N18 Gort to Crusheen Road Scheme

Site Name: Derrygarriff 2

Ministerial Direction No.: 044
Excavation Registration No.: E3711

Charcoal Kiln and Metallurgy Furnace

Final Report

On behalf of Galway County Council

Site Director: Joe Nunan
November 2009

IAC Irish Archaeological Consultancy

PROJECT DETAILS

Project Reference No.	A044
Project	N18 Gort to Crusheen Road Scheme
Ministerial Direction Reference No.	A044
NMS Registration Number	E3711
Excavation Director	Joe Nunan
Senior Archaeologist	Shane Delaney
Consultant	Irish Archaeological Consultancy Ltd, 120b Greenpark Road, Bray, Co. Wicklow
Client	Galway County Council
Site Name	Derrygarriff 2
Site Type	Charcoal kiln and metallurgy furnace
Townland	Derrygarriff
Parish	Inchicronan
County	Clare
NGR (Easting)	140356
NGR (Northing)	190940
Chainage	15,075
Height m OD	26 m OD
RMP No.	N/A
Excavation Dates	29 January – 6 February 2008
Excavation Duration	5 Days
Report Type	Final
Report Date	27 November 2009
Report By	IAC Ltd

ACKNOWLEDGEMENTS

The excavation was carried out in accordance with the Directions issued to Galway County Council by the Minister for Environment, Heritage and Local Government under Section 14A (2) of the National Monuments Acts 1930–2004 and the terms of the Contract between Galway County Council and Irish Archaeological Consultancy Ltd.

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ABSTRACT

Irish Archaeological Consultancy Ltd (IAC), funded by Galway County Council and the National Roads Authority (NRA), undertook the excavation of a charcoal kiln and metallurgy furnace under Ministerial Directions at the site of Derrygarriff 2 along the proposed N18 Gort to Crusheen road scheme (Figure 1). The following report describes the results of archaeological fieldwork at that site. The area was fully excavated by Joe Nunan under Ministerial Direction A044 and Registration Number E3711 issued by the Department of Environment, Heritage and Local Government (DEHLG) in consultation with the National Museum of Ireland. The fieldwork took place between 29 January and 6 February 2008.

The site was identified on raised ground within a wetland area in Derrygarriff townland in north Co. Clare. It was located at NGR 140356/190940 and was situated at 26 m OD.

The site consisted of four cut features. The largest, which measured 3.8 m east–west x 0.7 m x 0.42 m deep, contained large amounts of charcoal and was interpreted as a charcoal production kiln or clamp. Another feature which measured 2.45 m northwest–southeast x 0.68 m x 0.48 m deep showed signs of *in situ* burning and contained quantities of slag-like material. The other two pits both showed signs of *in situ* burning and contained charcoal. The site appears to represent an area of metal working activity.

A fragment of alder/hazel charcoal was dated from the metal-working kiln and returned an AMS result of 2144±21 BP (UBA 12716). The 2 Sigma calibrated result for this was 350–100 BC, placing its use to the Iron Age period.

A fragment of hazel charcoal was also dated from the charcoal production kiln but produced a relatively modern date. This was unexpected as it was assumed that the two features would be contemporary.

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1 INTRODUCTION

1.1 General

This report describes the excavation of Derrygarriff 1 (Figures 1–3; Plate 1), in the townland of Derrygarriff, Co. Clare undertaken by Joe Nunan for IAC Ltd, on behalf of Galway County Council and the NRA. It was carried out as part of the archaeological mitigation programme of the N18 Gort to Crusheen road scheme. The excavation was undertaken to offset the adverse impact of road construction on known and potential subsoil archaeological remains in order to preserve the site by record.

The site was not a Recorded Monument but was first identified during testing carried out by James Kyle in summer 2007 (Ministerial Direction No. A044, NMS Licence. No. 07E0489). All features identified during the assessment phase were subsequently re-identified and excavated during the full excavation phase of the site which took place between 29 January and 6 February 2008 with a team of 1 director and 5 assistant archaeologists.

The site was located approximately 3.5 km to the south of Tubber cross road (Clare OS sheet 18) and 200 m east of the Crusheen to Tubber road.

The site was assigned the following identification data:

Site Name: Derrygarriff 2; Ministerial Direction No.: A044; NMS Registration No.: E3711; Route Chainage (Ch): 15,075; NGR: 140356/190940.

1.2 The Development

The N18 Gort to Crusheen scheme involves the construction of a total of 44 km of road to include mainline roadworks (22 km), associated side roads (10 km) and access tracks (12 km). The road will have twin 7 m carriageways, 2.5 m hard shoulders adjacent to the verges and a median with a minimum width of 2.6 m which includes two 1 m hard strips. The selected route bypasses the town of Gort to the east and the village of Crusheen to the west.

1.3 Archaeological Requirements

The archaeological requirements for the N18 Gort to Crusheen road scheme, were defined in the Ministerial Directions issued to Galway County Council by the Minister for Environment, Heritage and Local Government under Section 14A (2) of the National Monuments Acts 1930–2004 and in the terms of the contract between Galway County Council and Irish Archaeological Consultancy Ltd. These instructions formed the basis of all archaeological works undertaken for this development. The archaeological excavation works under this contract were located between the townlands of Glenbrack, Co. Galway, and Carrowdotia, Co. Clare.

The proposed N18 was subjected to an Environmental Impact Assessment the archaeology and cultural history section of which was carried out by Babtie Pettit Ltd in 2006. The Record of Monuments and Places, the Sites and Monuments Record, Topographical files of the National Museum of Ireland, aerial photography, and documentary sources were all consulted. Two phases of geophysical survey were conducted. The main phase was by RSKENSR (Bartlett 2004) during the preparation of the EIA (Babtie Pettit Ltd 2006). A supplementary survey was carried out in Ballyboy by Target Geophysics Ltd (Target Geophysics Ltd 2007). As a result of the paper survey, field inspections, geophysical survey, archaeological testing and archaeological monitoring, a total of 22 fully recorded manual excavations were carried out on this section of the overall route alignment. In some cases where a

number of sites of similar type were located together in a single townland, the sites were excavated under one excavation number.

Phase 1 archaeological testing was completed by IAC Ltd and Phase 2 excavation of the sites identified during testing was conducted by IAC Ltd on behalf of Galway County Council and the NRA.

1.4 Methodology

The presence of archaeological remains beneath the topsoil layer was confirmed by machine-cut test trenches. Following testing, the topsoil was reduced to the interface between topsoil and natural subsoil using a 20 tonne mechanical excavator equipped with a flat toothless bucket under strict archaeological supervision. The remaining topsoil was removed by the archaeological team with the use of shovels, hoes and trowels in order to expose and identify the archaeological remains. A site grid was set up at 10m intervals and was subsequently calibrated to the national grid using GPS survey equipment.

All features were subsequently fully excavated by hand and recorded using the single context recording system with plans and sections being produced at a scale of 1:50, 1:20 or 1:10 as appropriate.

A complete photographic record was maintained throughout the excavation. Digital photographs were taken of all features and of work in progress.

An environmental strategy was devised at the beginning of the excavations. Features exhibiting large amounts of carbonised material were targeted. Animal bone, unburnt wood and stone samples were all retrieved through both hand and bulk collection and retained for specialist analysis wherever they were encountered during the excavations.

In the instances where artefacts were uncovered on site they were dealt with in accordance with guidelines issued by the National Museum of Ireland (NMI) and where warranted in consultation with the relevant specialists. All artefacts, ecofacts and paper archive are currently stored in IAC offices, Lismore, Co Waterford and will ultimately be deposited with the National Museum of Ireland.

Radiocarbon dating of the site was carried out by means of AMS (Accelerator Mass Spectrometry) dating of identified and recommended charcoal samples. All calibrated AMS dates in this report are quoted to 2 Sigma.

All excavation and post-excavation works were carried out in consultation and agreement with the Project Archaeologist, the National Monuments Section of the DEHLG and the National Museum of Ireland.

2 EXCAVATION RESULTS

The archaeological activity recorded at Derrygarriff 2 was an Iron Age metal working furnace.

Detailed descriptions of all excavated features and deposits are listed in Appendix 1.

2.1 Phase 1: Natural Drift Geology

Derrygarriff 2 was located on the south-facing slope of a limestone ridge running through an area of bog. The subsoil was grey gravel to the southeast close to the bog and changed to a mottled orange silty sand towards the higher ground in the northwest.

2.2 Phase 2: Iron Age Activity

The archaeological activity identified on site relates to metal-working activity in the form of three pits.

2.2.1 Shallow Pit

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation
11	N/A	0.32	0.3	0.1	Oval cut, shallow sides	Cut of a shallow pit
6	C11	0.32	0.3	0.1	Mid brown clay silt, charcoal	Fill of a pit

Finds: None

Interpretation

The function of the oval pit C11 is unknown; it may be a pit related to the metal preparation process (Figures 3–4; Plate 5). The pit, C11, had some *in situ* burning and contained one fill, C6, a single deposit of mid-brown, clay silt with slight inclusions of charcoal which may have been deposited as a result of natural formation silting.

2.2.2 Hearth

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation
12	N/A	0.6	0.52	0.46	Oval cut, moderate sides	Cut of irregular pit
13	C12	0.38	0.35	0.32	Yellow brown red clay	Burnt clay, basal fill
7	C12	0.47	0.35	0.14	Dark brown black charcoal rich silt	Top fill of pit

Finds: None

Interpretation

The pit C12 is likely to have been a hearth and was most likely used in association with the metal production process (Figures 3–4). The pit contained two fills, C13 and C7, the primary of which, C13, was burnt clay, the result of *in situ* burning and the secondary fill, C7, was charcoal from the fire.

2.2.3 Metalworking Furnace / Pit C5

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation
5	N/A	2.45	0.68	0.48	Linear cut, vertical to gradual sides	Cut of a linear smelting pit
4	C5	2.45	0.68	0.21	Brown silty sand	Basal fill of pit C5
3	C5	2.45	0.68	0.25	Orange black silty clay, charcoal, stone. Contained approximately 10 kg of slag.	Upper fill of smelting pit C5

Finds: None

Interpretation
A linear pit, C5, which measured 2.45 m northwest–southeast x 0.68 m x 0.48 m deep, showed signs of intense *in situ* burning and contained a quantity of slag-like material (Figures 3–4; Plates 3–4). It appeared that the irregular pit cut was lined with gravel to create a working surface. It contained two fills, the lower fill C4 and the upper fill C3, a firm, orange-black, silt clay with occasional burnt stone and charcoal inclusions. Approximately 10 kg of slag-like material was recovered from C3 the upper fill of the pit (Young, Appendix 2.3). The linear pit C5 may have functioned as an iron-smelting pit.

One AMS date was obtained from C3, a use fill within the furnace. A fragment (1.4g) of alder/hazel (*Alnus glutinosa/corylus avellana*) charcoal was identified (Cobain, Appendix 2.2). This charcoal returned an AMS result of 2144±21 BP (UBA 12716). The 2 Sigma calibrated result for this was 350–100 BC (Appendix 2.1).

