Appendix 11.7

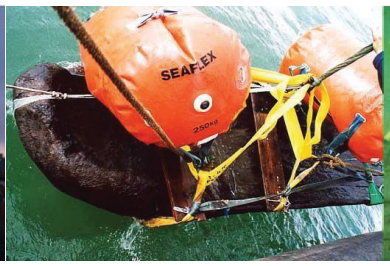
Arklow Bridge (NIAH 16322046) Site Investigations 2019

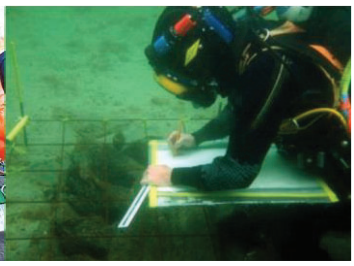
Licence No. 17E0482

Leading Maritime Archaeology

Arklow Bridge (NIAH 16322046) Site Investigations, 2019

17E0482



Arklow Bridge (NIAH 16322046) Site Investigations, 2019

17E0482

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Abbreviations

ADCO	Archaeological Diving Company Ltd
AIA	Archaeological Impact Assessment
DCHG	Department of Culture, Heritage and the Gaeltacht
E	Easting
EIS	Environmental Impact Statement
ITM	Irish Transverse Mercator
MHW	Mean High Water
N	Northing
NGR	National Grid Reference
NIAH	National Inventory of Architectural Heritage
NMS	National Monuments Service
OD	Ordnance Datum
RPS	Recorded Protected Structure
SMR	Sites and Monuments Record
WCC	Wicklow County Council

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Executive Summary

Subject: Arklow Bridge
Location: Arklow, Co. Wicklow
ITM: 724627E 673529N
Status: NIAH 16322046

Introduction
Site Investigations (SI) at Arklow Bridge were carried out in October–November 2019, aimed at gaining an understanding of the buried structure of the bridge foundations, to inform project design engineering for the Arklow Flood Relief Scheme. The work focused on the western end of the bridge, centred at ITM 724627E 673529N.

Archaeological Assessment
Arklow Bridge is recorded on the NIAH register and is a protected structure (A26-16322047). Archaeological survey of the riverbed upstream and downstream of the bridge has identified a series of timbers upstream and east of the central bridge pier.

SI Methodology
The SI works required the construction of a river bund upstream and downstream of the bridge at its western end. The bund was created using the river shingle that accumulates naturally upstream of the bridge. The bund permitted works to proceed under the bridge at Low Water.

The SI works comprised a series of trial pits. Trial pits were located under bridge arches 1, 2, 3 and 4 on the downstream side of the bridge, and a further trial pit was located immediately upstream of bridge arches 1, 2 and 3.

Archaeological Observations
While certain variations occurred in each of the downstream trial pits, the following pattern was observed overall:

A layer of concrete is added across the bridge and forms the current bed level. The concrete is approximately 300mm thick but can be considerably thinner.

The stone apron that exists between the bridge arches lies underneath the concrete skim and comprises substantial stones bedded in a mortar matrix. The inclusion of plastic and modern material within the matrix indicates that the apron is not of significant age.

The stratigraphy beneath the apron between the bridge piers revealed only river shingle and gravel and is indicative of the natural river bed. There was no indication of stone settings below the apron that may be indicative of earlier bridge piers.

The findings at the bridge piers either side of the stone apron present additional insight. A concrete surround is added to the stone piers and postdates the stone apron. Removal of the apron at the bridge piers revealed a sequence of timbers in four of the seven instances. The timbers comprise mostly round-sectioned soft woods, but some

rectangular-sectioned pieces were also observed. The timbers represent starling piles. Such timbers were used as a protective measure against scour and were set around the base of bridge piers. In one instance (Pier 1, Trial Pit TP-02) it was possible to observe the stone that is inside the line of starlings, and this is interpreted as evidence for the plinth of the bridge pier.

There was no rock outcropping observed in the 700mm–1.2m-deep trial pits.

The trial pit opened on the upstream side of the bridge across piers 1, 2 and 3 revealed a stratigraphy of natural river bed shingle only.

In conclusion, the SI works made shallow excavations into the bed level at the western end of Arklow Bridge.

A sequence of construction is evident associated with the western end of the stone bridge, as follows:

1. Bridge piers.
2. Stone apron added between the bridge piers, effectively raising the bed level in the modern period.
3. Concrete surrounds added to the base of the bridge piers.
4. Concrete added on top of the stone apron, raising the bed level to a standard height.
5. Bridge-widening in the 1970s with an addition to the bridge piers and apron on the north/upstream side.

Archaeological Impact Assessment

Works associated with the creation of bunds within the river channel at the bridge site have the potential to impact with the line of timbers recorded upstream of the bridge on its east side. Advance archaeological mitigation measures are strongly recommended.

The works associated with the proposed scheme are designed to lower the bed level between the bridge piers by 1m. This is associated with design plans to reduce flood risk in the town. The works will require extending down each bridge pier by 2m and lowering the river bed by 1.5m in order to place new apron and achieve the design level. This will remove the introduced stone apron and, in many respects, return the bed level to that which existed prior to the introduction of the stone apron.

The net reduction in the bridge floor level will be 1m, but the full depth of impact will be greater, with works on the piers being in the order of 2m.

The works will excavate the river shingle that underlies the stone apron.

The works will directly impact the starling piles that are a primary feature of the stone piers.

Archaeological Recommendation

This report finds no cultural heritage reason for the proposed works not to take place.

Design proposals associated with stabilizing the bridge ahead of excavation of the river gravels should be reviewed by an archaeologist and a conservation engineer to ensure that the proposals are in line with best practice from a conservation perspective.

Works associated with bunding the river channel at the bridge to provide works access to the bridge must avoid impacting with the line of timbers recorded upstream of the bridge at its centre and east side. The timber feature has been recorded based on timbers that are exposed above the current river bed. It is very likely that more substantial elements remain preserved below the surface of the river bed. It is recommended that this feature is subject to archaeological investigation and/or resolution prior to civils works proceeding.

Archaeological monitoring is required of all ground and riverbed disturbances associated with the Arklow Flood Relief Scheme, including works associated with extending downward all the bridge piers, and the excavation and removal of the bridge's stone apron and underlying river shingle. Archaeological monitoring is conducted with the proviso to record fully any features of archaeological interest exposed in the course of such works.

A series of archaeological management recommendations are included in this report.

Recommendations are subject to the approval of the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht.

1.0 Introduction

The Archaeological Diving Company Ltd (ADCO) was appointed by Wicklow County Council to monitor of Site Investigations (SI) works at Arklow Bridge to inform the design of the proposed Arklow Flood Relief Scheme (Figure 1). The SI work was aimed at gaining an understanding of the buried structure of the bridge foundations. A series of trial-pit locations was identified by the project engineers (Figure 2). The investigations were conducted in 2019 under archaeological licence 17E0482 and represent a second stage of such monitoring under this licence, the first of which was conducted in 2017 and was associated with three borehole investigations into the river channel downstream of the bridge.[1]

The 2019 work comprised a series of trial pits focussed on the western end of the bridge, centred on ITM 724627E 673529N. Access issues altered the intended locations, with a series of trial pits being excavated under bridge arches 1, 2, 3 and 4, positioned on the downstream side of the bridge, and one trial pit was excavated immediately upstream of bridge arches 1, 2 and 3.

2.0 Archaeological Assessment

Arklow Bridge is recorded on the National Inventory of Architectural Heritage register (NIAH 16322040) and in Wicklow's Record of Protected Structures (A26-16322047) but is not registered in the Sites and Monuments Record and is not a National Monument.

The NIAH describes the bridge as a nineteen-arch stone-built road-bridge over the Avoca River, built *c*. 1755. The bridge has a large central pier with cutwaters to both the north and south sides of the bridge piers. The arches have roughly dressed *voussoirs* with areas covered in cement render above. The low parapet is also cement-rendered and is topped with *c*. 1970s replacement metal railings.

Bridges are indicated in this location since the early eighteenth century. The standing remains belong to a mid-eighteenth-century bridge-building campaign. The structure spans *c*. 150m across the Avoca. It is shown on an historic drawing of the Battle of Arklow in 1798, when the bridge was used by Royalist troops to gain access across the river to the town. The bridge is recorded on the First Edition Ordnance Survey (OS) map as a structure containing nineteen in-water piers (Figure 3). The same number of piers are indicated on OS mapping from the early twentieth century (25-inch map), which shows the central upstream pier as being more massive in size. It is suggested that the massiveness of the central pier served a defensive role as a

[1] Niall Brady, 'Arklow Bridge Site Investigations, preliminary report, 17E0482', unpublished report of the Archaeological Diving Company Ltd, 2019.

fortified pier, which is an unusual feature of early bridge design in Ireland, and sets Arklow Bridge apart.[2]

The bridge has been inspected by ADCO in recent years.[3] The bridge has also been the subject of civil engineering inspection, concerned with the possibility of scour and structural stability.[4]

Arklow Bridge was modified in the 1970s when works included widening the bridge on its upstream side with the construction of openwork piles bedded into concrete; laying a concrete apron between the new elements to the piers; and replacing the parapet with a reinforced concrete surface and metal guard-rails. Blown concrete sheaths the undersides of the bridge arches.

