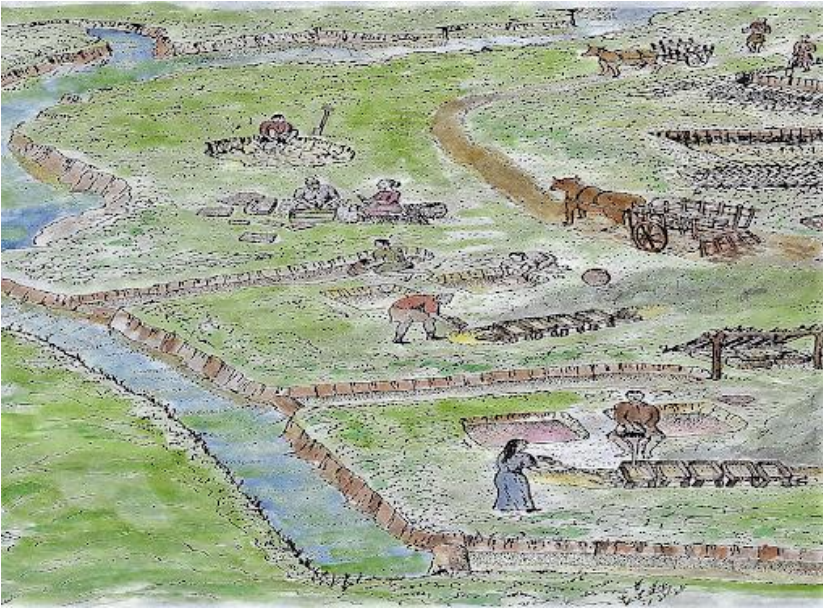




Exploring Early Medieval and Medieval Salt Production upon the Norfolk Fens: Prospecting for Saltern Mounds Between the River Great Ouse and the River Nene

ABSTRACT

This dissertation conducts a landscape study focused on prospecting saltern mounds associated with salt production in the Fens during the early medieval and medieval periods, particularly between the River Great Ouse and the River Nene. By employing a multi-faceted approach that includes LiDAR data, historic cartographic sources, satellite imagery and the results of archaeological excavations, the research aims to identify and interpret saltern mounds within this unique landscape. The findings reveal that the environmental particulars of the Fenland, characterised by tidal marshes and creeks, enabled extensive salt production practices such as sleeching, likely emerging in the 8th century. This study highlights the role of early landscape management strategies, exemplified by the construction of embankments like the Sea Bank, in facilitating saltworking activities. Ultimately, this research enhances our understanding of a saltworking landscape and provides a foundation for future investigations into salt production in the region.

Liam Podbury

MA Archaeological Practice



Y Drindod Dewi Sant

Trinity Saint David

Postgraduate Dissertation coversheet & feedback form:

Student Name: <i>Liam Podbury</i>		
Student University Email: <i>2111268@student.uwtsd.ac.uk</i>		
Module code: <i>HPAR7005</i>	Student ID number: <i>2111268</i>	Educational support needs: <i>No</i>
Dissertation title: <i>Exploring Early Medieval and Medieval Salt Production upon the Norfolk Fens: Prospecting for Saltern Mounds Between the River Great Ouse and the River Nene</i>		
Supervisor: <i>Martin Locock</i>		Word count: <i>14942</i>
I confirm that this is my original work and that I have adhered to the University policy on plagiarism. Signed: 		
Email submission: if you are submitting this form via email, please tick this box ☒ (as a substitute for your signature) to confirm that you agree to the above declaration.		
For completion by the first marker:		
Comments:		
First Marker's Mark:		Date:
Signature:		

For completion by the second marker:

Comments:

Second Marker's Mark:
Signature:

Date:

Agreed internal mark:

Date

Signature 1st marker:

Signature 2nd marker:

Comments (for completion by the internal markers which indicate how the agreed internal mark has been arrived at):

NB. All marks are provisional until confirmed by the final examination board.

For completion by the External Examiner:

Comments:

Proposed Mark:

Signature of External Examiner:

Final Agreed Mark:

Comments (to indicate how the final agreed mark has been arrived at):

1	INTRODUCTION.....	1
1.1	SALT: A VITAL RESOURCE.....	1
1.2	THE FENS AND SALTWORKING.....	2
1.3	WHY FOCUS ON SALTWORKING ON THE FENS? NEW DATA PERSPECTIVES.....	4
2	LITERATURE REVIEW	7
2.1	HISTORIOGRAPHY OF MEDIEVAL SALTWORKING.....	7
2.2	LANDSCAPE SURVEYS	10
2.3	ARCHAEOLOGICAL EXCAVATIONS.....	13
2.4	RECENT EXPANSION OF DATA SOURCES.....	14
3	METHODOLOGY	18
3.1	LIDAR DATA	18
3.2	HISTORIC ENVIRONMENT RECORD	18
3.3	ARCHAEOLOGICAL INVESTIGATIONS.....	18
3.4	INTEGRATION AND ANALYSIS	19
4	ANALYSIS: PROSPECTING AND INVESTIGATING SALTWORKING MOUNDS	20
4.1	TERRINGTON ST CLEMENT.....	20
4.2	CLENCHWARTON	30
4.3	TILNEY ALL SAINTS AND TILNEY ST LAWRENCE.....	36
4.4	WEST LYNN	40
4.5	WALPOLE ST ANDREW, WALPOLE ST PETER AND WALPOLE CROSS KEYS	48
4.6	WEST WALTON	52
4.7	VALIDATING THE UTILITY OF LIDAR: VIEW FROM KING'S LYNN	55
5	DISCUSSION: PROSPECTING AND INVESTIGATING A SALT PRODUCTION LANDSCAPE.....	58
5.1	PROSPECTING FOR SALTWORKING MOUNDS: LOCAL AND REGIONAL INSIGHTS	58
5.2	THE LIMITATIONS OF LIDAR IN PROSPECTING FOR SALTWORKING MOUNDS IN A COMPLEX LANDSCAPE	67
5.3	TERRINGTON ST CLEMENT: A CASE STUDY FOR THE INVESTIGATION OF EARLY SALTWORKING.....	69
5.4	THE POTENTIAL OF FUTURE ARCHAEOLOGICAL INQUIRY	72
6	CONCLUSIONS.....	74
7	BIBLIOGRAPHY.....	76
	APPENDIX 1: THE SLEECHING PROCESS OF SALT PRODUCTION	86
	APPENDIX 2: HER SEARCH PARAMETERS.....	91
	APPENDIX 3: WORK FLOW DIAGRAM.....	92
	APPENDIX 4: FUTURE RESEARCH TOPICS AND QUESTIONS	93

1 INTRODUCTION

1.1 Salt: A Vital Resource

The economic and societal importance of salt cannot be understated; it has been a vital, valuable, and culturally significant commodity throughout history (Hathaway 2008; Harding 2021). The significance of salt is succinctly captured in Ælfric's *Colloquy*, which dates to c.950-1010, in a conversation between a teacher and students learning their respective crafts (Harris 2003: 122-123):

Teacher: *Salter, how do we benefit from your craft?*

Student Salter: *My craft is of great use to you all. None of you eats lunch or dinner happily unless he be amenable to my craft.*

Teacher: *How?*

Student Salter: *Which man fully enjoys very sweet food without salt? Who can fill his cellar or storehouse without my craft? Look, you lose butter and cheese curds unless I am present as a preservative for you; you couldn't even enjoy your herbs.*

Today, as we are accustomed to salt being something we simply flavour our meals with, it is easy to overlook the vast quantities of salt that historic societies required for the preservation of their sustenance. Let us consider, for instance, the amount of salt necessary to preserve a single herring; a staple of the period (Kowaleski 2016). Documentary sources from the 18th century indicate a range of between 17g to 48g per herring (Bridbury 1955: 3). If the one million inhabitants of Anglo-Saxon England, as estimated Härke (2011: 8), each consumed ten salted herrings annually, and it required 28 grams of salt to preserve one herring, the total salt needed would be nearly 28,450kg (28 tons). Yet, the consumption of ten herring per person annually is certainly a gross underestimate of the true extent of salted food consumption by the early medieval and medieval population.

What Ælfric's *Colloquy* fails to mention, perhaps as it was intended to be a teaching-tool for schoolchildren, was that salt also served a multitude of other functions beyond the preservation of food. Salt, for example, was crucial in many industrial processes, from curing leather to soldering joints of pipes and gutters, and was even used for medicinal and ecclesiastical purposes (Keen 1989: 134). This underscores the profound economic and societal significance of salt and its production.

1.2 The Fens and Saltworking

The region surrounding and within The Fens, particularly in the counties of Lincolnshire and Norfolk, was particularly suitable for the production of salt due to its unique geographical and environmental conditions (Plate 1.1). This region, characterised by its extensive flat, low-lying marshlands, was directly influenced by tidal movements from The Wash (Albone *et al* 2007). Beyond the access to the salt impregnated silts deposited by the tide that were vital to the salt production process during this period, The Fens provided a readily available and efficient fuel source in the form of peat deposits (Silvester 1999).



Plate 1.1: The geology of The Fens (Oosthuizen 2015)

To ensure that the landscapes where salterns were situated were economically viable and exploitable, extensive embankments were essential. Unlike modern defences, these early embankments were not positioned beside the sea but were set back, often in association with a natural barrier. Generally low in height, they were designed not to protect the land from extreme conditions but to guard against spring tides (Plate 1.2). These embankments were intended as an unbroken barrier against inundation, extending around the estuaries of rivers (Allen 1999: 16). The most notable of these is the so-called Roman Wall—more accurately termed the Sea Bank or *Hafdic* – which encircled the Wash and extended along the Lincolnshire Fens. Likely constructed in the 11th century, the Sea Bank reinforced earlier, smaller banks of 10th century origins, likely constructed in a piecemeal fashion rather than as part of a cohesive construction programme (Crowson *et al* 2005; Oosthuizen 2016). Subsequent chapters will elucidate the functional and spatial relationships between the Sea Bank, its predecessors, and saltworking.



Plate 1.2: View to the west along the extant Sea Bank near Walpole St. Peter (Oosthuizen 2016)

The environmental suitability of the Fens is evident when one considers the particulars of the predominant saltworking process of salt-washing, or *sleeching*; a method distinct from the

more efficient and less labour-intensive solar evaporation technique used on the Continent (Forsythe *et al* 2018; Forsythe *et al* 2021). This process involves three main stages: collecting salt-impregnated tidal silt, filtering it, and crystallizing the resulting brine (Owen 1975a; McAvoy *et al* 1994; Clarke 2023). While the intricacies of this process are detailed in Appendix 1, it can be summarized as washing water through salt-rich silt deposits and evaporating the concentrated brine in hearth pans. This process resulting in the creation of mounds; a complex stratigraphy of desalinated silts and hearth waste. Excavations often reveal clay-lined structures associated with this process and accumulations of waste products, attesting to multiple seasons of saltworking.

1.3 Why Focus on Saltworking on the Fens? New Data Perspectives

Until the early 20th century, the origins of the large earthwork mounds scattered across the coastal marshes of Britain were not linked to saltworking (Thompson 1956: 44). It was only during the excavations of the long-perplexing Red Hills of Essex that some of these mounds were found to be an accumulation of waste deposits related to medieval saltworking (Plate 1.3; Christy and Dalton 1925: 27-56). Since then, research into salt production has significantly expanded, highlighting the broader significance of these mounds. Notably, the landscape-scale studies from the Fenland Project and the Norfolk National Mapping Programme (NMP) have been crucial in advancing our understanding of these features. These projects meticulously documented and analysed saltern mounds through fieldwalking and aerial imagery, providing invaluable insights into the scale and organization of salt production activities in the Fenlands.

The topic of early medieval and medieval salt production in the area west of King's Lynn is a relatively novel and emerging field of inquiry. Since the Fenland Project and Norfolk NMP, there has been a significant increase in available data sources, presenting new opportunities to enhance our understanding of saltworking on the Fens, particularly between the River Great Ouse and the River Nene, which is the focus of this thesis (Plate 1.4). This area is particularly interesting because, while the significant salterns to the east of the Ouse around King's Lynn and those to the west of the Nene in Lincolnshire have been extensively excavated and discussed, the region between these rivers has received comparatively little attention.

To address this gap, this study adopts a multi-faceted approach, integrating several methodologies and datasets: LiDAR data, HER data, historic cartographic sources, aerial

photographs, historic documentary sources, and the findings of numerous excavations . By synthesizing these data sources, this thesis reassesses the findings of the Fenland Project and Norfolk NMP. It identifies new potential saltworking sites and critically evaluates existing interpretations of earthwork mounds and recent archaeological investigations. This inquiry enhances our understanding of a relatively under-researched early medieval and medieval industry, and contributes to the broader discourse on socio-economic dynamics in the Norfolk Fen region.



Plate 1.3: *The medieval saltern mounds of the Hell Bridge Group (Christy and Dalton 1925:31)*

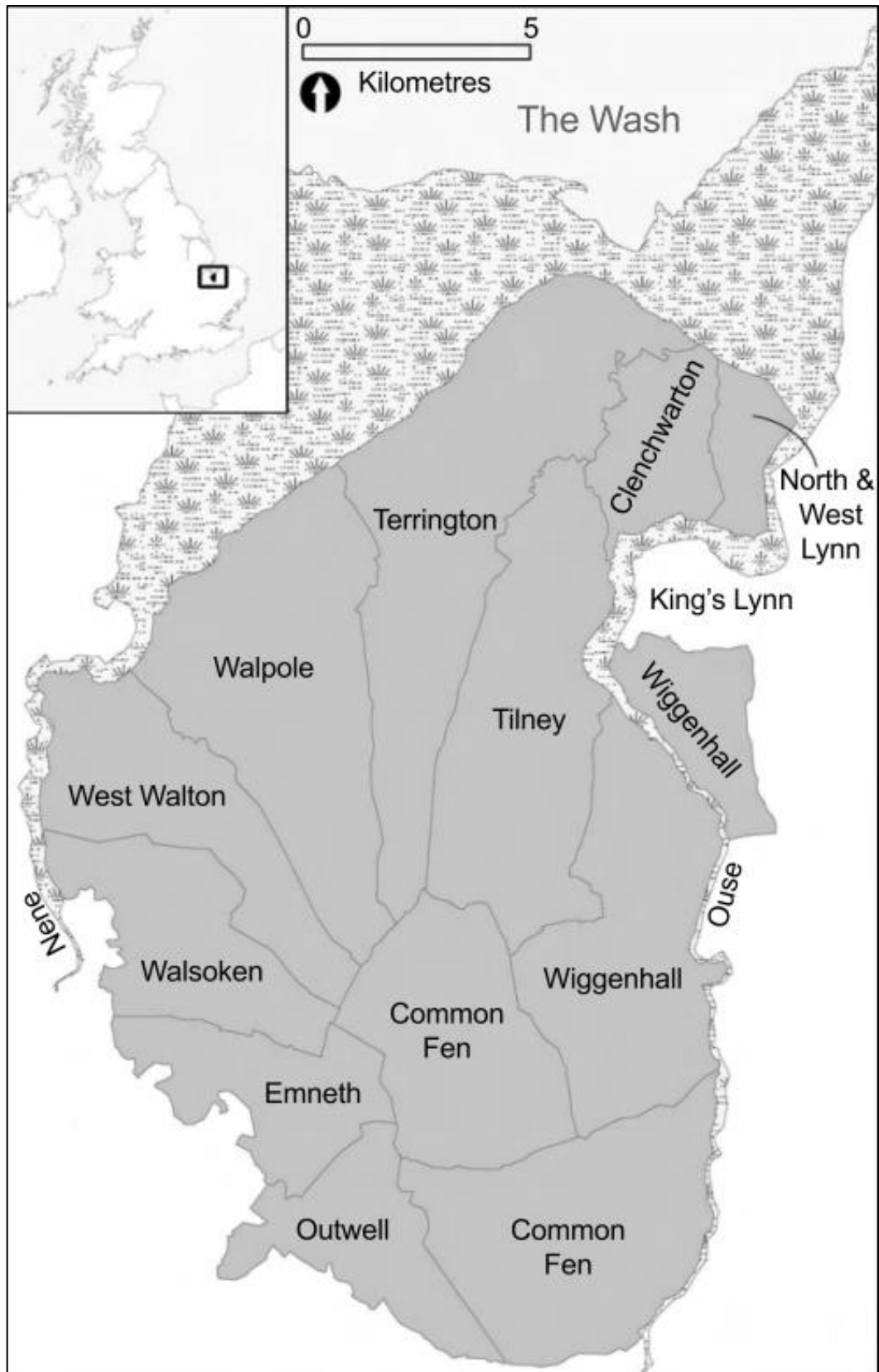


Plate 1.4: The parishes upon the Norfolk Fens, showing the medieval courses of the River Great Ouse and River Nene (Brown 2023: 70)

2 LITERATURE REVIEW

2.1 Historiography of Medieval Saltworking

Documentary Research: Grants, Rolls, and Domesday

Early research into medieval saltworking, such as Bridbury's (1955) work, primarily relied on contemporary manuscripts to examine the significance of salt as a commodity, its role in trade, and its economic impact during the medieval period. In England and on the Continent, many early salt production grants were linked to ecclesiastical centres (Keen 1988). Although Bridbury's (1955) research lacked archaeological evidence, focusing on the trade and ownership of salt in north-western Europe rather than production methods, he correctly suggested that the *sleeching* techniques used in Lincolnshire and Norfolk were akin to those that produced mounds in the Low Countries.



Plate 2.1: Saltpans in eastern England noted within the Domesday Book of 1086 (Darby 1977: 264)

The Domesday Book is crucial for understanding saltworking before the late Saxon period. Prior to recent excavations outside King's Lynn (Clarke 2023), our knowledge of saltworking upon the Norfolk Fens largely relied on this source and other sparse documentary references (Bell *et al* 1999). While Darby's (1952; 1977) research did not focus exclusively on saltworking, it provided valuable insights by analysing the Domesday Book regionally. Darby (1952; 1977) mapped the saltworks recorded, identifying a significant cluster of saltworks in north-western Norfolk, along with concentrations in the Lincolnshire Fenland and Norfolk Broads (Plate 2.1). It is important to note that, while the distribution of saltworks recorded within the Domesday Book is useful on a regional scale, their locations are largely nominal. For instance, West Lynn is included within the broader Lynn *vill* on the eastern side of the River Great Ouse (Table 2.1). As Darby (1952; 1977) acknowledged, the absence of an industry in the Domesday Book does not confirm its non-existence; for example, medieval saltworks are evidenced in Cambridgeshire (Owen 1975a; Lane *et al* 2019), yet none are recorded in the region. Moreover, some saltworks appear in upland *vills* too far inland to have feasibly functioned, even considering coastal changes since the medieval period (Owen 1975a). Lords of upland manors likely acquired land to access resources, like salt, unavailable in their own estates (Roffe 2005: 10). This is likely true for the upland manors in north-west Norfolk, where salt pans are recorded in the Domesday Book (Table 2.2). Many of these saltworks were likely part of the expansive complexes of King's Lynn, though some may have been located further west.

Table 2.1: The siltlands manors of between the River Great Ouse and River Nene, in addition to those of Lynn, recorded as holding saltworks within the Domesday Book		
The Settlements between the River Great Ouse and River Nene		
Manor	Tenure	Salt Workings
Islington [now Tilney]	Manorial Lord	2
	Manorial Lord	½
	Free Man	1
	Free Man	4½
	Manorial Lord	½
Terrington	Manorial Lord	7
	Manorial Lord	5½
West Walton	Manorial Lord and Free Man	14
	Manorial Lord	24
The Settlement of Lynn		
Lynn (King's Lynn, North Lynn, South Lynn and West Lynn)	Free Man	1
	Free Man	1
	Free Man	2½
	Sokemen	5

Table 2.2: The upland manors of north-west Norfolk recorded as holding saltworks within the Domesday Book	
Manor	Salt Workings
Anmer	1½
Ashwicken/Bawsey	½
Bawsey	1½
Castle Acre	5½
Castle Rising	13
Congham	1
East Winch	1½
Gayton	1½
Harpley	½
Hillington	1
Middleton	18
Necton	1
North Runcton	4
Roydon	3½

Research into saltworking prior to the Domesday Book is hampered by a lack of archaeological evidence and sparse documentary sources. Nevertheless, Keen (1987; 1988) provides valuable insights, citing early references to saltworking in ecclesiastical grants. One of the earliest, from 774, records King Cynewulf granting Æthelmod, Bishop of Sherborne, land along the River Lym in Dorset for saltworking to flavour food and for religious services (Keen 1988: 134). This grant reflects an 8th century trend of Saxon kings allocating land to monastic houses and thegns for saltworking (*ibid*: 133-136). Such early grants suggest that many saltern mounds predate the Norman Conquest, indicating a long historical development of the salt industry, with salterns being significant economic assets even in this early period.

Saltworking on the Fens

Utilising the Domesday Book alongside other documentary sources, although largely devoid of archaeological evidence as noted by Frere (1961: 105), Hallam (1960) and Rudkin and Owen (1960) studied saltworking during the medieval period upon the Lincolnshire Fens and Lindsey Marshland. These studies highlight a pattern in early salt production research in eastern England, where Lincolnshire salterns received more attention than those in Norfolk. This discrepancy is likely due to the better preservation of Lincolnshire salterns as rural earthworks, while many Norfolk salterns have been lost to urban development and intensive agriculture (Clarke 2023). Despite this disparity, research into Lincolnshire saltworks provides valuable parallels for understanding Norfolk's salterns, given their environmental and cultural similarities.

Owen's (1975a) research, following the influential conference on salt at the University of Essex, was the first to focus on medieval salt production in north-west Norfolk – an industry that had "hitherto gone largely unnoticed" (Owen 1975a: 43). Through field surveying, Owen identified saltern mound (*hoga*) complexes in West Walton, Terrington St Clement, and north of King's Lynn. Owen (1975a) posited that several medieval churches and villages were established on these elevated mounds, and convincingly demonstrated that the industry was more extensive than recorded in the Domesday Book. This is somewhat self-evident given that saltworks functioned before and after the Domesday survey. Additionally, Owen (1975a) attempted to construct a narrative of the industry, using documentary sources to provide insights into the trade mechanics and the relationships between saltern tenants and their respected bishops and lords.

Owen (1975a; 1975b; 1984; 1993) also extensively explored the relationship between sea banks and salterns; however, contrary to Owen's assertion that active salterns would not be located behind sea banks (1984: 46), later investigation has established that more landward salterns were often supplied with water via tidal streams and channels culverted through sea defences (Silvester 1988; Hall and Coles 1994: 145). Our understanding of the connections between saltworks and sea banks, as well as other landscape features like tidal streams, was limited until influential landscape-scale surveys produced substantial datasets that enhanced our insights.

2.2 Landscape Surveys

The *Fenland Project*, through extensive fieldwalking and small-scale excavation, uncovered numerous previously unknown archaeological sites across the Fens (Silvester 1988; Hall and Coles 1994). This project clarified the complex geological and environmental history of the region while documenting anthropogenic activities, creating a comprehensive archaeological database (Plate 2.2). Notably, it established a detailed historical narrative for each parish, identifying many salterns in the siltlands of the Norfolk Fens, particularly in Terrington St Clement and West Lynn (Hall and Coles 1994: 143-145). While no intrusive investigations of the salterns were conducted, pottery fragments and other artefacts recovered from the surface of these mounds and immediate surroundings offer valuable insights for future reassessment and analysis regarding the chronological development of saltern complexes.