Oak appears to have been the dominant fuel, most likely in the form of charcoal, used within the metal-working furnace, C5. This fuel would have produced the high temperatures required for the production of metallurgical material. The other species (hazel, alder, holly, Maloideae [hawthorn/rowan/crab apple]) retrieved from the furnace are most likely to represent kindling material used to ignite the oak charcoal (Cobain, Appendix 2.2).

2.3 Phase 3: Post-Medieval Charcoal-production Kiln

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation
10	N/A	3.9	1.05	0.52	Oval cut, moderate sides	Cut of possible kiln
9	C10	1.75	0.70	0.17	Mid greyish sandy gravel, charcoal	Basal fill of possible kiln
8	C10	3.3	0.55	0.16	Dark brown black silty clay, charcoal	Middle fill of possible kiln
14	C10	1.4	0.58	0.17	Mid grey silt	Top fill of poss. kiln

Finds: None

Interpretation
The long oval pit (C10) measured 3.9 m east–west x 0.7 m x 0.52 m deep and contained three deposits. The basal deposit, C9, was a sandy gravel that acted as a compact working surface (Figures 3–4; Plate 2). The middle fill (C8) was a compact, dark-brown, charcoal-rich deposit. The upper fill (C14) was a firm, mid-grey layer and formed due to silting. The pit contained large amounts of charcoal and it probably represents the remains of a charcoal-production kiln or clamp.

One AMS date was obtained from deposit C8, the middle fill within the kiln. A fragment (15.3g) of hazel (*Corylus avellana*) charcoal was identified (Cobain, Appendix 2.2). This charcoal returned an AMS result of 116±19 BP (UBA 12715). The 2 Sigma calibrated result for this was AD 1683–1955 (Appendix 2.1).

The charcoal remains identified from the charcoal production kiln, C10, indicate that ash was the main wood type undergoing the combustion process to produce ash charcoal, with additional species (hazel, alder and the Maloideae species (hawthorn/rowan/crab apple) used as kindling to ignite the ash wood (Cobain, Appendix 2.2).

2.4 Phase 4: Topsoil

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation
1	N/A	Site	Site	0.20	Mid brown stoney silt clay	Topsoil

Finds: None

Interpretation
The topsoil was a mid-brown stony clay between 0.20 m (north of site) to 0.10 m deep towards the southeast. It sealed all of the archaeological deposits at Derrygarriff 2.

3 SYNTHESIS AND DISCUSSION

3.1 Landscape Setting

Most of the low-lying areas along the route were associated with poorly drained bog and wet marshland which have developed within glacially formed depressions and seasonal lakes known as turloughs. The higher ground generally comprised well-drained, gently undulating pastureland with some uneven hummocky ridges, formed either of limestone epikarst or glacial features such as drumlins. The two dominant rock types of the region were Carboniferous Limestone, which underlay the entire length of the N18 Gort to Crusheen scheme, and the Devonian Old Red Sandstone, which formed the Slieve Aughty Mountains to the east of the project. The road alignment was predominantly underlain by either limestone and sand derived till deposited during the last glaciation or organic peat which has generally formed since then in the low-lying, poorly drained areas where standing water and slow percolation caused thin layers of peaty soil to accumulate.

The site at Derrygarriff 2 was located on the south facing slope of a low ridge within a wetland area of Derrygarriff townland in north Co. Clare. The Derrygarriff stream was located to the south of the site, bog existed to the east and raised well drained (but rocky) land was located to the north and west. The site was located at NGR 140356/190940 and was situated at 26 m OD. There are two cashels (CL018-021 and CL 018-018) located c. 145 m east and c. 276 m west southwest of Derrygarriff 2.

3.2 Iron Age Landscape

In comparison with the Bronze Age, evidence for Iron Age activity in Ireland as a whole is somewhat scarce. The later first millennium BC and the early centuries AD are amongst the most obscure in Irish prehistoric archaeology (Waddell 1998, 279). Waddell states that 'domestic occupation sites remain virtually unknown and our understanding of settlement, economy and social structure in the period from 600 BC to the early centuries AD is meagre in the extreme' (Ibid. 319).

This road scheme joins a number of recent large-scale infrastructural projects in the region which have included archaeological excavations, most notably the Gas Pipeline to the West (Grogan et al. 2007) which runs mostly parallel a short distance to the west of the N18, and the N18 road contracts to the north and south. Unfortunately despite these projects evidence for Iron Age settlement and activity remains relatively minor in this region.

One potential Iron Age site close to the N18 is the possible hilltop enclosure (GA122-078) located in the townland of Drumminacloghaun, Co. Galway, towards the northern end of the route (it is also possible however that this enclosure may simply have been an early medieval ringfort). The site appears on the 1st and 2nd edition Ordnance Survey map editions, apparently located on the edge of a ridge. It was subsequently destroyed and no trace of it was identified in the walkover survey conducted as part of the EIS for the scheme. Excavations at hilltop enclosures have produced evidence for occupation in the late Bronze Age and early Iron Age (Raftery, 1994, 58-62) and it is possible that some were only occupied sporadically in times of strife. They may have been used principally as meeting places on ceremonial, ritual or political occasions. Large resources would have been required to build these earthworks, indicating a movement perhaps towards larger population tribal groups.

The Iron Age is noted for its lack of native pottery and also the scant evidence for burials and settlements when compared to both the Bronze Age and early medieval periods. A concentration of funerary barrows is known to the north of the scheme, to

the east and north east of Ardrahan, and may well date to the Iron Age period. One example at Grannagh (east of Ardrahan) was completely excavated (Waddell 1998, 367). The excavation revealed a 15 m diameter ringditch which contained pockets of cremated bone, and a variety of finds including glass beads, dumbbell shaped beads and pins. It has been dated to the 1st century AD. Another ringditch was excavated at Oran Beg (Rynne 1970), near Oranmore. It was 11 m in diameter and there were cremation deposits within the ditch fill. Over 80 glass beads, mainly blue but also yellow, were recovered during the excavation and some of these appeared to have been fused in the cremation pyre. The finds of both the Grannagh and Oran Beg sites indicate an Iron Age date.

Moving south of the Gort to Crusheen road scheme there was evidence for Iron Age funerary activity recovered from the N18 Ennis Bypass and N85 Western Relief Road archaeological excavations. A site at Manusmore identified as containing 27 burial pits returned a date range from the Neolithic to the Iron Age periods (Hull 2006a), the later dated pits contained burnt animal bone and may not specifically be related to the cremations. Approximately 900 m to the northeast another pit burial site was located which too produced evidence for an Iron Age date (Hull 2006b).

At Killow, a site was identified which contained evidence for late Bronze Age and Iron Age activity, apart from a burnt mound this was mainly in the form of pits (one of the probable cremation pits was dated to the very early Iron Age. A wooden bowl found in peat close to the site also returned a similar Iron Age date (04E0191:50:1). A ringditch with a diameter of 6 m was also excavated as part of the N18 Ennis Bypass and N85 Western Relief Road and produced an Iron Age date. The site had been heavily truncated but produced cremated bone deposits and finds including yellow glass beads and fragments of quartz (Hull 2006c). Two ringditches have also been excavated as part of the N18 Gort to Crusheen scheme in Ballyboy townland and based on the artefact and bead types recovered from them they appear to date to the Iron Age period.

Most Iron Age sites identified within close proximity to the N18 Gort to Crusheen road scheme relate to the funerary deposition of cremated bone at the sites, either in ringditches or in pits. At most of these sites the cremated remains did not represent complete individuals and this may indicate that at times only token deposits were placed in the monuments. We know very little of the everyday activities of domestic life during this period as very little evidence of their houses or artefacts have been identified within the archaeological record. The site at Rathwilladoon 2 and 3 (Lyne 2009a) produced evidence for the foundation gully of a circular structure dated to 186–52 BC (2103±22; UBA 12731). This may be the remains of an Iron Age structure or dwelling and may be associated with a charcoal production kiln, Rathwilladoon 5, excavated approximately 300 m to the south (Lyne 2009b). This site, which appeared to also contain a charcoal-production kiln and a small metal working furnace, was found in marginal land adjacent to a low-lying wetland area. Its location was probably influenced by the presence of suitable timber for charcoal. The kiln was found alongside a very small pit with fragments of ferrous material, probably slag which returned a 2 Sigma calibration date of 155 BC–AD 67 (2018±37; UBA12739). Perhaps this poor quality land may have been used for the deliberate coppicing of certain types of tree for the purpose of making charcoal.

3.3 Archaeological Typology

3.3.1 Metalworking Furnaces

Furnaces, used for the smelting of ores into an iron bloom prior to the smithing stages, survive in the archaeological record as small shallow heat-scorched pits,

usually oval or hemispherical in shape, containing fills of iron slag, charcoal and, in many cases, oxidised clay. Dense blocks of slag commonly form at the bottom of the furnace which have been termed plano-convex or 'furnace-bottoms' (Scott 1990, 155–6). A total of 30 furnaces – with approximate diameters of between 0.40 m and 0.70 m and depths not exceeding 0.20 m – were identified in advance of the M4 road scheme and survived as bowl-shaped pits, with heat-reddened sides and bases, which contained slag and, in many examples, vitrified clay fragments (Carlin et al. 2008, 94). A recent summary of furnaces associated with raths has revealed similar morphological characteristics and deposits whereby they were all heat-scorched small pits containing charcoal, slag and burnt clay in many instances (Comber 2008, 115–7).

Much of the technology associated with the primary stages of iron production such as charcoal-production kilns, furnaces and smithing hearths, during the bloom-smithing process, were located close to natural resources such as wood and bogland. This is not surprising because oak was the preferred fuel for charcoal production as it is denser and burns for longer than softer woods (Raftery 1994, 148; Tylecote 1962), while bog ore was more readily available and required less work to extract compared to mining and was also a regularly renewable resource (Mytum 1992, 230). The primary stages of ironworking generally took place away from dwellings due to the dangers associated with production, such as the risk of fire and the toxic nature of the process. The results from recent excavations, such as along the M4 (Carlin et al. 2008) and the M7/M8 (Kenny 2007) testify to this as the majority of furnaces were located in marginal places, availing of limited drier and sloping ground, close to bog and woodland and away from settlements. However, furnaces do occur within enclosed early medieval settlements in some instances, such as Killickaweeny, Co. Kildare (Walsh 2008), and it appears that iron-smelting was practised sometimes within enclosures, possibly in controlled safe environments away from the dwellings.

The ironworking processes remained largely static until the 17th century so the features that survive archaeologically today appear similar in form even though they span the centuries between late prehistory and the later middle-ages. Diagnostic artefacts are also mainly absent so radiocarbon dating is vital for determining the age of various metallurgical features, including smelting furnaces. Radiocarbon-dated examples of furnaces from the M4 show that, despite their morphological similarities, they were in use from the beginnings of the fifth century BC until the late medieval period with the majority dating to the early middle ages (Carlin et al. 2008, 104). A number of possible furnaces along the M7/M8 have also produced dates spanning the middle Iron Age through to the later medieval period (Kenny 2007).

