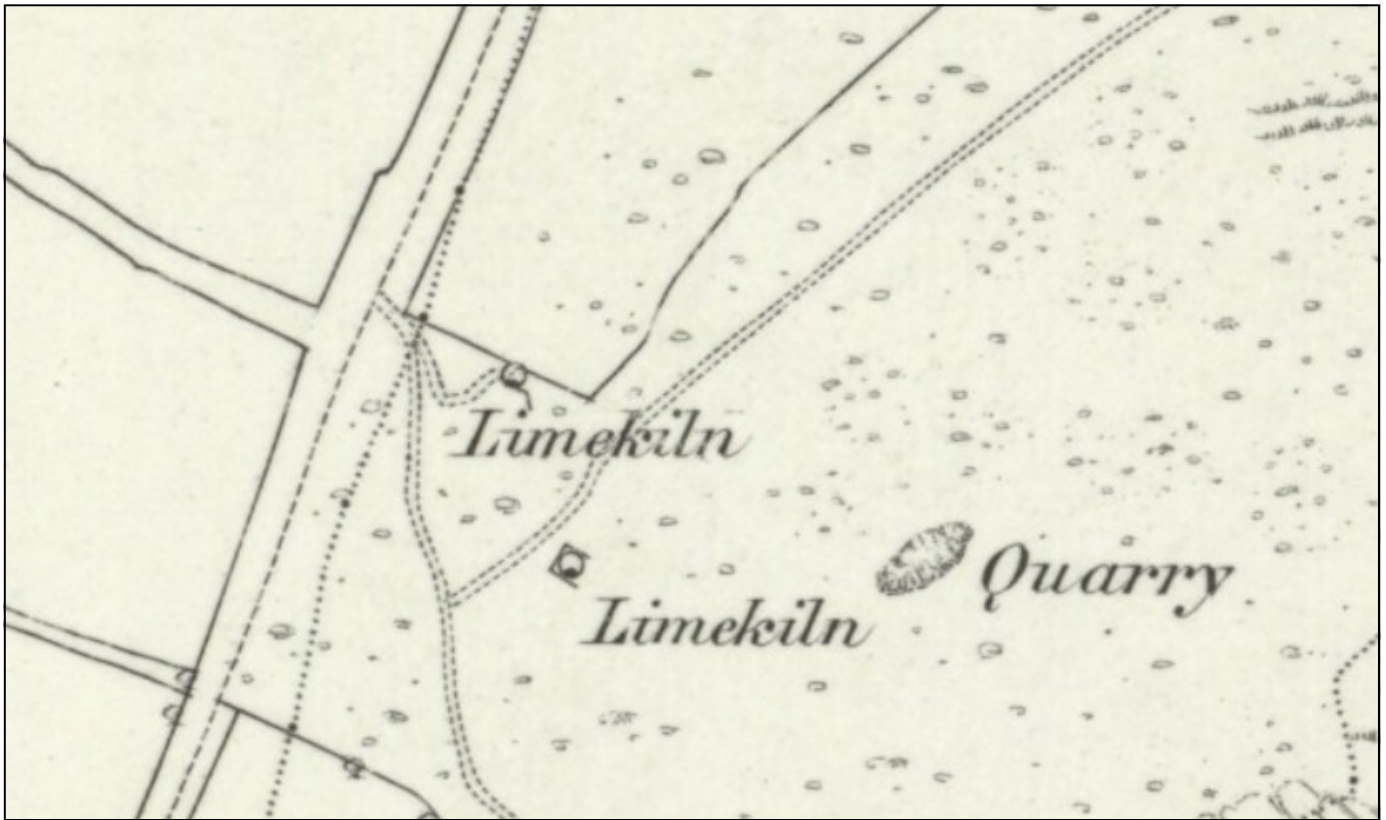
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PROJECT		FELL END LIME KILNS	
TITLE		GENERAL SITE LOCATION	
SCALE	AS SHOWN	DATE	MAR 2019
EDAS		FIGURE	1



Ordnance Survey map base provided by YDNPA.

