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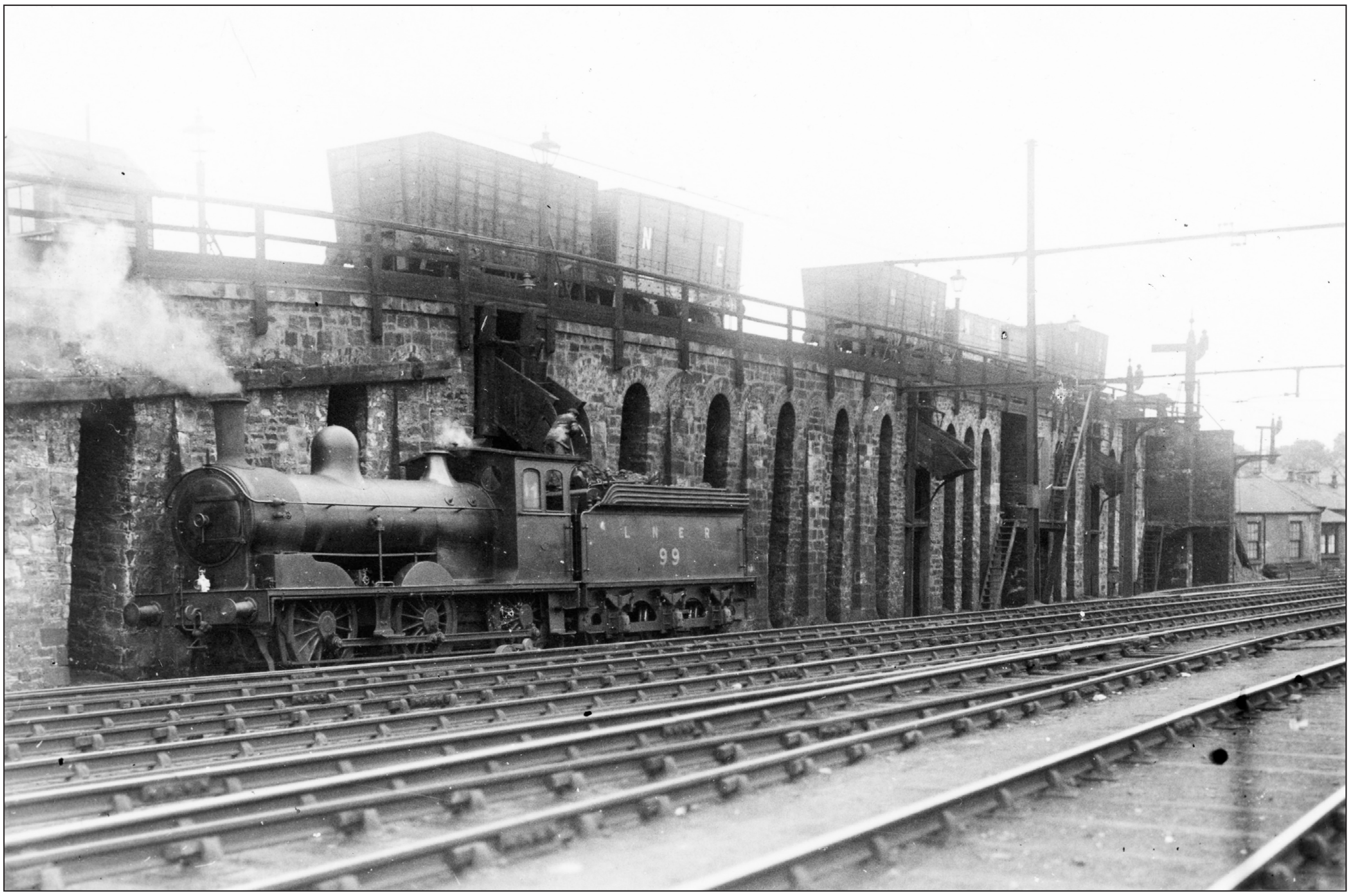
Stockton & Darlington Railway Locomotive-Coaling Stage, Shildon, Co. Durham: historic building investigation and assessment of significance

Marcus Jecock, Lizzie Stephens, Gary Young and Matt Bristow

Discovery, Innovation and Science in the Historic Environment



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STOCKTON & DARLINGTON RAILWAY LOCOMOTIVE-COALING STAGE, SHILDON, Co. DURHAM

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SUMMARY
This report describes and discusses the significance and place in railway history of the Shildon locomotive-coaling stage (aka 'Coal Drops'), built by the Stockton & Darlington Railway (S&DR) in early 1847 to improve the re-fuelling times of steam locomotives returning empty coal trains to the company's marshalling yard and engine shed at Shildon before they headed back east to staiths on the River Tees with their next train. Documentary research has shown that the coaling stage was designed by John Graham, the S&DR's Traffic Manager, acting under the instructions and supervision of William Bouch, foreman engineer of the S&DR's Shildon Works. It is argued that it represents one of the first attempts - if not *the* first attempt - in Britain (and given Britain's primacy in railways, possibly the world) to mechanise the process of coaling locomotives, which up until that time had been carried out by men hand-shovelling from lineside bunkers or wagons parked on an adjacent siding. Historic England carried out the study as part of its Historic Area Assessment (HAA) of Shildon; the HAA forms part of Historic England's S&DR Heritage Action Zone (HAZ).

CONTRIBUTORS
Geospatial survey was carried out by Lizzie Stephens, Geospatial Apprentice, under the supervision of Gary Young, Geospatial Surveyor, of Historic England's Geospatial Survey Team. Marcus Jecock conducted investigation of the fabric, site photography and documentary research, the latter aided at The National Archives by Matt Bristow; Marcus Jecock wrote the report. Marcus and Matt are Senior Investigators in the Landscape Archaeology Team.

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ARCHIVE LOCATION
Historic England Archive, Swindon: AF00447 and SHL20 and 21.

DATE OF INVESTIGATION
Survey and investigation were carried out on 6 March 2020. Report production was subsequently delayed by restrictions brought in to counter the Covid19 pandemic. A further site visit and additional photography were undertaken on 5 May 2022.

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1. INTRODUCTION

In the Delivery Plan for the Stockton & Darlington Railway (S&DR) Heritage Action Zone (HAZ) – which runs until March 2023 - Historic England undertook to conduct or fund a series of archaeological and architectural investigations in support of the research and listing work streams (Historic England 2018, 20). The main purposes of these work streams are to improve understanding of the significance of the S&DR's surviving built and engineered structures and to ensure their repair and long-term preservation ahead of the line's upcoming bicentenary in 2025. Recording and study of the 'Coal Drops' (more properly referred to as a locomotive-coaling stage) at New Shildon was conceived as part of Project 10 within the Plan: an Historic Area Assessment (HAA) of New Shildon (Jessop & Pougher forthcoming). However, study of the Drops is more detailed than required by the HAA, and so is reported here separately and in full.

New Shildon is the name given to the railway settlement that grew up after 1825 at the western end of the level section of the S&DR's main line (that is, the section over which steam locomotives could operate). Although the line continued a further 7km to the north-west to terminate at Witton Park Colliery (Figure 1), the gradients on this westernmost section were too steep for locomotives and were instead worked by a combination of horse power and steam-driven rope-inclines (the latter located at Brusselton and Etherley). New Shildon was also where several other early horse- or incline-powered colliery branch lines (the Black Boy Branch and the Surtees Railway, the latter also known as the Copy Crooks Branch) connected to the S&DR by 1827. The settlement therefore rapidly developed as an engineering and service hub for the company as well as a major marshalling facility where coal wagons arriving from these - and later many other - collieries were organised in to trains for the locomotive-hauled leg of their journey east to the staiths at Stockton and later

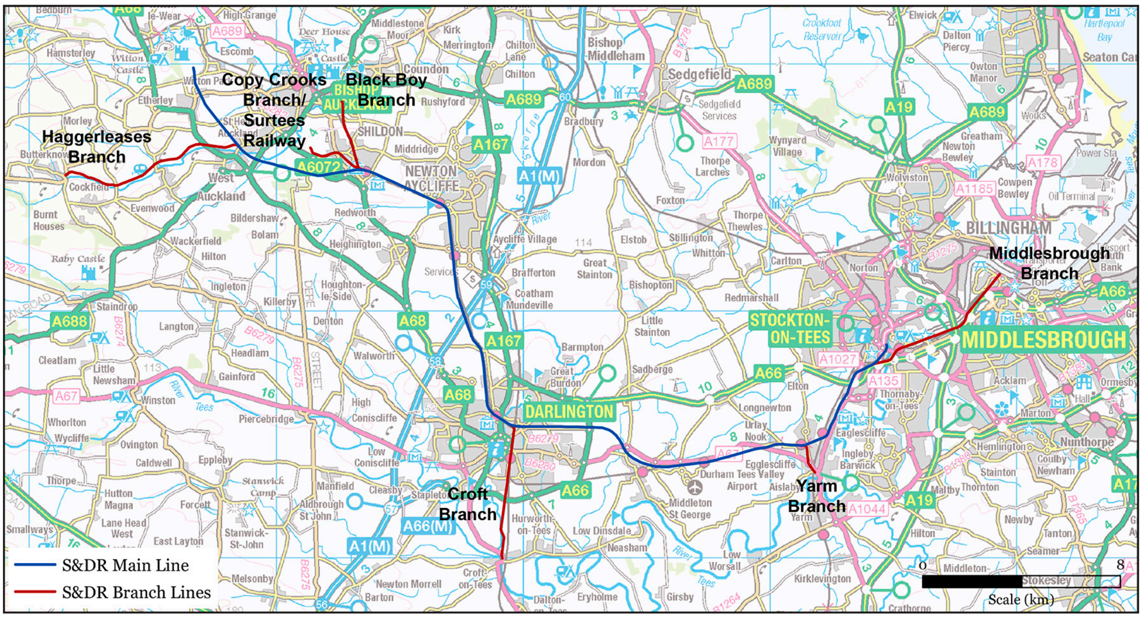

Figure 1. Location map of the Stockton & Darlington Railway and its early branch lines. [Dave Knight © Historic England Archive. Base map © Crown Copyright and database right 2022. All rights reserved. Ordnance Survey Licence number 100024900].

Middlesbrough, for onward transport by sea. As such, New Shildon is credited as the world's earliest railway town (e.g. Locomotion nd); it has also been dubbed the cradle of the railways (e.g. Corkin 1977). New Shildon lies about 1km south of the historic village of Shildon (later Old Shildon), but the two settlements have since conjoined and the original village name is now normally applied to the entire conurbation.

The need to improve the re-fueling and turn-round times of steam locomotives returning empty coal wagons to New Shildon before heading back east with their next train, led to the design in late 1846 by John Graham, the S&DR's Traffic Manager, acting under the instructions and supervision of William Bouch, foreman engineer of the S&DR's Shildon Works, of the extant (gravity-fed) locomotive-coaling stage, commonly now known as the Shildon Coal Drops. Previously all locomotive coaling seems to have been carried out by hand-shovelling from lineside bunkers. The new Drops consisted of three timber hoppers or bunkers each with a spout or chute, arranged at regular intervals along the length of a stone stage elevated above normal track-level and approached via a ramp. Coal wagons hauled up the ramp discharged their loads through doors in their base in to the hoppers accommodated in small bays within the stage, which in turn fed spouts that directed the coal in to the tenders of locomotives waiting on a short loop-line or coaling road that ran at the foot of the stage. The stage also included one simple raised timber platform (later increased to three in number), presumably on to which coal could be dropped and then shovelled by hand from a position near-level with the top of the tenders; these platforms seem to have been provided for the use of locomotives unable – for whatever reason - to re-coal at the gravity-fed chutes.

The Drops opened in early 1847 and remained in use for the best part of a century, before closing in 1935 at the same time as the Shildon engine shed due to the working-out of large parts of the west Durham coalfield and the consequential reduction in coal-traffic carried by the railway. In that year, Shildon-based locomotives were transferred to duties at sheds elsewhere and, as a result, locomotive-coaling facilities were no longer required at Shildon.

Following the loss of its shed, Shildon remained a centre for railway-wagon manufacture for a further 50 years. Although the Drops were disused, photographic evidence in the Head of Steam Museum in Darlington shows that they remained standing with much of the mechanism of the hoppers and spouts intact in to the 1970s. Following closure of the Wagon Works in 1984, the Shildon site was purchased from British Rail by Sedgfield District Council (SDC) (Guy in NRM E5B/243, pp1), with ownership passing to Durham County Council (DCC) in 2009 when Durham became a Unitary Authority. Since the purchase, that part of the site around and including the Drops has been developed as a visitor attraction and Museum ('Locomotion', part of the Science Museum Group (SMG)), under the joint aegis of SDC/DCC and SMG (Smith 2019, 152 and 161). In that time, however, and certainly by 1992, most of the timber and metal elements of the hoppers and spouts rotted or were removed. More recently, the Drops have been the subject of a programme of stonework consolidation and inspection by structural engineers to make sure they are in a safe condition for DCC to lease to Locomotion as part of the latter's display offer to the visiting public. Unfortunately, the repairs seem to have been carried out without prior architectural and archaeological investigation to understand and record the evidence of the fabric, with the result that in places that repair work has slightly altered or obscured parts of the structure's original form.

The Drops were first listed at Grade II in 1986 (Department of Environment 1986) but, following review as part of the S&DR HAZ, the grading was raised to Grade II* early in 2021 (National Heritage List of England (NHLE) no. 1160320; https://historicengland.org.uk/listing/the-list/list-entry/1160320).