Debates have recently focused on the arguments for (Carlin et al. 2008; Crew and Rehren 2002, 96; Mytum 1992, 231) and against (Pleiner 2000; Scott 1990; Raftery 1994, 148) the existence of the low-shaft furnace in Ireland with the former mainly arguing that the low-shaft furnace, in contemporary use in Britain, was more efficient than the bowl furnace. This view was based, to a large extent, on the experimental work on bowl furnaces by O'Kelly (1961) and later by Tylecote (1986). Bowl furnaces consisted of small open air bowl shaped pits occasionally with a dome-shaped clay roof where the flames were fanned with a bellows and the ore was separated by pooling at the base of the pit (Scott 1990, 159). Low-shaft furnaces differed in that they were clay-lined with clay sides constructed above ground in the shape of a conical- or a cylindrical-shaped chimney (Carlin et al. 2008, 92). They also differed to the bowl furnace because the charcoal and ore were placed in alternating layers (Mytum 1992, 231). Archaeologically, however, it is difficult to distinguish between the two because both survive as heat-scorched pits containing charcoal and slag deposits and, in many cases, vitrified clay fragments. The presence of the latter

cannot be used as evidence for the existence of the low-shaft furnace because bowl furnaces may also have been clay-lined or roofed by a clay dome. Regardless of the existence, or not, of the low-shaft furnace, the large number of furnaces found in excavations across the country demonstrate that iron smelting was an integral part of the iron production process and it usually occurred in marginal places, in proximity to raw materials, and away from settlements where the final process – iron forging – was frequently practised.

3.3.2 Charcoal-production Kilns

Charcoal-production kilns were essential to the ironworking process as charcoal was required as a fuel in the smelting and forging stages. There has been a large increase in the identification of these sites during the boom in development-led archaeology and excavations of charcoal-production kilns are beginning to feature in recent publications (Carlin et al. 2008; Grogan et al. 2007; Hull and Taylor 2006).

An unpublished paper by Niall Kenny (2008) has identified approximately 100 charcoal-production kilns in Ireland that range in plan from rectangular to oval and circular, with sub-variations of these, and there is an approximate equal amount of each type. It appears, on current evidence, that the classic type is large and rectangular in plan, such as Hardwood 3, Co. Meath for example, where long carbonised pieces of oak were found along the axis of the kiln and made up almost 100% of the deposit (Carlin et al. 2008, 101; Illus. 5.8b, 102). The rectangular kilns tend to be larger than oval and circular types with an average length of 2.5 m but they can also be as long as 4 m (Kenny 2008, 14-5). The oval kilns tend to be shallower than the other types while the circular examples are usually smaller but deeper compared to rectangular and oval charcoal-production kilns (ibid. 15).

Charcoal-production kilns are identifiable archaeologically as earth-cut pits, with charcoal-rich fills, and evidence for extensive *in situ* burning along the base and sides (Carlin et al. 2008, 101; Kenny 2008, 15). Those discovered along the M4 were rectangular or sub-rectangular in plan (Carlin et al. 2008), whereas Kenny (2008) has also identified circular and oval types. However, it is important to stress that charcoal-production kilns, such as Hardwood 3 and Kilmaniheen West 10 and 12, Co. Kerry (Hull and Taylor 2006, 29-30), were recognisable because the carbonised wood had survived *in situ* upon excavation. These kilns were abandoned possibly due to the charcoal becoming wet, which left it useless as a fuel. Successful kilns would not leave abundant charcoal within their primary fills so would appear archaeologically as heat-scorched pits probably containing only moderate amounts of charcoal. This, therefore, conveys the problems in positively identifying charcoal-production kilns, as many charcoal yields will have been previously removed.

The majority of charcoal-production kilns were located away from settlements and close to resources required for the primary ironworking processes such as bog and woodlands. Large quantities of trees were required for charcoal production and, similarly, large quantities of iron ore, available within surrounding bogs (Mytum 1992, 230; Raftery 1994, 147), were needed during the smelting process. Therefore, it made sense, logistically and for safety reasons, for charcoal kilns to be situated a distance from dwellings and farms and close to available raw materials. Kenny's (2008, 20-2) research has also shown that the majority of kilns are located on sloping and agriculturally unproductive ground and drainage was probably an important factor because it was imperative to keep the charcoal dry.

Radiocarbon dates are beginning to emerge from a number of charcoal kilns and possible examples. Of those dated, the majority appear to date to the latter part of the early medieval period. The kilns excavated along the M4 returned radiocarbon

dates between the eighth and thirteenth centuries (Carlin et al. 2008, 88). The dates appear to converge at a point between the eleventh and twelfth centuries. Kilns at Kilmaniheen West, Co. Kerry, and Barefield, Co. Clare, also returned radiocarbon dates spanning the latter part of the early medieval period (Hull and Taylor 2006). A circular kiln at Mondaniel 2, Co. Cork, was dated to AD 1420–1640 (Kenny 2008, 18) but, on current evidence, charcoal-production kilns generally date to the latter part of the early medieval period into the early years of the later middle ages.

Charcoal is the material produced from the incomplete combustion of wood and was used as an effective fuel, much more so than wood or turf for example, during the smelting and forging stages of ironworking. It was produced through the placement of wood, mainly oak, against a vertical post in earth-cut pits that were covered by layers of straw or bracken and were then sealed by a layer of earth or turf. The post was removed and the kiln was subsequently ignited as the wood was roasted to produce the charcoal over a number of days (Carlin et al. 2008, 89-91). This was a labour-intensive process that required careful supervision and plentiful raw materials. The identification of increasing number of charcoal kilns emphasises that it was a much more widespread industrial activity than previously considered and that it was an essential component of the iron production process.

3.4 Discussion

3.4.1 Phase 1: Natural Drift Geology

Derrygarriff 2 was located on the south-facing slope of a limestone ridge running through an area of bog. The subsoil was grey gravel to the southeast close to the bog and changed to a mottled orange silt sand towards the higher ground in the northwest.

3.4.2 Phase 2: Iron Age Activity

Three pits were identified at Derrygarriff 2. The two smaller pits appear to have been hearths as they both contained evidence for *in situ* burning. The largest pit was a metal-working furnace and was located to the southeast of the two hearths. Charcoal from the fill of the furnace produced a date of 350–100 BC. Oak was the dominant fuel identified from the furnace and oak charcoal would have burnt longer and at a higher intensity than most other timbers. Hazel, alder, holly and Maloideae species (hawthorn, rowan/crab apple) were also identified and probably represent kindling that was used to keep the fire burning. The relatively dry location of the site would have meant the process of ecological succession would have allowed the development of ash-oak woodland vegetation upslope, away from the wetland areas. The area of wetland further away from the site would have consisted of an alder-carr marsh woodland

Lab code	Context / sample	Sample material	Years BP	1 sigma	2 sigma
UBA 12716	C3 / S4	Charcoal Alder/Hazel	2144±21	Cal 342–121 BC	Cal 350–100 BC

Approximately 10 kg of ferrous/slag residue was recovered from the site. The assemblage is indicative of iron smelting in a shaft furnace (Young, Appendix 2.3). Analysis of the residues suggest that the upper fill of the pit may represent the collapsed superstructure of the furnace. The assemblage also contained two fragments which were from smithing-hearth cakes and some hammerscale indicative of smithing. Young suggests that the broader end of the cut to the northeast was the location of the furnace base with the narrower cut to the southwest suggesting the approach to the furnace arch. This style of furnace is known from other sites from the fourth to first centuries BC including Derrinsallagh, Co. Laois (ibid.).

It was likely to have been situated where it was as it was a dry location close to a bog. The bog may have been the source of the bog iron smelted in the furnace.

3.3 Phase 3: Post-Medieval Charcoal-production Kiln

The remains of the charcoal pit was a long oval pit. It contained three deposits, the basal layer was compacted to form a working surface or seal (Figures 3–4; Plate 2). The middle fill was a charcoal-rich deposit that was sealed by a silt. The pit contained large amounts of charcoal and it represents the remains of a charcoal-production kiln or clamp. The charcoal identified indicates that ash was the main wood type undergoing the combustion process to produce ash charcoal, with additional species (hazel, alder and the Maloideae [hawthorn/rowan/crab apple]) used as kindling to ignite the ash wood.

A fragment of hazel (*Corylus avellana*) charcoal was dated from C8 a secure context forming the middle fill of the kiln and disappointingly returned a late AMS result of 116±19 BP (UBA 12715). The 2 Sigma calibrated result for this was AD 1683–1955 (Appendix 2.1). It had been hoped that the dating would indicate that both the furnace and the charcoal kiln were contemporary as often both types of features are found together, representing the two phases of industry required on a metal-working site.

Lab code	Context / sample	Sample material	Years BP	1 sigma	2 sigma
UBA 12715	C8 / S1	Charcoal Hazel	116±19	Cal AD 1691–1922	Cal AD 1683–1953

3.4 Phase 4: Topsoil

The topsoil was a mid-brown stoney clay between 0.20 m to 0.10 m deep towards the southeast. It sealed all of the archaeological deposits at Derrygarriff 2. No artefacts were recovered from the topsoil.

4 CONCLUSIONS

An industrial/metalworking area was discovered in undulating scrubland in Derrygarriff townland, in north Co. Clare. The site consisted of four cut features.

The earliest phase of activity on the site related to a metal-working furnace with two associated hearths. The largest pit was a metal-working furnace and was located to the southeast of the two hearths. Oak was the dominant fuel identified from the furnace and oak charcoal would have burnt longer and at a higher intensity than most other timbers. Hazel, alder, holly and Maloideae species (hawthorn, rowan/crab apple) were also identified and probably represent kindling that was used to keep the furnace burning. Charcoal from the fill of the furnace produced a calibrated 2 Sigma date of 350–100 BC. Fragments of compact clay from the furnace represent the furnace superstructure and indicate it was a shaft furnace. Hammerscale was also retrieved indicating that smithing was carried out at the location.

A large linear / oval pit, located to the northwest of the metalworking pits, contained large amounts of charcoal and was interpreted as a charcoal-production kiln or clamp. The charcoal identified indicates that ash was the main wood type undergoing the combustion process to produce ash charcoal, with additional species (hazel, alder and Maloideae [hawthorn/rowan/crab apple]) used as kindling to ignite the ash wood. It was originally assumed that this feature was contemporary with the metal-working furnace but a 2 Sigma calibrated date from a secure sealed context within the feature of AD 1683–1955 places it in the post-medieval period.

The two main features identified on the site were securely dated and both represented industrial activity from different periods. The site was probably chosen on both of these occasions as it was relatively sheltered and dry, located on the south-facing slope of a limestone ridge running through an area of bog. It would have been close to a source of bog iron for smelting during the Iron Age phase of activity and may have been forested with suitable trees during the charcoal-production activity.

The Iron Age date from the metal-working furnace presents clear evidence for Iron Age activity in the region and taken into consideration with the Iron Age sites identified at Rathwilladoon 2 and 3 (Lyne 2009a) and Rathwilladoon 5 (Lyne 2009b) is of some significance, and helps to fill in our knowledge of the period in this area.

5 BIBLIOGRAPHY

5.1 References

Babtie Pettit Ltd 2006 *Cultural Heritage Section of N18 Gort to Crusheen Scheme Environmental Impact Statement* undertaken on behalf of Galway County Council.

