

THE WASHING FLOOR AT KILLHOPE LEAD MINE, CO. DURHAM: AN INTERIM REPORT

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ABSTRACT

Historical evidence suggests that the Killhope washing floor was constructed in the mid 1870s, immediately before an adjacent mechanised dressing mill. The excavation revealed an array of hand-operated ore-dressing structures, including what are interpreted as sets of linked grates, collecting boxes, trunk buddles and hotching tubs. Sediments were collected in settling tanks, and re-processed on Brunton Buddles.

INTRODUCTION

Park Level Lead Mine, Killhope, lies at the extreme head of Weardale (fig 1), some 2 1/2 miles east of Nenthead (Critchley 1984), and in the centre of the North Pennine orefield. The site is notable for its well-preserved ore-dressing works (both manual and mechanical), now being restored by Durham County Council. As part of this programme the author was engaged in 1983, 1984 and 1985 to excavate the washing floor and adjacent areas. The present report therefore concentrates on presenting the results of this excavation; no attempt is made to discuss the underground workings, or to present the results of Peter Brown's excavation in the Jigger House (Brown 1982), and only brief surveys are made of the historical evidence (relying heavily on work in progress by Ian Forbes), and of the layout of the rest of the site. The main published report on the site is by Beadle (1968); detailed information on recent work is contained in unpublished reports by Brown (1982), Coggins (1985), Cranstone (1985a and b), and Forbes (1985).

HISTORICAL SURVEY

Lead mining in the North Pennines has taken place intermittently since the Roman period, reaching a peak in the 18th and 19th centuries (Hunt 1970; Raistrick and Jennings 1965; Critchley 1984). In this latter period the regional industry was dominated by two large companies, the London Lead Company and the Blakett/Beaumont Company; the former was a national undertaking, though its operations were increasingly centred on the North Pennines, while the latter was confined to the North Pennines, where it was usually the largest employer. The London Lead Company's mines were centred on the Teesdale and Alston Moor areas (including Nenthead), whereas the Blakett/Beaumont Company owned the Allendale mines and leased the Weardale mines (including Killhope) from the Bishopric of Durham. Both companies were crippled by the slump of the late 1870s (Burt 1984); the Weardale mines were taken over in 1883 by the Weardale Lead Company, but after a short revival the long-term decline continued.

The first known references to mining at Killhope (quoted in Hunt 1970) date from the later 18th century, but probably reflect mining along the outcrop of the veins at Killhopehead, 1 mile west of Park Level. In 1828 an ore crushing mill was erected at Burn Bottom, c 400m upstream from Park Level. Driving of Park Level started in 1853 but ore production was minimal until the end of the decade and only increased dramatically in the mid 1870s when Park Level reached the rich Killhopehead Vein, and became the outlet from the formerly-separate Killhopehead Mine. By 1858, OS maps show the lodging shop adjacent to the Level mouth and a set of 5 or 6 bouse teams across the later washing floor site. In 1862, new bouse teams and a washing floor were

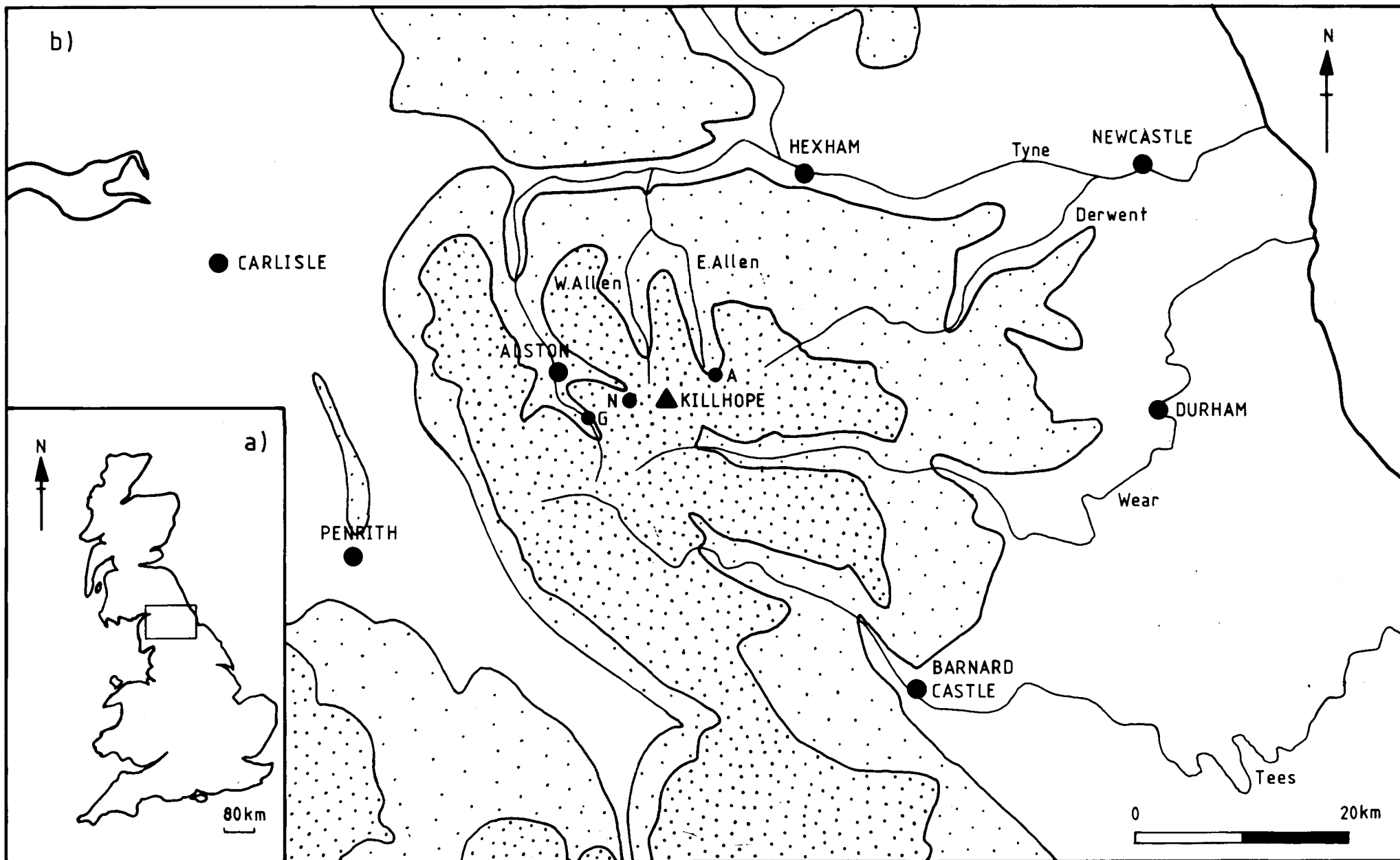


Fig. 1. Location map. A Allenheads G Garrigill N Nenthead
the 600 ft and 1400 ft contours are given.

constructed; it is uncertain how much of this phase survives in the existing teams and washing floor. From 1874 to 1878, a major reconstruction occurred; considerable work was done on the bouse teams and washing floor in the earlier stages of this programme, whereas construction of the mechanised dressing mill did not start until 1876, the mill coming 'on stream' in 1878. The mine remained an important producer until around 1890, when a long run-down began. Park Level was closed, ore from the remaining workings being brought up the Killhopehead shafts and carried above ground to the dressing mill. Intermit- tent underground work continued until 1917, though it is not clear exactly when the washing floor and dressing mill closed. An OS map of 1896 shows both in working order, though the washing floor may already have been partially abandoned.

