

3. Excavation of an early medieval vertical watermill at Killoteran, County Waterford

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Illus. 1—Location of Killoteran 9 and the Hiberno-Scandinavian site of Woodstown 6, Co. Waterford (based on the Ordnance Survey Ireland map)

During archaeological testing along the route of the N25 Waterford City Bypass in December 2003, structural timbers were exposed in Dooneen Marsh in the townland of Killoteran, Co. Waterford (Illus. 1). Dooneen Marsh is at the base of a small valley leading toward the River Suir to the north (Illus. 2). It is a very poorly drained area, with a small stream running through the centre and a second stream flowing around the eastern side. In modern times attempts have been made to drain the marsh, but the area is still very wet and prone to flooding. Radiocarbon dates from an oak plank and a yew post suggested that the wooden structure had been built in the late Iron Age or at the beginning of the early medieval period (see below), and it was decided to carry out a full excavation in order to reveal the extent and nature of the structure, now designated as archaeological site Killoteran 9 (NGR 253900, 109530; height 0 m OD; excavation licence no. 03E0406).

Excavation on behalf of the National Roads Authority, Waterford County Council, Waterford City Council and Kilkenny County Council was undertaken by Archaeological Consultancy Services Ltd from June to October 2004. The site was found to consist of the well-preserved remains of a substantial, vertical watermill. The excavation was continually hampered by the regular inundation of the site by water seeping out of the surrounding marsh and it was halted in October 2004 owing to a severe flooding event that left the



Illus. 2—Killoteran 9 in Dooneen Marsh, from the south (Studio Lab)

entire marsh under 0.5 m of water. The site was allowed to remain flooded in order to protect the exposed remains, and the level of water has been monitored since then. Some minor work was carried out in October 2005, but, with conditions worsening, it was decided to abandon the site again. Work is due to recommence in the spring and summer of 2006 when conditions become workable once more.

The mill at Killoteran

The mill was fed by a well-constructed mill-race that had an average width of 3 m. The mill-race diverted part of the flow of a small stream that ran to the west of the mill, and a tail-race immediately north of the mill-house emptied the water back into the stream a short distance downstream. Immediately to the south-west of the mill the race widened into a small, semicircular millpond, with a maximum width of 7 m (Illus. 3). The sides of the pond were lined with layers of brushwood, including some very substantial branches. The branches had been laid at right angles to the edge of the pond, running with the slope, and some had been secured in place with substantial stakes.