Bartlett, ADH 2004 N18 Gort to Crusheen Road Scheme: Report on Archaeogeophysical Survey of Proposed Route. RSKENSR, Helsby.

Carlin, N with contributions by V Ginn, and J Kinsella 2008 'Ironworking and production: an evaluation and assessment of the metallurgical evidence', N Carlin, L Clarke and F Walsh *The Archaeology of Life and Death on the Boyne Floodplain: The Linear Landscape of the M4*, 87–112, Dublin, National Roads Authority, Wordwell.

Comber, M 2008 *The Economy of the Ringfort and Contemporary Settlement in Early Medieval Ireland*. BAR International Series 1773. Oxford. Archaeopress.

Crew, P & Rehren, T 2002 'Appendix 1: High-temperature workshop residues from Tara: iron, bronze and glass', Roche, H *Excavations at Raith na Rig, Tara Co. Meath 1997,* Discovery Programme Reports **6**, 83–102. Dublin, Royal Irish Academy/Discovery Programme.

Grogan, E O'Donnell, L and Johnston, P 2007 *The Bronze Age Landscapes of the Pipeline to the West*. Dublin, Wordwell.

Hull, G 2006a Site AR100, Manusmore, Co Clare. Final Archaeological Excavation Report for Clare County Council. TVAS Ireland Ltd

Hull, G 2006b Site AR102, Manusmore, Co Clare. Final Archaeological Excavation Report for Clare County Council. TVAS Ireland Ltd

Hull, G 2006c Site AR131, Claureen, Co Clare. Final Archaeological Excavation Report for Clare County Council. TVAS Ireland Ltd

Hull, G and Taylor, K 2006 'Archaeological sites on the route of the N21 Castleisland to Abbeyfeale road improvement scheme, Co. Kerry', *Journal of the Kerry Archaeological and Historical Society*, Vol. 6, 5–59.

Kenny, N 2008 Charcoal Production and Ironworking: A Selection of Sites from the M7/M8. Unpublished report prepared for Archaeological Consultancy Services Ltd.

Kenny, N 2007 *On the Recent Archaeological Discoveries in the Townlands of Derryvorrigan and Derrinsallagh: Iron Production and Ironworking in the Iron Age and Beyond*. Unpublished report prepared for Archaeological Consultancy Services Ltd.

Lyne, E 2009a *Rathwilladoon 2 and 3, E3656. Final Report.* Unpublished report prepared for Irish Archaeological Consultancy Ltd

Lyne, E 2009b *Rathwilladoon 5, E3657. Final Report.* Unpublished report prepared for Irish Archaeological Consultancy Ltd

Mytum, H 1992 *The Origins of Early Christian Ireland*. London, Routledge.

O'Kelly, MJ 1961 'The ancient method of smelting iron', *Internat. Kongress fuer Von u. Fruegeschichte*, 459–91, Hamburg, Universitatsbibliothek Basel.

Pleiner, R 2000 *Iron in Archaeology: The European Bloomery Smelters*. Prague, Archaeologicky USTAV AV CR

Raftery, B 1994 *Pagan Celtic Ireland: The Enigma of the Irish Iron Age*. London, Thames and Hudson

Scott, B G 1990 *Early Irish Ironworking*. Belfast, The Ulster Museum

Target Geophysics Ltd. 2007. A Geophysical Survey at Ballyboy, Co. Galway

Taylor, K 2006 Site AR25, Carrowdotia, Co Clare. Final Archaeological Excavation Report for Clare County Council. TVAS Ireland Ltd

Tylecote, R F 1986 *The Prehistory of Metallurgy in the British Isles*. London, The Institute of Metals

Waddell, J 1998 *The Prehistoric Archaeology of Ireland*. Wordwell

Walsh, F 2008 Killickaweeny 1: high-class early medieval living. In N Carlin, L Clarke and F Walsh, *The Archaeology of Life and Death on the Boyne Floodplain: The Linear Landscape of the M4*, 27–54, Dublin, National Roads Authority, Wordwell

5.2 Other Sources

Record of Monuments and Places (RMP), The Department of the Environment, Heritage and Local Government, 7 Ely Place Upper, Dublin 2.

Topographical Files of the National Museum of Ireland, Kildare Street, Dublin 2

Cartographic References

Ordnance Survey, Map Editions 1842, 1899, 1915

Electronic References

Anonymous. *Charcoal: The Burning Question* (Accessed 28/02/2008)
www.gallica.co.uk/celts/charcoal.htm

Rynne, E 1970 Excavation of a Ring Barrow at Oran Beg (Licence Ref.: M 420 255)
http://www.excavations.ie/Pages/Details.php?Year=&County=Galway&id=5426

http://www.excavations.ie

PLATES

Plate 1 General view of the site, looking south

Plate 2 Pre-excavation view of kiln C10, looking east

Plate 3 Mid-excavation view of furnace C5, looking southwest

Plate 4 Post-excavation view of furnace C5, looking southwest

Plate 5 Mid-excavation view of pit C11, looking north

Plate 6 Post-excavation view of the site, looking southeast

APPENDIX 1 CATALOGUE OF PRIMARY DATA

Appendix 1.1 Context Register

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation	Description	Finds	Context Above	Context Below
1	N/A	Site	Site		Mid-brown, stoney, silty clay.	Topsoil				
2	N/A	Site	Site		Mottled grey-orange silt sand.	Subsoil				
3	C5	2.45	0.68	0.25	Orange black silty clay, charcoal, stone.	Fill of a smelting pit	Firm orange black silty clay. Occasional burnt stone and charcoal.	Slag	C1	C4
4	C5	2.45	0.68	0.21	Brown silty sand.	Base fill of C5	Loose brown silty sand.		C3	C5
5	N/A	2.45	0.68	0.48	Linear cut, vertical to gradual sides.	Cut of a linear smelting pit	Linear cut in plan, long axis orientated NW-SE. No corners. Sharp break of slope at top to N. Gradual break of slope at top to S. Vertical sides to N. Gradual sides to S. Sharp break of slope at base to N. Gradual break of slope at base to S. Linear base.		C4	C2
6	C11	0.32	0.3	0.1	Mid brown clay silt, charcoal.	Fill of a pit	Firm mid brown clay silt. Charcoal inclusions.		C1	C11
7	C12	0.47	0.35	0.14	Dark brown black charcoal rich silt.	Upper fill of C12.	Firm dark brown black silt. Frequent charcoal inclusions.		C1	C13
8	C10	3.3	0.55	0.16	Dark brown black silty clay, charcoal.	Middle fill of C10. Fill of a possible kiln	Firm dark brown black silty clay. Inclusions of large charcoal pieces.		C14	C9
9	C10	1.75	0.70	0.17	Mid grayish yellow sandy gravel, charcoal.	Basal fill of C10. Fill of a possible kiln	Hard compaction mid grayish yellow sandy gravel. Inclusions of small charcoal pieces.		C8	C10
10	N/A	3.9	1.05	0.52	Long oval cut, moderate sides.	Cut of a possible kiln	Oval cut in plan, long axis orientated N-S. No corners. Sharp break of slope at top. Moderate sides. Not perceptible break of slope at base. Irregular base.		C9	C2

Context	Fill of	L(m)	W(m)	D(m)	Basic Description	Interpretation	Description	Finds	Context Above	Context Below
11	N/A	0.32	0.3	0.1	Oval cut, shallow sides.	Cut of a shallow pit	Oval cut in plan, long axis orientated N-S No corners. Gradual break of slope at top. Shallow sides. Not perceptible break of slope at base. Concave base.		C6	C2
12	N/A	0.6	0.52	0.46	Oval cut, moderate sides.	Cut of irregular pit	Oval cut in plan, long axis orientated N-S. No corners. Sharp break of slope at top. Moderate sides. Gradual break of slope at base. Irregular base.		C7, C13	C2
13	C12	0.38	0.35	0.32	Yellow brown red clay.	Basal fill of C12. Burnt clay layer in pit	Firm yellow brown red clay.		C7	C12
14	C10	1.4	0.58	0.17	Mid grey silt.	Uppermost fill of C10. Fill of a possible kiln	Firm mid grey silt. No inclusions.			

Appendix 1.2 Catalogue of Artefacts

There were no artefacts from the excavations at Derrygarriff 2.

Appendix 1.3 Catalogue of Ecofacts

These results relate to the processed samples taken at the excavation. A full list of these samples was supplied with the preliminary reports lodged with Galway NRDO. A total of nine bulk soil samples were taken during the course of excavation at this site. All of these were processed by means of flotation and sieving through a 250/300µm mesh. The resulting retrieved samples of this process are listed below. In addition to this, a sample of slag was hand retrieved on site.

1.3.1 Charcoal

Two charcoal samples were recovered following flotation.

Context number	Sample number	Feature	Sample weight (g)
C8	1	Charcoal pit	189.5g
C3	4	Smelting pit	7.7g

1.3.2 Slag

One sample of slag was hand retrieved from C3, a smelting pit.

Context number	Sample number	Feature	Sample weight (g)
C3	9	Smelting pit	10 kg

Appendix 1.4 Archive Checklist

Project:	**N18 Gort to Crusheen**	**Irish Archaeological Consultancy Ltd**	
Site Name:	**Derrygarriff 2**		
NMS Number:	**E3711**		
Site director:	**Joe Nunan**		
Date:	**15/02/08**		
Field Records		**Items (quantity)**	**Comments**
Site drawings (plans)		2	2 Sheets
Site sections, profiles, elevations		7	1 Sheet
Other plans, sketches, etc.		0	
Timber drawings		0	
Stone structural drawings		0	
Site diary/note books		0	
Site registers (folders)		1	
Survey/levels data (origin information)			
Context sheets		14	
Wood Sheets		0	
Skeleton Sheets		0	
Worked stone sheets		0	
Digital photographs		66	
Photographs (print)		0	
Photographs (slide)		0	
Finds and Environ. Archive			
Flint/chert		0	
Stone artefacts		0	
Pottery (specify periods/typology)		0	
Ceramic Building Material (specify types eg daub, tile)		0	
Metal artefacts (specify types - bronze, iron)		0	
Glass		0	
Other find types or special finds (specify)		0	
Human bone (specify type eg cremated, skeleton, disarticulated)		0	
Animal bone		0	
Metallurgical waste		3 Buckets	Iron 'slag'
Enviro bulk soil (specify no. of samples)		9	10 Buckets
Enviro monolith (specify number of samples and number of tins per sample)		0	
Security copy of archive		Yes	IAC Digital

APPENDIX 2 SPECIALIST REPORTS

RADIOCARBON DATING RESULTS
DERRYGARRIFF 2, CO. CLARE, E3711

CHRONO LABORATORY, QUEENS UNIVERSITY BELFAST

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^{14}CHRONO Centre
Queens University
Belfast
42 Fitzwilliam Street
Belfast BT9 6AX
Northern Ireland

Radiocarbon Date Certificate

Laboratory Identification:	UBA-12715
Date of Measurement:	2009-10-16
Site:	E3711 Derrygarriff 2
Sample ID:	C8S1
Material Dated:	charcoal
Pretreatment:	AAA
Submitted by:	IAC