THE SITE

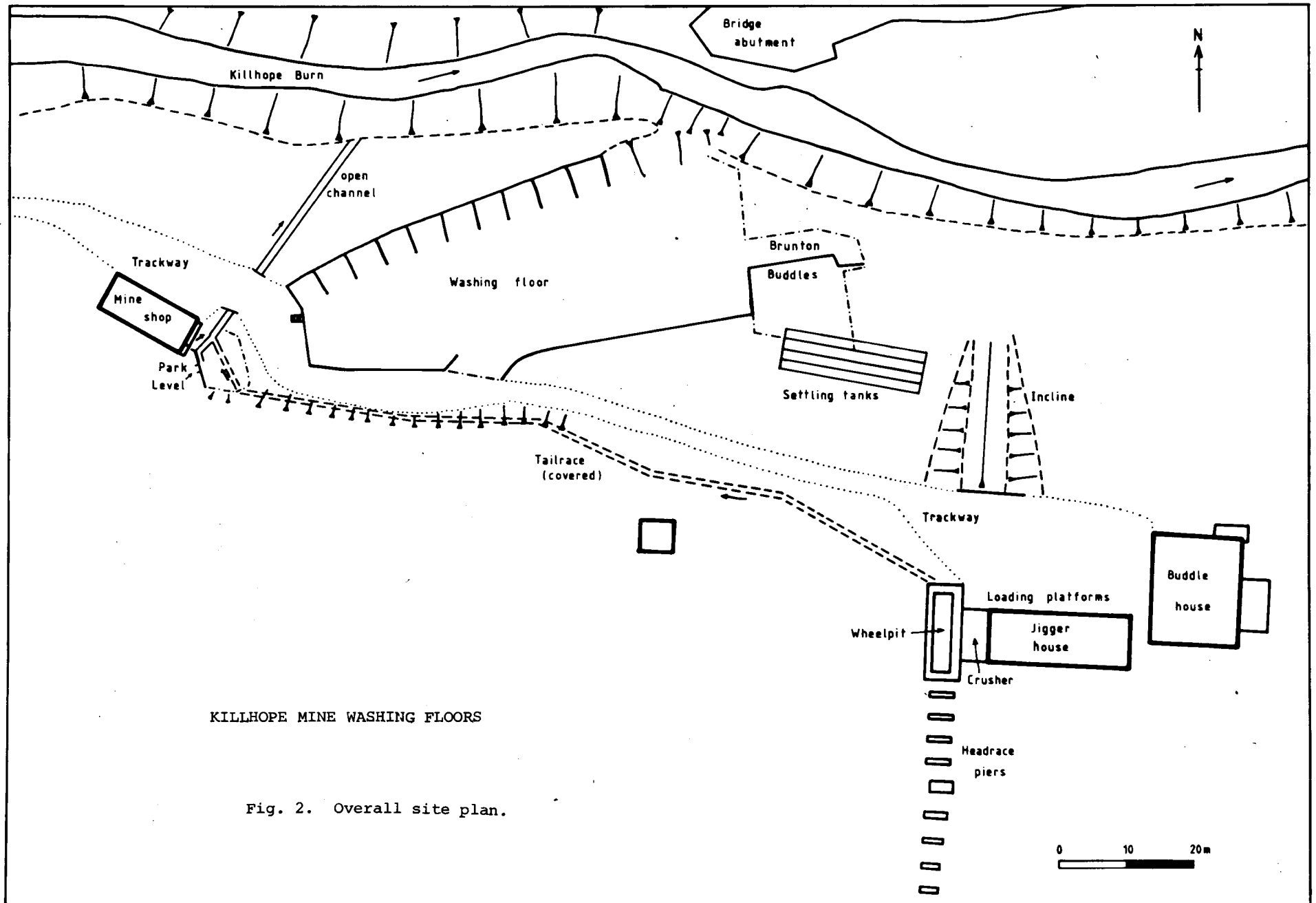
The overall layout of the site as it survives is shown on fig 2. Park Level lies at the west end, with a lodging shop beside it. The original deads heap ran northeast from the Level, and was later used to form an embankment to the (destroyed) access bridge across Killhope Burn, and also the rear of the bouse teams; by 1896 deads heaps extended some 250m down the Burn (these heaps have been totally removed by reprocessing and/or erosion, the Burn now occupying their site). The washing floor lies to the south and east of the bouse teams, with the Brunton Buddles at its east end; in 1896 a railway ran from the washing floor round the Brunton Buddles and up the incline to the mechanised mill.

This mill lies to the southeast of the washing floor, on higher ground. The west end is formed by an iron water-wheel, in a stone-built wheelpit, which powered the incline, crusher, elevator, and jigger house. The water supply to this wheel was carried by an overhead launder (the piers of which survive) and the tail water was led by a covered culvert to the portal of Park Level, where it combined with the outflow from the Level to feed a northeast- ward channel, which crossed Killhope Burn by an aqueduct, and eventually fed Burtree Pasture mine (2 miles to the east). Immediately east of the wheel lie the remains of the crusher (to which the incline was carried by a sloping bridge across the trackway). Crushed bouse was fed by an elevator into the jigger house, which contained a set of trommels and jiggers from Green's of Aberystwyth (probably conforming to Green's patent of 1871 (No 158)). Finer material was passed to the buddle house, where it was processed on four circular buddles. The slimes were then led northwest, under the incline, to a set of settling tanks south of the Brunton Buddles.

It is clear from the documentary, cartographic, and archaeological evidence that this surviving layout was in use from 1878 onwards, with only limited later alteration. However it is less certain how much of 1862 washing floor is incorporated in the surviving layout, or whether the 1874 reconstruc- tion was intended from the outset to include a mechanised mill; these points are discussed below.

THE WASHING FLOOR

The remainder of this report is concerned solely with the excavation of the unmechanised washing floor, the adjacent bouse teams to the north, and the Brunton Buddles to the east. Excavation of these areas started in 1983 and was completed in 1985, being conducted as annual seasons of four to eight weeks, with teams of up to twelve members. The normal constraints of display archaeology applied, in that excavation normally terminated at the latest



KILLHOPE MINE WASHING FLOORS

Fig. 2. Overall site plan.

floor surface, and structures were left intact. Thus the stages (if any) by which the observed layout developed could not be ascertained, though limited trial excavation suggested that in most places no appreciable stratigraphy had developed during the use of the surviving washing floor.

The excavated structures are described broadly from west to east, corresponding in outline with the flow of materials through the plant. The factual evidence has necessarily been abbreviated in this report; fuller details can be found in Cranstone (1985a and b). Structures are lettered where necessary for ease of reference; the lettering conforms to that used in Cranstone 1985a and b, with the result that not every lettered structure is referred to in the present text.

The washing floor was bounded to the north by the bouse teams and embankment, and to the west, south, and southeast by revetment walls against higher ground; the main access track to the dressing mill lay behind this revetment to the west and southwest. Vehicle access from this track was by a ramp in the south side of the washing floor, and a flight of steps was present in the west end. The only level access was at the east end, leading round the Brunton Buddles to the base of the incline.

The bouse teams formed a slightly curved line along the north side of the washing floor, onto which they opened. Each team consisted of a flat-floored, U-shaped storage bay some 4.3m wide and 4.3m deep; the rear walls were 2-2.5m high, and the side walls had been stepped. A tramway from Park Level ran over the rear tops of the side walls. Teams 9 and 10 (from the west) were structurally secondary to teams 1-8, and showed differences in detailed construction. At the west end, the west wall of team 1 had been secondarily cut back to the line of the west wall of the washing floor.

To the west of the ramp, the south side of the floor was occupied by two timber platforms, A and B (fig 3). A was of large east-west planks, rather oval in cross-section and lying en echelon; they rested on the hard stony surface to their north. The north and east limits did not survive, though there was evidence to suggest a more complex structure at the east end. Platform B was of north-south beams (probably re-used wooden rails) 0.08m square; it had extended to the ramp, but its east end was fragmentary. Its surface was covered with a pale grey powdery sand, perhaps derived from a water-channel through the revetment wall (5.5m west of the return to the ramp).

The north side of the washing floor, in front of the bouse teams, had been occupied by a similar platform (D and AA). The western part of this was intact, while the remainder was fragmentary; sufficient remained of its sand bedding to suggest that it had originally been continuous at least to the east end of bouse team 9, but the worn east end of the intact part indicated that the robbing had occurred well before the abandonment of the site. The west end had been partly buried by trampled earth, also before abandonment of the site.