2. SITE HISTORY

Surviving documentary records for the S&DR are relatively unforthcoming as to the genesis and subsequent development and use of the Coal Drops. When the Drops were first designated in 1986, the original listing description (Department of Environment 1986, reproduced verbatim in NRM E5B/243, pp1) referred to them as built about 1856 quoting a Shildon S&DR Jubilee Committee report of 1975. The suggested date presumably derived from the fact that the Drops are depicted (although not named) on the first edition of the Ordnance Survey (OS) 1:2500-scale map (Figure 2), surveyed the year before it was published (Ordnance Survey 1857). Other

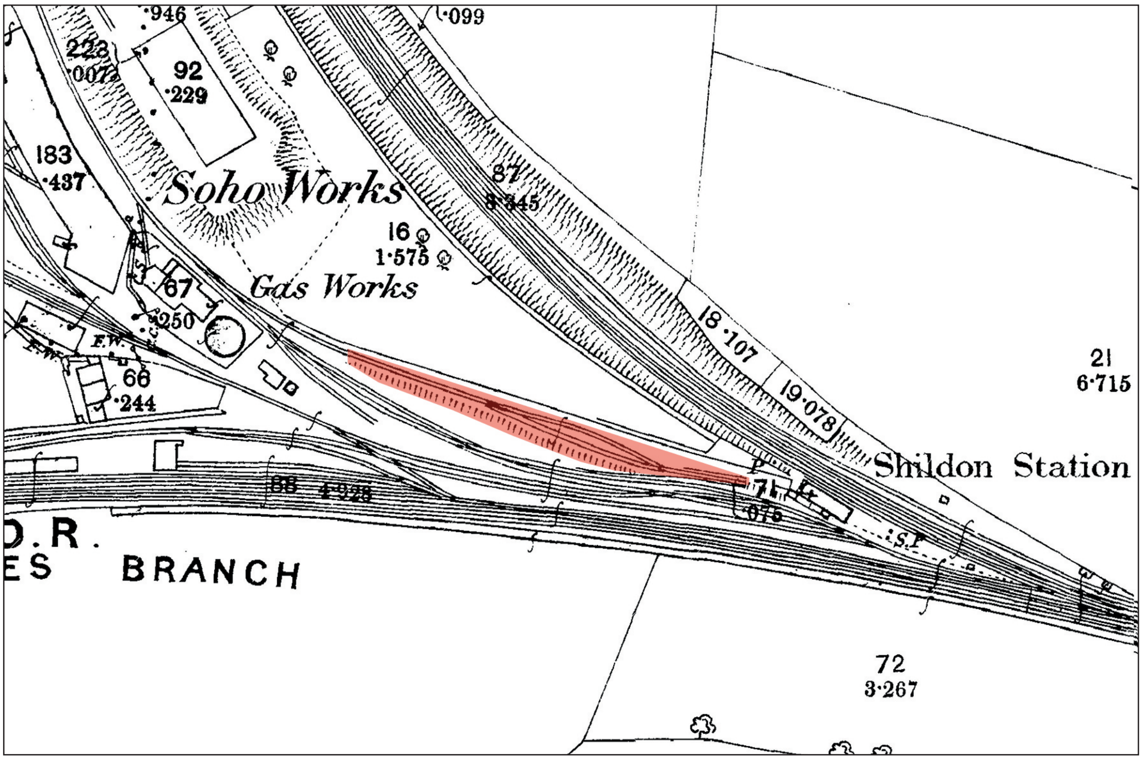

Figure 2. The Coal Drops (approximate outline in red) as depicted by the OS in 1856. Reproduced from the 1857 County Series 1:2500 map [© and database right Crown Copyright and Landmark Information Group Ltd (All rights reserved 2022). Licence numbers 000394 and TP0024].

map evidence shows the Drops must post-date 1839 for they are not portrayed on the earliest-known detailed plan of the S&DR, surveyed by Thomas Dixon (Figure 3). Within this 17-year time bracket, evidence recently unearthed in early Minute and Account Books and letters of the S&DR, now held at The National Archives (TNA) in London, suggests the date of construction may be narrowed down to late 1846 or more probably to early 1847.

The date 1847 was first suggested by the railway historian, Ken Hoole, who appended the pencil note 'BUILT 1847 DISUSED FROM 8-7-1935' against a photograph of the Drops he included in an album now kept at Darlington in the Study Centre that bears his name (KHSC KH945/19). According to Andy Guy (in NRM E5B/243,

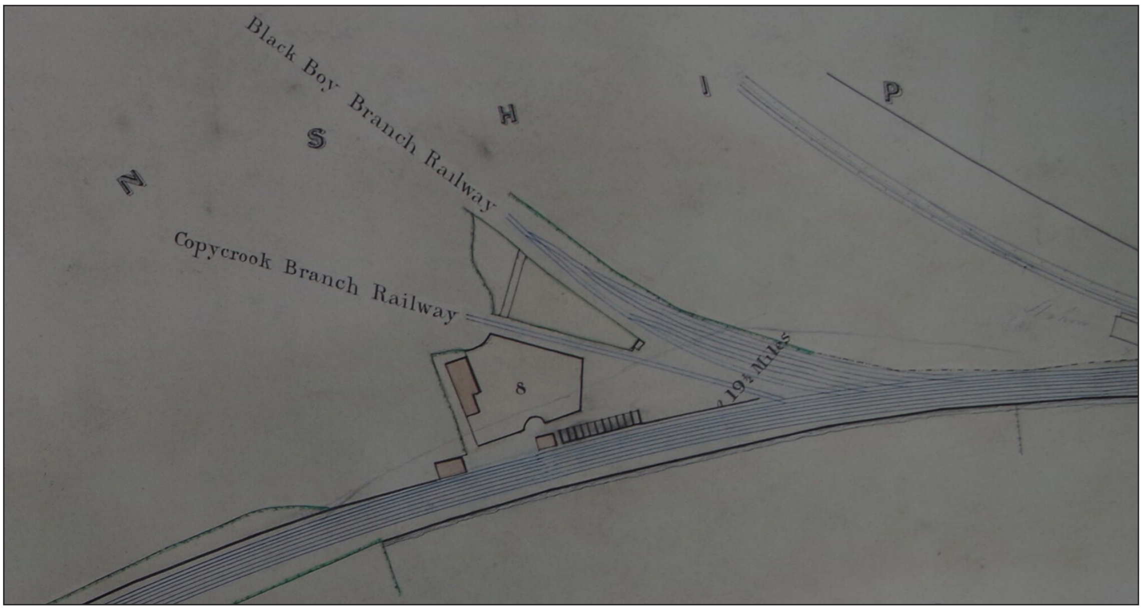

Figure 3. The junction of the Black Boy Branch with the S&DR main line as depicted by Thomas Dixon in 1839. The Coal Drops did not yet exist, but the line of small structures adjacent to the main line immediately south-east of '8' on plan may well be the lineside coal bunkers recorded as used for refueling locomotives at this time. [Reproduced from TNA RAIL 1037/453, with permission; photo courtesy of Niall Hammond].

pp3n), Hoole's information came from a report dated 21 January 1848 made to the S&DR Board by John Dixon, Consulting Engineer, namely that:

> 'Shildon – a shed for four engines is wanted very much, and we think the old coal depots adjoining (on the east side of) the Water Tank is the fittest place. These old engine depots have been superseded by the new self-filling spouts' (TNA RAIL 667/18).

The implication of this brief mention is that the earliest locomotive-coaling facilities at Shildon (that is, those which in early 1848 had recently been superseded by the 'new self-filling spouts' - undoubtedly a reference to the extant Coal Drops) were sited where the proposed engine shed was to stand. Specifications and a design for a 'Water Cistern to supply the Locomotive Engines Water on Black Boy Branch' had been put forward by the S&DR in 1833 (RAIL 667/296), suggesting the tank probably stood close to the junction of the branch and main lines. If so, the early 'coal depots' may well correspond to what appears to be a row of lineside bunkers depicted on the 1839 Dixon map at NZ 23361 25723 immediately east of a building shown standing just south of compound '8' on the plan (Figure 3). Although the same building (or one of a very similar plan) is also portrayed by the OS in 1856 (*see* Figure 2), the OS map does not state what purpose it served. However, if we are correct in identifying it as a water tank - and the feature to its east as the 'old engine depots' - the shed advocated by Dixon in 1848 was never built or was erected elsewhere.

Other brief and tangential documentary references largely corroborate early 1847 as the date the Drops were constructed/opened but indicate that they were designed, and even that construction may have begun, at the very end of 1846. For instance, the cost of 'Coal Depots at Shildon Wks' is included in the company accounts for

1846-7 (TNA RAIL 667/1596). More revealing is a letter from Oswald Gilkes, manager of the Shildon Works Company, to Joseph Pease (an S&DR Director) dated 14 October 1846 which suggests the Drops had then not yet progressed beyond the drawing board:

> 'Since Committee this morn[g] we have been conferring (WB [William Bouch] ~~myself~~ OG) respecting the great outlay which thou referred to for an easy mode of supplying coals and water to the Engines at this place and we are inclined to think thou art overrating the advantage that may accrue from the adoption of the elaborate hopper plan. We admit that an increase of accommodation is absolutely needed to the amount of fresh depots and water crane but are doubtful if it would be wise to expend many pounds additional in costly arrangements beyond as we think the saving of time effected will be but about as 7 minutes now to 5 minutes then. We think the great cause of delay is in the circumstance of the Engines that go down the line having to stop at Shildon to put away their empties and seek up their new load and our WB suggests that an auxiliary Engine kept always here with steam up would by taking the empties when they arrive and preparing the loads ready for the Engines to start away with the moment they are supplied with coals and water, would effect a greater saving of time than almost any other thing. The writer coincides in this sentiment entirely. We send this in order that thou mayst not be too sanguine as to the saving that would be effected by the Hoppers without the assistant Engine' (TNA RAIL 667/1596).

By 4 December 1846, however, we read that the Drops had been designed and construction approved:

> 'John Graham has submitted a plan for the Coal and Water Station at Shildon, and he is requested to confer with William Bouch and Oswald Gilkes and if they are all agreed upon the subject he is authorised to refer it to the Shildon Works Company for execution, with the exception of such part as they may require the Contractor's assistance for' (TNA RAIL 667/17).

Oswald Gilkes and William Bouch had taken over the S&DR's Shildon operations from Timothy Hackworth in 1840. The relationship between the two men is difficult to define precisely, but Bouch seems to have acted as engineer and contractor whilst Gilkes managed the finances and general day-to-day management (Smith 2019, 85). The situation is made more complex in that Shildon operated as a separate company (the Shildon Works Company) at arm's length from the S&DR, at least until the mid-1850s when the operation was brought more in-house. Bouch, however, was in effect the S&DR's Chief Mechanical Engineer from 1840 until his death in 1876. He designed and built many successful locomotives at Shildon before overseeing transfer of locomotive production to Darlington and giving the Shildon Works over to the design and manufacture of railway wagons. John Graham had been appointed the S&DR's first Traffic Superintendent (that is, Manager) in 1831, and remained in post until 1849 combining the role with that of Mining Engineer for the Pease family collieries (Smith 2019, 181; https://collection.sciencemuseumgroup.org.uk/people/ap244/graham-john). One of the mines the Pease family had a financial interest in was Black Boy Colliery. [1]

There is very little direct evidence for the original form of the Drops in 1847, and not much more on how they operated or whether they were adapted whilst in use. Map evidence surveyed 1856 (Ordnance Survey 1857) suggests they were initially approached from the west via an earthwork ramp (indicated on the map by hachuring; *see* Figure 2) seemingly terraced in to the side of rising ground, and that at this date only the eastern end (corresponding to the extant, high-level horizontal section where the hoppers and spouts were located) was retained by stonework (depicted as line detail on the map). The rail spur leading up the ramp is depicted as branching off the single line down from Black Boy Colliery a few hundred metres before the latter's junction with the S&DR main line to Brusselton Incline that ran past the Shildon Works, meaning that coal wagons coming down the branch from the colliery could readily be diverted directly on to the line serving the Drops. Since the Black Boy Branch is known to have been worked using a combination of horses and steam-powered rope-incline (Smith 2019, 89), the inference must be that coal wagons were hauled to the top of the Drops by horses or more likely were self-propelled up the ramp using momentum gained from descent of the incline, with 'bank-riders' regulating the speed of the wagons and bringing them to a halt by means of crude wooden brakes (Smith 2019, 36-7). The map shows a short passing loop existed at this date towards the top of the ramp, leading to a single head shunt running the length of the high-level section; the significance/purpose of the passing loop is unclear but may have been to accommodate empties.

However, when the OS revised the map in 1896 (Ordnance Survey 1897), by which time the S&DR had been absorbed in to the North Eastern Railway (NER), the Drops are shown as hard-line detail throughout suggesting the ramped section was later re-built in stone as well (Figure 4). Other new detail depicted on the map includes two short, parallel sidings immediately north of the Drops, squeezed in between them and the Shildon Tunnel Branch Line (labelled as Consett Line on the map) which had opened in 1842. The sidings are shown departing from the Black Boy Branch just before the start of the ramp, implying both were for storage of loaded coal wagons and/or empties prior to/after they were needed at the Drops. Furthermore, the map portrays the high-level section of the Drops now terminating almost cheek by jowl against the south-west corner of the waiting room on the down (southern) platform of Shildon Station on the Tunnel Branch Line, suggesting that in the years since 1856 the coaling stage had also been extended a distance to the east. The passing loop shown in 1856 on the ramped approach to the Drops no longer existed, presumably superseded by the new storage sidings.

1 As an aside, William Bouch was also the younger brother of Thomas Bouch, designer of the ill-fated Tay Bridge which disastrously collapsed during a storm in 1879. Strangely, Gilkes likewise had a family connection to that disaster in that his younger brother, Edgar – who for a few years was also on the S&DR payroll – owned the Middlesbrough foundry that supplied the metalwork, later deemed substandard by the Public Enquiry.

Later photographic evidence shows the extension comprised a flat timber deck carried on two freestanding stone piers (Figure 5; KHSC 945/20); neither deck nor piers now exists. Subsequent depictions of the Drops on the OS map revisions of 1915 and 1939 (Ordnance Survey 1920; 1946a) portray them virtually unchanged apart from that of 1939 which shows the track along the top of the Drops terminating short of the extension (Figure 6). The extension is depicted as still present/in use on a plan of Shildon Station dated 1925 (NERA 1418-02-24), as standing but seemingly undecked on a photograph dated 4 June 1932 (Figure 7; KHSC KH401/1733) but absent in a photograph (Figure 8; KHSC KH1629/95) of a Sentinel railcar refueling at the Drops and datable, therefore, to after 1928 which is when the London & North Eastern Railway (LNER, the successor to the NER) began to operate such railcars in the Shildon area (Guy in NRM E5B/243, pp8n). Taken together, this evidence suggests the extension became disused between 1925 and 1932 and was demolished sometime after 1932 but before the Drops closed in 1935, presumably because the structure had become increasingly unsafe (the photographs show it heavily braced) or because whatever function it originally served was by this time no longer needed.