^{14}C Date: 116±19
AMS δ^{13}C: -28.2

Information about radiocarbon calibration

```
RADIOCARBON CALIBRATION PROGRAM*
CALIB REV5.0.2
Copyright 1986-2005 M Stuiver and PJ Reimer
*To be used in conjunction with:
Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.
Annotated results (text) - -
Export file - c14res.csv
```

```
C8S1
UBA-12715
Radiocarbon Age BP    116 +/-   19
Calibration data set: intcal04.14c                # Reimer et al. 2004
  % area enclosed       cal AD age ranges           relative area under
                                                  probability distribution
  68.3 (1 sigma)     cal AD 1691- 1707                  0.157
                            1719- 1729                  0.091
                            1811- 1825                  0.124
                            1832- 1885                  0.549
                            1913- 1922                  0.078
  95.4 (2 sigma)     cal AD 1683- 1735                  0.288
                            1805- 1895                  0.573
                            1904- 1930                  0.131
                            1951- 1953                  0.008
```

```
 References for calibration datasets:
PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell,
  CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich,
  TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey,
  RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor,
  J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058.

Comments:
* This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^2 + curve std. dev.^2)
** 2 sigma = 2 x square root of (sample std. dev.^2 + curve std. dev.^2)
where ^2 = quantity squared.
[ ] = calibrated range impinges on end of calibration data set
0* represents a "negative" age BP
1955* or 1960* denote influence of nuclear testing C-14

NOTE:  Cal ages and ranges are rounded to the nearest year which
       may be too precise in many instances.  Users are advised to
       round results to the nearest 10 yr for samples with standard
       deviation in the radiocarbon age greater than 50 yr.
```

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Radiocarbon Date Certificate

Laboratory Identification: UBA-12716
Date of Measurement: 2009-10-16
Site: E3711 Derrygarriff 2
Sample ID: C3S4
Material Dated: charcoal
Pretreatment: AAA
Submitted by: IAC

^{14}C Date: 2144±21
AMS δ^{13}C: -30.5

Information about radiocarbon calibration

RADIOCARBON CALIBRATION PROGRAM*
CALIB REV5.0.2
Copyright 1986-2005 M Stuiver and PJ Reimer
*To be used in conjunction with:
Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.
Annotated results (text) - -
Export file - cl4res.csv

C3S4
UBA-12716
Radiocarbon Age BP 2144 +/- 21
Calibration data set: intcal04.14c # Reimer et al. 2004

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 342- 326	0.170
	204- 164	0.756
	128- 121	0.074
95.4 (2 sigma)	cal BC 350- 302	0.209
	226- 225	0.002
	209- 100	0.789

References for calibration datasets:
PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058.

Comments:
* This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^2 + curve std. dev.^2)
** 2 sigma = 2 x square root of (sample std. dev.^2 + curve std. dev.^2)
where ^2 = quantity squared.
[ ] = calibrated range impinges on end of calibration data set
0* represents a "negative" age BP
1955* or 1960* denote influence of nuclear testing C-14

NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.

THE CHARCOAL REMAINS
DERRYGARRIFF 2, CO. CLARE, E3711

SARAH COBAIN

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Introduction

The survival of plant macrofossils from dryland archaeology sites is usually dependant on the water table being high enough to keep the archaeological features in damp/wet and anoxic conditions. This does not usually occur on archaeological sites in Ireland, unless they are located on riverine flood plains or close to lakes. Wood is however preserved abundantly in the form of charcoal as a result of burning activities in features such as hearths, kilns, furnaces, burnt structures and as waste material disposed in ditches and pits.

The site at Derrygarriff 2 was located on the south facing slope of a raised plateau within an area of wetland in north County Clare. The site consisted of a charcoal production kiln, two pits with *in-situ* burning and charcoal fills and a possible metal working furnace (Nunan 2009, 1). Charcoal remains provide valuable information to determine industrial and socio-economic activity on archaeology sites. It is the aim of this report to identify the charcoal species recovered from the site at Derrygarriff 2 and to use this information to:

1) provide additional information regarding the function of features sampled
2) interpret socio-economic and industrial activities on the site
3) infer the composition of the local woodland

Methodology

There were 2 samples to be analysed for charcoal remains from Derrygarriff 2. The following methodology was used to identify the charcoal species.

Charcoal

The number of charcoal fragments to be identified is dependent on the diversity of the flora. A study by Keepax (1988:120–124) has indicated that depending on the location of the archaeology site, 100–400 fragments of charcoal would need to be identified in order to obtain a full range of species diversity. As Britain and Ireland have a narrow flora diversity in comparison to that of mainland Europe, an identification limit of 100 fragments has been deemed sufficient for samples from either of these two countries (Keepax, 1988 cited in Austin, 2005:1). All of the samples contained more than 100 fragments, therefore in accordance with Keepax (1998) a maximum of 100 fragments were identified. Of the samples which contained greater than 100 fragments these were sieved through a 10 mm, 4 mm and 2 mm sieve and an equal proportion of each sieve was identified. This was to prevent any bias that might have occurred if only larger pieces were identified (thereby ensuring any potential smaller species are equally represented).

Each charcoal fragment was fractured by hand to reveal the wood anatomy on radial, tangential and transverse planes. The pieces were then supported in a sand bath and identified under an epi-illuminating microscope (Brunel SP400) at magnifications from x40 to x400. The sand bath allowed the charcoal pieces to be manipulated into the flattest possible position to aid identification. As fragments less than 2 mm in size cannot be accurately identified (it is not possible to get a wide enough field of vision to encompass the necessary anatomical features for identification) only fragments above this size were examined. During identification, any notable growth-ring characteristics, evidence of thermal and biological degradation and any other unusual microscopic features were recorded. Identifications were carried out with reference to images and descriptions by Cutler and Gale (2000) and Heller et al. (2004) and Wheeler et al. (1989). Nomenclature of species follows Stace (1997).

Results
The charcoal results are fully tabulated in Figure 1 in the Appendix at the end of the report.

Charcoal identification notes
The anatomical similarities between (a) sessile/pedunculate oak (b) alder/hazel and (c) the *Maloideae* species (hawthorn/rowan/crab apple) mean that these taxa cannot be identified to species level (Cutler and Gale 2000).

Fill C8 (sample 1) was the primary and only fill of possible furnace C7 and contained hazel charcoal inclusions. There were two samples recovered from the charcoal-production kiln/clamp C3. Sample 2 (fill C4) was retrieved from the upper fill of charcoal-production kiln C3 and contained hazel and oak charcoal fragments. The basal fill, C5 (sample 4) of charcoal-production kiln C3 contained oak charcoal inclusions.

Discussion
Wood selection and fuel use is affected by two variables. The first being the availability of wood nearby (type of woodland) and the second being the requirements of the community and the types of activities that were being undertaken (Asouti and Austin 2005). Using the samples from Derrygarriff 2, it was possible to draw inferences of the composition of local woodland vegetation and to discuss the reasons for fuel selection on the site.

Function of Features
Pit C10 contained large chunks of ash charcoal and exhibited significant *in situ* burning around edges the cut, suggesting that it is a charcoal-production kiln. These kilns were typically earth cut features in oval, circular or sub-rectangular shapes. The wood would was stacked into the pit cut and then covered with vegetation and soil to produce an air-tight chamber with a controlled air flow/smoke outlet. The wood was ignited using kindling through the air flow vent. As it is deprived of oxygen, it was be able to fully combust, thereby carbonising the wood and forming charcoal (Kenny 2008, 28-31).

The metallurgical furnace C5 also had *in situ* burning around the edges of the cut, contained frequent charcoal and also had slag inclusions, suggesting a metal working function. This site would have been an ideal site location for charcoal-production and metallurgical activity as the ground is on a slope, allowing water to drain away easily, thus keeping the charcoal as dry as possible,

Social, economic and industrial activity on site including the selection / avoidance of wood for fuel
The archaeological evidence from Derrygarriff 2 suggests that charcoal-production and associated metallurgical activity was being carried out on the site. It appears that the charcoal produced within the kiln (during this phase of combustion) was ash. The reason for this is because the ash charcoal did not exhibit any obvious curved growth rings, which suggests that large branches or stem wood was being used within the kiln to form charcoal. Of the remaining charcoal fragments recovered from the kiln, alder has been found to have been processed within charcoal-production kilns to form charcoal on other sites (Hardwood, Co Meath (O'Connell 2003, 2) and Newcastle 2 Co Meath (O'Hara 2003, 31) on the M4 Motorway scheme) and is recorded as a good charcoal fuel (Cutler and Gale 2000, 34). It is also possible that the alder charcoal fragments originate from previous combustion events within the kiln and they were comprised of smaller fragments which had not been raked out of the kiln properly before it was used again.

An alternative suggestion is that the alder, hazel and also Maloideae (hawthorn/rowan/crab apple) were used as kindling material in order to ignite the ash within the kiln. These species all exhibited curved growth rings, which suggest they derived from round wood lateral branches rather than stem/trunk wood. It is therefore most likely that these branches were collected as deadwood and used within brushwood bundles as kindling for the fire. Alder, hazel and Maloideae (hawthorn/rowan/crab apple) are all species that are ideal to use for kindling as they are all anatomically less dense than for example, oak and burn quickly at relatively high temperatures (Cutler and Gale 2000, 34, 88-89, 183-4). This property makes them good to use as kindling, as the high temperatures produced by all these species would encourage the ash to start to burn.

The evidence of curved growth-rings within the alder and hazel could also be explained by the coppicing of alder and hazel. This type of woodland management would have been undertaken by cutting the tree to a stump every five to seven years and allowing it to re-generate. The new stems produced were harvested and used for fuel and construction of other wooden structures. This management ensured that the woodland resource was maintained for future generations (Van der Verf 1991, 97; Rackham 1980, 103).

The fuel used within metal production furnace C3 consisted of oak, alder, hazel, ash, holly and Maloideae (hawthorn/rowan/crab apple). There were curved growth rings exhibited on the ash, alder/hazel, alder, holly and Maloideae which suggests that these species were opportunistically gathered in local woodlands and used as kindling for the fuel within the furnace. As the oak did not show obvious curved growth rings, it is likely it derived from larger branches or stem (trunk) wood which would have been deliberately cut with the intention of burning (rather than opportunistic gathering of brushwood). The reason it would have been selected is that it has a dense heartwood and burns for long periods at a high temperatures (Cutler and Gale 2000, 205), which is ideal for metal working activities. As metal production requires high temperatures for smelting, it is likely the oak fuel used in this furnace was burnt in the form of charcoal, of which thus was likely to have been produced in the charcoal-production kiln, C10.

Composition of local woodlands

The archaeological site at Derrygarriff 2 was located on well drained land on the slope of a small ridge surrounding wetlands (Nunan 2009, 1). The relatively dry location of the site would have meant the process of ecological succession would have allowed the development of climax ash-oak woodland community vegetation up the slope away from the wetland areas. The area of wetland further away from the site would have consisted of an alder-carr marsh woodland (Cox and Moore 2005).