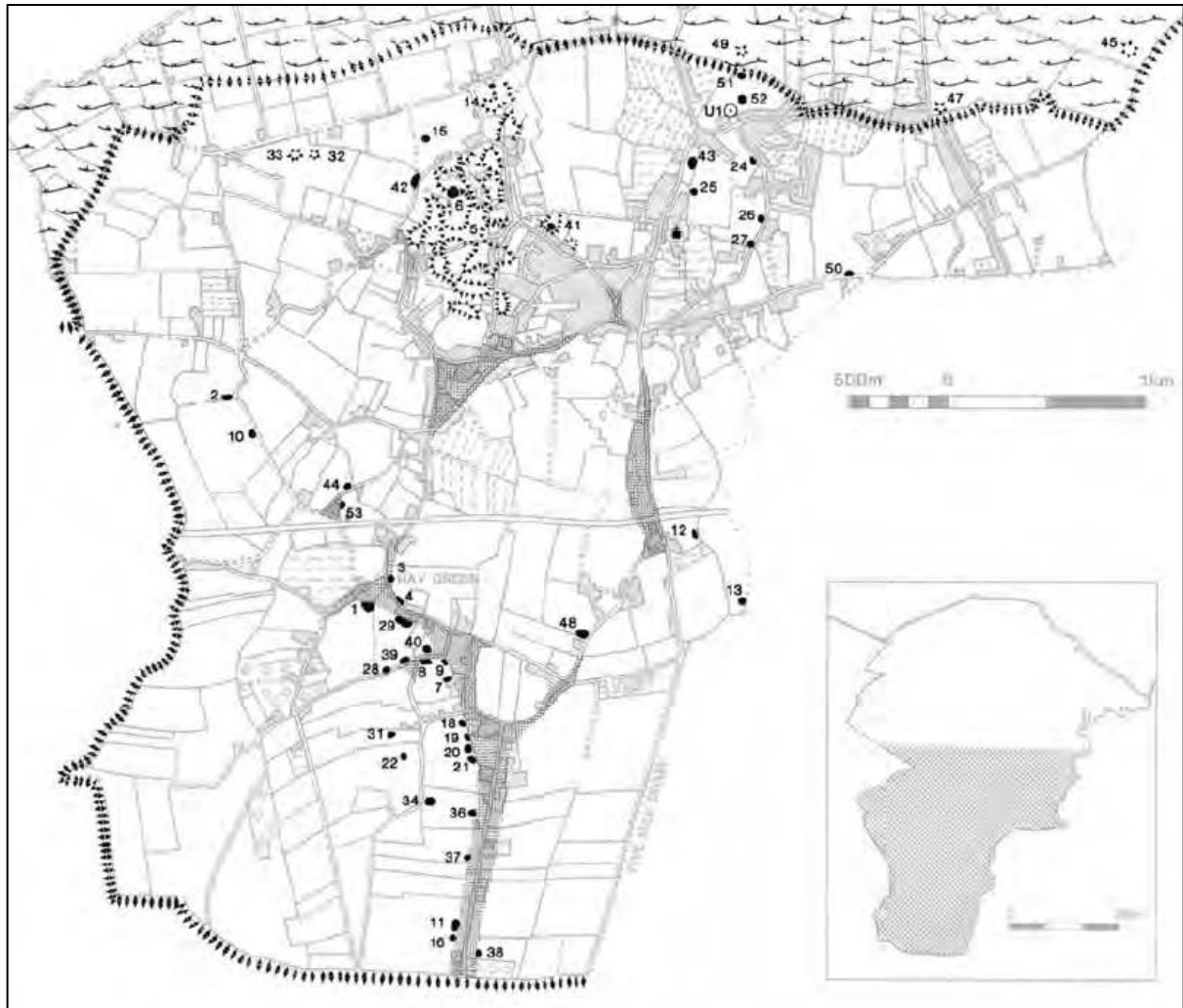


Plate 2.2: *The sites identified during The Fenland Project, showing the medieval landscape of Terrington St Clement and its expansive saltern complex (Silvester 1988: 39)*

The Fenland Project nevertheless had notable limitations. Firstly, it could not identify sites that were not visually discernible during fieldwalking, particularly those extensively affected by ploughing and truncation. Additionally, some potentially significant areas were excluded due to access issues or poor fieldwalking conditions (Plate 2.3). Furthermore, the limited samples of *surface* artefacts recovered left the chronological interpretation of these sites incomplete and somewhat outdated. This is particularly evident in the inference that “even if early and middle Saxon salting occurred, it could not have been on the scale needed to produce the high ridges now visible” (Hall and Coles 1994: 165); an interpretation conclusively contradicted by recent excavations near King’s Lynn (Clarke 2023).

The National Mapping Project (NMP) significantly expanded the archaeological dataset for Norfolk’s coastal zone (Albone *et al* 2007). The project mapped and interpreted

archaeological features visible in aerial photographs, with this geospatial data now incorporated into the Norfolk Historic Environment Record (NHER). The NMP identified nearly 300 medieval saltworks along Norfolk's coast (Albone *et al* 2007: 116-119). Many of these salterns were integrated into sea banks, which were crucial for land reclamation, creating areas suitable for settlement and agriculture (*ibid.*). However, the NMP was not without limitations, including gaps in coverage and potential misidentification and misinterpretation stemming from its reliance on aerial photography and the challenges of surveying wetland environments.

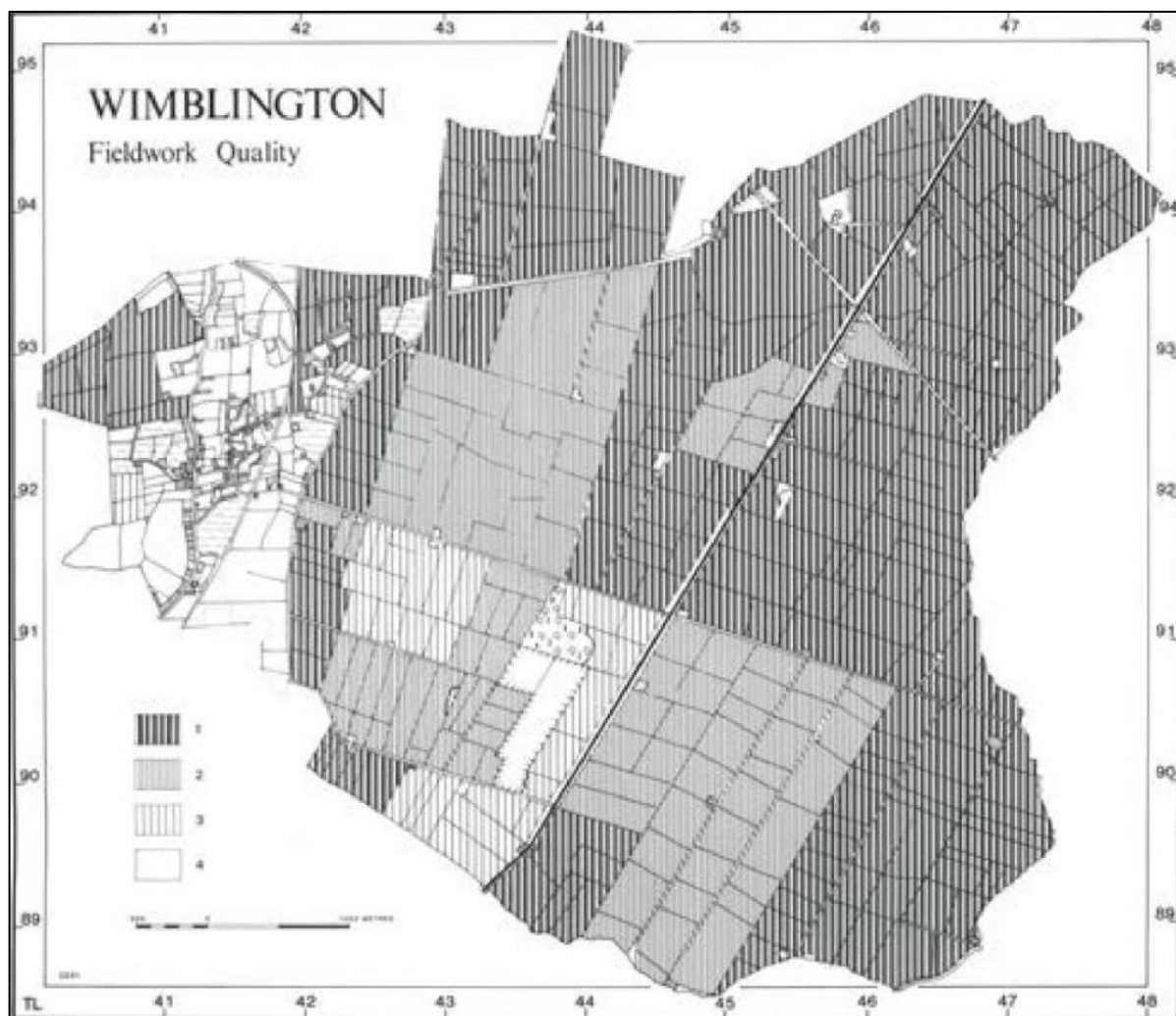


Plate 2.3: An example of the fieldwork intensity maps used in the Fenland Project survey, using Wimblington as an example (Hall and Coles 1994: 11).

Group 1: Fields were examined under very good conditions. Few sites can have been missed, given the constraints on time and space; Group 2: Fields were of several kinds: peat and fen clay fields were walked in more widely-separated transects, as were fields under pasture. Arable fields where conditions were less than ideal were also grouped here; Group 3: Fieldwalking conditions were poor, with unweathered soils or advanced crops, and where subsequent visits had not improved the record; Group 4: Areas were unvisited, most of them being under buildings or roads, or in hamlets or villages, or fields without access permission .

2.3 Archaeological Excavations

Excavations along the Lincolnshire Wash have demonstrated that processes for washing salt-impregnated sand date back to at least the 11th century, though most findings pertain to later periods (Lane 2018: 84-94). Significant sites include an 11th or 12th century saltworks at Bicker Bends (Healey 1988), a 14th century site at Bicker Haven (Healey 1975; Healey 1999; Bell et al. 1999), and the expansive, highly-organised, and well-preserved 15th and 16th century saltworks at Wainfleet St Mary (McAvoy et al. 1994; Plate 2.4).

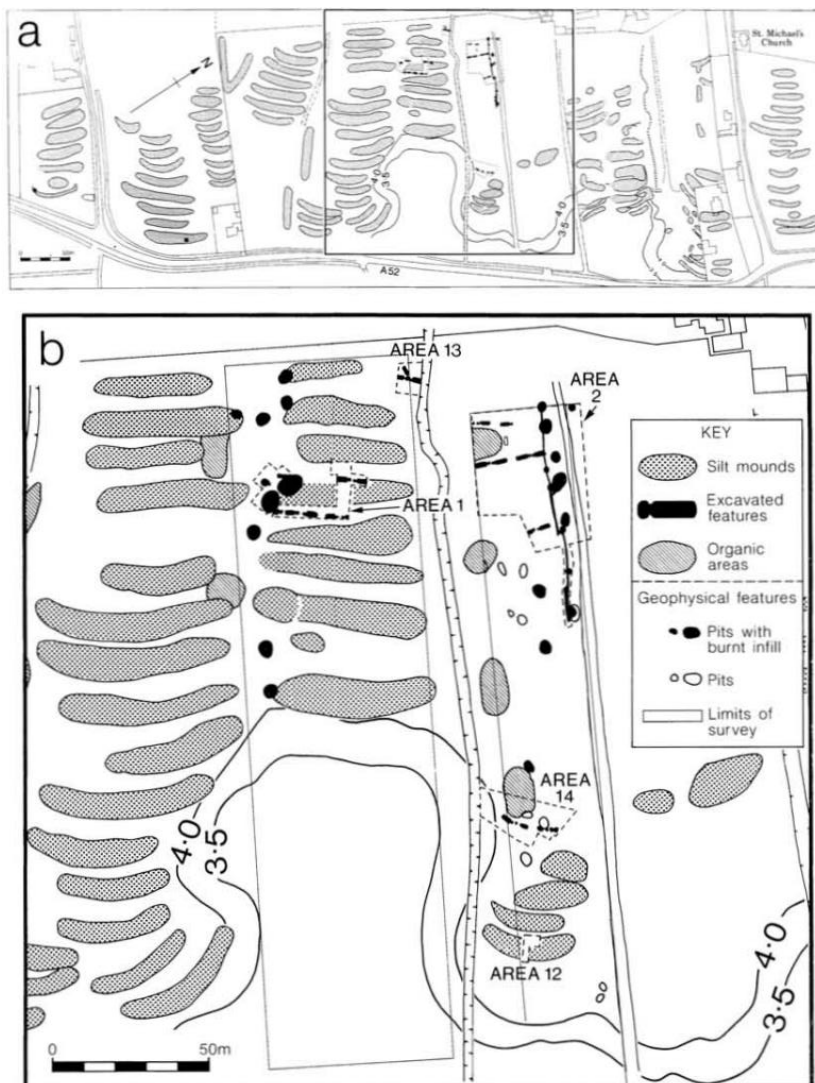


Plate 2.4: (a) General plan of features within the Wainfleet St Mary study area; (b) Plan of the excavation and geophysical survey areas (McAvoy 1994: 137)

The Lincolnshire landscape preserves numerous saltern mounds that illustrate the scale and precise locations of the industry. In contrast, Norfolk's known saltworking areas are predominantly situated in urbanised areas, significantly affected by development, much of which occurred prior to comprehensive archaeological excavations. While several salterns have been identified along the Norfolk coast, few have been excavated, and even fewer

published. Limited past excavations in north-west Norfolk (e.g., Hutcheson 1998; Mellor 2003; Mellor 2004; Trimble 2004; Stephens 2006) have provided valuable local insights. Recent, more extensive excavations east of the River Great Ouse, from which King's Lynn derives its name, have generated significant findings regarding this vital industry.

2.4 Recent Expansion of Data Sources

Recent Archaeological Excavations

Since the Fenland Project and Norfolk MNP, evidence from intrusive excavations has markedly increased, particularly from recent large-scale investigations around King's Lynn (Table 2.3). Notably, radiocarbon dating indicates that sand-washing in the region dates back to at least the 8th century (Clarke 2023: 101-103). The discovery of a middle Saxon saltworking landscape east of the Lynn has prompted a reassessment of Lincolnshire's saltworks (Lane and Fielding 2024). Bayesian modelling has established a chronology of salt production on the North Marsh, demonstrating that salt-winning techniques remained relatively consistent from the middle Saxon era into the medieval period (Clarke 2023: 98). This continuity underscores the industry's longevity over c.500 years and the stability of favourable environmental and economic conditions. Although beyond the scope of this thesis, the findings offer valuable nearby parallels.

In contrast, a limited number of excavations of saltworks have occurred between the River Great Ouse and Nene (Table 2.4). Nevertheless, some nearby excavations merit revaluation in this context (e.g. Adams 2013; Brunning and Freeman 2022). A notable investigation by Clarke and Clarke (2018) compared findings from the Walpole Electricity Substation (Site B) in Walpole St Peter and those on Marsh Lane (Site A) near King's Lynn (Plate 2.5). This study revealed changes in salt production dynamics and processing methods during the medieval and post-medieval periods, demonstrating how salt-workers adapted to environmental and economic changes.

Table 2.3: Recent excavations of salt production sites in the King's Lynn area					
Site Name		Type	Year	Reference	NGR
Marsh Lane	Marsh Lane Watching Brief	WB	2015	Clarke (2016a); Clarke and Clarke (2018); (Clarke 2018d); Clarke (2023)	TF 6349 2177
	Marsh Lane Evaluation	TT	2015	Webster (2015); Clarke and Clarke (2018); (Clarke 2018d); Clarke (2023)	TF 6352 2166

Table 2.4: Recent excavations and surveys of salt production sites between the Nene and Ouse					
Site Name		Type	Year	Reference	NGR
Beacon Hill, Terrington St Clement	Beacon Hill Evaluation	TT	2021	Lloyd-Smith and Clarke (2021)	TF 5417 2091
	Beacon Hill Excavation	EXC	2022	Podbury (2023); Podbury <i>forthcoming</i>	
Walpole Electricity Substation	Walpole Electricity Substation Geophysical Survey	GEO	2006	Stephens (2006); Clarke and Clarke (2018)	TF 4873 1636
	Walpole Electricity Substation Evaluation	TT	2008	Cooper (2008); Clarke and Clarke (2018)	
	Walpole Electricity Substation Evaluation	TT/WB	2008	Fitzpatrick (2008); Clarke and Clarke (2018)	
	Walpole Electricity Substation Excavation	EXC	2009	Clarke (2009); Clarke and Clarke (2018)	
	Walpole Electricity Substation Excavation	EXC	2013	Dransfield and Tibber (2013); Clarke and Clarke (2018)	

LiDAR Data

Remote sensing technologies, including LiDAR, have transformed landscape studies. LiDAR employs laser pulses to measure precise distances, generating three-dimensional point clouds (Glennie *et al* 2013). It detects subtle elevation changes and penetrates dense vegetation, enabling visualisations of both anthropogenic and natural features (Devereux *et al* 2008; Chase *et al* 2017). LiDAR is most effective when combined with numerous other data sources, underscoring the importance of a multi-faceted approach that includes excavation, archival research, and the analysis of cartographic sources and aerial photographs to accurately understand historic landscapes (Harmon *et al* 2006: 668). Caution is particularly necessary when interpreting LiDAR data in historic intertidal zones, as deep sediment deposits may obscure and distort features (Lobb 2016: 141-143). Nonetheless, the significance of LiDAR in saltworking landscapes is clear; it can reveal new details and features even in well-studied areas, where features may not be visible on the surface (Bewley *et al* 2005: 645).

Malone (2014) highlighted the value of LiDAR in the Lincolnshire Fenlands, where it effectively identified various sites and revealed patterns of dendritic tidal creeks and roddons. Notably, it was observed that while the HER records many saltworks in Lincolnshire, it does not fully capture the extent of medieval saltworking sites, especially around Bicker Haven and Wrangle, (*ibid.*). Lane (2018) recently highlighted LiDAR's utility in examining medieval saltworks at Wainfleet St Mary, providing significant insights into the expansion and decline of the industry. Green (2023) also utilised LiDAR to document and interpret the network of earthwork banks, creeks, and estuarine rivers crucial to Lincolnshire's salterns (Plate 2.5). This

study facilitated chronological analysis of saltern mounds and their spatial distribution in relation to often-datable sea banks. As noted by Lane and Fielding (2024: 17):

It is ironic that what archaeologists in Lincolnshire have been good at over the years is site prospection and discovery, be it through fieldwalking programmes or landscape projects, yet the biggest scientific breakthrough applied in Lincolnshire has been LiDAR, also used as a site prospecting tool, either to locate more of the mounds, including the low ones from the sand-washing sites, or the pattern of extinct creeks alongside which the earlier sites are located.

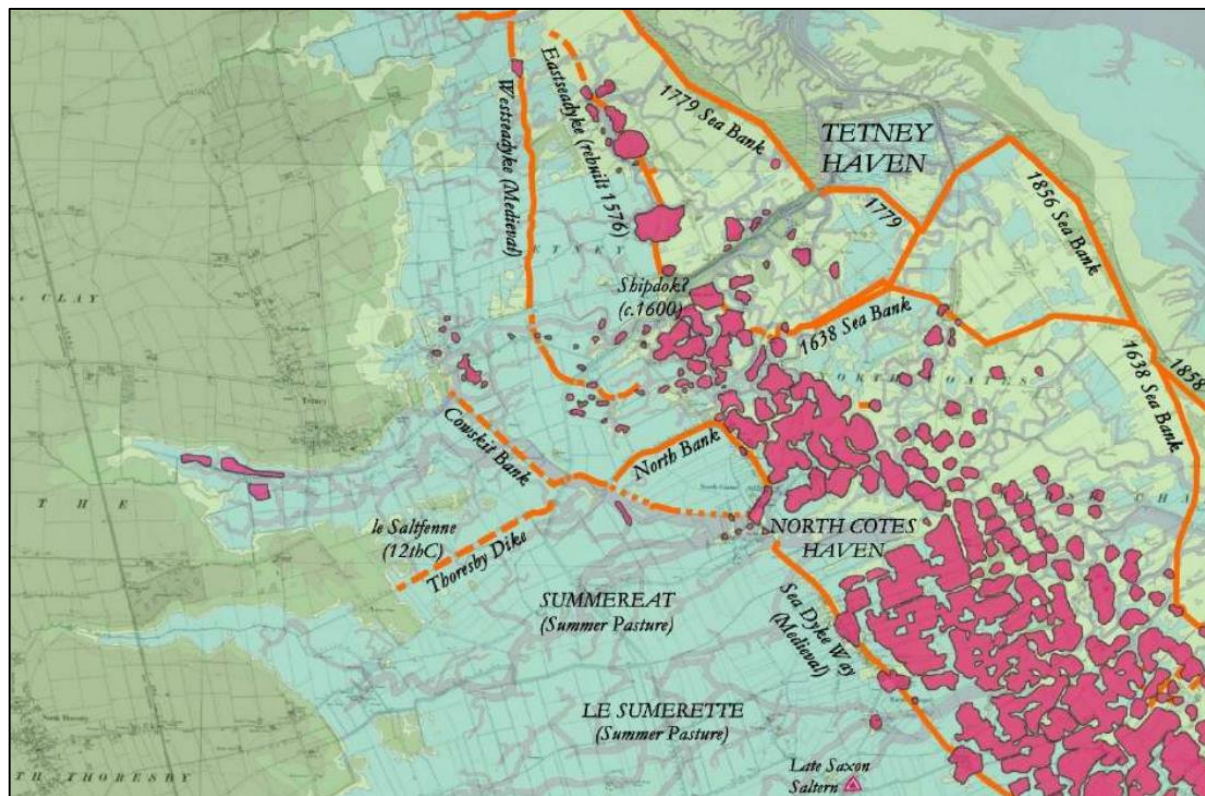


Plate 2.5: Annotated LiDAR plan showing the area from Tetney to Marshchapel in Lincolnshire, showing the location of late Saxon and medieval saltern mounds and their associated earthwork banks and creeks (Green 2023: 79)

3 METHODOLOGY

3.1 LiDAR Data

Airborne LiDAR technology produces precise digital terrain models (DTM) that reveal subtle topographic features. LiDAR measures ground height across landscapes, enhancing archaeological inquiry by providing visual representations that aid in detecting anthropogenic earthworks and geomorphological features.

The LiDAR data used in this thesis has been accessed under the Open Government Licence from the Environment Agency (© Environment Agency 2024). The LiDAR data utilised is the most current available, collected during surveys conducted in 2021 and 2022. With regards to the resolution of the data, these airborne surveys collected one point per m². While higher-resolution imagery with 60 points per m² is now achievable, such data is currently unavailable and prohibitively expensive to obtain (Shaw and Corns 2011: 77-86; Lozić and Štular 2021). The LiDAR data was processed with QGIS software, adjusting scales, height levels, and hillshade settings to enhance features. Salterns, sea defences, creeks, and other relevant features were mapped as polygons.

3.2 Historic Environment Record

The Historic Environment Record (HER) is a comprehensive database of known archaeological sites, historic buildings, landscapes, and heritage assets. It typically includes summaries of excavation reports, surveys, historical maps, aerial photographs, and other documentary sources. The HER data utilised in this thesis was obtained from Norfolk County Council (© Norfolk County Council 2024). Records were gathered from the Norfolk Fens and the Fen edge, extending east of the Lynn for additional context. Monument classifications, as defined in the *FISH Terminologies: Monument Type Thesaurus* (FISH 2021), are detailed in Appendix 2. Similar to the LiDAR data, the HER data was processed using QGIS.

3.3 Archaeological Investigations

The re-evaluation and reinterpretation of archaeological excavations between the River Nene and the River Great Ouse has likewise been undertaken. This analysis will cover sites with confirmed early medieval or medieval salt production, as well as those with ambiguous or overlooked evidence of saltworking. Special attention has been given to features potentially linked to salt production, such as hearths, brine/water tanks, briquetage, and possible waste

by-products. Excavation reports from the Norfolk HER, Oxford Archaeology's online library, and the Archaeology Data Service (ADS) database have been used for this analysis. Validation of findings included cross-referencing with historical records and results of other investigations.

3.4 Integration and Analysis

The integration and analysis of various data sources form the core of methodology of this thesis. By synthesizing LiDAR data, HER data, cartographic sources, aerial photographs, academic papers, and excavation reports, a multi-faceted understanding of the historical landscape is achieved. This combined analysis provides a comprehensive and nuanced interpretation of salt production sites, and improves the accuracy of saltern mound prospection. The integration of these data sources was achieved using QGIS, which facilitates the spatial alignment and overlay of various datasets to identify correlations and discrepancies. The integrated datasets were systematically analysed and cross-referenced to validate findings; for example, LiDAR data was used to confirm the presence of saltern mounds identified in aerial photographs. This approach also helped identify previously unrecognised or misinterpreted archaeological features. A workflow diagram (Appendix 3) illustrates the methodological process.

Similar to the Fenland Project (Silvester 1988), the data analysis is organized by parish or groups of parishes where appropriate. This approach provides a localised and detailed understanding of salt production activities and their distribution, helping to identify broader trends and variations in saltworking practices across the Fens.

4 ANALYSIS: PROSPECTING AND INVESTIGATING SALTERN MOUNDS

4.1 Terrington St Clement

Several saltern mounds have been recorded in Terrington, initially by Owen (1975) and later mapped in the Fenland Project (Silvester 1988). Owen (1975) also provides some useful documentary context for the industry here which, though too lengthy to include here, is discussed in Appendix 4. While some were scattered across the parish, most were concentrated near Orange Row, south of the Sea Bank. Multi-faceted analysis has identified further, though potential, saltern mounds (Drawing 1). LiDAR imagery largely confirms the topographic mapping of the Fenland Project (Plate 4.1-4.2), but recent excavations and LiDAR evidence suggest the complex was slightly larger than previously thought (Plate 4.3).



