5. Environmental archaeology: two examples from the N25 Waterford City Bypass and the N7 Limerick Southern Ring Road (Phase II)

Stephen Carter

Illus. 1—Location of the site at Newrath, Co. Kilkenny, on the route of the N25 Waterford City Bypass (based on the Ordnance Survey Ireland map)

Archaeology can draw on a wide variety of information to build up a picture of our past. Archaeologists are therefore trained to use an equally diverse range of skills and techniques to gather their evidence. Environmental archaeology is just one of many specialist areas within the discipline. Environmental archaeologists investigate past environments to understand the landscapes that people lived in and exploited. They employ a wide variety of techniques, many borrowed and adapted from the environmental sciences such as botany, zoology, geography and geomorphology.

Evidence for past landscapes can be found both ‘on site’ and ‘off site’. Environmental archaeology ‘on site’ could include the study of animal bones, shells and charcoal found in archaeological excavations. These represent the local resources that people were using in their settlements: food that had been farmed, hunted or gathered; wood, thatch or other materials brought in for building; wood and peat for fuel. These tell us both about how people lived and what their local environment was like.

Environmental archaeology ‘off site’ moves out from the archaeological ‘site’ and searches for evidence of past landscapes in naturally occurring deposits: peat bogs and lake sediments, for example. Anywhere that deposits accumulate there is potential for useful information to be preserved. This could be the remains of plants and animals (often microscopic remains such as pollen grains from plants) or the deposit itself. Different types of sediment are created in different environments, so the type of peat present, for example, will reflect the climate, water chemistry and vegetation conditions at the time that it formed.

In this paper I will use two examples of recent projects (one 'on site' and one 'off site') to illustrate the contribution that environmental archaeology is currently making to the National Roads Authority's archaeology programme. These formed part of the work carried out for the N25 Waterford City Bypass and Phase II of the N7 Limerick Southern Ring Road. In both cases there is a second paper in this monograph that describes evidence of the cultural archaeology of these projects based on more traditional fieldwork methods—namely excavation (see following papers by Wilkins [N25] and Taylor [N7]). The reader is encouraged to compare the methods of investigation, types of evidence and results obtained by these different, but complementary, approaches to archaeology.

The archaeology of estuaries

Both of the examples discussed below involve the environmental archaeology of tidal estuaries: the River Suir at Waterford and the River Shannon at Limerick. Over the past 10,000 years, since the end of the most recent ice age, most of Ireland's coastline has been gradually submerged by rising sea levels (the history is more complex in the north from Donegal to Down). River estuaries on coastlines that have experienced rising sea levels have a high potential for archaeological remains to survive, deeply buried in natural sediment accumulations. As sea level rises, low-lying land is submerged and sediments can accumulate in the sheltered environment of an estuary, burying and preserving that land surface. Continued sediment accumulation as sea level rises buries and preserves the evidence for human exploitation of the tidal channels and freshwater and saltwater marshes that make estuaries such valuable resources: boats, trackways, platforms, houses and fish-traps.

The permanent high water-tables lead to the preservation of organic materials (wood, cloth, leather), so the quality of the archaeological evidence can be exceptionally high compared with that typically encountered on dryland sites. It also makes particularly difficult conditions for archaeologists, with deep excavations through unstable sediments and the constant risk of flooding. But, as the paper by Wilkins shows, the archaeological rewards make the effort worthwhile.

N25 Waterford City Bypass: Newrath, Co. Kilkenny

On the N25 Waterford City Bypass, a complex sequence of waterlogged wooden structures has been excavated at Newrath, on the estuary of the River Suir in County Kilkenny, a short distance upstream from Waterford City (Illus. 1 & 2). The site is described in detail by Wilkins in the following paper. The archaeological structures and artefacts had been buried in several metres of sediment (Illus. 3) and range in date from the Late Mesolithic to the medieval period. We have used environmental archaeology techniques to study the changing landscape at Newrath: the aim was to document the development of the Suir

Illus. 2—Aerial view of Newrath looking north-west, with the River Suir in the foreground and Site 34 in the background near the trees (Tramore House Regional Design Office)

Illus. 3—Section cut through sediments at Newrath. The dark sediment at the base is wood peat dating from c. 3500–2800 BC; the pale sediment at the top of the section is estuarine silt dating from AD 200 to the present day (Headland Archaeology Ltd)

estuary and therefore better understand how the people who built the wooden structures exploited this landscape over several millennia.

Two undisturbed columns of sediment (monoliths) were collected by the archaeologists from the sides of the deep trenches dug to expose the wooden structures. Samples taken from these monoliths have been analysed to determine the nature of the local environment throughout the period of sediment accumulation. The principal methods of study have involved the analysis of these plant and animal microfossils to reconstruct past vegetation and sea level:

- pollen: grains from plants growing close to the site;
- diatoms: single-celled algae living in wetland habitats;
- Foraminifera: single-celled animals indicative of water salinity.