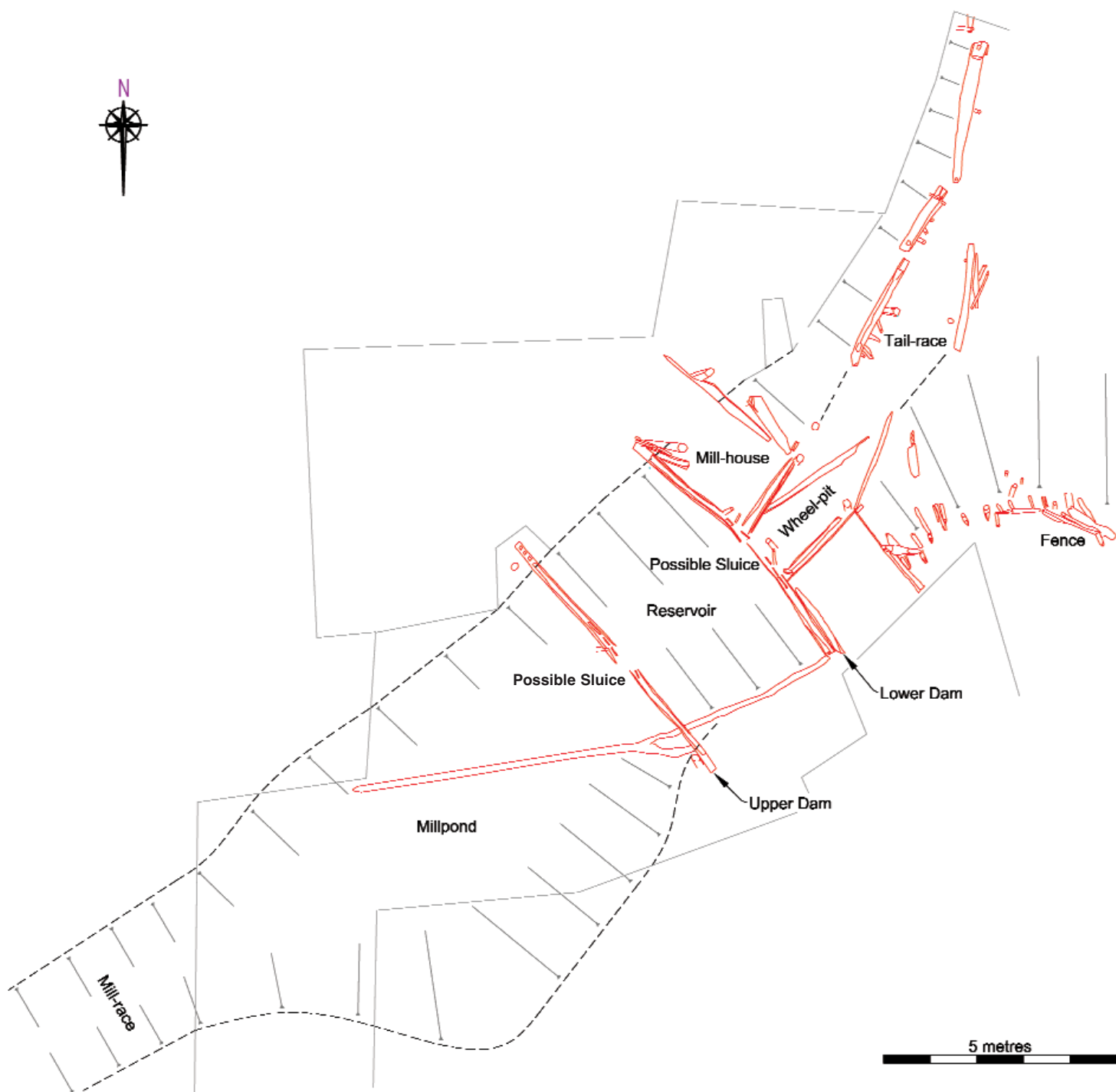
The flow of water to the mill-wheel was controlled by two wooden dams, both 5 m long and spaced 3.5 m apart (Illus. 4). The dams were constructed of oak planks set longitudinally into a slotted oak base plate. The base plate was set into alluvium on the bed of the mill-race and was cut into the sides of the channel and held in place by two large posts, one at either end. The gaps between the planks were filled with moss and alluvial clay in order to waterproof the dam. The bed of the channel downstream of the first dam was considerably lower than the bed of the millpond above the first dam, and it is assumed that

the full original height of the second dam would therefore have been lower than the height of the first dam. If this was the case, the water level between the dams would have been correspondingly lower than the water level in the millpond. This is consistent with the surviving heights of the posts that were used to secure the sides of the dams, but, of course, the surviving heights do not necessarily correspond to their original heights.

The flow of water across the dams would have been controlled by sluice gates or openings at the centre of each dam. The two dams were clearly contemporary with each other and would have worked in unison. The upstream dam probably had a sluice gate near its top, but no evidence of this survived. This dam was used to retain water in the millpond and maintain a constant level of water in the reservoir between the two dams. A small, rectangular opening found in the centre of the second dam, near to its base, represented the remains of a sluice opening (Illus. 5). Only the lower part of this opening was recovered, as the dam did not survive much above this point, and, therefore, its overall size and the amount of water it would have allowed through can only be estimated. The width of the opening was approximately 0.3 m. This was used to regulate the flow of water past the waterwheel; being so low down, it would have let water through under pressure. If the reservoir between the two dams was maintained at a constant level by manipulating a sluice gate on the first dam, water coming through the opening at the bottom of the second dam would always flow at the same speed and volume. If this interpretation is correct, then the people who constructed the mill used sophisticated engineering techniques to deliver very precise control over the volume and speed of water flowing past the waterwheel.