Metal tie-rods, visible on the downstream side, are inserted across the bridge, positioned above the arches and close to the piers. Concrete surrounds are added to the base of the stone piers. Such surrounds typically serve as protective measures against damage to piers from debris that would flow through the arches.

The bridge nevertheless retains an archaeological interest as well as an architectural one. Its core remains a stone bridge with piers, arches and façades. An historic apron is evident between the piers, comprising stone blocks set in mortar (measuring between 300mm by 280mm, and 800mm by 500mm in size).

The surrounding riverbed retains a natural appearance and comprises deep deposits of coarse sand (<2mm), gravel (<4mm), rounded pebbles (<40mm) and cobbles (<70mm). The sand tends to form the surface of the river on its eastern side, while the pebble and cobble forms the channel surface deposit on its western side. A very good holding-content is ascribed to this riverbed area, and its potential to retain material of archaeological significance is highlighted by the presence of a series of timber (oak) piles, protruding from the riverbed approximately 6m upstream of the bridge structure to the north of the central bridge pier (Pier 10) and also to the north of Piers 14 and 15 located to the east. The timbers suggest the possibility of a wooden bridge structure immediately upstream of the standing bridge remains.

An historic photograph of the bridge attributed to Robert French (1841–1917) and taken from the east bank downstream of the bridge shows a series of four wooden upright features through one arch upstream of the bridge and a further series of two uprights through another arch (Plates

[2] Peter O'Keeffe and Tom Simington, *Irish Stone Bridges* (Irish Academic Press, 1991), p. 62.

[3] ADCO has had the opportunity to consider the bridge during various in-river surveys completed under licence for the Arklow WWTP EIAR, and for surveys completed for the Flood Relief Scheme. Relevant documents include: Rex Bangerter, 'Archaeological site inspection, Arklow Bridge, River Avoca, Co. Wicklow, 17D0078' ADCO memorandum, 26/10/2017; Niall Brady and Rex Bangerter 'Cultural Heritage' chapter for Arklow FRS EIAR, pending.

[4] For example, R. S. McLeod, 'Arklow viaduct scour survey and upstream concrete column and beam survey', Norfolk Marine for Wicklow County Council, 10/09/2019.

1–2). It is reasonable to deduce that these are the same timbers visible below the waterline today.

The observation of these timber elements is an important indication of the potential for additional archaeological remains to be exposed in the course of riverbed disturbance works.

The photograph taken by French appears to have been taken at High Water, insofar as the waterline is almost level with the tops of the bridge piers. Another historic photograph that appears to be of more recent date is taken from the west bank downstream of the bridge (Plate 3). Exposure of the stone apron that extends downstream of the bridge piers suggests that the image was taken at Low Water. It also indicates that the apron has been in place for some time.

3.0 Site Investigations Methodology

The SI works required the construction of a river bund, extending upstream and downstream of the bridge at its western end (Figure 4). The bund was created using the river shingle that accumulates naturally upstream of the bridge and forms a shingle bar (Plates 4–7). The shingle was machine-excavated at Low Water and transported to the west bank from where it was spread along the edge of the active channel to form an access road. The shingle was then stock-piled upstream of the bridge before being spread out to create the bund. Bridge Arch 2 is somewhat higher than its neighbouring arches, and this permitted a smaller wheeled excavator to transport the shingle across the bridge apron between the piers and to place it along the toe of the bridge apron that is on the downstream side of the bridge, forming the bund on that side. The bund created a working environment at Low Water. This proved suitable except at Neap Tides, when Low Water tended to be too high.

The SI works design identified Bridge Piers 3, 4 and 5 as the locations for the excavation of 1m^2 trial-pits, to be positioned at the corners of the upstream and downstream sides of the piers behind their respective cutwaters (Figure 2). The trial-pits on the upstream side would be cut through the 1970s-widened portion of the bridge. Those on the downstream side would be cut through the apron alongside the old stone piers. In the event, access to the upstream corners was not possible due to the low level of the arches in this widened portion of the bridge. In addition, because of seasonally dynamic river conditions, it was decided to move the investigations closer to the river bank. The SI work took place at Piers 1, 2, 3 and 4 (Figure 4).

In preparation for the trial-pits on the downstream side of the bridge, the stone and concrete apron was cut by road saw and broken-up using a pneumatic hammer-driven rock-breaker (Plates 8–9). While excavation focussed on the bridge corners, the full width of the apron was removed under Arches 2, 3 and 4 because the large stone used in the apron made the process

of digging 1m^2 trial-pits impractical. This resulted in a series of four trial-pits altogether (trial-pits TP-01–TP-04). The trial pits were backfilled on completion (Plate 10).

To address the issue of the upstream side of the bridge, three pits were machine-excavated against Piers 1, 2 and 3, with the works creating effectively one large excavation between the piers (TP-05).

4.0 Archaeological Observations

Archaeological record was taken in writing. Measurements were recorded using a hand tape with height readings relative to the current bed level at each trial pit. A photographic record was also taken. Access to the trial pits was possible for TP-01–TP-04 but not for TP-05 as the excavated sides were unstable. Surfaces were cleaned down using a trowel when necessary.

4.1 TP-01

Trial-pit TP-01 was located under Arch 1 on the south-western corner of Pier 1, at ITM 724617E 673518N. A concrete surround is added to the base of the stone pier. Preparation for the trial-pit required cutting the apron that lies between the pier and the quay wall. Work was confined to a cutting measuring 1.2m wide by 1.2m long (Plate 11). Excavation was completed on 12/11/2019 and achieved a depth of 1.2m below current bed (apron surface) level.

A concrete skim forms the surface of the apron and is 300mm deep (Plate 12). It is a weak concrete/mortar and it sits on large stones that represent the underlying stone apron that is approximately 250mm thick. The apron in turn sits directly on silt and river shingle that continues beneath the depth of the excavation (1.2m).

No artefacts were observed in the trial-pit.

4.2 TP-02

Trial-pit TP-02 was located under Arch 2 and extended across from the south-eastern corner of Pier 1 to the south-western corner of Pier 2, absorbing two of the anticipated trial pits into one. It was centred at ITM 724621E 673521N. A concrete surround is added to the base of the stone piers. Preparation for the trial-pit required cutting the apron that lies between Piers 1 and 2, which was achieved on 31/10–01/11/2019. The trench extended the width of the apron and was 1.3m wide. Tidal restrictions with very high Low Waters resulted in excavation being postponed until 12/11/2019. Excavation achieved a depth of 900mm at Pier 1 and 700mm at Pier 2 below current bed (apron surface) level.

The concrete surround added to both piers is 300mm wide and stands 300mm above the bed level (apron surface). The apron has an upper layer of concrete that measures 300mm deep.

Excavation began alongside Pier 2 and continued to a depth of 500mm, encountering only stone (Plates 13–14). The excavation did not proceed deeper.

Across the width of the trench, excavation reached 700mm, exposing the stone apron under the concrete cover, and river silt under the stone apron. A large stone of the apron was recovered from the trial pit and its underside had mortar/loose cement attached (Plate 15). The stone measured 700 x 400 x 100mm. A series of objects was recovered from the mortared matrix of the apron and underneath the large stones (Plate 16). They included an L-shaped metal strap, a piece of wire sheathed in plastic and a piece of decaying rubber. The objects provide a dating context for the stone apron, indicating that it is not of ancient date but is comparatively modern.[5] As indicated on Plate 2, the apron is recorded on an historic photograph. Robert French's earlier photograph of the bridge (Plate 1) indicates gas lights as the public lighting employed on the bridge. The lighting recorded on Plate 2 is not the same, and the globe-shaped light bowls might represent early electrification. This would place the photograph in the second quarter of the twentieth century, which is in keeping with the objects recovered from the apron's matrix.

The situation was different at Pier 1. A concrete mix extends 300mm below bed level (apron surface) and sits directly on top of a mixture of river clay and stone (Plate 17). Excavation revealed that the stone lies against the bridge pier, while the clay included timber fragments. Excavation at 500mm depth revealed the timber fragments to be the tops of a line of timber posts that are set close against the stone. Deeper excavation indicated that the stone bottoms-out at 500mm while the timber posts continue to depth and extend below the excavated depth of 900mm (Plate 18). The timber posts are round in section for the most part and measure 100mm in diameter. The posts are starling piles, which served as an early form of pier protection, encircling a bridge pier to provide an outer ring that negates the effects of scour, in much the same way as the concrete surrounds added to the base of bridge piers are intended to do in modern bridge works. The fact that the starlings lie close against the stone revealed at the western edge of the trial pit further suggests that the stone is not part of the apron but perhaps the basal plinth of Pier 2.

4.3 TP-03

Trial-pit TP-03 was located under Arch 3 and extended across from the south-eastern corner of Pier 2 to the south-western corner of Pier 3. It was centred at ITM 724625E 673526N. A concrete surround is added to the base of the stone piers. Preparation for the trial-pit required cutting the apron that lies between Piers 2 and 3, and the trench extended the width of the apron. It was excavated to a depth of 700mm at Pier 2 and 900mm at Pier 3 below the current bed (apron surface) level on 29–30/10/2020.

