

Appendix 11.6

Underwater Archaeological
Impact Assessment, Avoca
River, Arklow Flood Relief
Scheme Licence No. 17D0078
(ADCO, Brady, 2020a)



Underwater Archaeological Impact Assessment
Avoca River, Arklow Flood Relief Scheme
17D0078





**Underwater Archaeological Impact Assessment
Avoca River, Arklow Flood Relief Scheme
17D0078**

Issued

Client

Project Director

Report Author

Figures

Beverley Studios, Church Terrace, Bray, Co. Wicklow

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ARUP for Wicklow CC

Niall Brady

Niall Brady

Rex Bangerter

www.adco-ie.com

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Abbreviations

ADCO -	Archaeological Diving Company Ltd
AIA -	Archaeological Impact Assessment
CC-	County Council
DCHG -	Department of Culture, Heritage and the Gaeltacht
E -	Easting
EIAR -	Environmental Impact Assessment Report
FRS -	Flood Relief Scheme
GI -	Geotechnical Investigations
ITM -	Irish Transverse Mercator
LA -	Lease Area
MHW -	Mean High Water
N -	Northing
NGR -	National Grid Reference
NIAH -	National Inventory of Architectural Heritage
OD -	Ordnance Datum
OPW -	Office of Public Works
SI -	Site Investigations
SMR -	Sites and Monuments Record
UAIA -	Underwater Archaeological Impact Assessment
WwTP -	Waste Water Treatment Plant

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Executive Summary

Subject: Avoca River, Arklow FRS
Location: Arklow
Status: River channel

Introduction

An Underwater Archaeological Impact Assessment (UAIA) was carried out by the Archaeological Diving Company Ltd (ADCO) of the Avoca River as it passes through Arklow Town to inform the Arklow Flood Relief Scheme (FRS).

The UAIA comprised a desktop review and a detailed swim search of the river channel, extending from below the M11 motorway bridge upstream of the town at ITM 723241E 674269N, to a point downstream of Arklow Bridge, terminating at the marina on the North Quay at ITM 725033E 673133N.

Site work was completed in April 2018 and overlapped with surveys conducted previously by ADCO for the Arklow Wastewater Treatment Project. The UAIA also absorbs observations made during ADCO's monitoring of Site Investigations works completed at Arklow Bridge in 2018 and 2019.

Receiving environment

The history of the Avoca River as it passes through Arklow town is intrinsically connected to the town's growth from its early origins and Norse associations to the industrial era of the nineteenth and early twentieth centuries when Arklow's boat-building and chemical works/munitions factories were directly linked with the river.

The river channel has been modified through reclamation works associated with the developments. Upstream of Arklow Bridge, the old shoreline on the south bank that would have been active in the middle ages is now buried under made ground, which has moved the riverbank away from the historic core of the town. In turn, the original estuary of the river downstream of the bridge was a small delta with many channels traversing silt and sands to empty into Arklow Bay at Ferrybank. The delta has been reclaimed, focusing attention on the main channel, and both the north and south bank areas have been developed progressively to accommodate boat-building, berthage and industrial activities. Much of the nineteenth- and early twentieth-century development has been augmented with lighter industrial and service activities.

Archaeological work across the town area has yet to reveal the detail of its medieval history. Indications to date record post-medieval and more recent layers that are built up over the natural underlying estuarine deposits. The results speak to the progressive reclamation of the river area and support the narrative of historical development.

Arklow Bridge is the most striking cultural heritage feature on the active river. A protected structure (NIAH 16322046, A26-16322047), the bridge spans c. 150m across the river. It is a nineteen-arch road-bridge that was built c. 1755. It has a large central pier that serves to anchor the structure, while the piers to the north and south are slighter in mass

and size. All the piers have v-shaped cutwater features on their upstream and downstream sides, while the bridge arches have roughly dressed *voussoirs*. Cement render today covers much of the original stonework underneath the arches, but the stone façade is exposed on its downstream (South) side. The bridge was widened on its upstream (North) side in the 1970s.

2018 Underwater survey

The underwater survey completed by ADCO in 2018 extended over an approximately 2.3km long stretch of the river channel, from below the M11 motorway bridge upstream of the town at ITM 723241E 674269N, to a point downstream of Arklow Bridge, terminating at the marina on the North Quay at ITM 725033E 673133N. The survey completed a comprehensive swim search of the river channel and included the river banks and quaysides.

The survey identified twenty features in the river channel. The features comprise:

- F01: Riverbed deposits, Avoca River.
- F02: Possible section of log-boat or part of ancient revetment.
- F03: Series of stakes protruding from clay bank.
- F04: Four *in situ*, vertically set, timber posts; probable remains of jetty structure.
- F05: Large, conical-shaped, riveted iron object.
- F06: Large length of shaped timber, semi-circular in cross section.
- F07: Iron Anchor and length of attached open-link chain.
- F08: 2.5m long section of timber planking, poss. boat plank.
- F09: Series of un-bonded limestone blocks.
- F10: Timber plank with fitting attached to it.
- F11: Displaced length of timber, probable shuttering.
- F12: Displaced length of timber, probable shuttering.
- F13: *In situ* timber pile/ shuttering.
- F14: Timber Pile.
- F15: Timber Pile.
- F16: Timber Pile.
- F17: Timber Pile.
- F18: Arklow Bridge.
- F19: *In situ* section of wreckage (boat/ship) comprising six lengths of timber planking and underlying framing piece that protrude from the riverbed.
- 17D0078:001, Ship's block.

Designation of the river channel as an archaeological feature (F01) highlights the potential of the river to retain a multitude of archaeological objects and features in the matrix of the river gravels that constitute its river bed.

Features F02–F04 are located upstream of the Flood Relief Scheme works.

The timber pile features F11–F17 form a small cluster upstream of Arklow Bridge on its east side, and highlight the potential for the individual exposed timbers to be part of a greater composite piece that lies buried in the river silts.

Feature F19 was exposed on the riverbed downstream of the bridge and is a piece of wreckage that warrants further consideration.

Arklow Bridge is described in this report.

The quays downstream of Arklow Bridge are described in this report.

2017–2019 Monitoring of Bridge SI works

Site Investigations (SI) at Arklow Bridge were carried out in November 2017 and in October–November 2019, aimed at gaining an understanding of the buried structure of the bridge foundations, to inform project design engineering for the FRS.

The SI works in 2017 comprised a series shell-and-auger boreholes. Three boreholes located downstream of Arklow Bridge revealed only river gravel.

The SI works in 2019 comprised a series of trial pits 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. The work focused on the south end of the bridge, centred at ITM 724627E 673529N.

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 southern 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.

Impact assessment

The proposed development will comprise of the following elements:

- Arklow Bridge Works: Bridge underpinning of pier, remedial works and scour protection including lowering the floor of Arklow Bridge by approximately 1m;
- River Dredging Works: Channel capacity improvement works comprising dredging of the river channel for 320m upstream of Arklow Bridge and 520m downstream of Arklow Bridge;
- Debris and Gravel Traps: Construction of debris and gravel traps to accommodate the collection and regular removal of large floating debris and sediments at a single controlled location.
- Flood Defences – South Bank: Flood defence walls and drainage along South Bank including local alterations to the river channel along River Walk (upstream of Arklow Bridge) and South Quay (downstream of Arklow Bridge)
- Flood defences – North Bank: Flood defence earthen embankment and sheet-piled wall with concrete cap to be constructed upstream of Arklow Bridge on the north bank (east of Arklow Marsh)

Riverbed dredging

The FRS works will have no impacts on features F2–F04 because these features lie upstream of the proposed works.

The river dredging will impact on the locations of features F1, F05-F19 and 17D0078:001.

Gravel trap

Creation of the gravel trap requires excavation across the river to a depth that will be deeper than the dredging that is otherwise proposed along the river. This is a location of archaeological sensitivity as the gravel trap is located within the area of the former harbour of Arklow town.

River bank

The bankside works will impact on made ground surfaces that are built up over pre-existing ground levels that could retain cultural layers and deposits.

Quaysides

There will be no impact on the North Quay downstream of Arklow Bridge, while impacts will occur along the South Quay. Portion of the South Quay retaining its original stone structure will extend out beyond the flood protection measures.

Arklow Bridge

The works associated with the proposed scheme are designed to lower the bed level between the bridge piers by 1m. This will require extending down each bridge pier by 2m

and lowering the river bed by 1.5m in order to place a 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.

The proposed new concrete apron will extend upstream of the bridge and will impact with the location of the timbers (F11–F17) recorded upstream of the bridge on its east side.

Enabling works

River bunds and vehicle way leaves will be created along the river banks to facilitate access for the dredging plant.

The works at Arklow Bridge will require the creation of bunds within the river channel at the bridge site to facilitate access.

The various way leaves and bunds will be created from existing river shingle and supplemented with introduced material where necessary.

The bunds and way leaves will be constructed each season and removed at the end of each season. This represents direct and continuous impacts on the underlying riverbed sediments over the course of the FRS construction period.

Works compounds

A series of works compounds will exist that will include areas for re-spreading dredge spoil to facilitate archaeological inspection. The proposed locations are places that have no known archaeological material.

Mitigation measures

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

Advance works mitigations

Gravel trap investigation

It is proposed that investigation of the riverbed at the gravel trap will take place as an advance works underwater archaeological contract, prior to the civils works proceeding, to safeguard against the discovery of archaeological material at the location of the former harbour of Arklow town.

F11–F17 investigation

It is proposed that investigation of the timbers F11–F17 and associated riverbed immediately upstream of Arklow Bridge will take place as an advance works underwater archaeological contract, to safeguard against the discovery of a composite archaeological feature/s immediately upstream of the bridge in a location that will be impacted directly by the proposed new upstream bridge apron.

F19 investigation

It is proposed that investigation of the section of wreckage (F19) observed downstream of Arklow Bridge will take place as an advance works underwater archaeological contract, prior to the civils works proceeding, to resolve the feature and remove it from the riverbed.

Construction phase works mitigations

Archaeological monitoring licensed by the Department of Housing, Local Government and Heritage is required of all ground and riverbed disturbances associated with the Arklow Flood Relief Scheme. Archaeological monitoring is conducted with the proviso to record fully any features of archaeological interest exposed in the course of such works.

Archaeological monitoring includes:

- Monitoring the riverbed dredging.
- Examining the dredged spoil before it is disposed of.
- Monitoring of works associated with extending downward all the bridge piers, and the excavation and removal of the bridge's stone apron and underlying river shingle.

A series of archaeological management mitigation measures are included in this report.

Mitigation measures are subject to the approval of the National Monuments Service at the Department of Housing, Local Government and Heritage.

1.0 Introduction

The Archaeological Diving Company Ltd (ADCO) was appointed by ARUP consulting engineers for Wicklow County Council and the Office of Public Works to carry out an Underwater Archaeological Impact Assessment (UAIA) of the Avoca River as it passes through Arklow Town, to inform the Arklow Flood Relief Scheme (FRS) (Figure 1).

The proposed development will comprise of the following elements (Figure 2):

- Arklow Bridge Works: Bridge underpinning of pier, remedial works and scour protection including lowering the floor of Arklow Bridge by approximately 1m;
- River Dredging Works: Channel capacity improvement works comprising dredging of the river channel for 320m upstream of Arklow Bridge and 520m downstream of Arklow Bridge;
- Debris and Gravel Traps: Construction of debris and gravel traps to accommodate the collection and regular removal of large floating debris and sediments at a single controlled location.
- Flood Defences – South Bank: Flood defence walls and drainage along South Bank including local alterations to the river channel along River Walk (upstream of Arklow Bridge) and South Quay (downstream of Arklow Bridge)
- Flood defences – North Bank: Flood defence earthen embankment and sheet-piled wall with concrete cap to be constructed upstream of Arklow Bridge on the north bank (east of Arklow Marsh)

The UAIA comprised a desktop review of available archaeological and cultural heritage information that is relevant to the flood scheme area, and a detailed swim search of the river channel conducted in 2018 that was tasked with identifying any features of archaeological interest and potential that might lie exposed on the riverbed within the project area.

The underwater survey overlapped with surveys conducted previously by ADCO for the Arklow Sewerage Scheme (WwTP), which focused on the river channel area downstream of Arklow Bridge.¹

The UAIA also absorbs observations made during ADCO's monitoring of Site Investigations works completed at Arklow Bridge in 2018 and 2019.²

¹ The reports are associated with the following licences: Rex Bangerter 06D059, 06R129; Rex Bangerter 12D008, 12R036; Niall Brady 16D0079.

² Niall Brady, 'Arklow Bridge Site Investigations preliminary report. 170482', unpublished report of the Archaeological Diving Company Ltd, 2019; Niall Brady, 'Arklow Bridge (NIAH 16322046) Site Investigations, 2019. 17E0482', unpublished report of the Archaeological Diving Company Ltd, 2020.

The archaeological approach represents a comprehensive and robust study that allows for a detailed assessment of the archaeological constraints associated with the FRS.

2.0 Receiving environment

2.1 Cartographic sources and historical development

The Avoca River as it passes through Arklow town flows east and then south downstream of Arklow Bridge, creating a north bank and a south bank. The history of the river is intrinsically connected to the town's growth, from its early origins and Norse associations to the industrial era of the nineteenth and early twentieth centuries.

The Irish name for the town is *An tInbhear Mór*—'the big estuary', which speaks directly to the topographic importance of the river.³ In the nineteenth century, the river's mouth was wider than it is today and formed a small delta that issued across Ferrybank, ably creating the sense of a large estuary (Figure 3). The place name 'Arklow' echoes this association, albeit from a slightly different source. The name is derived from the conflation of Old Norse *Arknell*, considered to be a personal name, and *lo*—'marsh or meadow', and reflects the low-lying marshland that still defines the estuarine basin of the Avoca River.

The early settlement would have been relatively small in size. No physical remains for the Norse seaport or any predecessor have been located, although a ninth-century burial in the Viking tradition and associated with Threemilewater to the north of Arklow is considered to be an indication of settlement in the area (Sites and Monuments Record (SMR) WI031-040). Physical remains exist from slightly later and are associated with the later medieval period when the town was among the assets developed by the Anglo-Normans:

In AD 1185 the manor of Arklow was granted to Theobald FitzWalter by King John and may have been settled soon afterwards. The lands remained in the hands of FitzWalter's family, the Butlers, throughout the medieval period. There may have been a harbour; a 'haven' is mentioned in a 1571 covenant, as are town defences in the form of 'gates, ditches, and pales' ...Earthwork ramparts ...[appear to have been] constructed around Arklow in 1576. [O]nly the street pattern and a portion of the castle (WI040-029002-) survive of the medieval town.⁴

Five medieval elements can be identified, although only the castle remains upstanding. Four of the elements lie on the west bank of the present-day town and upstream of Arklow Bridge and are clustered in an envelope that is defined to the north and east by the bend in the river channel, which must define the northern and eastern extent of the main settlement (Figure 3).

³ (www.logainm.ie) (accessed 05/08/2020).

⁴ SMR WI040-029.

To the west, and perhaps defining the western edge of the main town area lies Arklow Castle (WI040-029002, Plate 1). The castle is situated on the edge of a steep scarp dropping northwards to the river. This section of the river is known today as Pound-a-Cholly, which is thought to be a corruption from the Irish meaning 'Harbour Pool', and may indicate the location of the town's harbour in the middle ages.⁵ A length of castle's curtain wall forming a slight angle and a circular corner tower constructed of randomly coursed rubble are all that survive of the thirteenth-century structure. The tower was originally higher. The site of the medieval church of St Mary is the second principal medieval element and lies approximately 160m east of the castle, on the north side of Main Street (WI040-029003). The church does not survive but its site was marked as a 'Grave Yard' on the Ordnance Survey (OS) First Edition 6-inch map of 1838 and was later made into a public park with eighteenth- and nineteenth-century headstones arranged around the perimeter. The castle and the church are key elements that highlight the principal focus of the medieval town, while it is thought that the East-West trajectory of Main Street today follows the alignment of the medieval street.

The location of the Dominican friary (WI040-029001) to the south of Main Street and off Abbey Lane might indicate the southern limit of the town, since friaries were typically built outside the immediate core of the medieval settlement, representing the first expansion or growth of the town beyond its original limits. Situated on level terrain on the south side of the town, the friary was founded in 1264 by Thomas Theobald FitzWalter. Portions of the church and claustral buildings survived into the mid-eighteenth century but are not visible today and the site is a public park. The abbey site is located in the very northeast corner of Abbeylands townland, which is a sizeable block of land that no doubt represented the abbey's principal holding close to the town. The townland reaches south to Tinahask Upper and borders the former estuarine area to the southeast that is occupied by Tinahask Lower townland. An indication of these elements is preserved in the only map of the town associated with the Down Survey in 1654 (Plate 2).

The final medieval element in Arklow is the probable location of the former Cistercian Abbey, also granted by Theobald Walter (WI040-029004). In contrast to the other principal medieval features, the abbey site is located off the east bank of the river and reflects an extension of the borough area across the Avoca River. The location is on low-lying marshy ground. The abbey was associated with the Cistercians of Furness, Lancashire, and was possibly only in existence for a short period. Human skeletons reported in 1839 in what appear to have been lintelled graves or 'long cists' at the location that is marked 'Site of Grave Yard' on the 1838 OS 6-inch map suggests where the abbey was situated.⁶ Human bone was also recovered from close by as recently as 1997.⁷ A trapezoidal-shaped tombstone, possibly of medieval date, was also found and was relocated to Shelton Abbey. The site is now occupied by houses. The presence of the Cistercian Abbey supports the likelihood that the river was a crossing point at this time. There are no records

⁵ Jim Rees, 'The Arklow Yawl', in Críostóir Mac Cárthaigh (ed.), *Traditional boats of Ireland. History, folklore and construction* (Cork, 2008), pp 389–397, at p. 389.

⁶ Jim Rees, *Arklow: the story of a town* (Dee Jay, 2004), p. 40 note 14.

⁷ *Ibid.*, p. 41.

associated with a ford or a medieval-period bridge, but perhaps the townland name 'Ferrybank' offers the best clue, suggesting that a ferry might have operated across the river and its delta to the drier land to the north. It appears that a ferry did operate in the early 1600s and that Cromwell used a ferry when moving his forces south to Wexford.⁸ The earliest reference to a bridge in Arklow is in the 1690s (see section 2.3 below).

The river channel with its wide and marshy estuary has been modified through reclamation works associated with the developing town. The southern shoreline upstream of Arklow Bridge that would have been active in the middle ages has been buried under made ground. Reclamation works effectively moved the riverbank away from the historic core of the town. Elements of this reclamation can be traced by comparing the 1838 OS map with later editions (25-inch, 1911) (Figures 3–5). It is possible to see incremental extension of the land area to the north of the castle. This is also recorded on the river bend to the east, where the gardens of houses terminated directly on the riverfront in 1838 but by 1911 a slight buffer area of marshy ground existed between the gardens and the active channel.

More significant change is mapped on the north bank of the river. A broad inlet feature recorded in 1838 to the west of the graveyard associated with the Cistercian Abbey site is largely filled in by 1911. This is related to the construction of an embankment along the north bank of the river that extends the length of the town marsh (Marsh townland) and continues upstream into the townland of Shelton Abbey. The 1838 map shows the embankment reaching from Shelton Abbey but terminating in Marsh, suggesting that it was a 'work in progress' in 1838 and was completed by the time of the 1911 map. The embankment was part of a series of measures to channel the trajectory of the river and to aid in the reclamation of the lands. This process of active reclamation is a feature of the nineteenth century, which permitted the development of the east bank area downstream of Arklow Bridge in association with the progressive industrialization of the town.

Mining activities in the Vale of Avoca since the late eighteenth century led to development activities within the town, many of which took place on the north side of the river and were associated with improving the harbour and reclaiming the sand flats on the delta. The works were associated in part with the former Hibernian Mining Company, which obtained rights to develop the port, as they sought to import coal to process their copper ore. The complex network of channels that formed the delta estuary of the river were recorded in 1821 by Lieutenant Colonel Hardy for the mining company (Plate 3).⁹ Hardy recorded 'the old course of the river' downstream of Arklow Bridge as flowing to the north of its present course. The route of Mill Road today follows broadly the former river course, while it emptied into the bay somewhat to the north. Plans were afoot to improve the river for shipping by redirecting the river's course to the south. Hardy's plan of 1821 proposed the beginnings of what was to become North Quay. He indicated a wall downstream of the bridge, followed by a sod embankment, which was in turn to be followed by a stone wall, while the harbour mouth was to be a 'new cut' across the sand bar that was to be 60

⁸ *Ibid.*, chapter 4.

⁹ Jim Rees, 'The Arklow Yawl', p. 389.

feet wide and 7 feet deep. Although a retaining wall appears to have been started in the 1820s, the 1838 Ordnance Survey map does not record the engineered features of Hardy's plan, and it is not until later in the century that works gained momentum.

By 1911, the principal elements appear to have been complete. Construction of the North Quay allowed for the new single access to the sea to be cut. The location of the present-day marina on North Quay was maintained as an inlet and served the important boat-building industry. A sequence of slips and dams are recorded within the inlet. The inlet also employed the relict channel that ran under Mill Road. The relict channel was in turn joined with a further length of channel to its north that facilitated the siting of a smelting house, possibly associated with processing the Hibernian Mining Company's copper ore during the 1780s. Reference to the marina location as the 'back guts' or 'back cuts' may be an acknowledgement of its use of relict channels.

Work took place across the delta's shoreline to the north of the main channel and initially the site was developed by the Arklow Chemical Works, which was set up around 1872 for the use of the Wicklow Copper Mining Company.¹⁰ In 1895, the Chemical Works site was bought and the factory was adapted to produce cordite for Kynoch.¹¹ The factory's hey-day was during World War I when it helped to meet the extensive need for munitions on the Western Front. The development of the factory was associated with further reclamation. The marina inlet on North Quay remained but the relict channel to the north was canalized and a tramline built beside it that connected the munitions factory to a network of magazines that reached north along the coastal strip of Ferrybank. Kynoch's closed in 1918 and only a handful of its buildings survive, some of which have succumbed to coastal retreat along the North Beach.¹²

Reclamation of the south bank downstream of Arklow Bridge also witnessed the slow development of the former sandflats. A spine of town development is recorded on the 1838 map extending south of Main Street and recorded as 'Fishery'. It was also known as the 'lower town' and served as the hub for Arklow's long seafaring tradition. In the mid-eighteenth century, Arklow was an important fishing port nationally, with a fleet of oyster boats, sloops, trading vessels and small coasters mooring in the estuary, but this industry was in decline by the time Kynoch's opened.¹³ By 1911, Fishery was renamed Lower Main Street, and further development included the addition of Tinnahawk and Harbour Roads. The land adjacent to the river front remained largely undeveloped. An embankment was constructed by 1911 to the north, offering protection to the properties on Lower Main Street, while a boat-building yard, smithy and slip also existed close to the river's edge.

¹⁰ Colin Rynne, *Industrial Ireland 1750-1930, an archaeology* (Cork, 2006), p. 294.

¹¹ Anthony Cannon, 'Arklow's explosive history: Kynoch 1895-1918', *History Ireland* 14 (2006).

¹² The extreme weather event of 1989, 'Hurricane Charlie', exposed remains of Kynoch's bogies and tram on the foreshore; see Rees, *Arklow*, p. 299.

¹³ *Ibid.*

Arklow's history of boat-building was transformed in the 1850s when the industrialization of the town and improvements to the harbour permitted better access to the river. Not only were boats now being built for fishing, but purpose-built trading vessels were being built locally (Plate 4).¹⁴ In 1864, John Tyrrell opened his boat-building yard on the south side of the river, while in the 1871 census, Arklow returned a count of 217 vessels, the majority of which were in fishing, although many of these were used for general cargo as well. Early photographs indicate that the main channel was divided down its middle by a timber palisade feature, perhaps to serve as a breakwater feature associated with the boatbuilding yard (Plates 4–5). In 1981, Tyrrell's yard built the Irish Naval Service's training ship, *Asgard II*, a brigantine.