Opposite bouse teams 2, 3, and 4, platform D was adjoined to the south by a group of smaller platforms (E, F, G, and H). Platform E consisted of wide thin north-south planks, sloping down to the north, and with remnants of a sandstone kerb along its south side. Platform F was similar, but was raised above the level of E, and contained a rectangular rubble-filled recess at its north end. G was very similar in construction to B and D; its north, west, and south edges were clearly original, and the east end was probably also original (as it was retained by an iron spike). Platform H was composed of

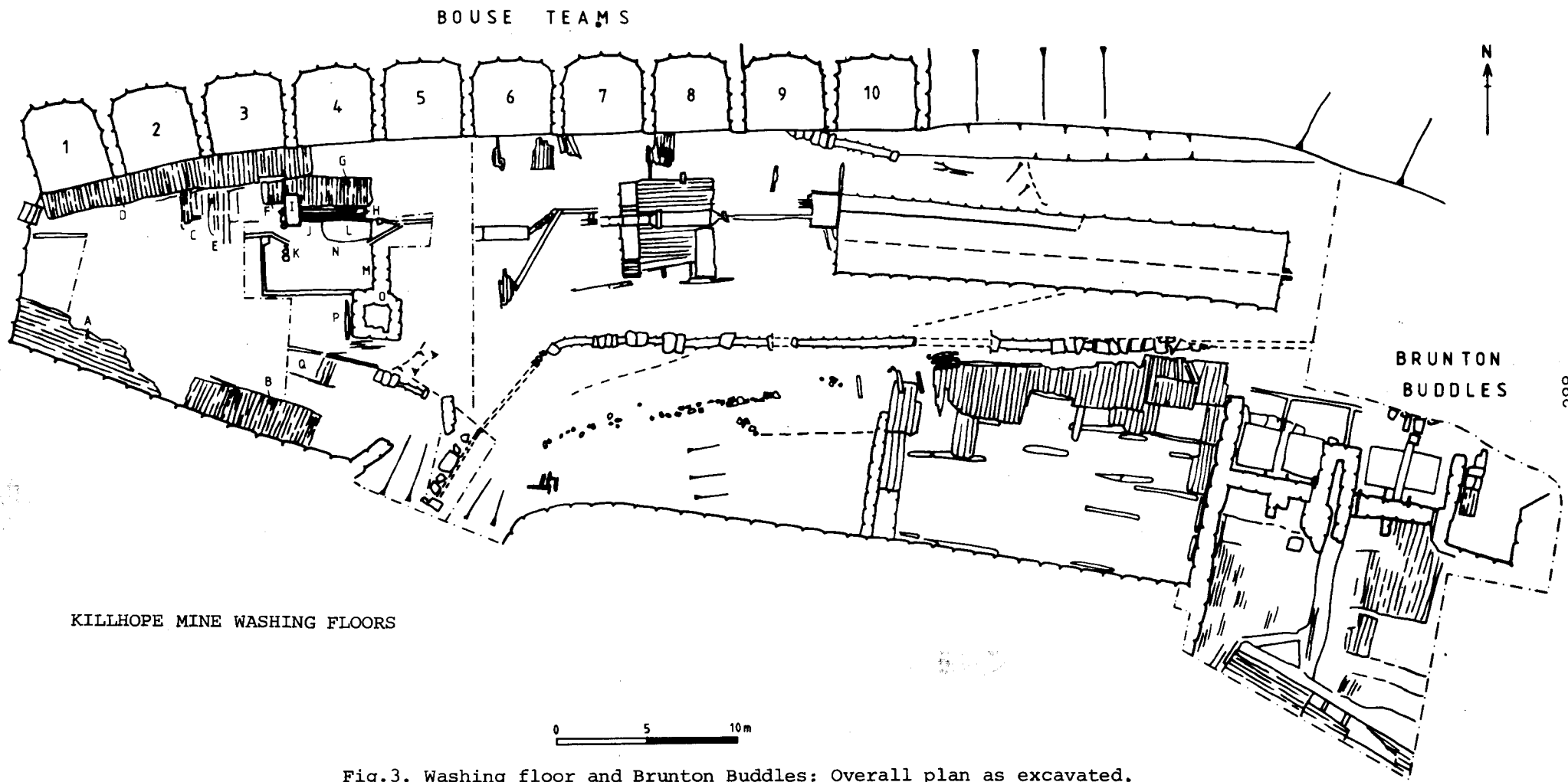


Fig.3. Washing floor and Brunton Buddles: Overall plan as excavated.

wide thin east-west planks, on underlying joists, and was probably used in conjunction with adjacent structure L.

Platforms D-H were largely overlain by banks of veinstuff rubble up to 0.2m thick, containing fragments of coal; the rubble appeared to have been deliberately laid to cover the platforms, perhaps for ease of shovelling-off. It overlay the edges of some of the ore-dressing structures, but its edges had been worn by trampling, indicating that it had been deposited appreciably before the final cessation of activity on the site; platforms A and B may still have been in use.

To the south of platforms F-H lay a group of structures (I-O) which had clearly been built and used as an integrated array; the timber-lined members of this group contained deposits of fine-grained galena concentrate, indicating functions as ore-dressing apparatus of some description. The structures had been robbed out to varying extents, but appear originally to have had close similarities to the complex group of structures AD further east (see below). The structures are described from northwest to southeast, followed by a description of their water supplies.

Structure I was a rectangular pit 0.3m deep, walled to the east and north with edge-laid planks, and to the west by a stone wall. The base was of hard earth, in which lay three cross-planks, forming the base of a planked structure on which the west wall rested. The south end was open to structure J, and an iron pipe drained away eastwards from the southeast corner. Structure J survived as a rectangular hollow running east from the broken-off ends of I and K, to deeper structure L; it may have been the site of a separate robbed structure, or of a robbed continuation of I, K, and/or L. Structure K survived as a rectangular hollow with a stone wall along its west side, and sufficient planking to indicate that it had originally been similar to structure I (of which it could have been a continuation). All these three structures had been infilled (after abandonment and robbing) with hard rubbly soil, which passed under part of platform F, and had been secondarily incorporated into the trampled earth surface of the washing floor.

Structure L was the largest of the rectangular pits, measuring 2.8m x 0.8m, by 0.5m deep from the level of platform H. Its surviving walls and floor were of hard earth, with cross-planks across its base; however the sides were too steep to have stood for any period, and there is little doubt that a timber structure had been robbed out. The surface immediately to the east was formed by north-south planking, the west edge of which had been rounded by wear. Unlike structures I-K, structure L had been open after the final abandonment of the site, being filled with soft marsh deposits. Its east end was adjoined to the south by the north end of structure M, a shallow rectangular hollow defined to the east and south by the stone walls of structure O, and to the west by a gentle slope. Patches of galena concentrate in the base preserved the nail-stains and timber-impressions of a planked structure. The area (N) between structures J, K, L and M was occupied by a gentle dome of orange gravel, with a north-south beam-slot across its centre.

The above group of structures had been supplied with water by a launder from Park Level, which had been carried over the west wall of the washing floor, and thence below floor level to a point 1.5m west of structures I, J and K; since it was totally enclosed, it presumably maintained the hydrostatic pressure generated by its 2m fall from Park Level. It then bifurcated into a main launder running southeast, and a smaller launder to the south. A small box-like structure at the junction presumably held a sluice, and close to this

two squared holes in the lid of the main launder had presumably carried 'risers'. The main launder was robbed out as it approached the structures, so that its precise feed could not be ascertained; the subsidiary launder was carried round the south side of area N, and under the (patched) northwest corner of structure O, to feed into the base of structure M at the centre of its south end. The outlets from structures I and M were by iron pipes draining to the east and northeast respectively. These pipes, and a complex arrangement of vertical and horizontal launders at the east end of structure L, all converged to feed a set of two or three superimposed launders, which dipped away to the east and were not traced beneath the earth floor; their precise correlation to the launders in the area of structure AD is uncertain (see below).

To the southeast of the structures just described lay a stone structure (O), consisting of an earth-cored plinth 2.8m square and standing to 0.2m high, the north side of which was abutted by a stone wall running north along the east side of structure M. Structure O had been adjoined to the west and south by an area of timbering (structures P and Q), consisting of flimsy frames and platforms resting on the hard earth surface; robbing and disturbance rendered these impossible to interpret in detail.

The area running south from bouse team 5 towards the ramp consisted of a hard gravelly surface virtually devoid of surviving features, though platforms D and G had probably originally continued across its north end. The south end of this area sloped upwards to the ramp, and had suffered from a combination of slight truncation, deposition of gravel by floods down the ramp (which continued during the excavation) and disturbance by later use of the ramp (which continued until the 1960s). A group of structures (see fig 4) consisting of a curving culvert (AS) with a ditch cut into its north side, a wooden launder or revetment (AT), and a stone wall (AU), could not be satisfactorily interpreted.