Radiocarbon dates have been obtained (see Appendix 1 for details) to provide a chronological framework for the sediments and relate them to contemporary archaeological features. This work is still in progress, so the results described here are rather general and will be refined as further, more detailed analyses are completed.

Preliminary results

Preliminary results have established a chronology for the site and indicate major changes in the landscape over the period between 3500 BC and the present day. Prior to 3500 BC, the site was a well-drained wooded slope in the valley of the River Suir at a point where a small tributary joined the river.

Around 3500 BC the woodland floor became wetter and peat started to accumulate, preserving the remains of trees and other plants that grew there. This change was triggered by rising sea level further down the river, which caused freshwater to back up and create waterlogging in the soils. In turn this promoted the spread of alder and birch trees, better able to cope with wet soils, at the expense of oak and hazel.

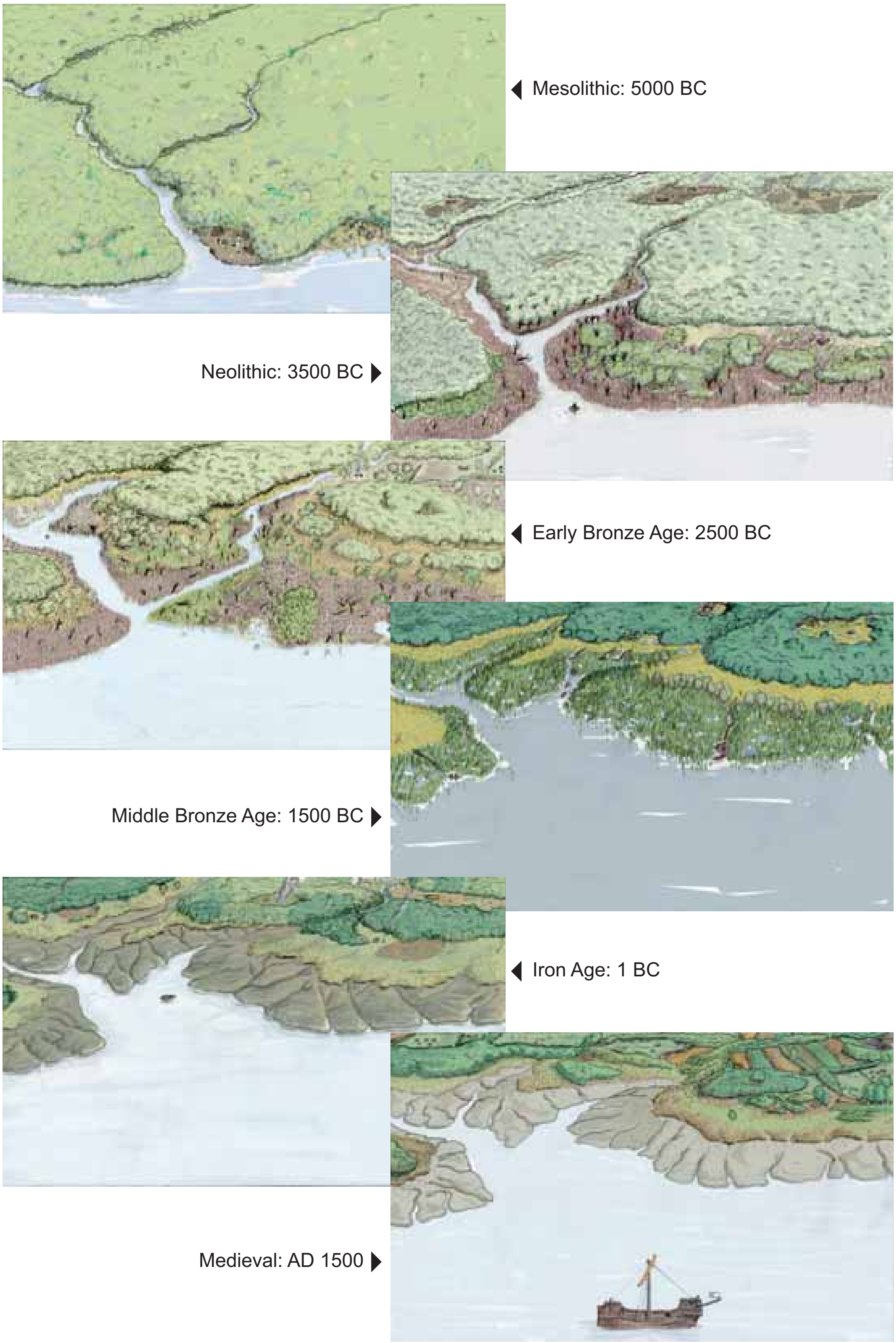
The woodland hung on in increasingly wet conditions until some time after 2800 BC, when freshwater flooding finally killed off the last trees and a reed swamp developed in their place. This dense stand of reeds was probably flooded in winter but drier in summer; upslope it would have merged into wet woodland.