The river offered some shelter to the fleet, and records exist that reveal boats using the cutwaters of Arklow Bridge to secure mooring posts. When the river was in flood, however, such shelter was compromised. A storm of 1866 saw the destruction of many vessels moored on the river, the results of which were captured in photographs taken in the aftermath of the storm (Plate 4).

The Arklow Harbour Act of 1882 facilitated the development of the harbour entrance, which was formalized by 1911 with the construction of the North Pier and the South Pier, and a large saw mill complex was located close to the South Pier, with a Lifeboat house just upstream that was established in 1826.

Development in the twentieth century has further transformed much of the lower harbour into an industrial quarter on both sides of the river, with larger vessels being able to berth along the North Quay, and a new basin created across largely undeveloped ground on the south quay upstream of the Lifeboat station (Plate 6). As recently as the 1950s, the lower North Quay area retained its stone-wall quayside (Plate 7). A series of historical aerial photographs reveal the relatively piecemeal development of the lower harbour (Plates 5, 8). In 1934, Arklow Pottery was founded on the South Quay and became an economic mainstay for the town until it ceased production in 1998. A complex of service pipes extend along North Quay upstream from the docks and under Arklow Bridge to transport materials to the former Nitrogen Éireann Teoranta (NET) / Irish Fertilizer Industry (IFI) fertilizer factory (founded in the early 1960s) in Shelton Abbey. The town's boat-yards on the south quays have now all but gone, with a concrete slipway being the only clear reminder of the former activities. However, the presence of Arklow Shipping and Arklow Marine Services on the North Quay clearly define the continued importance of shipping to the town in the twenty-first century.

2.2 Archaeological records

The archaeological potential of the Avoca River was highlighted in 1966 when fragment of a wooden dug-out canoe or logboat was recovered from a location on the south bank, in Yardland townland, which is upstream of Arklow Bridge. The fragment was considered to have washed in

¹⁴ Rees, 'The Arklow Yawl', p. 390; (<https://www.arklowmaritimeheritage.ie/boatbuilding.php>) (accessed 10/08/2020).

from an unknown upstream source location.¹⁵ More recent finds of logboat pieces are recorded, and these are also considered to have been washed down from an unknown upstream location.¹⁶

A series of licenced archaeological interventions have taken place in Arklow (Table 1).

Reference	Location	Findings
98E0187	South Quay	Urban, medieval. Residential development, two trenches were dug by ACS Ltd. Trench 1 was 88m long, 1m wide and 2m deep. At the south end of the trench was a black, organic layer, 0.3m thick, containing nineteenth-century pottery. It sat on natural estuarine gravels. At the north end a layer of red brick rubble overlay natural gravel.
00E0891, 00E0891 ext	Main Street	Urban, Post medieval. Arklow town gas pipeline entered the zone of archaeological potential in an area corresponding to the original harbour. The main area of concern in relation to Arklow was the crossing of the Avoca. The pipeline was strapped to the side of the bridge. Monitoring by Red Tobin for MGL Ltd of trenching on the South Quays c. 100m south of the bridge and extending for about 150m revealed a 0.5m-deep concrete road surface sealing 1.6m+ of infill. The fill was mainly composed of sand, coarse gravel and pockets of large cobbles and clay. Further south and for the length of the quay, the underlying stratigraphy was composed of natural yellow/red, sandy clay sealed by the road surface. No archaeological features or deposits were encountered. Work along Main Street reached a depth of 1.5m and a trench width 0.5m, revealing post-medieval material represented by several box drains and deposits of household and construction debris. The features confirm that the present streetscape is relatively unchanged.
03E0737	Ferrybank	Foreshore and salt marsh. Monitoring by Kieran Campbell during the excavation of a trench for electricity cables at Ferrybank that extended from a landfall on the North Pier along the former foreshore and reclaimed salt marsh to the Brittas Road. The cable trench, 0.6m wide and 1.2-1.4m deep, revealed stone rubble and industrial waste, clinker, etc., datable to the latter half of the twentieth century. Monitoring over the northern half of the trench route recorded the reclaimed salt marsh level, with modern landfill. Many fragments from large 'chemical stoneware' vessels occurred within 150-200m of Kynoch's munitions factory. A short length of an above-ground concrete tunnel structure close to the cable trench route is one of the few surviving remnants of the factory. On the ground rising up to the Brittas Road, natural sand was encountered directly under topsoil and sod for most of the length of the trench.
05E0686	Bridgewater Centre, North Quay	No archaeological significance. Monitoring of topsoil stripping by Eoin O'Sullivan for MGL Ltd recorded a shallow topsoil layer, on average 150mm, which overlay disturbed clay at the eastern and southern portions of the site containing a high proportion modern refuse, including many ceramics from the nearby pottery works. The topsoil at the northern and western portion of the site directly overlay sand. The site consisted of a sand bank that ran diagonally across the site.
05E1375	4 River Walk	Urban. Monitoring of groundworks on a location on the South Quay by Melanie McQuade recorded fill and sterile river gravel deposits. A band of compact gravel lay c. 3m below present ground level and that bedrock was c. 12m below present ground level. Nothing of archaeological significance was found.

¹⁵ National Museum of Ireland, topographical files, record.

¹⁶ Information courtesy of Karl Brady, National Monuments Service.

Reference	Location	Findings
06D059, 06R129	North Quay	Riverine. Non-disturbance underwater assessment of a 50m-long stretch of the river and North Quay 150m downstream of Arklow Bridge at the Bridgewater Centre by Rex Bangerter of ADCO Ltd. No archaeological features noted.
07E0315	Main Street Upper	Post-medieval. Test trenches were excavated in two areas by Maurice Hurley, associated with the castle/barracks site (Area 1) and with the southern slopes of the Avoca valley and in 'the fosse' (Area 2) (in reality a natural steep-sided valley). Finds of seventeenth–twentieth-century date occurred in unstratified contexts on the southern slopes of the 'fosse' (below the castle walls and to the west). The area in the south-west of the 'fosse' is made ground (long used as a dump known locally as 'Anthony's Alps'). The backyards of Nos 32–34 Main Street consist of c. 3m of modern made ground. To the west of the 'Hall' (Area 1), late seventeenth-century to modern material occurred in a garden soil that overlay natural subsoil and similar material occurred to the south-east of the Hall. Modern material overlay subsoil throughout most of Area 1, while a cobblestone surface overlay subsoil in Trench 5. No datable material was associated with the cobblestones but the surface may be associated with the military barracks. There were no indications of archaeological features, remains or any finds from the site.
07E0433	62 Main Street	No archaeological significance.
12D008, 12R036	Avoca River, Arklow	Riverine. Non-disturbance survey of the riverbed downstream of Arklow Bridge and assessment of the North and South Quays by Rex Bangerter of ADCO Ltd observed modern debris within the matrix of a shingle deposit located on the south side of the river. This material included twentieth-century pottery fragments, red brick, and metallic debris. The central channel was largely free from surface debris, only mooring chain attached to risers and associated surface marker buoys were encountered.
12E162 ext	Arklow	Urban. De Faoite Ltd monitored trenches for the Arklow watermain rehabilitation works. No finds or features of archaeological significance were exposed in any of the trenches.
15E0118	South Green and Harbour Road	No archaeological significance. Ground works associated with the installation of watermain, storm sewer and combined sewer pipes were monitored intermittently by Paul Duffy of IAC Ltd. The stratigraphy encountered comprised modern road surfaces and road formation overlying reclamation deposits and contaminated sands, which in turn overlay estuarine deposits of sand. One exception to this occurred c. 10m north of the junction between South Green and Tinahask. In this area, an organic mid-brown peaty marl was encountered at a depth of 1.8m below present ground level. The deposit, which contained an abundance of preserved reed stems, is thought to represent the former edge of the estuary, which appears to have been a marshy area of shallow, brackish standing water. A fingernail-sized crumb of Leinster Cooking Ware (Medieval ceramic) was retrieved from this deposit. The preservative qualities of this deposit, its suspected location at the edge of the estuary and the retrieval of a small fragment of medieval pottery increases the archaeological potential of this area.
16R0219	Arklow Bay	Marine geophysical survey for proposed outfall pipe presented the opportunity to study the nature of the seabed extending 1km seawards from Ferrybank.

Reference	Location	Findings
17D0078, 17R0197	Arklow Bay	Underwater inspection of a series of marine geophysical survey targets identified in 16R0219 by Niall Brady for ADCO Ltd confirmed the absence of archaeologically significant features exposed on the seabed surface.
17E0482	Arklow Bridge	Monitoring of Site Investigations works at Arklow Bridge by ADCO Ltd recorded the presence of starling piles at the base of the bridge piers on the west side of Arklow Bridge, informing the nature of the bridge construction.
18E0084	Boland's, Main Street	No archaeological significance. Monitoring was carried out by Faith Bailey for IAC Ltd of site investigations associated with the proposed redevelopment of Boland's, Main Street. A total of 15 test pits were excavated as part of the site investigations works, with post-medieval remains associated with former walls or culverts recorded in three. No evidence was identified for burials extending beyond the current limits of the graveyard. No archaeological deposits were noted within the bore holes.
18E0263	Town Marsh, Tiknock	No archaeological significance. Archaeological assessment by Courtney Deevy in advance of proposed flood alleviation works at the Arklow Town Marsh. Site investigations were initially to take the form of test pits approximately 2m x 2m, however, due to the wet ground conditions experienced in the marsh area, window sampling in 12 locations took place. No archaeological features, finds or soils were encountered as a result of the on-site archaeological monitoring programme.
18E0304	Back Street	Urban. The site at Back Street is between 200-300m from the nearest SMR monument and the stratigraphy and historic mapping indicates that the site has had many phases of modern development built upon a horizon of natural gravels and sand. The stratigraphy indicates that this area may have been prone to flooding by the Avoca River in antiquity. An assemblage of largely nineteenth-century material was recovered by Yvonne Whitty from the uppermost demolition layer. All horizons above the natural sand bed exhibited evidence of considerable disturbance, which began in the nineteenth century and continued into living memory.
19E0072	Abbey Street	No archaeological significance. Monitoring of pipe laying was carried out by TVAS Ltd on various streets in Arklow town.

Table 1: Licensed archaeological interventions, Arklow town.

Source: (www.excavations.ie) (accessed 10/08/2020)

Archaeological work across the town area has yet to reveal the detail of its medieval history. Instead, the various test-trenching and monitoring of groundworks that have taken place record post-medieval and more recent layers that are built up over the natural underlying estuarine deposits. The results speak to the progressive reclamation of the river area and support the narrative of historical development outlined in section 2.1.

2.3 *Arklow Bridge*

Arklow Bridge is the most striking cultural heritage feature on the active river. A protected structure (National Inventory of Architectural Heritage (NIAH) 16322046, A26-16322047), the bridge spans c. 150m across the river. The NIAH describes the bridge:

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 other smaller 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.1960s replacement metal railings.¹⁷

The bridge is recorded on the 1838 OS map as a bridge containing nineteen in-water piers. The same number of piers are indicated on the 1911 25-inch map, which shows the central upstream pier as being more massive in size. The central pier serves almost as an anchor to the less massive piers to either side. It is suggested that the massiveness of the central pier served a defensive role as a fortified pier, which is an unusual feature of early bridge design in Ireland, and sets Arklow Bridge apart.¹⁸

As noted above (section 2.1), a ferry appears to have operated across the Avoca in 1649 prior to the construction of any bridge. There is no indication of a bridge recorded on the Down Survey map of 1654 (Plate 2). The first indications of a bridge are recorded in documentary sources from 1690 or 1691, when William of Orange is said to have had a timber bridge erected to facilitate the crossing of his artillery. Herman Moll's *New Map of Ireland* dated 1714 shows a series of roads crossing the Avoca River in Arklow, implying the presence of a bridge there.¹⁹ A bridge is illustrated on a map of Arklow dated 1725.

Construction of a stone bridge to replace the timber bridge got under way in the late 1740s, and this is the bridge that stands today. County Wicklow's Grand Jury appointed Andrew Noble of Carnew to the task, and the bridge was completed in 1756. Noble died the same year and is buried in the old cemetery in Enereilly to the north of the town.²⁰ Noble's bridge was eighteen arches long. The nineteenth arch was added to the structure to take the overflow from drainage canals that were excavated across the Marsh above the bridge in attempts to drain the Marsh in the 1760s. The 1838 OS map records a narrow channel emerging from the downstream side of the bridge and continuing into the deltine area to the south; the detail suggests that the feature may be a leat channel constructed to take the outflow from the marsh and, as such, it may date to the late eighteenth century. The location today is built over by the roundabout at the east end of the bridge.

¹⁷ <https://www.buildingsofireland.ie/buildings-search/building/16322046/arklow-bridge-arklow-arklow-county-wicklow>

¹⁸ Peter O'Keeffe and Tom Simington, *Irish Stone Bridges* (Irish Academic Press, 1991) p. 62.

¹⁹ O'Keeffe and Simington, *Irish Stone Bridges*, p. 241 and Appendix 10.

²⁰ Rees, *Arklow*, pp 83–85.

The stone bridge is shown on an historic drawing of the Battle of Arklow in 1798, when the United Irishmen from north Wexford attempted to defeat the royalist garrison in Arklow and march on Dublin (Plate 9). The bridge became a focal point in the battle, as royalists attempted to rout the rebels with a cavalry charge across the bridge. The drawing shows royalist troops on the bridge. However, the charge was repulsed by rebel sharpshooters and pike men, who drove the cavalry back across the river. An attempt by the rebels to force entry into the town through the fishery was in turn repulsed by the royalists. It is estimated that 1,200 rebels and 96 defenders were killed in the Battle of Arklow. The dead were buried in sand pits adjoining Ferrybank, some of which were unearthed a century later when constructing Kynoch's factory in 1897.

In 1864, Arklow Town Commissioners installed three oil operated lamps on the bridge (Plate 10). Ferrybank was starting to be developed and housing began to be constructed along Ferrybank Road to facilitate the mining agents and the management of Kynoch's. The factory workers would also cross the bridge daily to and from work. Better access to the narrow bridge was required. In 1898, the wall on its upstream side was removed and a wrought-iron pedestrian pathway installed, constructed by John Dorricot, while Kynoch's installed electric lighting (Plate 11).

Arklow Bridge was further modified in the 1960s and '70s, when extensive works were carried out, including the underpinning of the existing piers; laying a concrete apron between the piers, and widening the bridge on its upstream side with the construction of openwork piles bedded into concrete. Following an extreme weather event in 2010 when the bridge took the strain of flood waters dammed against its upstream side, a programme of works in 2013 saw the infilling of cracks underneath the bridge and the use of blown concrete to sheath the undersides of the bridge arches. The parapet was also replaced with a reinforced concrete surface and metal guard-rails, and new public lighting was added on the south-bound lane.²¹

The bridge has been inspected by ADCO in recent years.²² All the piers have v-shaped cutwater features on their upstream and downstream sides. 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), while the stone façades of each pier are evident. The bridge has also been the subject of civil engineering inspection concerned with the possibility of scour and structural stability, and a structural report.²³

²¹ *Wicklow People*, 28/08/2013.

²² 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 Bangarter, 'Archaeological site inspection, Arklow Bridge, River Avoca, Co. Wicklow, 17D0078' ADCO memorandum, 26/10/2017. The monitoring of site Investigations works has also taken place: Brady, Arklow Bridge Site Investigations preliminary report; Brady, 'Arklow Bridge (NIAH 16322046) Site Investigations, 2019.

²³ 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; Lisa Edden, 'Arklow Bridge, Arklow, Co. Wicklow; CORA for Wicklow County Council, 2019.

3.0 Underwater survey

The underwater survey completed by ADCO in 2018 extended over an approximately 2.3km long stretch of the river channel, from below the M11 motorway bridge upstream of the town at ITM 723241E 674269N, to a point downstream of Arklow Bridge, terminating at the marina on the North Quay at ITM 725033E 673133N (Figure 6). The survey completed a comprehensive swim search of the river channel and included the river banks and quaysides.

3.1 Operational

Assessment of the river area combined walkover inspection of the river banks and quaysides where accessible and in-water inspection of the river channel.

Bank-side inspection progressed in tandem with the in-water inspection as the survey project commenced upriver and moved progressively downstream. The north bank area running along Marsh townland was not accessible due to the presence of heavy overgrowth that masks the boundary between the river bank and the nineteenth-century embankment behind it (Plate 12).

The river channel was inspected by swim-search that was conducted by a seven-person archaeological team,²⁴ using a combination of surface-towed Surface Supplied Diving Equipment and SCUBA, as the water depths were shallow and provided suitable conditions. The dive station was set up on the Dive Support Vessel. Three divers were deployed at any one time to inspect the river channel (Plates 13–14). The divers would cross over from one side of the river channel to the other, using the river flow to assist and ensuring overlap between the zig-zag or criss-cross patterns of inspection. Observations would be reported to the dive station where an archaeologist/archaeological assistant would record same in writing.

The positioning of all observations was recorded using a DGPS Roving Total Station that was positioned on the river bank and was redeployed at regular intervals as the survey progressed downstream.

Survey was completed over three days in April 2018. The area upstream of Arklow Bridge was completed on 16th April when river conditions were good. Foul weather on the night of the 16th resulted in flood conditions on 17th April, preventing safe access to the river. Survey resumed on 23rd April and was completed on the 24th.

3.2 Archaeological observations: Riverbanks and Quays

Upstream of Arklow town and on both sides of the river, the river bank is a clay formation that slopes steeply into the river channel and in places stands 2m high above the riverbed but it is

²⁴ The team comprised: Niall Brady, Rex Bangerter, Brian MacAllister (Dive Supervisor), Daniel Lenehan, Simon Bennett, Feargal Morrissey and Derek Copeland (Topographic Surveyor).

generally lower (Plate 15). The degree to which the banks are a 'natural' feature is affected by the extent of historic work along the river. It is probable for the most part that the clay river bank on each side is a product of both historic cutting and reclamation. An expanse of shelving bedrock was observed on the south bank, forming the base of the river bank upstream of Arklow Castle and extending to a point downstream that is more or less in line with the castle site (Figure 7, Plate 16). A number of outfalls enter the river from the south bank (Plates 17–18).

Revetment along the river banks begins at the Riverwalk on the south bank, where a series of modern concrete blocks serve to retain the base of the bank under the reclaimed land that constitutes Riverwalk (Plate 19). As the river turns south, the revetment along the south bank is replaced with more formal enquaying, where concrete slab presents a low quayside upstream of Arklow Bridge.

Formal quays occur downstream of Arklow Bridge. A stone retaining wall defines North Quay upstream of the marina (Plates 20–21). The wall is slightly battered in profile and is made up of roughly shaped granite blocks. A series of granite capstones defines the upper edge, and these are also roughly finished (Plate 22). Where the North Quay runs up to the bridge, the stone façade has been replaced by a concrete revetment that holds the service pipes that conveyed material to the NET/IFI factory in Shelton Abbey (Plate 23). The stone quay extends 275m downstream from the bridge to Arklow Sailing Club, but it has been repaired in places through a series of repointing and also replacement by poured concrete (Plate 24). Between Arklow Sailing Club and the Marina, the North Quay is a simple concrete/caisson-built quay wall that is straight-sided (Plate 25). A 150m-long floating pontoon supported by steel piles is linked to the quayside by galvanised gangways (Plate 26), reaching 470m downstream from the bridge. The concrete quayside continues to the Marina, at which point it is replaced with Larsen piles capped with a concrete deck (Plate 27). The Larsen piles form the entrance to the marina and continue downstream, defining the remainder of the North Quay past the downstream limit associated with the Flood Relief Scheme works (Plate 28). This sheet-piled quayside has replaced the former stone retaining wall that was recorded as recently as the 1950s (Plate 7). The quayside downstream of the marina is slightly wider (by 13m) than it was recorded on the 1911 OS map, indicating that this portion of North Quay has been reclaimed in the recent past.

The South Quay in turn retains a sequence of construction periods. A short expanse of stonework at Arklow Bridge is associated with the bridge abutment (Plate 29). The area immediately downstream of the bridge is referred to as the 'Coal Quay', and it retains a now-ruined slipway associated with the Coal Quay (Plate 30). A low stone-built river wall extends downstream from the Bridge and serves as the quay (Plate 31–32). Concrete has been added to the stone wall in two phases. A wide plinth is added to the riverside, constructed from a poured concrete and greenstone mixture, while a reinforced concrete flood wall has been added to the top of the stone wall. This arrangement continues downstream to a point that is level with the junction of South Quay and Green Street, at which location the concrete cladding of South Quay terminates and the original stone quay is fully exposed (Plates 33–34). The quay stands approximately 1m high

above river shingle that forms the riverbed. The wall is constructed from a series of irregularly-shaped stone that forms a series of low courses. It is capped by large flat irregularly-shaped capstones that reach up to 500mm back from the quayside (Plate 35). A grass verge reaches landward and terminates at the present roadway. A series of white-painted stone mooring posts occupy the grass verge (Plate 36). The mooring posts are set low into the ground, suggesting that either they have been reset lower than their original position or that the ground level has been built up around them. The exposed length of stone quay is interrupted in places with modern outfalls. The southern extent is also rendered with a concrete skim on its river façade (Plate 37). It terminates at the slipway that served the boat-building yard (Plate 38). The slipway is covered in a concrete slab. An iron I-beam runs along the base of the slipway, where the concrete has been eroded away to expose same. The concrete wall that defines South Quay downstream of the slipway has been armoured with a suite of Larsen piles that are placed approximately 1m riverside of the base of the wall, with the intervening space infilled with concrete (Plate 40). A wave protection profile is added above the river wall a little further downstream, and rock armour is added as well. This arrangement envelopes a small groyne that may cover an outfall pipe, and it continues for 60m downstream, at which point the South Quay is defined by a line of Larsen piles with a concrete cap, as per the North Quay (Plate 41). This arrangement continues into and passed the harbour basin on South Quay.

3.3 Archaeological observations: Channel topography

The channel is relatively flat along its course, with slight variations due to the principal course as it winds its way downstream. Upstream of the bridge, the main channel is located centrally but this dissipates as the river widens around the bend (Plate 42). While a clay sub-stratum was observed at the upstream end of the survey area (Plate 43), closer to the bridge the surface of the river bed becomes predominantly river shingle and gravel (Plates 44–45). Naturally deposited gravel forms islets in the central area so that at the bridge itself the principal flow occurs in the southern half of the channel, and this helps to explain the occurrence of river shingle across the southern half in contrast to lighter sands and silt that form the river surface in the northern half of the channel. The northern half of the channel also retains a narrow curving shingle bar that lies close to the shoreline. This location is marked by a squatter shingle bar on the historic OS maps but its linear nature suggests that it may be part of a relict feature associated with the drainage activities in the town Marsh, directing outflow to the additional nineteenth arch on the bridge.

Downstream of the bridge, the predominant surface of the river is river shingle and rounded cobble. Intertidal survey was possible immediately downstream of the bridge (Plate 46). The water here is noticeably clear, and the riverbed surface is one of small pebbles and stone. A shingle bar becomes exposed in the central section of the river channel at Low Water. On the north bank, the area exposed at Low Water beside the bridge is stone- and rock-strewn, and a steel pipe runs into the river from the bank. A large berm of scree lies on its downstream side, perhaps to protect

the pipe. Further downstream, a more 'natural' intertidal element is exposed, revealing the soft mud surface with stone inclusions (Plate 21).