To the east of this blank area lay a second, better-preserved, group of ore-dressing structures (AB-AM), shown in more detail on fig. 5. Structure AB had a floor of tightly-laid east-west planking, sloping down eastwards by 0.09m along its length, and dug in 0.1-0.2m below the adjacent ground surface; its long sides were demarcated by edge-laid planks. The floorboards were heavily worn except for a 0.04m strip across the west end, shown by stains on the side planks to be the site of a headboard angled at 20° to the vertical; a beam slot and area of clay behind this may have supported a superstructure. The structure was drained by a launder (1) running northeast from its east end. It had been deliberately infilled with rubble, before the final abandonment of the area.

Structure AC survived as a small area of planking; a smooth surface with streaks of sand showed the former presence of a robbed westward continuation, this robbing having pre-dated a final surface of trampled soil over the area. The surface of the surviving planking retained a semi-circular area of white staining 1.7m in diameter, possibly indicating the site of a tank. The structure had been drained by a launder (2) sloping away sharply to the northeast, where it converged with launder 1 to feed down into launder 3. A higher-level inlet may have been present from structure AT, or by the ditch from culvert AS.

The tops of launders 1 and 2 had been close to contemporary ground level. However they ended at a vertical feed into underlying west-east launder 3, 0.2m deeper, which may either have originated here or have been the



Plate 1. Overall view from the northeast before excavation: bridge abutment in foreground, washing floor and Brunton Buddles in the middle distance, with mechanised dressing mill behind.



Plate 2. Overall view of washing floor from the east during 1985 excavations.

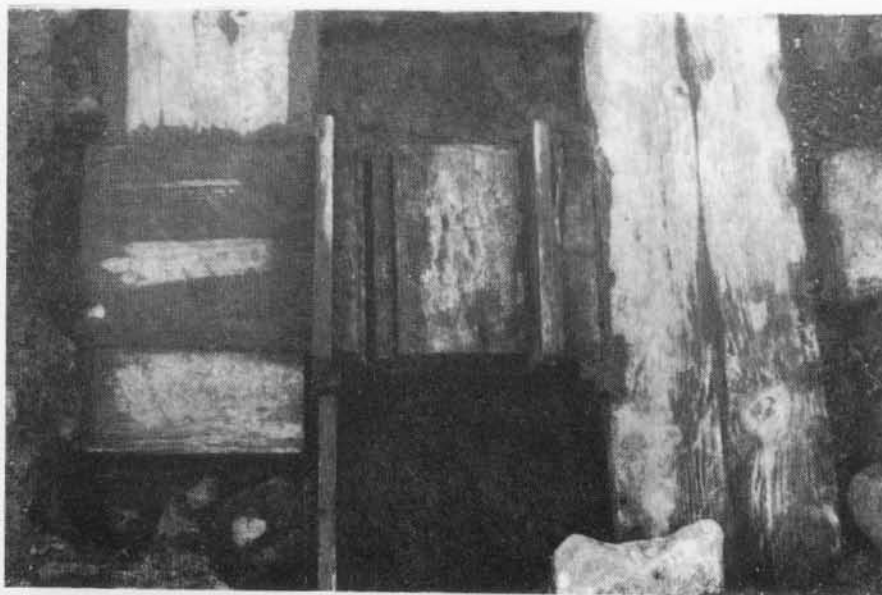


Plate 3. Launders 3 (on right) and 4; riser from launder 4 to AD complex at bottom left, sluice in centre.

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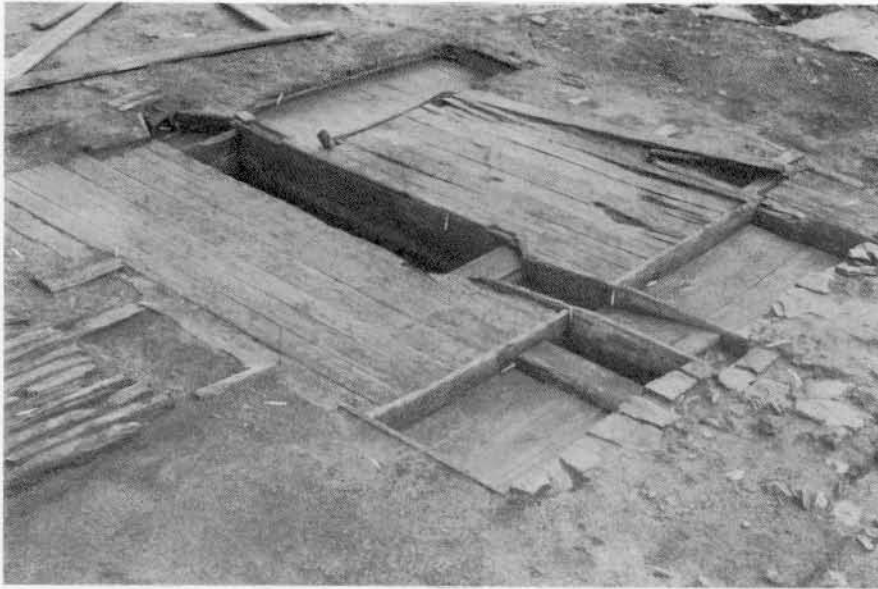


Plate 4. Ore-dressing structures AD from the northeast.

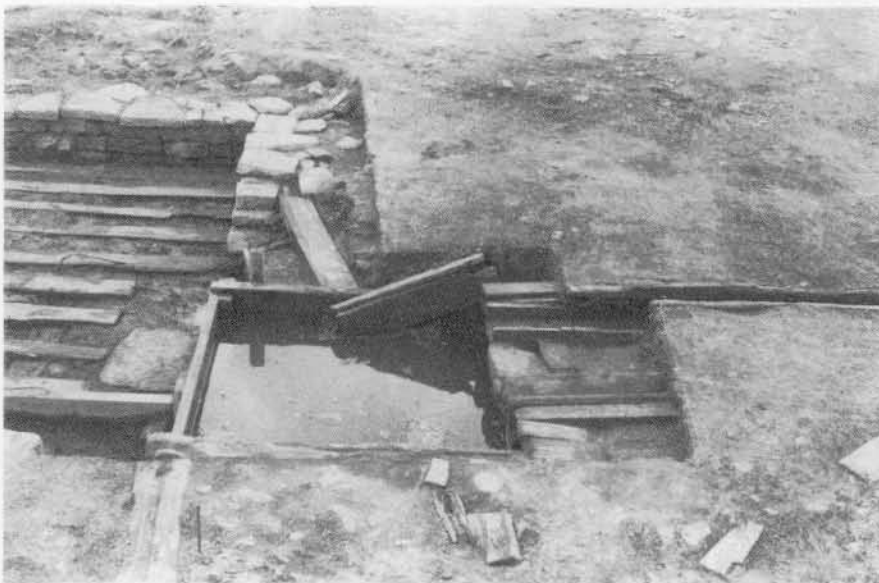


Plate 5. Tank AO from the north; settling tanks to the left.



Plate 6. Brunton Buddles as excavated from the northwest.