Map and photographic evidence, therefore, strongly indicate that the form of the Drops as they currently survive is not as first built, nor even as later adapted. This suspicion is supported by the single documentary reference the present study has been able to locate that pertains to the Drops in use. This is a local-newspaper report of a fatal accident that occurred in early December 1884, when a driver named Thomas Hutchinson had the top of his head taken off by one of the spouts:

> 'Henry Shaw, deceased's fireman, said that on Saturday night, shortly after six o'clock, he and deceased were on the engine at the coal depot, had filled the tender at the middle spout, and were going down the siding to get on to the main line, in order to do which they must pass under the bottom spout; and as they passed under the latter deceased was standing on the footboard of the engine, which was travelling tender first. Witness then heard a 'thud', and on looking round saw deceased fall on the footboard, where witness found him with the top of his head off. Deceased's head must have been caught between the spout and the top of the engine-house [cab]. Deceased stood over six feet in height, and when standing on the footboard his head would be above the top of the engine-house. Deceased was a careful, steady man, and the engine was like one in previous use, although the footboard was a little higher than the old one. The spouts are fixtures and it was the deceased's duty to be looking out. The spouts at York worked up and down with a lever, and witness did not know of any fixed spouts anywhere like those at Shildon. Deceased would know they could go "all right" to the spouts, at which deceased had frequently lowered his head. – Railway-policeman Bath said he had never known an accident at these spouts before. – Geo. Scriven, fireman, said he had been twice slightly injured there. On one occasion he was felled to the ground, when stepping from the platform to the tender, whilst the engine was standing. On the second occasion, whilst levelling the

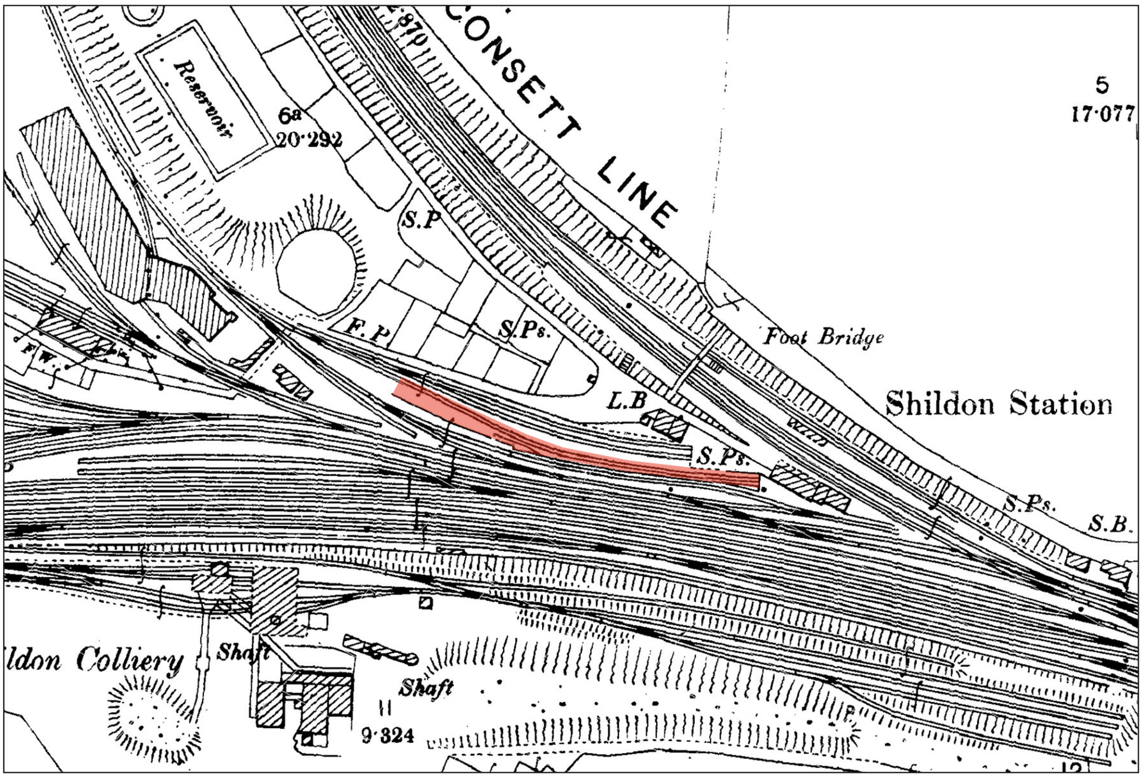

Figure 4. The Coal Drops (approximate outline in red) as depicted by the OS in 1896. Reproduced from the 1897 County Series 1:2500 map [© and database right Crown Copyright and Landmark Information Group Ltd (All rights reserved 2022). Licence numbers 000394 and TP0024].

Figure 5. 1925 photograph showing the pre-1896 timber-decked extension. Note timber bracing is visible within the two bays of the extension but only towards the rear of those bays. Note also the door beneath the platform in the end bay suggesting the sub-platform area was at one time used for storage. [Unknown photographer © Ken Hoole Collection/ Head of Steam – Darlington Railway Museum].

> coals, the bottom of the spout caught him and knocked him off. His leg was scratched, but he did not report it, though he went off work. He thought he was as much to blame as anyone for the second accident. – The jury returned a verdict of 'Accidental Death', with a recommendation "that the spouts should be altered and made moveable, as the jury considered them dangerous in their present state"' (*The Northern Echo* 1884, 4).

It thus seems likely that the form of the Drops would have been modified around this time in accordance with the jury's recommendations to make them safer, and that the precise hopper and spout mechanism that we observe in the early 20th-century photographs (Figures 7 and 8), may date to 1885 or later. The accident may also have been the occasion for raising the height of the coaling stage – evidence for which is visible in the fabric – but if so that implies that the extant buttressing is later still (see below, Description).

As we have heard, the Drops remained in use until 8 July 1935 which is when the Shildon engine shed closed and its stock of locomotives dispersed to other sheds, mainly West Auckland which had itself closed in 1931 but was re-opened upon Shildon's closure (Smith 2019, 119; John Askwith, pers. comm.). The shed closure

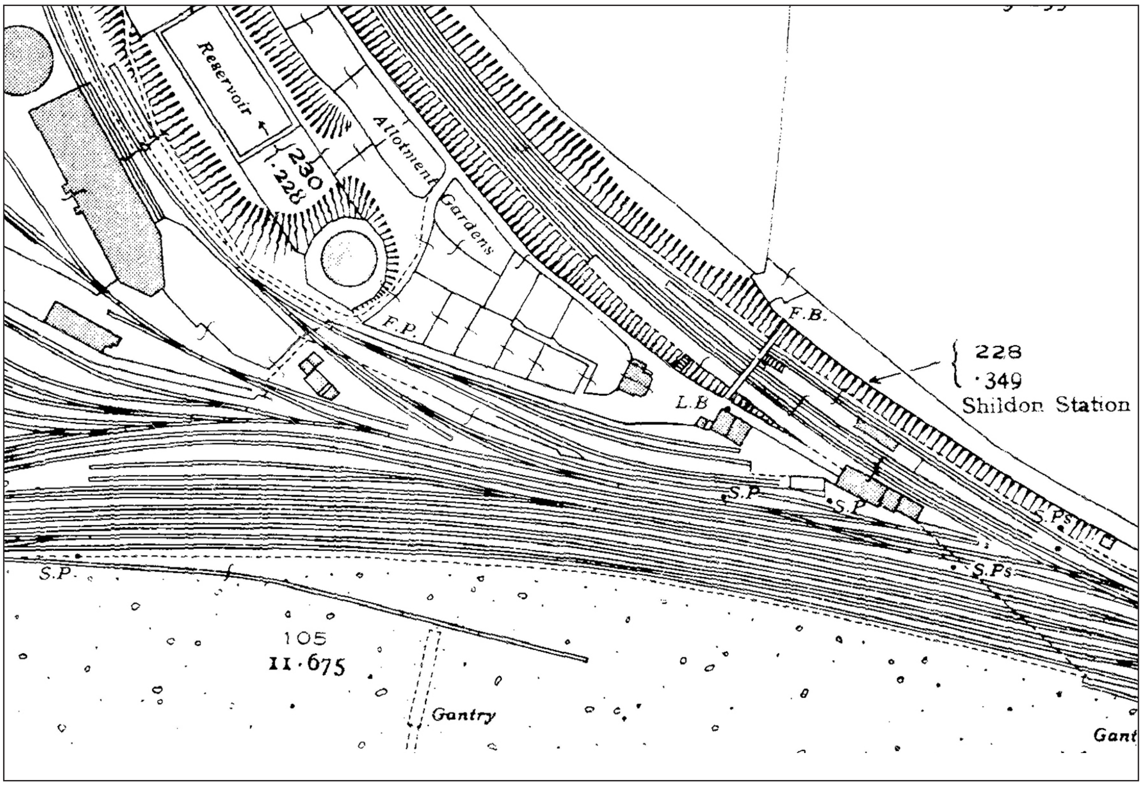

Figure 6. The Coal Drops as depicted by the OS in 1939. Note the track along the top of the Drops now terminates short of the buildings on the down platform of Shildon Station, suggesting the timber-decked eastern extension is disused and/or demolished by this time. Reproduced from the 1946 County Series 1:2500 map [© and database right Crown Copyright and Landmark Information Group Ltd (All rights reserved 2022). Licence numbers 000394 and TP0024].

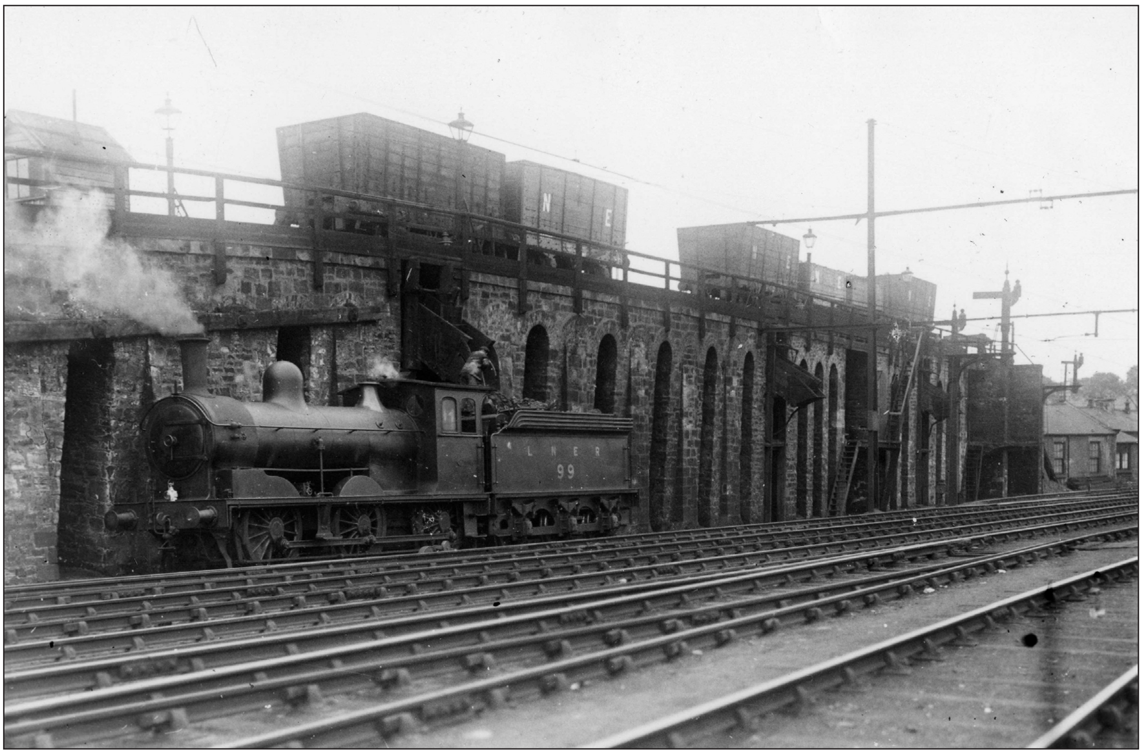

Figure 7. LNER 'J21 Class' locomotive (ex-NER 'C Class') no. 99 coaling at the Drops, photographed 4 June 1932. Note the eastern extension appears undecked and out of use. [Unknown Photographer © Ken Hoole Collection/Head of Steam – Darlington Railway Museum].

Figure 8. LNER Sentinel railcar coaling at the Drops sometime between 1932 and 1935. Note the eastern extension has been demolished. [Photographer: J. W. Armstrong? © Ken Hoole Collection/Head of Steam – Darlington Railway Museum].

was reportedly a direct consequence of the general diminution in output of the west Durham coalfield, and the concomitant reduction in the need to have locomotives on hand at Shildon to marshal and pull coal trains. However, it might also be pertinent to note that Black Boy Colliery's output was waning by this time, too, with several seams already exhausted and abandoned by 1932; the colliery closed completely in 1939 (Durham Mining Museum nd). The output of other (later) collieries that were also served by the Black Boy Branch (Auckland Park and South Durham Collieries) was similarly reducing around the same time. If the Drops were supplied with coal exclusively from Black Boy and immediately adjacent collieries as seems likely (the line leading up on to the Drops led directly off the original Black Boy Branch), then the supply source for which they had been designed and which accounted for their precise location, was under threat by 1935 as well.

Academic study of the Drops has to date been limited, the only detailed work being an unpublished - and therefore hitherto largely unnoticed - report researched and written by Andy Guy in 2009 on behalf of the Drops' curators, the National Railway Museum (NRM E5B/243). That report is a documentary study only, using sources that were readily accessible from York. In contrast, the present investigation has involved search of original material held at TNA in London and elsewhere and combined it with detailed recording and inspection of the physical fabric. Otherwise, the Drops have warranted only brief mention and description in a few regional or general works of railway history (e.g. Rounthwaite 1969, 14; Biddle 2003, 364-5; Smith 2019, 96 and 161-4). Rounthwaite speculated (erroneously) that the Drops were built to transfer coal brought down from Black Boy Colliery in chaldron wagons in to different types of wagons for onward transport to the staiths by the S&DR, rather than for the purpose of coaling locomotives which is clearly indicated by the documents and historic photography.

3. DESCRIPTION

As they survive, the Drops consist of a stone-faced platform or stage, inclined or ramped in the west to give access up on to an eastern, horizontal, high-level section which is where the actual drops (that is, the hoppers and spouts) were located (*see* Figures 33-37 at end of report). In plan view (*see* Figure 35), the ramped section is slightly curved (convex), the high-level section straight.

The south front of the stage is retained in stone, and comprises an arcade of 49 narrow, blind, arched recesses (*see* Figures 33-34) that were presumably designed to add strength to the structure but were also perhaps intended to double as refuges for railway employees to retreat in to for safety when locomotives were moving on the adjacent coaling road. The recesses gradually and progressively increase in height toward the east and the high-level section which commences after recess 30, following which arch heights are constant. Each arch head is formed in three rings of yellowish/grey bricks laid as headers. The widths of the recesses vary slightly, but generally each is between 1.08 and 1.1m wide. Depths are more variable and increase with height: recesses 1-6 measure 0.54-0.65m, recesses 7-12 0.8-0.88m and recesses 13-17 0.92-1m deep. Between recesses 18 and 28, wide stone buttresses infill every two recesses with the third left open (so double buttresses infill recesses 18 and 19, 21 and 22, 24 and 25, and 27 and 28), and the depth of the open (measurable) recesses increases to 1.52-1.59m. Thereafter, narrower, single, buttresses fill alternate recesses as far as recess 39 (hence recesses 30, 31, 33, 35, 37 and 39 are all buttressed). The reason why two apparently adjacent recesses - 30 and 31 - are buttressed is because the rhythm of the arcading is also interrupted by three, narrow, rectangular cells or bays, the first of which lies between these two recesses at the very start of the high-level section, the second between recesses 40 and 41, and the third between recesses 46 and 47. In addition, a fourth, wider, bay lies between recesses 43 and 44 (*see* Figure 34). The ramped section (recesses 1-30) of the staging rises at a gradient of 5° or 1:11.8 to reach an eventual height of some 6m above modern ground level and has an overall chord length of 65.84m. The extant length of the eastern high-level section is 51.35m, although map and photographic evidence shows it formerly extended approximately 23m further east as a timber deck carried on two free-standing stone piers (*see* chapter 2 above, especially Figure 5), all now demolished, in effect providing two more of the wider type of bay.

Based on these characteristics, Andy Guy (in NRM E5B/243, pp1) has divided the coaling stage in to six sections, which he labels A-F, defined largely by their relationship to the four extant bays (labelled I to IV). Thus, his section A corresponds to the western ramp as far as the start of bay I, B to the elevated, high-level section between bays I and II, C to the high-level section between bays II and III, and so on, with section F reserved for the now-demolished easternmost timber-decked section. The division in to lettered sections and numbered bays is useful and will for the most part be followed here. However, Guy then subdivides the recesses (which he calls ‘arches’) by section – so, A1-30, B1-10, C1-3, D1-3, E1-3 – which seems less useful. Recesses will here be referred to by their cumulative place in the overall numerical sequence, starting in the west, that is recesses 1-49. In addition, rather than referring to the timber-decked extension simply as section F, it will here also be treated as two extra bays, hence bays V and VI.

The historical map evidence reviewed in the previous chapter suggests the ramped section A was initially an earthen incline, only later (sometime between 1856 and 1896) faced in stone, whereas the high-level sections B-E were stone-faced right from the start (compare Figures 2 and 4). Unfortunately, due to later buttressing and rebuilding of the front of the staging above the level of the buttresses (*see* below), no evidence of a construction join (at the transition from ramp to high-level section between recess 30 and bay I) is visible that would corroborate the construction sequence suggested by the historic mapping.