The riverbed downstream varies over the survey area, but it remains generally flat and relatively featureless, with shingle and stone exposed in the upstream sections, and silt and sediment covering the surface downstream. There was no indication of the former divisions or timber breakwater features indicated on historical photographs (Plates 4–5). It is not a clean section of the river, and the presence of floating sewerage is problematic, reducing visibility where it occurs. Where sheet-piling occurs, rock armour is constantly present, extending some 10m from the sheet-piling.

At the downstream end of the survey area, the riverbed surfaces is a silty sand, allowing for 50cm penetration by hand, with rounded pebble inclusions (Plate 47). There are some light ripples but the surface is otherwise flat and featureless. Close to the South Quay, leaf litter and dirt abound close to an outflow pipe. In the area upstream of the marina on North Quay and opposite the boat-building slipway on South Quay, the riverbed is noticeably dirty and a mobile almost 'soupy' sediment lies above the silty sand surface. In mid-channel there is a slight elevation, which is the remnant of the slightly higher ground or sand bar recorded on the 1911 OS map, and may belie the presence of the former timber breakwater. Some sherds of white ware ceramic were observed, of no significant age. Red brick fragments, ceramic sherds, shells and tree branches were observed in this area, highlighting the activity associated with the slipway and its past use.

Along North Quay, the base of the riverbed is firmer. The riverbed at the entrance to the marina has a relatively clean bottom, with a noticeable absence of leaf litter. A section of the quay wall between the marina and the floating pontoon upstream has been repaired, and grout bags associated with the repair lie discarded on the riverbed. The riverbed underneath the pontoon is stony, and some tyres lie on the surface. Visibility underwater improved further upstream, but the riverbed remained consistent. A patch of reduced visibility was observed close to the Aldi site, and the crude repointing of the river wall at this upstream section reveals the roots of dead tree stumps sticking out from the wall.

3.3 Archaeological observations: Features

The survey identified nineteen features in the river channel, all but two of which lie upstream of Arklow Bridge (Figures 6–9). The features comprise:

- F01: Riverbed deposits, Avoca River.
- F02: Possible section of log-boat or part of revetment.
- F03: Series of stakes protruding from clay bank.
- F04: Four *in situ*, vertically set, timber posts; probable remains of jetty structure.
- F05: Large, conical-shaped, riveted iron object (poss. nineteenth century).
- F06: Large length of shaped timber, semi-circular in cross section.
- F07: Iron Anchor and length of attached open-link chain.

- F08: 2.5m long section of timber planking, poss. boat plank.
- F09: Series of un-bonded limestone blocks.
- F10: Timber plank with fitting attached to it.
- F11: Displaced length of timber, probable shuttering.
- F12: Displaced length of timber, probable shuttering.
- F13: *In situ* timber pile/ shuttering.
- F14: Timber Pile.
- F15: Timber Pile.
- F16: Timber Pile.
- F17: Timber Pile.
- F18: Arklow Bridge.
- F19: *In situ* section of wreckage (boat/ship) comprising six lengths of timber planking and underlying framing piece that protrude from the riverbed.
- 17D0078:001, Ship's block.

The description of the features below is dealt with in sections relevant to their location with respect to the proposed Flood Relief works.

Throughout proposed river dredging area

F01: Riverbed deposits, Avoca River

Designation of the river channel as an archaeological feature (F01) highlights the potential of the river to retain a multitude of archaeological objects and features in the matrix of the river gravels that constitute its river bed. It is routine practice for flood relief schemes to have river dredging activities monitored archaeologically to retrieve material of archaeological significance. In the case of the Avoca River, the area upstream of Arklow Bridge close to the medieval town and its presumed harbour at Pound-a-Cholly should be regarded as a zone of high archaeological potential. In other projects, such as the River Nore Flood Alleviation Scheme, or the Enniscorthy Flood Defence Scheme, archaeological levels have been exposed once the mobile river cobble that constitutes the surface level is removed, and there is an expectation that dredging activities on the Avoca River would expose material in the same way.

This potential for discovery might also be applied to the area downstream of Arklow Bridge in the vicinity of the former boat-building yards that operated off both the North Quay at the marina, and the off the South Quay. This lower channel area has also been a mooring area for all craft that serviced Arklow since the nineteenth century (Plate 4), and there are records of significant loss and damage to moored vessels during historic extreme weather events, such as occurred in 1866.

Upstream of Flood Relief Works

F02: Possible section of log-boat or part of ancient revetment. ING 323343E 174143N, ITM 723266E 674182N

Partially exposed long timber close to the foot of clay river bank. No particular tool marks or other distinctive features are apparent but the shape of the timber might suggest that it is part of a wooden log-boat. It could also be part of a revetment feature. The timber has the appearance of being hewn and measures 4.4m in length x 450mm (max. width), depth is 35mm (north) at one end and 25mm at other (south) The location is upstream of Yardland townland, where a piece of a logboat was recovered and reported to the National Museum of Ireland in 1966.

F03: Series of stakes protruding from clay bank. ING 323351E 174128N, ITM 723274E 674167N

A series of four small stakes are evident, protruding from the clay river bank, close to and downstream of F01. Tool marks on the stakes suggest that an axe was used to cleave their pointed ends (Plate 48). Sizes range between 400mm and 700mm length, diameter 40mm-45mm.

F04: Four vertically set timber posts. ING 323396E 174066N, ITM 723319E 674105N

A series of four timber posts, two of which are located at the foot of the clay river bank, and two of which are located 3m into the river channel. Three of the timbers are round in section, and a fourth (the Northeast timber) is rectangular in section (Plate 49). It is probably the remains of a jetty feature of recent date.

Features F02–F04 are all located upstream of the Flood Relief Scheme works and will not be impacted by the works.

Within Flood Relief Works area, upstream end

F05: Large, conical-shaped, riveted iron object (poss. nineteenth century). ING 324269E 173566N, ITM 724192E 673605N

A small collection of material located in close proximity to each other, beside the exposed bedrock that forms the base of the river bank in this location that is close to Arklow Castle. The collection comprises a conical-shaped rivetted iron object, and iron fly wheel and concrete block. The material is both nineteenth- and twentieth-century in date and probably represents casual discard/dumping of material.

F06: Large length of shaped timber. ING 324467E 173625N, ITM 724390E 673664N

A length of shaped timber that is semi-circular in cross-section and retains two drilled holes (30mm diameter) at either end for fastening. The timber measures 2.5m in length, 1.4m in width and 600mm deep. It was observed close to the north bank.

F07: Iron Anchor and length of attached open-link chain. ING 324468E 173578N, ITM 724391E 673617N

A discarded anchor of nineteenth-century date was recorded close to a length of open-link chain, beside the south bank at the start (west end) of the Riverwalk (Plate 50).

F08: 2.5m long section of timber planking, poss. boat plank. ING 324635E 173633N, ITM 724558E 673672N

The timber is long and narrow and tapered slightly at both ends, one end of which is fractured (Plates 51–52). It measures 20mm thick and is not rectangular in section. There are no dowel holes or other evident fixings.

One of a small cluster of items (F08–F10) located beside the north bank immediately upstream of the shingle bank that forms in the central channel area upstream of Arklow Bridge.

F09: Series of un-bonded limestone blocks. ING 324639E 173632N, ITM 724562E 673671N

Measured on average 200mm long by wide and 110mm thick (Plate 53). One of the blocks retains a recessed channel on one long edge side.

F10: Timber plank with fitting attached to it. ING324645E 173630N, ITM 724568E 673669N

A shaped timber that is semi-circular in cross-section and retains several cut holes along its length (Plate 54).

Features F05–F10 were recorded and returned to their find location after being photographed. They appear to be isolated finds and are not obviously associated with more integral or composite pieces. Their presence highlights the potential for dredging activity in this area to reveal additional objects. Features F06 and F07 are close to the proposed location of the debris and gravel trap and are in the area regarded as the former harbour of Arklow. The iron anchor F07 in particular speaks to the potential for this zone to retain remnants of vessels that have been moored in the Pound-a-Cholly harbour area.

Upstream of Arklow Bridge

Feature No	ING E	ING N	ITM E	ITM N
F11	324766	173575	724689	673614
F12	324764	173576	724687	673615
F13	324735	173551	724658	673590

Feature No	ING E	ING N	ITM E	ITM N
F14	324736	173545	724659	673584
F15	324737	173543	724660	673582
F16	324737	173540	724660	673579
F17	324744	173545	724667	673584

Table 2: Timber features located in close proximity to and upstream of Arklow Bridge.

A series of timber pile features have been recorded upstream of Arklow Bridge on its north side (Figure 9). Two elements, F11 and F12, are located upstream of Arch 15 and at the downstream tip of the linear shingle bar. The two timbers appear to be displaced pieces and may be associated with a shuttering feature.

Five other elements, F13–F17, are clustered together upstream of the large central pier. The timbers represent vertical posts. F13 is a cut piece that is rectangular in section (Plate 55). F14–F17 are softwood piles that are round in section (Plates 55–56). F15 and F16 occur closest to the bridge pier and are exposed within a scour pocket that has developed next to the pier.

The location of these elements is indicated on an historical photograph of the bridge taken from downstream (Plate 57). The photograph shows a line of three timbers in one cluster that would be in keeping with some of the cluster represented by F13–F17, with a second grouping to the right approximates with the position of F11 and F12.

It is not clear what the timbers represent. However, the possibility that they could be associated with an earlier bridge structure must be allowed for. Their presence recalls the historic note that Cromwell had a timber bridge built across the Avoca in 1690.

Alternatively, the timbers could be associated with various works that were part of the river improvements of the eighteenth century, or indeed with shuttering associated with the construction of the stone bridge.

The timbers are located within the proposed dredge area and will be within the footprint of supporting works to facilitate the underpinning of the bridge. The location will be directly impacted by the FRS works. It is a priority to investigate the timber as advance works, to further understand the nature and association of these elements and to resolve the timbers and any associated features in advance of the construction works of the FRS commencing.

Downstream of Arklow Bridge

F19: In situ section of wreckage (boat/ship). ING 324977E 173248N, ITM 724900E 673287N

A section of boat/vessel wreckage was observed close to the former boat-building yard on South Quay. The piece comprises five lengths of timber planking and an underlying framing piece that

protrudes from the riverbed. The section measures 1.2m in length, 700mm wide and 300mm deep. The framing timber measures 70mm wide and 40mm deep. It is likely to be wreckage associated with a smaller boat or coastal trader. A galley brick is associated, and various pieces of concreted metal are located close by.

The final element to note as part of the swim-search inspection was a timber ship's block that was identified further downstream but also close to the boat-building yards. The piece was recovered and is registered as artefact 17D0078:001.

It is unsurprising to record F19 and the ship's block given the proximity of the historic boat yards. As indicated in Plate 4, the estuary was filled with vessels in the nineteenth century and according to records relating to the extreme weather event of 1866, many vessels within the river were lost at that time.

3.4 Archaeological observations: Arklow Bridge

The archaeological assessment of Arklow Bridge comprised a detailed walkover inspection and recording of information using the DGPS Total Station and a laser scanner. The inspection extended 5m upstream and 5m downstream of the standing structure and overlapped with the river survey. Attention focused on the standing structure of the bridge but also noted scour pockets apparent on the upstream side. Access to the downstream area beneath the apron proved to be not possible to survey effectively because of the force of the water.

The stone bridge remains intact across the structure. However, the bridge-widening works of the 1960s and underpinning and related works of the 1970s have covered over much of the stonework, while the blown concrete, or shot-crete, added in 2013 masks the stonework of the arches themselves. The base of the bridge structure between the piers has an anti-scour apron that comprises stone (granite) blocks bedded in mortar (Plate 58). Concrete skim has been added on top of the stone across much of the bridge. A further scour apron is added against this on its downstream side and forms a glacis that slopes down to the riverbed below (Plate 59). The best presented aspect of the stone bridge is its downstream elevation, where the stonework remains fully exposed (Figure 11). The stone is characteristically roughly shaped and an amalgam of limestone, schist and red sandstone blocks.

The bridge abutments are both impacted by modern works. The south abutment is all but masked by concrete. The bridge-widening required a concrete abutment and this has been added flush with the line of Arch 1, obscuring any sight of the stone abutment upstream. The abutment does however appear to survive on the downstream side, where a c. 1m extension beyond the arch exists and rises vertically to the parapet level. The location of the north abutment is entirely concealed from view.


The arches are segmental in shape, and the stones or voussoirs in the arch rings are narrow edge-set stones that appear for the most part to be schist. No two arches are the same width but there is a pattern insofar as the five most southerly arches and the four most northerly arches are






in the order of 4.9m wide, while the remaining ten central arches are in the order of 6.9m wide. It suggests an engineered design to open the arches as wide as possible to permit water flow underneath in the central channel area, while adopting a more conservative approach closer to the bridge abutments.





The piers are made from similarly roughly cut stone blocks and retain v-shaped cutwaters on both the upstream and downstream sides. The only exception to this is the large central pier (Pier 10), which only has an upstream cutwater. It is not possible to follow the integration of the stonework between pier and cutwater below the arches because the blown concrete is continued to the outer edge of the arch and masks this point. It is however possible to consider the integration above the arches where the cutwaters were continued to the parapet. In these cases, the arch ring is set behind the cutwater, indicating that the construction of the arch came first. On occasion, it is possible to see the cutwater stones above the arch ring are keyed into the spandrel, suggesting at this point that the bridge parapet and the tops of the cutwaters were built at the same time. The piers vary in width but are consistent in this variation across the bridge with the exception Pier 10 that measures 9.86m wide compared to the average width of 1.6m–1.7m. Pier 10 also uniquely extends upstream beyond the bridge footprint.





The widening of the bridge on its upstream side is a rather functional addition that is placed directly against the earlier stonework (Plates 60–63). It is supported by sets of three concrete piles forming small triangular plans that perhaps mimic the upstream cutwaters. The entire addition is bedded in a thick concrete apron, and scour holes are evident consistently upstream of the steel piles (as indicated on Figure 10).






To simplify presentation, a description of the bridge is given in Table 3. It progresses from south to north, with the arches and bridge piers numbered sequentially from the south side. The accompanying images from Arch 1 to Arch 5 show the bridge from its downstream side. Arches 6–19 are shown from the bridge’s upstream side.





Item	Description	Image
South Abutment	The south abutment extends either side of the bridge but the stonework is only exposed on the downstream side as the bridge widening works present layers of concrete formwork on the upstream side. A 1m-long straight-walled buttress extends downstream from the base of the bridge to the bridge	





Item	Description	Image
	<p>parapet above. The upper courses of the buttress are reworked to accommodate the openwork guard rail. The buttress in turn is keyed into the river wall that extends downstream from there.</p>	
<p>Arch 1</p>	<p>The voussoirs are clearly visible and have been repointed. Metal tie rods are inserted through both sides of the arch. The original parapet has been replaced with concrete. The arch is 4.87m wide.</p>	
<p>Pier 1</p>	<p>In common with all the piers, the pier base is buried in a modern concrete curtain that measures c. 300mm wide and deep. The pier is otherwise well preserved and measures 1.72m wide.</p>	
<p>Arch 2</p>	<p>The arch is slightly higher than those on either side and this explains why the concrete replacement parapet above comes so close to the arch ring. There are no tie rods inserted through Arch 2. The arch is 4.85m wide</p>	
<p>Pier 2</p>	<p>The pier is 1.64m wide</p>	<p>As above</p>
<p>Arch 3</p>	<p>As per Arch 1, metal tie rods are inserted through both sides of the arch. The arch is 4.79m wide</p>	

Item	Description	Image
Pier 3	While the arch ring is behind the cutwater, the stones of the cutwater above the arch ring appear to be keyed into the spandrel. The pier is 1.7m wide	As above
Arch 4	There are no tie rods inserted through Arch 4. The arch is 4.9m wide	
Pier 4	The pier is 1.51m wide	As above
Arch 5	A metal tie rod is inserted on either side of the arch. The arch is 4.82m wide	
Pier 5	The pier is 1.65m wide	As above
Arch 6	A metal tie rod is inserted on either side of the arch. The arch is 6.98m wide	
Pier 6	The pier is 1.71m wide	
Arch 7	The arch is 6.83m wide	
Pier 7	The pier is 1.64m wide	

Item	Description	Image
Arch 8	The arch is 6.82m wide	
Pier 8	The pier is 1.64m wide	
Arch 9	The arch is 6.9m wide	
Pier 9	The pier is 1.66m wide	
Arch 10	The arch is 6.98m wide	
Pier 10	<p>The large central pier lacks a downstream cutwater and its upstream cutwater extends several metres beyond the widened bridge footprint. It otherwise shares much in common with the construction of the other piers. As presented today, the cutwater does not reach the parapet and the interior of the cutwater is filled with soil. Two concrete piles are driven through the body of the cutwater. The pier is 9.86m wide</p>	

Item	Description	Image
		
	<p>North-facing elevation of upstream cutwater</p>	
<p>Arch 11</p>	<p>The arch is 6.89m wide</p>	
<p>Pier 11</p>	<p>The pier is 1.62m wide</p>	
<p>Arch 12</p>	<p>The arch is 6.89m wide</p>	
<p>Pier 12</p>	<p>The pier is 1.66m wide</p>	

Item	Description	Image
Arch 13	The arch is 6.9m wide	
Pier 13	The pier is 1.6m wide	
Arch 14	The arch is 6.83m wide	
Pier 14	The pier is 1.55m wide	
Arch 15	The arch is 6.99m wide	
Pier 15	The pier is 1.78m wide	
Arch 16	The arch is 4.85m wide	
Pier 16	The pier is 1.78m wide	

Item	Description	Image
Arch 17	The arch is 4.73m wide	
Pier 17	The pier is 1.43m wide	
Arch 18	The arch is 4.95m wide	
Pier 18	The pier is 1.67m wide	
Arch 19	Arch 19 accommodates the service pipes to the former NET/IFI factory in Shelton Abbey. In doing so, a concrete wall is constructed across the north side of the downstream opening to hold the service pipes, as indicated on the accompanying image. The arch is 4.31m wide	
	The second image shows the arch from the upstream side	




Item	Description	Image
North Abutment	The north abutment on the downstream side of the bridge is masked by a concrete-built wall that was added in the twentieth century to take the NET/IFI service pipes. However, it appears that the stone wall of North Quay may have merged with the original abutment that now lies buried from view.	
	The upstream side of the bridge today has a stone retaining wall that is built against the cutwater of Arch 19/Pier 19. The retaining wall was built after the bridge arch and pier, suggesting again that the original return of Pier 19 and the associated north abutment is not visible today but lies buried in the reclaimed land to the north.	
	Detail view showing the phasing of wall construction against Pier 19, upstream side.	

Table 3: Catalogue presentation of Arklow Bridge.

3.5 2017–2019 Monitoring of Bridge SI works

Site Investigations (SI) at Arklow Bridge were carried out in November 2017 and October–November 2019, aimed at gaining an understanding of the buried structure of the bridge foundations, to inform project design engineering for the FRS.

The SI works in 2017 comprised a series shell-and-auger boreholes. Three boreholes located downstream of Arklow Bridge revealed only river gravel.²⁵

The SI works in 2019 comprised a series of trial pits 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

²⁵ Niall Brady, 'Arklow Bridge Site Investigations, preliminary report, 17E0482'.

bridge arches 1, 2 and 3. The work focused on the south end of the bridge, centred at ITM 724627E 673529N (Figure 10).²⁶

A bund was created to enable the works to take place. The bund used the river gravel that accumulates naturally as a bar above Arklow Bridge. The bund included a haul road that ran alongside the south bank and reached 70m upstream of the bridge.

While certain variations occurred in each of the downstream trial pits completed in 2019, 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, representing modern underpinning works. 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 (Plate 64). 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 south end of Arklow Bridge.

A sequence of construction is evident associated with the south 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.

²⁶ Niall Brady, 'Arklow Bridge (NIAH 16322046) Site Investigations, 2019. 17E0482'.

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 1960s with an addition to the bridge piers and apron on the north/upstream side.

4.0 Impact assessment

The proposed development will comprise of the following elements:

- Arklow Bridge Works: Bridge underpinning of pier, remedial works and scour protection including lowering the floor of Arklow Bridge by approximately 1m;
- River Dredging Works: Channel capacity improvement works comprising dredging of the river channel for 320m upstream of Arklow Bridge and 520m downstream of Arklow Bridge;
- Debris and Gravel Traps: Construction of debris and gravel traps to accommodate the collection and regular removal of large floating debris and sediments at a single controlled location.
- Flood Defences – South Bank: Flood defence walls and drainage along South Bank including local alterations to the river channel along River Walk (upstream of Arklow Bridge) and South Quay (downstream of Arklow Bridge)
- Flood defences – North Bank: Flood defence earthen embankment and sheet-piled wall with concrete cap to be constructed upstream of Arklow Bridge on the north bank (east of Arklow Marsh)

The FRS works will have no impacts on features F2–F04 because these features lie upstream of the proposed works.

4.1 Riverbed dredging

The riverbed dredging will remove the current riverbed surface levels to a depth of up to 1m below current riverbed level. The potential for the discovery of cultural heritage material is highlighted by the archaeological features F1, F05-F19 and 17D0078:001. Such work will undoubtedly present the opportunity to recover archaeological material.

Riverbed dredging works are not to impact on the stone wall sections of North Quay and South Quay, as the dredging operations will be stepped out into the river channel so as to not impact or undermine the quaysides (EIAR chapter 4 section 4.4.3; chapter 5, section 5.5.2 see project drawings 1003, 1004-1010 in Appendix 4.1 of EIAR).

4.2 Gravel trap

Creation of the gravel trap requires excavation across the river to a depth that will be deeper than the dredging that is otherwise proposed along the river (see project drawings 1021, 1022, 1023 in Appendix 4.1 of EIAR and refer to EIAR chapter 4, section 4.4.4; chapter 5, section 5.5.3). This is a location of archaeological sensitivity as the gravel trap is located within the area of the former harbour of Arklow town. The recording of a substantial timber (F06) off the north bank and an anchor (F07) off the south bank close to the gravel trap location highlight the potential for the excavation of sediment in this location to retain maritime cultural heritage material.

4.3 River bank works

The bankside works will impact on made ground surfaces that are built up over pre-existing ground levels that could retain cultural layers and deposits. This is the case upstream of Arklow Bridge where the works will take place along the south bank that is reclaimed land adjacent to the medieval town and its former harbour.

4.4 Quayside works

There are no proposals to construct permanent works on the North Quay downstream of Arklow Bridge, but there will be construction access from the North Quay to facilitate the in-channel FRS works (see project drawing 1065 and refer to EIAR chapter 4, section 4.4 and Figure 5.3).

Impacts will occur along River Walk and the South Quay (see project drawings 1031, 1036-1039 and 1040–1049, and refer to EIAR chapter 4, section 4.4.5; chapter 5, section 5.5.4). These include the raising the existing stone wall that offers some flood protection along South Quay.

That portion of the South Quay that has its original stone structure visible to the riverfront downstream of South Green Street and upstream of the boatyard slipway will remain *in situ* but the new flood relief wall will be aligned inside (west) of the quayside (see project drawings 1041, 1047). This will require crossing over the stone quay at either end and releveling the ground surface of the grass verge between the quay and the roadway. The white-painted stone mooring posts will be repositioned as part of this process, reasserting their integral relationship to the quay wall where possible.

The former slipway associated with Tyrell's boatyard will remain *in situ*. Impacts associated with this structure are minimal and are related to renewing the existing flood barrier across the entrance to the slipway.

The remaining impacts along South Quay and into the harbour basin are restricted to the construction of a low flood wall that is set back from the active quayside.

4.5 Arklow Bridge

The works associated with the proposed scheme are designed to lower the bed level between the bridge piers by 1m (see project drawings 1003, 1004-1010 in Appendix 4.1 of EIAR, and refer to EIAR chapter 4, section 4.4.2; chapter 5, section 5.5.1. 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 a 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.