As asserted by Scholtz (1986) cited in Prins and Shackleton (1992, 632), the "Principle of Least Effort" suggests that communities of the past collected firewood from the closest possible available wooded area. If this theory were to be used it would assume that the woodland surrounding the site would consist of an oak-ash climax community on drier land up slope closer to the site and an alder-carr marsh woodland in wetland areas. Whilst this can be used as the basic theory, other variables affecting wood collection must be taken into account (Prins and Shackleton, 1992, 632). These include:

1) Selection of particular species in favour of others within the woodland

Oak and ash were likely to have been selected for use in charcoal-production kiln and metal working furnace as they are considered long lasting and effective fuels

(Stuijts 2005, 140, 142) so it is likely they were preferentially searched for and harvested and may have a higher percentage representation within the charcoal assemblage.

2) Differential preservation of charcoal/non-uniform survival of charcoal over time
Preservation rate of charcoal can be affected by a number of variables, for example a) preservation conditions – mechanical abrasion on a site with stony subsoil may cause the charcoal fragments to be broken into smaller unidentifiable fragments, b) two identical pieces of wood may fragment into different numbers of charcoal fragments when burnt. Some, all or none of these may be recovered from the archaeological record which would affect possible woodland reconstructions and c) the overall heat of the fire may cause the wood to turn to ash and not be represented at all in the archaeological record (Asouti and Austin 2005, 1-5).

3) Deforestation during the medieval period and the influence of trade
The medieval period also saw a huge increase in the deforestation of natural woodland throughout Ireland, for example a pollen diagram from Derragh Bog, Central Ireland shows a decrease in percentage of tree pollen from approximately 50% to 10% from AD 1032–1760 (Brown et al. 2005, 88). This occurred due to the intensification of both arable and pastoral agriculture and would have made wood for fuel harder to obtain. As asserted by Comber (2001, 73-74), trade networks had also hugely increased by the early medieval period so wood such as oak and ash could easily have been brought in from elsewhere and purchased or have been available as waste wood from wood working in towns. It is however likely that the kindling wood (ash, alder, hazel, holly and Maloideae [hawthorn, rowan, crab apple]) would have been obtained from close by to the site as it would not be worth wasting money/tradable items on essentially 'waste' wood that could be collected from the local environment.

As a result of these variables it is not possible to use the fragment counts obtained to infer the percentages/numbers of each of these species within the local environment. This is particularly important on charcoal-production sites as wood is heavily selected based on its ability as an effective fuel, therefore may be over represented within the record. It is however possible to apply the assumption that communities will collect wood from the closest possible source (Scholtz 1986) to the fuel used for kindling. This is because this wood is economically less important and is not worth the labour - travelling long distances to collect it. It can therefore be tentatively assumed that local vegetation would have consisted of an ash-oak woodland which would have included hazel, ash, oak, holly and Maloideae (hawthorn/rowan/crab apple). The presence of alder also indicates a wetland environment, which suggests that the wetland that exists today downslope from the site, also existed during the early medieval period.

Conclusion
The samples retrieved from Derrygarriff 2 have allowed an interesting insight into the use of fuel within metallurgical working areas and composition of local woodlands in the Derrygarriff area. The charcoal remains identified from the charcoal-production kiln, C10, indicate that ash was undergoing the combustion process to produce ash charcoal, with addition species (hazel, alder and Maloideae (hawthorn/rowan/crab apple) used as kindling to ignite the ash wood. Oak appears to have been the dominant fuel, most likely in the form of charcoal, used within the metal-working furnace, C5. This fuel would have allowed the high temperatures required for metallurgical activity to be reached. As with the charcoal production kiln, the other species (hazel, alder, holly, Maloideae (hawthorn/rowan/crab apple)) retrieved from

the furnace are most likely to represent kindling material used to ignite the oak charcoal.

The reconstruction of local woodlands is difficult using charcoal assemblages as there are several variables to be taken into account, for example the selection of particular species in favour of others within the woodland, differential preservation of charcoal/non-uniform survival of charcoal over time and deforestation during the medieval period and the influence of trade. However the presence of kindling material, which being economically less important, was most likely collected within the local area, means that it can be assumed that as oak-ash woodland containing holly, hazel, oak, ash and Maloideae existed within the vicinity of the site and the presence of alder suggests wetland areas, most likely downslope from the site.

References

Asouti, E & Austin, P 2005 Reconstructing woodland vegetation and its exploitation by past societies, based on the analysis and interpretation of archaeological wood charcoal macro-remains. *Environmental Archaeology* 10:1-18

Austin, PJ 2005 Analysis of wood charcoal macro-remains from Glanworth Castle, Co. Cork. Excavation No. E236. Unpublished palaeobotanical report.

Cox, CB and Moore, PD 2005 *Biogeography*. Blackwell Science, Oxford.

Cutler, DF and Gale, R 2000 *Plants in Archaeology – Identification Manual of Artefacts of plant origin from Europe and the Mediterranean*. Westbury Scientific Publishing and Royal Botanic Gardens, Kew.

Heller, I Kienast, F Schoch, W Schweingruber, FH 2004 *Wood Anatomy of Central European Species* Online version: www.woodanatomy.ch

Keepax, CA 1988 *Charcoal Analysis with Particular Reference to Archaeological Sites in Britain.* Unpublished PhD thesis, University of London.

Kenny, N 2008 Charcoal Production and Ironworking: A Selection of Sites from the M7/M8. *Unpublished report prepared by Archaeological Consultancy Services Ltd*.

Nunan, J 2009 Archaeological Stratigraphic Report: N18 Gort to Crusheen Road Scheme E3711 Derrygarriff 2. *Unpublished report prepared by Irish Archaeological Consultancy Ltd for Galway County Council*.

O'Connell, E 2003 Species identification of charcoal samples from Hardwood 3, Co Meath (02E1141). *Unpublished report prepared by Archaeological Consultancy Services Ltd*.

O'Hara, R 2003 Final Report for Newcastle 2 Archaeological Excavations from the M4 Kinnegad-Enfield-Kilkock Bypass, Contract 2. Unpublished report prepared by *Archaeological Consultancy Services Ltd*.

Prins, F and Shackleton, C M 1992 Charcoal analysis and the "Principle of Least Effort" - A conceptual Model. *Journal of Archaeological Science*, 19, 631-637.

Rackham, O 1980 The medieval landscape of Essex. In Buckley, D G (Ed.) *Archaeology in Essex to AD1500.* Council for British Archaeology, Research Report No. 34.

Scholtz, A 1986 *Palynological and Palaeobotanical Studies in the Southern Cape*, MA Thesis of Stellenbosch, Stellenbosch, South Africa.

Stace, C 1997 *A New British Flora.* Cambridge: Cambridge University Press.

Stuijts, I 2005 Wood and Charcoal Identification. In Gowen, M, O'Néill, J and Phillips, M *The Lisheen Mine Archaeological Project 1996-1998*. Wordwell Ltd, Bray: Co Wicklow.

Van der Verf, S 1991 The influence of coppicing on vegetation. *Vegetatio*, 92 (2), 97-110.

Wheeler, EA Baas, P and Gasson, PE (eds) 1989 IAWA List of Microscopic Features for Hardwood Identification. *IAWA Bulletin ns* 10: 219-332.

Appendix 1

Figure 1: Charcoal species identified from E3711 Derrygarriff 2, Co Galway.

Sample Number			1	4
Fill Number			C8	C3
Cut Number			C10	C5
Family	Species	Common Name		
Aquifoliaceae	*Ilex aquifolium*	Holly		3
Betulaceae	*Alnus glutinosa*	Alder	7	2
	Corylus avellana	Hazel	12	
	Alnus glutinosa/Corylus avellana	Alder/hazel		3
Fagaceae	*Quercus robur/ petraea*	Pedunculate/sessile oak		79
Oleaceae	*Fraxinus excelsior*	Common ash	60	11
Roseaceae	*Maloideae* spp (*Crateagus monogyna /Sorbus* spp/*Malus sylvestris)*	Hawthorn/ rowan/crab apple	21	2
		Indeterminate species	5	8
		Total fragments identified	100	100

ANALYSIS OF ARCHAEOMETALLURGICAL RESIDUES DERRYGARRIFF 2, CO. CLARE, E3711

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Abstract

Archaeometallurgical residues were recovered from a single context at Derrygarriff 2. The residues were contained within context [c3], the upper fill of feature [c5], mainly at its interface with [c4], the lower fill. The total assemblage weight was approximately 10 kg. The residues include a large proportion (6.4 kg) of deeply vitrified and variably indurated slabs of furnace wall, together with a lesser proportion of flow slags (3 kg). The flow slags are mainly in the form of large rounded flows and masses, some showing contact with large pieces of charcoal/wood. Many of the flow slag pieces show contacts with either the wall of the furnace or its floor.

The assemblage as a whole is mainly indicative of iron smelting in a non-slag tapping shaft furnace (a slagpit furnace).The materials present are dominantly those associated with the structure of the furnace, rather than slags cleared from the furnace during normal use, as more commonly found. The apparent occurrence of the residues on the interface between the lower fill of the cut with the overlying fill (described as a stiff orange-black silt clay) is strongly suggestive of the orange clay representing a collapsed furnace superstructure, of which the indurated blocks described here formed the inner face. The denser slags probably originally lay adjacent to the walls of the slag pit.

The assemblage also included two pieces (total 546 g) which are probably from smithing hearth cakes. Sieving of the material washed from the slags during their cleaning also yielded a few fragments of hammerscale. This suggests a small quantity of residues from iron working (smithing) was also present in the assemblage, raising the question of whether the assemblage is a dump, or represents a more-or-less in-situ furnace.

Field photographs suggest that collapsed superstructure layer dominantly towards the northeast end of the cut, where the broader cut is compatible with the location of the furnace base. The southwest-narrowing extension of the cut cannot be paralleled precisely on other sites, but is suggestive of a hollow permitting access to a furnace arch. The closest parallel for a slagpit furnace with an arch would be the furnace [c397] from Derrinsallagh 4 (a furnace which is not itself dated, but ^{14}C dates from the site as a whole are apparently from the 4th century BC to 1st century AD). However, in the lack of evidence definitely tying the superstructure to the cut, it is also possible that all the material was produced elsewhere and simply dumped in this cut.

Methods
All materials were examined visually with a low powered binocular microscope. Macroscopic slag pieces were individually weighed, described and recorded to a database. The summary catalogue is given in Table 1.

The conclusions reached in this report are therefore limited by the nature of the evaluation inspection. No chemical analysis or high-powered microscope work is attempted during an evaluation.

The assemblage was supplied unwashed; the macroscopic slags were all therefore washed before inspection. The fine debris washed from the specimens was saved and sieved at 100□m in order to provide supplementary evidence on the nature of any fines present in the deposit.

Table 1: summary catalogue of residues from [c3]

Wt (g)	***No.***	***Notes***
178		fines from washing slag, not all archaeometallurgical
264	1	probable SHC, plano-convex, lobate margin, gravel on base, 85x85x40mm
282	1	c70% of probable SHC, flat-topped dense puddle, some clay on rather prilly base, (70)x90x35mm
2512	26	larger pieces of dense flow slag and associated massive slags
518	18	smaller pieces of dense flow slag
5567	24	larger blocks of indurated furnace lining
822	50	smaller fragments of structural ceramic

Results

Description of the residues

Furnace ceramic: the fired clay occurs with varying degrees of vitrification. In several cases the vitrification comprises several zones, each10-20mm thick, indicative of relining of the furnace. Many of the pieces show vitrified faces coincident with the bounding fractures, suggesting that the walls had developed deep cracks during use.