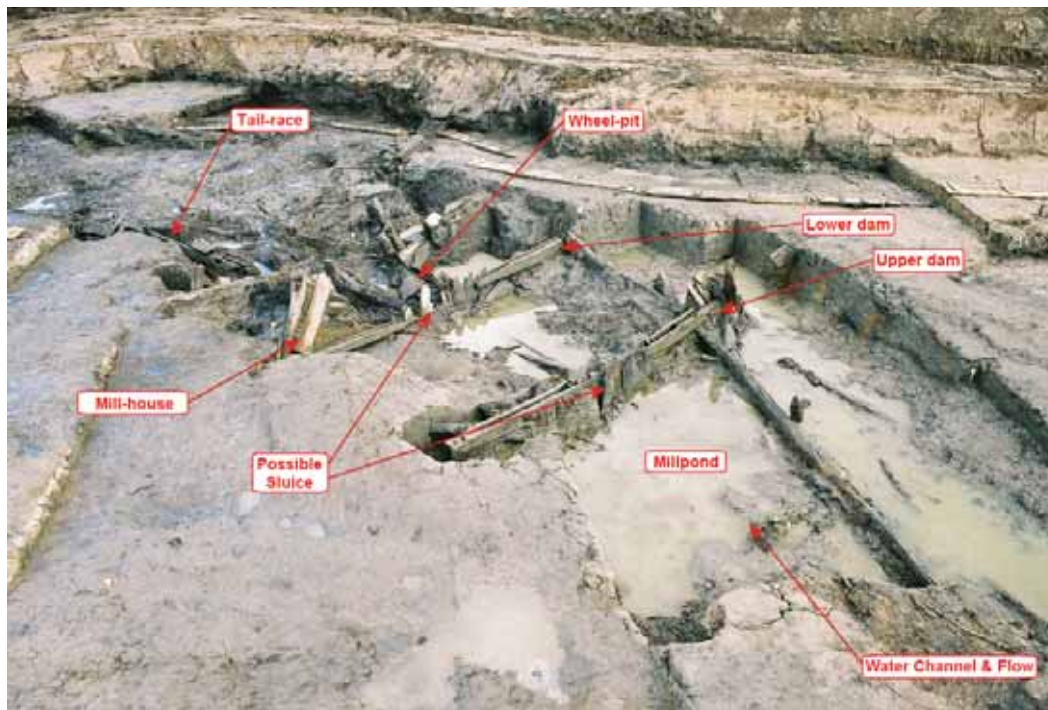
A final point is worth noting with regard to the management of the flow of water into the mill: the excavations that have taken place so far have identified traces of a possible overflow channel, which ran from the north-eastern end of the millpond around the east of the mill itself to join up directly with the tail-race (Illus. 6). One of the first priorities upon resuming work at the site will be to verify the existence of this feature.

The main workings of the mill were constructed immediately beyond the lower dam, on the north-west side of the channel. The workings consisted of the wheel-pit and the mill-house. The wheel-pit was in a position central to the dams and in line with the mill-race. It consisted of a rectangular area, 2 m long and 1.5 m wide. The pit could have held a wheel with an estimated diameter of up to 1.8 m, but it seems more likely that it held a smaller wheel with a fast rate of spin rather than a large wheel turning more slowly. A small, rapidly rotating wheel is known in modern terms as a flutter wheel, and this design would be consistent with the small size of the opening in the second dam. The wheel-pit was lined on both sides with a series of planks lying sideways on top of each other and held in place by wooden posts at either end. These plank walls would have retained the earth-cut channel on either side of the wheel. The floor of the wheel-pit was lined with large planks that would have prevented the flowing water from scouring out the bottom of the channel and thereby reducing the efficiency of the wheel. The axle of the wheel would have been supported on both sides of the channel and would have exerted pressure on the permanently sodden ground to either side. While the structure of the mill-house would have retained this force on the north-west side of the channel, it was the plank-built revetment of the side of the channel that performed this task to the south-east. Additional support on the south-eastern side was provided by the lower dam and by a second revetment aligned at right angles to the channel and running away from the north-east corner of the wheel-pit.



Illus. 3—Plan of main structural features (Archaeological Consultancy Services Ltd)