The proposed new concrete apron will extend upstream of the bridge and will impact with the location of timbers (F11–F17) recorded upstream of the bridge on its east side. Advance works archaeological mitigation measures are proposed to investigate and resolve the features associated with F11–F17 ahead of construction commencing.

4.6 Enabling works

River bunds and vehicle way leaves will be created along the river banks to facilitate access for the dredging plant (see project drawings 1003, 1011-1020 in Appendix 4.1 of EIAR, and refer to chapter 5, section 5.5 and relevant works figures in Appendix 5.2).

The works at Arklow Bridge will require the creation of bunds within the river channel at the bridge site to facilitate access.

The various way leaves and bunds will be created from existing river shingle and supplemented with introduced material where necessary.

The bunds and way leaves will be constructed each season and removed at the end of each season of the projected three-year in-water works schedule. This represents direct and continuous impacts on the underlying riverbed sediments over the course of the FRS construction period.

4.7 Works compounds

A series of works compounds are proposed to cater for the plant and machinery and for the re-spreading of dredge spoils to facilitate archaeological inspection (see project drawing 1065, and refer to EIAR chapter 5, section 5.3.2). The locations will be within existing open area and/or greenfield sites. The location of site compound SC1 will require an advance works archaeological mitigation, and this is addressed in the EIAR cultural heritage chapter..

5.0 Mitigation measures

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

5.1 Advance works mitigations

A series of advance works archaeological measures will be conducted. The following highlight those pertaining to the underwater archaeological environment, while the terrestrial archaeological environment is considered in the EIAR cultural heritage chapter. Such work will be licensed by the Department of Housing, Local Government and Heritage.

5.1.1 Gravel trap investigation

It is proposed that investigation of the riverbed at the gravel trap will take place as an advance works underwater archaeological contract, to safeguard against the discovery of archaeological material at the location of the former harbour of Arklow town. Such work will be an underwater archaeological investigation where a team of archaeological divers employing Surface Supplied Diving Equipment will excavate a trench across the riverbed at the location of the silt trap to assess the presence of archaeological material in the riverbed.

5.1.2 F11–F17 investigation

It is proposed that investigation of the timbers F11–F17 and associated riverbed will take place as an advance works underwater archaeological contract, to safeguard against the discovery of a composite archaeological feature/s immediately upstream of Arklow Bridge in a location that will be impacted directly by the proposed new upstream bridge apron. Such work will be an underwater archaeological investigation where a team of archaeological divers employing Surface Supplied Diving Equipment will excavate a trench/es across the riverbed at the location of the known timbers to assess the presence of archaeological material in the riverbed. Should the investigation observe that the timbers are associated with a larger feature/s, that feature/s will need to be archaeologically resolved in advance of construction works. Sufficient lead time will be allowed for in the project schedule to permit the investigation and resolution of features in this location.

5.1.3 F19 investigation

It is proposed that investigation of the boatwreck feature F19 and associated riverbed will take place as an advance works underwater archaeological contract, to safeguard against the discovery of a larger boatwreck feature at this location downstream of Arklow Bridge and close to the former Tyrell's boatyard slipway. Such work will be an underwater archaeological investigation where a team of archaeological divers employing Surface Supplied Diving Equipment will excavate around the piece of boat wreck to expose it more fully and to ascertain whether there

are related elements buried or close by. The investigation should result in the proper recording of the vessel remains on the riverbed, and its removal from the riverbed for storage in secure waterlogged conditions that meet the requirements of the National Museum of Ireland. Such will permit the fuller study of the vessel remains and will inform decisions as to its permanent storage context.

5.2 Construction phase works mitigations

Archaeological monitoring licensed by the Department of Housing, Local Government and Heritage 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.

5.2.1 Monitoring of the active dredging faces

Archaeological monitoring the active dredging faces is required to ensure that material exposed/recovered during the dredging works is recovered and stored securely. Such dredging faces include the works required to establish way leaves and bunds where such work requires the use of river gravels whose excavation have not been previously archaeologically monitored.

5.2.2 Examination of dredged spoils that are brought to the works compounds

Archaeological examination of the dredged spoils that are brought to the works compounds prior to export off-site for reuse/disposal will provide a second opportunity to assess the archaeological potential of the sediments and recover material of archaeological interest. It is recommended that this element of the monitoring will be based on a percentage of the dredge spoils to be agreed with the National Monuments Service and the National Museum of Ireland. A higher percentage of such monitoring is anticipated for spoils from archaeologically sensitive locations such as the former harbour area upstream of Arklow Bridge and from Arklow Bridge itself. A lower percentage is anticipated for spoils from downstream of Arklow Bridge, where the archaeological sensitivity is less.

5.2.3 Monitoring of works at Arklow Bridge

Archaeological monitoring of works associated with extending downward all the bridge piers, and the excavation and removal of the bridge's stone apron and underlying river shingle will be carried out. This work will be conducted with the aim of recording all bridge elements that are exposed in the course of such works and before such elements may be removed by such works. The monitoring will record fully such features in writing and photographically, and will include metrically accurate measurements and drawings to permit the generation of scaled drawings that illustrate the history of bridge construction that may be revealed in the course of such work.

5.3 Archaeological management mitigations

An experienced and competent licence-eligible maritime archaeologist will be 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, and to supervise and direct the archaeological measures associated with the scheme, including to undertake the advance works archaeological mitigations, and to undertake the construction phase archaeological monitoring.

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.

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 Housing, Local Government and Heritage. 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. Other consents include a Dive Survey licence to conduct archaeological dive work, and a Detection Device licence to use a metal-detector.

THE TIME SCALE for the construction phase will 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 will be recommended. The extent and duration of excavation will be advised by the client's archaeologist and 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 will be complimented in the event

of a full excavation. The team will include provision for an archaeological dive team, in the event that discoveries are made underwater during dredging.

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

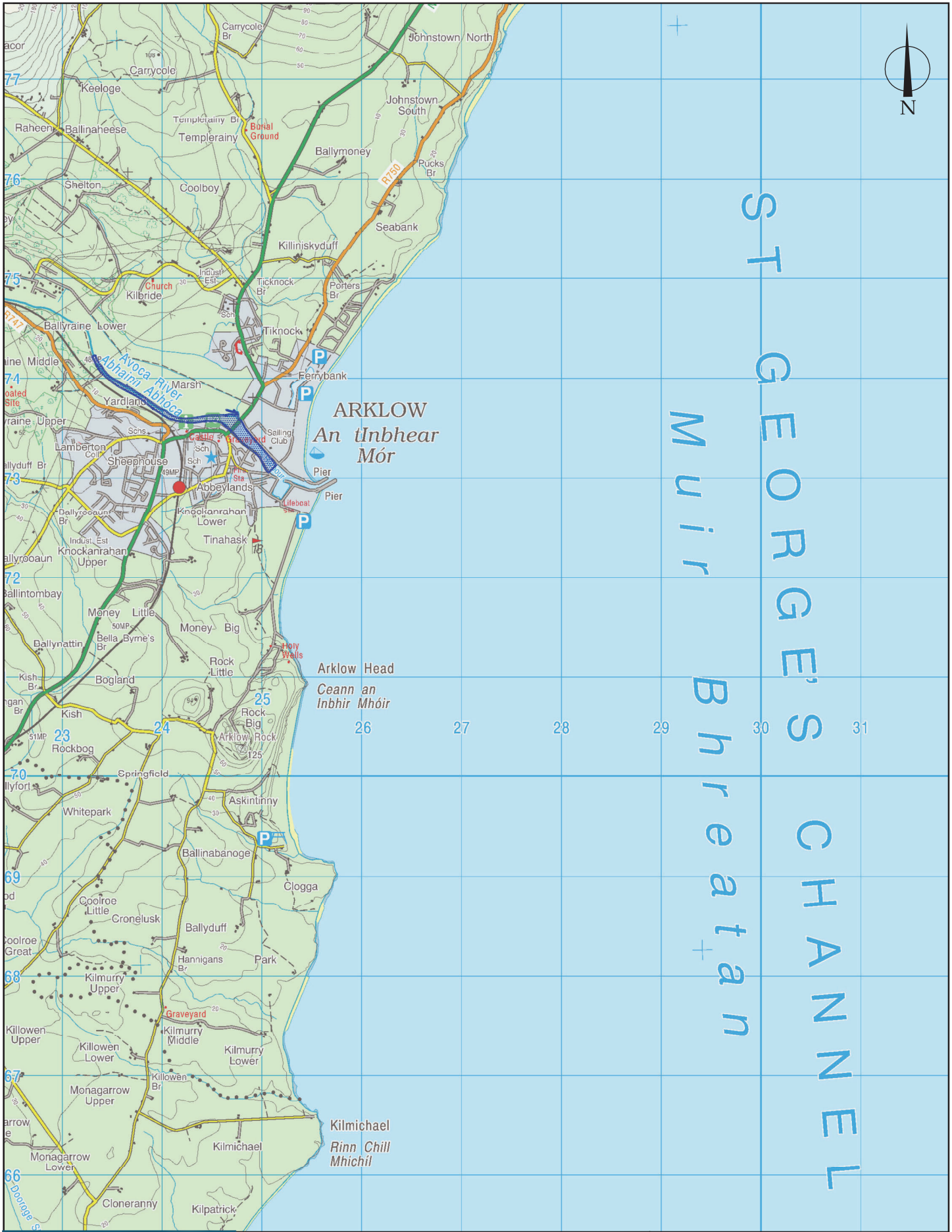
SECURE WET AND DRY STORAGE for artefacts recovered during the course of the monitoring and related work will be provided on or near those sites where excavation is required.


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

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

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

The mitigation measures contained in this report are subject to the approval of the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht.



Notes
 Source: OSi Discovery Series (1:50,000) Mapping
 Extent of UAIA undertaken by ADCO.

Title
 Figure 1- OS Map showing location and extent of the UAIA carried out by ADCO as part of the Arklow Flood Relief Scheme.

Client
 ARUP/ Wicklow County Council

A4

Project
 UAIA, Arklow Flood Relief Scheme

Job/Exc No.
 17D0078

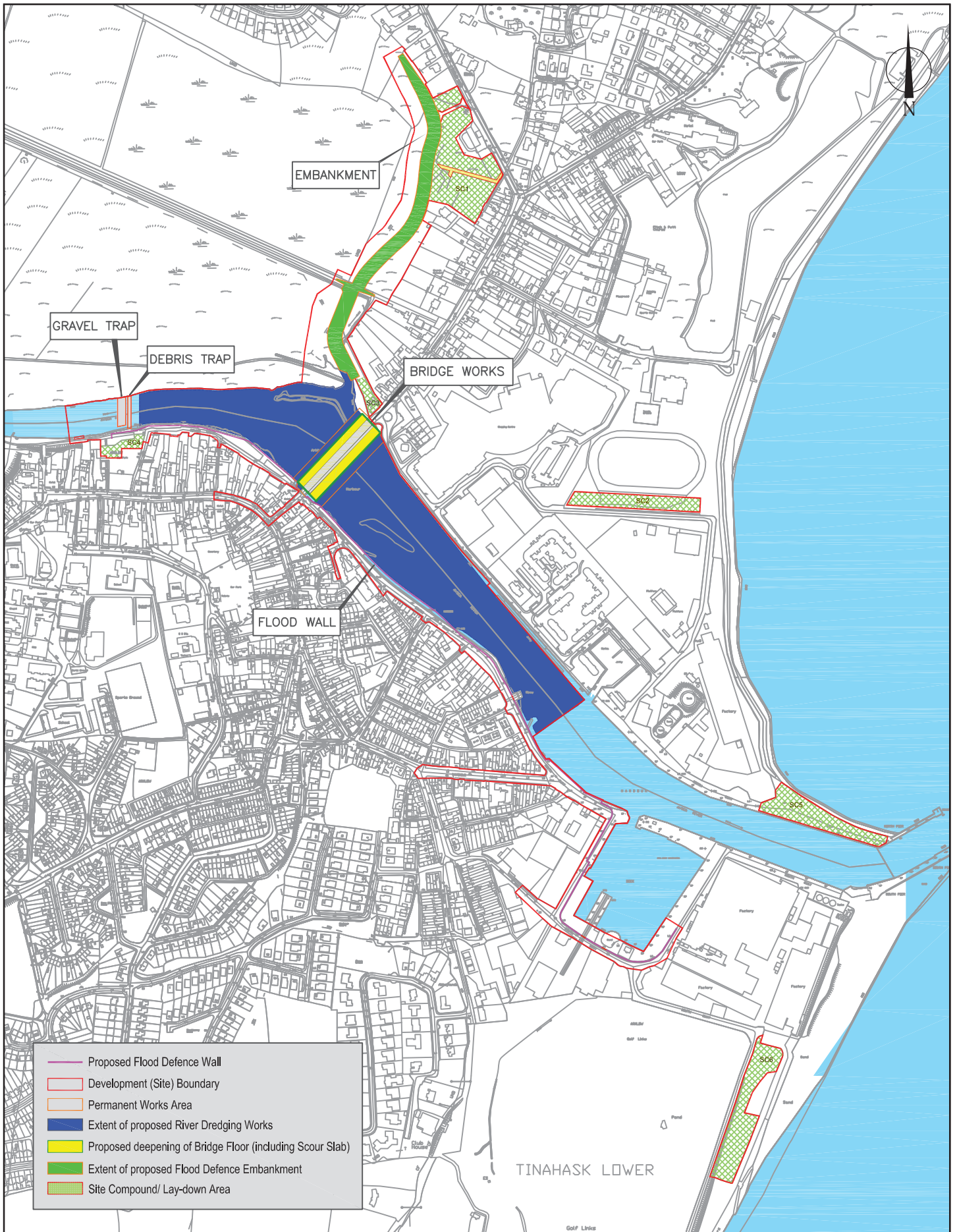
Compiled by
 R.Bangerter

CAD reference
 Arklow_FRS

Date
 18.08.20

Scale
 1:50,000

Drawing No.
 Figure 1



Notes
 Source: Figure adapted from Project Drawing provided by ARUP [PH00886/01 1065
 Rev. 2- produced by Byrne Looby 23.09.20]

Title
 Figure 2- Location and Extent of the proposed Arklow
 Flood Relief Scheme

ADCO

Client
 ARUP/ Wicklow County Council

A4

Project
 UAIA, Arklow Flood Relief Scheme

Job/Exc No.
 17D0078

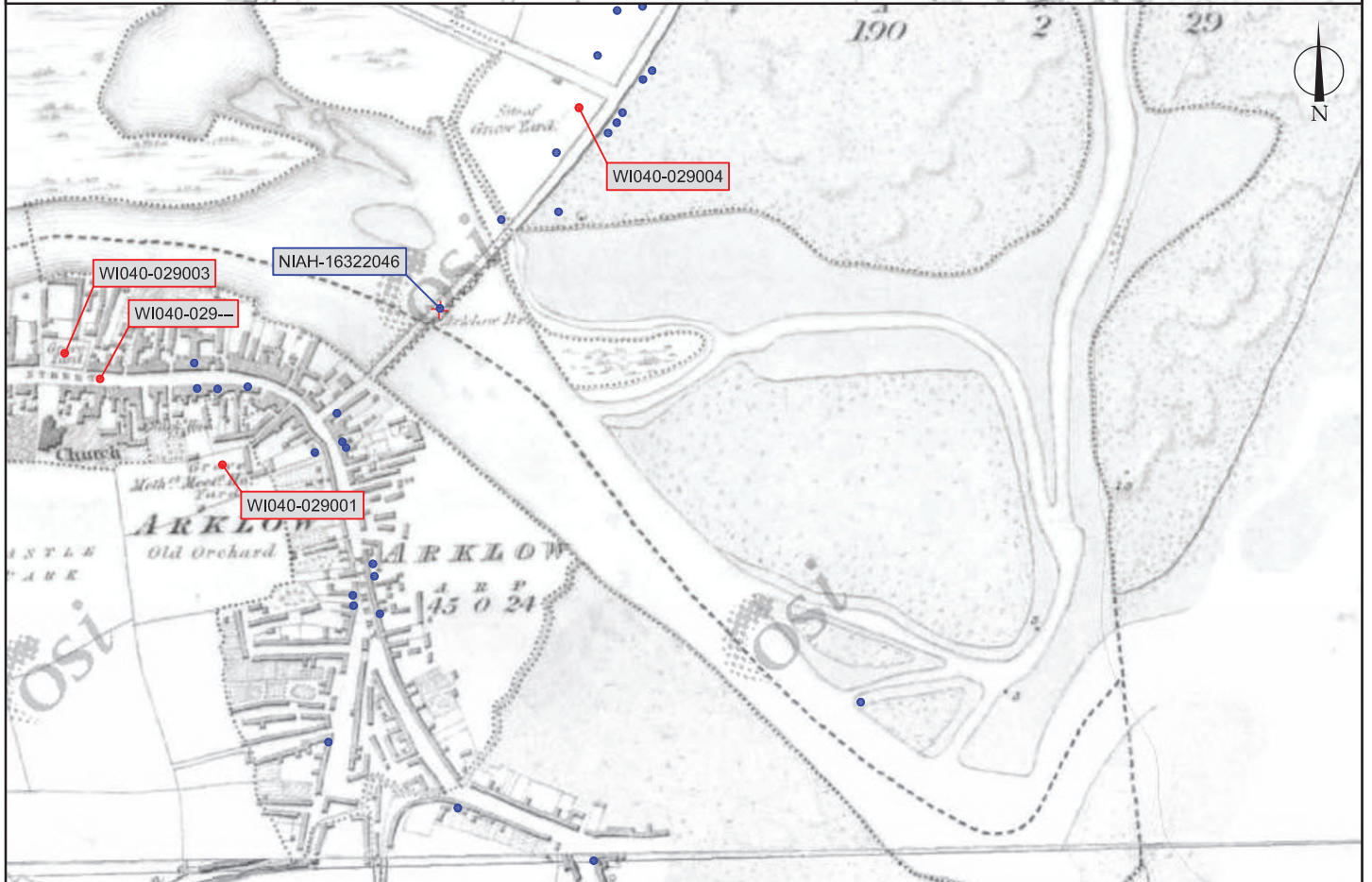
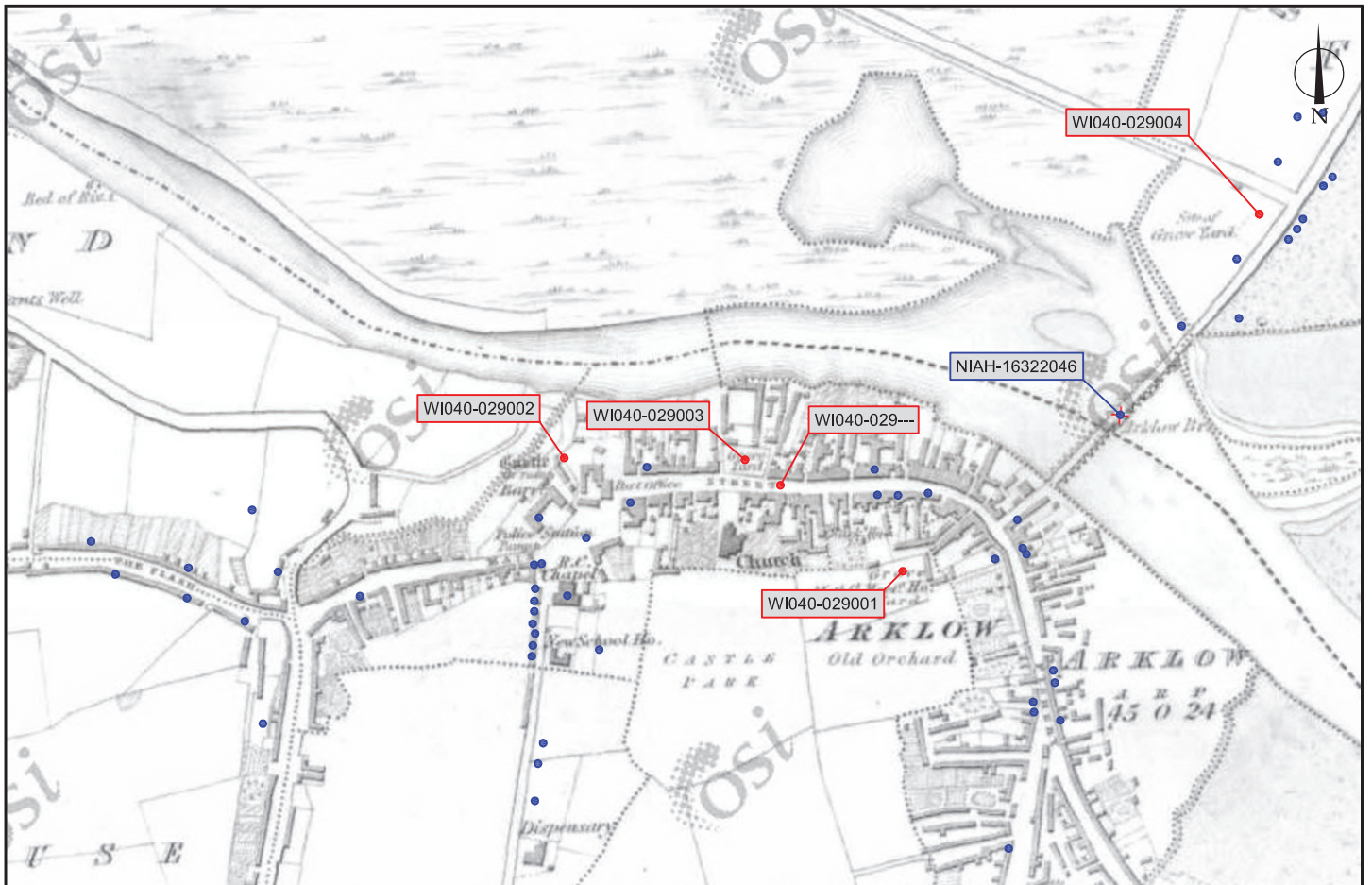
Compiled by
 R.Bangerter

CAD reference
 Arklow_FRS

Date
 15.03.21

Scale
 1:7,500

Drawing No.
 Figure 2



Notes
 Source: OSi Historic Map Archive
 ● RMP Site
 ● NIAH Site
[\[http://wegis.archaeology.ie/historicenvironment/\]](http://wegis.archaeology.ie/historicenvironment/)

A4 Title
 Figure 3- Extract from OS First Edition Map (1838) of Arklow Town with known cultural heritage assets (RMP/NIAH) superimposed.