Nevertheless, construction joins and/or areas of rebuilt fabric are apparent in the masonry. First, in the west, a diagonal construction join is discernible a short distance below the level of the coping stones that cap the front wall of the staging. This is present over approximately the western third of section A, commencing close to the base of the ramp and continuing as far as the western springing of the arch in recess 10 (Figure 9) where it disappears, destroyed by later rebuilding (*see* below). The fact that the masonry above the join is laid on a slight angle in keeping with the overall gradient of the ramp in contrast to the masonry below which is laid more on the horizontal indicates that it represents a later raising of the height of the staging with consequential slight lengthening of the ramp. The vertical height of the raise is about 0.48m.

Figure 9. The vertical raise in height to the Drops, destroyed by later rebuilding (the larger blocks at right of frame) east of the start of recess 10. [Marcus Jecock 6 March 2020 © Historic England].

Secondly, it is clear that the buttresses which infill certain recesses in between recess 18 in section A and recess 39 in section B, are all secondary, and that the masonry above them (from the coping down to a level just below the crowns of the arches, beginning at recess 10 and continuing as far east as the crown of recess 40) was at some point (but subsequent to the raising just described) rebuilt in a different, darker stone (Figure 9). This rebuilding is evidenced visually by the presence of large, rectangular blockwork laid in slightly irregular horizontal courses, in noticeable contrast to the quality of the masonry elsewhere in the front wall of the staging which, apart from quoining is generally smaller, more rubbly, lighter in colour and more heavily weathered. Indeed, the bricks used to form the arch rings above some of these recesses, particularly recesses 30-40, also appear darker than elsewhere (certainly darker than those lying further west towards the base of section A), suggesting that unless the colour difference is due to smoke-staining these arch heads were rebuilt at the same time in a different brick. The two elements (buttressing and rebuilding) are almost certainly contemporary with each other: both must have been part of the same programme of work, the purpose of which was to address a substantial (5°) outward lean that had developed in the front wall of the staging due to soft ground and/or inadequate foundations particularly on the curved ramped section (Figure 10) where lateral

Figure 10. The Drops looking west from bay IV, showing the lean out of the curved ramp section and the buttressing added to remediate the lean. [Marcus Jecock 6 March 2020 © Historic England].

forces on the structure were greatest. The buttressing was needed to stop the lean developing further, the rebuilding to return the masonry above the level of the buttresses to the vertical (as is demonstrated by vertical sections through the Drops generated from the 3D modelling, illustrated at Figure 37, especially sections 6 and 8). The buttresses are built up from foundations that chamfer in at ground level (Figure 11).

Figure 11. Detail of a buttress base. [Marcus Jecock 6 March 2020 © Historic England].

As already stated, the front wall of the staging is capped by flat coping stones. Some of these have square, iron straps (or else bear the remains of now incomplete examples) leaded in to them (Figure 12) at intervals of 2.4-3.0m between centres. These mark the positions of timber uprights that formed part of a post-and-rail safety fence attached to the edge of the more elevated parts of the Drops (as can be seen on the various historic photographs Figures 5, 7 and 8). The photographs show that the fence also featured a low kickboard. However, some of the coping stones were seemingly badly damaged or else had become loose and had fallen when recent restoration work was undertaken in 2018 (a diagram showing the extent and specification for the works is held by DCC). Visual inspection suggests that some displaced coping stones were retrieved and put back in place, while others that were missing or too damaged were replaced by new. However, the field evidence also suggests that some of the replaced stones have been put back in positions that they could never have occupied originally. For instance, an original stone that retains part of an iron strap (part of the safety-fence attachment mechanism) and therefore which must have formerly lain along the front wall of the staging, has been re-instated to the north-west corner of bay II (Figure 13), while stones with traces of leading also now cap the rear wall of bay IV. Following on from this, the positioning of other

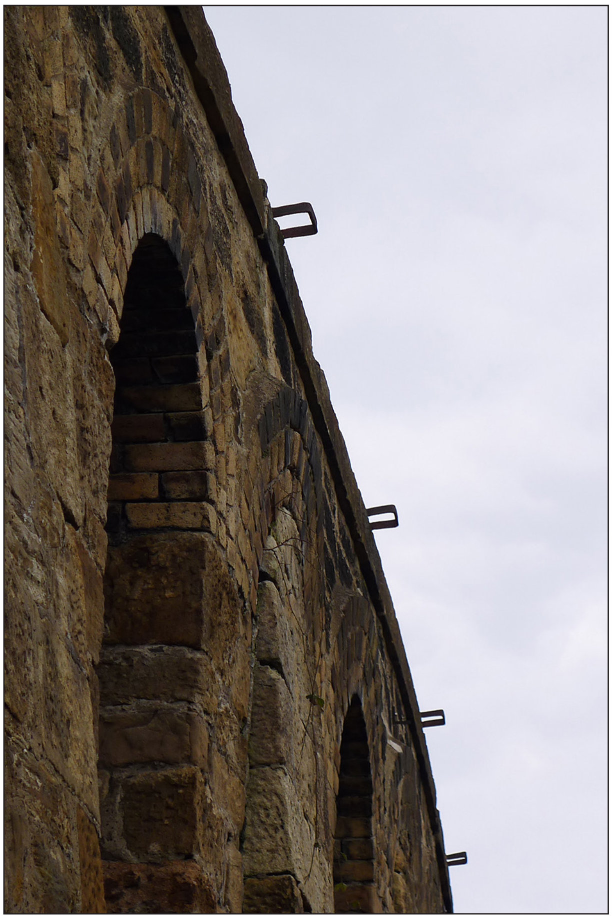

Figure 12. A run of the iron straps that supported the upright posts of the safety fence. [Marcus Jecock 6 March 2020 © Historic England].

Figure 13. Coping stone (with part of an iron strap) wrongly re-sited to the north-west corner of bay II. Note the large padstones surviving in the top of the far wall. [Marcus Jecock 6 March 2020 © Historic England].

original coping stones may be questioned. For example, it is very unlikely that the coping originally continued all the way round the bays (as it now does), since here it would have interfered with the placement of the rail track that ran along the top of the staging. Indeed, two large padstones are still visible towards the top of most sides of bays I - IV – with centres some 1.5m apart (approximating to the standard UK track gauge of 4 feet 8.5 inches or 1428mm) - sometimes with a thin fillet of stones now laid above them to level up to the height of the coping (e.g. Figure 14). Fillet and coping along the sides of the bays must represent modern 'over-restoration', since the purpose

Figure 14. Padstones in the west wall of bay III. The narrow stone fillet and the coping stones above the two large in-situ padstones represent modern 'over-restoration'. [Marcus Jecock 6 March 2020 © Historic England].

of the padstones is to take the weight of large timber waybeams or steel girder rails that would have been placed to carry the track across each bay while allowing open space between the rails for coal to fall through from the bottom-discharge wagons in to the hopper mechanism suspended beneath. This is confirmed by photographs in the Historic England Archive dating from 1992 that show the coping then terminated prior to the centre of the first padstone in bay I (Figure 15). Girder rail (that is, flat-bottomed rail with an enlarged basal flange strengthened at intervals by triangular stiffening plates

Figure 15. Photograph looking west over the top of bay I in 1992 showing the state of disrepair but also the original extent of coping stones. [Roger Thomas 7 July 1992 © Crown copyright Historic England Archive AA92/4236].

to make it capable of bearing weight unsupported over long distance (Foster 1988, 33-4, especially plate 1.25)) was certainly the normal means used by the NER in later periods to bridge bunkers positioned beneath the track at its public-facing 'coal depots' (goods yards attached to passenger stations where coal was dropped in to cells beneath the track for direct 'landsale' to coal merchants and members of the public). However, it is unclear at what date the NER began to use girder rail, and prior to its introduction waybeams would have been the normal means of supporting track in such situations.

By 1896 when we know the timber-deck eastern extension (section F, bays V and VI) existed, the coaling stage seems to have consisted of a total of six drops of two different types: three 'self-filling' (that is, gravity-fed) hoppers/chutes (bays I, II and IV), and three consisting of a timber platform raised about 2.4m off the ground (bays III, V and VI). The three bays containing the gravity-fed chutes are each 2.13-2.15m wide by 3.0-3.15m deep; bay IV (the only one of the platform type that survives and can be accurately measured) is 3.63m wide by 4.63m deep.

The actual mechanism of the three gravity-fed coal drops is difficult to reconstruct in detail. No drawing or written description is known, and the only evidence is the historic photographs plus hints in the surviving stonework. It must be stressed that the photographs record the mechanisms in their final phase of use which may not be exactly as they were initially designed and built. The photographs suggest coal was dropped from bottom-discharge wagons in to a timber hopper suspended directly beneath the track and housed within the bays. Rather than being attached directly to the staging, each hopper seems to have been carried on a largely free-standing timber framework of uprights and beams within its bay, although a number of empty sockets visible in the extant fabric (one in bay II with the end of a timber still *in situ*; Figure 16) suggest this framework was keyed - at least at a high level - in to the sides of its bay. Bay IV has a second pair of sockets at a lower

Figure 16. Socket in the east wall of bay II for tying the hopper support-framework to the bay wall. Inset: detail of surviving in-situ timber. [Marcus Jecock 6 March 2020 © Historic England].

level suggesting equivalent sockets in bays I and II may have been inadvertently infilled during the recent restoration. The rear of each hopper was attached to this framework close to the top of its bay, but the front sloped down to a vertical trapdoor that retained the coal within the hopper until such time as it was needed by a locomotive on the coaling road below. Just beyond this door was the actual chute mechanism which may perhaps be best described as a hinged metal trough with triangular sides that extended back against the outside of the hopper. The chute hinged at its base and had curved slots in its side plates that engaged with lugs on the sides of the hopper (Figure 17). It seems likely that the fireman of a locomotive wishing to coal first pulled down the chute before raising the hopper door by means of a long handle attached to a lever mechanism suspended from an iron bar above the hopper, to allow the coal in the hopper to fall in to his tender (Figure 18).

The purpose and means of functioning of the other three 'platform' bays is harder to discern. The most plausible explanation is that coal from the wagons drawn to the top of the stage was emptied directly on to the platforms ready to be shovelled by hand in to the tenders of locomotives on the coaling road. This view is arguably supported by historic photographic evidence of bays V and VI (*see* Figure 5) which shows internal diagonal timber struts bracing the free-standing stone piers but only toward the rear wall, suggesting it was important to keep the main area of the platforms clear of obstruction, presumably so as not to interfere with coal dropped from wagons overhead. In bay III, platform level seems to have been about 2.4m above modern-day ground level (calculated by allowing 0.3m as the combined depth of joists and floor planks added to the height of a ledge in the bay's side walls, on which the joists would have rested). The ledge in the eastern wall is interrupted by two small stone plinths of unknown purpose (Figure 19).

The historic photographs also show that the platform extended forward a short distance beyond the face of the staging to connect with two flights of stairs, one at the west end leading from ground level, the other leading from the east end of the platform to the top of the staging (described further below). A metal C-profile girder (now very decayed) set in to the bay walls at a rotated angle spans the width of this bay at a height of about 4m (*see* Figure 14). It is unclear what purpose it served (it is not visible in any of the historic photographs); possibly it supported a screen that directed coal dropped from above towards the rear of the platform to stop it spilling off the platform on to the coaling road below. One of the historic photographs (*see* Figure 5) shows that the platforms in bays V and VI were at the same height as that in bay III, with the west end of that in bay V again accessible from trackside (but not from the top of the stage) via a flight of timber stairs. Access to the platform in bay VI seems to have been by walking across in front of the intervening pier from bay V. The base of what is now the end wall of the coal stage (formerly the west face of bay V) is obscured by a stack of squared stones (presumably derived from the two demolished freestanding piers that formed the sides of bays V and VI), overlain by tumbled earth and vegetation, but three beam sockets are visible close together in line horizontally (Figure 20); these must be for the longitudinal joists that supported the platform in bay V.

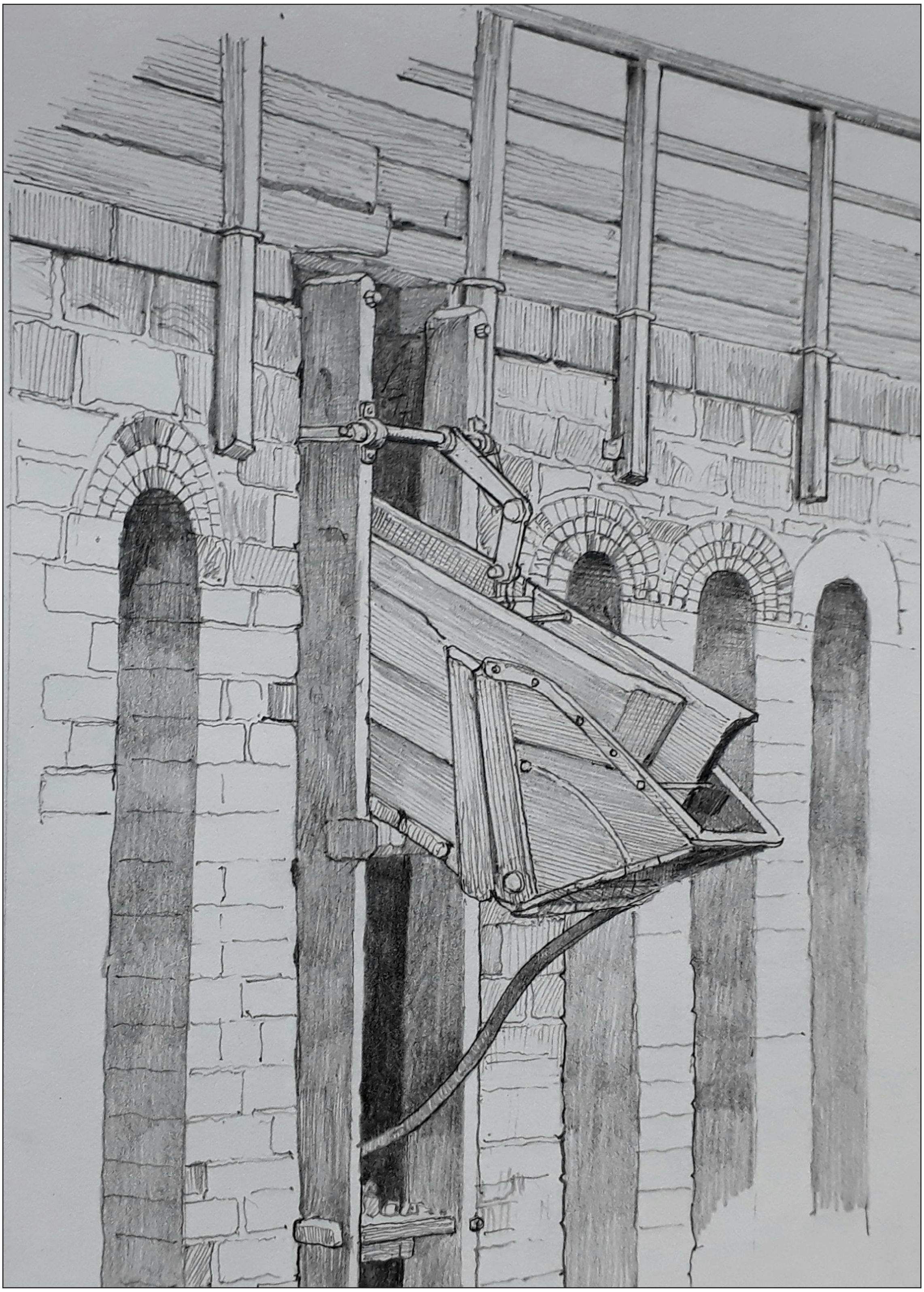

Figure 17. Reconstruction drawing of the hopper/chute mechanism, based on historic photographs, especially Figure 7. [Allan Adams © Historic England].