PROJECT		FELL END LIME KILNS	
TITLE			
		DETAILED SITE LOCATIONS	
SCALE	AS SHOWN	DATE	MAR 2019
EDAS		FIGURE	2

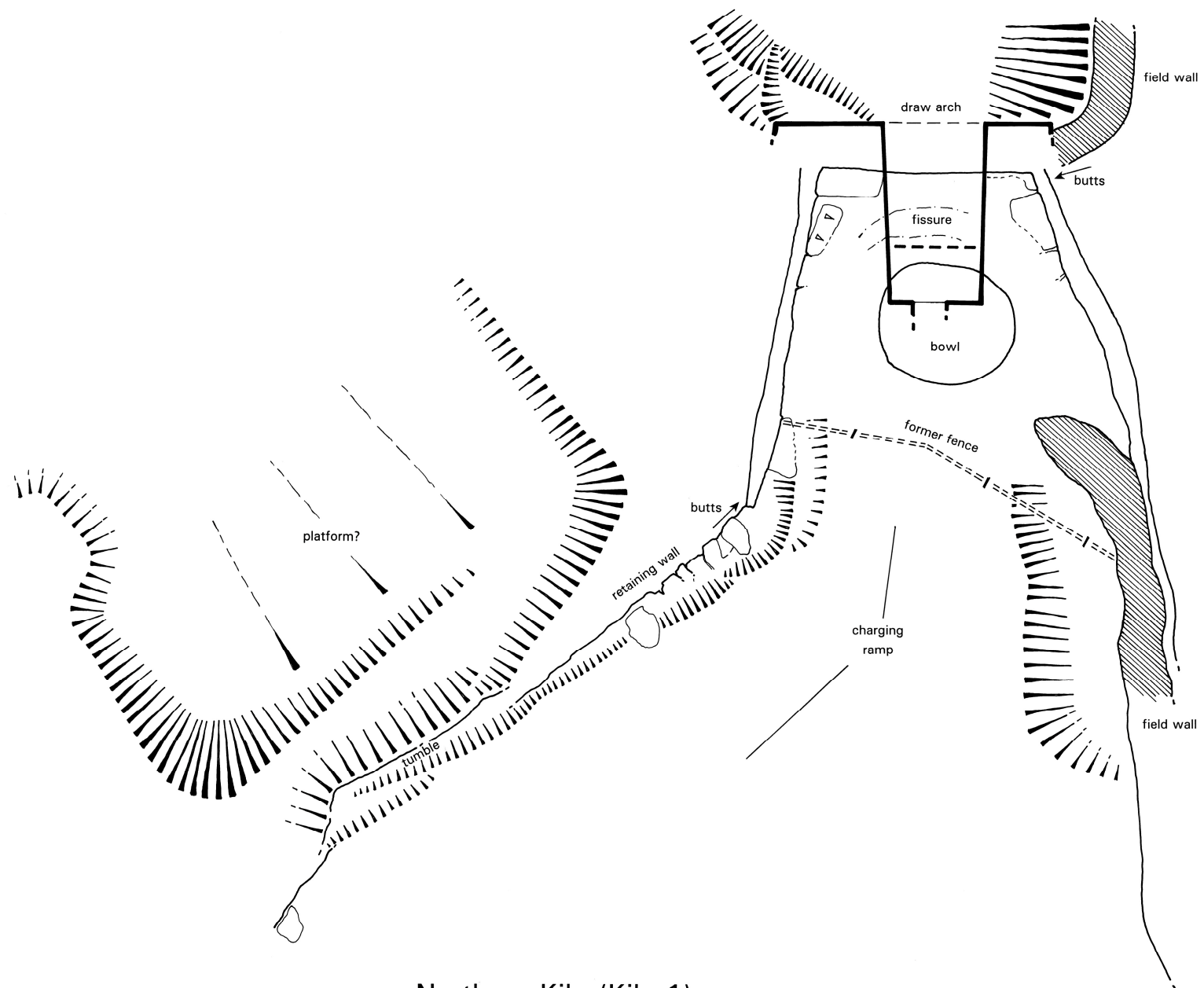


Top: 1862 Ordnance Survey 6" map Westmorland sheet 36 (surveyed 1857-58).