Client
 ARUP/ Wicklow County Council

Project
 UAIA, Arklow Flood Relief Scheme

Job/Exc No.
 17D0078

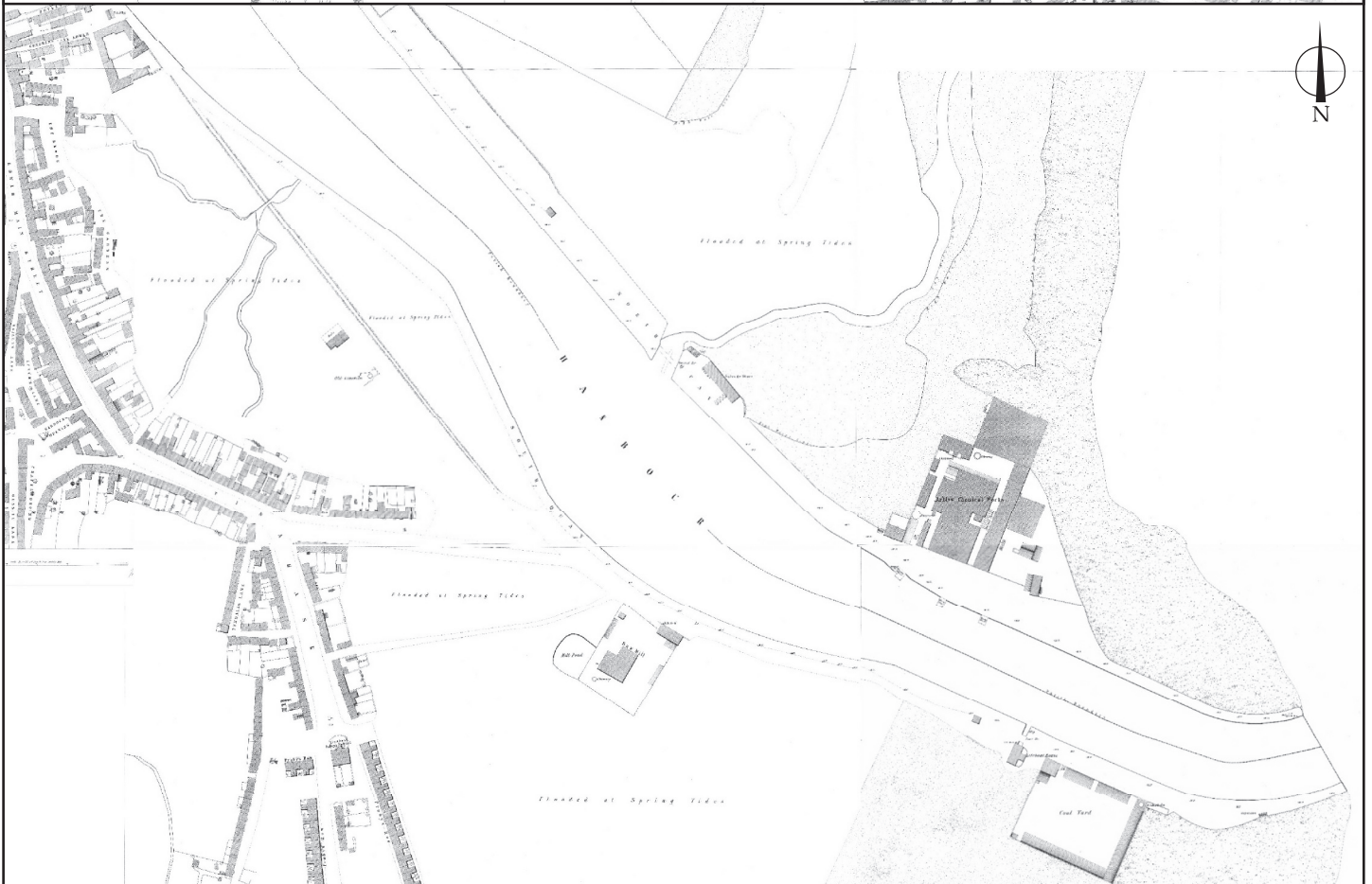
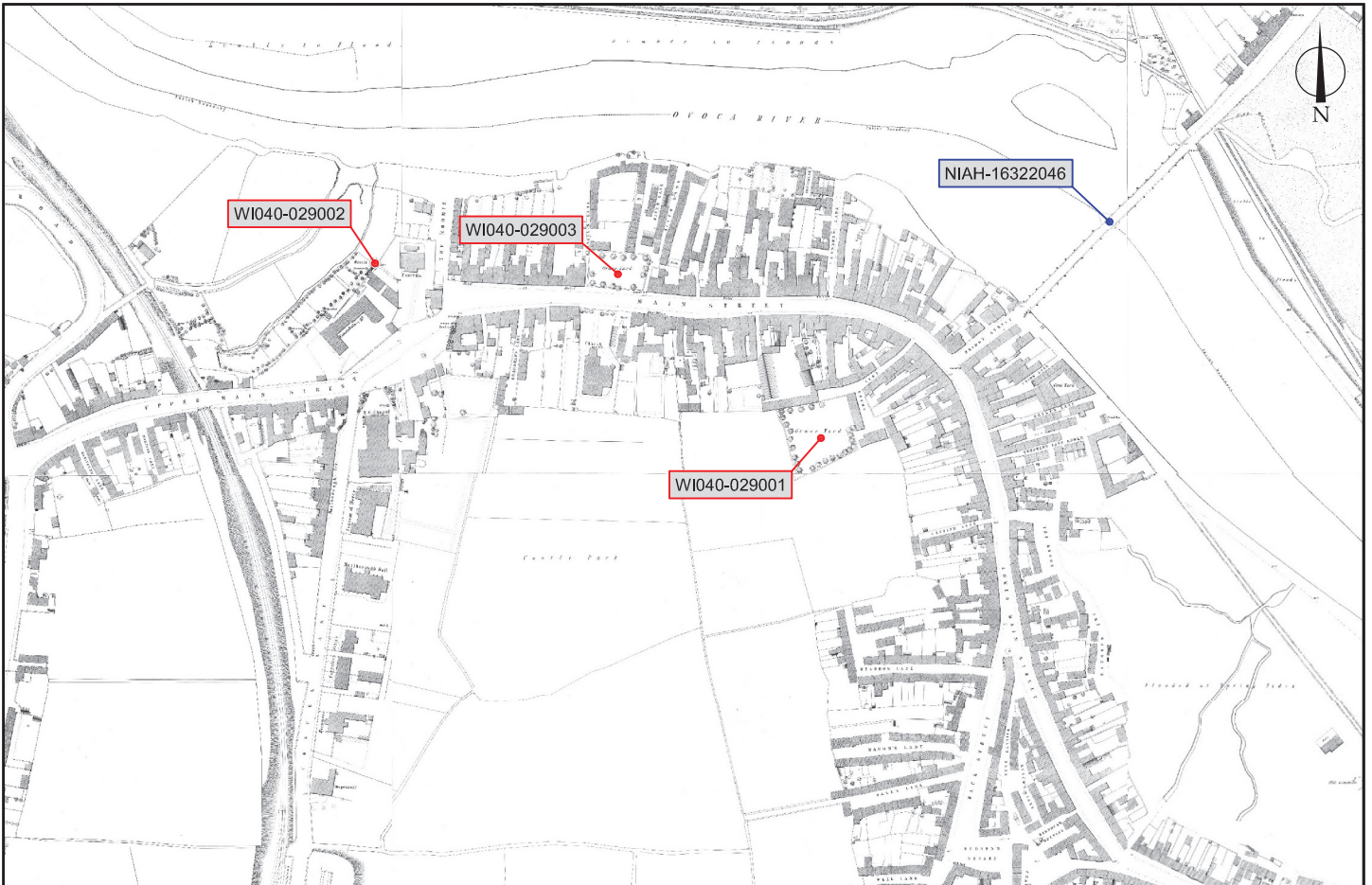
Compiled by
 R.Bangerter

CAD reference
 Arklow_FRS

Date
 18.08.20

Scale
 1:7000

Drawing No.
 Figure 3



Notes
 Source: OS mapping accessed via UCD Digital Library
 [Maps numbers WW040-16_18, WW040-16_19, WW040-16_24,
 WW040-4_4, and WW040-4_5]

- RMP Site
- NIAH Site

Title
 Figure 4- Historic OS Map of Arklow (1885) with
 RMP sites and NIAH number for Arklow Bridge
 superimposed.

A4

Client
 ARUP/ Wicklow County Council

Project
 UAIA, Arklow Flood Relief Scheme

Job/Exc No.
 17D0078

Compiled by
 R.Bangterter

CAD reference
 Arklow_2018

Date
 18.08.20

Scale
 1:4500

Drawing No.
 Figure 4

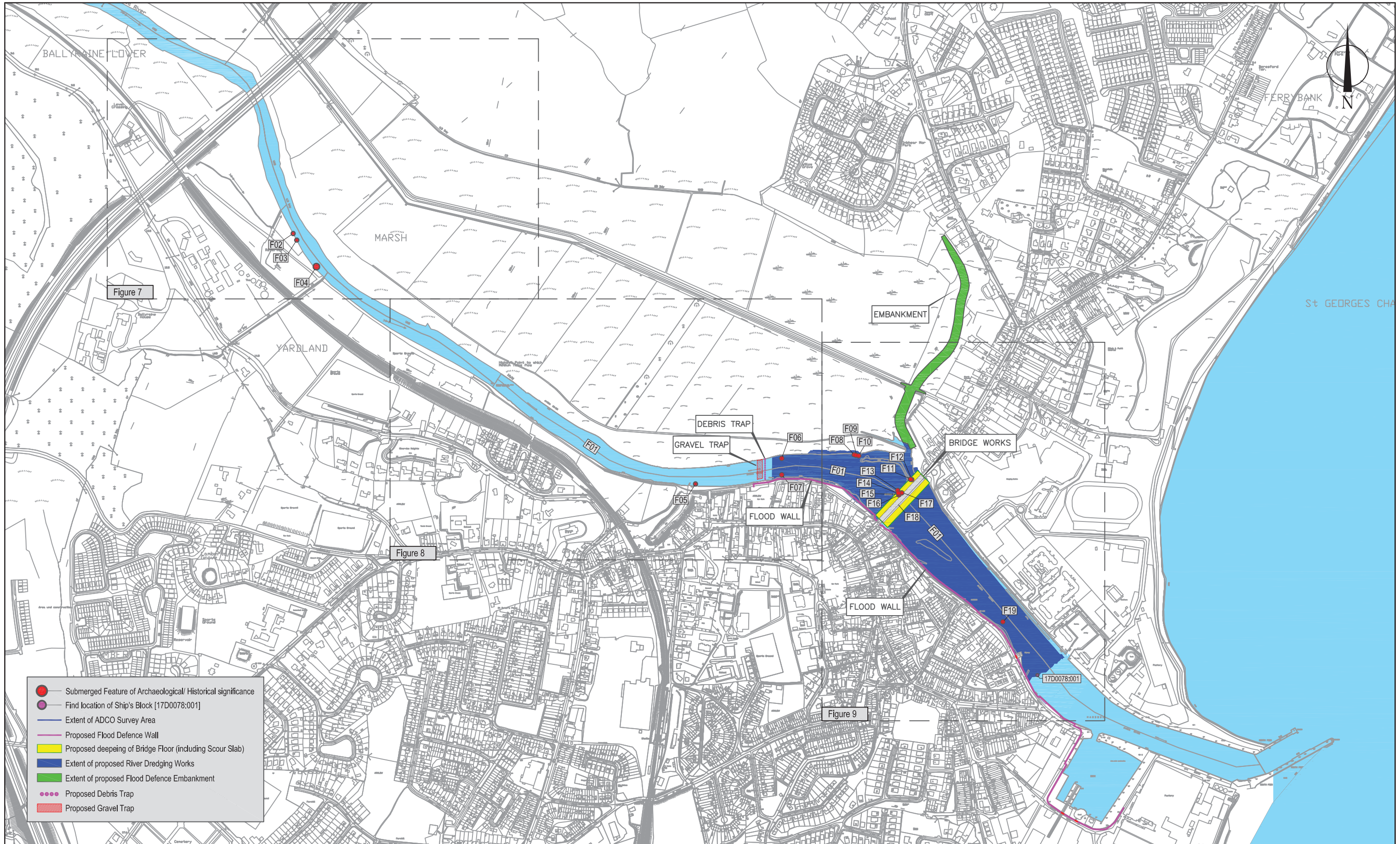


Client
ARUP/ Wicklow County Council

Notes
Source: OSi Historic Map Archive
● RMP Site
● NIAH Site
[<http://wegis.archaeology.ie/historicenvironment/>]

A4 Title
Figure 5- Extract from OS 25-inch Edition Map (1897-1913) of Arklow Town with known cultural heritage assets (RMP/NIAH) superimposed.

Project UAIA, Arklow Flood Relief Scheme	Job/Exc No. 17D0078	Compiled by R.Bangerter	CAD reference Arklow_FRS	Date 18.08.20	Scale 1:4500	Drawing No. Figure 5
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Notes
 Source: Figure adapted from Project Drawing-SK001, Rev. F1 [Byrne Looby PH McCarthy].

A3

Job/Exc No.
17D0078

Date
01.03.21

Compiled by
R.Bangerter

Scale
1:8,000

CAD reference
Arklow_FRS

Drawing No.
Figure 6

Client
ARUP/ Wicklow County Council

Project
UAIA, Arklow Flood Relief Scheme

Title
Figure 6- Overview Figure showing location of features (F01-F18) identified as part of the UAIA of the River Avoca, Arklow.

- F01 — Riverbed [River Avoca]
- F02 — Length of hewn timber [possibly part of logboat], NGR: 323343E, 174143N [centre-point]
- F03 — Series of timber posts with axe-cleft end pieces, NGR: 323351E, 174128N [centre-point]
- F04 — Four vertically set timber piles [remains of timber jetty], NGR: 323396E, 174066N [centre-point]



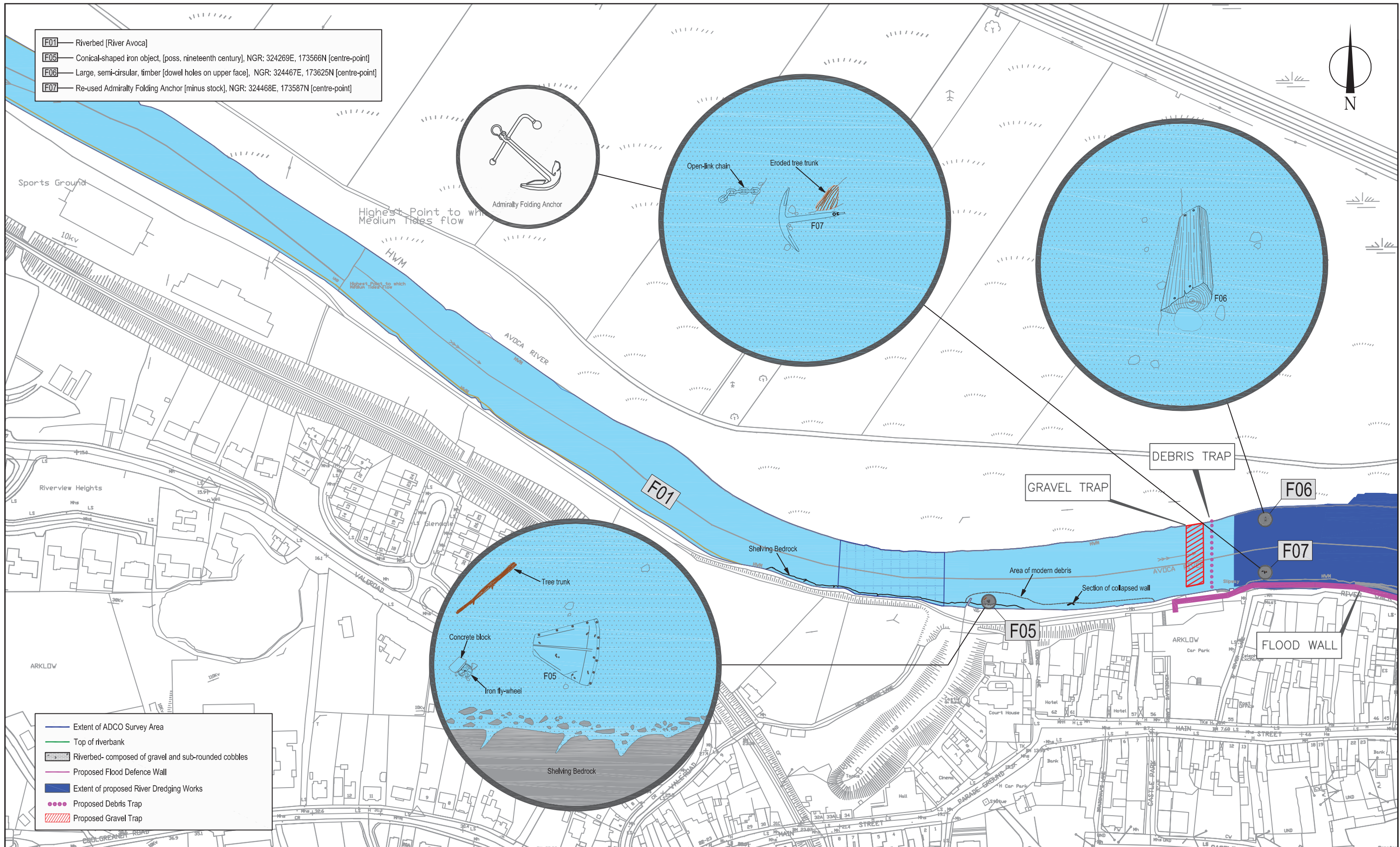
- Extent of ADCO Survey Area
- Top of riverbank
- Riverbed- composed of gravel and sub-rounded cobbles
- Proposed Flood Defence Wall
- Extent of proposed River Dredging Works

Notes
 Oniste survey data gathered by ADCO using DGPS
 [FDS project coordinate projection- Irish National Grid]
 Circular thumbnails- 1:100 scale
 Main- 1:2500 scale

A3	Job/Exc No. 17D0078	Compiled by R.Bangerter	CAD reference Arklow_2018	Client ARUP/ Wicklow County Council
	Date 01.03.21	Scale 1:2500/ 1:100	Drawing No. Figure 7	Project UAIA, Arklow Flood Relief Scheme

Title
 Figure 7- Figure showing location and extent of Features F02-F04, positioned along the southern bank of the River Avoca, close to start of ADCO Survey Area; c.1.5m upstream of Arklow Bridge.





- F01 — Riverbed [River Avoca]
- F05 — Conical-shaped iron object, [poss. nineteenth century], NGR: 324269E, 173566N [centre-point]
- F06 — Large, semi-circular, timber [dowel holes on upper face], NGR: 324467E, 173625N [centre-point]
- F07 — Re-used Admiralty Folding Anchor [minus stock], NGR: 324468E, 173587N [centre-point]

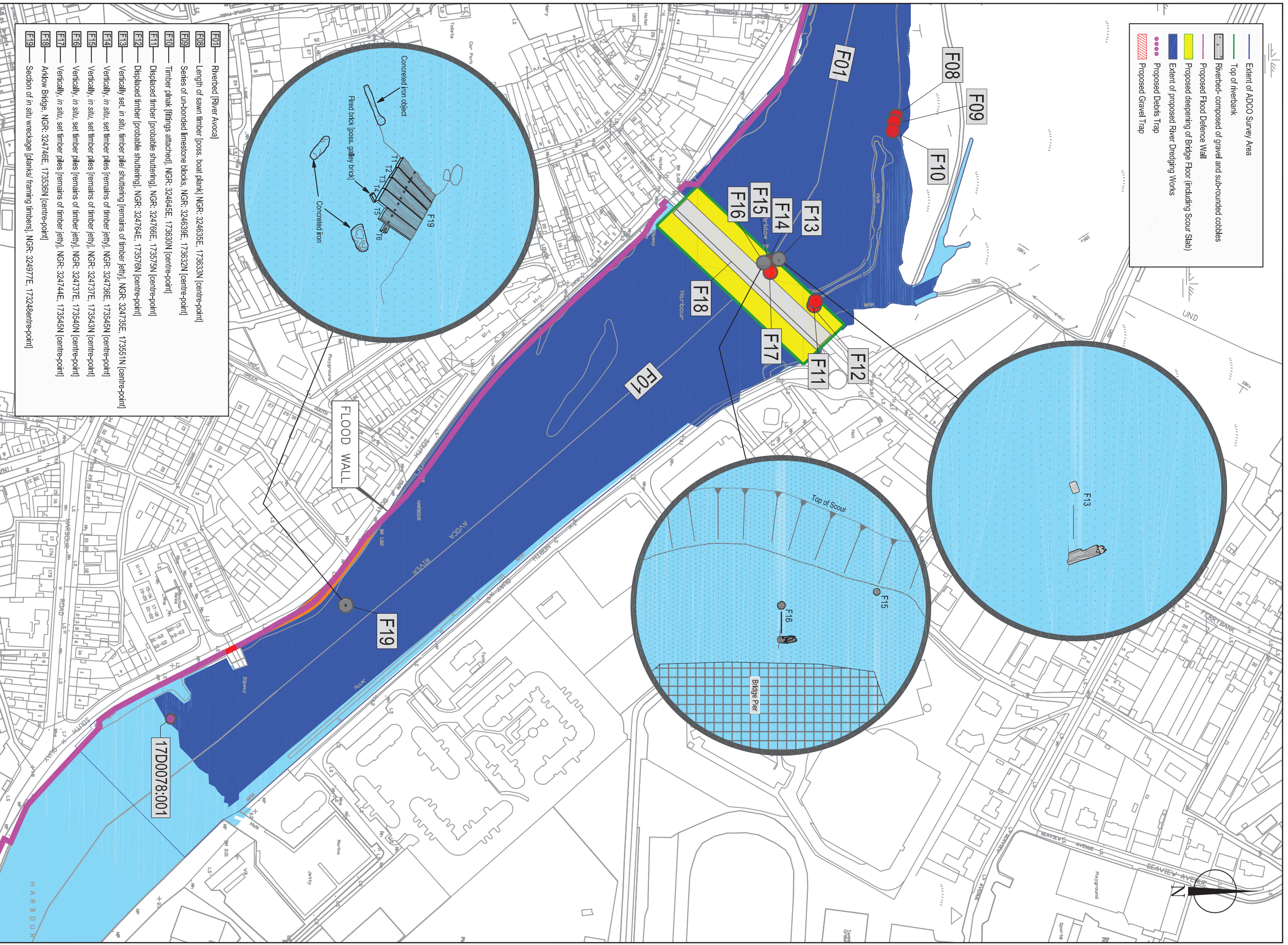
- Extent of ADCO Survey Area
- Top of riverbank
- ▨ Riverbed- composed of gravel and sub-rounded cobbles
- Proposed Flood Defence Wall
- Extent of proposed River Dredging Works
- Proposed Debris Trap
- ▨ Proposed Gravel Trap

Notes
 Oniste survey data gathered by ADCO using DGPS
 [FDS project coordinate projection- Irish National Grid]
 Circular thumbnails- 1:100 scale
 Main- 1:2500 scale

A3	Job/Exc No. 17D0078	Compiled by R.Bangerter	CAD reference Arklow_2018	Client ARUP/ Wicklow County Council
	Date 01.03.21	Scale 1:2500/ 1:100	Drawing No. Figure 8	Project UAIA, Arklow Flood Relief Scheme

Title
 Figure 8- Figure showing location and extent of Features F05-F07, positioned approximately mid-point along ADCO Survey Area; situated between 270m and 470m upstream of Arklow Bridge.