The vitrified faces of the ceramic are typically rough, with adhering slaggy material. The only pieces which show smooth glazed surfaces are some of the small fragments which are rounded and vitrified on all surfaces, suggesting these are wall fragments that have become detached and fallen into the charge. Further suggestion of failure of the wall is provided by the abrupt termination of some individual layers in the multi-layer fragments.

Although many of the pieces show a gentle curvature, because of their irregularity it is not possible to orient these to reconstruct the furnace shape. The fragments do not appear to constitute the entire area of vitrification within the furnace.

No pieces suggestive of the furnace blowhole were found.

Flow slag: the flow slags were mainly derived from rather large flow lobes. Most of the flow slags have dull, slightly rough, surfaces, although there are a few dense shiny pieces. Many of the pieces show evidence for contact with either the furnace walls or floor.

Several of the pieces show moulds of large pieces of charcoal or wood, although there were no moulds that were sufficiently large to indicate the split wood fragments commonly seen in slagpit furnaces.

The more massive dense slag pieces were probably associated with the blowing wall of the slagpit.

There were just two pieces indicative of vertical prills, and no good cross-floor flows. Small blebs and prills were entirely absent.

Smithing hearth cakes (SHCs): the assemblage contained two slag cakes which appear to be SHCs. One was a complete plano-convex slag cake, with somewhat lobate margins, weighing 264 g, roughly circular in plan, 85 mm in diameter and 40 mm thick. The other was incomplete (approximately 70% surviving), plano-convex with a central dense slag "puddle", weighing 282 g (c. 400 g originally), probably originally about 90 mm in diameter and 35 mm thick.

Microresidues: the washings from the macro-residues were sieved to provide a sample of microresidues. The microresidues retrieved were mainly small slag fragments and droplets, together with some small, rounded, highly magnetic material, that may be iron ore; all indicative of iron smelting.

Alongside this material, however, there was also a small quantity of flake hammerscale, indicative of iron working.

Distribution of the residues
The assemblage was all retrieved from a single context C3, described as the upper fill of [c.5] comprising stiff orange and black silty clays.

Interpretation
The evidence from the residues is dominantly for iron smelting. The flow slags are typical of slags from the basal pit of a slagpit furnace (a low-shaft smelting furnace, which is non-slag tapping, instead the slag flows down from the reaction zone and accumulates in the basal pit). The furnace fragments are all compatible with an origin in the shaft of such a furnace.

The presence of some residues from iron-working (smithing) in the same assemblage can be paralleled at a few other sites, but poses problems for the interpretation.

It is tempting to see the coincidence of the distribution of the fired clay of C3 with the wide end of cut C5 as suggesting the original location of the shaft of the furnace at that end (the northeast) of the cut. The recorded location of the major fired/vitrified ceramic blocks below the bulk of C3 would be entirely compatible with the collapse of the furnace shaft.

The flow slags are mainly slag materials that formed along the walls of the furnace and which might not necessarily be cleared from the furnace between smelts – so they too might be relatively *in situ* in the collapsed furnace.

It is certainly noteworthy that the assemblage does not include any of the fine-grained flow slags (prills, blebs and spheroids) that normally abound within the slagpit after use, but which are relatively easily cleared between uses. Equally, there are no pieces of the characteristic prilly, charcoal-rich, "furnace bottoms" that form a

major slag block immediately below the bloom. These too will be removed from the furnace between uses, perhaps, in some cases, being removed in a single block with the iron bloom.

The smelting slag assemblage can, however, be interpreted in an alternative way. Since the materials recovered (the blocks of slagged /vitrified wall and the wall-associated flow slags) are intimately associated with the structure of the furnace, any repair of the furnace involving clearing of these materials must be a major overhaul and rebuilding of the structure. Such repairs would be undertaken sporadically to keep the furnace functioning properly. The material described here (and the silty clay of C3) could therefore be viewed as the debris produced during the overhaul of a furnace – and thus not *in-situ* at all.

The distinction between these deposits as a collapsed furnace and as debris from the reconstruction of a furnace elsewhere, must rest on whether the cut C5 can be identified as a furnace cut – or whether it is simply a pit.

The "tadpole" shape of C5 in plan cannot be precisely paralleled elsewhere, but is suggestive of a slagpit furnace, with an elongate "working hollow" giving access to the slagpit via a furnace arch. Although arched furnaces are commonly associated with slag tapping, arches were also employed for clearing non-tapping furnaces, and possibly for the removal of the bloom too.

A good example of such a furnace was recovered from Derrinsallagh 4 C397; Young 2008d), but suggestions of arches have also been made at other sites: Derrinsallagh 3 (Furnace C819 and working hollow C640; Young 2008b), Derryvorrigan 1 (Young 2008c), Cappakeel West and Morrett (Young 2005). All of these sites are dated to between the 3rd Century BC and 1st Century AD. In N Wales, Iron Age furnaces with arches, although not normally sunken into the ground, have been described by Crew (1987, 1989, 1998) and their use reconstructed (Crew 1991).

The presence of large blocks of vitrified furnace superstructure is not common (thereby contributing to the myth of the bowl furnace). Examples of material broadly similar to the present collection are known from Cherryville (where the slabs of vitrified furnace had been dumped into features F4 and F5, although these features were not necessarily themselves metallurgical; Young 2008a) and Cappakeel West (Young 2005), both of Iron Age date.

The presence of the macro- and microscopic evidence for smithing is potentially problematic if the structure represents an in-situ smelting furnace. However, Crew (1998) has noted instances where disused smelting furnaces were employed as hearths for smithing the blooms produced in other furnaces. The SHCs are of fairly small size (262 and 400g), and although Iron Age smithing assemblages are currently not well known, it seems that the size of SHC produced during bloomsmithing in the Iron Age may have been quite modest. Crew's evidence from N Wales suggests sizes of <500g for that area.

In summary, it would appear likely, although not certain, that the deposit represents a collapsed iron-smelting furnace. The morphology of the cut suggests there may have been a sub-circular shaft furnace over the wider end of the cut, with the narrow section allowing access, below ground level, to a furnace arch into the slag pit for clearance and or bloom removal. This style of furnace is known from other sites of the 4th – 1st centuries BC. The location of the site, close to a bog, suggests that local bog iron ore would have been smelted.

Evaluation of potential

The slags from the furnace are a rather incomplete suite of residues from the smelting process, so have limited potential to allow full description of the chemistry of the smelting. In addition, the possibility that the assemblage may represent material dumped during refurbishment of a furnace elsewhere on the site also slightly reduces confidence in the homogeneity of the assemblage.

On this basis no further analysis of this material is recommended. The assemblage is unusual however, so it is recommended for retention.

References

Crew, P 1987 Bryn y Castell Hillfort – a Late Prehistoric Iron Working settlement in north-west Wales. In Scott, B G & Cleere, H (eds) *The Crafts of the Blacksmith.* 91-100.

Crew, P 1989 Crawcwellt West excavations 1986-1989. A late prehistoric ironworking settlement. *Archaeology in Wales*, **29**, 11-16.

Crew, P 1991 The Experimental Production of Prehistoric Bar Iron, *Historical Metallurgy*, **25**, 21-36

Crew, P 1998 Excavations at Crawcwellt West, Merioneth, 1990-98: A late prehistoric upland iron-working settlement. *Archaeology in Wales*, **38**, 22-35.

Young, T P 2005 Evaluation of archaeometallurgical residues from the Heath-Mayfield N7 development (03E0151, 03E0966, 03E0461, 03E0603, 03E0633, 03E0679, 03E0602, 03E0635). *GeoArch Report 2005/12*. 28pp.

Young, T P 2008a Archaeometallurgical residues from Cherryville Site 12, Kildare Bypass. 01E0955 *GeoArch Report 2007/24*. 33pp

Young, T P 2008b Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Derrinsallagh 3 (E2179). *GeoArch Report 2008/22*. 11pp.

Young, T P 2008c Evaluation of Archaeometallurgical residues from the M7/M8 Contract 2: Derryvorrigan 1 (E2193). *GeoArch Report 2008/26*.

Young, T P 2008d Detailed recording of furnace C397, Derrinsallagh 4 (E2180), M7/M8 Contract 2. *GeoArch Report 2008/34*, 10pp.

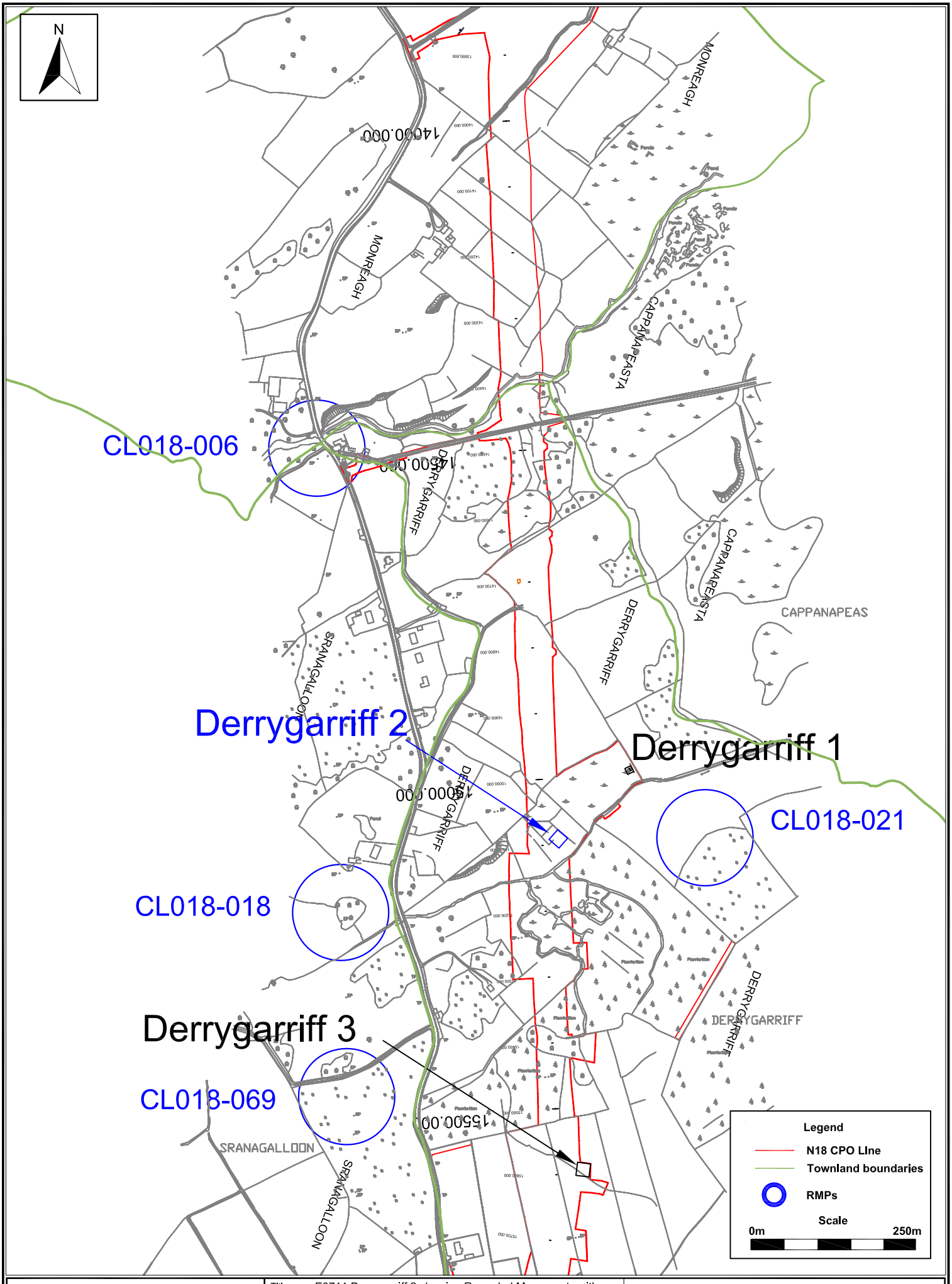
APPENDIX 3 LIST OF RMP SITES IN AREA

RMP No	Description
CL018-006001	Bridge
CL018-006002	Water Mill
CL018-018001	Ringfort Cashel
CL018-018002	House – undetermined date
CL018-021	Ringfort Cashel
CL018-069	Redundant Record

See Figure 2 for location.