Plate 4.1: *Satellite imagery of the Orange Row saltern complex.*

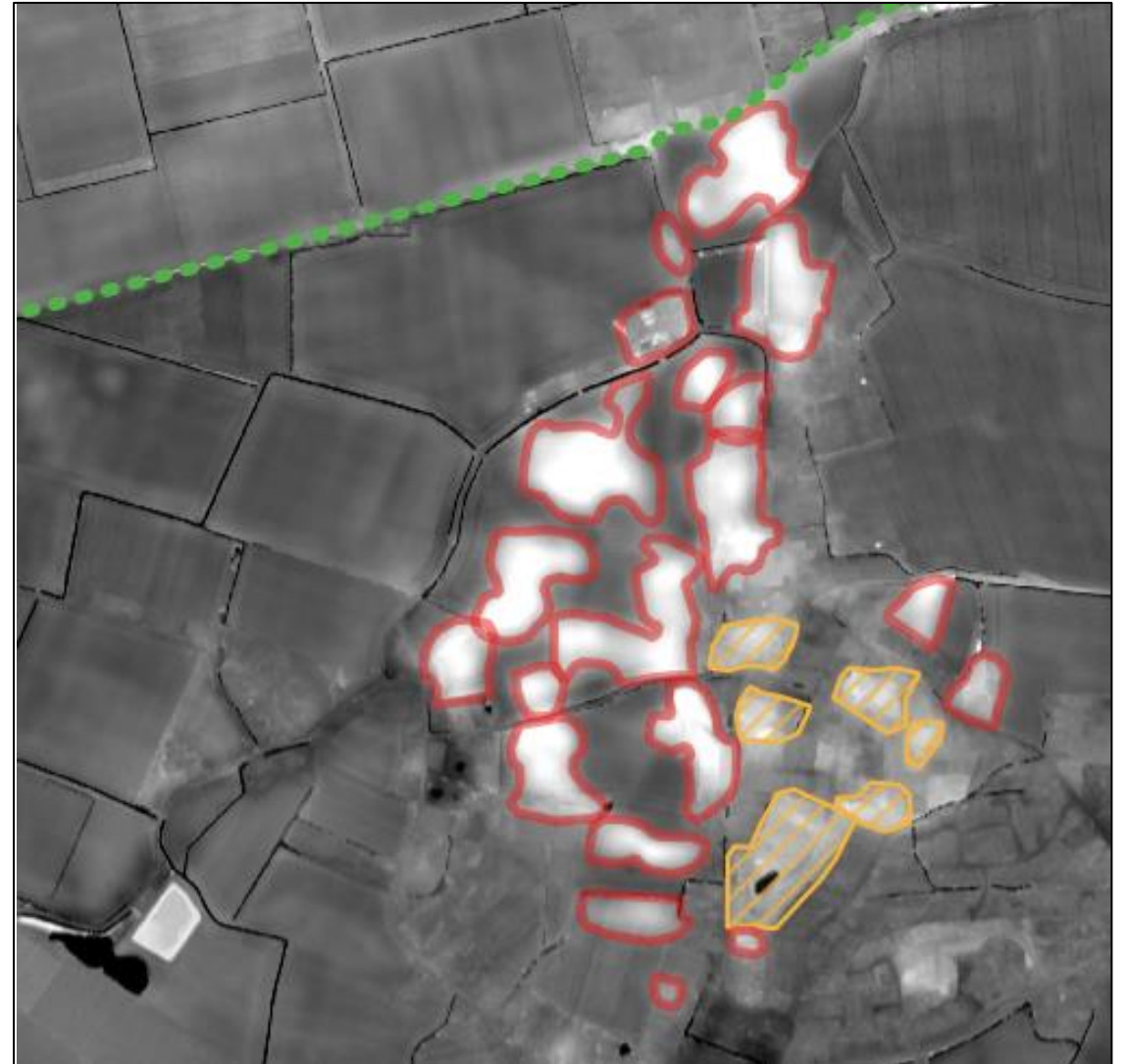


Plate 4.2: [Above] The Orange Row saltern complex recorded during the Fenland Project (Silvester 1988).

Plate 4.3: [Right] The Orange Row saltern complex as viewed via LiDAR imagery – demarking the Sea Bank (green); potential saltern mounds in developed areas (yellow); and saltern mounds (red).



Plate 4.4: [Top] Hearth waste and desalinated silts found at the Beacon Hill site, sealed by modern construction deposits. [Left] One of the clay-lined silt filtration structures revealed at Beacon Hill (Podbury 2023)

Two excavations near the northern edge of the saltern complex, in areas previously recorded as lacking mounds, have offered new insights. Trial-trenching at Belmont Nursery, just beyond the Sea Bank (Hutcheson 1998), was the first excavation in the Orange Row area. It revealed a probable medieval saltworking mound to the south, evidenced by burnt silt and hearth waste, and a single sherd of Grimston ware pottery from the 12th to 15th century. Further south, at Beacon Hill, excavations uncovered a complex stratigraphy of desalinated silts and hearth waste (Plate 4.4), in addition to a series of clay lined features, with pottery evidence dating saltworking to the 11th to 12th centuries (Podbury 2023). Stratigraphic and artefactual evidence indicates saltmaking likely continued beyond the 12th century, but much was

probably destroyed by early-19th century farmstead construction. A late hearth waste deposit, directly overlain by post-medieval or modern building sand, suggests later deposits were likely truncated (*ibid.*).

The construction of a farmstead on elevated terrain, which is less susceptible to flooding (*cf.* Powell 2009), likely accounts for the failure to identify the mound during the Fenland Project, as the associated landscaping would have truncated its former prominence. Unlike other mounds within the complex, the Beacon Hill saltern is not readily discernible in the LiDAR imagery. This issue, where modern construction occurs over potential saltern sites, complicates efforts to accurately define the extent of the Orange Row saltern complex. While the morphology suggests that modern development has obscured a substantial portion of the salterns, conclusive evidence can only be obtained through intrusive excavation. It remains plausible that landscaping associated with these developments could mimic the appearance of large mounds.



Plate 4.5: The watching brief conducted at the Church of St Clement (Bull 2011).

The possibility that the historic core of Terrington St Clement, particularly the Church of St Clement, was built on saltern mounds has been debated by archaeologists. The church, largely constructed in the 15th century, encompasses reused Anglo-Saxon masonry and Norman architectural elements (Mortlock and Roberts 1985). Owen (1985) and Keen (1988) argue that the church stands on a remnant mound, while Silvester (1988) posits that the elevation is due to silt-ridged roddons Silvester further refutes the saltern mound theory, suggesting that the presence of late Saxon pottery in this area would imply an improbably early origin for saltworking; however, recent excavations at King's Lynn suggest that saltworking may have begun as early as the 7th or 8th century (Clarke 2023).

Since the aforementioned, somewhat superficially evidenced theories, new evidence from excavations and LiDAR offer the potential to enhance this discourse. Similar to the 'developed' but elevated areas at Orange Row, two conspicuously elevated areas exist within the historic core of the village: one at the Church of St Clement, and another north of its graveyard. A watching brief near the church provided an opportunity to test these theories, but its shallow depth (Plate 4.5) only revealed topsoil and subsoil (Bull 2011). It was not excavated to the depths necessary to reveal saltworking or roddon remains. It remains plausible that landscaping efforts raised the ground upon which the church is founded, potentially masking roddon or saltern remains.

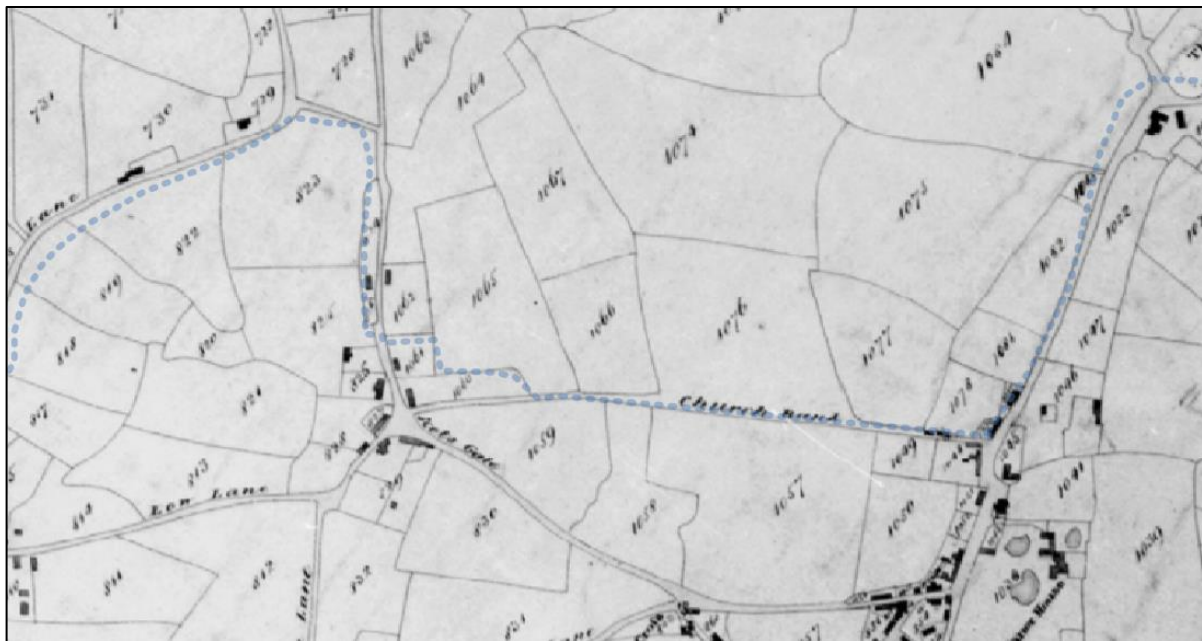


Plate 4.6: Overlay of the potential sea defence pre-dating the Sea Bank (blue) upon the tithe map of Terrington St Clement, showing the Church Bank.



Plate 4.7: The hypothesised sea defence pre-dating the Sea Bank (orange), the Sea Bank (green), potential saltern mounds in developed areas (yellow), and saltern mounds (red).

An earthwork bank associated with the Church of St Clement, and potentially linked to salt production, nevertheless warrants further investigation. Visible on LiDAR data and denoted as *Church Bank* on the 1841 tithe map of Terrington St Clement, this feature may be part of an early sea bank (Plate 4.6-4.8). This potential bank would have predated the Sea Bank to the north, possibly dating to the 10th or even 9th century. Silvester (1988) cursorily suggested that this early sea defence might have been located along the winding road near *South Newland Field*, with the western portion marked by the road north of *West Field* (Plate 4.6). LiDAR data supports this theory, showing that saltern mounds in Orange Row, particularly south of *South Newland Field* and *Perkin Field* (see Plate 4.9), conspicuously did not extend beyond Beacon Hill Lane to the north and northwest, suggesting a possible earlier sea bank along this road.

Silvester (1988) nevertheless does not consider that the earlier sea bank, which likely follows Beacon Hill Lane and bounds the complex, may have extended along the historical earthwork of *Church Bank* (Plate 4.7). Instead, Silvester suggests the bank continued north from the salterns to the Sea Bank – something which does not correlate with LiDAR data, nor with known boundaries. Given that many sea defences later became roads, it is plausible that *Churchgate Way*, the principal road through the historic core of Terrington St Clement, may have formed the eastern arm of this theorized sea bank beyond Church Bank. This eastern

section of Churchgate Way appears to lead directly into a conspicuous right-angle of the Sea Bank, suggesting it may have been one of several smaller parish defences incorporated into the Sea Bank in the 10th or 11th century.

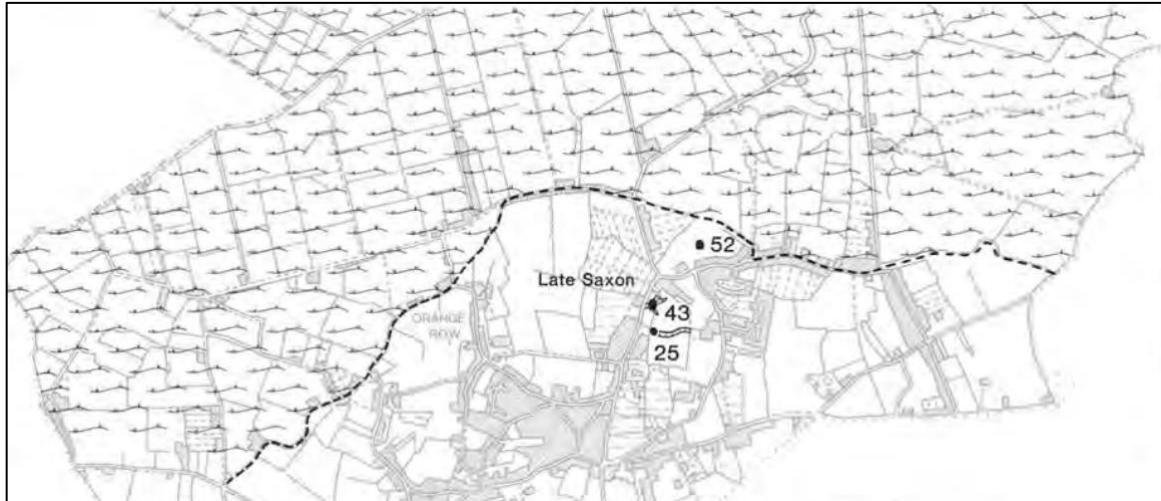


Plate 4.8: The hypothesised sea defence pre-dating the Sea Bank, as depicted by Silvester (1988).

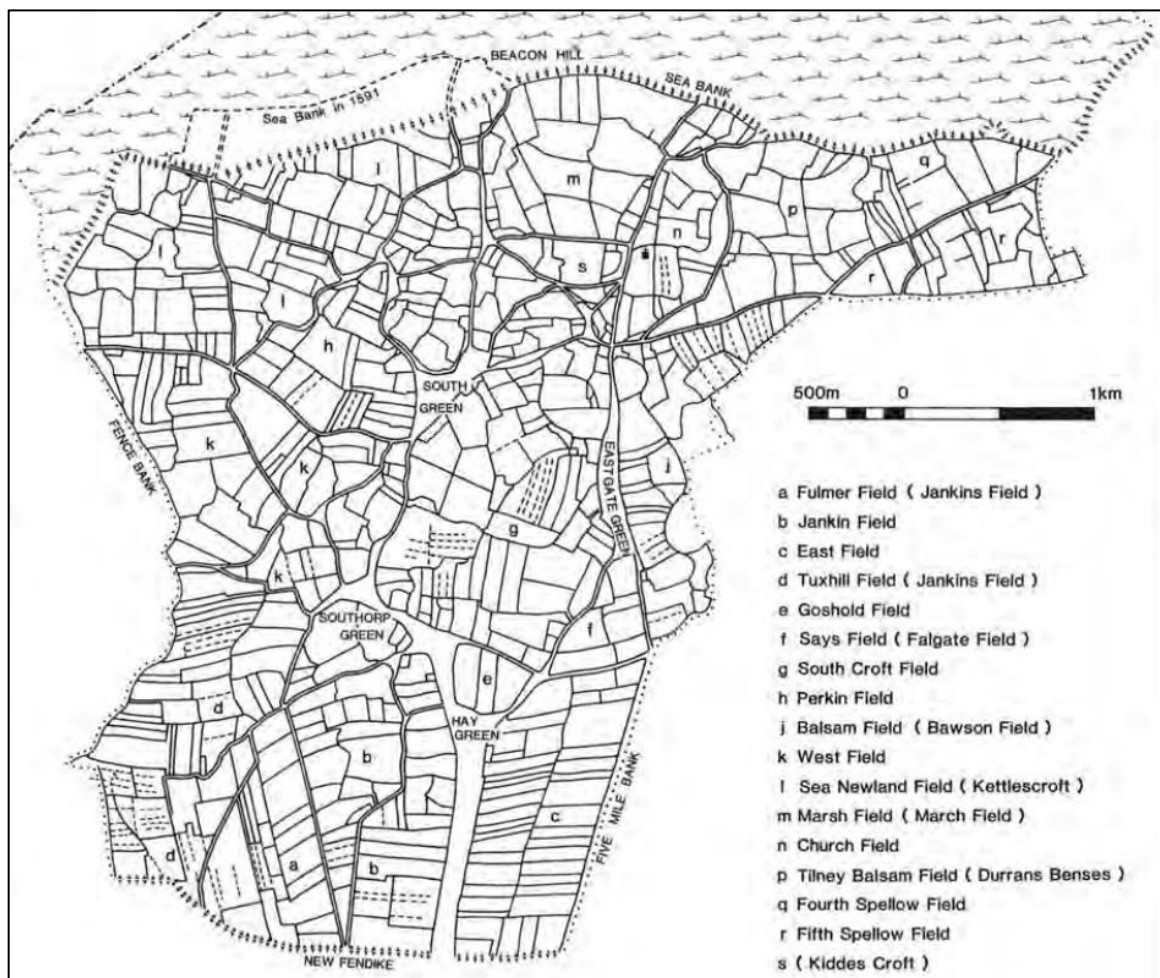


Plate 4.9: The early field names of Terrington St Clement as drawn by Silvester (1988).

The presence of this earlier bank suggests that some saltern mounds in the south of the Orange Row complex may be relatively early, possibly dating to the middle Saxon period, due to the typical and gradual land reclamation process associated with saltworking (Silvester 1999; Rippon 2009; Simmons 2014; Simmons 2017; Simmons 2018). Although no excavations have been conducted in this southern area, fieldwalking has recovered pottery dating to the 13th or 14th century from the surface of a mound (Silvester 1988). Nevertheless, this ‘surface’ date does not accurately reflect the age of the mound, not only because the particulars of pottery deposition are unknown, but because these mounds accumulated over multiple seasons, so earlier evidence of salt-working could be buried deeper within the mound.



Plate 4.10: *The salterns (red), the course of some of the former tidal creeks or watercourses in the area (blue), the Sea Bank (green) and the eastern limit of the parish (yellow).*

While three previously unidentified potential saltern mounds have been prospected on the landward side of the Sea Bank, most mounds identified via LiDAR are located to the north of the Sea Bank. Nineteen of these mounds, situated in the east of the parish, are isolated and functionally associated with former creeks (Plate 4.10). This connection between salterns and creeks is well-documented in the Lincolnshire Fens, such as at Saltfleet Haven and Mar Haven (Green 2023). Their proximity to watercourses and position beyond the Sea Bank made them

particularly vulnerable to inundation, and therefore abandonment, which may explain why they did not develop into larger complexes.

LiDAR data, confirming the presence of a single salt-working mound recorded by the Norfolk NMP (HER 27163), also reveals a small saltern complex at Green Bank Farm (Plate 4.11). These mounds are likewise visible as pale soilmarks on satellite imagery. Located about 850 meters north of the Sea Bank, in an area excluded from the Fenland Project survey due to its marshland location, this group includes at least three probable and three potential saltern mounds. Situated near a tidal creek noted in 19th century maps and discernible on aerial photographs, but not clearly visible on LiDAR (Plate 4.8), these mounds are also close to the *Bentwick's Embankment* built in 1775 (HER 27191).

Analysis of aerial photography has revealed that two purported saltern mounds recorded during the Fenland Project, in reality represent different archaeological features. This highlights the challenges of identifying salt-working mounds using only fieldwalking or indeed LiDAR data, as the feature appears to be a ditched enclosure or moat (Plate 4.12-4.13). It would have been easy to misinterpret this mound solely on LiDAR evidence, underscoring the need for multi-faceted investigations to accurately define potential salterns.



Plate 4.11: Satellite imagery showing the area of salterns north of Green Bank Farm, showing the soilmarks of salterns (red) and a tidal creek or channel (yellow).



Plate 4.12: *Satellite imagery showing the archaeological features formerly identified as two salterns from fieldwalking.*

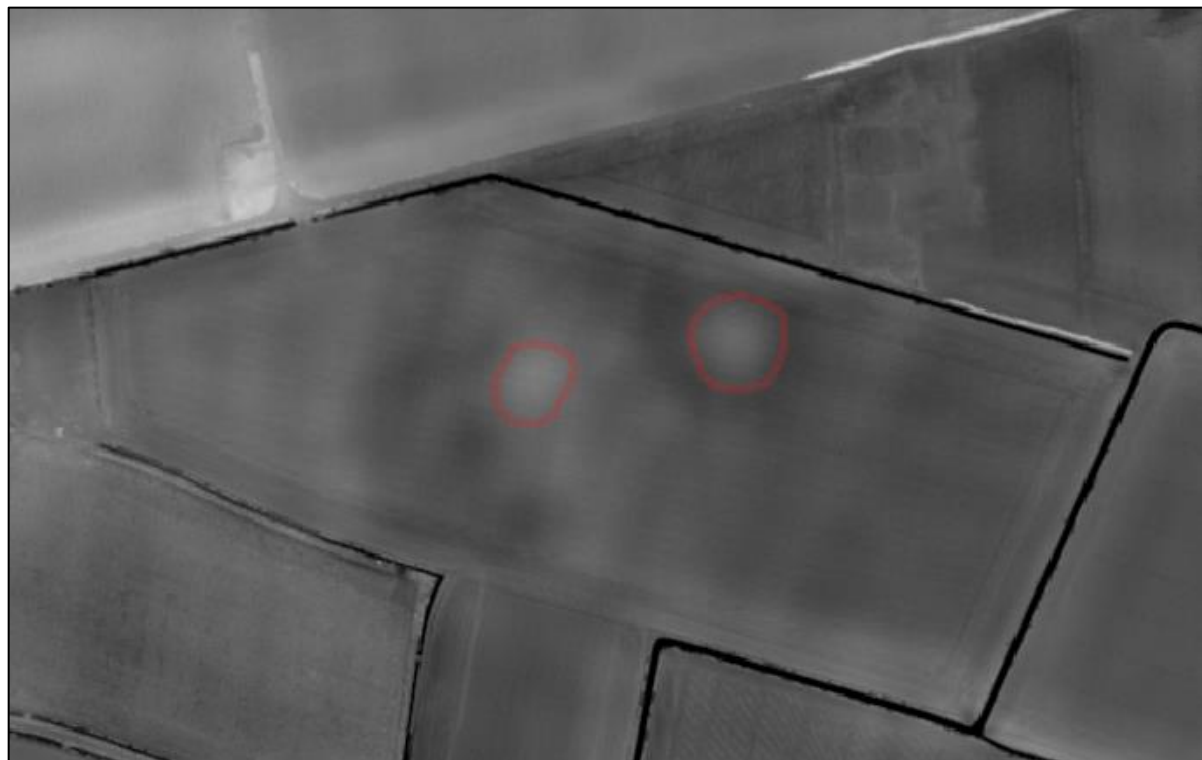
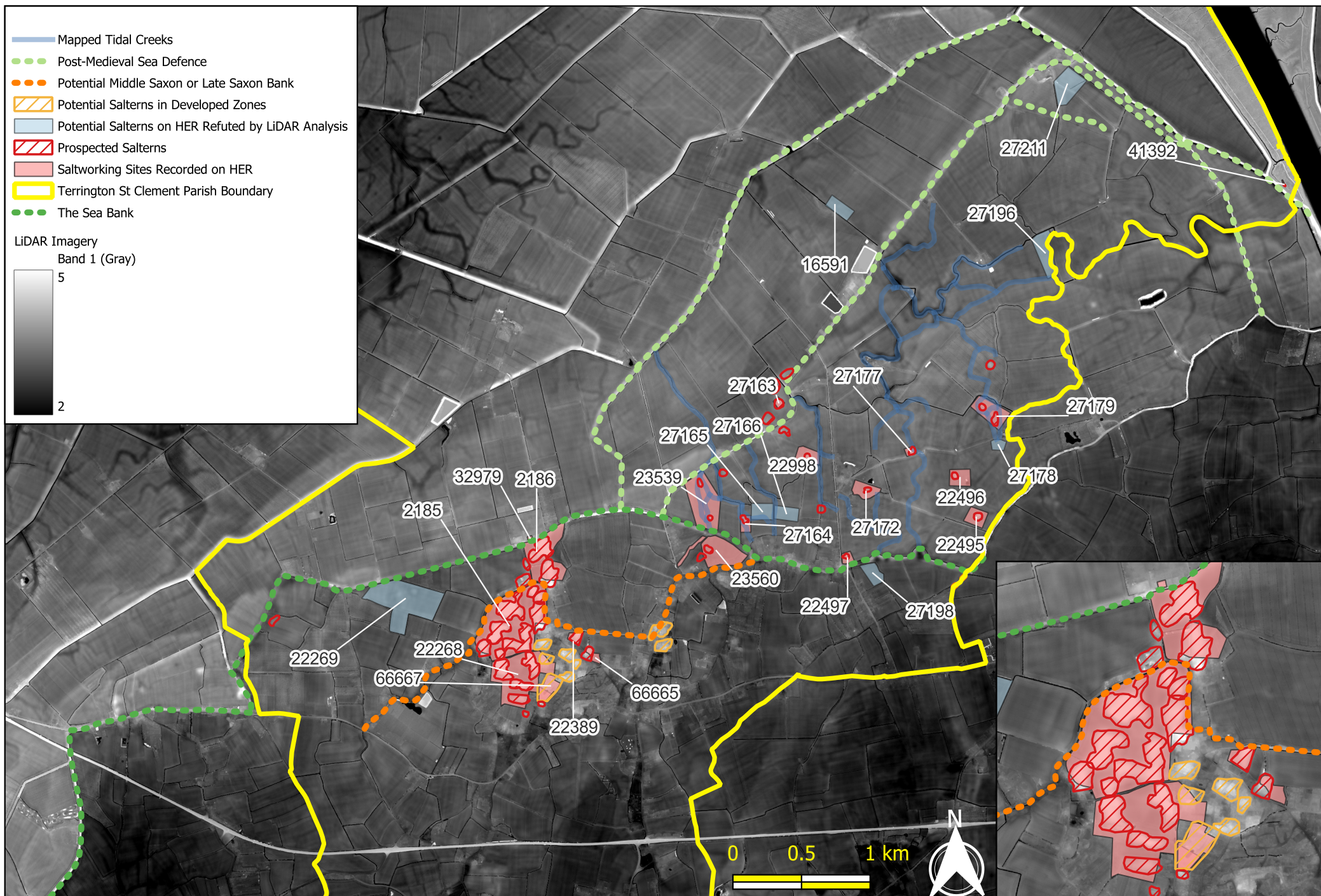


Plate 4.13: *LiDAR imagery showing the archaeological features formerly identified as two salterns from fieldwalking.*



Drawing 1: Terrington St Clement LiDAR and HER

4.2 Clenchwarton

During the Fenland Project (Silvester 1988) and Norfolk MNP (Albone *et al* 2007), five saltern mounds were recorded in Clenchwarton (Plate 4.14). LiDAR analysis has revealed several previously unknown saltern mounds in the parish (Drawing 2). Many are relatively inconspicuous, possibly due to intensive agricultural denuding their former prominence.