Sea level continued to rise, and around 500 BC the first evidence of brackish (slightly salty) water is recorded. At first this would have been a rare event: extremely high spring tides or particular weather conditions allowing saltwater into the freshwater reed swamp. The saltwater incursions became more and more frequent, however, and estuarine silts started to accumulate within the reed peat. By about AD 200 the saltwater had gained the upper hand and the site had become a saltmarsh, regularly flooded by high tides and crossed by a network of tidal creeks.

Accumulation of silt in the saltmarsh meant that it kept pace with rising sea level, and for the next 1,500 years there was apparently no significant change in the local environment. Then, at some point in the recent historic past, the area was embanked and reclaimed for farmland.

Implications for archaeological interpretations

The documented history of environmental change over the past 5,500 years demonstrates



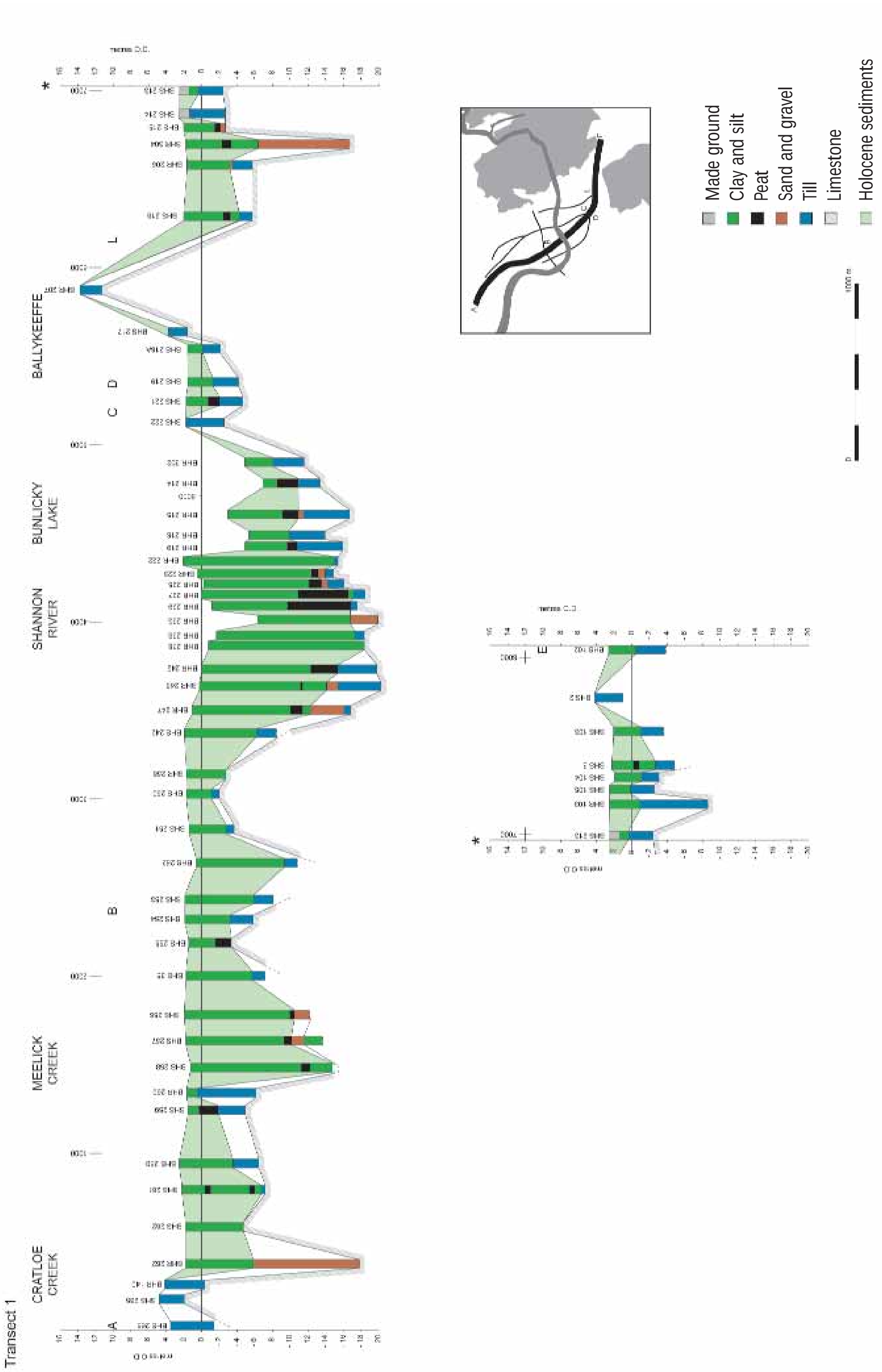
Illus. 4—Artist's impressions of the changing landscape at Newrath from the Late Mesolithic to the medieval period (Headland Archaeology Ltd)