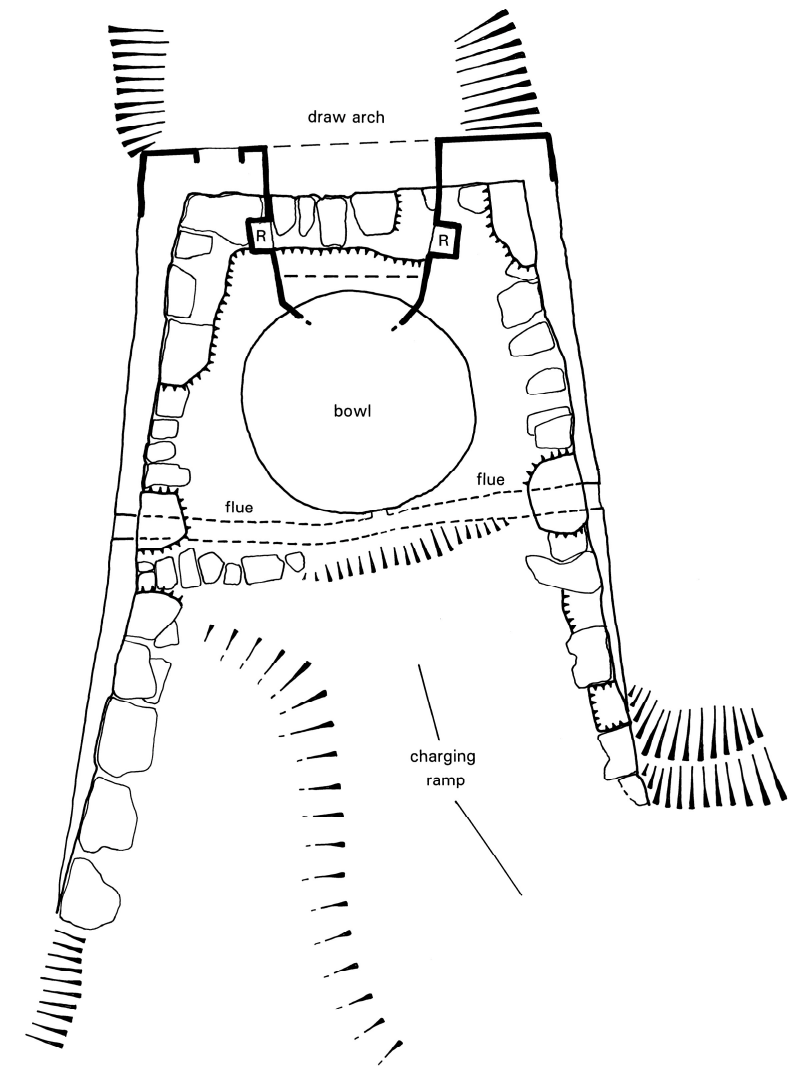
Bottom: 1898 Ordnance Survey 25" map Westmorland sheet 36/1 (revised 1896).



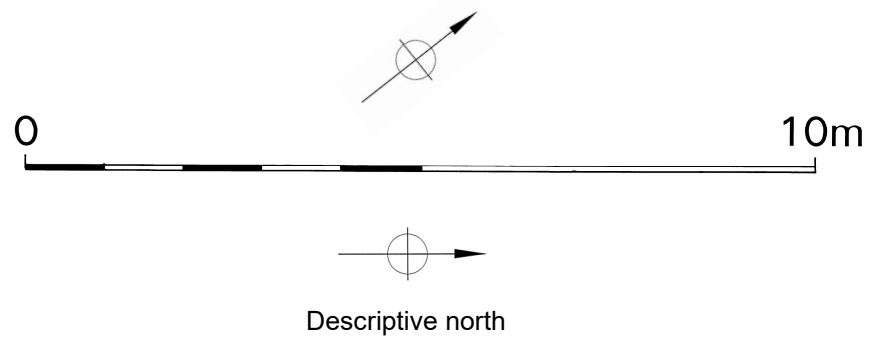
PROJECT		FELL END LIME KILNS	
TITLE			
HISTORIC ORDNANCE SURVEY MAPS			
SCALE	NTS	DATE	MAR 2019
EDAS		FIGURE	3



Northern Kiln (Kiln 1)



Southern Kiln (Kiln 2)



PROJECT		FELL END LIME KILNS	
TITLE		GROUND PLANS	
SCALE	AS SHOWN	DATE	MAR 2019
EDAS		FIGURE	4



Plate 1: Kilns 1 and 2, looking SE (photo 1/155).



Plate 2: Kiln 1, south elevation, looking N (photo 1/148).



Plate 3: Kiln 1, west elevation, looking E (photo 1/152).



Plate 4: Kiln 1, draw arch interior, looking E (photo 1/105).



Plate 5: Kiln 1, impressed fire brick 'F & L' (photo 1/156).



Plate 6: Kiln 1, charging ramp, looking NW (photo 1/097).



Plate 7: Kiln 1, platform and charging ramp retaining wall, looking N (photo 1/099).



Plate 8: Kiln 1, bowl mouth, looking NW (photo 1/098).