Near the historic core of Clenchwarton, two additional concentrations of salterns have been prospected. The westernmost complex is located 365 meters east of the largely flattened *War Dyke* (or *Bar Dyke*), believed to date to the 11th century (HER 253288). This area was not surveyed during the Fenland Project due to access issues, and the Norfolk NMP did not identify any salterns. Within this complex, four salterns are generally sub-circular (Plate 4.16); however, a potential elongated saltern mound to the south may contrarily represent upcast from a nearby drainage dyke. Notably, medieval pottery was recovered from adjacent fields during fieldwalking (HER 22590; 22591).

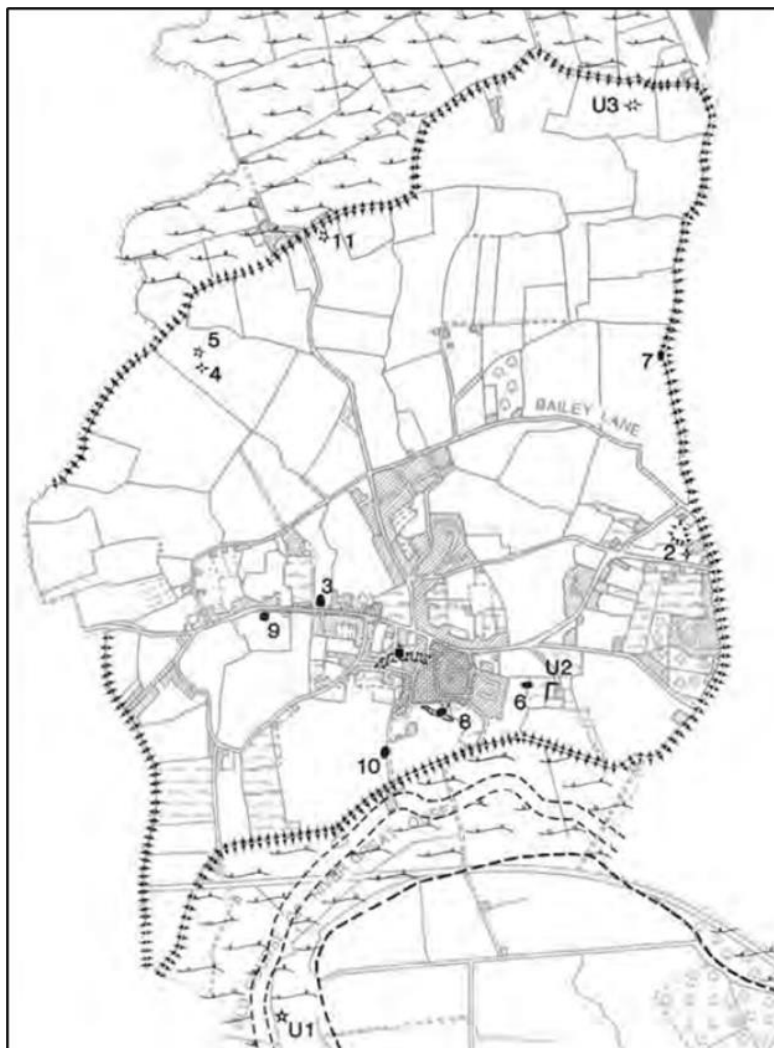


Plate 4.14: Medieval Clenchwarton as recorded during the Fenland Project (Silvester 1988)

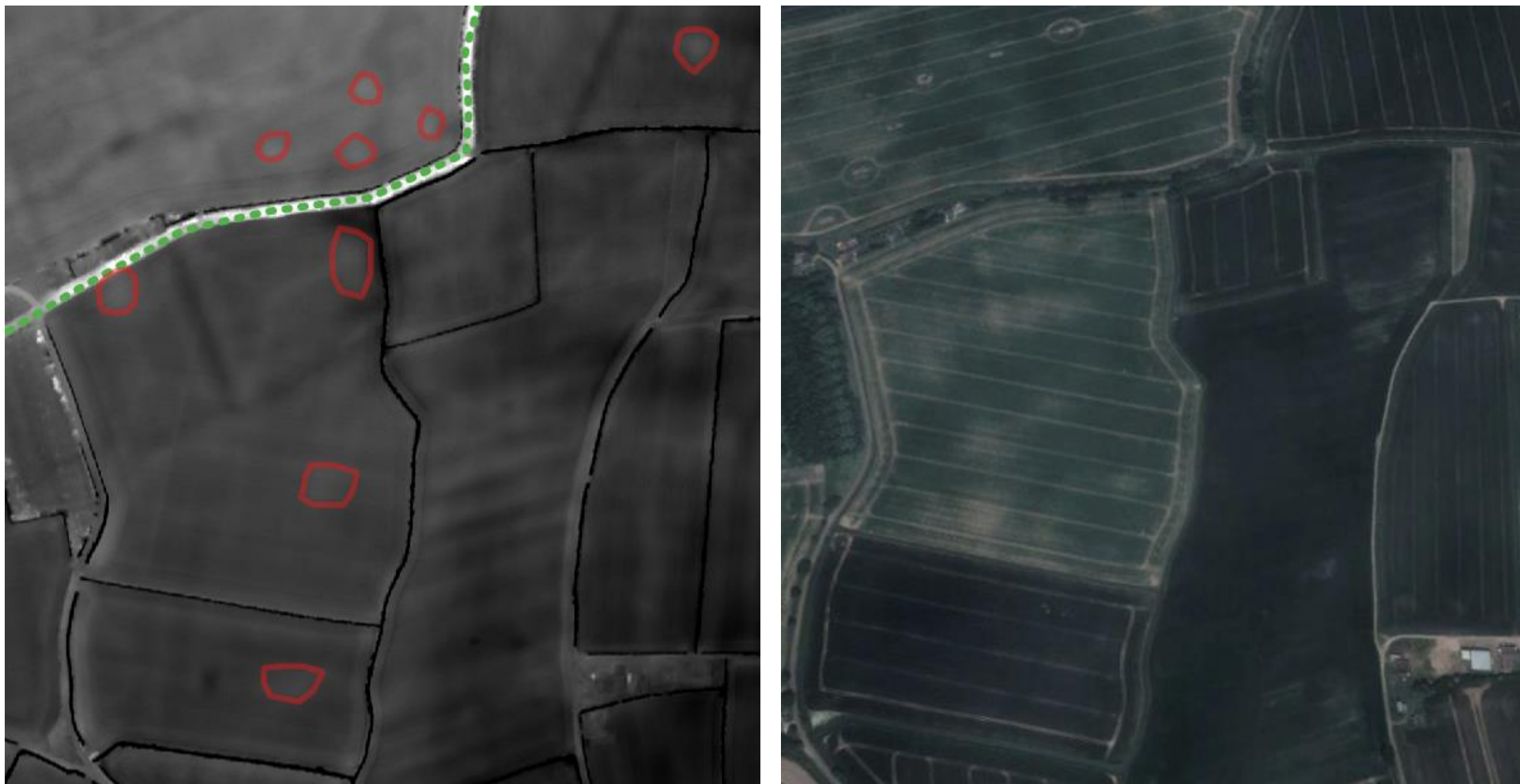


Plate 4.15: *[Left] LiDAR imagery showing the saltern mounds (red) close to Banklands Farm, beyond and within the Sea Bank (green); [Right] satellite imagery showing the soilmarks of potential saltern mounds.*



Plate 4.16: *The western saltern complex (red) close to Clenchwarton, the Sea Bank (green); the War Dyke (blue); and the parish boundary (yellow).*

Near the eastern extent of the Sea Bank in Clenchwarton, a potential concentration of five low mounds are identifiable (Plate 4.17). These mounds are situated close to a tidal creek that may pre-date the Sea Bank or was culverted to supply the saltworks. The easternmost mound, noted by Silvester (1988) as a possible saltern, is now within a tree plantation established around 2002; however, LiDAR imagery reveals a noticeable, sub-circular elevation in this area. During a survey before the plantation, it was suggested that this mound might be upcast from a nearby pond, noting that the soil "does not appear especially salty" (HER 20879). This observation is speculative without soil salinity measurements, and regardless any deposits would consist of *desalinated* waste silts if related to saltworking. The westernmost mounds of the hitherto unidentified complex were interpreted during the Norfolk NMP as an undated bank that may pre-date the Sea Bank associated with medieval pottery (HER 27202). The potential identification of salterns here does not contradict this interpretation; banks were often constructed by linking abandoned saltern mounds (Owen 1984: 45-46; Green 2023: 84-85).

In the north-east of Clenchwarton, on the seaward side of the Sea Bank, LiDAR analysis has identified numerous potential salterns (Plate 4.18). The Norfolk NMP (Albone et al. 2007) documented a larger area of salt workings surrounded by ditches (HER 27070; 27745; 27746; 27949; 27950; 41392), noting that aerial imagery does not fully elucidate this complex site.

LiDAR indicates considerable elevation variations, revealing previously unidentified post-medieval sea defences and alluding to other archaeological remains. Sub-circular soilmarks visible in the south-east could suggest saltworks, though intensive agriculture may have truncated these mounds, obscuring their visibility on LiDAR. The Norfolk NMP also proposed that these mounds might have been repurposed for structures like farmsteads or coastal defences. Further intrusive archaeological investigation or higher-resolution LiDAR data is needed to assess the extent and spatial organisation of saltworking in this area.

Similar to the Church of St Clement, it has been speculated that the Church of St Margaret in Clenchwarton was built on saltern mounds. The church, likely of late-14th century origins (Mortlock and Roberts 1985), was suggested by Keen (1988) to be constructed upon a remnant saltern mound, while Silvester (1988) proposed that it was built upon a roddon. Despite its elevated position, the surrounding ridge aligns with a modern road and residential area (Plate 4.19), and no nearby prominent elevation indicative of a saltern complex is evident. Moreover, an excavation south of the church revealed medieval occupation but no saltworking evidence (Barlow 2010). While intrusive excavation is needed for certainty, LiDAR data strongly suggests the church is on a roddon or in a heavily landscaped area.

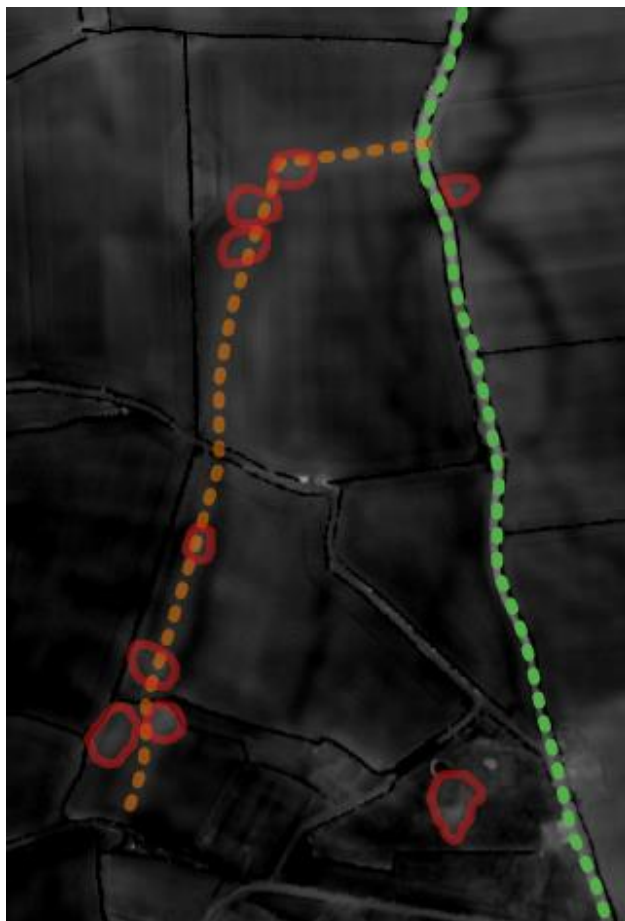


Plate 4.17: The eastern saltern complex (red) close to Clenchwarton, the Sea Bank (green); and the hitherto unnamed sea defence (orange).

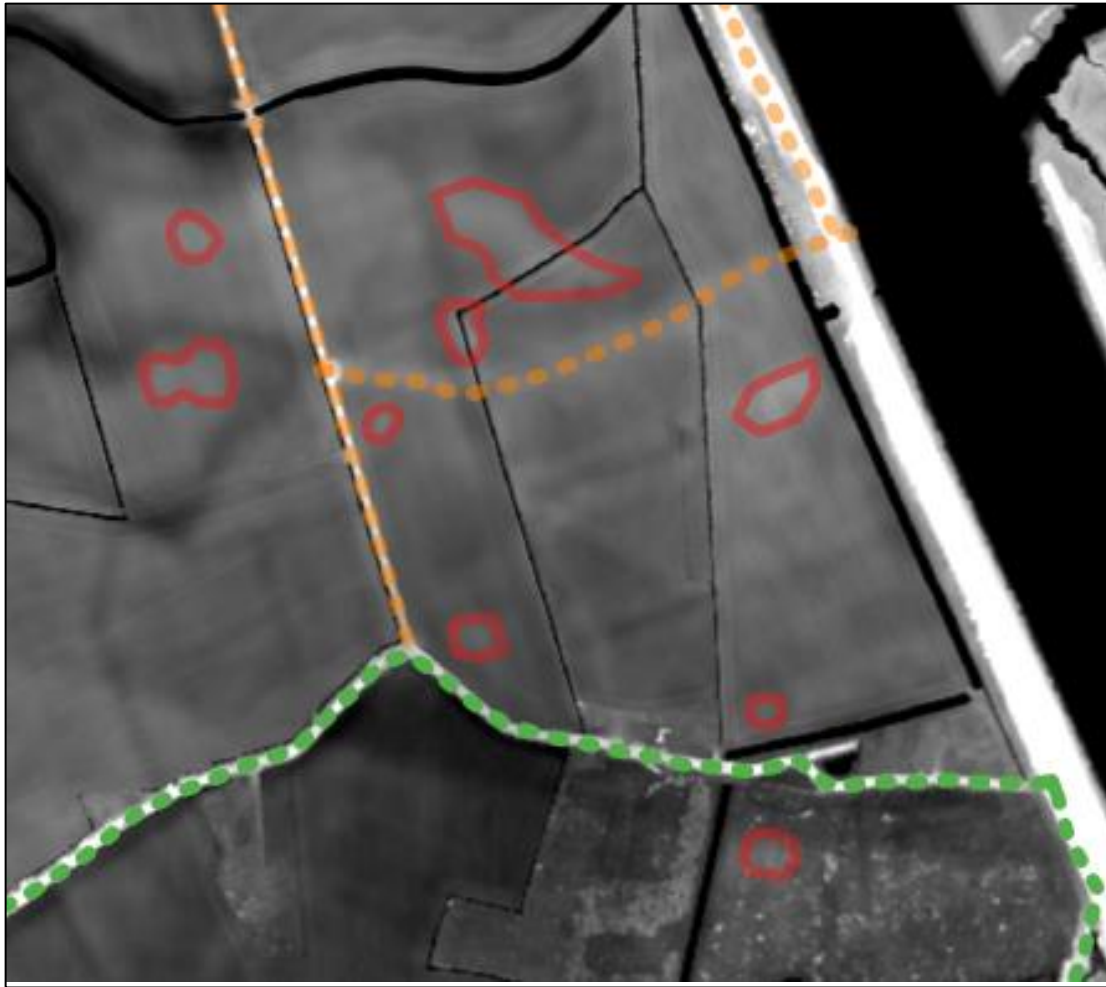
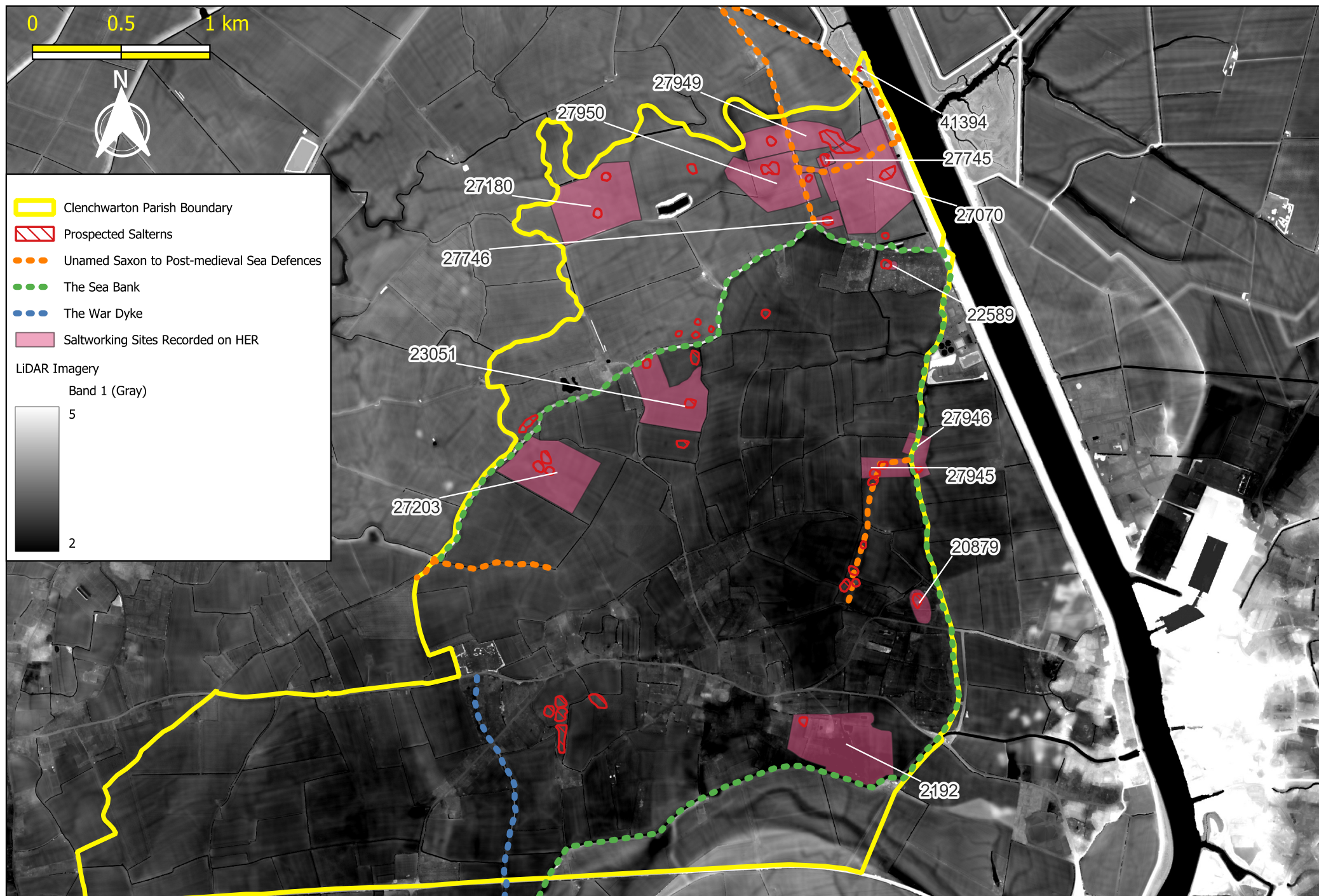


Plate 4.18: [Left] LiDAR imagery showing the saltern mounds (red) in the north-east beyond the Sea Bank (green), an unnamed post-medieval sea defences (orange); [Above] Satellite imagery showing the soilmarks of potential saltern mounds (red).



Plate 4.19: *The Church of St Margaret as viewed on LiDAR imagery.*



Drawing 2: Clenchwarton LiDAR and HER

4.3 Tilney All Saints and Tilney St Lawrence

Previously, no saltern mounds have been recorded in Tilney St Lawrence, but LiDAR analysis has now revealed a few isolated mounds potentially linked to saltworks (Drawing 3). Similarly, while only one saltern mound was previously recorded in Tilney All Saints, a small number of potential saltworks have been prospected. Due to limited modern development in rural Tilney, archaeological investigations are sparse, with no direct evidence of saltworking encountered, though medieval occupation remains have been found (e.g Donald 1996; Moulis 2010; Jones 2015). While Tilney is not specifically listed in the Domesday Book, it was part of the Islington manor, where 8½ saltworks were recorded, making the prospecting of additional salterns unsurprising.

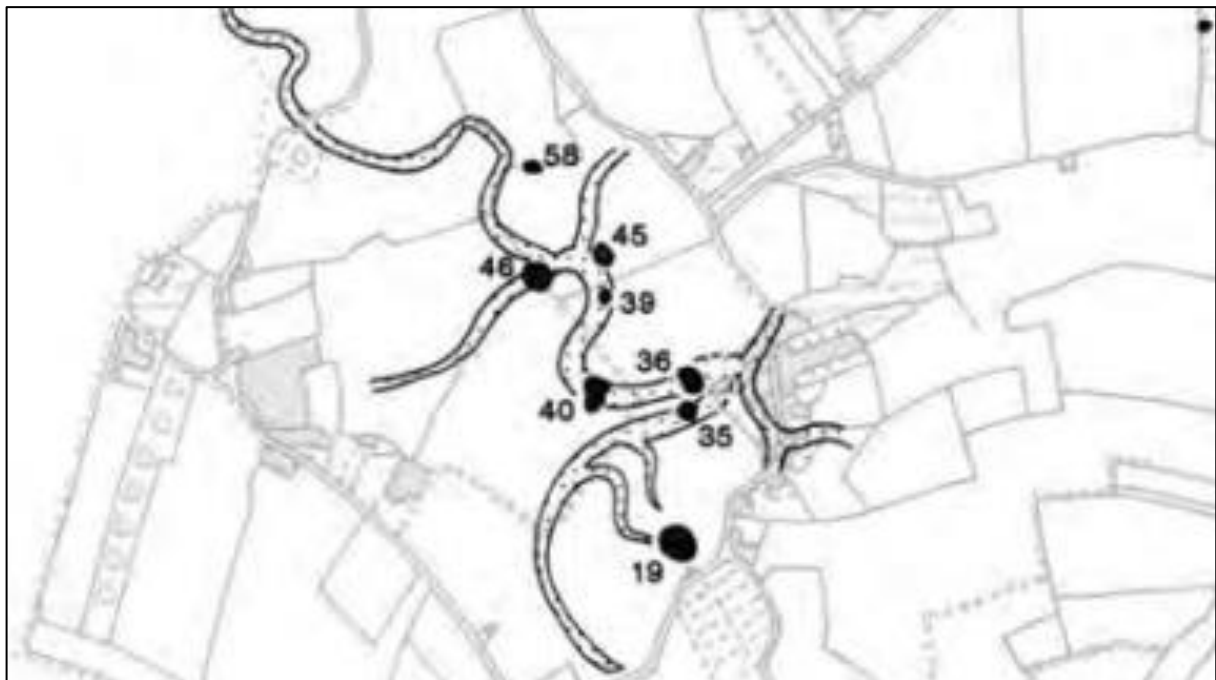


Plate 4.20: *The tidal creek and pottery sites upon the purported 'levees' in Tilney All Saints, as mapped by Silvester (1988)*

In Tilney All Saints, six of the nine potential saltern mounds lie west of the historic settlement, closely associated with a tidal creek that once flowed south-east through the Sea Bank past Terrington St Clement (Silvester 1988: 47-49). During the Fenland Project, 10th to 11th century pottery was recovered near these mounds (e.g. HER 22155; 22382; 22384; 23580) (Plate 4.20). Silvester (1988) suggested these elevated areas could be sandy-silt levees that formed the elevated foundations of Saxon settlement in Tilney. These levees, often linear sea defences or natural ridges (Pye 1992; Lewin 2010), nevertheless appear conspicuously sub-

circular on LiDAR imagery and morphologically comparable to saltern mounds (Plate 4.21). Excavation is required to conclusively determine the origins of these mounds; however, the established connection between salterns and creeks (*cf.* Green 2023) supports their interpretation as salterns. Moreover, the challenging riverside conditions and risk of flooding complicate the idea of early settlement, regardless of the limited protection afforded by the elevation of the mounds. Historical records mention significant floods in Islington in 1287 and 1338 (Brown 2023: 71-80) (Plate 4.22), and the mid-14th century *Nonae* rolls describe the financial burden of maintaining sea defences in Tilney (Livingstone 2016: 341).