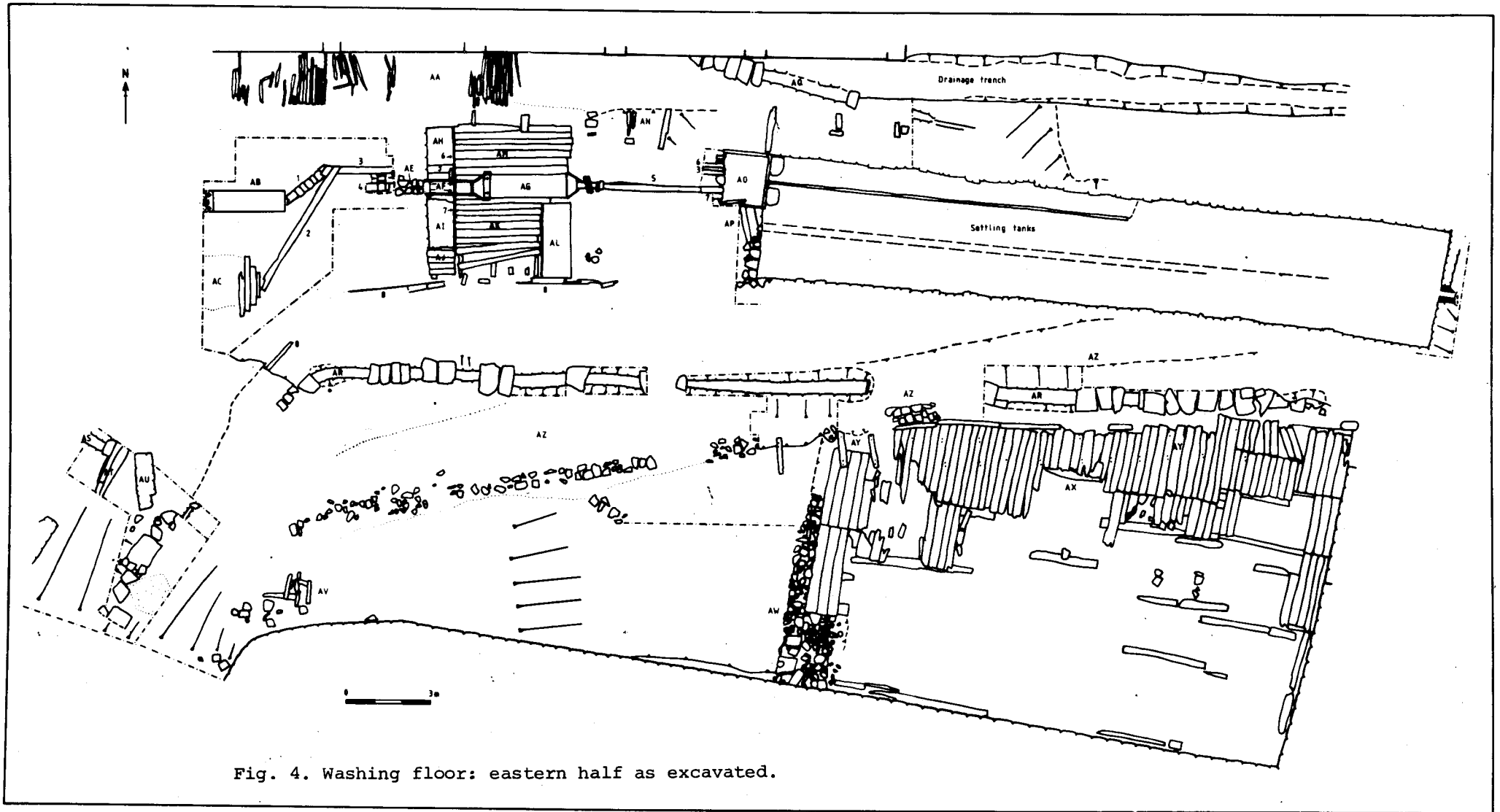
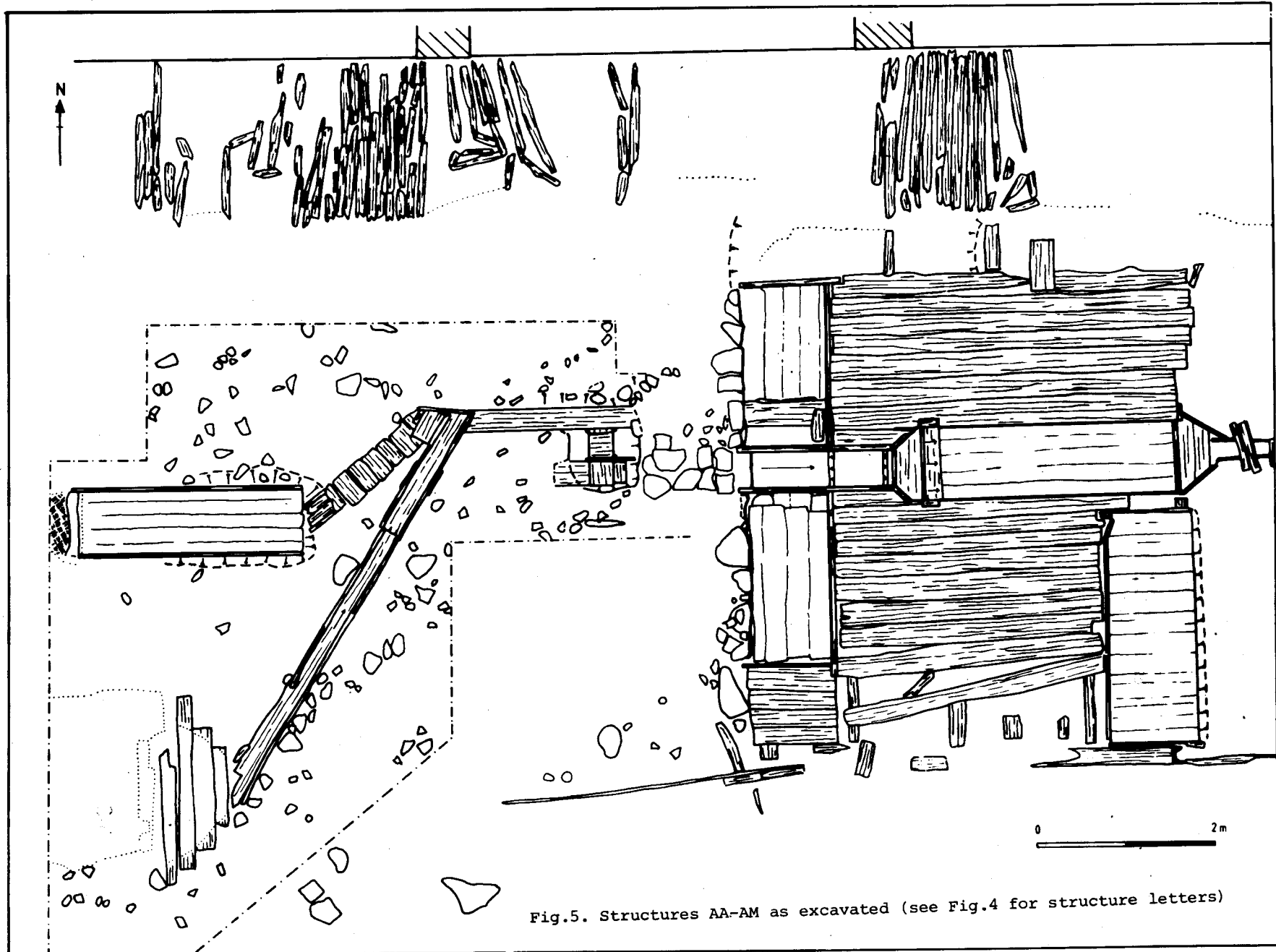


Fig. 4. Washing floor: eastern half as excavated.



continuation of one of the outlets from the area of structure L. Launder 3 flowed ultimately into tank A0, with a fall of 0.14m along its 13.5m observed length. To the south of Launder 3 lay a second launder (4) on an almost-parallel course; the westward origin of this is unknown. Launder 4 ended to the east at a (presumed) riser against the west face of stonework AE; just short of this it had an outlet into launder 3, controlled by a sluice in its roof (the slot for which survived). There was evidence of alteration or repair to this area.

The riser from launder 4 had apparently formed the main water feed to a complex group of structures (AE-AM), referred to overall as AD. The central axis of this group is described first, followed by the structures to either side.(Fig.6).

The west end of the axis was formed by a rectangular area of sandstone masonry (AE), faced to the east only, and covered with sandy clay (perhaps the bedding for a superstructure). The east side was adjoined by the side-walls of structure AF, though the floor of AF was separated by a gap of 0.2 m, filled with clay. AF consisted of two parts, a shoot feeding eastwards into a box. The shoot was 0.4 m wide and 0.86 m long, with a fall of 0.15 m along its length; its east end was 0.26 m above the floor of the box. The box was 0.66 m long at the top, and 0.56 m at the base, the end walls being inclined at 20° to the vertical. The side-walls of the whole structure were of single stout edge-laid planks; they were flat-topped to the west, but sloped eastwards from a point 0.2 m short of the west end of the box. There was a wear-mark above the junction of the shoot and the box, and the tops contained nailholes from here eastwards. The floor of the shoot, and the floor and all walls of the box, were plated with iron, the shoot having been patched.