Excavation commenced at Pier 3. The concrete surround added to Pier 3 is 320mm wide and stands 300mm above the bed level (apron surface). A 300mm-thick concrete layer forms the

[5] The objects will not be retained as artefacts and have been recorded for information purposes only.

surface of the bed level at the pier, and this lies directly on a series of large stones that continue in towards the pier and under the concrete surround above (Plates 19–20). The stones are part of the stone apron that underlies the concrete surface. A large rock was encountered that was 900mm thick and reaches westward, for a distance of 1.6m, into the space between Piers 3 and 2. This was the first trial-pit cut through the bridge and the large rock was considered as a possible indicator of bedrock. It was not removed, and this terminated excavation at Pier 3.

Excavation continued across the trench on 30/10/2020 towards Pier 2 and revealed only a thin layer of concrete at bed level (50mm thick) that lies above the stone that forms the apron (Plate 21). The stone apron in turn lay above a dark grey-coloured river silt/clay.

Excavation at Pier 2 revealed a different narrative. The concrete surround added to the base of the stone pier is 300mm wide and high above bed level. The bed level is made up of a 300mm-thick layer of concrete that lies directly on top of river clay. Within the river clay and set close against the bridge pier, is a line of timber posts that lie against the pier and do not extend into the space between the bridge arches (Plates 22–23). The posts are starling piles and are a soft wood timber and round in section for the most part, measuring 100mm in diameter. One square-sectioned timber was also observed. The posts were exposed to a depth of 700mm below bed level and continue down into the unexcavated portion below. No artefacts were observed.

4.4 TP-04

Trial-pit TP-04 was located under Arch 4 and extended across from the south-eastern corner of Pier 3 to the south-western corner of Pier 4. It was centred at ITM 724630E 673531N. A concrete surround is added to the base of the stone piers. Preparation for the trial-pit required cutting the apron that lies between Piers 3 and 4, and the trench extended the width of the apron. It was excavated to a depth of 500mm at Pier 3 and 930mm at Pier 4 below current bed (apron surface) level on 30/10/2020.

The concrete surround added to Pier 3 is 270mm wide and stands 280mm above the bed level (apron surface). A thin layer of cement lies over the stone apron that extends to a depth of 280mm below bed level. The stone apron lies directly on top of a line of seven starling timbers that are set close against the pier (Plates 24–25). Six of the timber posts were round in section with an average diameter of 100mm. The seventh timber lies on the most upstream (North) side of the excavated area and is squared in section.

Excavation across the trench towards Pier 4 continued to show that the stone apron lies just under the more recent concrete skim (50mm thick). Several of the apron's stones were removed, showing how large these were when originally put in place (Plate 26). One of the apron stones retained a quarried shot hole, or drilled hole into which explosive was placed before detonation, to blast the rock from its original quarry. A piece of clear glass was also recovered from within the matrix for the stone apron, further indicating the relatively modern nature of this feature. The apron lies above a dark grey-coloured river silt/clay.

Excavation at Pier 4 revealed a similar stratigraphic sequence to that observed at Pier 3 within TP-04. The concrete surround added to the base of the stone pier is 300mm wide and high above bed level. The stone apron and its mortared/cement matrix is shallower at 200mm thick, and it lies directly on top of a line of softwood starling posts that were exposed to a depth of 930mm below bed level (Plates 27).

4.5 TP-05

Trial-pit TP-05 was located immediately upstream of the bridge. Though excavated as three separate cuts, the works merged them into a single unit that was a 6m long and 2m wide beside Piers 1, 2 and 3, centred on ITM 724615E 673532N. The work was completed on 29/10/2019.

As the trial pit was located over the active river channel, no surface preparation was required. Excavation continued to a depth of approximately 2m and ran up against the concrete plinth that was added to the bridge as part of the 1970s bridge-widening works (Plate 28). The stratigraphy revealed was the same throughout, namely a depth of river shingle. This is in keeping with the borehole investigations completed in 2017 on the downstream side of the bridge.[6] In addition to the concrete plinth, TP-05 also recorded the concrete bridge piles inserted in the 1970s continuing beneath the plinth to a depth below the excavated area.

4.6 Discussion

While certain variations occurred in each trial pit, the following pattern was observed overall in trial-pits TP-01–TP-04.

A layer of concrete is added across the bridge and forms the current bed level. The concrete is approximately 300mm thick but was noticeably thinner in TP-03 and TP-04, where it is as little as 50mm thick. The concrete layer appears to be coequal with the plinth added to the north side of the bridge as part of the bridge-widening works in the 1970s. This might suggest that the concrete was added above the stone apron at this time.[7]

The concrete appears to present a consistent bed level height across the investigation area. The same is not the case of the underlying stone apron. In TP-03 and TP-04, the stones are set to a height that is 50mm below current bed level, while in TP-01 and TP-02 the stones are set 300mm below the modern concrete surface. It is an indication that the stone apron was laid at different heights and is not set at a consistent height across the width of the bridge. The height differential is in the order of 250mm.

The stone apron comprises substantial stones bedded in a mortar/cement matrix. The inclusion of plastic and modern material within the matrix indicates that the apron is not of significant age, as does the line of a quarry shot hole seen in one of the stones in TP-04 (Plate 26). The

[6] Brady, ‘Arklow Bridge Site Investigations, preliminary report, 17E0482’, p. 5, pl. 6.
[7] Such deductions could be qualified if records attesting to historic works on the bridge are located.

recording of the apron in an historic photograph might suggest that its construction dates to the second quarter of the twentieth century.

The stratigraphy beneath the apron varies between whether it is associated directly with the bridge piers or not. In the space between the bridge piers, excavation only revealed river shingle/gravel and is indicative of the natural river bed. There was no indication of stone settings below the apron that may be suggestive of earlier bridge piers. It is the case at other bridge sites that developments over time result in a widening of the bridge arches to permit better water flow between them. In such instances, it is the case that excavation into the riverbed can reveal the remnant of earlier designs where the arches were narrower and supported by more closely-spaced bridge piers. This was the case, for instance, at the site of Kilcarn Bridge, Co. Meath (RMP ME025-039), where rehabilitation works in 2016 required bunding and dewatering of the bridge site, and this revealed the base of an earlier bridge pier in the riverbed.[8] For the western end of Arklow Bridge, it is possible to conclude that the standing stone bridge is essentially that which was originally designed and it does not appear that there is a sequence of buried bridge constructions under the existing bridge.

A caveat to this must be added however, because the timber elements recorded by ADCO in 2018 during the river survey lie within 6m of the bridge, positioned on its upstream side at Piers 10 and 14–15, and indicate the presence of an earlier wooden structure that could be evidence for a pre-existing bridge. The wooden structure would have occupied a different footprint to the stone bridge.

The findings of the SI work at the bridge piers present additional insight. A concrete surround is added to the base of the stone piers. The relationship of the surround to the concrete layer added to the stone apron is unclear, but the surround was added before the widening works of the 1970s. This is indicated by the layering of concrete between the different construction phases. A timber plank, for instance, is in place at the east-facing side of Pier 4 and marks the separation between the concrete surround and the later bridge widening (Plates 29–30). If, as is suggested above (p. 12), the layer of concrete added to the apron is associated with the 1970s work, then the concrete surrounds would predate the laying of this concrete.

The stone apron extends under the concrete surrounds. At Piers 2 and 3, investigations at their respective western sides revealed large stone only. The trail pit at Pier 3 was the first to be investigated (TP-03). Excavation was completed when it encountered a large rock because this was thought to represent bedrock. On reflection, and informed by the sequence of starling piles revealed across the trial pits, it is entirely probable that the rock encountered at Pier 3 is part of the later protective stone apron. This is also the case with the stone at Pier 2.

Removal of the apron at the bridge piers revealed a sequence of mostly round-sectioned soft wood posts that served as starling piles. Such timbers are a common enough feature of older

[8] The rehabilitation works at Kilcarn were monitored by ADCO, Ministerial Consent C000691.

bridges in river gravels, and were used as a protective measure against scour and damage to the bridge piers – functioning in much the same way as the later concrete surrounds. The timber posts would be set around the base of the bridge piers. In Arklow, they have been observed on the east side of Pier 1 (TP-02), on the east side of Pier 2 (TP-03), and on the east side of Pier 3 and the west side of Pier 4 (TP-04).

In one instance it was possible to observe the stone that is inside the line of starlings, and this is interpreted as evidence for the plinth of the bridge pier (Pier 1, TP-02). The stone extends to a depth of 500mm below current bed level, while the starlings penetrate deeper into the river gravels. This might indicate that the stone base of Pier 1 is relatively shallow. The stone exposed is interpreted as part of a basal plinth to the pier.

There was no rock outcropping observed in the trial pits.

In conclusion, the SI works made shallow excavations into the bed level at the western end of Arklow Bridge. The SI works proceeded to a maximum depth of 1.2m at Pier 1, TP-01, and to minimum depth of 500mm at Pier 3, TP-04, while on average the depths achieved were between 700mm and 900mm. There is no indication of rock outcropping, suggesting the possibility that the bridge was founded on river shingle.