Interestingly, fieldwalking in this area revealed a network of late Saxon or medieval trackways (HER 22056; 22057; 22139). These may have been used for traversing farmland and driving livestock, but if the mounds were linked to saltworking, they could also have been part of a broader network of routes for salt traders and producers—similar to *Salters Lode* or *Salter's Waie* near King's Lynn (Clarke 2018; Clarke 2023).

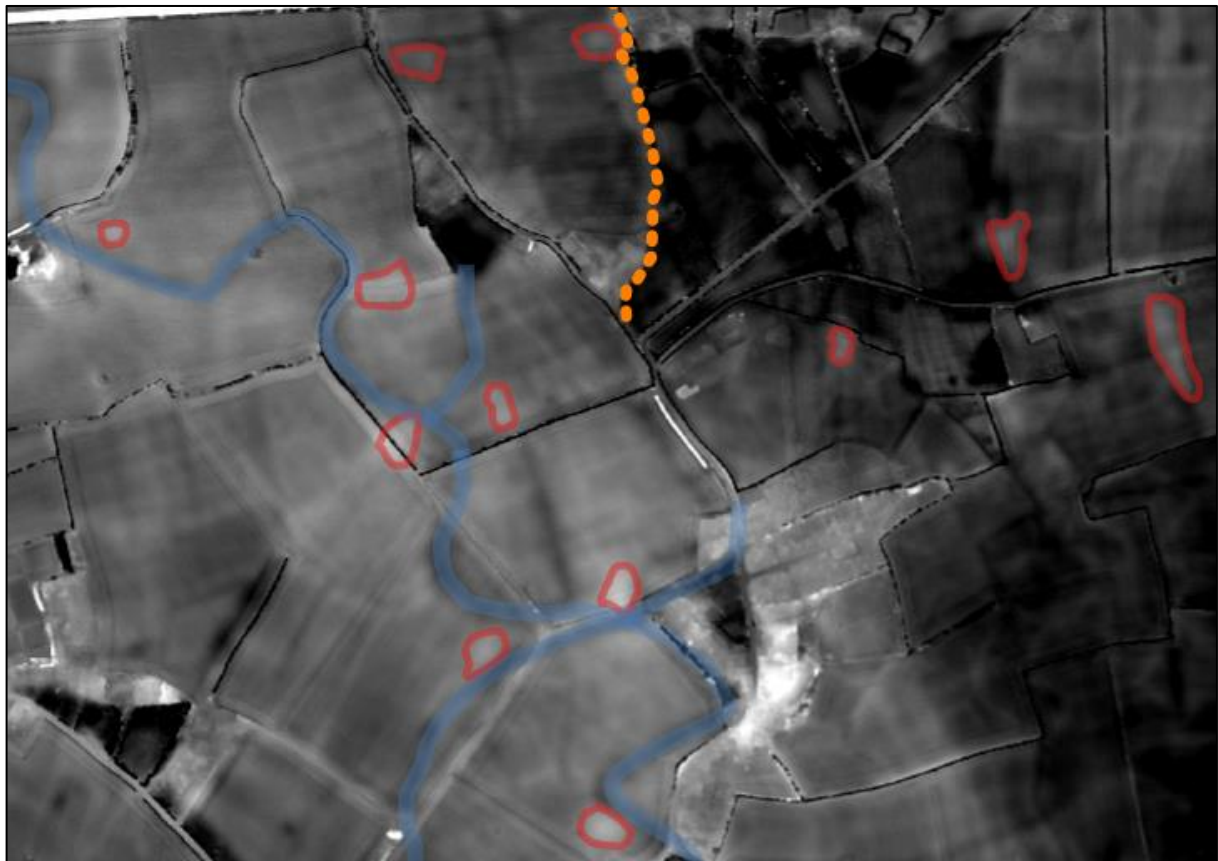


Plate 4.21: The salterns (red) and the course of some of the former tidal creeks or watercourses west of Tilney All Saints (blue)

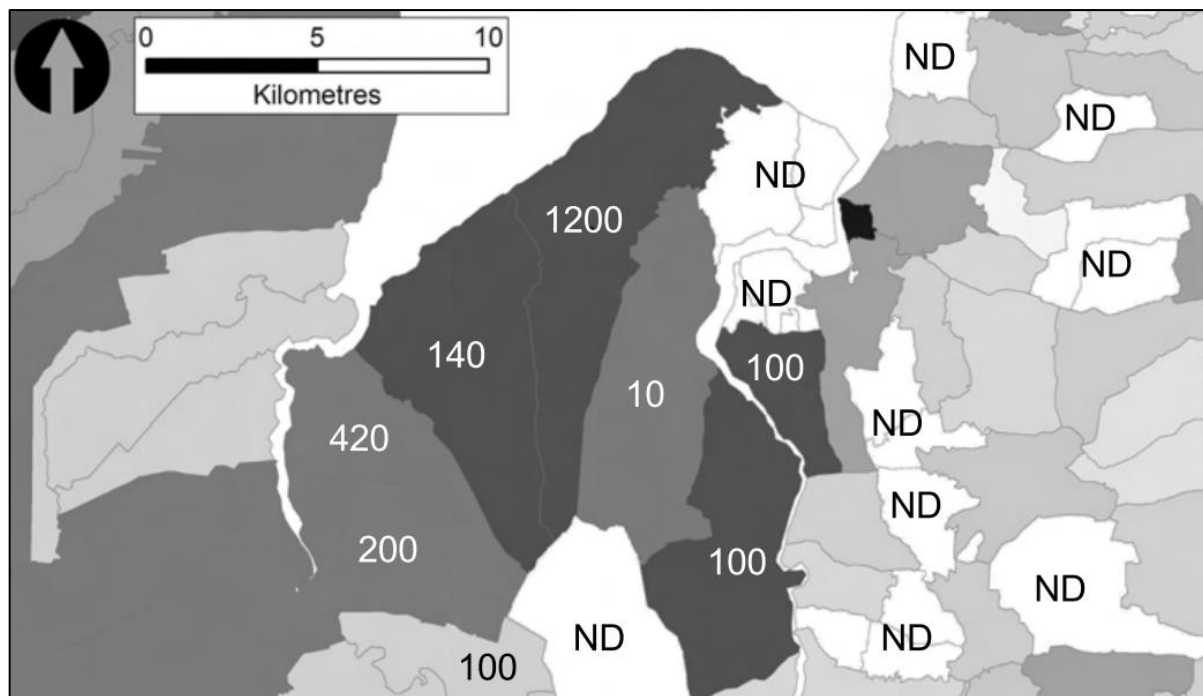


Plate 4.22: Acreages impacted by flooding in the parishes of Marshland in 1338, overlaid with taxable wealth data from the 1334 Lay Subsidy – darker shades indicate higher wealth, lighter shades indicate lower wealth; 'ND' refers to parishes not listed (Brown 2023: 78)

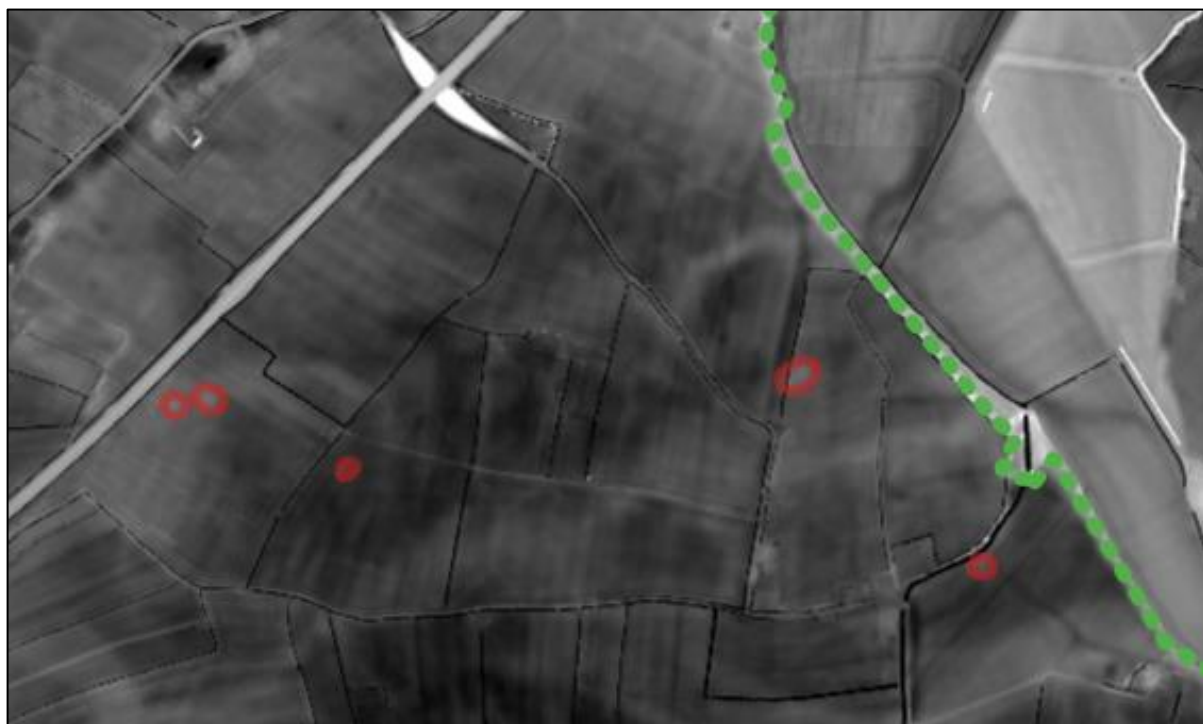
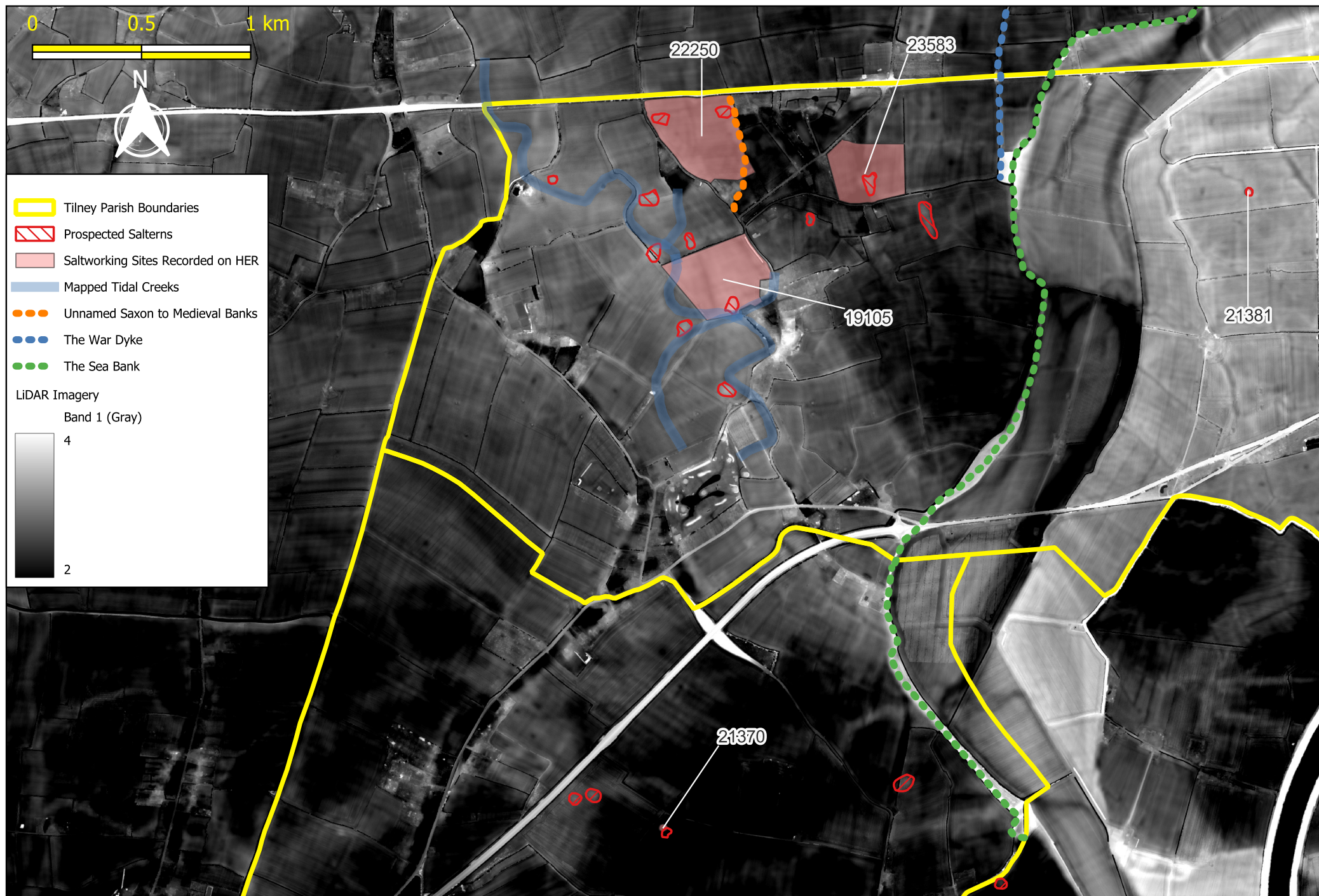


Plate 4.23: The salterns (red) and the Sea Bank (green) in Saltgate Field, Tilney St Lawrence

To the south, a network of roddons and creeks is visible in Tilney St Lawrence. Before the redirection of the Ouse, the southern part of the parish was likely unsuitable for saltworking. Nevertheless, LiDAR analysis reveals five potential salterns to the west of the Sea Bank in the

north of the parish (Plate 4.23). Fieldwalking at these potential sites, particularly the two western mounds (HER 21377), uncovered assemblages of pottery dating from the middle Saxon to medieval periods (e.g. HER 22055; 21930; 22332; 23577). Notably, all of these potential saltern mounds are located within *Saltgate Field*. The central mound, identified during the Fenland Survey, was tentatively interpreted as a windmill mound due to its morphology, despite its resemblance to a saltern mound and the lack of documentary evidence (Silvester 1988; HER 21370). The easternmost potential saltern, thought to be entirely lost, though denuded, is visible on LiDAR imagery. This mound, in the 1930s, was unconvincingly speculated to have been a Napoleonic-era beacon fire (HER 2234).



Drawing 3: Tilney All Saints and Tilney St Lawrence LiDAR and HER

4.4 West Lynn

While LiDAR analysis has identified a few additional salterns within West Lynn (formerly *Old Lynn*), most were recorded during the Fenland Project (Silvester 1988) and Norfolk MNP (Albone et al 2007). The prominence of these salterns explains their thorough documentation, highlighting the longevity of the industry in West Lynn and the minimal truncation in the area (Plate 4.24). Nevertheless, further saltworks in the north-east of the parish have likely been destroyed by the rerouting of the River Great Ouse during the creation of the *Eaubrink Cut* in 1821 (Silvester 1988: 26-27).

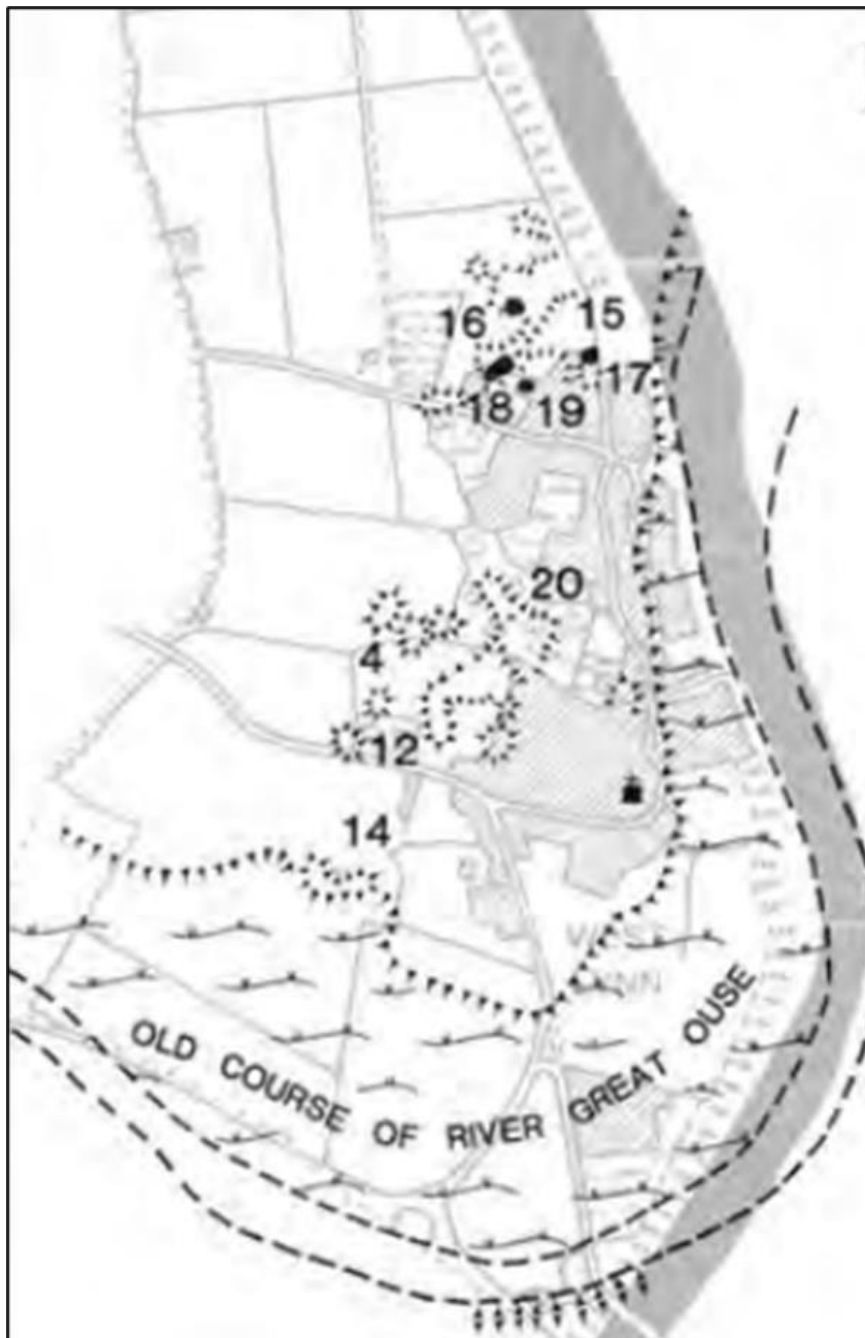


Plate 4.24: The saltern mounds of West Lynn and the Ouse, as mapped by Silvester (1988)

The hitherto unidentified potential saltern mounds are mainly located north of the village, near North Farm; an area not extensively surveyed during the Fenland Project. Two saltern mounds were recorded here by the Norfolk NMP (HER 27069); however, the extent and morphology of the saltworking area identified is not clearly discernible on LiDAR visualisations. These mounds are less prominent compared to the larger earthworks south of West Lynn. Regardless, it is evident that the topography around North Farm is undulating and irregular, alluding to the presence of archaeological earthworks (Plate 4.25). In the northern part of this area, the Norfolk NMP recorded a later medieval or post-medieval sea defence; however, reanalysis of LiDAR data suggests that this feature may be an elongated saltern mound. Given the potential significance of these mounds, intrusive excavation in this area is essential to assess the morphology of any saltworks, particularly since the earthworks may be the result of upcast from the *Eaubrink Cut*.

Three saltworks south of North Farm seem to have been integrated into a later sea defence. This embankment, recorded by the Norfolk NMP (HER 27057), follows a winding path from east to west across the reclaimed salt marsh. Absent from late-18th and 19th century maps, it likely ceased to be used by the 18th century and is probably late medieval or early post-medieval in origin.

Near the historic core of West Lynn, two well-documented saltern complexes, likely once connected, are preserved (Plate 4.26). The southern complex centres around a watercourse that may have fed the salterns and served as a navigable route for small boats. The Norfolk NMP and Fenland Project recorded several saltern mounds within this complex (HER 22541; 22542; 22543; 22645; 38313), in addition to earthworks potentially indicative of saltcotes (HER 22594). Three subsequent excavations have expanded our understanding of saltworking in this area. An excavation west of St. Peter's Church, in a developed area unsuitable for prior survey, uncovered substantial evidence of salt production, including a saltern mound (Mellor 2003; Mellor 2004). Five gullies or ditches, two pits, and a pond likely associated with 13th century saltworking were also revealed. Notably, a rare lead waste fragment, possibly from a boiling pan, and briquetage linked to saltworking were likewise recovered. While the mound might represent overbank deposits from a former channel, the associated remains suggest it primarily consists of layers of desalinated waste silt from saltworking.

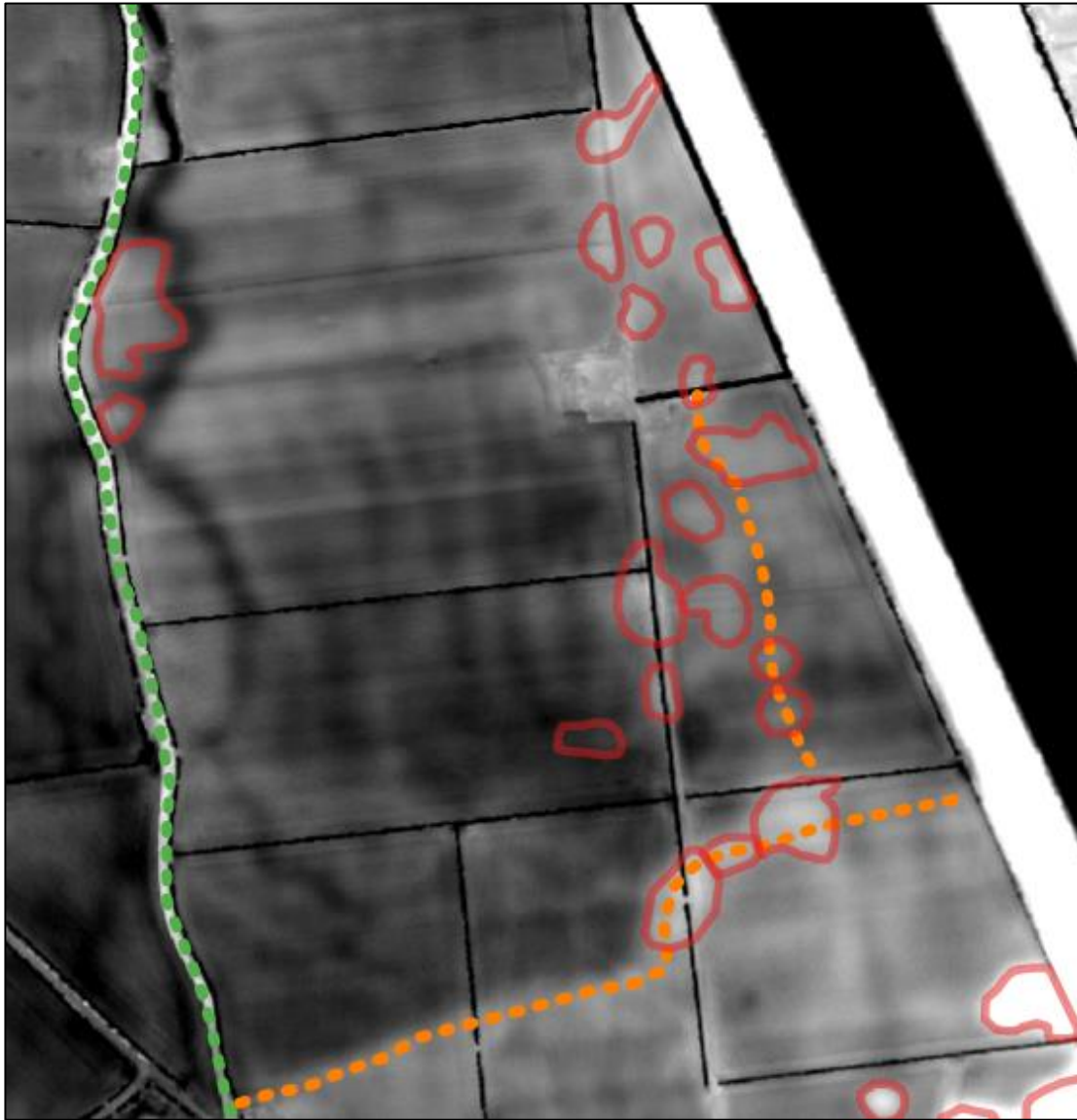


Plate 4.25: [Left] The salterns (red), potential salterns in built-up areas (yellow), the unnamed sea defences (orange, and the Sea Bank (green) in West Lynn as visible of LiDAR imagery; [Right] Satellite imagery of the potential salterns in West Lynn, showing the multitude of soilmarks – some of which correlate with the LiDAR data, some which conspicuously do not.