ADCCO

Client
ARUP/ Wicklow County Council

Project
UALA, Arklow Flood Relief Scheme

Job/Exc. No.
17D0078

Compiled by
R.Bangerter

CAD reference
Arklow_2018

Date
01.03.21

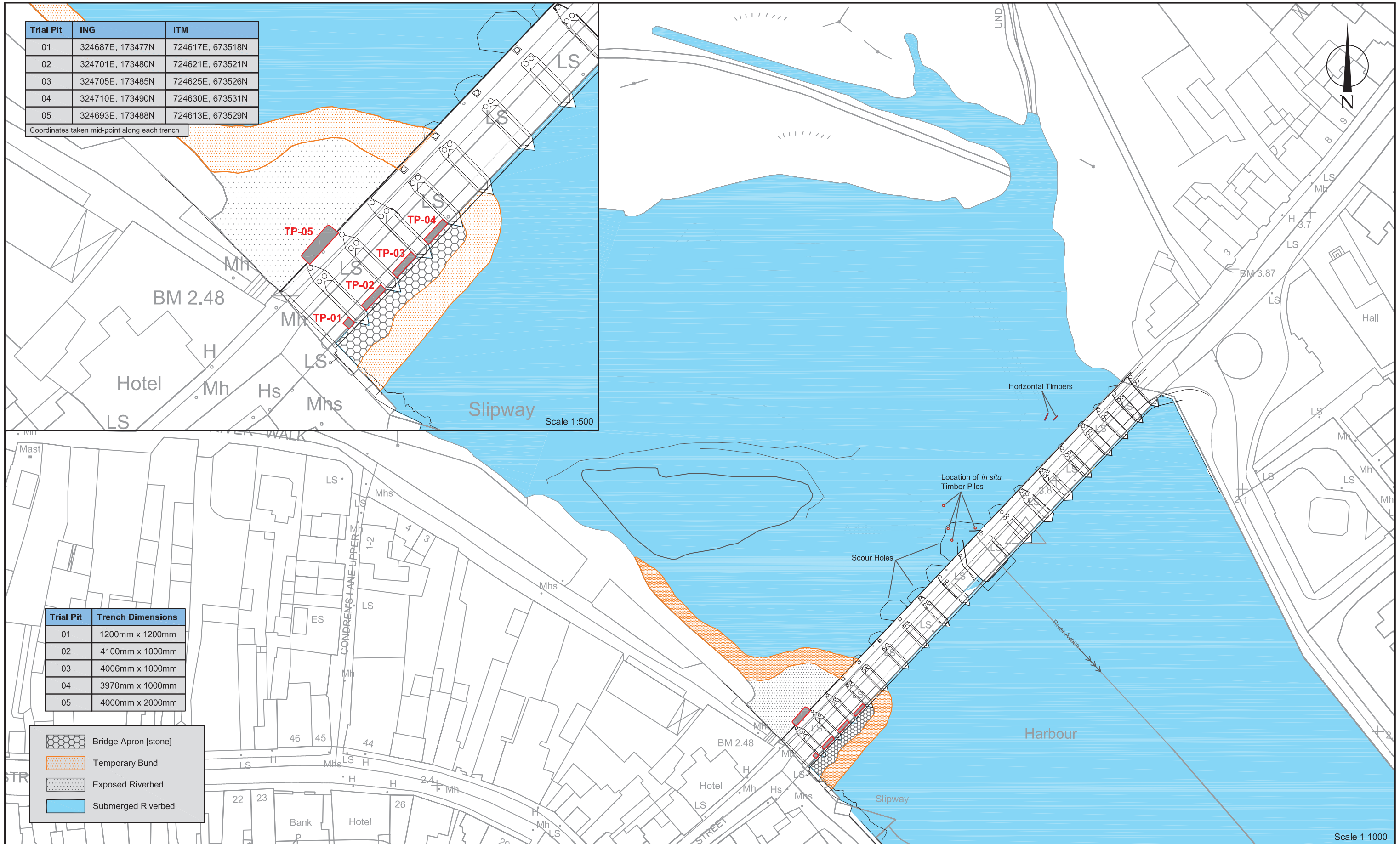
A3

Scale
1:2500/ 1:100/ 1:50

Drawing No.
Figure 9

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

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

A3 Job/Exc No.
17E0482, 17D0078

Compiled by
R.Bangertner

CAD reference
Arklow_FRS

Client
ARUP/ Wicklow County Council

Title
Figure 10- Location of Geotechnical Trial Pits along footings/ foundations of Arklow Bridge.

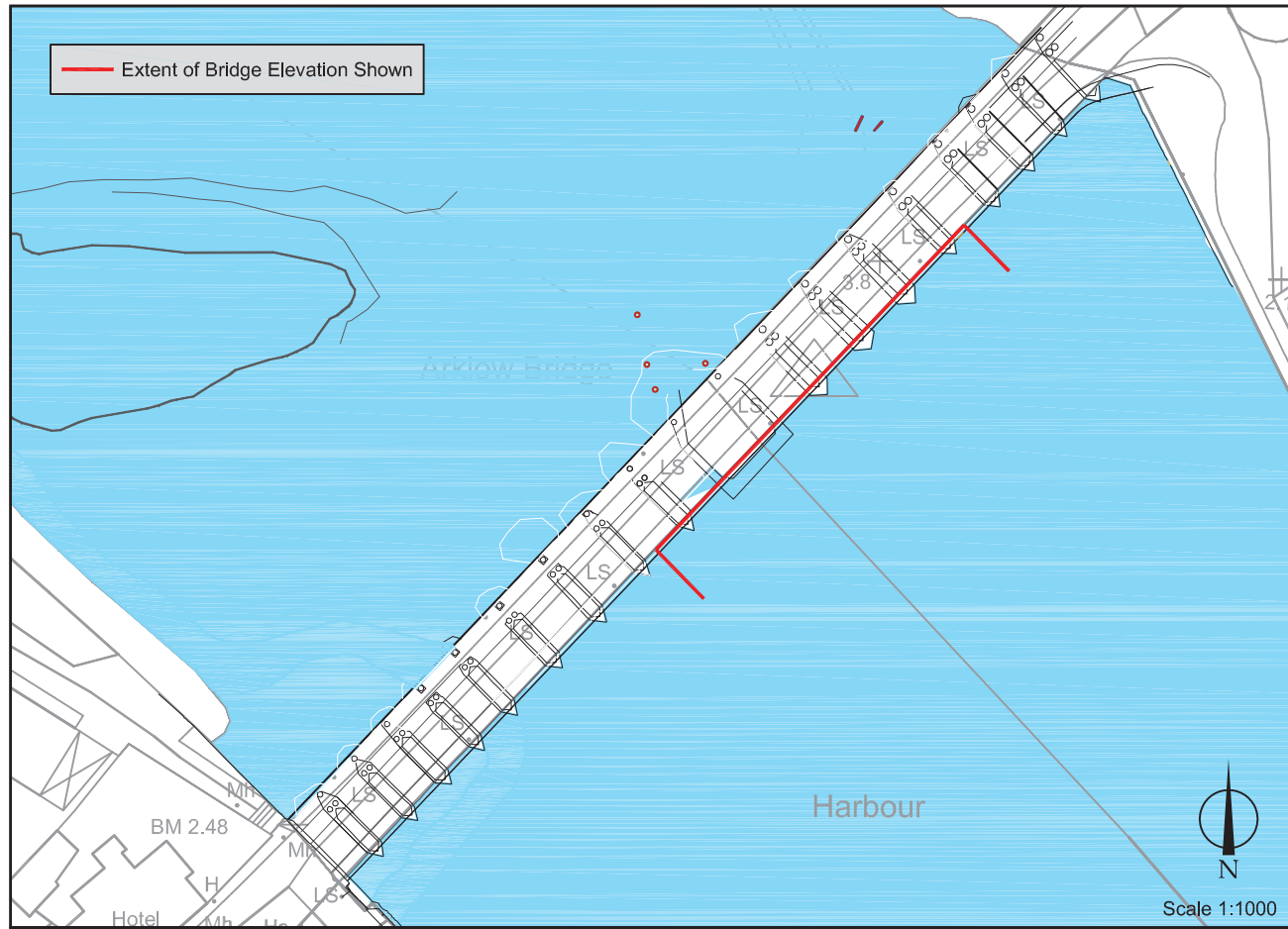
Date
18.08.20

Scale
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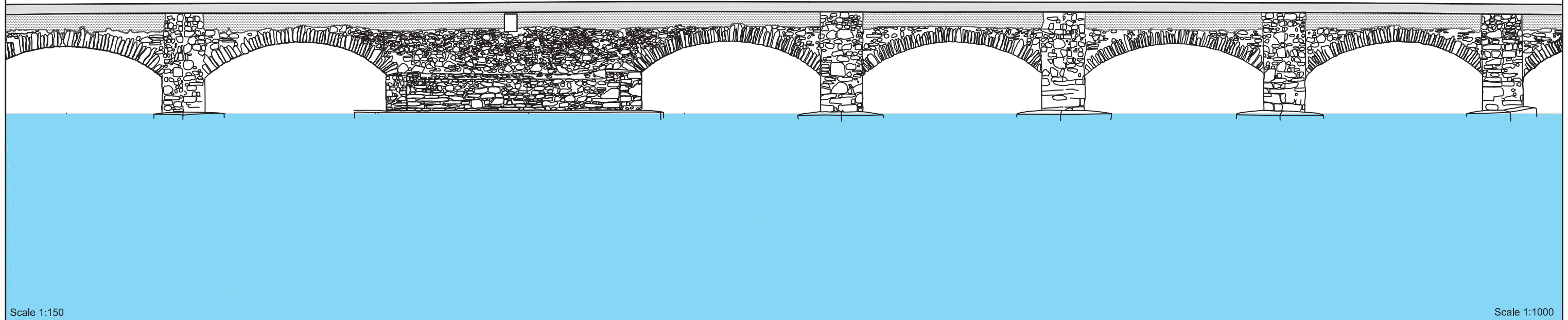
Drawing No.
Figure 10

Project
UAIA, Arklow Flood Relief Scheme





Downstream Elevation



Scale 1:150

Scale 1:1000


	Notes [Survey data for bridge elevation gathered by ADCO using Total Station, DGPS, and Laser Scanning.].	A3	Job/Exc No. 17D0078	Compiled by R.Bangerter/ D.Copeland	CAD reference Arklow_FRS	Client ARUP/ Wicklow County Council	Title Figure 11- Sample Elevation on downstream side of Arklow Bridge [location as indicated in thumbnail].
		Date 18.08.20	Scale 1:150/ 1:1000	Drawing No. Figure 11	Project UAIA, Arklow Flood Relief Scheme		



Plate 1: Arklow Castle, c. 1880–1900, by Robert French. Source: National Library of Ireland.

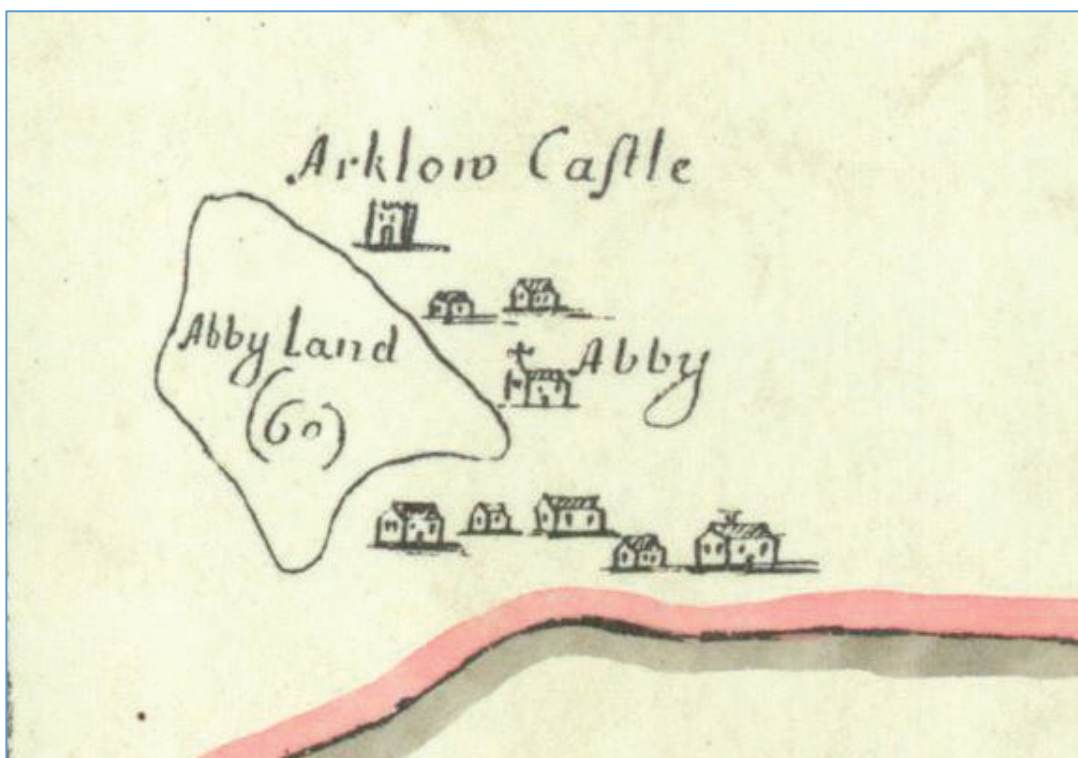


Plate 2: Down Survey map (c. 1654) depicting Arklow town. Source: www.downsurvey.tcd.ie

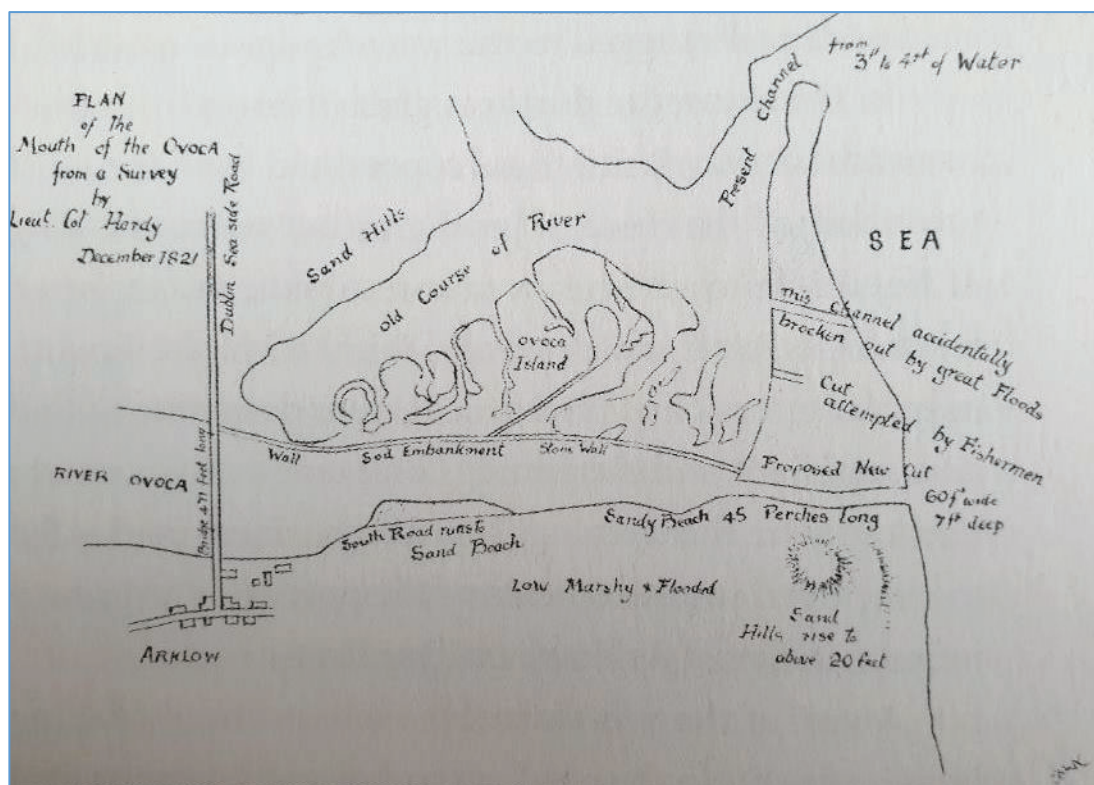


Plate 3: Plan of the mouth of the Avoca River commissioned by the Hibernian Mining Company in 1821. Source: Jim Rees, 'The Arklow Yawl'.



Plate 4: Arklow Harbour, c. 1880–1900 by Robert French. Source: National Library of Ireland.

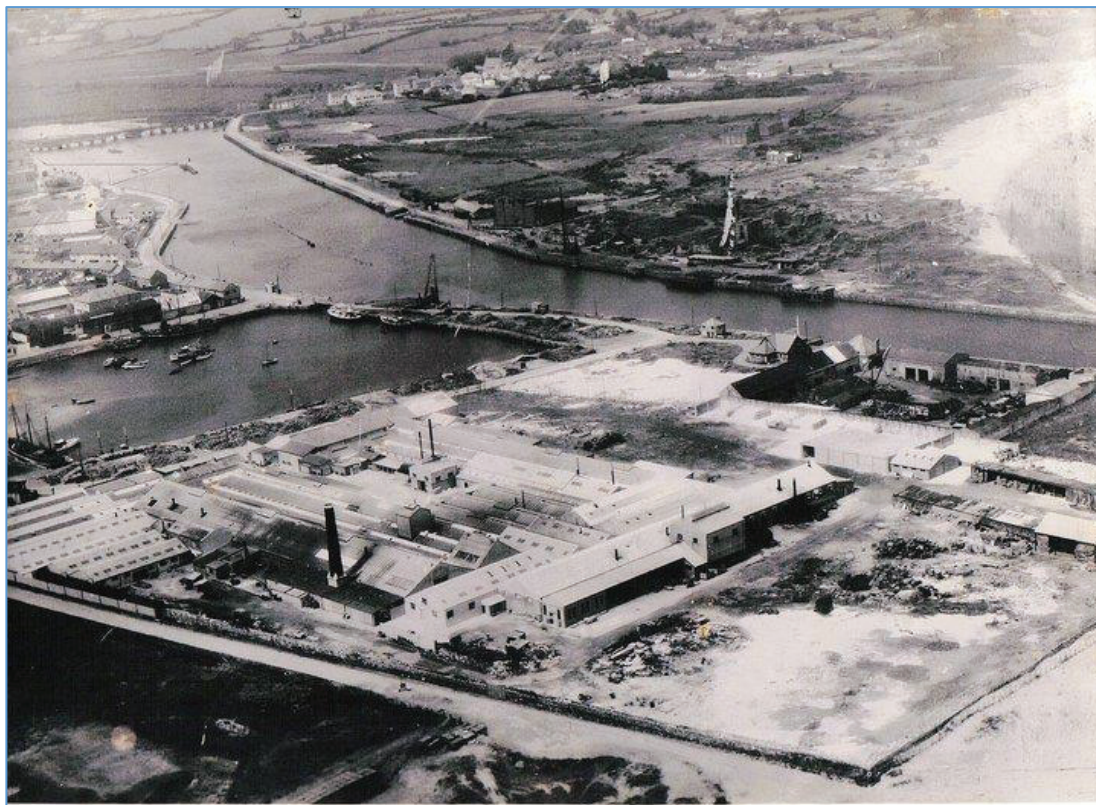


Plate 5: Historic aerial photograph of Arklow Harbour. Date unknown. Source: ARUP.



Plate 6: Arklow Harbour showing the South Quay basin, 1956 by Alexander Morgan. Source: National Library of Ireland.



Plate 7: Arklow Harbour, the lower North Quay area showing the stone quayside in 1956. By Alexander Morgan. It is now replaced by sheet-piling. Source: National Library of Ireland.

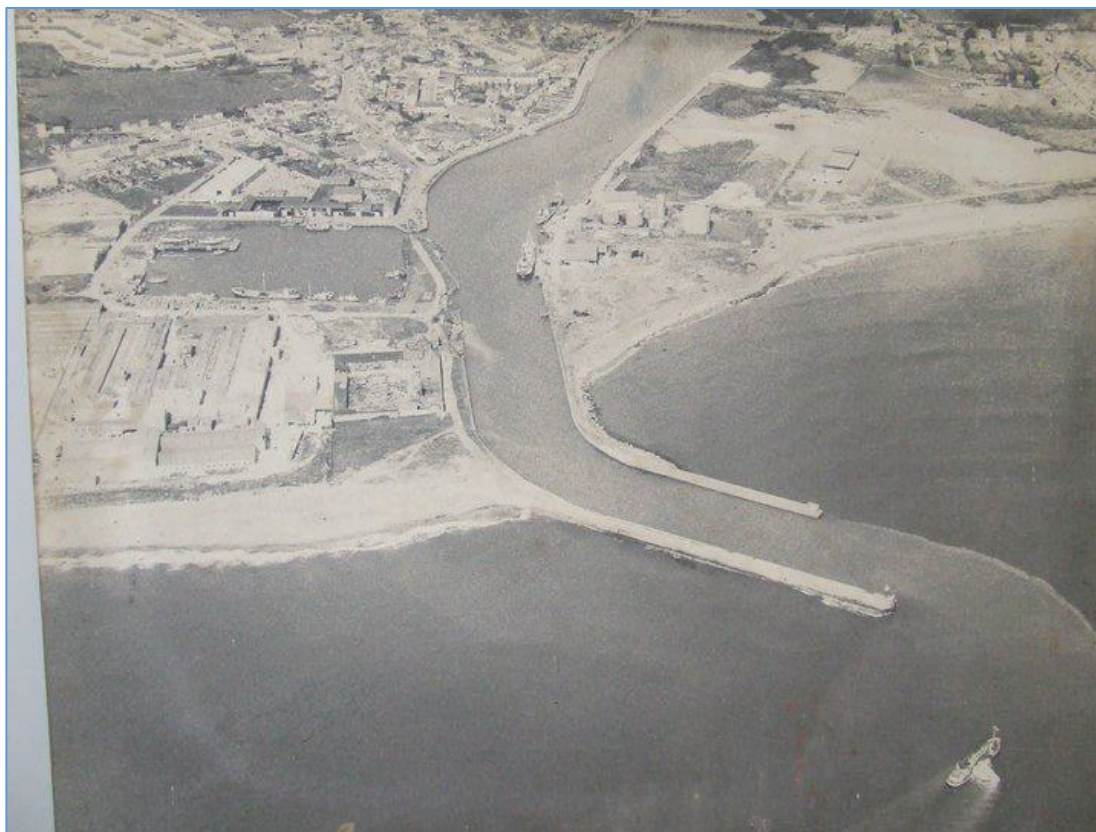


Plate 8: Historic aerial photograph of Arklow Harbour. Date unknown. Source: ARUP.



Plate 9: Detail from historic image of the Battle of Arklow in 1798, showing the bridge and the south bank downstream. Note the south bank area is open ground. Source: National Library of Ireland, PD C30: Captain Holmes, 'Plan of the site of the Battle of Arklow, showing the town and troops crossing bridge over Avoca River, with Rebel and Army positions indicated on hills behind'. Accessed online at: <http://catalogue.nli.ie/Record/vtls000039145>

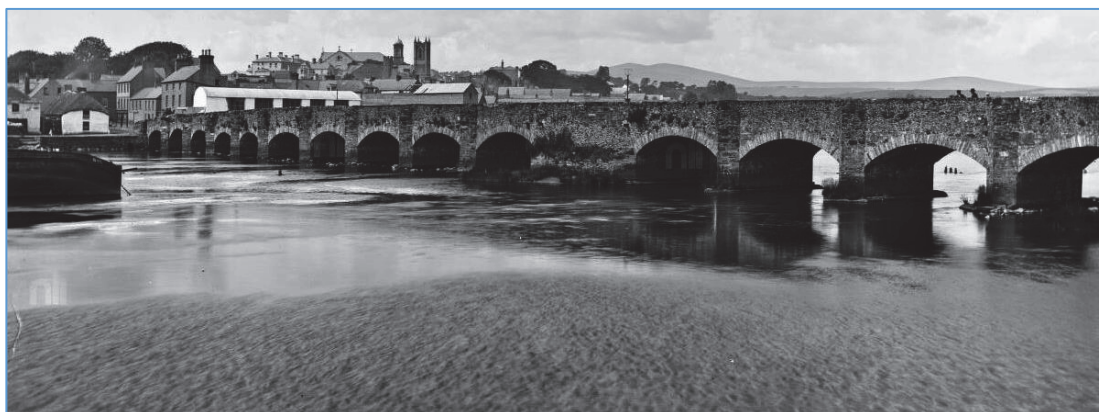


Plate 10: Arklow Bridge, photographed by Robert French (1841-1917), part of the Lawrence Photograph Collection, National Library of Ireland



Plate 11: Historic photograph of Arklow Bridge taken from the west bank. Date unknown, Collection unknown. Source: ARUP.



Plate 12: View of north bank area upstream of the town, showing the dense overgrowth on the river bank.



Plate 13: Typical deployment upstream of Arklow Bridge.