that successive generations of people were faced with a very different landscape, offering different resources and opportunities to exploit. This changing environment is brought to life in a series of artist's reconstructions that illustrate six stages in the evolution of the Newrath site from the Late Mesolithic to the medieval period (Illus. 4). Inhabitants in 3500 BC would have known the site as a wet and impenetrable wood along the banks of the River Suir. A thousand years later this area was a swamp, rich in waterfowl to hunt and reeds for thatching. By the early medieval period it was a saltmarsh, offering good grazing for livestock during the summer months. Faced with a complex sequence of excavated timber structures spanning much of this history, the local environment provides a key to understanding the nature of human activity and the purpose of the structures.

N7 Limerick Southern Ring Road (Phase II)

The N7 Limerick Southern Ring Road presented a different challenge for environmental archaeologists. Phase II of the ring road runs from the N20 Cork road to the N18 Ennis road, crossing under the tidal estuary of the River Shannon in a tunnel (Illus. 5; the route of the proposed road is outlined in orange in Illus. 7a–d). As with the Suir at Waterford, this is a landscape created by rising sea levels, and it was known that there were deep deposits of estuarine alluvium (water-borne silts) beside the Shannon. Earlier intertidal surveys had also identified well-preserved waterlogged archaeological sites within these sediments (O'Sullivan 2001). Our challenge was to locate these sites along a route where the alluvium

Illus. 5—Aerial view of the Shannon estuary looking east towards Limerick, at the point where the ring road will tunnel beneath the Shannon. The estuary is now contained by flood banks with only narrow reed beds on either side (brown in photo). Former tidal saltmarshes, now reclaimed, occupy most of the photo. The houses on the left are built on a low 'island' at Coonagh, rising just above the marshes. Bunlicky Lake, to the right of the Shannon, is a flooded quarry where the alluvium was dug for cement manufacture (TVAS [Ireland] Ltd)



Illus. 6—Borehole transect through deposits along the line of the ring road. Note the almost level modern ground surface at 2 m OD (only Ballykeeffe Hill still projects above this), contrasting with the underlying bedrock topography. The buried valley of the Shannon underlies the present-day estuary, with deep peat deposits (black) on the floor of the valley dating from 9000–7000 BC (Headland Archaeology Ltd)

was up to 17 m deep. Conventional archaeological testing methods (trenching and geophysical survey) cannot cope with such depths.

The answer to this challenge was to try to predict where sites were most likely to be, using our knowledge of past landscapes, and then target areas of high potential using more conventional archaeological testing techniques. The result is a 10,000-year history of this part of the Shannon. During this time it changed from a marshy, wooded river valley to a wide, open-water estuary and then to a narrow tidal river with saltmarshes.

Landscape reconstruction was based on records of sediments from the many boreholes made by the road engineers. Different sediments form in different landscapes, so the boreholes could be used to map the prehistoric landscapes (Illus. 6). A large number of boreholes had already been commissioned by the project's engineers; these covered not only the final selected roadline but also various route options. As a result, it was possible to obtain detailed information about sediment stratigraphy over a wider area of land and therefore place the results for the roadline itself into a landscape context. Additional boreholes were commissioned to obtain fresh sediment cores. These were described in detail, providing a record of sediment stratigraphy, and were also used to provide samples for radiocarbon dating (see Appendix 1 for details).

Landscape evolution

Landscape change is a continuous process but we have selected particular times in the past 10,000 years to illustrate its progress. Four dates have been chosen, as these represent four distinct stages in the evolution of the landscape:

8000 BC—before any marine influence;
6000 BC—Mesolithic period, at the end of the period of rapid sea-level rise;
4000 BC—Neolithic period, the first landscape to experience major human impact;
AD 1000—early medieval period, the landscape before embankment and drainage.

The geographical extent of the reconstructions was determined by the extent of the available borehole data. As a result, the area is somewhat irregular and does not conform well to natural topographic features. Each reconstruction was based on a contoured plan of the early landscape, before deposition of any alluvium. Estimates of sea level and sediment deposition were then used to map the distribution of different environments, ranging from open water to dryland. The four reconstructions are presented in Illus. 7a–d, using the following categories of environment:

open water—freshwater rivers and tidal estuaries below low-water mark;
low saltmarsh—mudbanks and partly vegetated saltmarsh, submerged at every high tide;
high saltmarsh—fully vegetated saltmarsh, flooded only at spring tides;
peat—freshwater/terrestrial peats, above the limit of tidal waters;
dryland—land above the influence of tidal waters and freshwater.