The remainder of the axis was occupied by a rectangular tank (AG), with shallower triangular extensions at each end. The west end consisted of a flat-floored channel widening to the east, with a narrow cross-batten at the junction with AF (above which the adjacent platforms were heavily worn). The floor was 0.1 m below platform level, and 0.24 m above the floor of the box of AF. The main tank was 0.8 m wide and 0.6 m deep from platform level, with a precisely-flat floor. The west wall sloped at 20° to the vertical, and the east wall at 3° . The basal infill consisted of 0.1 m of hard galeniferous sand, with a single large plank laid along its centre. The triangular east end had a rather poorly-laid floor, 0.2 m below platform level, and separated from the main tank by a 0.1 m lip. It fed into an outlet launder (5) flowing into tank A0, with a fall of 0.05 m over its 5 m length. While the walls and floor were of normal solid construction, the roof was of loose offcuts and pieces of wood, at surface level.

The remainder of the west end of the AD complex was formed by two roughly-symmetrical rectangular pits or tanks, AH and AI. The west walls of these were formed of sandstone masonry, while the other walls were of edge-laid planks. The floor of AI was entirely of planking, sloping slightly down to the north; this floor had been raised, blocking an original outlet launder (7) from the east side to tank A0. Most of the floor of AH was similar, and had probably been raised to block outlet launder 6, but it ended to the south against the side of launder 3, which was carried across the base of the structure (where it was heavily worn and patched). The gap between this and the south end of the structure was not floored.

The southeast corner of the area was formed by a third rectangular timber-lined pit (AL); this was only 0.15 m deep and its floor of tightly-laid

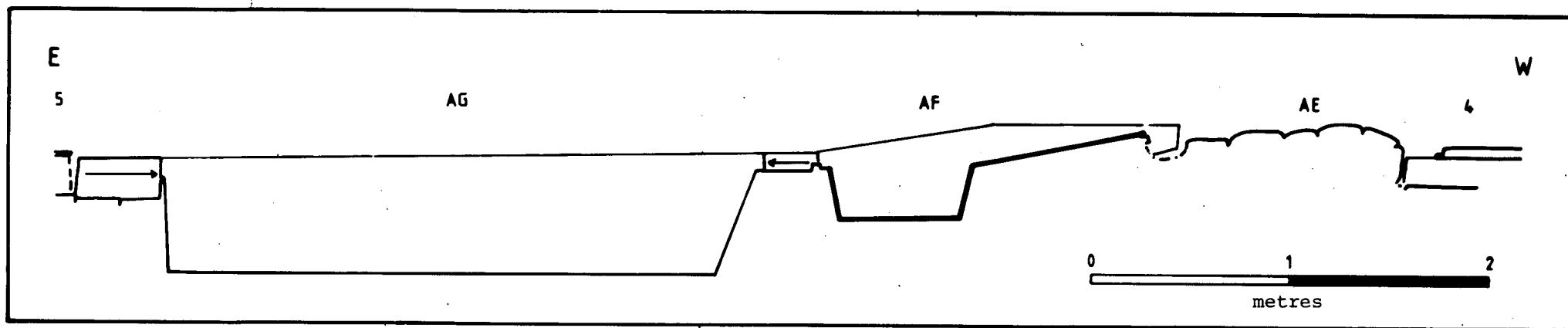


Fig.6. Profile along the axis of the AD group.
Projected side walls of structures in thin line;
iron plates in AF in heavy line.

cross-planks was very worn. The stubs of vertical posts survived at the northwest corner, and close to the northeast and southeast corners; there may also have been a post beside the centre of the west side. This structure had an independent water-supply from launder 8, which passed immediately behind the south end, and has a rebated opening at floor level, and also in its roof. The further course of launder 8 could not be fully established due to later damage, but it had probably entered the washing floor via the ramp (possibly ultimately from Park Level), and it had continued east from structure AL, possibly feeding into the southwest corner of the settling tanks; changes in its fill here suggested that it had been an outlet from, as well as an inlet to, structure AL.

The remainder of the AD complex was formed of timber platforms (AJ, AK, and AM), consisting of wide thin east-west planks resting on north-south joists. Voids and accumulations of galeniferous sand were present beneath the planks in places, suggesting that, unlike most of the platforms described above, these had been sprung above the ground surface rather than being bedded in.

The north side of platform AM was adjoined by a build-up of thin soil layers during its use; the lowest of these passed under platform D/AA, implying that this had been built after AM. These layers were overlain by a bank of hard rubbly soil (AN) with scattered cross-planks in its surface, running east-southeast across the northeast corner of the platform, and continuing 4 m to the east. As well as encroaching across platform AM, this material directly overlay the bedding for the robbed eastward continuation of AA, indicating that its deposition post-dated the robbing of AA. It would be possible to interpret AN as the ballast and sleepers of a tramway, though this interpretation rests more on the cartographic than on the site evidence.

The outlet water from all the ore-dressing structures on the washing floor was carried by launders to tank A0, at the northwest corner of the settling tanks (the probable exception is AL, whose outlet water may have flowed directly to the settling tanks). This tank measured 1.76 m x 1.52 m and was 0.95 m deep from the ground surface to its north; the (damaged) west half of the south side had also probably extended to ground level, whereas the remaining sides were only 0.7 m high. The tank was walled and floored with planks, retained with pegs and battens. Launders 3, 5, 6, and 7 fed into the tank over the top of the west wall, their sides being supported in places with slabs. Water had presumably flowed over the east wall into the northern and central divisions of the settling tanks (there were no surviving traces of the sluices that would be expected, though slabs in the floors of the settling tanks suggested the locations of the inlets). A damaged timber structure (AP) running south-southeast from the south side is interpreted as the remains of a feed to the southern division of the settling tanks. Tank A0 had been infilled before the settling tanks.

Most of the remainder of the north side of the washing floor was occupied by the settling tanks. Unfortunately these were excavated in the very wet summer of 1985, when repeated flooding rendered full detailed recording impossible. Except where they adjoined A0 and AP, the outer walls of the tanks were of drystone masonry, and the floors of rather flimsy planking, with a very slight slope to the east. The tanks were 0.55 m deep at the northwest corner (0.4 m shallower than tank A0), but the walls may have been lower elsewhere; the eastern parts were increasingly truncated and disturbed. The tanks had been divided into three divisions by longitudinal partitions of heavy edge-laid planks, retained by bolts and iron plates. The northern of

these divisions only extended halfway along the length of the tanks, and was narrower and deeper than the central and southern divisions: its outlet was unclear. The outlets from the other divisions were by iron pipes at floor level in the east end, one of which was blocked with a wooden bung. The tanks had been infilled with compacted rubbly soil, which had itself been truncated to the northeast, and underlay trackway AZ (see below).

The area to the north of the settling tanks contained few surviving features; the most interesting of these was a stone culvert (AQ) running east-southeast from beneath bouse team 9. This culvert had been unroofed and infilled at an early stage, and the settling tanks had been built across its line; beyond these it aligned with a culvert along the stream bank north of the Brunton Buddles, now functioning as the outlet from culvert AR. To the east of AQ, the surface was occupied by a bank of compacted redeposited shale, apparently continuous to the north with the deads heap east of the bouse teams (from which it was separated by a modern drainage ditch).

The southeast quadrant of the washing floor was separated from the remainder by a culvert, AR, which originated at a sluice and spillway from the tail-race culvert (Fig. 2), entered the washing floor beneath the ramp, and flowed northeast then east to the east end; beyond the excavation (where it was water-jetted to re-establish drainage) it took up the line of culvert AQ. The roof of this culvert was flush with the surface of the washing floor, but there were no inlets or outlet within the excavated area. The stratigraphy of AR was ambiguous.

The area south of AR was divided into two parts by wall AW. To the west of AW preservation was very poor; a fragment of timber platform (AV) survived near the ramp, but to the east the firm sand bedding for this faded out over a natural deposit of soft peaty clay. This was presumably overlain by some solid surface, but no evidence remained. Wall AW had revetted a step in the working surface, floor AX to its east being c 0.2-0.3 m lower than the surface to its west. Almost the whole area had been occupied by a floor of solid north-south planking, bedded on gravel and attached to underlying joists the eastern 4 m was pegged down, whereas the remainder was nailed. The southern part of the floor had been robbed, but scattered joist impressions survived in the surface of the gravel bedding. A rectangular sandstone structure against AW, at the southwest corner of the floor, may have been a flight of steps.