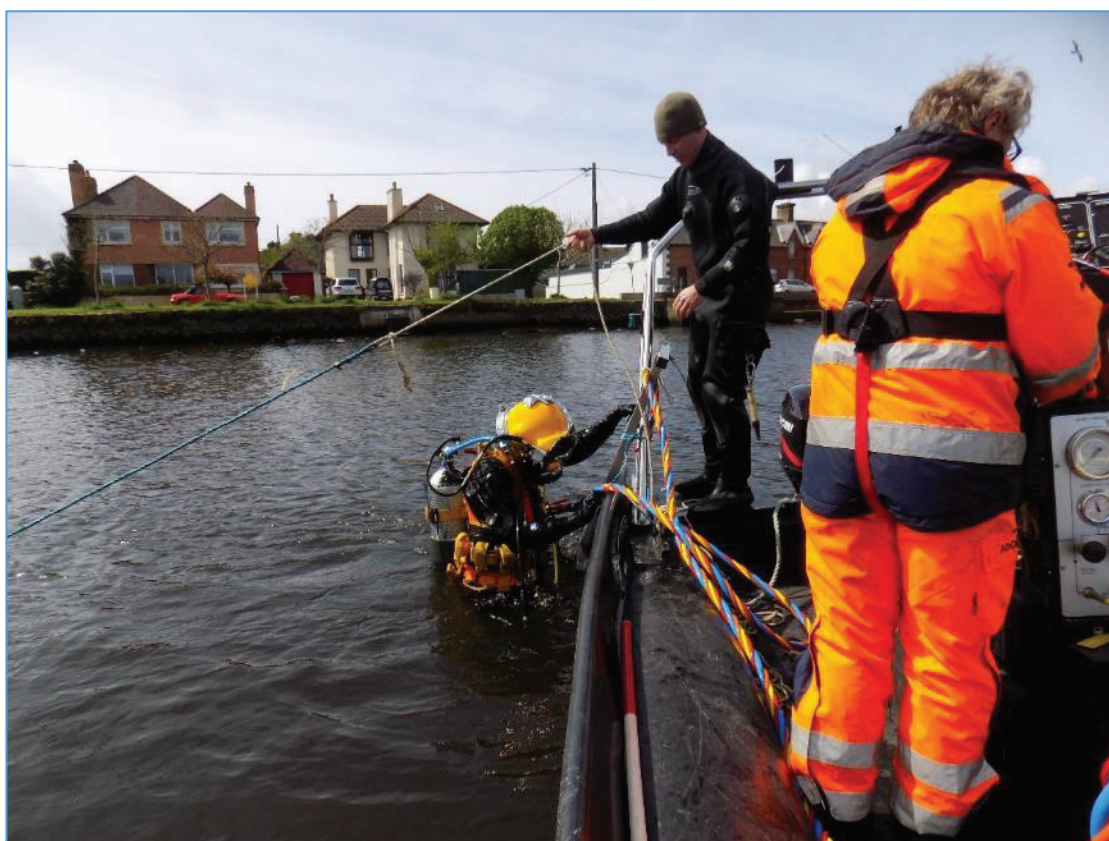


Plate 14: Typical deployment downstream of Arklow Bridge.



Plate 15: The riverbank upstream of the town, which is typically a clay bank.

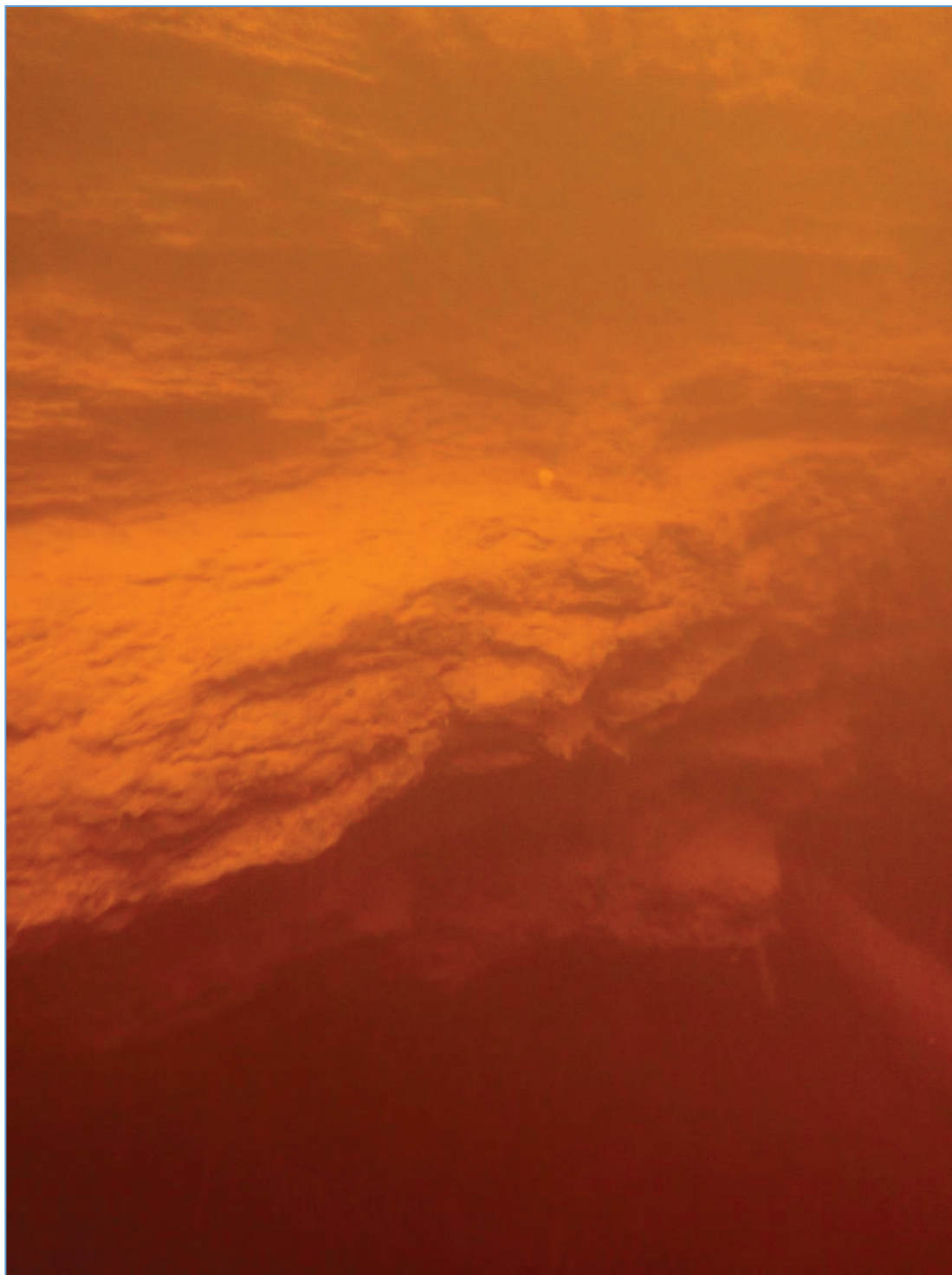


Plate 16: Underwater image of the shelving bedrock that is exposed on the south bank close to Arklow Castle.



Plate 17: Outfall entering the river from the south bank above Arklow Bridge.



Plate 18: Outfall entering the river from the south bank above Arklow Bridge.



Plate 19: View looking upstream along the retaining measures at the Riverwalk.



Plate 20: View downstream from Arklow Bridge at the stone retaining wall of North Quay.

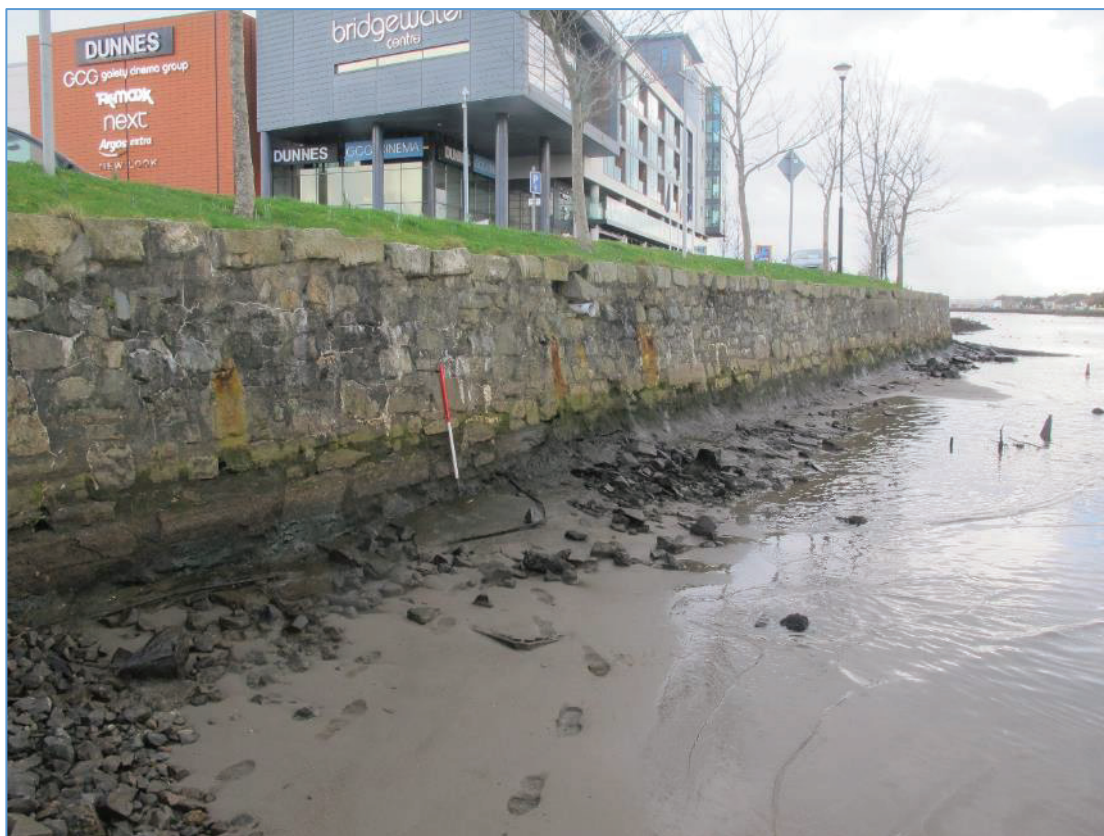


Plate 21: Close-up view of the stone retaining wall of North Quay.



Plate 22: View looking downstream on North Quay, showing the granite capstones of the quay.



Plate 23: View looking across to North Quay, showing the service pipes to the former NET/IFI factory carried on the wall.

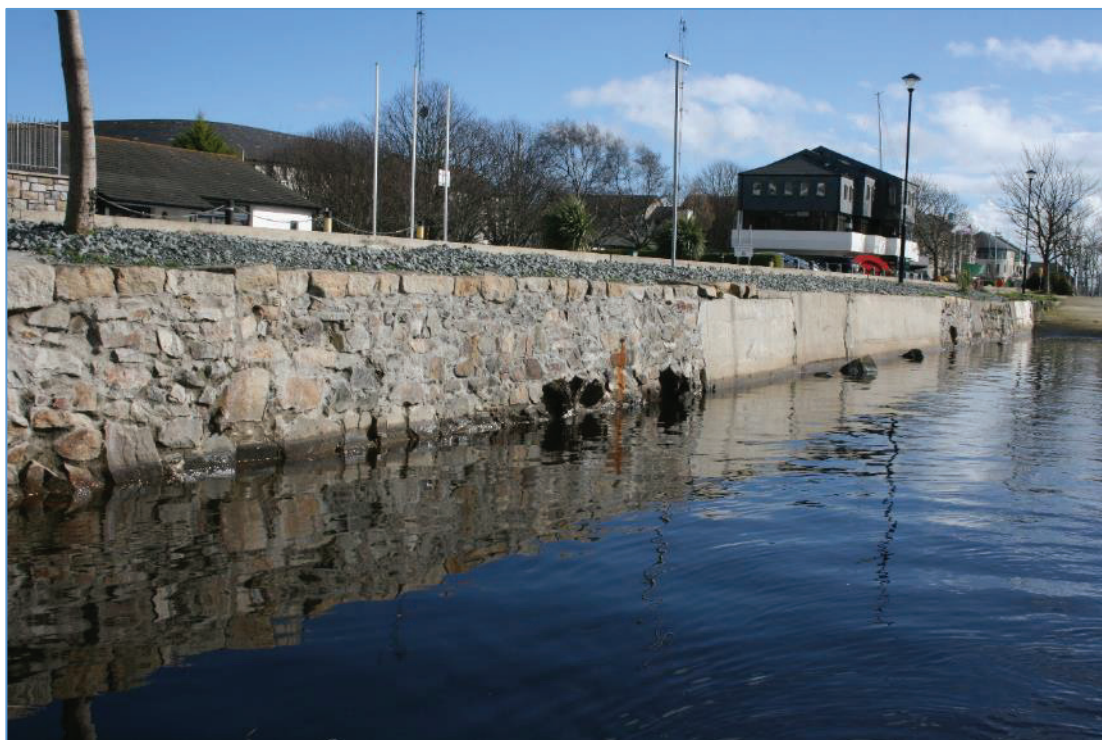


Plate 24: View along the North Quay stone wall showing patches of repair and replacement by concrete.



Plate 25: A concrete caisson solution marks the North Quay between the sailing club and the marina.



Plate 26: View along North Quay should galvanized gangways to access the floating pontoon.



Plate 27: At the marina, the concrete caissons are replaced by sheet-piling capped with a concrete deck.



Plate 28: Sheet-piling now defines the remainder of the North Quay downstream of the marina.



Plate 29: View from Arklow Bridge of the South Quay and Coal Quay.



Plate 30: View of the now ruined Coal Quay.



Plate 31: View along South Quay showing the stone wall and later concrete additions.



Plate 32: View of South Quay showing the stone wall and later concrete additions.



Plate 33: View on South Quay looking upstream from where the stone quay becomes buried under modern concrete.



Plate 34: View on South Quay looking downstream, showing the surviving visible element of the original stone structure.



Plate 35: View on South Quay looking upstream showing the nature of the stone capstones that are part of the original stone structure.



Plate 36: View on South Quay looking upstream at one of a series of white-painted stone mooring posts.

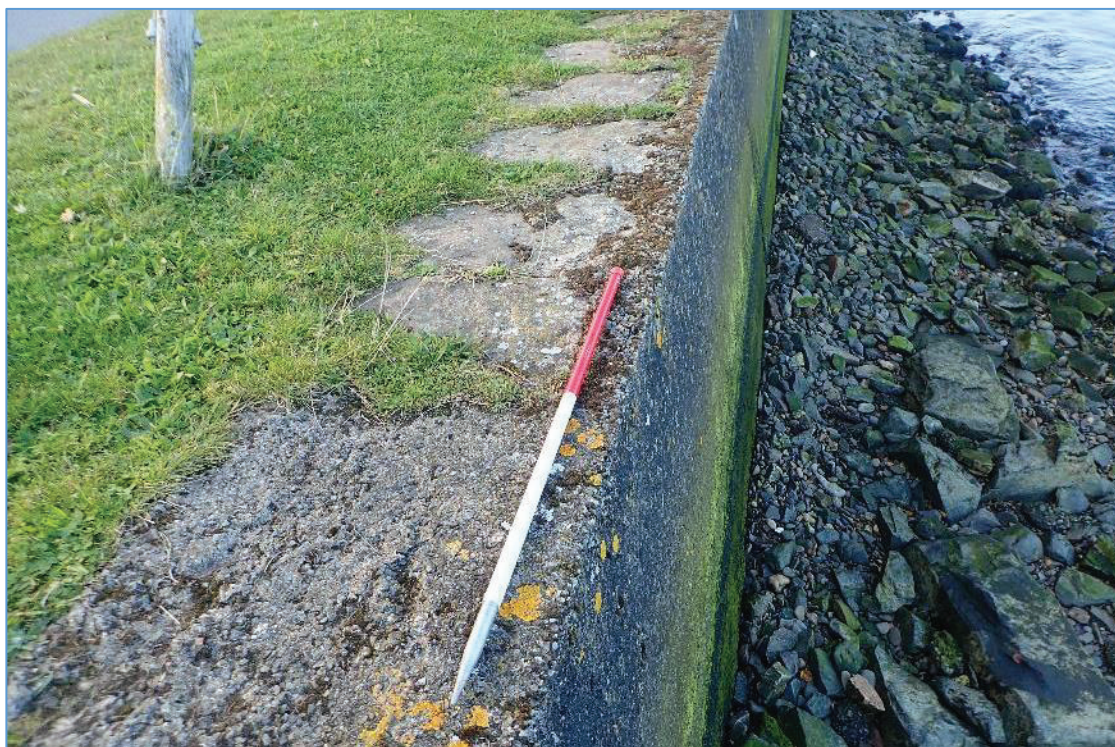


Plate 37: View of South Quay looking upstream showing where the original stone façade becomes masked by later concrete render.



Plate 38: View from boatyard slipway looking upstream, showing the convergence of South Quay and its later concrete rendering.



Plate 39: View looking southwest and downstream at the concrete-covered slipway that formerly served as the slipway for a boat-building yard that is recorded on the OS 1911 map.

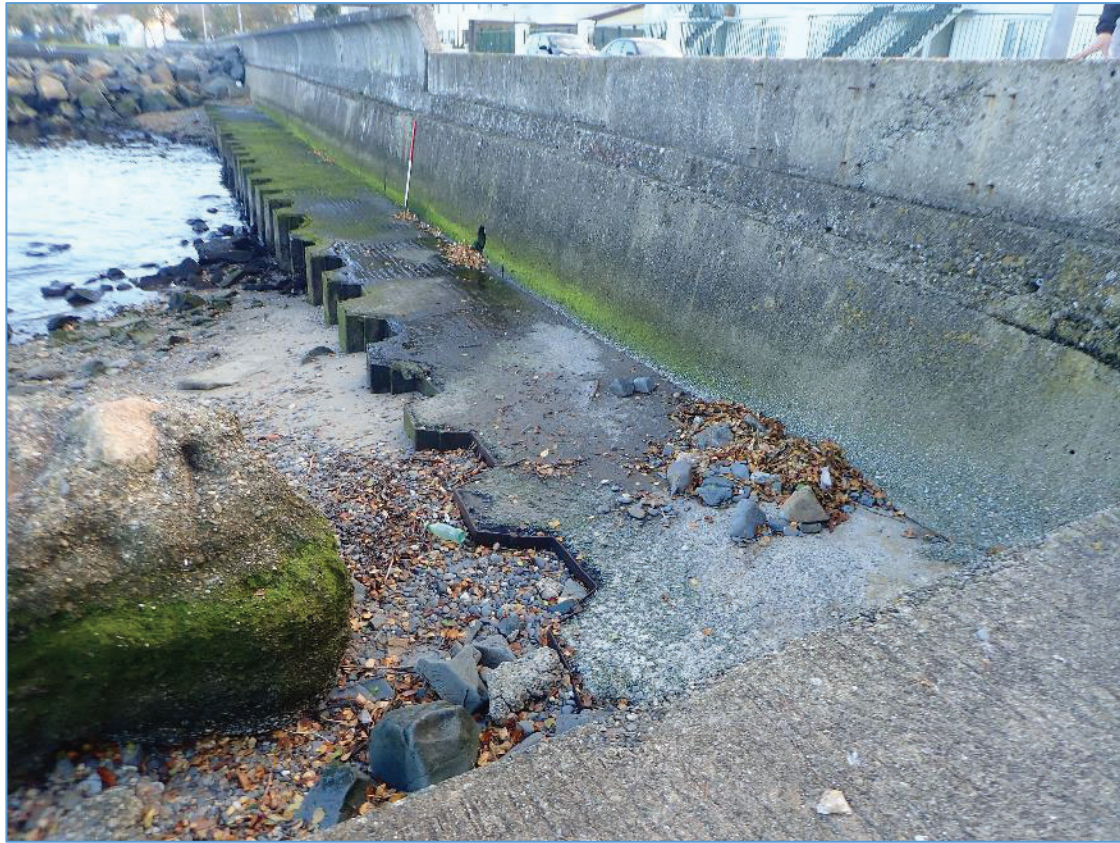


Plate 40: View looking downstream from boatyard slipway along foreshore at base of South Quay.



Plate 41: View of sheet-piling that defines the lower reaches of South Quay.

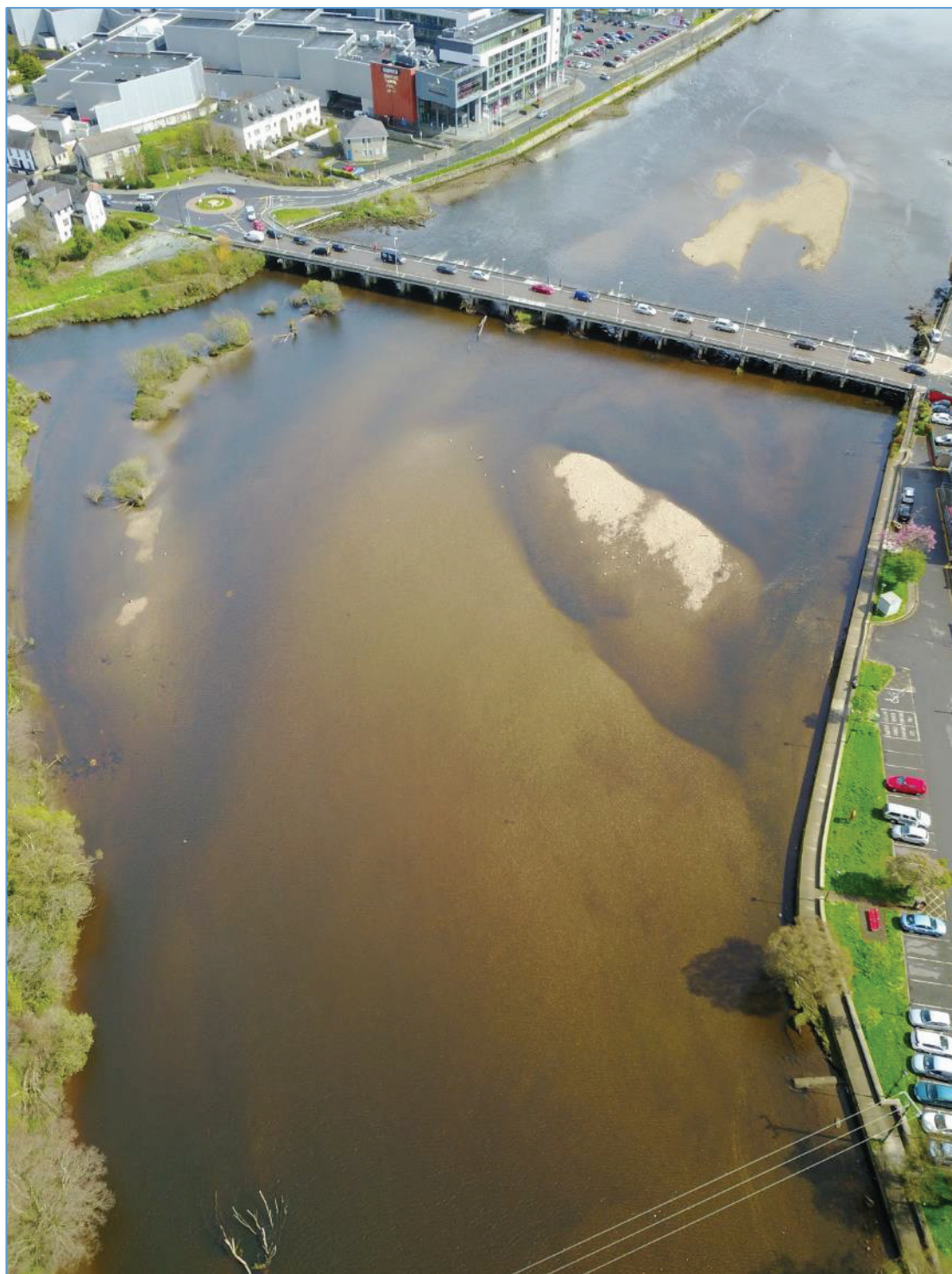


Plate 42: ADCO drone image showing the river channel upstream of Arklow Bridge.