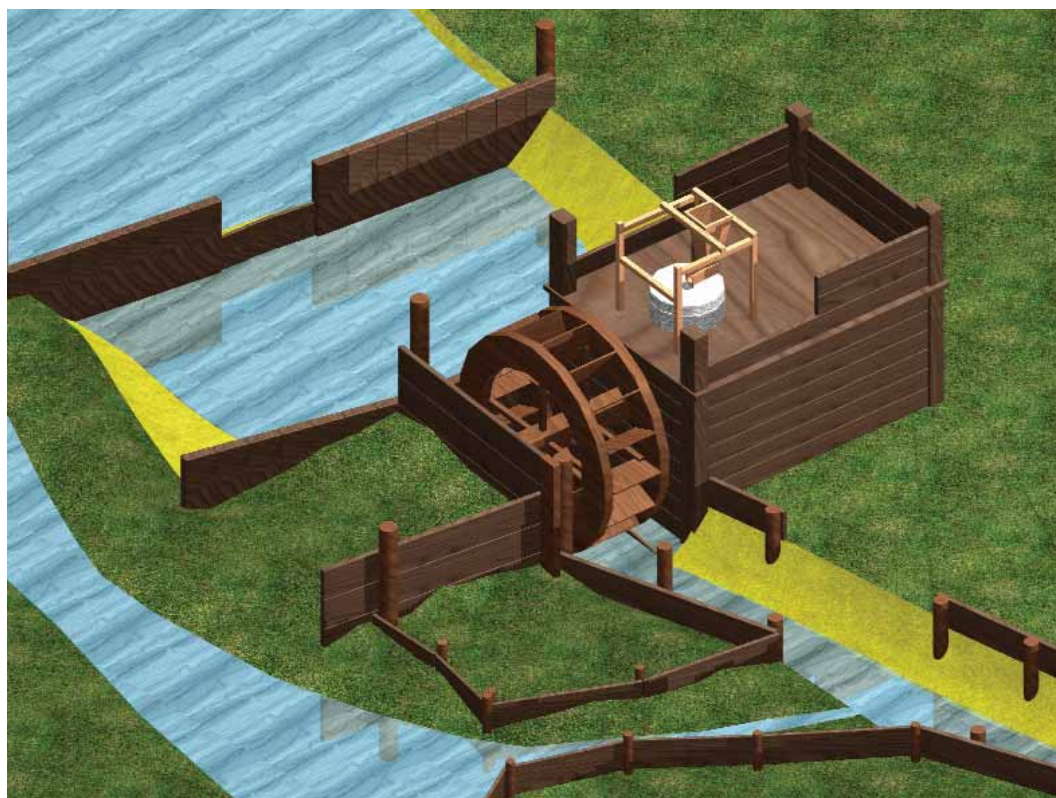
An early medieval vertical watermill at Killoteran, County Waterford



Illus. 4—Photograph showing main elements of the mill's design (Archaeological Consultancy Services Ltd)



Illus. 5—Photograph of wheel-pit under excavation, showing rectangular opening in lower dam (Archaeological Consultancy Services Ltd)



Illus. 6—Suggested reconstruction of vertical mill (Archaeological Consultancy Services Ltd)

The mill-house was situated along the north-west side of the wheel, where portions of two upright plank-lined walls were exposed. The first of these walls was formed by the north-west end of the lower dam, and the second was formed by planks laid on their edge and held by two large posts at a distance of 2 m from the first wall. The floor of the mill-house was constructed from a mixture of imported clay and turf. The overall dimensions were small, approximately 3 m by 2 m. Despite its small area, the mill-house may have been quite a tall structure, as it had to contain the axle of the waterwheel, a set of gears, a vertical drive shaft, a set of millstones and any hoppers that may have been used.

Beyond the main workings of the mill, a small tail-race was exposed, consisting of a small channel, only 2 m wide, cut into the alluvium. This was revetted on both sides with reused timbers secured by small posts. The remains of a small wattle fence were exposed along the south-east side of the tail-race, and this may have been used to stop surface water from flowing in and causing a backwash onto the wheel.

More than 600 fragments of wood were recovered, in addition to the mill structure itself. For the most part, these consisted of unworked branches that either had been washed along the mill-race or were used to revet the edges of the millpond. Worked fragments were also recovered, including planks, posts, a possible wheel-shaft and possible mill-wheel paddles.

Artefacts

A total of 21 upper and lower millstone fragments were recovered from the tail-race in the vicinity of the mill-house. These stones were all made from locally quarried Old Grey Sandstone. Millstones would have broken on a regular basis and would have been discarded nearby. The original diameter of one of the millstones has been calculated from the curvature of one fragment. The diameter was estimated to have been 0.53 m, which would have made the stone reasonably small and light and supports the interpretation that the waterwheel itself had a small diameter and a fast rotation.