8000 BC (Illus. 7a)

This earliest reconstruction shows the landscape prior to any marine influence. It is a landscape with considerably more relief than it has in the present day. A series of low limestone hills rise 20–30 m above adjacent valley floors. The Shannon flows in a bedrockcontrolled channel that closely matches its present-day course. Its valley is of variable width, with narrow, rocky reaches opening out into a broader basin with substantial accumulations of peat on the valley floor. Tributary rivers are incised into well-defined valleys through the limestone, cutting down to the level of the Shannon.

6000 BC (Illus. 7b)

In 2,000 years, sea level rose from about -20 m OD to around -5 m OD. This rapid rise meant that the rising water levels outstripped the deposition of alluvium, so the river valleys were flooded by the expanding estuary. Illustration 7b shows wide expanses of water, even at low tide, and an intertidal zone dominated by low mudflats. Most of the early peats have been submerged, but increased ground waterlogging has allowed peat to accumulate higher up the gentle slopes around the new estuary.

4000 BC (Illus. 7c)

The rate of sea-level rise slowed significantly between 6000 and 4000 BC, probably reaching about -1 m OD by the latter date (i.e. a rise of only 4 m compared with the 15 m during the preceding two millennia). The key result of the slow-down in sea-level rise was that the accumulation of alluvium in the intertidal zone started to catch up with sea level. Illustration 7c shows a much-reduced area of open water, replaced by intertidal alluvium with an increasing proportion of high saltmarsh. There is very little evidence for marginal peat deposits by this date, although it is assumed that a narrow fringe of peaty reed swamp existed at the landward margin of the saltmarsh.

AD 1000 (Illus. 7d)

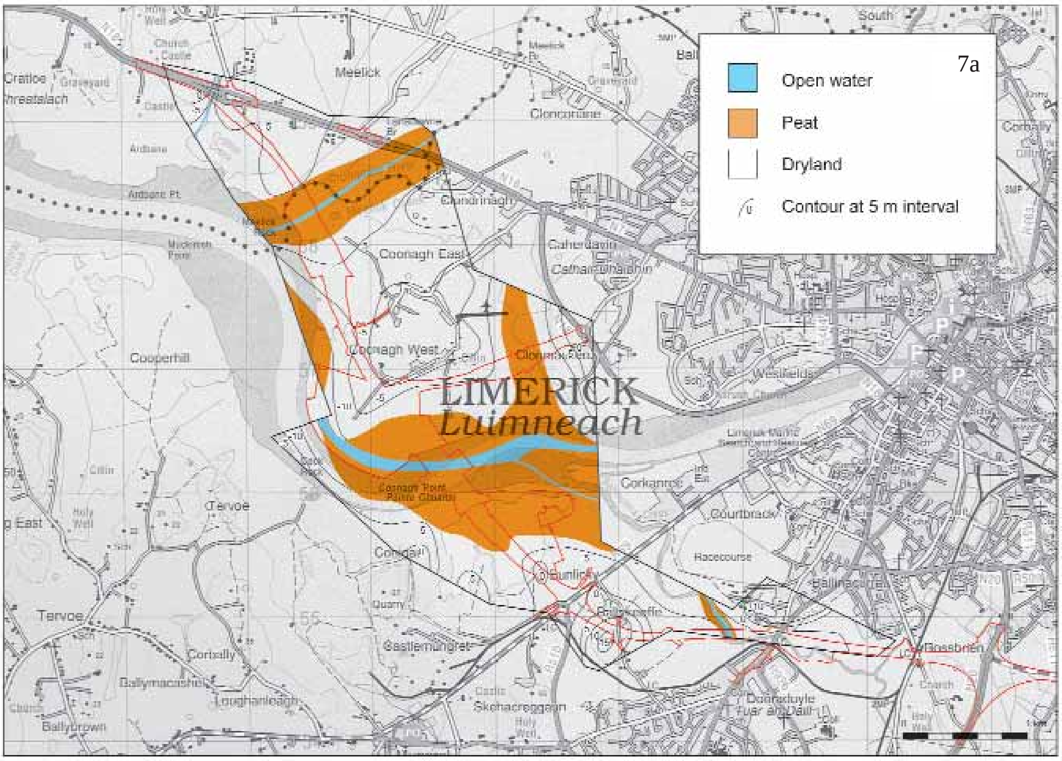
From the Neolithic period onwards, a slow rate of sea-level rise combined with continued deposition of alluvium allowed the extent and height of the saltmarshes to increase progressively. The situation reached by roughly AD 1000 is shown in Illus. 7d. The intertidal zone is now dominated by high saltmarsh, only flooded at spring tides, and the main tidal channels are fixed in positions that they have more or less retained to the present day. Coonagh is visible as a small island of dry ground, accessible on foot except at high-water spring tides. This early historic landscape is essentially the same as the present-day landscape, except that the high saltmarshes have all been embanked and drained since the 17th century. As a result, what would have been extensive grazing marshes became drained arable land in the post-medieval period, although they have now reverted to wet pasture.