The only objects observed were modern pieces, associated with the laying of the stone apron. There were no medieval or early-modern period objects observed within the river gravels and silts, either under the stone apron or at the starling piles. The absence of early material supports the historical narrative that bridge-building at Arklow is a relatively recent phenomenon. It remains to be seen whether the timber uprights recorded upstream of Piers 10, 14–15 represent a pre-existing bridge or associated structure.

4.7 Conclusion

A sequence of construction is evident associated with the western end of the stone bridge in Arklow. The sequence is as follows:

1. Bridge piers, protected by starling piles.
2. A stone apron was added between the bridge piers, perhaps in the early twentieth century. This work effectively raised the bed level across the bridge by up to 900mm in the modern period. The height of the new bed level was not consistent.
3. Concrete surrounds were added to the base of the bridge piers. This would have narrowed the water flow between the bridge piers.
4. Concrete was added on top of the stone apron, raising the bed level to a standard height. This may have taken place as part of the bridge-widening works in the 1970s.
5. The bridge was widened in the 1970s by the addition of a second traffic lane to its road surface above, supported by concrete piled foundations added to the upstream side of each stone pier with a concrete apron to link it all together.

5.0 Archaeological Impact Assessment

Works associated with the creation of bunds within the river channel to facilitate the flood relief measures at the bridge site have the potential to impact with the line of timbers recorded upstream of the bridge on its east side. If avoidance is not possible this will be a direct and permanent impact on a feature that appears to retain high archaeological potential. Advance mitigation measures are strongly recommended.

The works associated with the proposed scheme are to lower the bed level between the bridge piers by 1m. This is associated with design plans to reduce flood risk in the town. The works will require deeper excavation than 1m. To lower the floor of Arklow Bridge will require all of the piers of the bridge to be extended downwards by approximately 2m. The existing river bed will then be lowered by 1.5m. This will remove the introduced apron. A new 250mm-thick concrete slab will be placed on the new bed level of the river, extending upstream and downstream of the bridge, in order to prevent scour of the new bed and the bridge piers. A depth of 250mm of gravel will be placed over the concrete to restore the natural appearance of the river bed, and effectively returning the bed level to that which existed prior to the introduction of the stone apron.

The net reduction in the bridge floor level will be 1m, but the full depth of impact will be greater, with works on the piers being in the order of 2m. It is reasonable to conclude that the actual depth of impacts will be in the order of up to 2.5m.

The works will excavate the river shingle that underlies the stone apron.

The works will directly impact the starling piles that are a primary feature of the stone piers. Archaeological mitigation is required, employing the protocol of ‘preservation by record’.

6.0 Archaeological Recommendations

This report finds no cultural heritage reason for the proposed works not to take place.

6.1 Pre-construction Recommendations

Design proposals associated with stabilizing the bridge ahead of excavation of the river gravels should be reviewed by an archaeologist and a conservation engineer to ensure that the proposals are in line with best practice from a conservation perspective.

Works associated with bunding the river channel at the bridge to provide works access to the bridge must avoid impacting with the line of timbers recorded upstream of the bridge at its centre and east side. The timber feature has been recorded based on timbers that are exposed above the current river bed. It is very likely that more substantial elements remain preserved below the surface of the river bed. It is recommended that this feature is subject to archaeological investigation and/or resolution prior to civils works proceeding. Such investigation/resolution would be conducted as an archaeological exercise, including underwater work, and would be licensed by the National Monuments Service at the Department of Culture, Heritage and Gaeltacht. Where construction impact avoidance is not possible, any direct and permanent impact on the feature must be resolved by employing the protocol of 'preservation by record'. Such resolution would take place as advance works prior to the construction phase commencing.

6.2 Construction Phase Recommendations

Archaeological monitoring licensed by the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht is required of all ground and riverbed disturbances associated with the Arklow Flood Relief Scheme, including works associated with extending downward all the bridge piers, and the excavation and removal of the bridge's stone apron and underlying river shingle. Archaeological monitoring is conducted with the proviso to record fully any features of archaeological interest exposed in the course of such works.

6.3 Archaeological Management Recommendations

It is recommended that an experienced maritime archaeologist is appointed directly by the client to advise the project team on archaeological and cultural heritage matters during construction; to acquire any consents required to conduct the work; to undertake the archaeological monitoring, and to supervise and direct the archaeological measures associated with the scheme.

THE CONSENTS REQUIRED include an archaeological Excavation Licence. Licence applications are made by the licence-eligible archaeologist on behalf of the client to the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht. In addition to a detailed method statement, the applications must include a letter from the client on client letterhead that confirms the availability of adequate funding. There is a prescribed format for the letter that must be followed.

THE TIME SCALE for the construction phase should be made available to the archaeologist, with information on where and when the various elements and ground disturbances and dredging will take place.

SUFFICIENT NOTICE. It is essential for the client to give sufficient notice to the archaeologist/s in advance of the construction works commencing. This will allow for prompt arrival on site to undertake additional surveys and to monitor ground disturbances. As often happens, intervals

may occur during the construction phase. In this case, it is also necessary to inform the archaeologist/s as to when ground disturbance works will recommence.

DISCOVERY OF ARCHAEOLOGICAL MATERIAL. In the event of archaeological features or material being uncovered during the construction phase, it is crucial that any machine work cease in the immediate area to allow the archaeologist/s to inspect any such material.

ARCHAEOLOGICAL MATERIAL. Once the presence of archaeologically significant material is established, full archaeological recording of such material is recommended. If it is not possible for the construction works to avoid the material, full excavation would be recommended. The extent and duration of excavation would be a matter for discussion between the client and the licensing authorities.

ARCHAEOLOGICAL TEAM. It is recommended that the core of a suitable archaeological team be on standby to deal with any such rescue excavation. This would be complimented in the event of a full excavation. The team should include provision for an archaeological dive team, in the event that discoveries are made underwater during dredging.

SECURE SITE OFFICES and facilities should be provided on or near those sites where excavation is required.

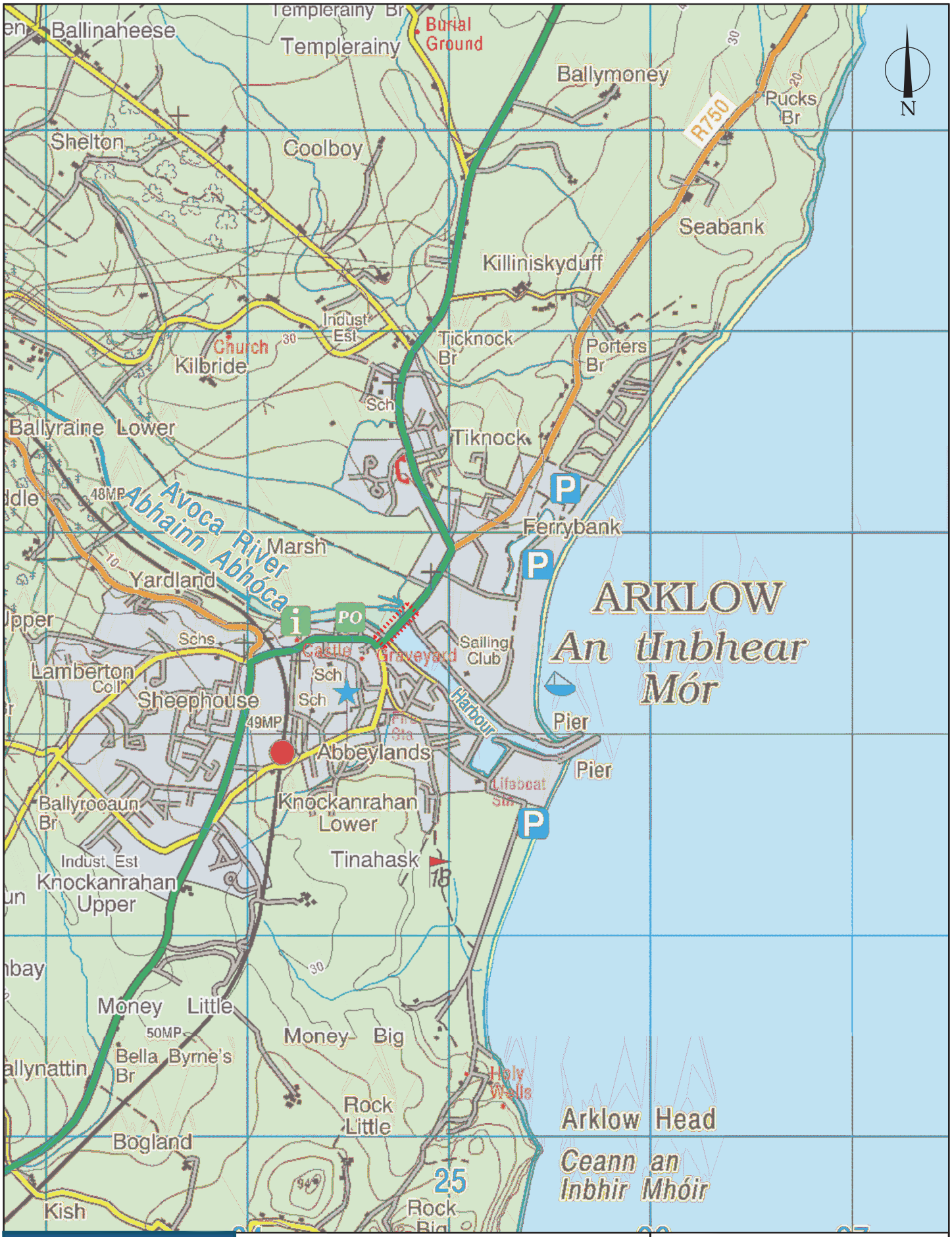
SECURE WET AND DRY STORAGE for artefacts recovered during the course of the monitoring and related work should be provided on or near those sites where excavation is required.