A small number of other artefacts were recovered from this site; as would be expected with a waterlogged site, many of them were made from organic materials. Organic finds included six pieces of worked antler, a bone knife-handle, two fragments of leather and a 0.5 m length of rope. Non-organic finds included iron nails and rivets, a bronze chain link, five whetstones, two small pieces of slag and a circular slate fragment with a central perforation. A small amount of animal bone was also recovered and included cattle remains and antler. Detailed analysis of these finds is under way, but preliminary work indicates that they are early medieval in date. A possible hammerstone and a flint flake of prehistoric date were also recovered from the fill of the mill-race, but these may be residual objects unrelated to the mill.

Site abandonment

Although excavation of this site is incomplete and further work may reveal additional features, it is thought that the structure represents a single building phase, with the possibility of some running repairs and slight modifications to the design. The site may have been abandoned because, despite the builders' efforts to control water-flow through the mill, the area was too prone to flooding to be viable. (This speculation is based on our own experience of the rapid way in which water inundates this area.) Once the mill was abandoned, it rapidly silted up, and it was this silting that protected so much of the superstructure and ensured its survival. The mill was exposed below 2 m of alluvium, indicating quite considerable silting since the site was abandoned.

The mill-race was itself cut into alluvium that had accumulated here before construction of the mill. The massive accumulation of this alluvium was probably due to a number of factors in the surrounding landscape. The first of these was the fact that the site floods during high tides on the River Suir. Secondly, the area is in a basin between the hills of Killoteran and Adamstown. A number of prehistoric habitation sites were found on the hill at Adamstown, dating to the first and second millenniums BC, and, more recently, evidence of habitation during the same period was discovered on the hill in Killoteran. The presence of these sites would suggest that farming was being carried out in the immediate locality since at least the Early Bronze Age, and perhaps tillage had the effect of emptying silt into the basin below. This process is likely to have continued until early medieval times, and the accumulation of silt may have increased the frequency of flooding episodes and infilling of the mill structure. The abandonment of the mill may also have come about as a result of climate change, which led to almost continual flooding of the area. It is worth noting that, although considerable effort has gone into draining this area in recent times—both through the canalisation of the original stream so that it now runs to the east of the

mill and through the use of a very extensive network of field drains—this area still floods regularly and spends much of the winter covered in water.

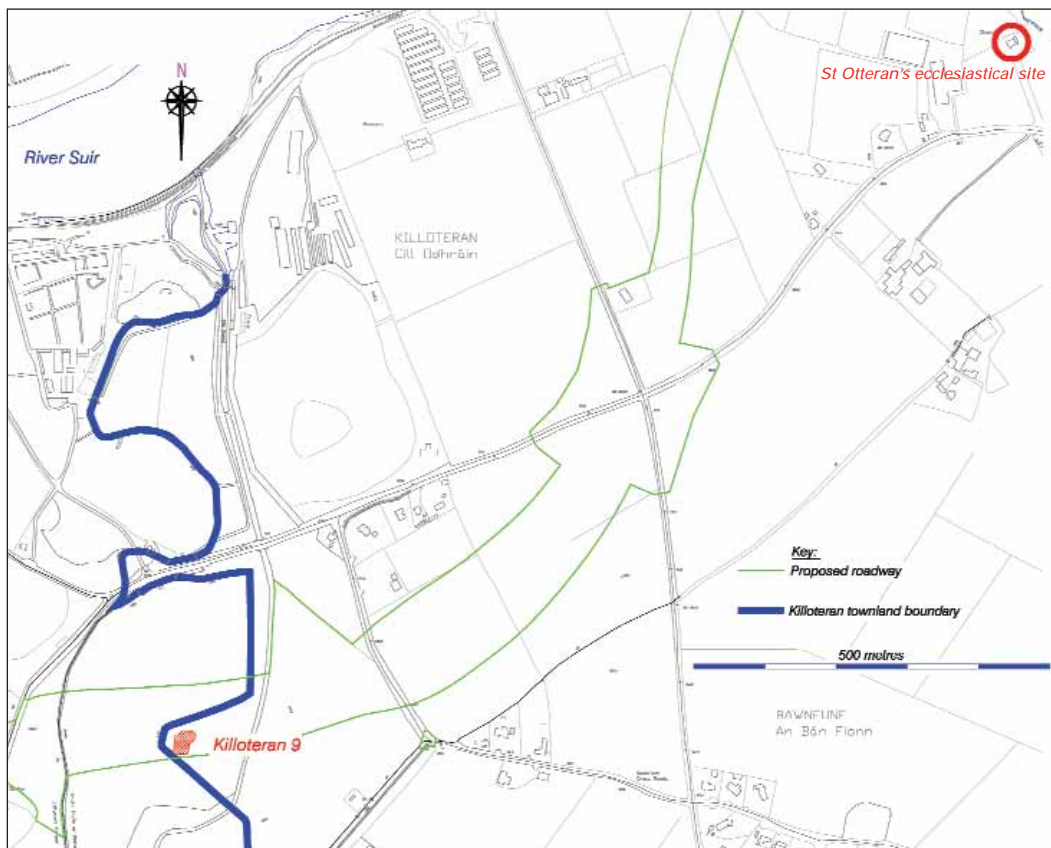
The stream that the mill-race was linked to flowed into the River Suir, which is some 800 m north of the mill. Interestingly, the Suir is currently tidal to a point a short distance upstream from the confluence with this stream, and at high tide this stream may well have backed up with tidal floodwater. However, it would be a mistake to consider this site to be a tidal mill, as these are typically situated on shorelines. There is no evidence that the structure was adapted to take advantage of this tidal backflow, and the stream itself would have been sufficient to maintain the height of water in the millpond. Indeed, if the area was inundated with water during high tide, it would have been an inconvenience to the operators of the mill; as such flooding would have temporarily stopped their operations.