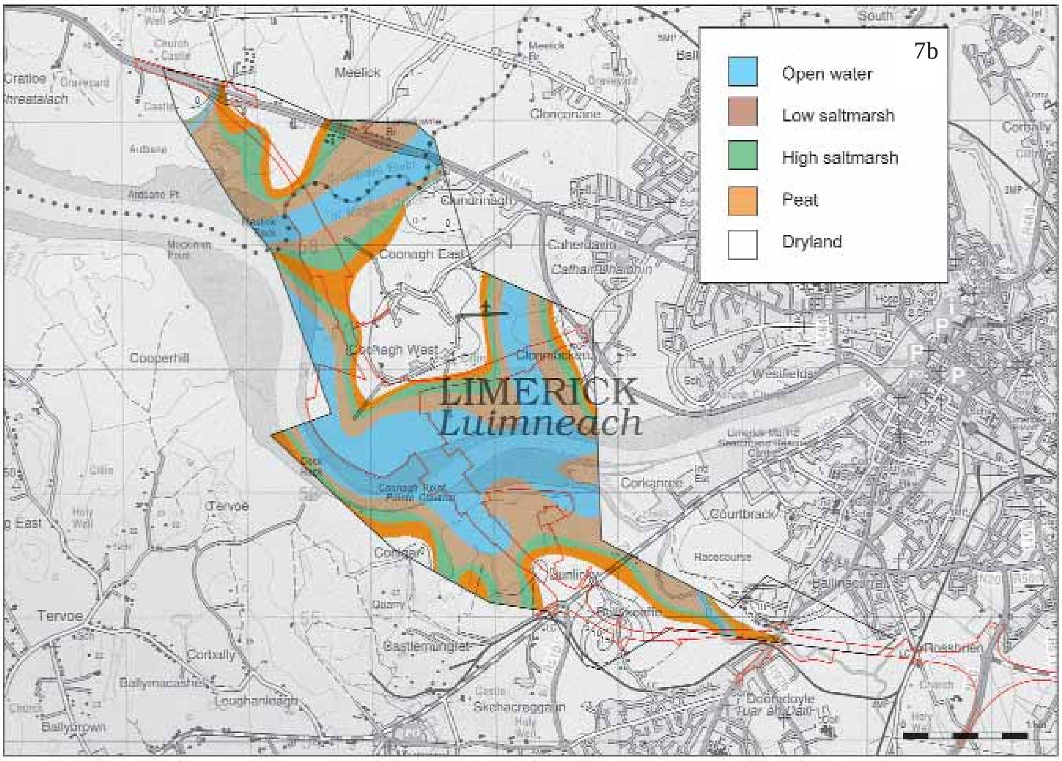
A predictive model for archaeological potential