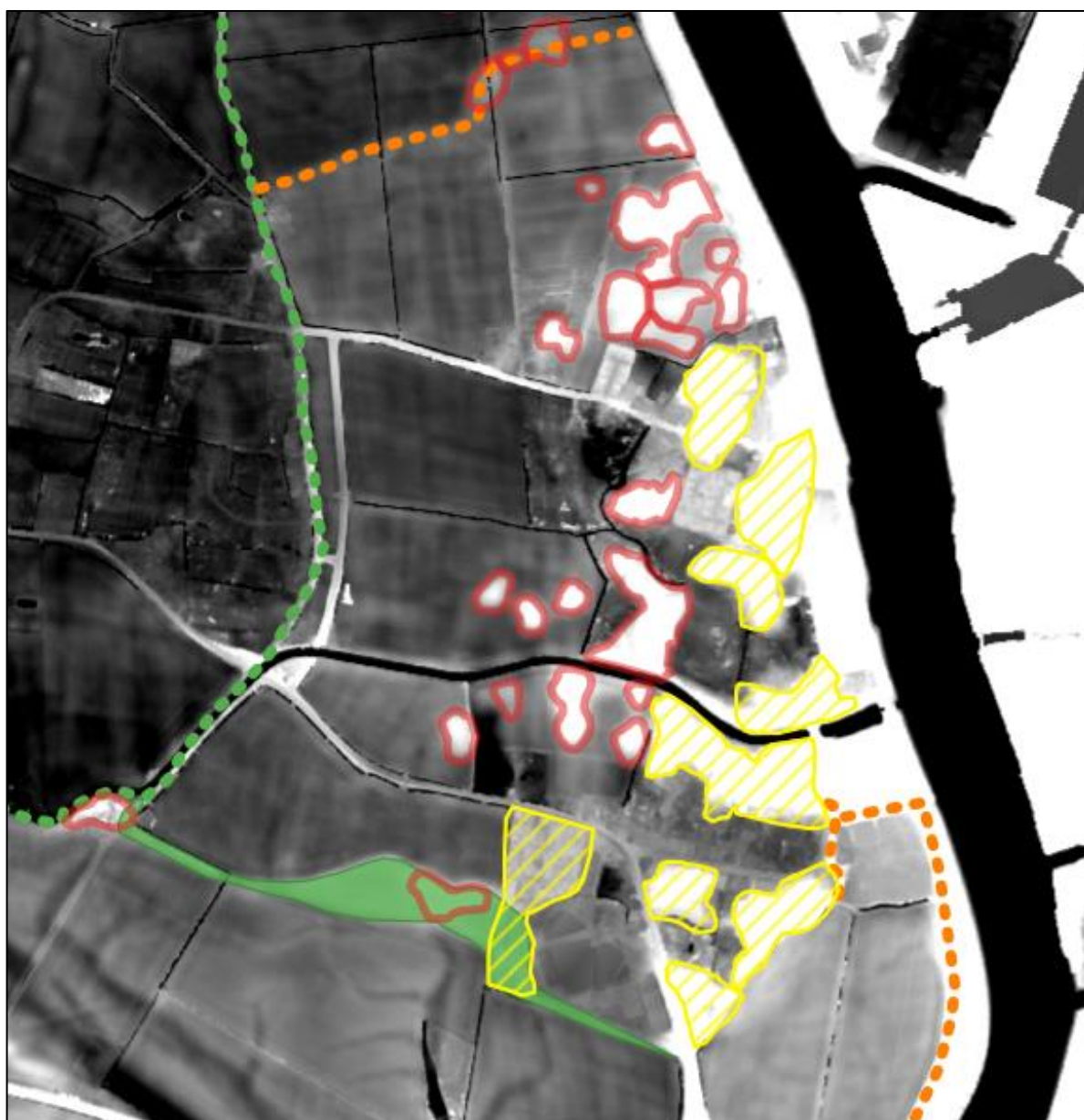


Plate 4.26: *The salterns (red), potential salterns in built-up areas (yellow), the unnamed sea defences (orange), and the Sea Bank (green) in West Lynn*

A trial trench was excavated on the Sea Bank south of West Lynn, immediately east of a known saltworks (HER 22541), encountering a thereto unidentified saltern mound (Adams 2013; Plate 4.27-4.28). This investigation highlights the close relationship between salterns and Sea Banks, as well as their chronological development. Several shallow, irregular features truncated the surface of the bank, one of which yielded fragments of fired clay (Plate 4.29). Clay dumps, many clearly fired, were also recovered that, although not interpreted as such at the time, appear to be indicative of the hearth waste characteristic of saltworking sites. Though only small amounts of burnt clay were found, their presence suggests that the

earthwork may represent a relict middle or late Saxon saltern mound incorporated into the Sea Bank; however, no datable remains were found and the burnt material may have originated from the adjacent mound or simply represent convenient waste dumping unrelated to saltworking.

Trial-trenching has also been conducted close to the southern complex in West Lynn, near the Sea Bank on Clenchwarton Road (Cockin 2006). The investigation uncovered a section of a medieval sea defence, two possible medieval/post-medieval features, and two undated clay-lined pits, all likely associated with specialized industrial activities (Plate 4.30). The pits were interpreted as water tanks; however, due to the presence of metalworking waste in their 'post-operation' backfill (burnt clay, metal slag, charcoal, and flue ash), were tentatively linked to lead production. While it is plausible that these pits were used for storing water/brine, similar to those found in King's Lynn and Terrington St Clement (*cf.* Clarke 2023; Podbury 2023), revaluation is difficult without readily-available photographic evidence. Regardless, the potential lead production is significant for understanding salt production. Although rarely found at Saxon and medieval saltworking sites, lead pans were commonly used in brine boiling during the salt-washing process (McAvoy et al 1994; Shannon 2023; Griffin et al 2024). This excavation may indicate a close spatial and functional relationship between lead and saltworking in West Lynn.

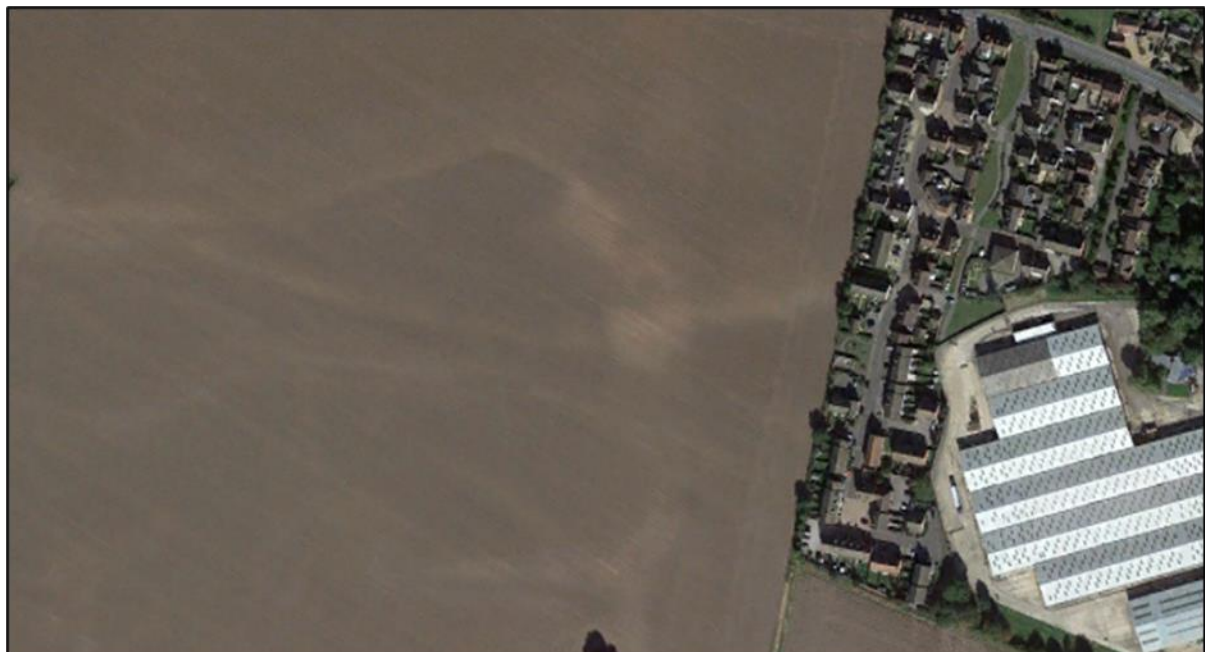


Plate 4.27: *Satellite imagery clearly showing the linear Sea Bank and at least two saltern mounds*

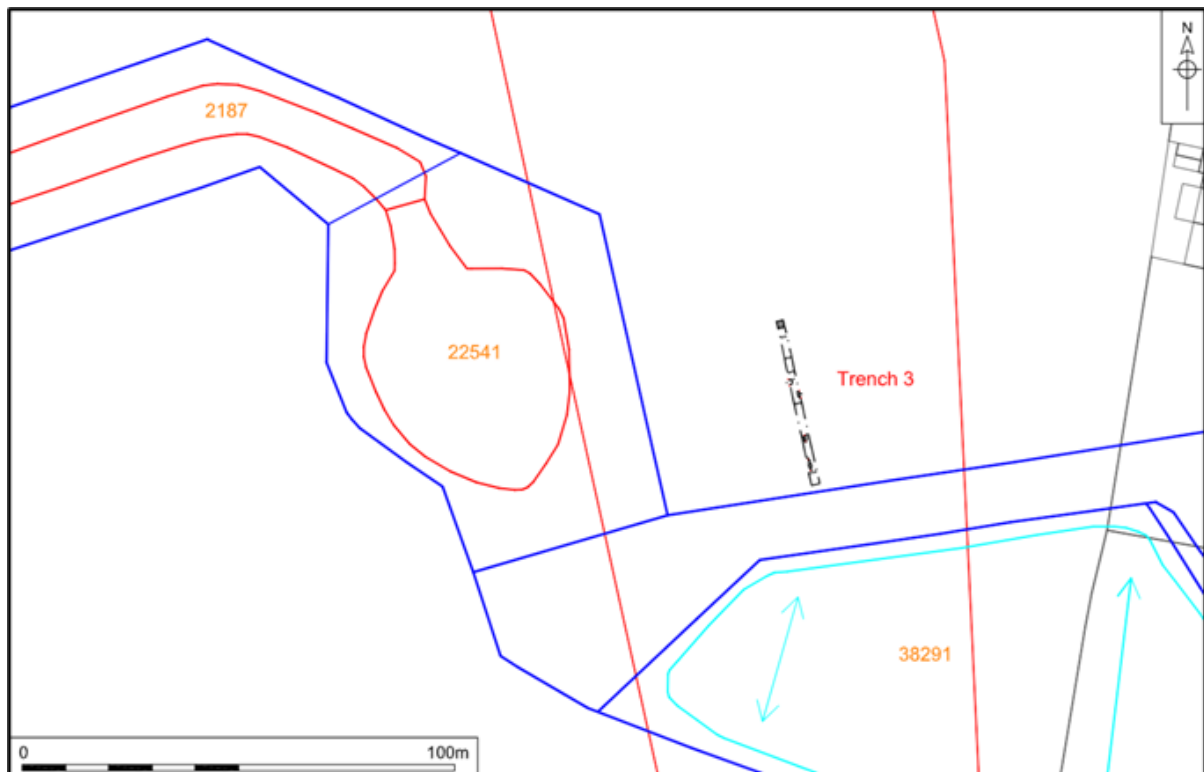


Plate 4.28: The location of the trial-trench in relation to the Sea Bank and one of the recorded salterns (Adams 2013)



Plate 4.29: Probable hearth waste and fired clay (Adams 2013: 10)

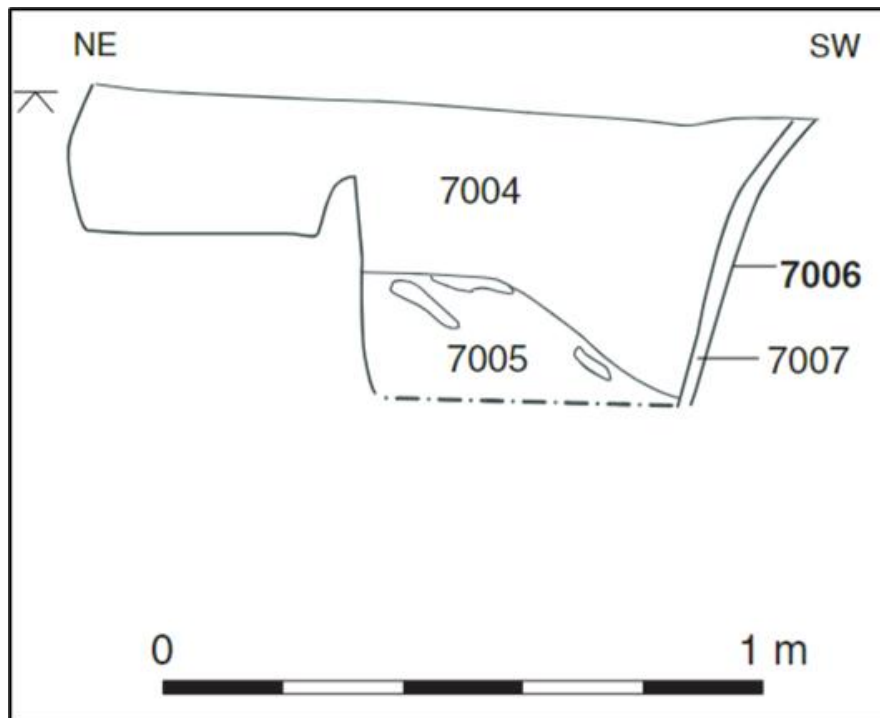


Plate 4.30: One of the clay-lined water storage tanks from the Clenchwarton Road site (Cockin 2006)

Silvester (1988) notes that the mounds in West Lynn likely represent remnants of a larger group, levelled during settlement expansion. Evidence of these mounds is visible in the undulating terrain beneath roads and houses near the church, both on the ground and via LiDAR analysis, though their origins remain inconclusive. Perhaps unsurprisingly, speculation exists about whether the church in West Lynn was built on a relic saltern mound (Keen 1988; Owen 1975a; Silvester 1988). Unlike the churches of Terrington and Clenchwarton, however, evidence for this is more convincing in West Lynn (Plate 4.31). Historical documentation records that the original church was lost to flooding before 1271, prompting the rector to relocate St. Peter's Church further west, away from the Ouse (Blomefield 1808: 535). It is likely that a disused saltern mound, despite potential stability issues, provided a more elevated and thus protected site. The gentle rise of the adjacent road and topographical dip in front of the church support this theory (Silvester 1988). Furthermore, immediately north of St. Peter's Church, an oven and gully of initially indeterminate function were encountered during excavation (Trimble 2003). While their purpose was initially unclear, they likely relate to saltworking; the oven may have been used for boiling brine or drying salt, while the gully could have channelled water. Five pieces of briquetage found in alluvium overlying the oven, supporting this interpretation. Given the church's late-13th century origins, when saltworking

in West Lynn was already well-established, its elevation, proximity to known salterns, and the lack of roddons in the area suggest it was indeed built on a saltern mound.

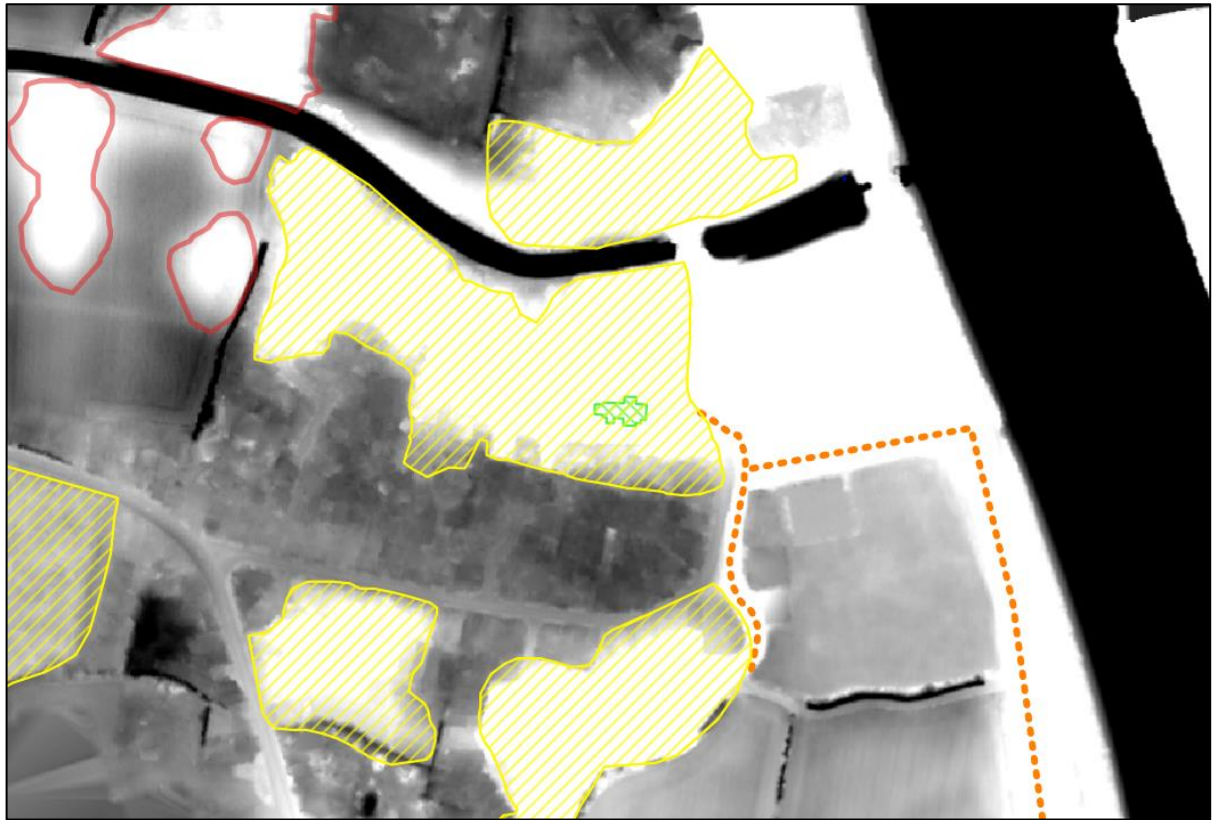
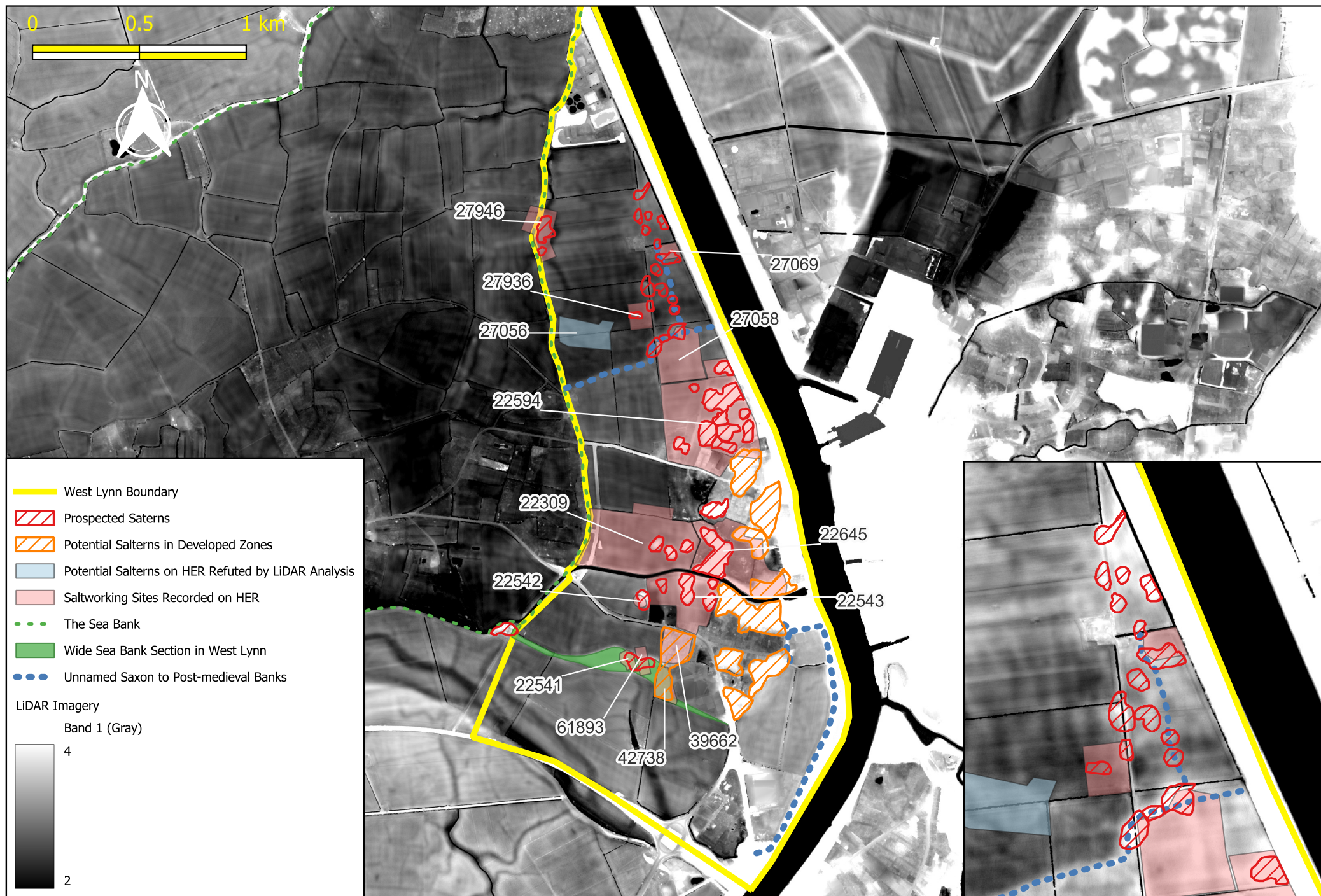


Plate 4.31: The salterns (red), potential salterns in built-up areas (yellow), the unnamed sea defences (orange), and the Church of St Peter (green) in West Lynn



Drawing 4: West Lynn LiDAR and HER

4.5 Walpole St Andrew, Walpole St Peter and Walpole Cross Keys

Several saltern mounds are recorded in Walpole, primarily beyond the Sea Bank. Most were documented by the Fenland Survey and Norfolk NMP, with additional mounds identified through LiDAR analysis. In Walpole Cross Keys two medieval saltern mounds were previously recorded south-west of Poplar Tree Farm (HER 21941; 21942). LiDAR confirmed their presence, but revealed four additional potential salterns to their west (Plate 4.32). The two largest mounds appear to have been incorporated into the post-medieval sea defence, *Middle Bank*. Fieldwalking near these potential salterns was limited during the Fenland Project, but medieval pottery sherds were recovered from nearby fields (HER 22020; 22270; 22287; 22290).