Dating

As mentioned above, two radiocarbon dates were obtained from a yew post and an oak plank exposed during the preliminary phase of this project. The samples returned dates of AD 340–600 and AD 410–650 (see Appendix 1 for details), which, taken at face value, are significantly earlier than most other dates so far obtained from other Irish watermills, of either horizontal or vertical type. Forty-two mills have been excavated and dated in Ireland. The dates range from the mid-first millennium AD to the 14th century, with a significant concentration from the early eighth century to the early 10th century (Brady, in press). It is unfortunate that the dates so far obtained from Killoteran 9 have such large deviations, ranging as they do from the fourth to the seventh century, but it is hoped that the structure will be precisely dated in the future using dendrochronology (tree-ring dating). It will be particularly interesting to see whether the Killoteran 9 site fits neatly alongside other early seventh-century examples, such as Nendrum, Co. Down, and Little Island, Co. Cork, or the site extends the known use of watermills in Ireland back into the fifth or even the fourth century.

Ecclesiastical association?

With regard to the location of the mill, it is probably significant that the boundary of Killoteran townland juts out into the marsh in an unusual manner at this point (Illus. 7). This deviation from the general north–south alignment of the boundary may be related specifically to the mill's location and may represent a desire to incorporate it into Killoteran townland. It is tempting to infer that the mill may, therefore, have been associated with the early ecclesiastical establishment of St Otteran, situated less than a mile to the north-east in the same townland. Little is known about St Otteran's itself, but it was probably the centre of an ecclesiastical estate. Killoteran church is described as being in ruins in an ecclesiastical survey of 1615, but the site probably dates back to the sixth century. A holy well is situated 300 m WNW of the church. The name Killoteran is translated as Cill Odhrain, or 'Church of St Odran', a sixth-century saint who later became a patron saint of the Vikings and was chosen as patron saint of the city of Waterford in 1096. Recent research into such establishments has suggested that their economic clout and ability to organise and manage



Illus. 7—Map showing location of Killoteran 9 and townland boundary extending into the marsh to include the mill (Archaeological Consultancy Services Ltd, based on the Ordnance Survey Ireland map)

landscapes have previously been underestimated (Doherty 2000). St Otteran's is the most likely candidate to be the patron of this sophisticated mill, and its connection to the early levels of occupation at the Hiberno-Scandinavian site of Woodstown 6—elsewhere on the River Suir (Illus. 1)—also requires examination (O'Brien & Russell 2005, 118–20). Two more unusual and unexplained kinks in the townland boundary occur between the site of the mill at Killoteran and the River Suir, and investigations in these areas might reveal traces of subsequent mills built to replace Killoteran 9 once it had become unusable, although this is highly speculative.

Conclusion

The mill at Killoteran has great potential to develop the study of milling technology in early Ireland. Future work will focus on dating the construction of the site more accurately, examining the lower portions of the superstructure and looking for evidence of earlier activity at the site. Once excavation is complete, it should be possible to model the flow of water through the mill accurately and to calculate how much energy the mill would have generated. Excavations in Ireland have already made significant contributions to the understanding of the development of milling technology in Europe. The excavation of Killoteran 9 has great potential to add to our understanding of this process.

Acknowledgements

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