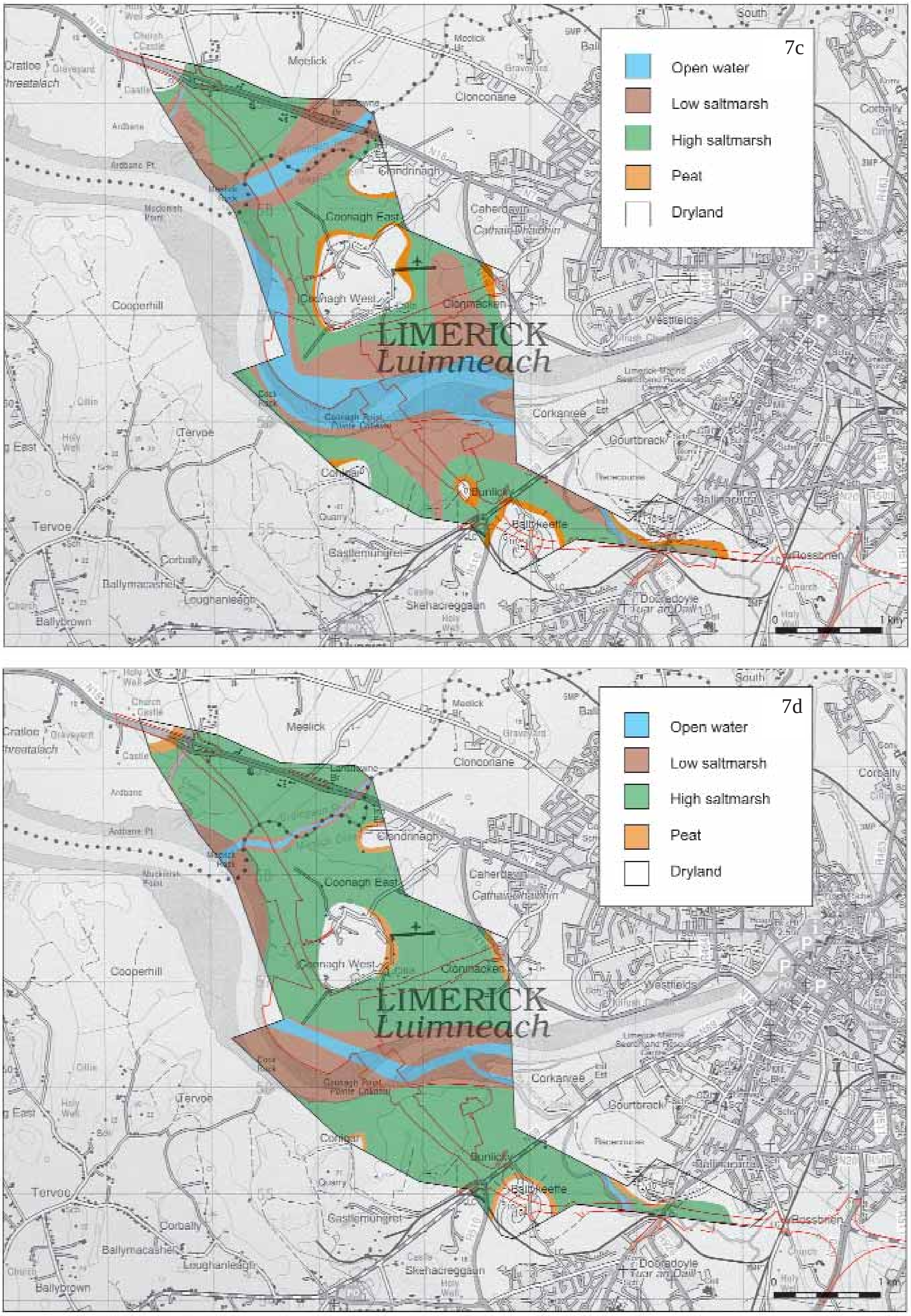
The record of environmental change, summarised above, provides the factual basis for the prediction of zones of archaeological potential in the alluvium. Three contrasting zones can be identified, with distinct environmental histories and therefore different archaeological potentials (Illus. 8).

Zone 1: Main channel of the Shannon

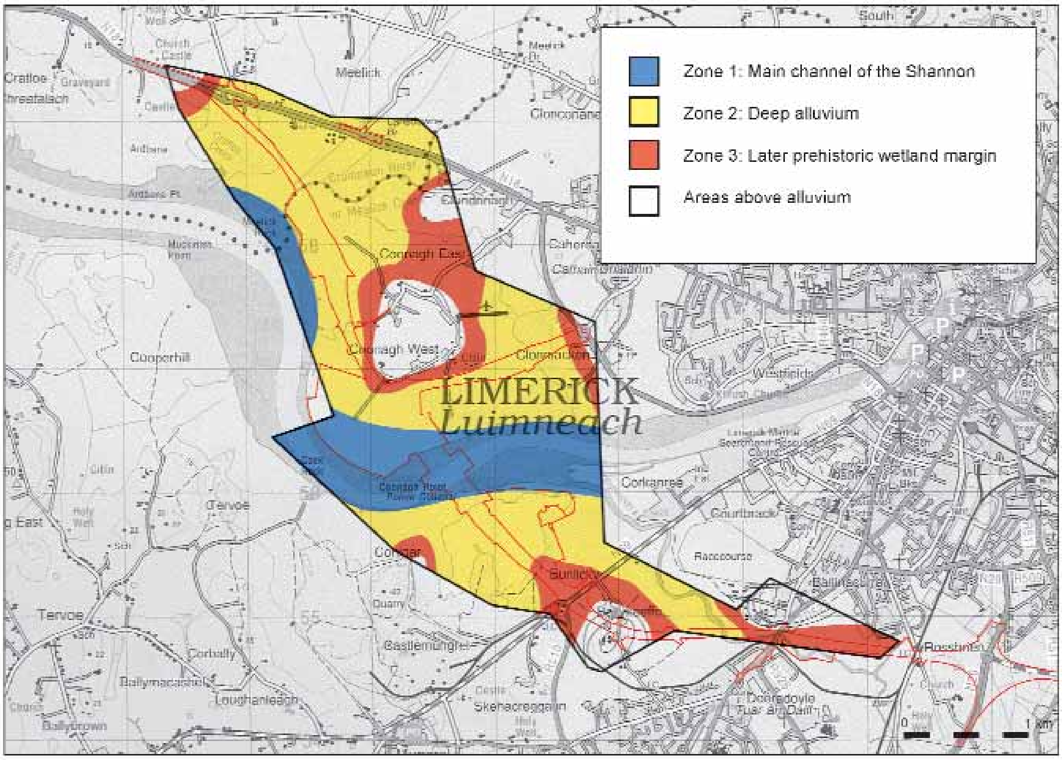
Zone 1 is restricted to the present Shannon channel and land immediately adjacent to it. This zone overlies the buried early valley of the River Shannon and has the deepest