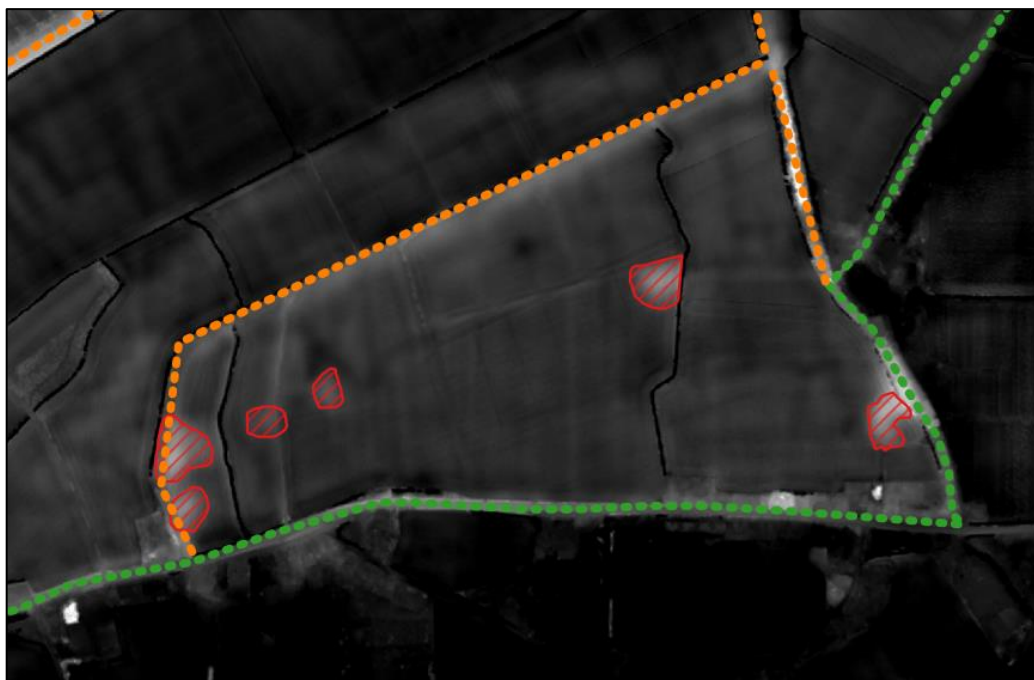


Plate 4.32: The salterns (red), Middle Bank (orange), and the Sea Bank (green) in Walpole Cross Keys

To the south, near Walpole St Andrew and Walpole St Peter, saltern mounds are visible on LiDAR (Plate 4.33). Notably, a prominent roddon, relatively intact, lies immediately west of these historic settlements, upon which middle and late Saxon artefacts have been recovered (Silvester 1988: 76). Unlike other siltland areas, these elevated formations are clearly geological; however, unrecognisable saltern mounds may still be scattered among them. Two potential salterns are located north of another roddon system, in the area of Walpole Electrical Substation, where middle Saxon pottery has been found (Plate 4.34). No additional mounds are visible in Walpole St Andrew and Walpole St Peter on LiDAR.

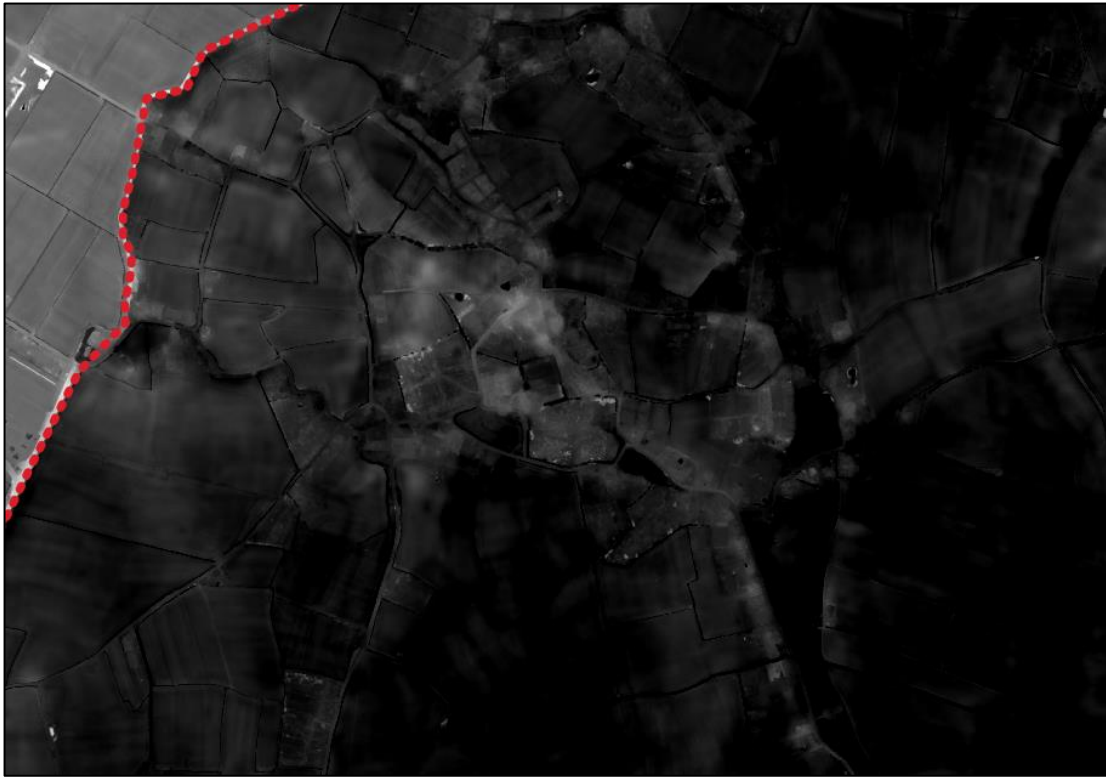
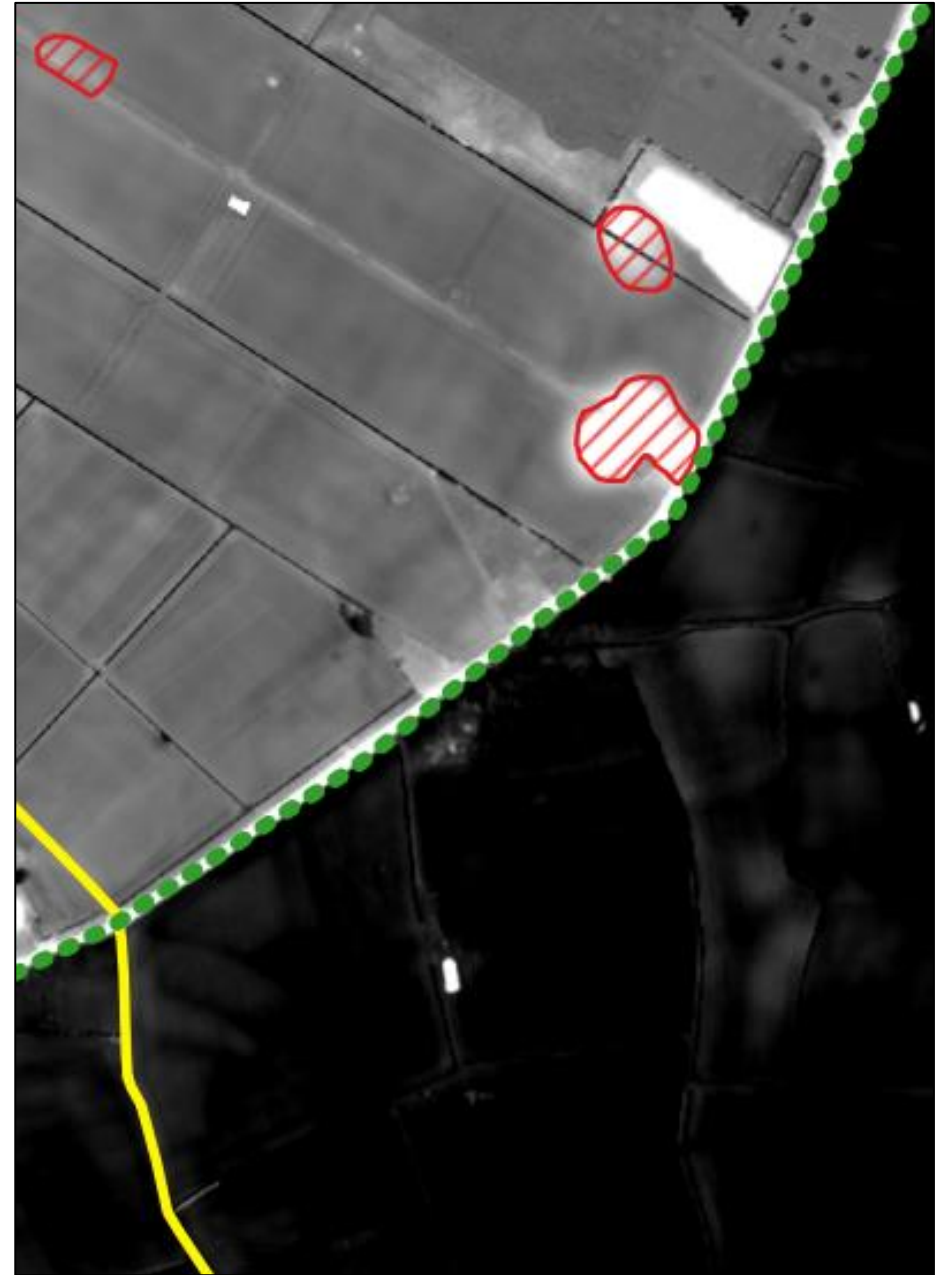


Plate 4.33: [Above] The Sea Bank (red) and the sinuous and linear areas of elevation throughout Walpole, indicative of roddons.

Plate 4.34: [Right] The Sea Bank (green), the saltern mounds (red), the parish boundary of Walpole, and the Walpole Electricity Substation to the north-east. Note the probable roddon remnants to the south, which form a more sinuous and dendritic geological feature to the south.



Although LiDAR data provides relatively limited insight in this area, the Walpole region has witnessed considerable archaeological excavation. Notably, an investigation north-east of the aforementioned salterns near the Walpole Electricity Substation revealed significant saltworking remains (Stephens 2006; Cooper 2008; Clarke 2009; Clarke and Clarke 2018). The earliest datable remains encountered indicate saltworking on the site began between the mid-12th and 13th centuries. The site contained a large channel or creek, with the saltworking evidencing comprising a large rectangular tank and at least two phases of revetment, including timber-framing that stabilised the inner bank of the channel (Plate 4.35). After possible abandonment, further revetment phases from the mid-15th to 17th centuries, along with pits, tanks, troughs, and channels, related to ongoing salt processing, were identifiable.

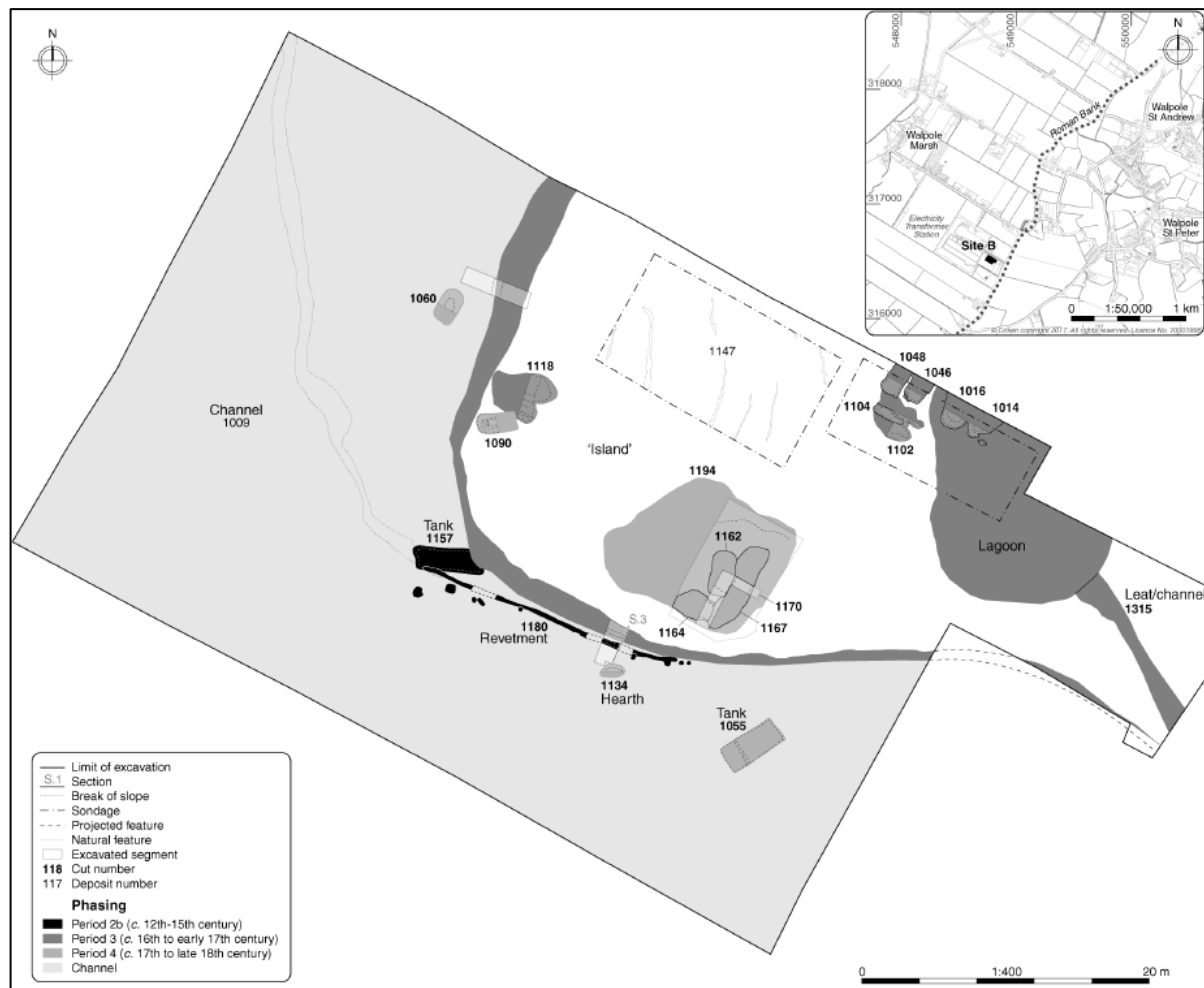


Plate 4.35: Excavation area at the Walpole Electricity Substation (Clarke and Clarke 2018: 12)

Further excavations near the Walpole Electricity Substation similarly suggest a more extensive saltworking industry than the two remaining mounds indicate. At a site adjacent to the

substation, no features were found during an evaluation, but fragments of fired clay and charcoal were recovered from alluvial deposits (Fitzpatrick 2008); while these remains could represent domestic debris, they may be related to saltworking. A geophysical survey at Rose Hall Farm to the north-east also identified sinuous anomalies indicative of tidal creeks but did not identify features explicitly linked to saltworking (Bunning and Freeman 2022). Two trial-pits were excavated upon two possible saltern mounds (NHER 19693; 19694), revealing silty sand deposits sealed by alluvium (Farell 2023); no saltworking debris was recovered from the mounds, though the deposits could represent desalinated silts. Furthermore, a gully infilled with fired clay was encountered that could represent hearth by-products. A watching brief near Wisbech Road, also close to the substation, similarly encountered burnt silt layers and organic deposits associated with fired clay and early medieval pottery (Tremlett 2000). Elsewhere in areas theoretically viable for saltworking in Walpole excavations have predominantly revealed complex palaeochannels rather than evidence of saltworking (e.g. Dransfield and Tibber 2013; Roberts 2017).



Drawing 5: Walpole St Andrew, Walpole St Peter and Walpole Cross Keys LiDAR and HER

4.6 West Walton

West Walton was noted for its numerous saltworks in the Domesday Book, second only to Caister on the eastern coast of Norfolk (Silvester 1985: 109). Today, however, few saltern mounds are visible in the area. It is probable that Walton's manors owned land in nearby areas for saltworking, a practice documented two centuries later (Roffe 2005). Post-Domesday references to saltworking in Walton are limited, though a 14th century document mentions saltworking in a rent assessment for *Neucroft*, near the Sea Bank and adjacent to the lord's saltworks (National Archives: E40/3147). While no such area appears on historic maps, *New Croft* is noted further south in Walsoken. Given the proximity of at least seven salterns to the Sea Bank, it is plausible that some identified via LiDAR correspond to *Neucroft*; however, Haiwarde's 1604 map labels these mounds as *Cony Hills*, and an early 18th century map simply refers to them as *Salt Hills* (Cambridge University Archives: MS Plans 598).

Two excavations have been conducted in Walton upon a saltern mound. Two watching briefs have focused on the salterns near Ingleborough Farm, formerly *Hill House Farm*. The most recent investigation remarked that despite excavating to a depth of 0.90m, the natural geology was not observed; the silt deposits revealed were interpreted as 'mound material', not natural subsoil, though no artefacts were found (Craven 2024). The earlier excavation uncovered saltern debris, including briquetage and charcoal, as well as a pan-shaped tank and a water channel (Redding 1999). The unlined tank likely functioned as a brine tank, similar to those at Beacon Hill (*cf.* Podbury 2023). Due to the absence of datable artefacts, dating of these remains is speculative; however, they were tentatively assigned to the Romano-British period for the following reasons:

Some of the [briquetage] pieces have a smoothed surface and are typical of material used in salterns...The material is not closely datable, but it is likely to be part of a saltern and will be pre-medieval. Medieval salterns around the Wash produce no briquetage, as pottery vessels were used to evaporate brine. A date in the Roman period is likely (Redding 1999: 6).

The remains from the excavation are nevertheless likely of late Saxon or medieval origin. Beyond the contradictory evidence for lead pans mostly being utilised for evaporation, the term 'briquetage' is generally not applied to post-Roman salterns, largely because the predominant, and often sole, ceramic material found at these sites consists of remnants from hearths or ovens (Lane and Fielding 2024); exceptions nevertheless exist, such as at Fishtoft,

(Morris 2012: 67) and the Queen Mary's site (Cope Faulkner 2014). Moreover, the size of the nearby large mounds is more indicative of medieval saltworking, as opposed to the smaller 'Red Hills' associated with Roman saltworking. (Rippon 1999: 7; Biddulph 2016: 20-28). The mound's size, the extent of medieval saltworking nearby, and early post-medieval cartographic evidence suggest the remains are actually of Saxon or medieval origin.

Most saltern mounds visible through LiDAR and aerial photographs have been previously documented (Silvester 1985; 1988), but three additional potential mounds have been prospected (Plates 4.36-4.38). The northernmost mound, about 35m in diameter, resembles previously recorded isolated mounds. Two less prominent mounds within the Sea Bank, each approximately 80m in diameter, are also noteworthy. Although the Fenland Project suggested one of these mounds could be a roddon, its lack of a sinuous morphology features indicate otherwise. These mounds may pre-date the Sea Bank, with both middle and late Saxon, and medieval pottery found on the eastern mound (Silvester 1988: 92).

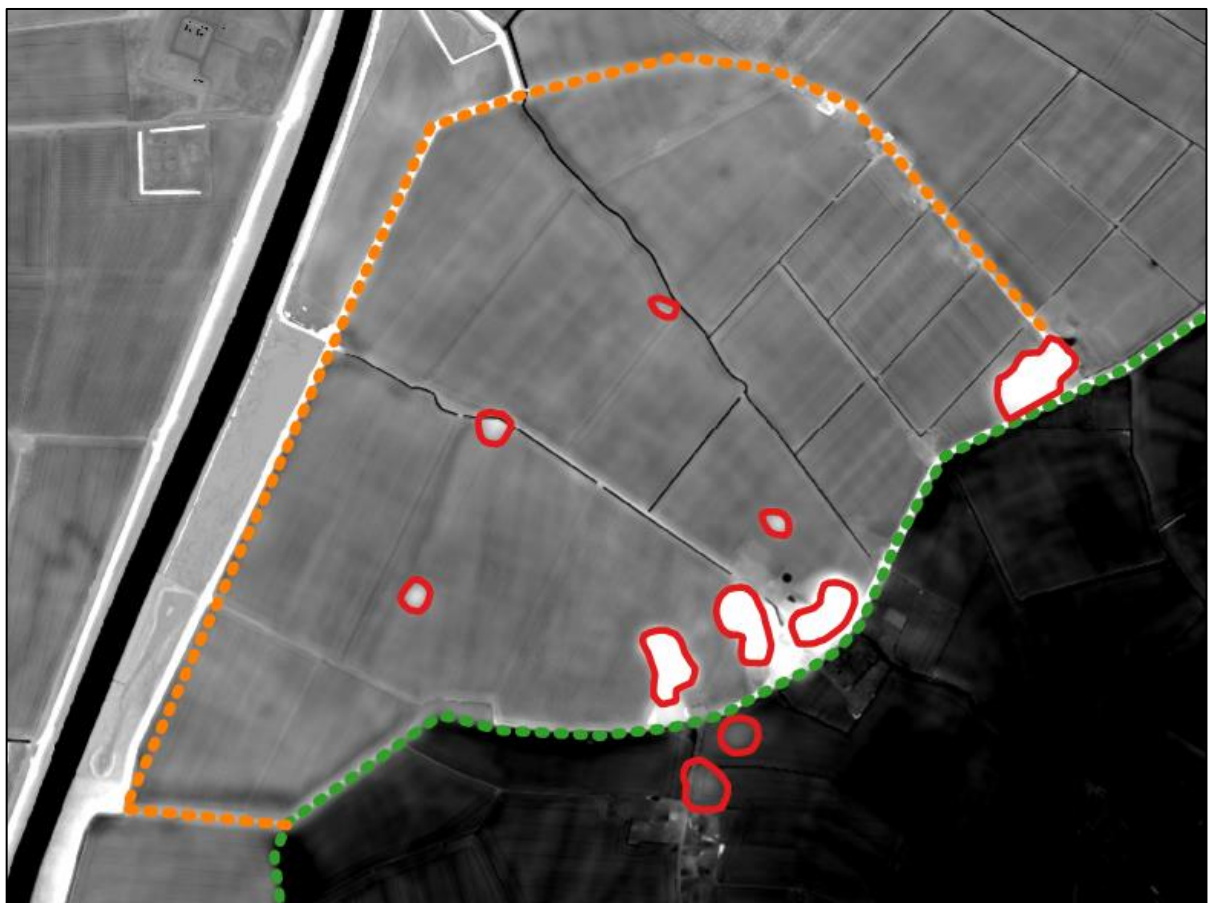


Plate 4.36: *The Sea Bank (green), an unnamed post-medieval sea defence, and the saltern mounds (red) of West Walton*



Plate 4.37: [Above]
Satellite imagery of
the West Walton
salterns

Plate 4.38: [Left]
Plan of medieval
West Walton,
showing the
identified saltern
mounds highlighted
in red in the north
(Silvester 1985)



Drawing 6: West Walton LiDAR and HER

4.7 Validating the Utility of LiDAR: View from King's Lynn

The recent excavations north of King's Lynn provide an opportunity to validate and 'ground-truth' the utility of LiDAR imagery in prospecting for saltworks, with the excavations taking place after the available LiDAR data was collected. LiDAR data collected in 2008 will be compared with the eventual findings of the Lynnsport 4 and 5 excavations undertaken in 2017 (Clarke 2017) below, demonstrating the effectiveness of utilising LiDAR data to prospect for saltern mounds.

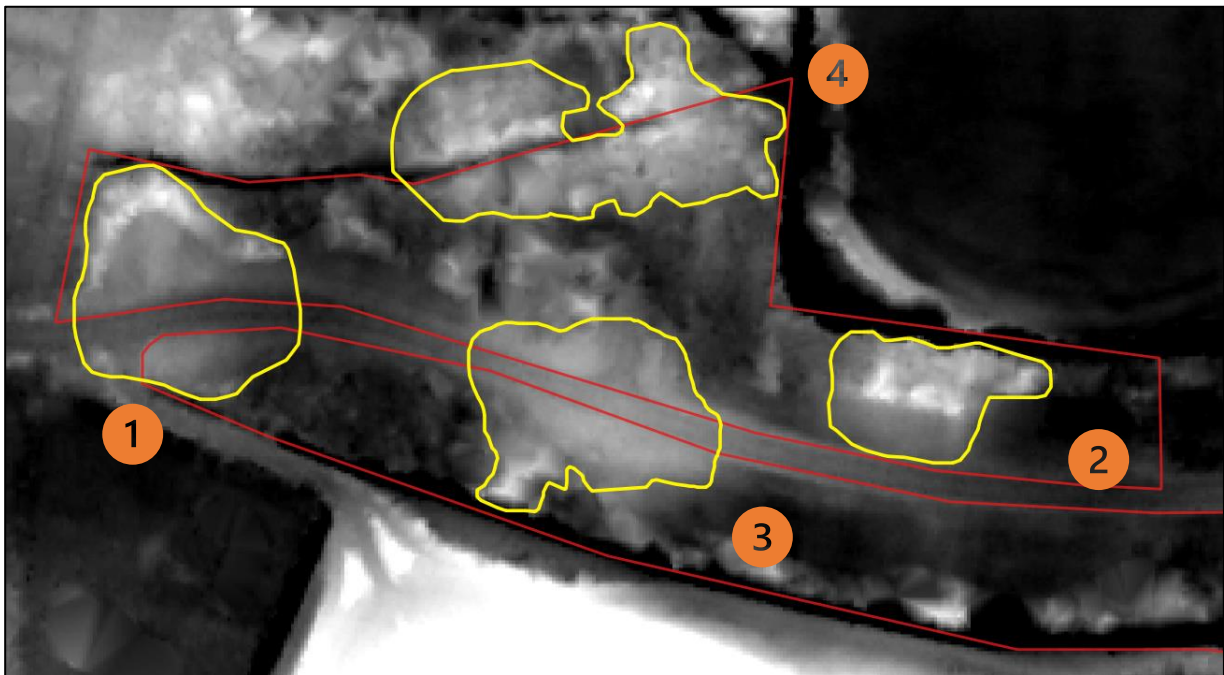


Plate 4.39: [Above] LiDAR imagery showing the salterns (yellow) from 2008 in the area of the Lynnsport 4 and 5 excavations.