Figure 18. Reconstruction drawing of a locomotive taking on coal using the hopper/chute mechanism, based on historic photographs especially Figure 7. [Allan Adams © Historic England].

In one of the historic photographs (*see* Figure 5), the area beneath the platform in bay VI has what looks like the remains of a dilapidated timber door at its western end, suggesting the sub-platform area had once been boarded off as a storage facility. If so, the absence of boarding beneath the rest of the platform indicates that this function had ceased long before the photograph was taken in 1925.

Figure 19. Stone plinths on the platform ledge in the east wall of bay III. [Marcus Jecock 5 May 2022 © Historic England].

Figure 20. Joist sockets in the west wall of the demolished bay V. [Marcus Jecock 6 March 2020 © Historic England].

That these three 'platform' bays share common characteristics (all the platforms are at the same height and are directly accessible from trackside) suggests they were designed with the same function in mind. The most credible explanation is that were designed for locomotives that for whatever reason were unable to coal at the gravity-fed chutes. The need for this alternative type of coaling-point evidently remained and furthermore increased through the later 19th century in to the early 20th, since bays V and VI were late additions (post-1856, but pre-1896; *see* chapter 2 above). Having said that, the photographic evidence (*see* Figure 8) suggests that even the steam-powered Sentinel rail-cars of the 1920s and 1930s were able successfully to re-fuel at the gravity-fed spouts.

It was obviously important for locomotive crews to be able to access the top of the stage from trackside, if only to replenish the hopper after use or move an empty coal wagon away from the drop and replace it with a loaded one (unless this was done by a dedicated attendant or cokeman always on hand at the staging). The historic photographic evidence (e.g. Figure 7) shows that access was facilitated by the two-stage flight of wooden stairs that first gave access to the western end of the platform in bay III before at the eastern end of the platform a second flight led on up to the top of the staging. No evidence for either flight survives apart from a short diagonal length of metal handrail attached to the brick arch rings of recess 45 (Figure 21).

Guy (in NRM E5B/243, pp19) has called attention to the fact that historic photographs show recess 44 immediately east of bay III as boarded-in by the 1920s, presumably as a small storage area or shelter accessible from the platform and the foot of the upper flight of stairs. A timber batten survives *in situ* set in to the springings of the arch in this recess; in addition, thin cement fillets survive down the sides of the recess and around the soffit of the arch against which timber boarding or framing for a door and overpanel would have fitted (Figure 22). The fillet is present within the recess down to a level just above that of the ledges in bay III, suggesting the recess was floored at the same height as the adjacent platform. However, if so, there is now no evidence for how the floor was fixed to the walls. There is a shallow area of missing masonry in the west face of this recess, but it is unclear whether the hole is the product of something once set in to the wall having been removed or is just where stones have worked loose and fallen out. A number of iron nails and brackets survive in the rear wall of the recess.

The photographic evidence from 1925 also shows a lamp attached to the staging above recess 44, apparently to illuminate the platform in bay III and/or upper flight of stairs. There are hints in this and other photographs that there were free-standing standard lights of identical design adjacent to bays I, II and IV as well (*see* Figures 5, 7 and 8). Other photographic evidence suggests all lamps had disappeared before 1973. There is no visible evidence in the fabric for how the lamp at bay III was attached to the wall. All lamps appear to be of a standard NER design.

A number of fittings (in addition to the metal handrail and nails already described) do survive attached to the front wall of the staging, however. These include: two

Figure 21. Detail of metal hand rail attached to the arch rings in recess 45. [Marcus Jecock 6 March 2020 © Historic England].

Figure 22. Timber batten and cement fillet in recess 44. [Marcus Jecock 6 March 2020 © Historic England].

Figure 23. Iron brackets either side of bay II, probably anchor points for cable-stays bracing an overhead power gantry. Inset: detail of western bracket showing end of in-situ *cable. [Marcus Jecock 6 March 2020 © Historic England].*

Figure 24. Eye bolt between recesses 38 and 39. [Marcus Jecock 6 March 2020 © Historic England].

small, identical, metal clamps or brackets set at the same high level either side of bay II, one retaining the start of a cable or round bar (Figure 23 and inset); two eye bolts at low level but again at identical heights, one between recesses 38 and 39 (Figure 24) and the other recesses 41 and 42; and sundry metal nails, or holes where nails have been, in the rear walls of some of the recesses and in the walls of the bays (e.g. Figure 25). Furthermore, there appear to be the remains of timber or metal spikes set or driven in to the rear walls of recesses 14, 16 and 26, just below arch-crown height (e.g. Figure 26). Historic photographs suggest the two metal brackets may be anchor points for cables bracing a nearby overhead power gantry (*see* Figures 7 and 8): the line between Shildon and Thornaby - which branched from the S&DR main line at Simpasture Junction to run direct to docks on the Tees - was electrified in 1915 and remained electric-hauled until the mid-1930s (Smith 2019, 140-46). Without similar direct evidence, it is presently impossible to suggest functions for any of the other fittings.

Figure 25. Detail of nail holes in fabric. [Marcus Jecock 6 March 2020 © Historic England].

Figure 26. Detail of metal or wooden spike (ringed) in rear wall of recess. [Marcus Jecock 6 March 2020 © Historic England].

4. DISCUSSION, PARALLELS AND SIGNIFICANCE

According to Guy (NRM E5B/243, pp11n), how locomotives were coaled is one of the few subject areas that, to date, has been less than comprehensively researched by railway historians. Readily available information is therefore somewhat limited. Guy also states that no exact parallels for the Shildon Coal Drops are known anywhere on the national rail network. While it is true to say that no other locomotive-coaling plant operating on the precise same model as the Shildon Drops is known to survive today, research for the present report has identified one comparable former example: that built in 1917 by the Lambton Railway (a privately owned colliery railway later subsumed in to the National Coal Board) at its engine works/running shed at Philadelphia in County Durham (Lambton Locomotives Trust nd; information from John Teasdale). This stood at NZ 33444 52327 (Ordnance Survey 1946b - on which map it is named as 'Gantry' with its extent indicated by a dashed line), 28.5km north-north-east of Shildon as the crow flies. Photographic evidence (Figures 27 and 28) shows that the Philadelphia coaler comprised an elevated stage carried on steel trestles, approached by a ramp on stone piers, from which bottom-discharge wagons emptied their loads in to metal bunkers suspended beneath the stage; locomotives wanting to coal took on fuel from the bunkers through metal spouts or chutes that hinged upwards out of the way when not in use. The Lambton Railway closed in 1967; the coaler appears to have been demolished in the 1990s, and certainly prior to December 2001 (Google Earth imagery).

Nationally, arrangements for coaling locomotives seem to have been rudimentary for much of the first hundred and more years of the existence of steam-hauled public railways in this country; arrangements also varied between companies. In fact, looking at the readily available evidence (reviewed briefly below), the Shildon coaling stage could even be said to have been one of the more automated coaling plants in operation before *circa* 1910 when the UK's first fully mechanised coaler based on the gravity-feed principle was constructed at Crewe. That said, other methods of coaling locomotives in Victorian and Edwardian Britain were seemingly almost as fast, if not faster, in dispensing fuel and may not have required many more cokemen to operate than the Shildon Drops.

The aforementioned mechanised coaler at Crewe was innovatory in that it employed a rotary tippler to turn an entire rail wagon upside-down and discharge its load in to an underground hold, from which a conveyor supplied an overhead bunker ready for coal to be discharged under gravity in to locomotive tenders brought underneath (Guy in NRM E5B/243, pp11). The NER constructed their first such mechanised coaler in 1916 at the Hull Dairycoates shed: as with the Crewe prototype, this tipped coal in to an underground hold but in contrast used a chain of buckets to move it up to two overhead bunkers (Foster 2007, 61). More than 100 such mechanised coalers (e.g. Figure 29) were built at engine sheds in Britain, to a variety of designs, in the ensuing almost six decades until the demise of steam traction on Britain's railways in 1968. Only one still stands: that built by the London, Midland & Scottish (LMS) Railway between 1938 and 1940 at Carnforth (and which is listed at Grade II* (NHLE 1078213)). Such 20th-century behemoths (they had massive frames of steel or ferro-concrete) were of two basic designs: one elevated the entire coal wagon and

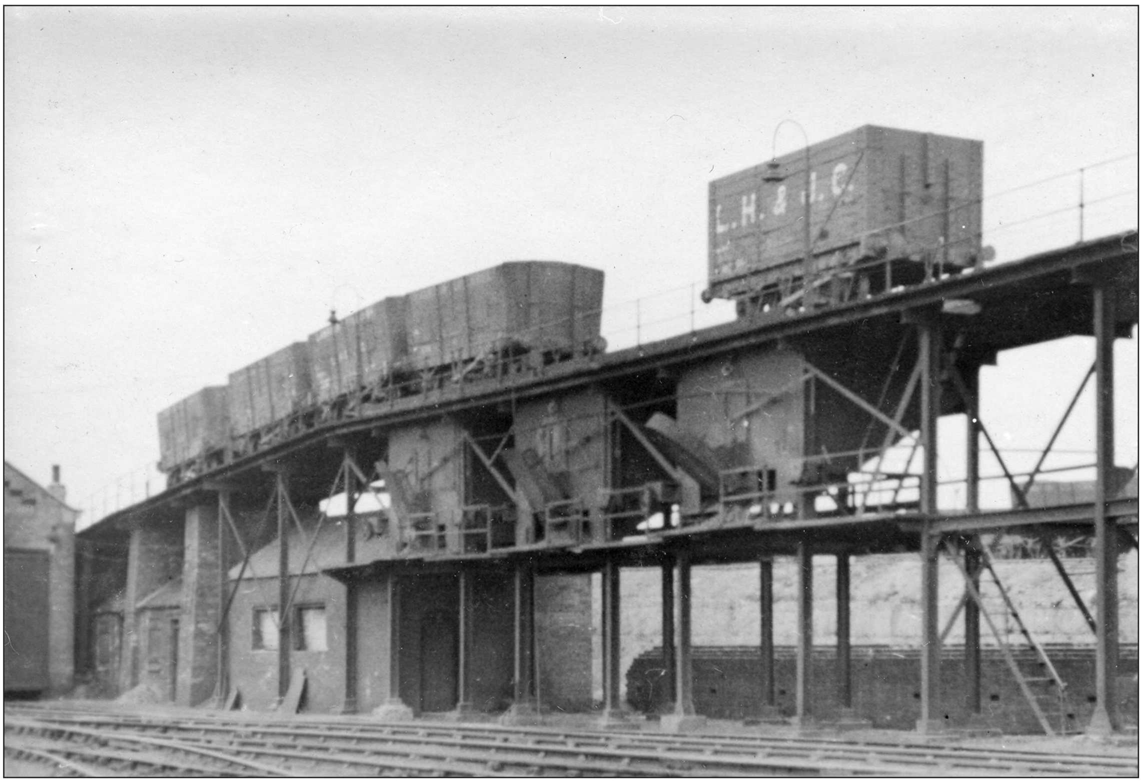

Figure 27. The Lambton Railway's Philadelphia coaler as photographed on 2 July 1938. Note the stone piers to the ramped section and the metal bunkers with chutes that hinged up out of the way when not in use. [Unknown photographer; © Ken Hoole Collection/ Head of Steam – Darlington Railway Museum].

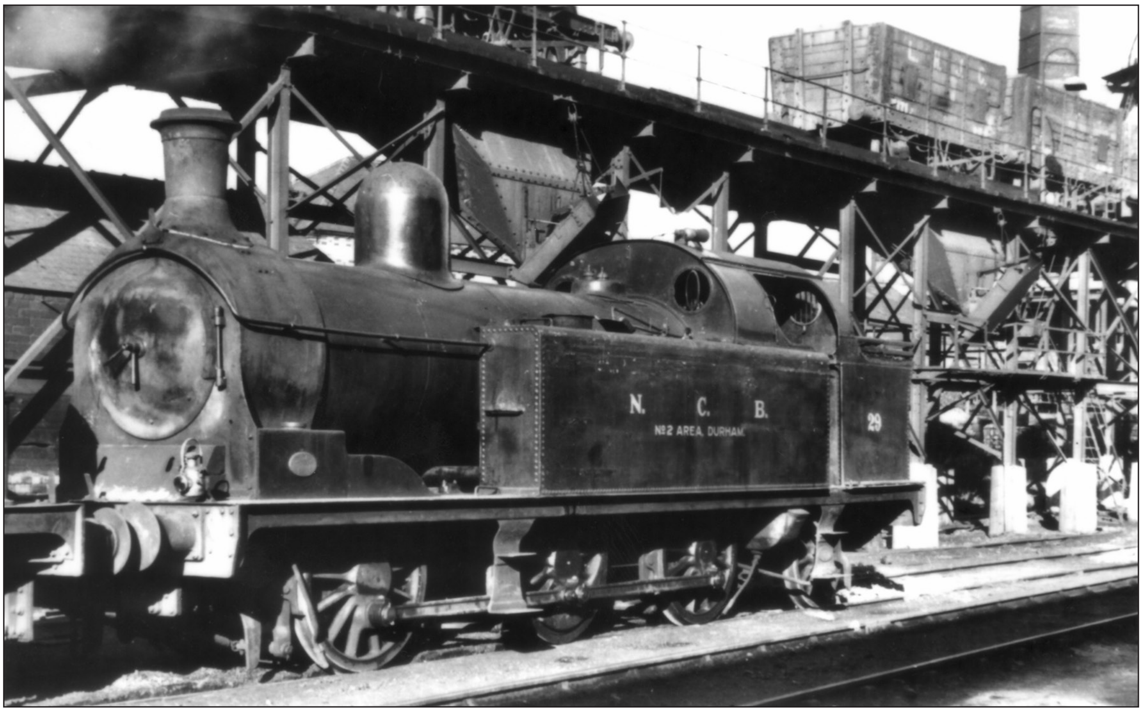

Figure 28. The coaler erected in 1917 by the Lambton Railway (later incorporated in to the National Coal Board) at their Philadelphia engine shed, here photographed in 1954. [Unknown photographer; image courtesy of John Teasdale].

emptied it in to an overhead bunker, the other emptied the wagon at ground level as at Crewe and Hull Dairycoates in to underground holds from which coal was raised to bunkers over the tracks. Experience showed the latter design was more efficient since raising a skip rather than a whole wagon to height was less demanding in energy; it was also easier to make sure that different grades of coal went in to the correct bunker and to spot offending items in the delivering wagon (The Railway Hub 2019). However, underground holds presented their own set of problems, such as the requirement for pumps to counteract a tendency to flood. Useful papers describing the form and discussing the advantages and disadvantages of mechanised coalers erected in Britain before the start of the Second World War can be found in two issues of the *Journal of the Institution of Locomotive Engineers* (Parker 1923; Critchley 1937).