ADEQUATE FUNDS to cover excavation, post-excavation analysis, and any testing or conservation work required should be made available.

MACHINERY TRAFFIC during construction must be restricted as to avoid any of the selected sites and their environs.

SPOIL should not be dumped on any of the selected sites or their environs.

PLEASE NOTE: Recommendations are subject to the approval of the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht.



ADCO

Client
Wicklow County Council

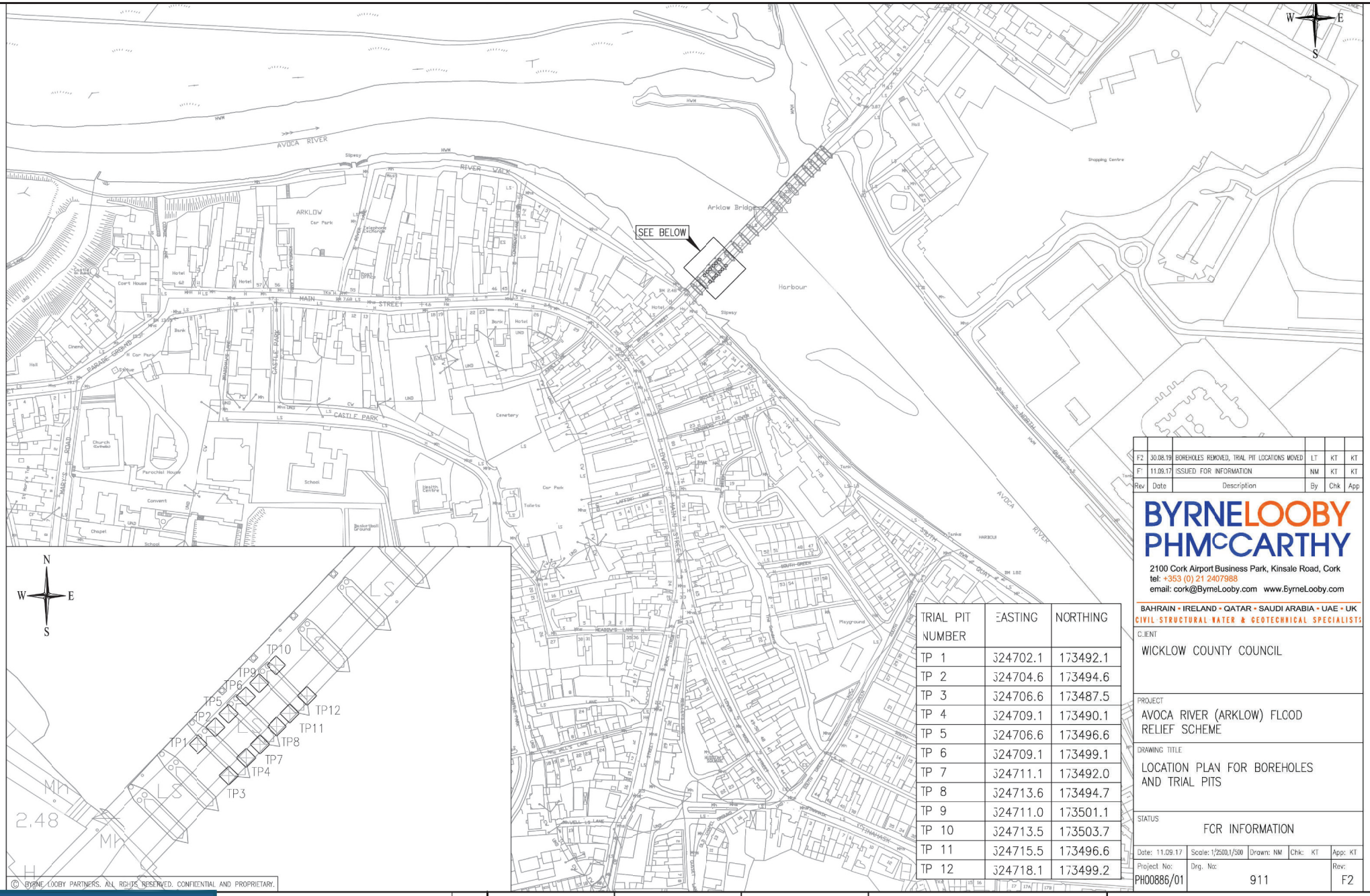
Notes
Source: OSi Discovery Series (1:50,000) Mapping

Arklow Bridge

A4

Title
Figure 1- Location Map showing location fo Arklow Bridge, Avoca River, Arklow, Co. Wicklow.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Site Investigations Works, Arklow Bridge	17E0482	R.Bangerter	Arklow_Bridge	03.11.19	1:20,000	Figure 1



TRIAL PIT NUMBER	EASTING	NORTHING
TP 1	324702.1	173492.1
TP 2	324704.6	173494.6
TP 3	324706.6	173487.5
TP 4	324709.1	173490.1
TP 5	324706.6	173496.6
TP 6	324709.1	173499.1
TP 7	324711.1	173492.0
TP 8	324713.6	173494.7
TP 9	324711.0	173501.1
TP 10	324713.5	173503.7
TP 11	324715.5	173496.6
TP 12	324718.1	173499.2

Rev	Date	Description	By	Chk	App
F2	30.08.19	BOREHOLES REMOVED, TRIAL PIT LOCATIONS MOVED	LT	KT	KT
F1	11.09.17	ISSUED FOR INFORMATION	NM	KT	KT

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CLIENT
WICKLOW COUNTY COUNCIL