7a
Open water
Peat
Dryland
Contour at 5 m interval
LIMERICK
Luimneach


7b
Open water
Low saltmarsh
High saltmarsh
Peat
Dryland
LIMERICK
Luimneach



Illus. 7a–d—Reconstruction of past landscapes along the line of the Limerick Southern Ring Road (indicated in orange): A—8000 BC, B—6000 BC, C—4000 BC, D—AD 1000 (Headland Archaeology Ltd, based on the Ordnance Survey Ireland map)



Illus. 8—Zones of contrasting archaeological potential along the line of the Limerick Southern Ring Road (Headland Archaeology Ltd, based on the Ordnance Survey Ireland map)

accumulations of sediments. It formed the wet valley floor of the Shannon prior to sea-level rise and early land surfaces are extensively preserved, with deep peat deposits providing a source of environmental data for this period. These ground surfaces were covered by rising sea levels probably around 7000 BC, and the potential for cultural archaeological remains (objects, structures, deposits) is considered to be very low.

Over 12 m of alluvium has subsequently accumulated over the early land surfaces. These are sediments deposited within or immediately adjacent to the main tidal channel of the Shannon and therefore were deposited as intertidal mudflats. Archaeological material likely to occur in this environment includes fish-traps on the sides of channels and floating debris within channel fills. The main tidal channel has remained within a relatively narrow zone throughout its history, however, so the sediments have been repeatedly reworked. As a result, the potential for survival of archaeological features is very low, except for those dating from the recent past.

Zone 2: Deep alluvium

Zone 2 includes all areas that were submerged by rising sea levels before 4000 BC and then progressively accumulated alluvium up to the recent past. The base of the alluvium in Zone 2 occurs between -15 m and -2 m OD and is widely marked by peat deposits on the former land surface. These are a source of environmental data for the period up to 4000 BC. The potential for cultural archaeology on the buried land surface is considered to be low, although material of Mesolithic date could be present.

Alluvium appears to have accumulated more or less continuously in Zone 2 up to the time that the land was embanked in the recent past. At first the alluvium was deposited low in the tidal range (tidal mudflats). After 5000 BC, as the rate of relative sea-level rise declined, alluvium gradually accumulated to a greater height, allowing vegetated saltmarshes to develop. This process was progressive, but the absence of widespread peat deposits in the alluvium indicates that these saltmarshes never completely rose above the influence of tidal waters.

It is unlikely that Zone 2 was ever dry enough to attract even seasonal settlement and, given the proximity of dryland, it could have been readily accessed from settlements on the adjacent slopes. It is predicted, therefore, that it would have been exploited for activities such as grazing, fowling and reed-cutting, but the potential for archaeological structures or deposits is low.

Zone 3: Later prehistoric wetland margin

Zone 3 comprises the interface between wetland and dryland as it would have existed since the Neolithic period (4000 BC). All deposits in this zone are relatively close to the present-day land surface (no more than 4 m in depth). Archaeological potential exists in two categories: the later prehistoric ground surface and marginal wetland deposits.

Any evidence for past human activity on the original land surface will have been sealed by accumulating alluvium as sea level rose. The potential for buried archaeological features of later prehistoric date is therefore high. This potential has been realised in part with the discovery of at least two *fulachta fiadh* beneath the alluvium during the archaeological testing of the roadline.

There is also potential for the preservation of archaeological features in marginal wetland peat deposits that occur in this zone, representing human activity extending out onto the edge of the wetlands. An obvious location for such activity is the area between the Coonagh 'island' and the dryland to the north-east. Again this potential has been realised by the discovery of prehistoric features extending into the alluvium from Coonagh. These are described by Taylor elsewhere in this volume.

Further reading

The most accessible introduction to the environmental archaeology of Ireland is provided by *Reading the Irish Landscape* (Mitchell & Ryan 2003). This book was first published by the late Frank Mitchell in 1986 as *The Irish Landscape* and has been revised twice since then. It now combines the expertise of Mitchell and archaeologist Dr Michael Ryan. There are a number of more academic texts on environmental archaeology and a recent, recommended, example is *Environmental Archaeology: principles and methods* (Evans & O'Connor 1999). Finally, an excellent introduction to the archaeology of Ireland's estuaries is provided by Dr Aidan O'Sullivan's account of his intertidal archaeological surveys of the Shannon estuary: *Foragers, Farmers and Fishers in a Coastal Landscape* (O'Sullivan 2001).

Acknowledgements

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