Prior to the introduction of mechanical coaling in 1910, one common method of fueling locomotives (certainly on the NER) was to shunt coal wagons up an incline on to a stage - as at Shildon and Philadelphia - but to offload the coal by hand through doors in the sides of the wagons in to various forms of barrow and tub which were wheeled to the edge of the stage and manually tipped in to the tenders of waiting locomotives. The design was obviously necessary where the dominant form of coal wagon was one with side- rather than bottom-opening doors. Subtle variations in detail are known. At some NER and neighbouring Great Northern Railway (GNR) engine sheds, photographic evidence shows that a two-wheeled metal barrow with an off-centre axle to allow easy manoeuvring by a single cokeman was in use (Figure 30). The wheels had distinctive curved spokes, suggesting to Foster (2007, 61) that they were mass-produced and that their use was probably more widespread than just on the NER and GNR. However, prior to ‘Grouping’ in to the London & North Eastern Railway (LNER) company in 1923, the NER and GNR were already operating in close alliance to provide through-train services between London and Scotland; it is therefore possible the two companies shared a common design of coaling barrow simply on account of these links. The barrows appear to have been tipped off metal platforms (hinged at the base and supported by side chains) which could be lowered over the tender whilst coaling and raised to the vertical when not in use, thus helping to prevent accidental falls off the stage by the cokeman or cokemen as well as keeping the locomotive-coaling road clear of overhead obstructions.

On the NER/LNER and later in British Rail days, photographs record this design of coaler installed at both Middlesbrough (Figure 30) and South Blyth sheds; by 1961, the coaling stage at South Blyth was also protected against the weather beneath a framed structure, roofed and walled with corrugated-metal sheets (ibid., 63 figure 5). However, at sheds elsewhere, including York, the NER employed four-wheeled tubs with the tub body attached to the bogie by an off-centre pivot enabling the body to be tipped and emptied through a hinged door in its far end – at York in to counter-weighted, hinged, metal spouts attached to the side of the stage (ibid.; Guy in NRM E5B/243, pp10). At Alnmouth shed, coal wagons seem to have been drawn up on to a low stage only high enough to raise the wagon floor to a height coincident with the top of the tender waiting on the adjacent coaling road, to facilitate direct shovelling from the side doors of the wagon in to the tender (Foster 2007, 61); this would appear

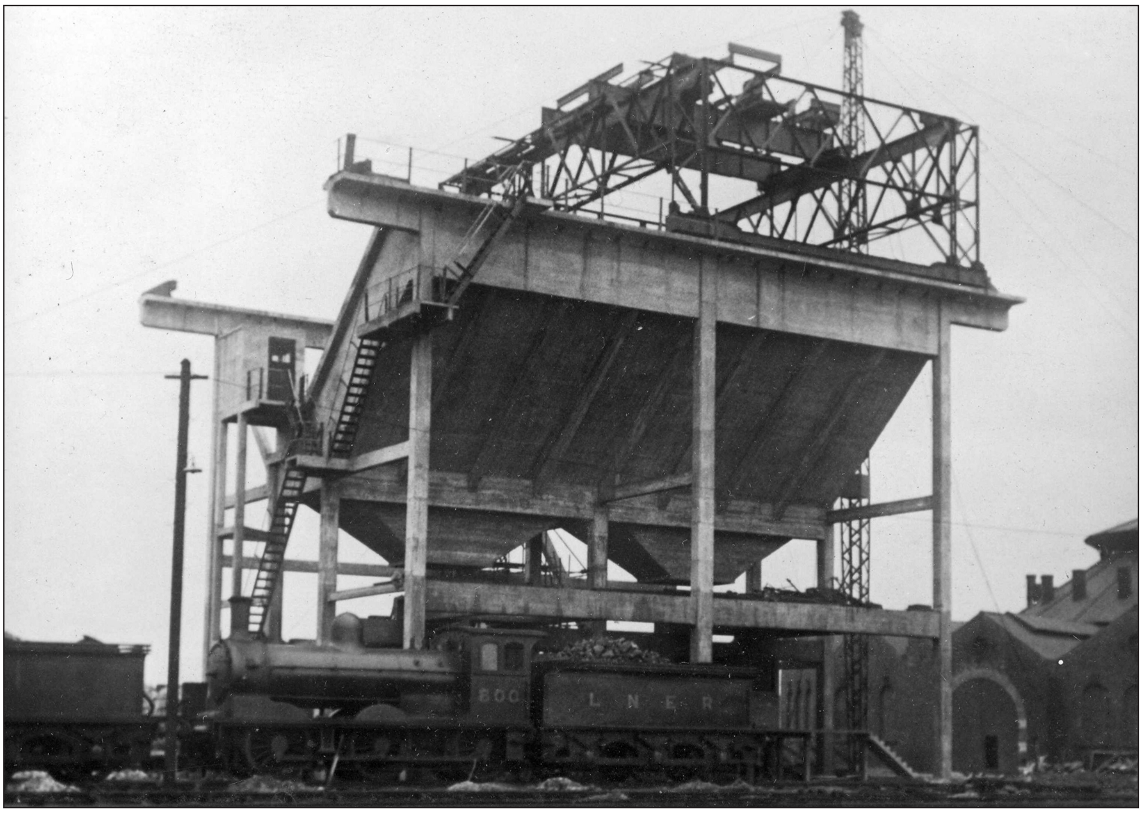

Figure 29. The mechanised coaler at Darlington Bank Top, photographed 19 March 1939. [Unknown photographer; © Ken Hoole Collection/Head of Steam – Darlington Railway Museum].

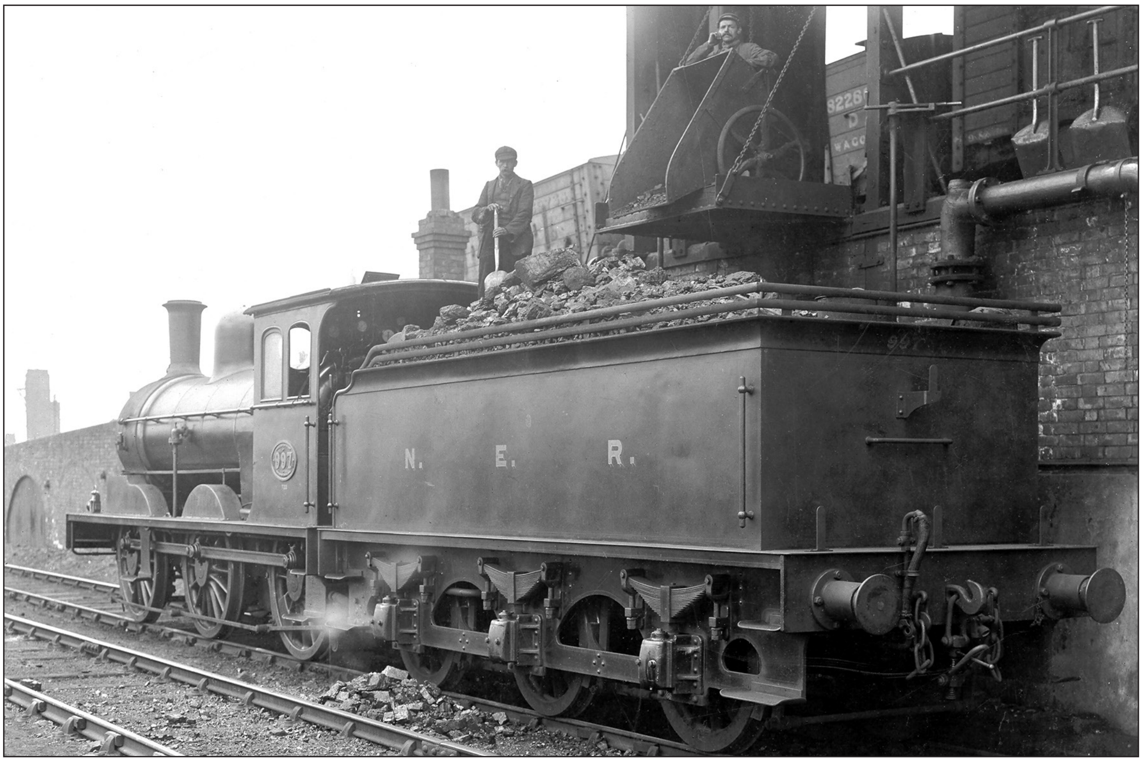

Figure 30. NER 'C1 Class' locomotive no. 997 takes on coal at Middlesbrough sometime between 1904 and 1917. [NERA Collection, reproduced with permission].

to provide an analogue (of sorts) for the type of coaler in bays III, V and VI of the Shildon Drops, although at Shildon the coal was seemingly shovelled off a platform rather than directly from parked wagons.

Other railway companies probably used similar methods, but with slight regional variations. At the coaler which the Great Western Railway (GWR) constructed at their Didcot shed in 1931 for example (which is Grade II-listed (NHLE 1389009)), coal wagons were shunted up a ramp on to a high-level stage and then emptied by hand in to tubs that ran on a short set of rails set perpendicular to the stage and which turned up at the end providing a stop-mechanism and pivot-point against which the rear end of the tub could be manually lifted to discharge its contents through a hinged door at the front in to the waiting tender below (Didcot Railway Centre nd). The reason why the GWR did not erect an automated mechanical coaling plant along the Crewe model at Didcot in 1931 - when after all such designs had been in use and their benefits apparent for over 20 years - is not clear. It may have been to do with capital outlay, especially at a time of economic depression and hardship in the years following the Wall Street Crash of 1929; it may not be without significance that the coaler was built using Government money advanced under the Development (Loans, Guarantees and Grants) Act of 1929, the specific purpose of which was to provide employment during the Great Depression (NHLE 1389009). Manual methods of coaling that required more labour than the modern, mechanised plants may have been the very reason why an old-fashioned design was preferred in this instance.

At sheds where it was not possible to provide an incline and stage, other methods of coaling are evidenced before 1910, and again such methods continued in use afterwards, often right up to 1968. Such methods ranged from filling small tubs by hand from lineside bunkers or parked wagons and using steam (and later, diesel and electric) cranes to lift and empty them in to the waiting locomotive tender (e.g. Figure 31), to at the Manchester London Road (later Manchester Piccadilly) shed a (seemingly) unique design comprising a rotating carousel of 20 wrought-iron buckets carried on a canted pole that could raise coal from wagons on one track up and over a locomotive tender positioned on the adjacent coaling road (Figure 32).

The former practice (of using cranes to lift tubs of coal) continued right up to the demise of steam on Britain's rail network. Sometimes the cranes were mobile, as is recorded photographically at Kittybrewster shed, near Aberdeen, in the 1920s or early 1930s (Guy in NRM E5B/243, pp12) and again at Whitby shed in the 1960s, but at Consett shed the crane was stationary and mounted on a brick base (Foster 2007); West Auckland shed also had a stationary steam crane in the 1930s but by 1964 this had been replaced by an electric gantry crane (John Askwith, pers. comm.). At other northern English sheds including Pickering, Saltburn, Barnard Castle and Masham, small hand-operated cranes similar to those found inside goods sheds were used; at Kirby Stephen, Carlin How and Wear Valley Junction sheds these cranes had double jibs, presumably to allow a full tub to be attached to one jib whilst the tub on the second jib was being emptied in to the tender, thereby speeding the coaling process. The tubs in such cases had a 'handle' across their top attached to lugs on each side of the body to facilitate lifting by the crane (Figure 31); once above the tender, a lever and rod mechanism was operated by the locomotive fireman

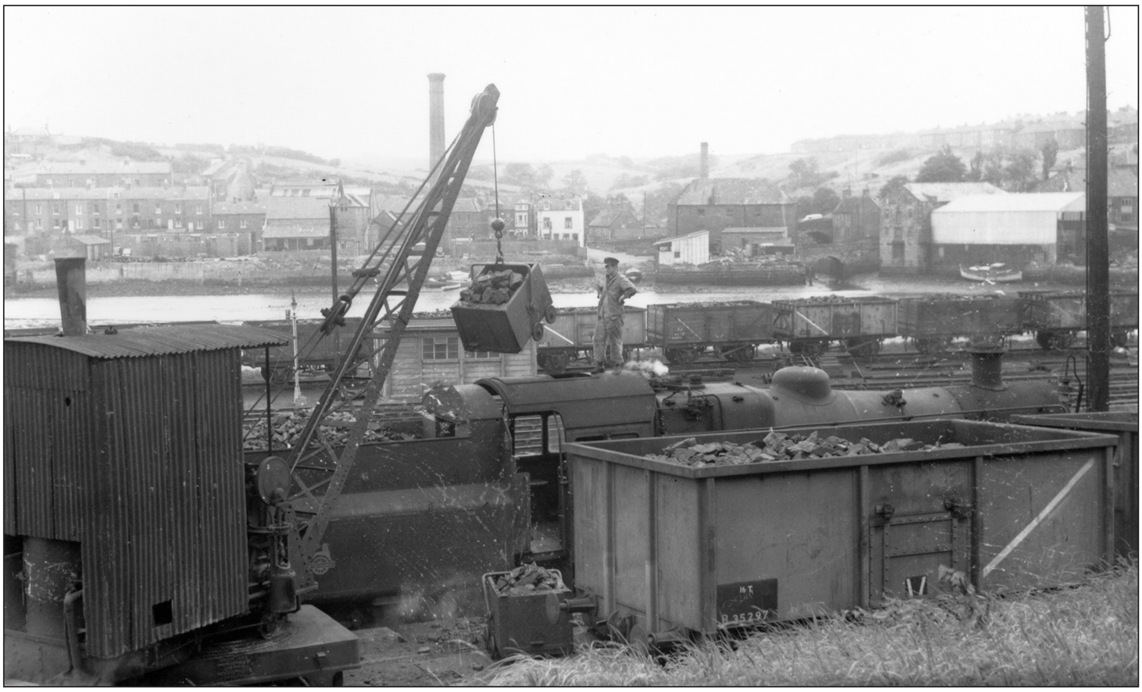

Figure 31. Steam crane coaling a locomotive tender at Whitby shed, in August 1957. [NERA Collection, reproduced with permission].

standing in the tender or on the locomotive-cab roof to release the coal through an end-door. Tubs came with and without wheels (Foster 2007).

The second practice (the rotating carousel at Manchester London Road Station) was designed by John Ramsbottom for the London & North Western Railway (LNWR) in 1851 or 1852 (Figure 32). Belying its somewhat Heath-Robinson appearance, it reportedly needed only one cokeman additional to the locomotive fireman to operate and was said to be capable of delivering up to 21 hundredweight (hereafter abbreviated to cwt), equal to 1.067 tonnes, of coal within two minutes in to a waiting tender if the buckets were loaded beforehand; a downside was that the carousel easily fouled the chimney of the engine being coaled which consequently had to reverse carefully in to position (Ramsbottom 1853). This probably accounts for why this particular method did not catch on more widely; it seems to have been a design dead-end.

So, questions remain: what were the precedents for the Shildon Coal Drops (if any), what inspired their design, and why was the design not imitated widely on the Victorian and early 20th-century rail network? Let us consider these questions in order.