PROJECT
AVOCA RIVER (ARKLOW) FLOOD RELIEF SCHEME

DRAWING TITLE
LOCATION PLAN FOR BOREHOLES AND TRIAL PITS

STATUS
FOR INFORMATION

Date: 11.09.17	Scale: 1/2500,1/500	Drawn: NM	Chk: KT	App: KT

Project No:	Drg. No:	Rev:
PH00886/01	911	F2

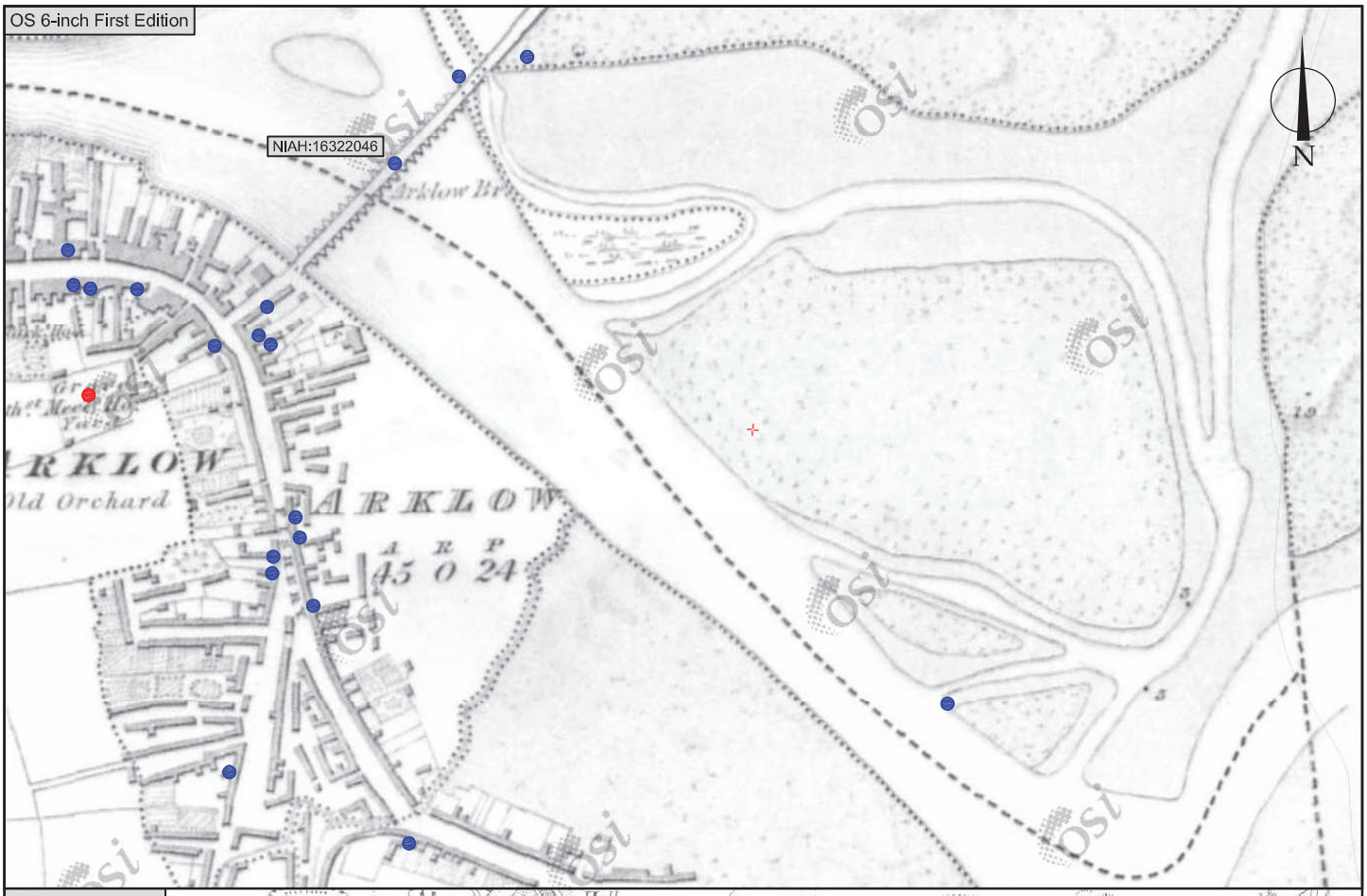
ADCO

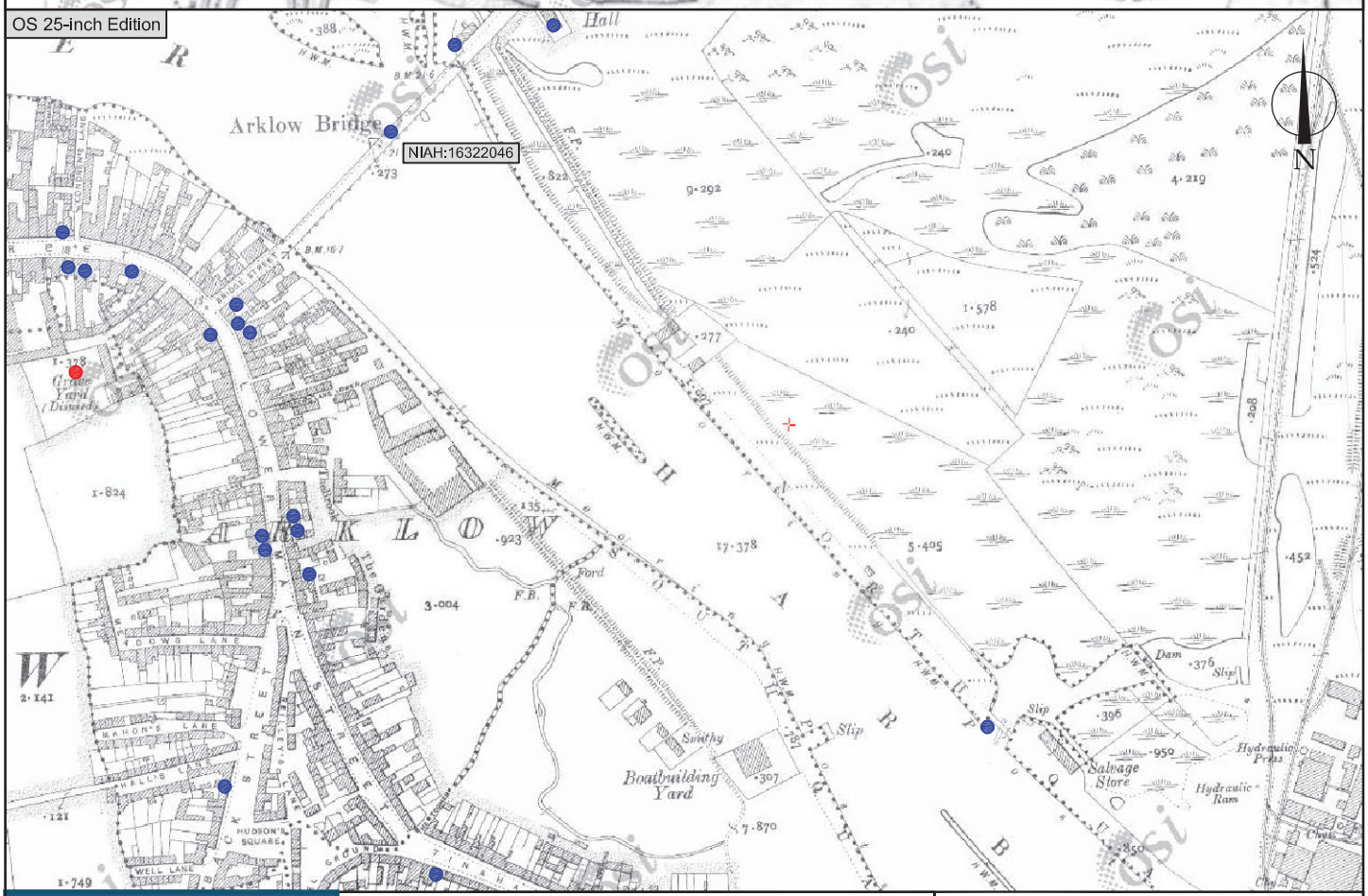
Notes
Source: Project Drawing PH0886/ 01-911-Rev. F2 [Byrne Looby & Partners].

A4

Job/Exc No. 17E0482	**Compiled by** R.Bangerter	**CAD reference** Arklow_Bridge	**Client** Wicklow County Council
Date 03.11.19	**Scale** 1:3750	**Drawing No.** Figure 2	**Project** Site Investigation Works, Arklow Bridge

Title
Figure 2- Extract from Project Drawing showing proposed location of the Site Investigation works at Arklow Bridge [Trial Pits TP1-TP12].





ADCO

Client
Wicklow County Council

Notes
Source: http://wegis.archaeology.ie/historicenvironment/

- SMR
- NIAH

A4

Title
Figure 3- Details from OS historic mapping, showing Arklow Bridge, with SMR and NIAH sites superimposed.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Site Investigation Works, Arklow Bridge	17E0482	R.Bangerter	Arklow_Bridge	03.12.19	1:4000	Figure 3

Trial Pit	ING	ITM
01	324687E, 173477N	724617E, 673518N
02	324701E, 173480N	724621E, 673521N
03	324705E, 173485N	724625E, 673526N
04	324710E, 173490N	724630E, 673531N
05	324693E, 173488N	724613E, 673529N

Coordinates taken mid-point along each trench

Trial Pit	Trench Dimensions
01	1200mm x 1200mm
02	4100mm x 1000mm
03	4006mm x 1000mm
04	3970mm x 1000mm
05	4000mm x 2000mm

Bridge Apron [stone]
Temporary Bund
Exposed Riverbed
Submerged Riverbed

TP-01
TP-02
TP-03
TP-04
TP-05

Horizontal Timbers
Location of *in situ* Timber Piles
Scour Holes
River Avoca
Harbour
Slipway
Hotel
Bank
BM 2.48
BM 3.87
Hall
CONDREN'S LANE UPPER
STREET
RIVER WALK
Scale 1:500
Scale 1:1000

Notes

[Survey data for bridge plan gathered by ADCO using Total Station and DGPS recording].

A3

Job/Exc No.	Compiled by	CAD reference	Client	Title
17E0482	R.Bangerter	Arklow_Bridge	Wicklow County Council	Figure 4- Location of Geotechnical Trial Pits along footings/ foundations of Arklow Bridge.
Date	**Scale**	**Drawing No.**	**Project**	
03.12.19	1:1000/ 1:500	Figure 4	Site Investigations Works- Arklow Bridge	

ADCO

Notes
Source: ADCO onsite survey
Note: levels shown are relative to Bed Level

A4

Job/Exc No. 17E0482	**Compiled by** R.Bangerter/ N.Brady	**CAD reference** Arklow_Bridge	**Client** Wicklow County Council	**Title** Figure 2- Schematic drawing showing Trial Pits TP1-TP4 in Plan and Elevation.
Date 17.02.19	**Scale** 1:100	**Drawing No.** Figure 5	**Project** Site Investigation Works, Arklow Bridge	

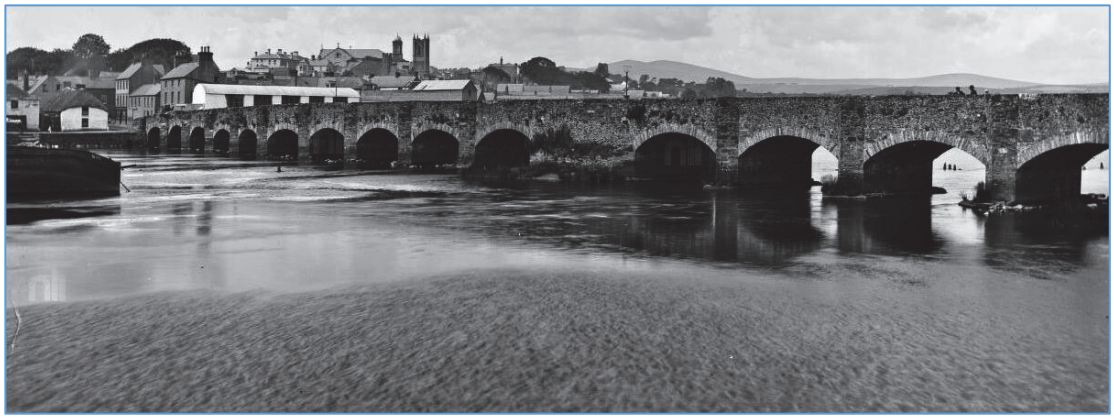


Plate 1: Arklow Bridge, photographed by Robert French (1841-1917), part of the Lawrence Photograph Collection, NLI, accessed www.catalogue.nli.ie