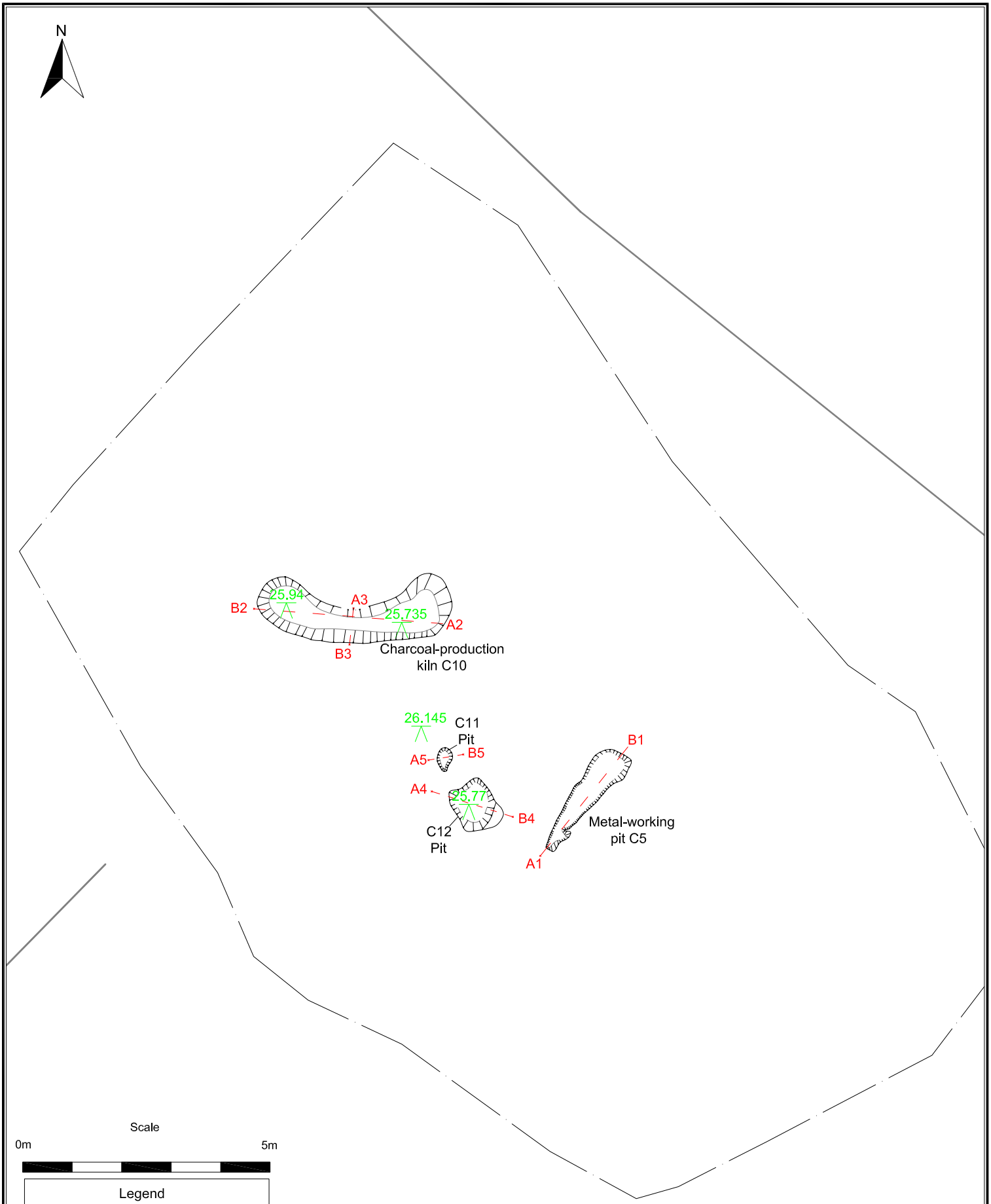
APPENDIX 4 LIST OF N18 GORT TO CRUSHEEN SCHEME SITE NAMES

Site Name	Ministerial Direction No.	NMS Registration Number	Site Type
Drumminacloghaun 1	A044	E3720	Burnt mound
Ballyboy 1	A044	E3719	Ringditch
Ballyboy 2	A044	E3718	Ringditch
Curtaun	A044	E3721	Burnt mounds and early medieval cereal kilns
Rathwilladoon 2 & 3	A044	E3656	Prehistoric settlement
Rathwilladoon 4	A044	E3655	Burnt mound
Rathwilladoon 5	A044	E3657	Charcoal production kiln
Gortavoher 1	A044	E3904	Burnt mound
Monreagh 1 & 2	A044	E3712	Burnt mound
Monreagh 3	A044	E4037	Burnt mounds
Derrygarriff 1	A044	E3716	Burnt mound
Derrygarriff 2	A044	E3711	Metal production site
Derrygarriff 3	A044	E3710	Burnt mound
Sranagalloon 1	A044	E3713	Burnt mound
Sranagalloon 2/Site 146	A044	E3714	Enclosure
Sranagalloon 3	A044	E3897	Burnt mound
Gortaficka 1 & 2	A044	E3898	Burnt mounds
Clooneen 1	A044	E3722	Burnt mound
Caheraphuca 1	A044	E3654	Burnt mound
Caheraphuca 3 - 12	A044	E3653	Burnt mounds
Ballyline 1 & 2	A044	E3717	Burnt mounds
Ballyline 3	A044	E3715	Prehistoric pit



IAC Irish Archaeological Consultancy

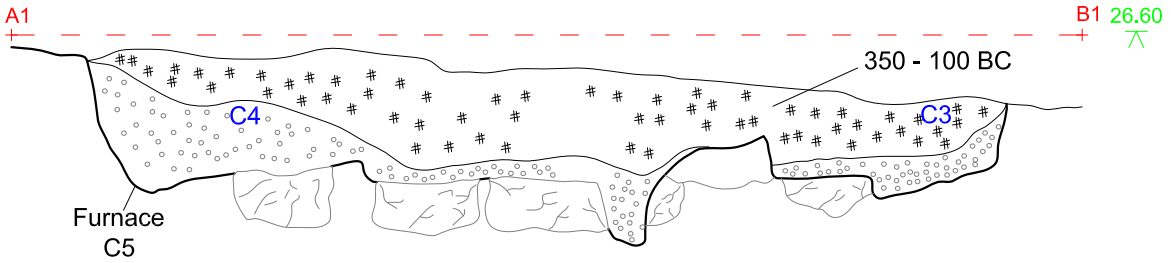
Title:	E3711 Derrygarriff 2 showing Recorded Monuments with OSI background	Scale:	1:10,000 @ A4
Project:	N18 Gort to Crusheen	Date:	18/11/09
Client:	Galway County Council	Produced by:	G Kearney
		Job No:	J2440
		Figure No:	2



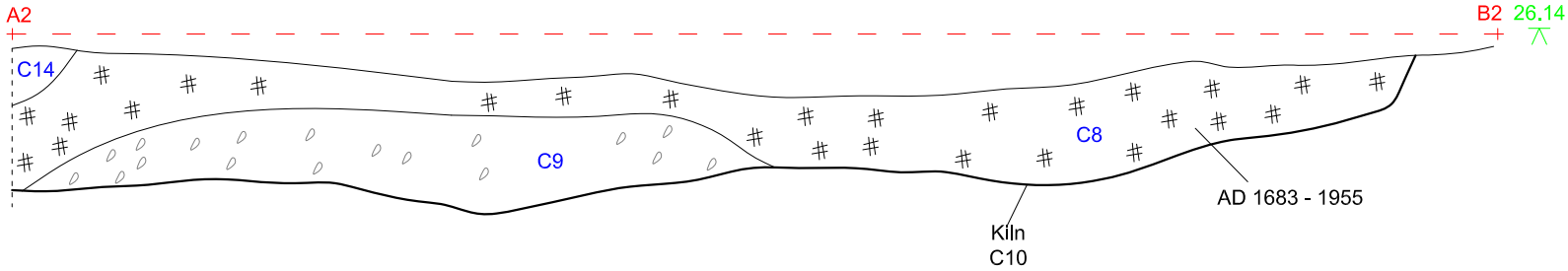
IAC Irish Archaeological Consultancy

Title:	E3711 Derrygarriff 2 post-excavation plan of site
Project:	N18 Gort to Crusheen
Client:	Galway County Council
Scale:	1:100 @ A4
Date:	08/12/09
Produced by:	G Kearney
Job No:	J2440
Figure No:	3

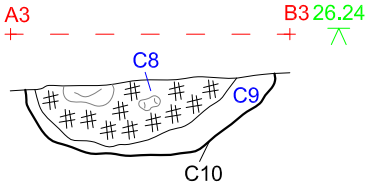
Southeast facing section of C5



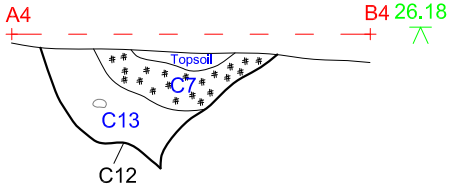
North facing section of C6



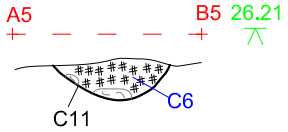
West facing section of C10



Southwest facing section of C12



South facing section of C11



Scale

0m 1m

Legend

Cxx	Cut numbers
Cxx	Fill numbers
	Stone
#	Charcoal
xx.xx	Levels - metres OD

IAC Irish Archaeological Consultancy

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Project:	N18 Gort to Crusheen
Client:	Galway County Council

Scale:	1:20 @ A4
Date:	08/12/09
Produced by:	G Kearney
Job No:	J2440
Figure No:	4