We have already seen (above, pp5) that prior to the opening of the Drops in early 1847, locomotives were in all probablity coaled at Shildon by cokemen shovelling from lineside bunkers (possibly with the assistance of a small lineside crane, although there is no direct information to confirm that). According to Critchley (1937, 780), such hand-shovelling either from bunkers or from wagons parked on a parallel siding to the coaling road was indeed the earliest method used to coal locomotives. The present study has found no evidence to suggest this was anything other than normal practice on the S&DR - or other railway companies – prior to 1847; indeed, it would seem that railway engineers elsewhere in England were trying to come up with mechanisms to improve and speed coaling practice at just this same time, such as Ramsbottom's rotating carousel of the early 1850s just discussed. In consequence, the available evidence points to the Shildon Drops of 1846/7 being the earliest attempt to mechanise the process of locomotive coaling in Britain and, given Britain's primacy in railways, possibly the world.

What inspired the Shildon design? Without original documentation or design drawings it is not possible to arrive at definitive conclusions, but for over a century prior to 1847 coal drops of various designs had been in use at riverine and coastal staiths (the preferred regional, North-East English, spelling of that term) to transfer coal arriving in wagons from inland mines along the multitude of colliery plate-, wagon- and rail-ways that had sprung up nationally, in to colliers for onward sea-transport to distant markets. The design of wagon used on these colliery lines varied regionally. In north-east England, the preference was to transport coal in large wagons each holding 53 cwt (2.693 tonnes). These were known as chaldron wagons after the volume of their load (a chaldron was a legal measure of volume for bulk dry goods, especially coal); they generally had bottom-opening doors. In other parts of the country smaller wagons of a variety of designs were preferred, some with hinged end-doors. In every case, the goal was to avoid dropping coal from height in order to minimise breakage: large lump coal was more valuable than small lumps was more valuable than dust. At some staiths, wagons were put on a platform that lifted them up and over the gunwale of the collier and lowered them in to the ship's hold before the load was released (for wagons with end doors, this could involve tipping the platform as well); at other staiths, especially those handling bottom-discharge chaldron wagons and where the railway approached the staith at height and so was already above gunwale-level, coal was frequently released on to diagonal chutes (also called shoots or spouts) to slide gently down in to the hold (counterbalanced platforms were used in such locations, too). The S&DR's early staiths at Stockton may well have employed such chutes, but by 1830 much of the company's coal traffic had transferred down river to new deep-water staiths at Port Darlington (Middlesbrough) where, because the line did not approach the staiths at height, the company's engineer, Timothy Hackworth, designed special lifts to raise each chaldron wagon, one by one, up, over and down in to the collier before its contents were released (Powell 2000, 19-20). Elsewhere in the north-east of England, however, chutes were common by the 19th century (ibid., *passim*), including for example those designed in 1858 by the NER's then Chief Engineer, T. E. Harrison, for the company's staiths at Tyne Dock. These incorporated a series of chutes stacked vertically to overcome the problems of loading ships of different size at different states of the tide and the effect of a ship settling in the water as its load increased, but Harrison's design also featured traps to retain coal within the upper part of each chute (in effect transforming it in to a bunker as well) until the lower part of the mechanism was in place (Los & Proud 1988, 104). This is reminiscent of the trapdoors we see incorporated in to the Shildon Coal Drops by the early 20th century (above, chapter 3, especially Figure 17). Admittedly it cannot be proven that such trapdoors were present in the Shildon drops as early as 1847: it is plausible that they were only introduced as part of the re-design recommended by the jury adjudicating the 1884 fatal accident inquest (above, pp8-10).

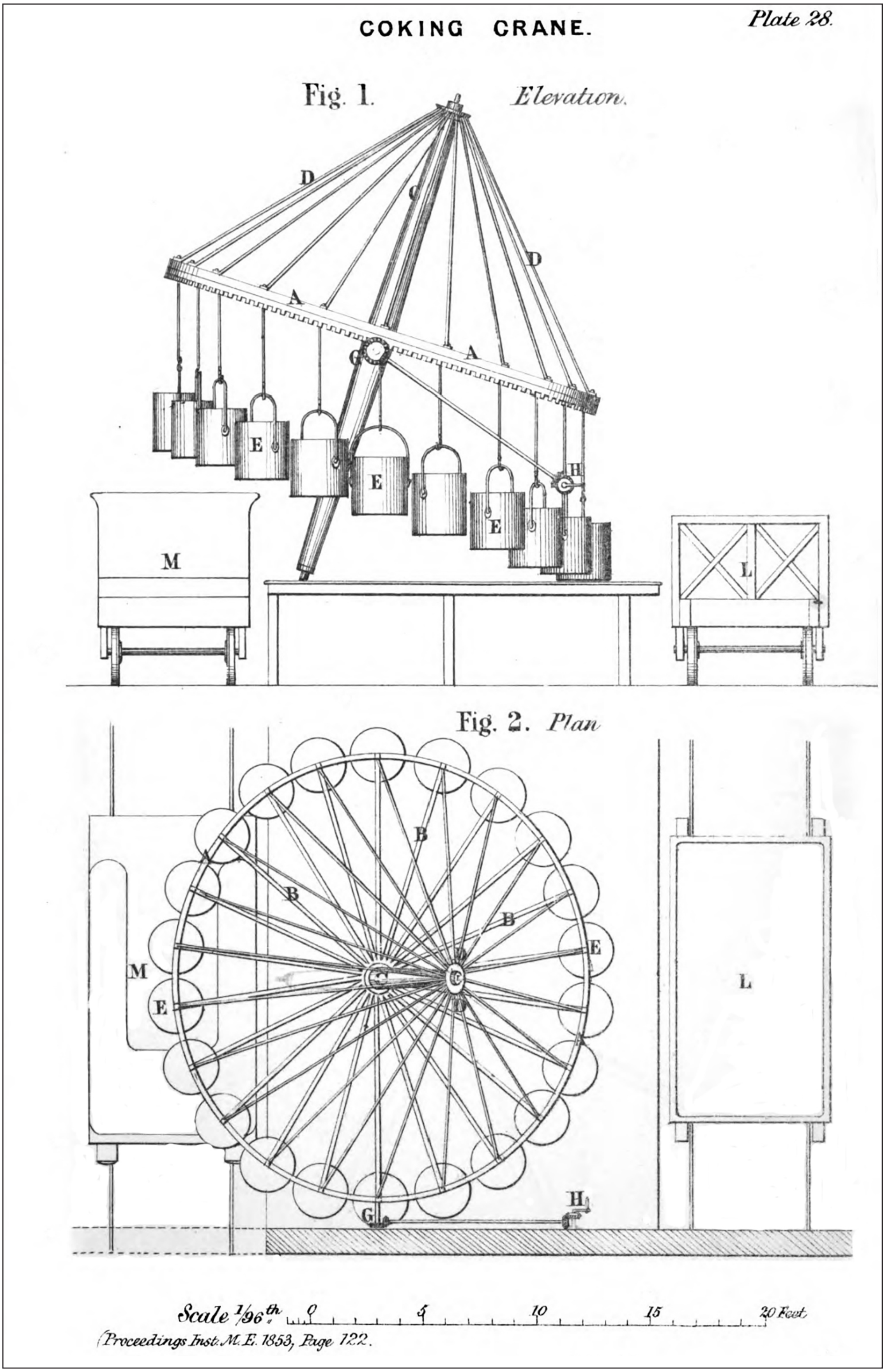

Figure 32. The canted, rotating carousel designed by John Ramsbottom circa 1851 for the LNWR and installed at Manchester London Road (later Manchester Piccadilly) Station (Ramsbottom 1853, plate 28).

Finally, let us consider the question of why the basic operating principle of the Shildon Coal Drops appears not to have been copied widely on the Victorian and early 20th-century rail network. The fundamental issue militating against widespread adoption of the design must be the variety of types of coal wagon that were used by different rail companies and collieries. Obviously, gravity-fed coal bunkers suspended above a coaling road were only possible where it could be guaranteed that coal would always arrive in wagons with bottom-opening doors. At Shildon, the coaling stage was designed right from the start to receive all its coal from a single colliery, Black Boy (above, pp7 and 12), whose entire wagon fleet presumably consisted of the bottom-discharge type. In contrast, coalers built by other early rail companies may well have received their coal from collieries whose wagons had end- or side- rather than bottom-opening doors. Until 1910 and the advent of coalers that upended the whole wagon, it was only where a railway was specific to a colliery or number of collieries in the same ownership and operating a standard design of bottom-discharge wagon (such as the Lambton Colliery Railway's engine shed at Philadelphia) that the Shildon design of coaling stage could be contemplated.

5. SURVEY METHODOLOGY

A baseline was established utilising Global Navigation Satellite System (GNSS) equipment employing network Real Time Kinematic (RTK) corrections. This provided Ordnance Survey National Grid coordinates from which scale factor was then removed in order to generate a local grid system suitable for accurate, divorced survey. A series of black and white scan-targets were then observed using a total station theodolite to act as control for Terrestrial Laser Scanning (TLS). Overlapping photography was also captured sufficient to carry out Structure from Motion (SfM) photogrammetric modelling of the whole structure; photographic imagery was captured from the ground as well as from above utilising a drone-based camera.
A registered point cloud was then produced and processed together with the SfM photography to produce a 'Reality Capture' model of the whole structure: this is a 3D model which benefits from the photorealistic textures provided by SfM modelling whilst retaining all of the robust geospatial framework provided by the registered point cloud. All plans, sections and elevations have been generated from this textured model.

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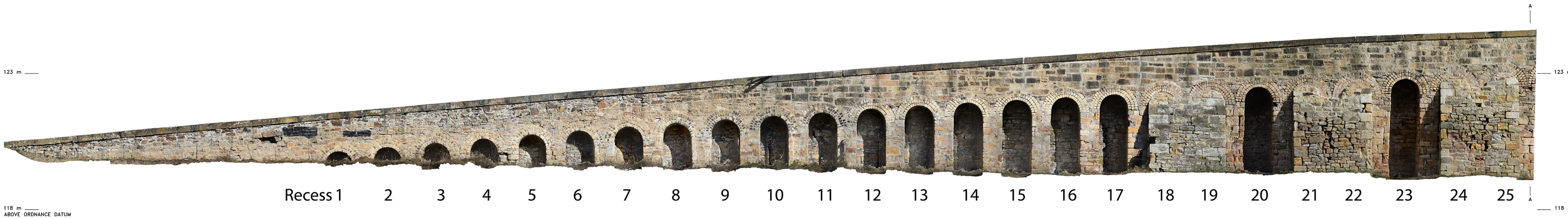

Figure 33. Orthophotographic elevation of the south face of the Coal Drops (western end). From original survey drawing. [© Historic England].

MAIN TITLE SHILDON COAL DROPS
TOWN SHILDON
COUNTY Co DURHAM

SUBSIDIARY SOUTH FACE – SHEET 1
SCALE 1:50

BENCH MARKS USED ORDNANCE DATUM NEWLYN BY MEANS OF GNSS OBSERVATION

LOCATION DIAGRAM

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Figure 34. Orthophotographic elevations of the south face of the Coal Drops (recess 25 to end) and of the west face of bay V. From original survey drawings. [© Historic England].

SHILDON COAL DROPS
SHILDON
Co DURHAM

SOUTH & EAST FACES – SHEET 2

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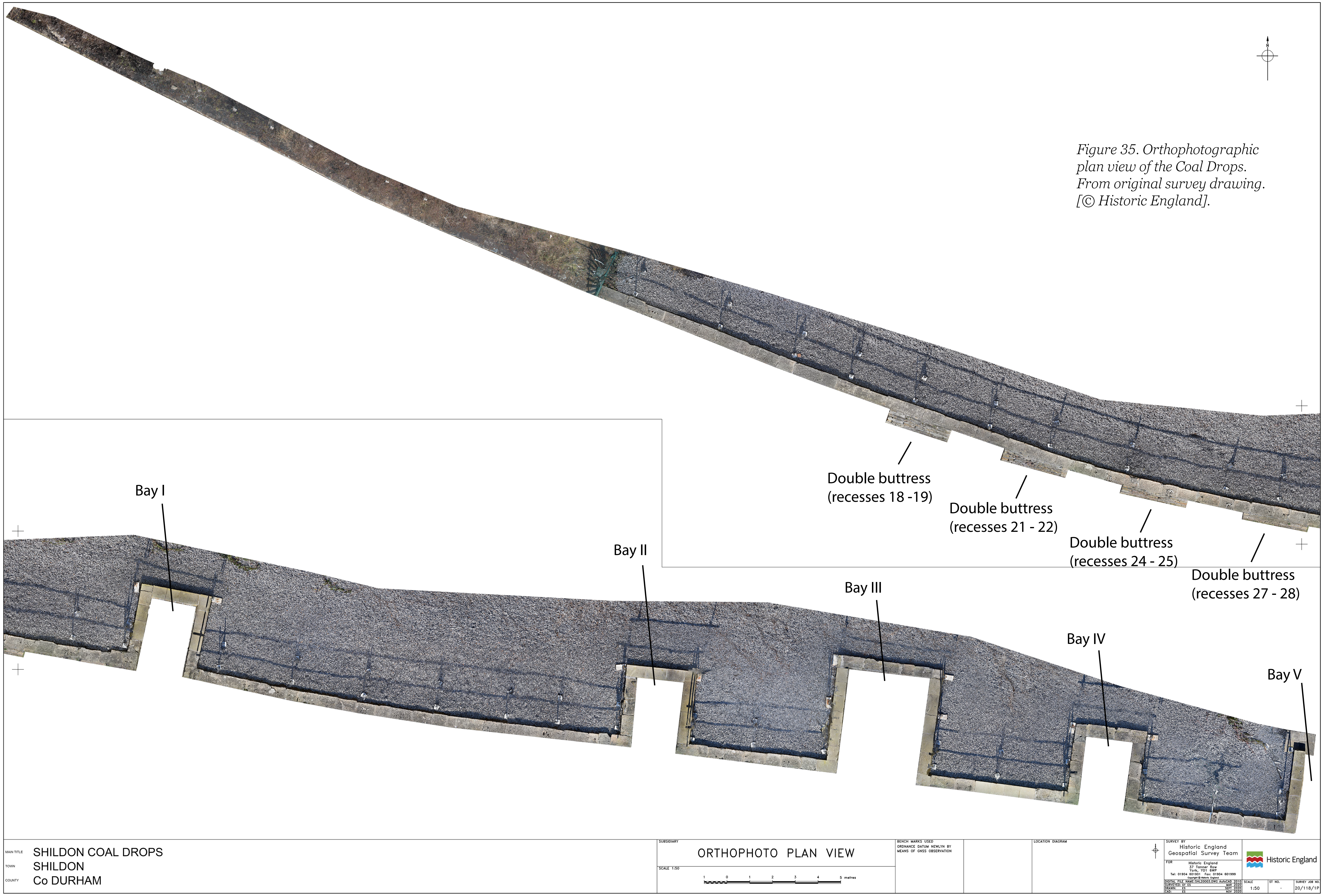


Figure 35. Orthophotographic plan view of the Coal Drops. From original survey drawing. [© Historic England].