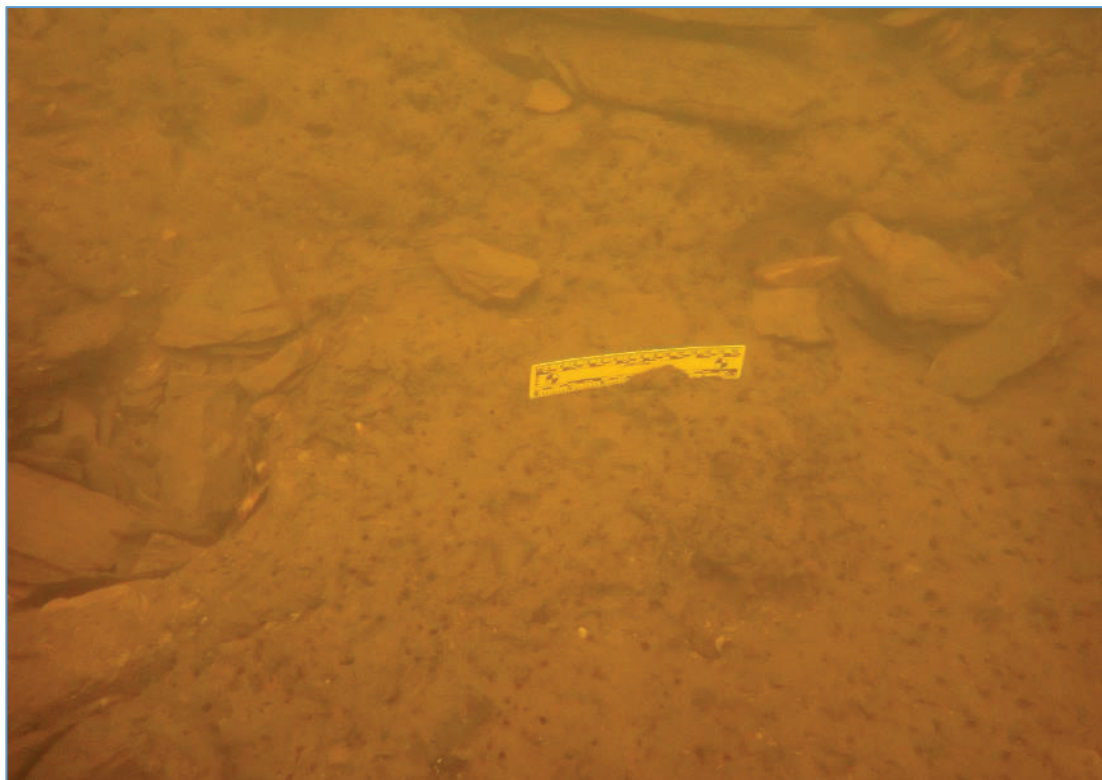


Plate 43: Underwater shot showing the nature of the clay riverbed stratum exposed upstream of Arklow Bridge.

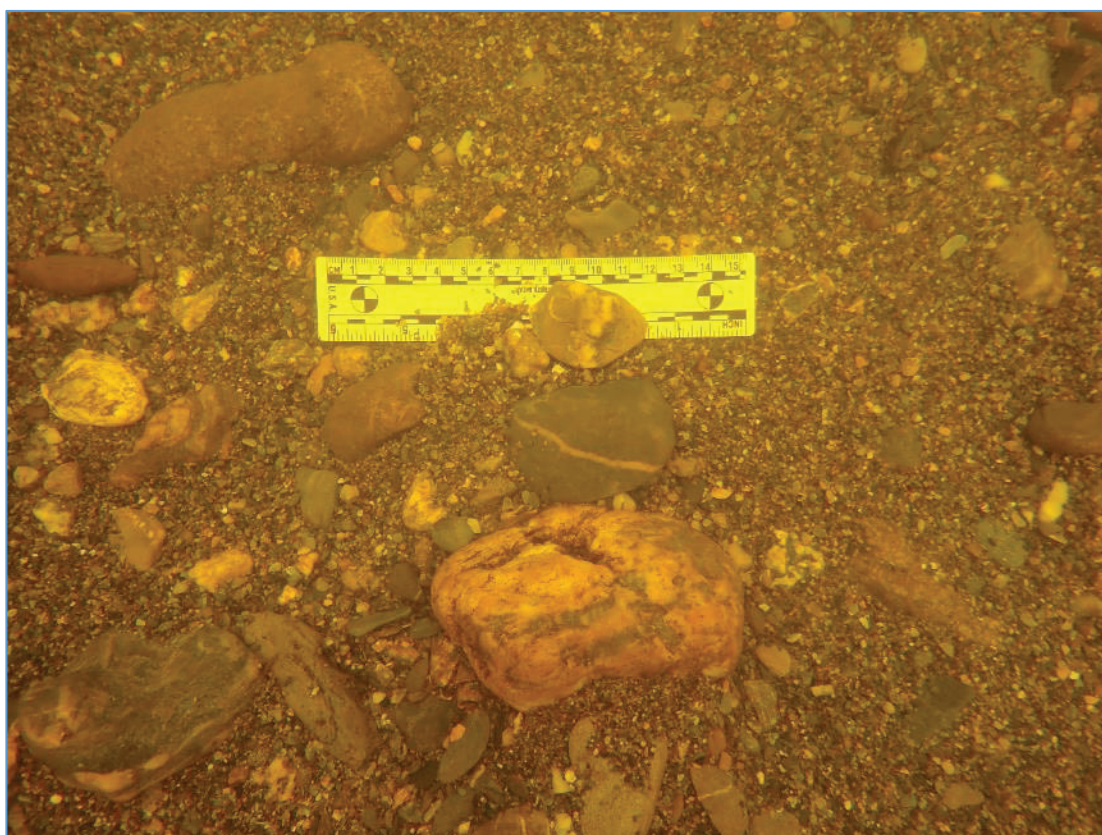


Plate 44: Underwater shot of the river bed surface approximately 100m upstream of Arklow Bridge.

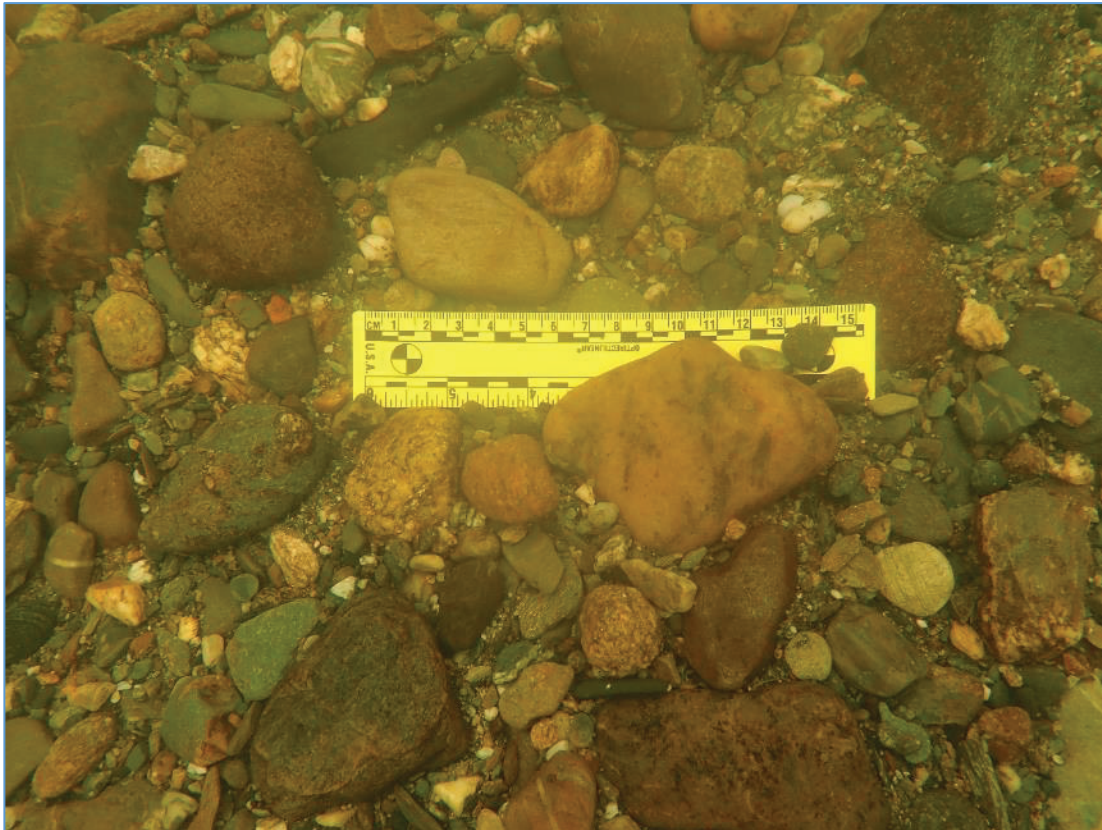


Plate 45: Underwater shot of the river bed surface approximately 5m upstream of Arklow Bridge



Plate 46: View showing the nature of the riverbed surface downstream of Arklow Bridge close to South Quay, where the small pebbles and stone predominate. Loose tree branches and other wash-in debris occur in some profusion.



Plate 47: Underwater shot capturing the typical riverbed surface at the downstream limit of the FRS, showing a silty sand matrix with small stone and pebble inclusions. The poor visibility is due to the finer silt and dirt carried in suspension.

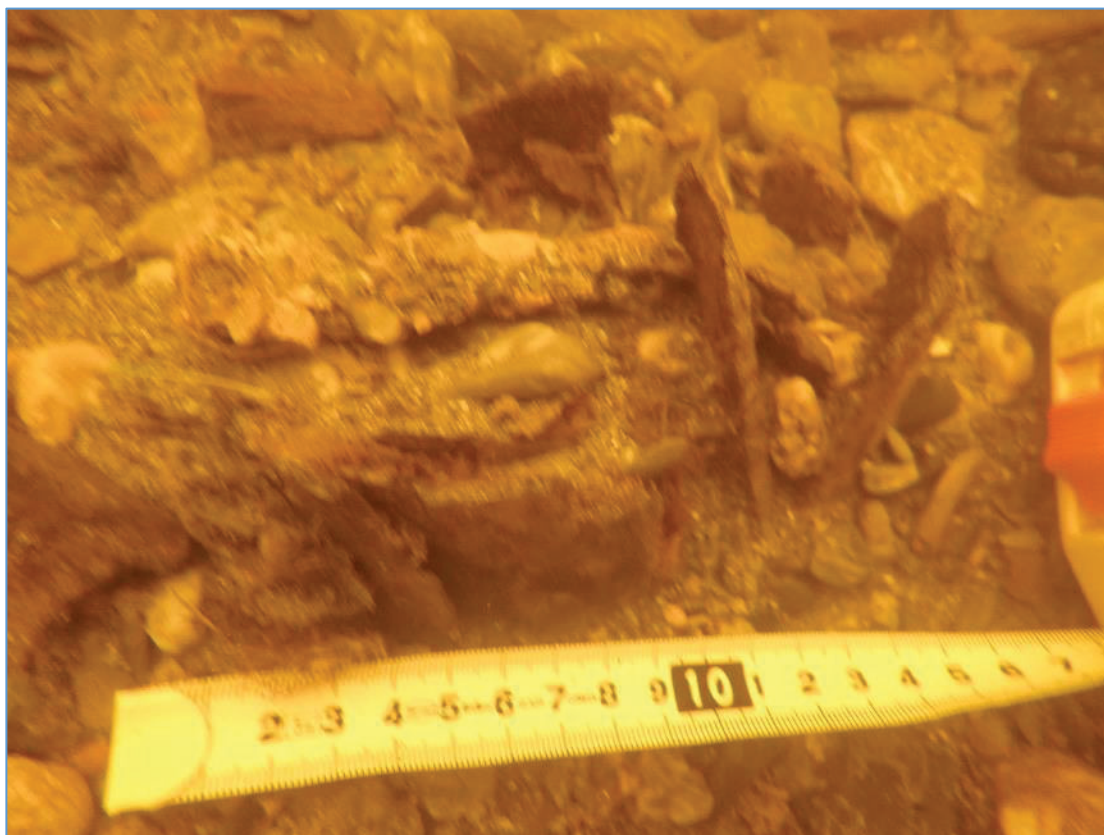


Plate 48: Underwater shot showing sequence of small stakes, F03.



Plate 49: Underwater shot showing rectangular-sectioned post, part of F04.

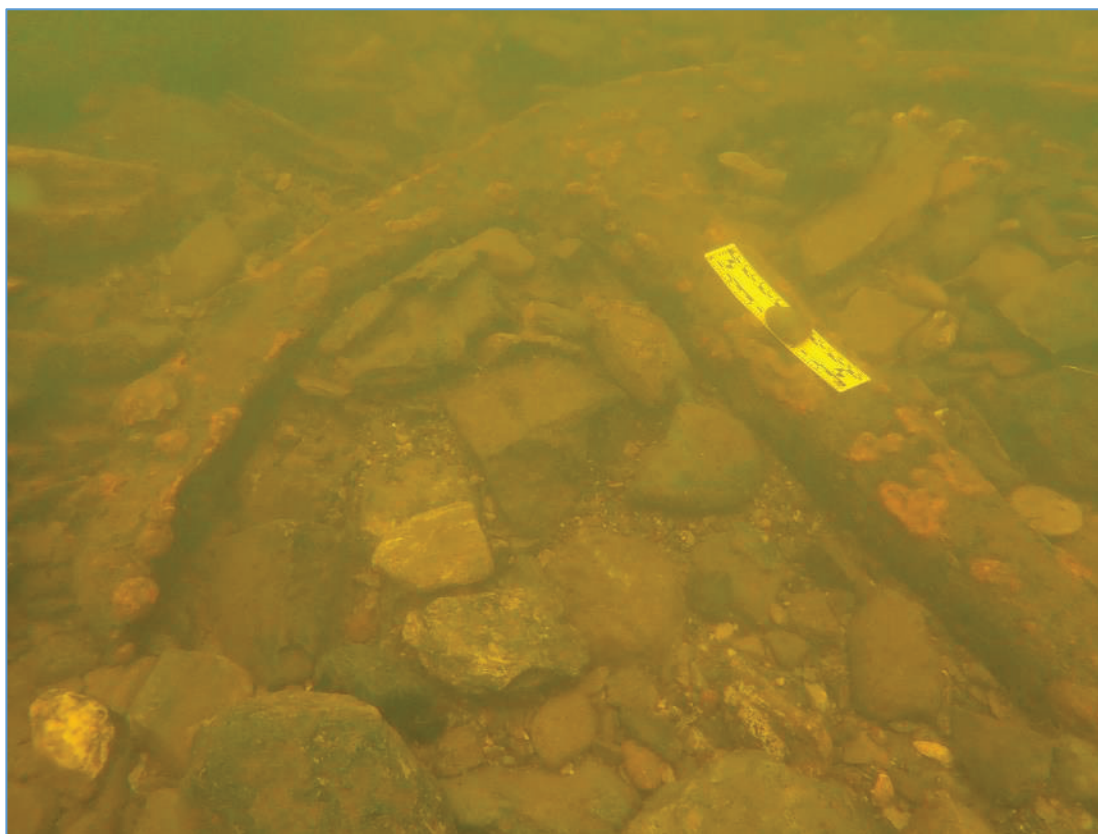


Plate 50: Underwater shot of anchor, F07.



Plate 51: View of timber plank, F08.



Plate 52: View of timber plank, F08.



Plate 53: View of limestone block, F09.



Plate 54: View of timber, F10.

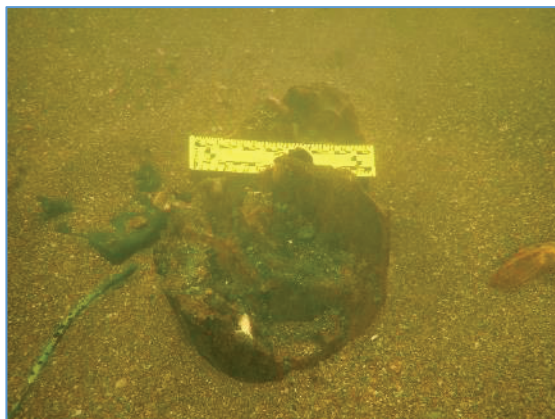


Plate 55: Underwater shots of timbers F13 and F14.



Plate 56: Underwater shorts of Timbers F15 and F16.

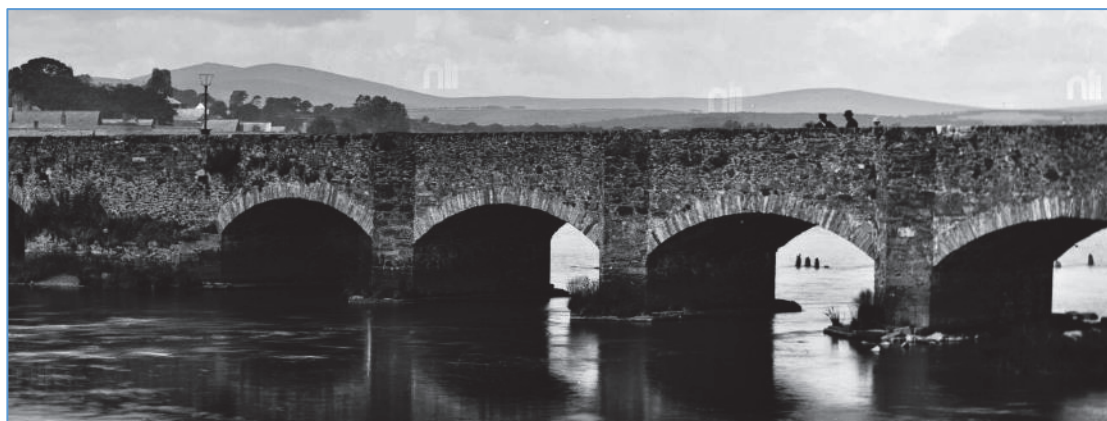


Plate 57: Detail of Arklow Bridge photographed by Robert French (1841-1917) (Plate 10), showing timber posts lying upstream of the bridge on its east side.



Plate 58: View of stone scour apron set between the bridge piers, Arch 19.



Plate 59: Stone scour apron added to the downstream side of Arklow Bridge, forming a glaciais feature.



Plate 60: View looking North across the base of Arklow Bridge, showing the 1960s addition to widen the structure.



Plate 61: View looking South at the junction of the 1960s work with the upstream façade of the stone bridge.



Plate 62: Detailed view of the junction of the 1960s work with the stone bridge.

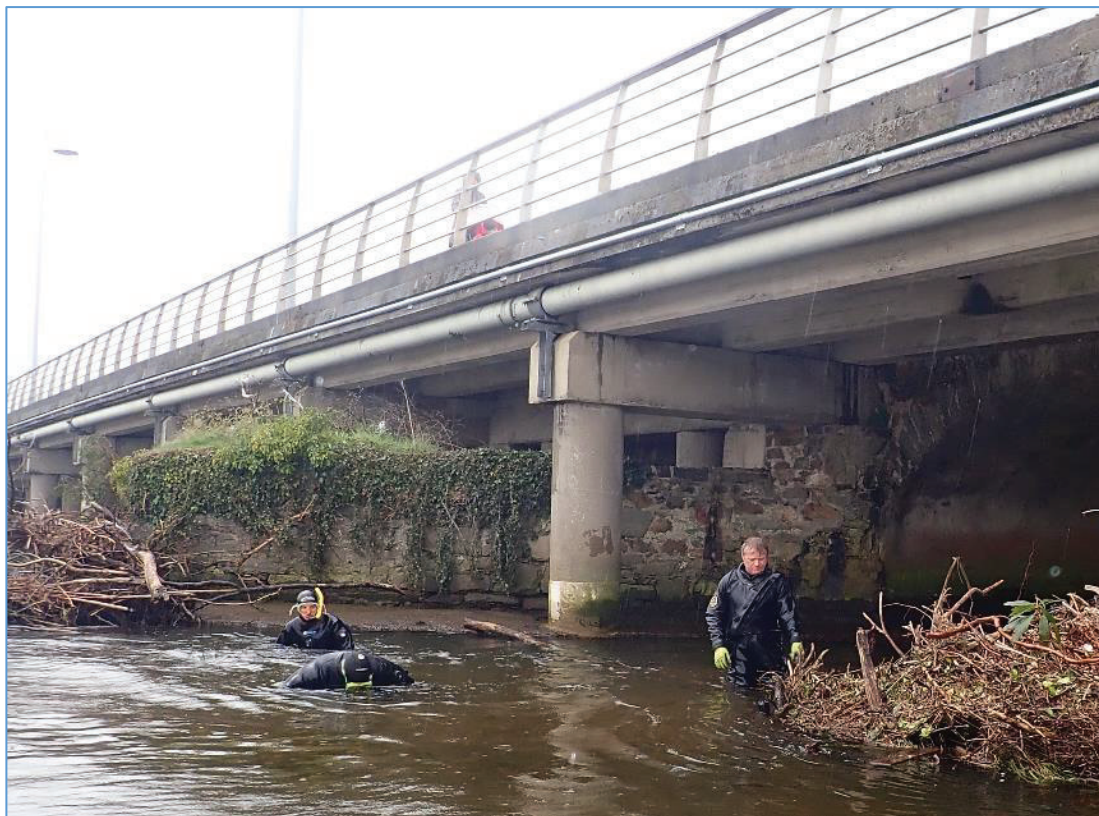


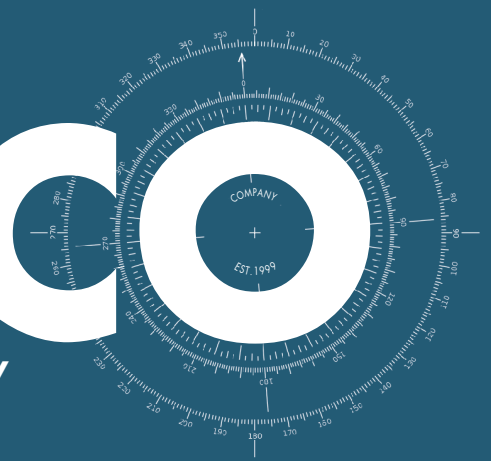
Plate 63: View showing the junction of the 1960s work with Pier 10.



Plate 64: TP-04 at Pier 4. Excavation reveals a line of starling piles under the stone apron.

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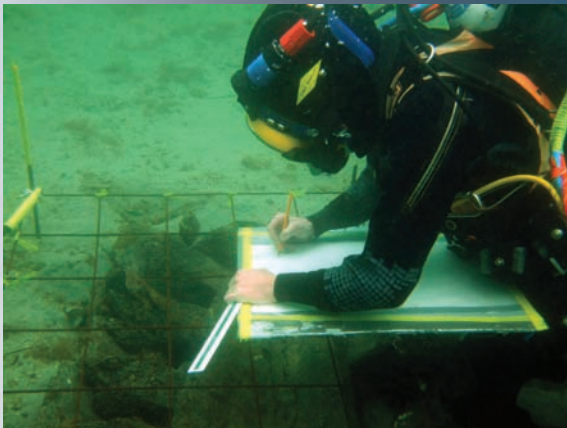


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Church Terrace, Bray
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www.adco-ie.com
info@adco-ie.com
+353 (0) 1 908 1541