Floor AX had later been crossed by a tramway (AY). The evidence for this consisted of three sleepers at the west end (probably post-dating the destruction of the north end of wall AW) the line of which was continued eastwards by sets of peg-holes; each set consisted of four peg-holes spaced (from north to south) at 0.14 m, 0.69 m, and 0.14 m apart respectively. The 0.14 m spacings correspond to the peg positions of the iron rail chairs recovered from various deposits on the site, and the whole structure is interpreted as the setting for an east-west tramway of 0.83 m gauge. A tramway on this line is shown on the 1896 OS map, running from the base of the ramp, round the north end of the Brunton Buddles, to the crusher incline.

The only later feature of note was a trackway (AZ) with an intermittent stone kerbing, which ran from the base of the ramp east-northeast across the site, over the east end of the infilled settling tanks, and round the north side of the Brunton Buddles. This feature may have dated from the dismantling of the site, and/or from re-processing of the deads heaps.

THE BRUNTON BUDDLES

The Brunton Buddles (Fig. 7) lay beside the southeast corner of the washing floor, but were physically and functionally a clearly-discrete area, and are therefore only briefly described here. Since the excavated evidence corresponded closely to contemporary illustrations (e.g. Louis 1909), the description assumes a measure of interpretation. It should be noted that the area divided topographically into three clear units:- a platform extending north from a set of settling tanks to define the southeast corner of the washing floor; the site of the Brunton Buddles themselves, at washing floor level to the north of the Platform; and a small building at washing floor level immediately east of these.

Only the west end of the northernmost settling tank was investigated. This was similar in construction to the settling tanks on the washing floor, except that its outlet (in the west end) was by a wooden sluice, into a launder draining northeast into an eastward culvert beneath the Platform.

The Platform was defined by the settling tanks to the south, and by revetment walls to the west, north and northeast; most of the east side was undefined. Its floor was some 1.5 m above that of the adjacent washing floor. The floor had been almost entirely of planking. As excavated, it was divided into two parts by a ditch running north to the wheelpit (see below) in the centre of the north wall; however this ditch probably resulted from the robbing of an original piped water feed to the wheelpit. The north end of the platform was divided (by the wheelpit and two spur walls) into four bays corresponding to the four Brunton Buddles beyond; the western two bays had been paved with slabs, while the eastern had been floored with planking.

The Brunton Buddles themselves had lain immediately to the north of the Platform; a set of four had been present, divided into two pairs by a central wheelpit which had powered them. This wheelpit projected through the north wall of the platform, and was 2.9 m long and 0.5 m wide. The water inlet had been by an iron pipe (see above) only 0.6 m above the base; this had probably syphoned up to feed the top of an overshot or pitchback wheel. The tailrace was only 0.5 m wide and 0.2 m high and fed into a smaller launder. The wheelpit was of one build with the Platform to its west, but was abutted by the Platform to its east, indicating that the eastern two Brunton Buddles were an addition - this was confirmed by various slight differences in construction.

The Brunton Buddle consisted of an endless loop of conveyor belt, onto the upper surface of which was fed a 'pulp' of fine sediment, and a flow of fresh water. Galena particles collected on the belt and were carried over the top of the loop, whereas waste was washed off down the belt. The 'heads' were recovered by passing the belt through a cistern of fresh water, from which they were shovelled at intervals. Four belts had been present at Killhope, the upper ends being held by eight beams projecting from the north face of the Platform wall. Beneath each pair of beams lay a collecting cistern, consisting of a solidly-built timber tank 0.6 m deep. A length of conveyor belt survived in one of these tanks. The tanks were divided into two pairs by the wheelpit; the overflows from each pair had passed into a small box at the north end of the space between the tanks, and thence via small launders into an outlet launder along the north edge of the excavation (which also carried the tail water from the wheelpit). The spaces round the tanks had been planked, whereas the area to the north had been flagged.

The area immediately east of the northeast corner of the Platform had been occupied by a structure measuring 3.6 m by at least 3.0 m internally, and

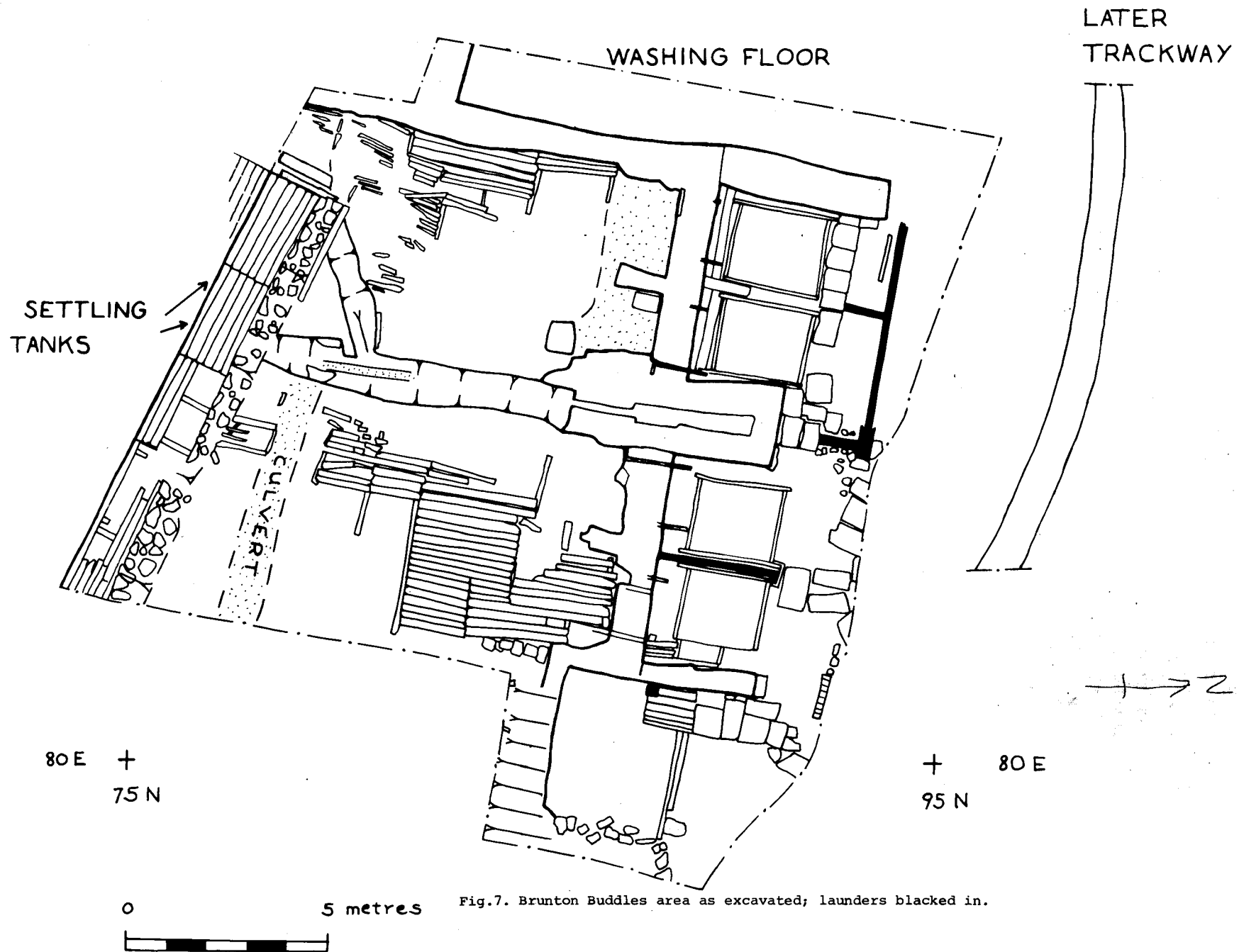


Fig.7. Brunton Buddles area as excavated; launders blacked in.

shown on the 1896 OS map as a roofed building. This building opened to the north onto the level ground connecting the washing floor to the incline, and was defined on its other sides by revetment walls against higher ground; these walls were extensively robbed, but enough survived to show that they had been plastered. The north wall was probably marked by an east-west beam, with a single surviving flagstone against its outer face. The west end of the beam adjoined a square area of planked floor (probably marking the doorway), through which a vertical wooden launder was carried. The interior of the building was floored with sand (to the west) and redeposited shale (to the east).