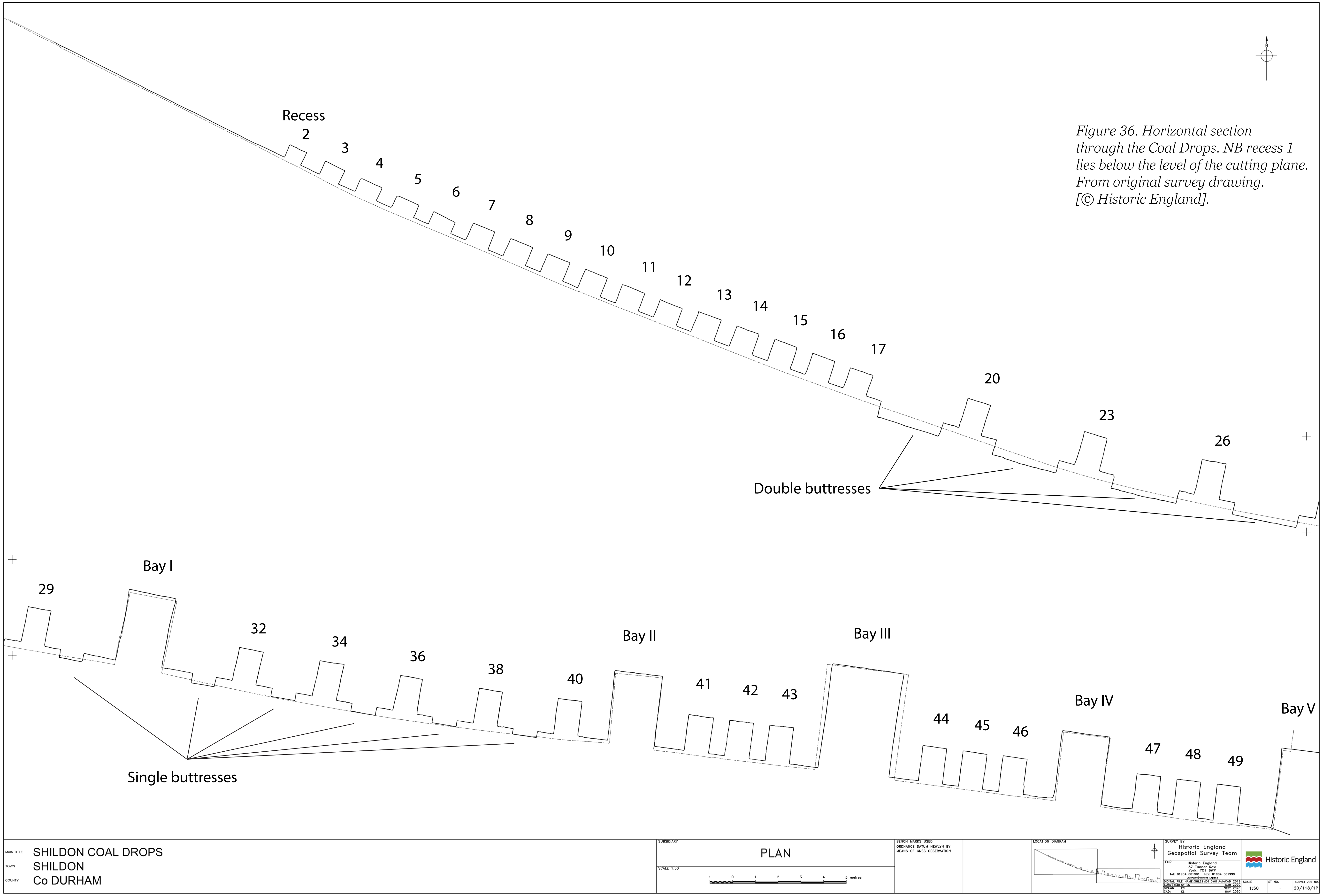


Figure 36. Horizontal section through the Coal Drops. NB recess 1 lies below the level of the cutting plane. From original survey drawing. [© Historic England].

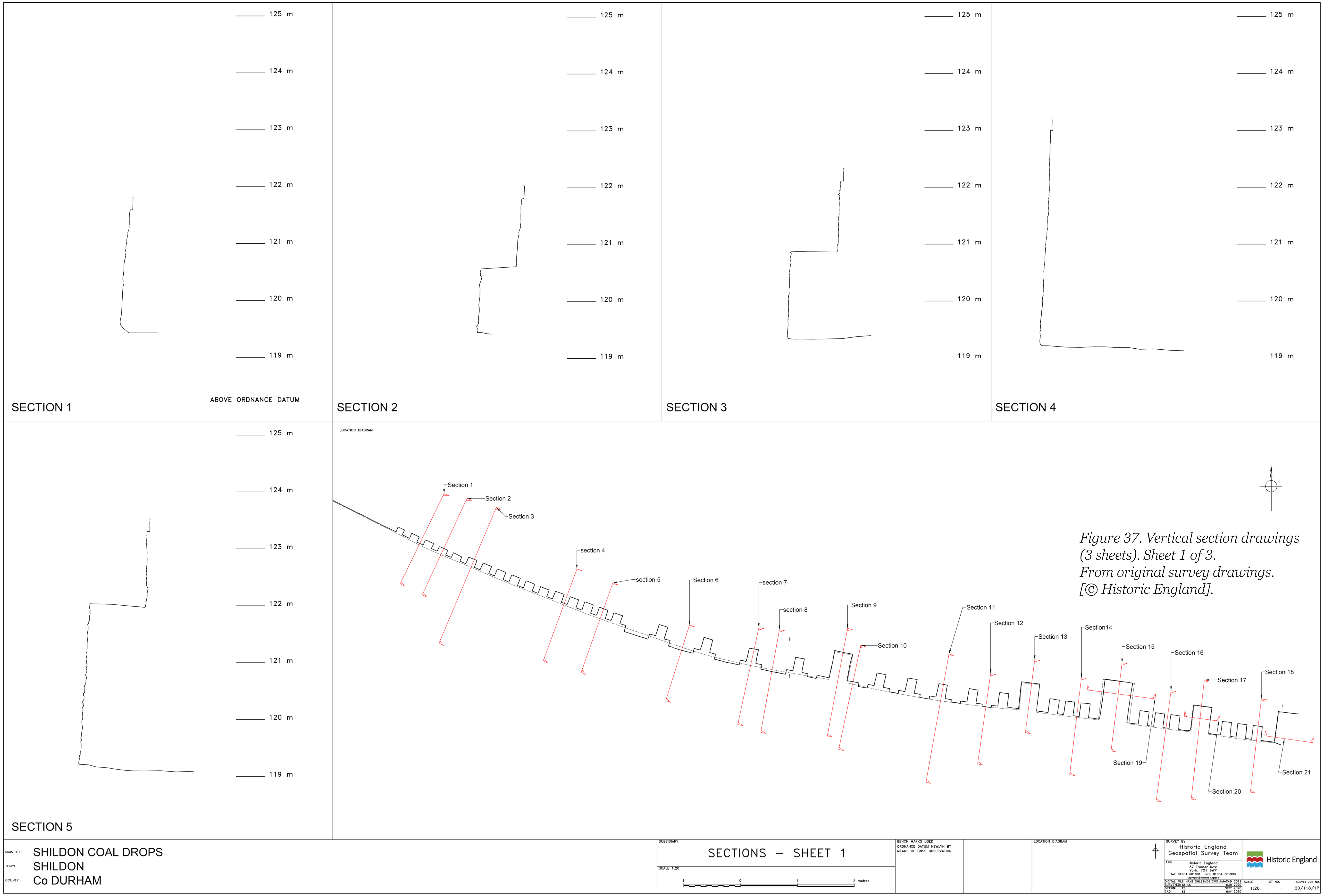
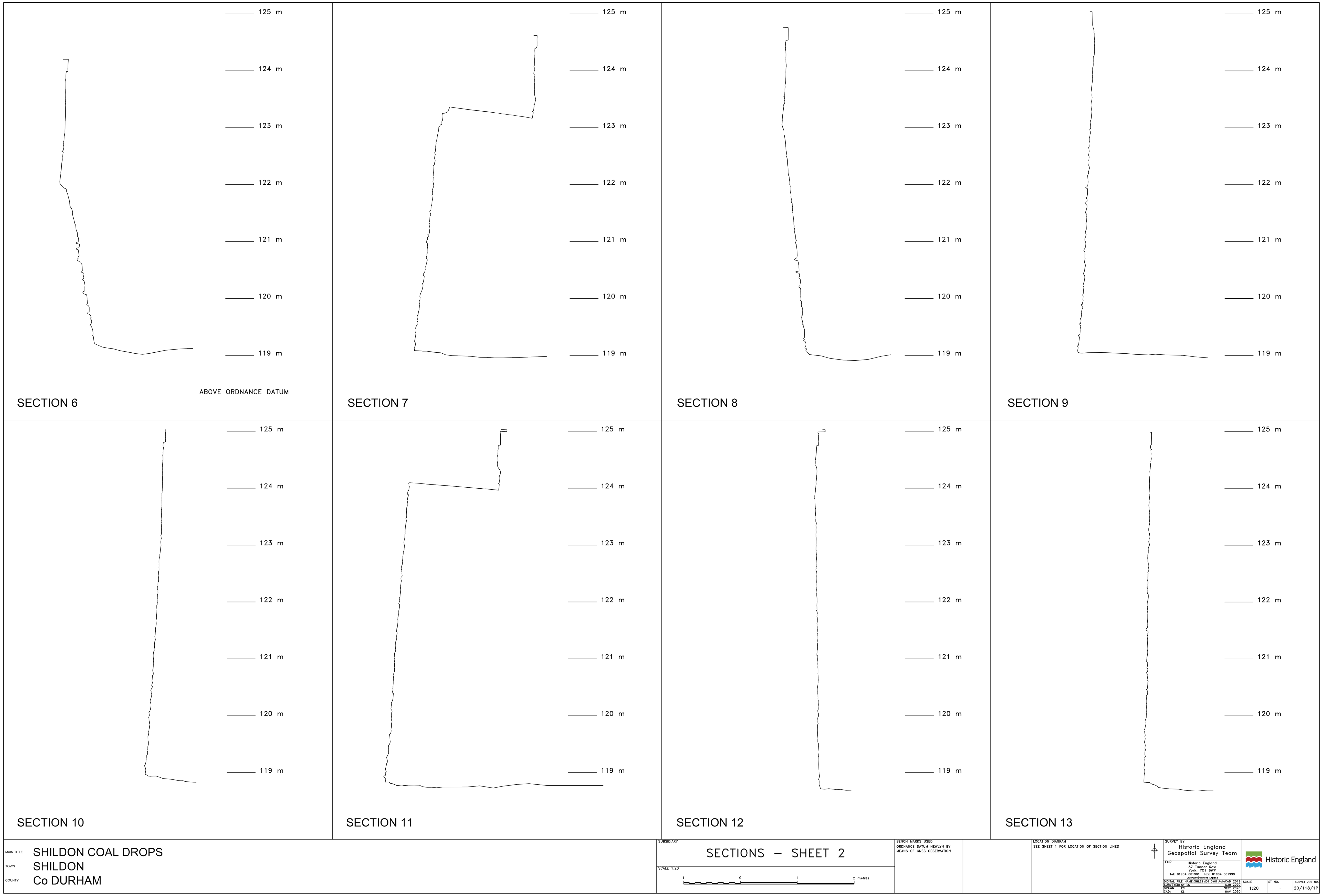


Figure 37. Vertical section drawings (3 sheets). Sheet 1 of 3. From original survey drawings. [© Historic England].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MAIN TITLE
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TOWN
SHILDON
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SUBSIDIARY
SECTIONS – SHEET 2
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BENCH MARKS USED
ORDNANCE DATUM NEWLYN BY MEANS OF GNSS OBSERVATION
LOCATION DIAGRAM
SEE SHEET 1 FOR LOCATION OF SECTION LINES
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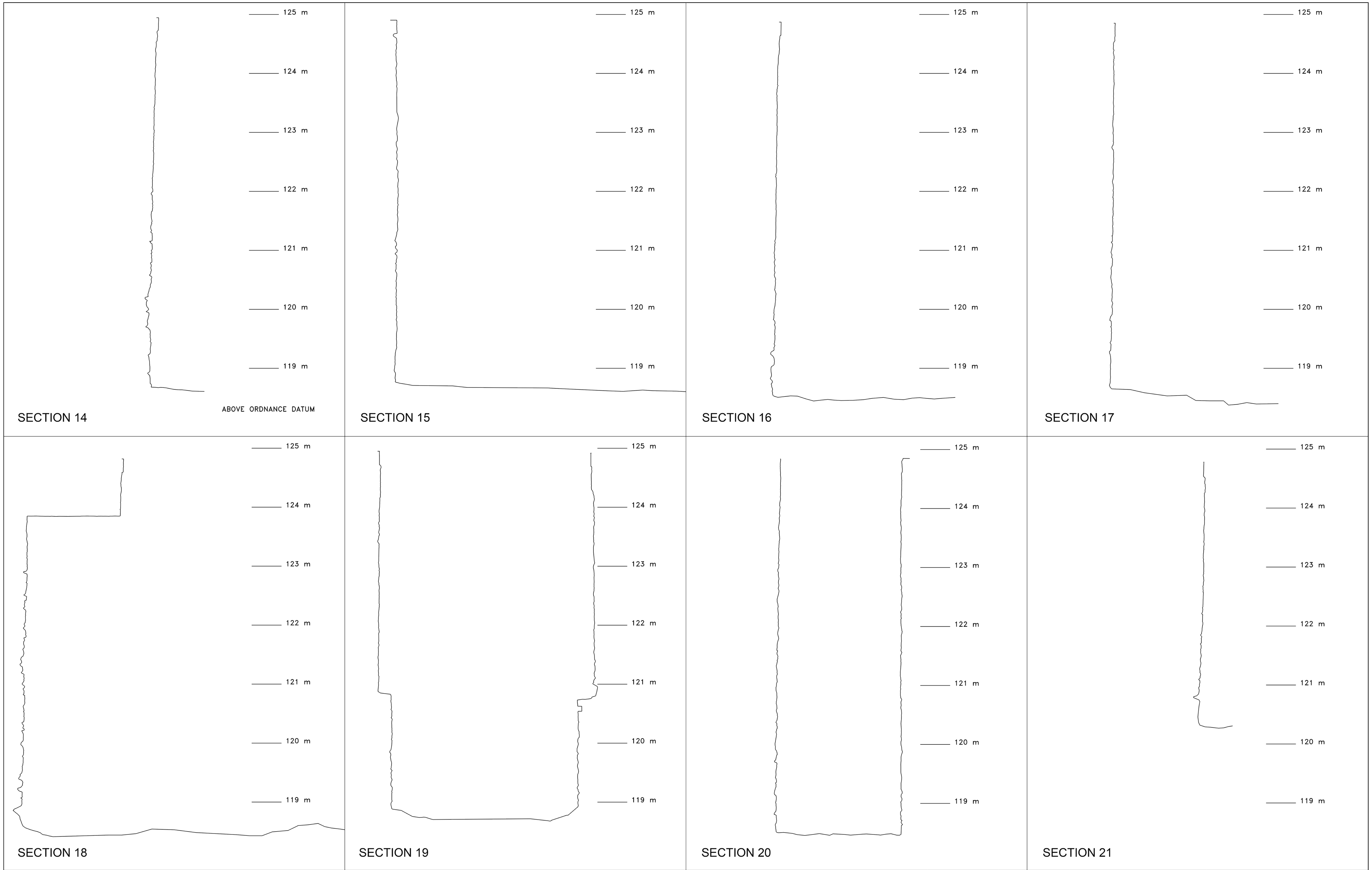

MAIN TITLE SHILDON COAL DROPS
TOWN SHILDON
COUNTY Co DURHAM

SUBSIDIARY
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BENCH MARKS USED
ORDNANCE DATUM NEWLYN BY MEANS OF GNSS OBSERVATION

LOCATION DIAGRAM
SEE SHEET 1 FOR LOCATION OF SECTION LINES

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