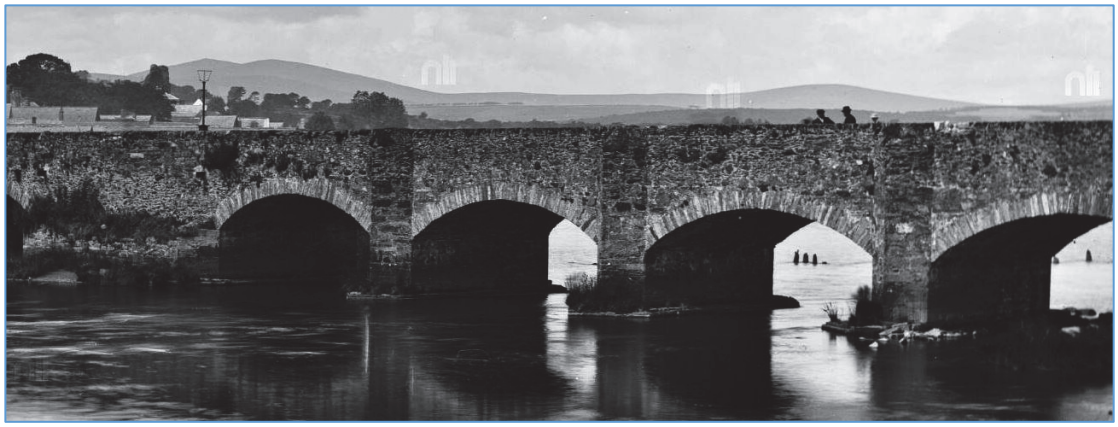


Plate 2: Arklow Bridge, photographed by Robert French (1841-1917), detail of showing timber posts lying upstream of the bridge on its east side.

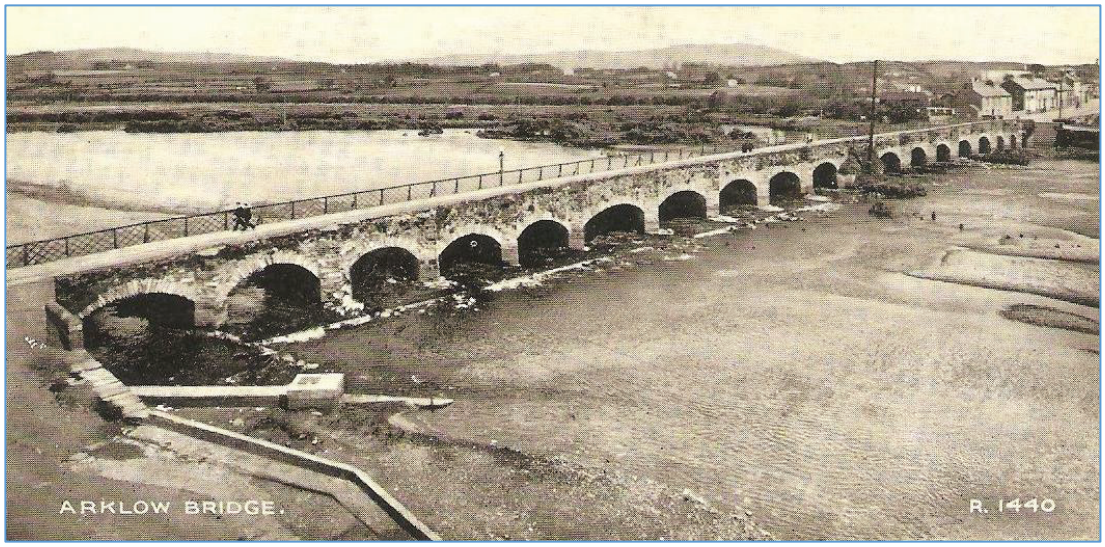


Plate 3: Historic photograph of Arklow Bridge taken from the west bank. Date unknown, Collection unknown. Source: ARUP.

Plate 4: Excavation of the shingle bar that forms naturally upstream of the bridge, which was the source of the shingle used to create the access road and river bunds.

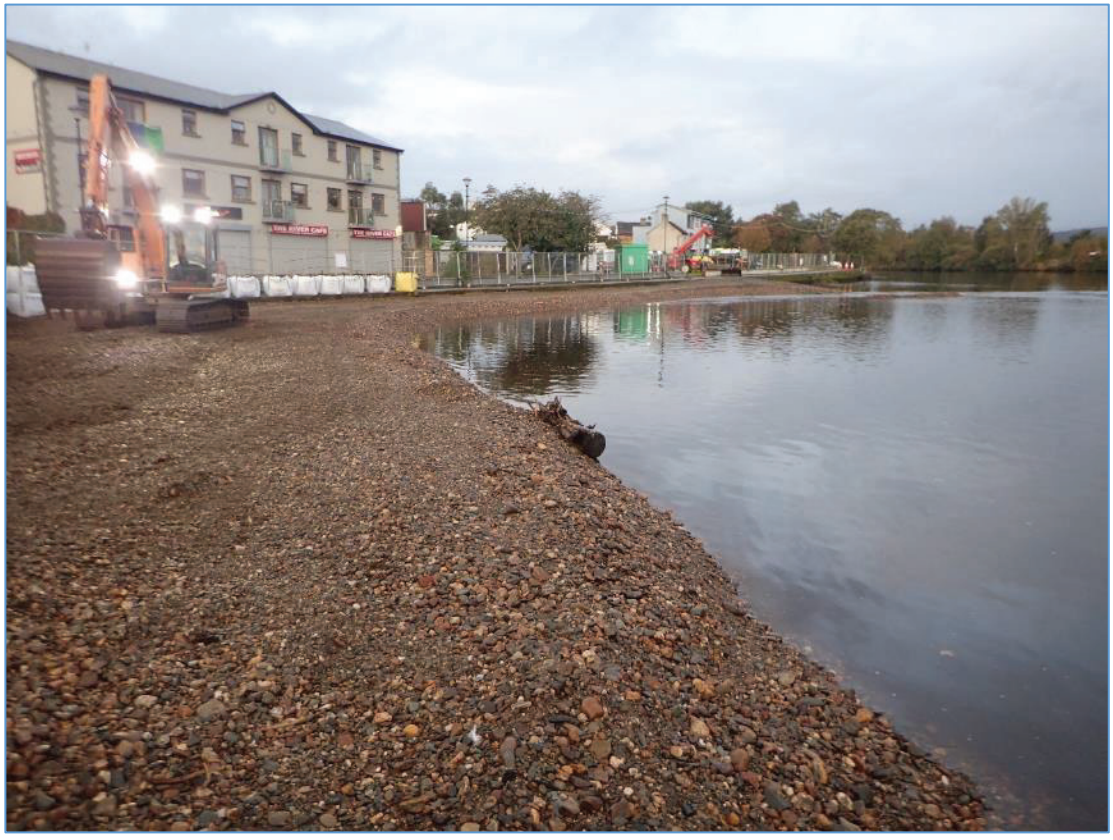


Plate 5: View looking upstream of the access route created along the west bank from river shingle.

Plate 6: View looking downstream showing the access route and upstream bund created from river single.

Plate 7: View from west bank of the bund created on the downstream side of the bridge.

Plate 8: Record shot of cut through the apron between the piers in preparation for excavation of the trial pits.

Plate 9: Record shot of the rock-breaking employed to break through the apron at the trail pit locations.

Plate 10: Record shot showing the back-filling of the trial pits. This would be replaced later with a concrete solution on completion of the SI work.

Plate 11: Trial-pit TP-01.

Plate 12: TP-01, close-up view showing large stone associated with the apron underlying the more recent concrete surface and overlying river shingle.

Plate 23: TP-02, view showing the stone of the bridge apron exposed below the more recent concrete layer above.

Plate 14: TP-02, view showing the full excavated depth at Pier 2.

Plate 15: TP-02 showing a large stone removed from the apron. The stone measured 700mm long, 400mm wide, 100mm thick.

Plate 16: TP-02, selection of objects recovered from the mortar matrix of the stone apron, indicating a dating context for the apron. A metal strap, with each arm measuring 150m (6”) long, 26mm (1”) wide and 3mm thick, and with two perforations for screw fittings. The ball of wire has a plastic sheath and a single strand metal core, 4mm in diameter. The rubber fragment on the right is originally orange in colour and is 200mm long, 60mm wide and 4mm thick.