DISCUSSION

The excavated structures on the washing floor present considerable difficulties in detailed interpretation; pending full study of the historical evidence, and analysis of the many samples of concentrates and other deposits taken during the excavation, only an interim assessment can be offered here, as a basis for discussion. The main contemporary sources consulted are Mulcaster (1795), Westgarth Forster (1883) and an undated plan of Grove Rake washing floor (Durham Record Office D/WL/1/12/8) which shows many similarities to Killhope. In addition, I have been guided by Ian Forbes' wide knowledge of the North Pennine lead industry.

The phasing of the excavated structures is not entirely clear, due largely to the constraints of display archaeology; the stratigraphic evidence suggests that most of the exposed structures were designed and used as parts of a single integrated ore-processing plant, with only limited modification during their working lives. The evidence that the west wall of the washing floor was structurally secondary to bouse teams 1-8, coupled with historical evidence for considerable earth-moving on the washing floor in 1874-5, suggest that (of the fully exposed structures) only bouse teams 1-8 and culvert AQ survive from the 1862 washing floor. Traces of earlier structures beneath the exposed features were observed in several places, but could not be interpreted on the limited evidence available; these may also have been remnants of the 1862 washing floor. It is therefore suggested that the remaining structures were built in 1874-75, with some later modifications. The 1896 map shows features corresponding to structures L, M, and O, the settling tanks, and tramways along the north side of the washing floor, and from the ramp to the northeast corner. In addition, rails are shown from Park Level across the tops of the bouse teams, but Park Level is described as 'disused'. This combines with the site evidence to suggest that the eastern group of ore-dressing structures had been abandoned, platform AA partly robbed, and the tramways inserted across this and floor AX. In the western group of ore-dressing structures, the map combines with the stratigraphy to indicate that structures I, J, and K had already been abandoned. This partial abandonment could have dated from the run-down of the mine around 1890, or from the opening of the mechanised dressing mill in 1878 (if this is seen as an afterthought to the 1874 reconstruction rather than the second stage of a single design, and as replacing rather than complementing the unmechanised washing floor). At Grove Rake, the plan shows a manual washing floor and mechanised mill (the latter brought from Green's at the same time as the Killhope Mill) both in full working order, and the modifications to the Killhope ore-dressing structures would suggest an appreciable working life. It is therefore suggested that the washing floor was retained in conjunction with the mechanised mill, for an appreciable period. In the discussion of the

function of the individual structures, it is assumed that all lettered structures (except AQ) were in simultaneous use.

The north side of the washing floor, and the south side west of the ramp, had been lined with timber platforms (A, B, D-F, AA), which were probably used for preliminary washing and picking of the bouse. Platforms A and B (on the south side) had probably remained in use later than the platforms on the north side; it is possible that the west end of the washing floor was 'turned round' to process bouse brought by road from Killhopehead after the closure of Park Level, rather than the bouse from Park Level tipped into the bouse teams, for which it had originally been designed. Platforms P and Q may have performed similar functions, whereas G and H are more likely to have been used for shovelling out concentrate from the adjacent ore-dressing structures.

The two groups of ore-dressing structures (I-M and AD) bear many similarities to each other, and in outline the AD group can be considered as a better-preserved version of the western (I-M) group. The form of these groups, and their layout 'in series' with each other (in terms of water flow; ore flow is discussed below) have close parallels on the Grove Rake plan, where the function of some parts is indicated. Combining this with Mulcaster's and Westgarth Forster's descriptions, the following interpretation is suggested.

At the west end of the AD group, the water supply from Launder 4 was carried by a riser to a tank or sluice over stonework AE, whence it fed onto a grating over the west end of AF. Bouse was placed on the grating, and raked around in the flow of water; the oversize left on the grating was divided by eye into clean ore and waste (to the bing-stead and dead heaps respectively), and mixed material (to the crusher). This material may have been raked off into pits AH and AI, though wooden platforms are referred to in contemporary descriptions. The undersize was washed down the shoot into the box; when this was full, grating was stopped, and the box re-used as the box of a box-and-trunk (or trunk buddle). The material in the box was agitated with a shovel, so that the fine material was washed over into the trunk (AG), and the coarse material left in the box. This was shovelled out and concentrated in hotching tubs based in pit AL (where the remains of the posts for the lever frames survived; this corresponds with the locations of hotching tubs at Grove Rake). When AG was almost filled with fines, these were shovelled out and re-processed in the same tank (now used as a trunk buddle), shovel-fulls being placed on the headboard and stirred in a gentle flow of water to wash away the waste and leave the ore on the board.

The above description assumes that the eastern and western groups of ore-dressing structures were independent of each other, and therefore worked in parallel (as regards the flow of ore through the plant). A more complex and sophisticated interpretation (suggested to me by Ian Forbes) would have the two groups working in series, the waste or fines from one (or more) stages in the first group being introduced into the box of the second group. Given the range of variations possible on this second theme, it is wisest in an interim report simply to state this as an equally-plausible interpretation in principle, but not to attempt a detailed reconstruction.

The western group of structures differs from the eastern mainly in the presence at its southeast end of stone structure O. The surviving form of this indicates that it was a plinth for a structure or surface at a higher level. Perhaps the most likely interpretation is as the base for a knocking wall, on which large lumps of bouse were manually broken with hammers.

The two structures (AB and AC) between the main ore-dressing groups could have been used with either group or (most probably, in view of the location) with both. AB can be fairly confidently identified as some sort of flat buddle (perhaps a 'smiddum buddle'), though the slope along (rather than at right angles to) the axis conflicts with most contemporary descriptions. It could be used in conjunction with the main groups in various ways, for example to process the material that passed through the sieve of the hotching tubs.

In form, AC probably consisted of a circular tank set on the surviving planking, and feeding, or draining into, launder 2. The functional interpretation is however more difficult, and three alternatives can be suggested. Firstly, it could have been a sieving tub as described by Mulcaster (1/95, pp 50-53); the description fits well, but the device seems anachronistic for the late 19th century when hotching tubs performed a similar function. Secondly, it could have been a dolly tub (Westgarth Forster Plate 9, figs 4 and 5); dolly tubs are known to have been used at Killhope (from an undated inventory of after 18/8, in private hands), but their normal use for very fine material would suggest a location near the Brunton Buddles (Louis (1909) described their use for working-up the 'heads' from Brunton Buddles). Thirdly, it could have been a header tank, for flushing the underground launder system with fresh water. This third alternative is perhaps the most likely.

Waste water from all the washing and dressing structures was carried by launders to the settling tanks at the east end of the washing floor. The solid material that settled in the tanks was re-processed in the Brunton Buddles, located between the settling tanks that marked the ends of the mechanical and non-mechanised processes. Much of the interpretation of these has already been assumed in the description. It is not clear how the addition of the eastern pair of Brunton Buddles fits into the overall phasing of the site; a logical guess would associate the first (western) pair with the 18/4-5 reconstruction of the washing floor, and the addition of the eastern pair with the construction of the mechanised dressing mill in 18/6-8.

It is not clear how the washing floor and dressing mill functioned in relation to each other, assuming (as seems likely) that the washing floor remained in use in conjunction with the dressing mill. One scenario would be for the washing floor to have been retained as a back-up facility, for use during breakdowns or water shortages at the mechanical mill, or at times when low output rendered use of the mill uneconomic. A second would see the washing floor used for the separation of 'clean' ore and waste from the bouse, all the 'middlings' (i.e. lumps containing both ore and waste) being sent to the mill for crushing. A third alternative would reserve the washing floor for special treatment of batches which for some reason (such as silver content or the presence of hard-to-separate gangue minerals) were to be kept separate from the 'run-of-the-mill' bouse.

CONCLUSIONS

The above report is an attempt to present an interim assessment of one aspect of the project currently under way at Killhope; the interpretations offered are very much a first approximation, intended to provoke further consideration. In particular, it hopes to focus attention on the much-neglected field of ore-processing.

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