Plate 9: Kiln 2, looking NE (photo 1/141).



Plate 10: Kiln 2, N elevation, looking S (photo 1/108).



Plate 11: Kiln 2, flue passage in north elevation, looking S (photo 1/143).



Plate 12: Kiln 2, south elevation, looking N (photo 1/132).



Plate 13: Kiln 2, draw arch in west elevation, looking E (photo 1/122).



Plate 14: Kiln 2, charging ramp, looking W (photo 1/111).



Plate 15: Kiln 2, bowl, looking W (photo 1/127).



Plate 16: Kiln 2, bowl, showing flue slit to east side, looking SE (photo 1/131).

APPENDIX 1
PHOTOGRAPHIC CATALOGUE

FELL END LIME KILNS PHOTO CATALOGUE

Film 1: Colour digital photographs taken 22nd June 2018

<i>Film</i>	<i>Frame</i>	<i>Subject</i>	<i>Scale</i>
1	097	Kiln 1, charging ramp, looking NW	2 x 1m
1	098	Kiln 1, bowl mouth, looking NW	-
1	099	Kiln 1, platform and charging ramp retaining wall, looking N	2 x 1m
1	101	Kiln 1, west elevation, draw arch, looking E	2 x 1m
1	105	Kiln 1, draw arch interior, looking E	1m
1	106	Kiln 1, draw arch interior, looking E	1m
1	107	Kiln 1, track approaching base, looking SW	2 x 1m
1	108	Kiln 2, north elevation, looking S	2 x 1m
1	109	Kiln 2, north elevation, flue passage, looking S	1m
1	110	Kiln 2, charging ramp, looking W	2 x 1m
1	111	Kiln 2, charging ramp, looking SW	2 x 1m
1	112	Kiln 2, charging ramp, looking W	2 x 1m
1	113	Kiln 2, charging ramp, looking W	2 x 1m
1	114	Kiln 2, charging ramp, looking W	2 x 1m
1	115	Kiln 2, charging ramp, looking NW	2 x 1m
1	116	Kiln 2, bowl, looking W	-
1	122	Kiln 2, west elevation, draw arch, looking E	2 x 1m
1	123	Kiln 2, west elevation, draw arch, looking E	2 x 1m
1	124	Kiln 2, draw arch interior, S side, looking SE	1m
1	125	Kiln 2, draw arch interior, N side, looking NE	1m
1	126	Kiln 2, bowl, looking W	-
1	127	Kiln 2, bowl, looking W	-
1	128	Kiln 2, bowl, looking SW	-
1	129	Kiln 2, bowl, looking NW	-
1	130	Kiln 2, bowl, flue slit to E side, looking S	-
1	131	Kiln 2, bowl, flue slit to E side, looking S	-
1	132	Kiln 2, south elevation, looking N	2 x 1m
1	133	Kiln 2, south elevation, looking N	1m
1	134	Kiln 2, south elevation, looking N	2 x 1m
1	135	Kiln 2, south elevation, looking N	2 x 1m
1	136	Kiln 2, south elevation, entrance to flue passage, looking N	1m
1	138	Kiln 2, south elevation, flue passage interior, looking N	-
1	139	Kiln 2, west elevation, looking E	2 x 1m
1	140	Kiln 2, west elevation, draw arch, looking E	2 x 1m
1	141	Kiln 2, looking NE	2 x 1m
1	142	Kiln 2, looking SE	2 x 1m
1	143	Kiln 2, north elevation, flue passage interior, looking S	-
1	145	Kiln 2, trackway to west, looking S	-
1	146	Kiln 2, trackway to west, looking S	-
1	147	Kiln 2, trackway to west, looking S	-
1	148	Kiln 1, south elevation, looking N	2 x 1m
1	149	Kiln 1, south elevation, looking N	2 x 1m
1	150	Kiln 1, south elevation, looking N	1m
1	151	Kiln 1, looking NE	2 x 1m
1	152	Kiln 1, west elevation, looking NE	2 x 1m
1	153	Kiln 1, west elevation, looking E	2 x 1m
1	154	Kiln 1, west elevation, looking SE	-
1	155	Kilns 1 and 2, looking SE	2 x 1m
1	156	Kiln 1, impressed fire brick 'F & L'	-
1	157	Kiln 1, impressed fire brick 'F & L'	-
1	158	Kilns 1 and 2, from Fell End road, looking E	-
1	159	Kilns 1 and 2, from Fell End road, looking E	-