Plate 37: TP-02 at Pier 1. Excavation of the covering concrete layer revealed the tops of large stone and timber fragments.

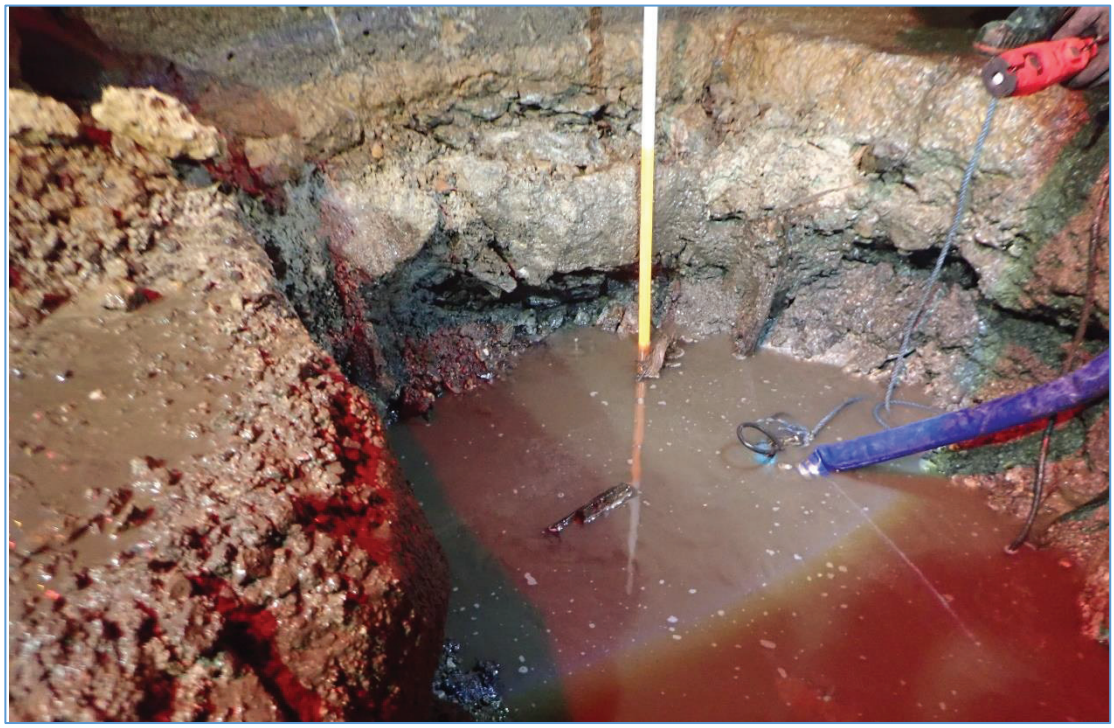


Plate 18: TP-02 at Pier 1. Excavation beneath the concrete revealed the base of stone considered to be associated with the originally plinth of the stone pier, as well as a series of starling piles that lie outside the plinth stones and continue in depth below the excavated levels.

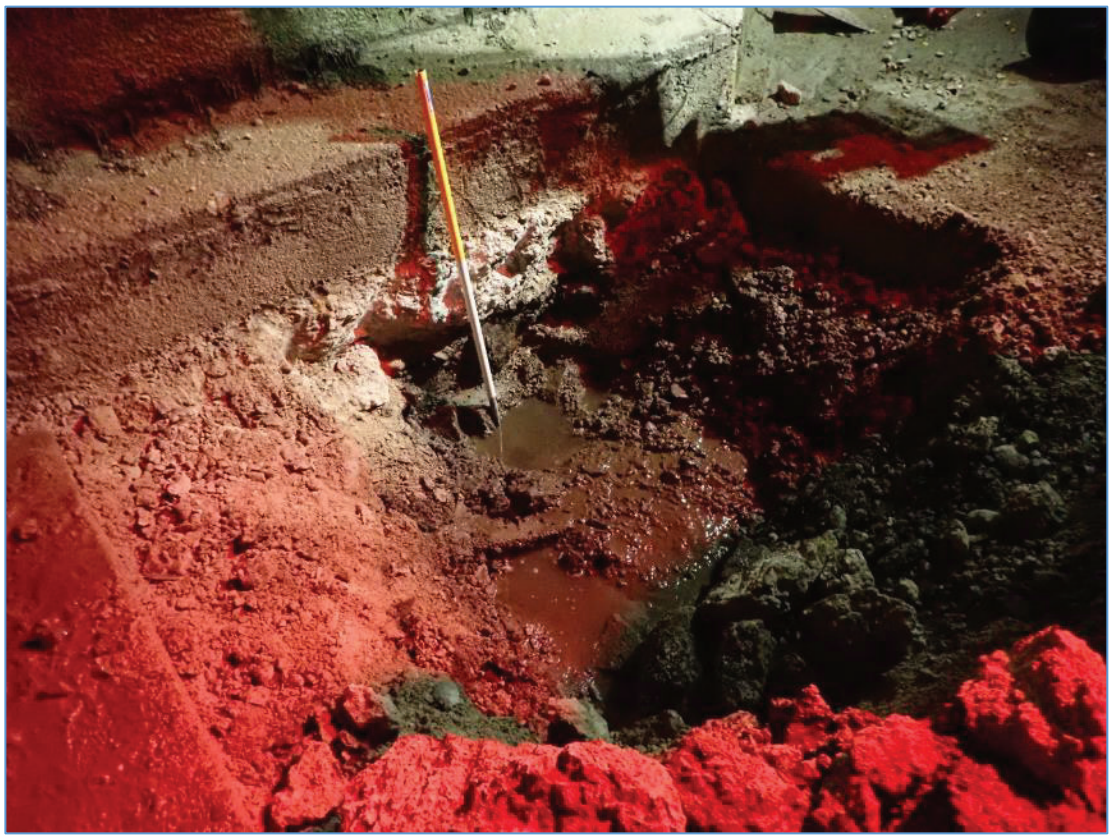


Plate 19: TP-03. Excavation of the concrete above the bridge apron at Pier 3 reveals the apron's stone.

Plate 20: TP-03 at Pier 3, cleaned down as excavated.

Plate 24: TP-03 as it was being excavated across the space between the bridge piers, reveals the shallow nature of the concrete added above the stone apron.

Plate 22:TP-03 at Pier 2. Removal of the covering concrete reveals river clay and starling piles.

Plate 23: TP-03 at Pier 2, close-up view of the starling piles to their excavated depth.

Plate 24: TP-04 at Pier 4. Excavation reveals a line of starling piles under the stone apron.

Plate 25: TP-04 at Pier 4. View of the fully excavated area.

Plate 26: TP-04. Stone apron stone recovered. Note the shot hole on the stone in the foreground, a tell-tale indication of the quarrying process to extract the stone.

Plate 27: TP-04 at Pier 4. Excavation revealed starling piles under the stone apron that in turn lies under the more recent concrete that forms the current bed level.

Plate 28: TP-05, view from the west, showing the extent of the area opened upstream of the bridge, exposing the concrete plinth added as part of the bridge-widening works in the 1970s.

Plate 29: Pier 3, east-facing side, showing the join where the bridge-widening works of the 1970s is added to the concrete surround to the earlier stone pier. This presents a stratigraphic sequence of the bridge works in the modern period.

Plate 30: Pier 4, east facing side, showing a timber plank that survives as part of the form-work associated with the addition of the concrete surround to the stone piers, and which in turn is impacted on by the insertion of the concrete pile as part of the 1970s bridge-widening works.

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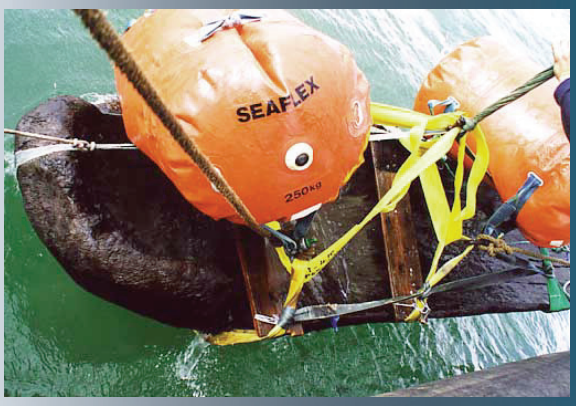

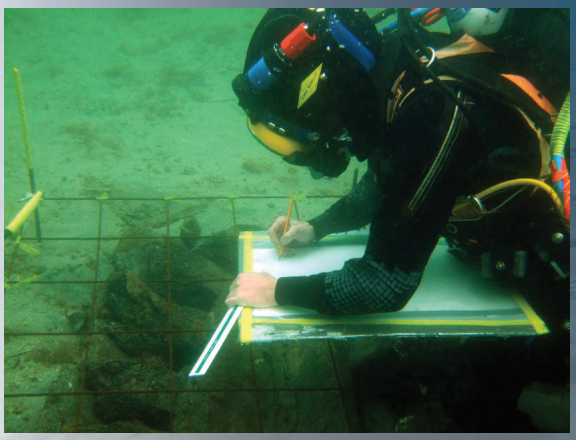

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