Plate 4.40: [Left] LiDAR imagery showing the Lynnsport 4 and 5 saltern (yellow) and the well-preserved salterns clearly visible to the north near North Wooton

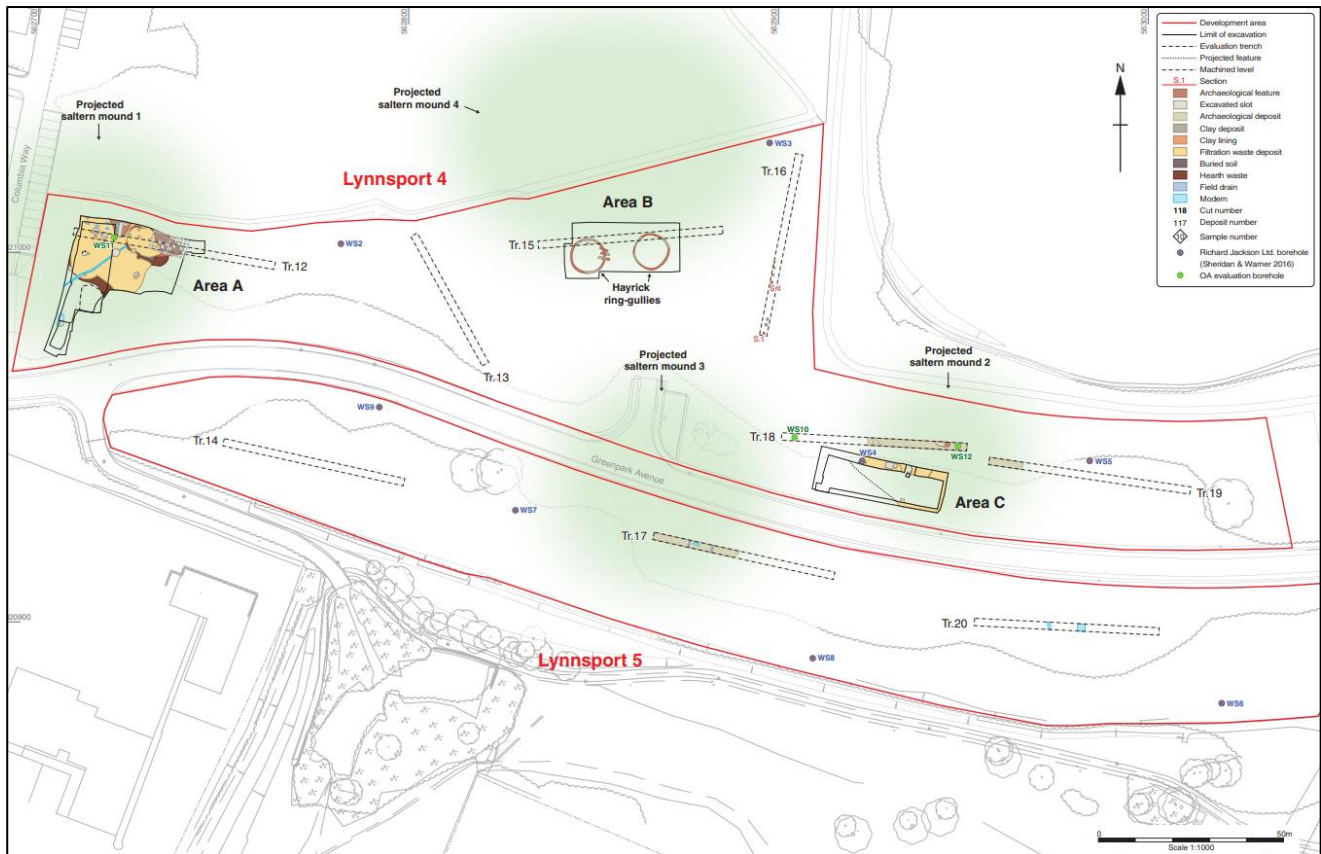


Plate 4.41: Plan of the Lynnsport 4 and 5 site, showing the excavation areas and the projected extents of the saltern mounds (Clarke 2017: 125)

LiDAR imagery reveals at least four elevated saltern mounds within the Lynnsport 4 and 5 sites (Plate 4.39). Unlike the well-preserved mounds north of King's Lynn (Plate 4.40), these mounds are relatively low, at approximately 1.20 meters in height. Their diminished elevation likely results from erosion, given their location near central North Lynn.

Trial-trenching and targeted excavations confirmed saltern mounds in this area (Plate 4.41). In Area A (Plate 4.42), features like clay-lined filtration tanks, brine storage tanks, hearths, and rake-out pits were uncovered, alongside waste deposits dating from the late-8th to early-10th century (Clarke 2017: 20-26). While tidal silt accumulation against the mound may have obscured the full extent of the mound, LiDAR data would have effectively identified the denuded saltworking activity (Plate 4.39; Saltern 1). In Area C (Plate 4.42), similar features were found, and the mound's extent matched the LiDAR results. Trench 17 also confirmed the southernmost saltern mound (Plate 4.43). Although another saltern mound was noted in Area B, excavations did not investigate it, instead focusing on hayrick gullies identified during trial-trenching (Clarke 2017: 18).



Plate 4.42: [Left] Excavation Area A of Lynnsport 4 (Clarke 2017: 127)

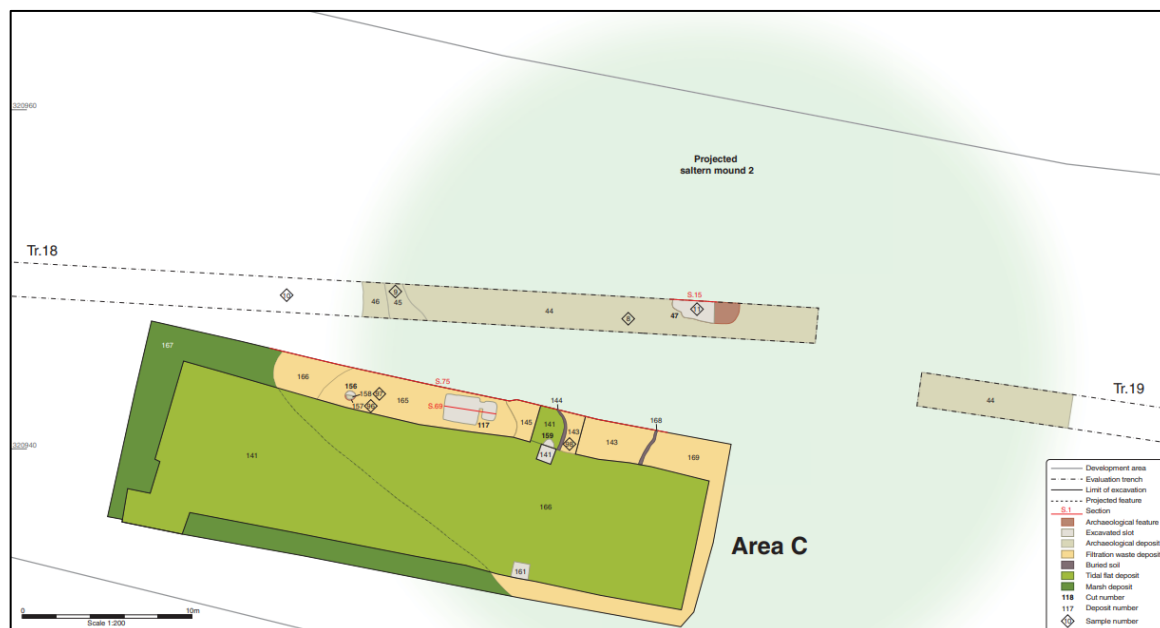


Plate 4.43: Excavation Area C of Lynnsport 4 (Clarke 2017: 130)

5 DISCUSSION: PROSPECTING AND INVESTIGATING A SALT PRODUCTION LANDSCAPE

5.1 Prospecting for Saltern Mounds: Local and Regional Insights

The above multi-faceted analysis highlights the effectiveness of LiDAR in identifying saltern mounds, a method increasingly employed in studies of medieval saltworking (Lane 2018; Clarke 2023; Green 2023; Lane and Fielding 2024). Using LiDAR, several previously unrecognised saltern mounds, though requiring further investigation, have been identified. Most are beyond the Sea Bank in outmarsh areas that were under-surveyed during the Fenland Project, which covered only 66% of the Norfolk Fenlands (Hall and Coles 1994: 8). Unlike the large saltern complexes of Terrington St Clement and West Lynn, the prospected mounds are relatively isolated and low, some rising less than 1.00m above ground level, likely due to truncation or ephemeral use. Given the low-lying and often flat nature of the wetlands surveyed, this landscape is particularly suitable for LiDAR analysis. Their exact number is unclear, as some appear physically connected or obscured by development, but this study has prospected 62 previously unidentified potential saltworks (Table 5.1).

Table 5.1: An estimate of the hitherto unidentified, potential saltern mounds prospected		
<i>Parish or Parish Grouping</i>	<i>Salterns Prospected</i>	<i>Percentage of Salterns Prospected</i>
Terrington St Clement	12	19.35%
Clenchwarton	21	33.87%
Tilney All Saints and Tilney St Lawrence	12	19.35%
West Lynn	11	17.74%
Walpole St Andrew, Walpole St Peter and Walpole Cross Keys	4	6.45%
West Walton	2	3.23%

Clenchwarton: A Prominent Centre for Saltworking?

Prospecting yielded particularly fruitful results in Clenchwarton, likely due to the limited fieldwalking conducted in this parish during the Fenland Project and the relatively limited extent of excavation in this area in general. This study suggests the presence of a more substantial industry in Clenchwarton than previously recognised, which is perhaps not surprising given its advantageous location. Nonetheless, while the Domesday Book references the parish, it is noteworthy that the entry exclusively addresses land ownership, omitting any discussion of population or productive resources. The etymology of the placename Clenchwarton is of significance in the context of saltworking; Clenchwarton derives its name from the Old English elements *clenc* meaning ‘hill’, *wara* meaning ‘public land’, and *tūn*

meaning 'small estate' (Oosthuizen 2015). Within this notably low-lying and conspicuously flat landscape, *clenc* may allude to the presence of early, potentially middle Saxon, saltern mounds in this area.

In particular, a cluster of the prospected saltern mounds in Clenchwarton may attest to middle Saxon saltworking. A series of saltern mounds located to the east of the village appear to have been integrated into a linear sea defence, positioned on the landward side of the Sea Bank. Due to its landward position and its function, this sea defence likely predates the Sea Bank, which is believed to have been constructed in the 11th century. While it is not feasible to construct a precise chronological account of the development of the earthworks in this region, it can be reasonably posited that the saltern mounds are of early origin, potentially dating to the middle Saxon period. This inference is supported by the observation that these mounds were extant and functionally abandoned prior to their integration into the linear bank, which is likely one of numerous discrete, low earthen structures erected during the 10th century throughout the area.

Nevertheless, compounded by the lack of conclusive material evidence, the differential distribution of rights of common may cast doubt on the hypothesised early origins of saltworking in Clenchwarton. The region that currently constitutes the parish of Marshland St James historically served as common land for the villages situated between Wisbech and King's Lynn, collectively referred to as the '*seven towns of Marshland*' (Lee 2015). This region was significant not only for grazing but also in the sourcing of the peat that was vital for the production of salt. The differing distribution of the common rights of this region offers insights into the chronological evolution of the settlement and economy of the region (Oosthuizen 2015). A notable concentration of common rights was associated with three primary *vills*: Walton, Walpole, and Walsoken. Terrington St Clement, though to a lesser extent, also held rights (*ibid.*). In contrast, the *vills* of Tilney and Clenchwarton, in contrast, held minimal common rights. Those *vills* that participated prominently in intercommoning – Walpole, Walsoken, West Walton, and Terrington St Clement – have yielded evidence of settlement dating back to around the mid-7th century (*ibid.*). Conversely, *vills* that were largely excluded from intercommoning displayed scant evidence of habitation until the late Saxon period. The history of Clenchwarton before the Norman Conquest remains largely obscure, with the limited evidence comprising small scatters of later Saxon pottery (HER 20880; 21384; 23051;

23053). This pattern suggests that the allocation of rights reflects the chronology of territorial development across the eastern siltlands. Regardless, this pattern does not conclusively negate the possibility that industrial activity, namely saltworking, preceded and even provided the necessary conditions for settlement.

Tilney All Saints, Tilney St Lawrence: A Peripheral, but Profitable, Saltworking Region

While neither Tilney All Saints nor Tilney St Lawrence are explicitly listed in the Domesday Book, they formed part of the Islington manor, where 8½ saltworks were recorded, making the discovery of additional salterns in the region a reasonable expectation. Islington has its own distinct entry in the Domesday Book, which complicates any attempt to reconcile the Domesday Book figures with the limited evidence for late Saxon settlement and saltworking observed through fieldwork and LiDAR analysis in Tilney. The most plausible explanation is that, at the time of the Norman Conquest, Tilney, not mentioned by name until the mid-12th century, functioned as a secondary settlement to Islington. Nevertheless, altogether, the Domesday Book alludes to a populous and wealthy parish; indeed, by 1254, Tilney had emerged as the dominant settlement in the manor (Hudson 1910: 103). The ecclesiastical wealth of the Marshland parishes, as revealed in the 1291 Taxation of Pope Nicholas, also presents Tilney as relatively prosperous, ranked third after Lynn and Terrington (*ibid.*) – regions where saltworking was prevalent. By 1334, the Lay Subsidy Roll indicates that Tilney had the fifth-highest assessment in the Freebridge Hundred, after Lynn, Terrington, Wighenhall, and Walpole, with a value of £30 (Glasscock 1975: 197).

Spatially, it seems that the salterns in this area appear to have been placed in order to benefit from the water, a vital resource in the *sleeching* process, supplied by the adjacent tidal creek that flowed through Terrington St Clement to Tilney. It should be noted, however, that the prospected Tilney salterns were situated at a significant distance, some 3.15km, from the tidally influenced foreshore from which the salt impregnated silt deposited by the spring tides was sourced. This distance – in comparison to the conveniently situated saltworks of Terrington St Clement, West Lynn and Clenchwarton besides the Sea Bank – was likely somewhat prohibitive due the relative cost and effort of transporting silt and likely explains the comparatively limited scale of saltworking in this area. While further examination of historic documentary sources referencing Tilney and Islington is required, intrusive excavation is necessary to further elucidate the saltworking industry in this region and to

ground truth the findings of this study. In particular, excavations, perhaps in the form of trial-pits, are required upon the purported 'levees' beside the tidal creeks discussed by Silvester (1988) that have been reinterpreted within this study.

Walpole St Andrew, Walpole St Peter and Walpole Cross Keys: A Lost Saltworking Landscape

Conversely, fewer saltern mounds have been prospected in Walpole St Andrew, Walpole St Peter, and Walpole Cross Keys. The relative paucity of prospected saltern mounds in Walpole is likely the result of, at least in part, the partial destruction of the earthworks in this region by the development of the Walpole Electricity Substation. While only a small number of saltern mounds remain preserved near the Walpole Electricity Substation, excavations in this area have uncovered significant medieval saltworking remains. The earliest evidence points to activity beginning between the mid-12th and 13th centuries, with features such as large channels, rectangular tanks, and timber-framed revetments used to stabilise the banks, indicating a well-developed salt extraction process. Unlike many of the excavations of known Saxon and medieval saltworking in the region – including those conducted in Terrington St Clement (Podbury 2024), West Lynn (Mellor 2003; Mellor 2004), and even the investigations around King's Lynn (Clarke 2023) – the Walpole Electricity Substation project illuminated the considerable water management and infrastructure maintenance efforts that would have been required to viably produce salt in this wetland landscape, particularly on the seaward side of the Sea Bank.

While it is well-established that settlement in Walpole has middle Saxon origins (Glazebrook 1997: 49-40), as attested by the distribution of rights to the commons of Marshland St Peter and other material evidence, saltworking does not appear to have such early origins in this region. Considering that the datable material evidence recovered during the Walpole Electricity Substation investigations was exclusively of medieval origin and that all the saltern mounds in this region were situated beyond the Sea Bank, it is highly unlikely that saltworking in this region predated the late Saxon period. Indeed, despite the *vill* being recorded in the Domesday Book, no saltworks were noted in this area at the time of the survey, further reinforcing the notion that significant salt production developed later in the medieval period. This lack of earlier saltworking evidence stands in contrast to other locations, such as West Lynn and Terrington St Clement, where such early activities are more likely. The absence of earlier saltworking evidence in Walpole emphasises the need to fully understand the unique

trajectory of salt production in this locality; the evolution of its saltworking industry may represent a distinctly later development, reflective of broader economic shifts across medieval England.

West Walton: Controlling the Production of Salt from Afar

Similar to the aforementioned saltworks of Walpole, the majority of the saltern mounds prospected in West Walton were identified beyond the Sea Bank, which may suggest that the industry had origins postdating the late Saxon period, despite the earlier origins of the settlement. Nonetheless, two small mounds have been prospected on the landward side of the Sea Bank, which may have earlier origins. Despite this spatial distribution, it is entirely plausible that the salterns could postdate the Sea Bank as it may have been culverted in this area, facilitating access to the water that was vital to the *sleeching* process. Intrusive excavations, focussing on one of these two mounds, is required to elucidate the origins of saltworking in this regions. Nevertheless, it is the notable paucity of saltern mounds prospected that is a significant finding of this study in relation to West Walton.

The relative scarcity of saltern mounds prospected in West Walton is conspicuous when juxtaposed with the details contained within the Domesday Book, which recorded a significant number of saltworks in the region. Although West Walton was recorded as a populous and exceedingly wealthy *vill* in the Domesday Book and in the proceeding centuries (Silvester 1986; Silvester 1988: 93), its apparent lack of physical remains from large-scale salt production suggests that the industry was considerably smaller in scale than the Domesday entry implies. Notably, there is insufficient documentary or archaeological evidence to support any assertion that industry and agriculture in West Walton developed more rapidly than its neighbouring settlements in the area. Rather, we must assume that the wealthy manors of West Walton held lands in adjacent *vills*. Given the centrality of salt to medieval economies for food preservation and other essential processes, it is likely that the prosperity of West Walton was supported by saltworks located in adjacent parishes. This idea aligns with broader patterns observed in medieval England, where resource exploitation was not always confined to the immediate geography of a single estate or village. Instead, lords frequently acquired land beyond their manors to secure access to scarce and valuable resources (Roffe 2005: 10). In this context, the study of saltworking in West Walton provides insights into the

dynamics of manorial economics and politics, illustrating how lords capitalised on both local and distant resources to maintain wealth and secure vital resources.

Terrington St Clement: A Well-established, Organised and Profitable Saltworking Landscape

Numerous mounds were prospected in Terrington St Clement and West Lynn, where significant saltworks are already well-documented. This outcome is somewhat predictable, especially considering the application of LiDAR technology, which had not been employed in earlier studies of these regions. With regards to Terrington St Clement, the most significant finding of this study is the identification of a potential sea defence predating the Sea Bank to the north – something which is discussed in more detail below. Setting aside the Orange Row saltern complex and the early sea defence for now, a number of isolated mounds situated close to systems of tidal creeks have been prospected by this study, particularly around Green Bank Farm. Little is known about the isolated saltern mounds generally and, to date, none of these mounds have been excavated upon the Norfolk Fens. Unlike the sizable complexes known elsewhere, relatively little can be gleaned from studying LiDAR and aerial photography of these isolated mounds beyond prospection and analysis of the natural landscape in which they originated. Intrusive excavations upon these isolated mounds are required – not only in Terrington St Clement, but within the adjacent parishes.

Their isolation raises numerous significant questions that are hitherto unanswered and largely underexplored: Were the isolated mounds ephemeral and temporary and, if so, what caused their abandonment? Did they use the same saltworking methods and infrastructure as the larger complexes? What was their relationship with tidal creeks? How did they function in relation to the inevitable tidal inundation in these areas and what preventative methods did they employ? Is there a chronological pattern in their development that can be discerned spatially? Is their isolation and potential temporality related to dynamics of ownership or tenure?

Owen (1975a: 43-44) provides valuable context on the organisation and scale of salt production in Terrington St Clement during the medieval period, drawing on historical sources that may include information on these isolated mounds. A 1251 survey of the Bishop of Ely's manor (British Library: *Cotton Manuscript Claudius C.XI*) is particularly informative, recording that twenty-four salterns were operated by tenants in Terrington St Clement, alongside several in the lord's demesne. The survey lists the names of these salterns, such as *Fleggishill*,

Wennyngeshill, and *Clerkishill*. A notable feature of the *Wennyngeshill* tenure was the requirement to pay rent in salt even if the saltern was disturbed or destroyed by flooding. This condition underscores the susceptibility of this landscape to flooding, with ‘goules’ visible on aerial photographs near the Sea Bank in Terrington St Clement where it was breached by heavy seas (Silvester 1988a: 41; Brown 2023). The historical record is replete with references to significant flooding events in Terrington St Clement, with significant inundations recorded in 1338 when around 1200 acres were flooded (Brown 2023). Indeed, the presence of alluvial layers (e.g. (3009), (4075), (4076)) at the Beacon Hill site suggests evidence of past marine flooding (Podbury 2023). It is likely that further traces of such flood events, which would have been financially disastrous, were truncated by later development or remain buried at greater depths on the site.

Using the example of William Wennyng, the tenant of the *Wennyngeshill* saltern in Terrington St Clement, Owen (1975a: 44) explored the typical responsibilities of the tenant and the general organisation of the industry. William Wennyng and his partners were obliged to produce, pack, and transport four *bleds* of salt to Ely twice a year. Notably, the surveyor of the Bishop of Ely’s manor details the measurements and output of the saltworks in Terrington St Clement. The surveyor records that there are 3 *gats* of salt in a *bled*; 12 *bleds* in a *wayam*; 2½ *gats* in half a quarter; and that a *wayam* of salt amounts to 5 quarters, or 63.6kg (140lb). This implies that William Wennyng alone was required to pay 61.52kg (135.62lb) of rent per year. Significantly, the total amount of salt due from the salterns in Terrington St Clement, according to the Terrington measure (*mensurate in Tyrrington*), is recorded as 16 *wayams* and a third of a *gat*, equating to an annual rent of around 1,015kg of salt. Of this amount, due to a reported shortage of transport that year, 6 *ways* were sent to the Prior of Ely and 5 *ways* and 31 *gats* to the Bishop of Ely. This likely represents only a fraction of the salt produced in this region in 1251, with the remaining salt likely sold at local and regional markets, including the prominent King’s Lynn, or shipped further afield from nearby ports

West Lynn: Integrating Local Salt Production with Regional Trade

Much like the saltworking industry of Terrington St Clement, the prospection in this study has not provided momentous new insights into the industry of West Lynn beyond the identification of a small number of mounds and elucidating the relationship between saltern mounds and sea defences in this region. The prominence of salterns in West Lynn has led to

their thorough documentation, reinforcing the accurate notion of a long-standing and persistent saltworking presence in the area.

Excavations are especially needed north of West Lynn, in the North Farm area, where analysis of complex earthworks using aerial photographs and LiDAR data has provided an incomplete and insufficient narrative of saltworking activity. The earthworks here were likely even more extensive before the excavation of the Eau Brink Cut in the 19th century. Nonetheless, excavations undertaken to date provide a wealth of evidence that enhances our understanding of salt production in West Lynn (Mellor 2003; Mellor 2004). What sets these excavations apart from other saltworking sites in the wider region is the identification of lead remains. Evidence of lead production, including lead fragments likely associated with lead boiling pans, attests to the functional and spatial interconnectedness of the lead-making and salt production industries. The relationship between saltworking, lead production, and other ancillary industries, along with their respective economies, requires further investigation – analysis of medieval documentary sources may be especially fruitful in this regard

The economic significance of salt production in West Lynn – as well as the surrounding areas – is self-evident. Historically, West Lynn was likely considered a part of a 'Greater Lynn' due to the substantial business interests and properties owned by merchants from Bishop's Lynn, which later became known as King's Lynn. In a similar vein, merchants operating from West Lynn maintained substantial ties to Bishop's Lynn, creating a crucial interdependent economic relationship between the two areas (Liddle 2014). West Lynn, and the other settlements studied within this survey serviced a remarkable demand for salt, driven principally by the necessity to preserve fish that could not be marketed for immediate consumption during the medieval period (Carus-Wilson 1962). In the 13th century, ships from Norway, Denmark, Germany, the Low Countries, and various regions within England arrived at the prominent ports of King's Lynn and Boston, often solely to procure salt (*ibid.*). While this study may not have uncovered groundbreaking revelations about West Lynn's saltworking industry, it highlights the integral role that salt production played in the economic framework of the region. The interconnectedness of West Lynn with larger merchant networks and its responsiveness to nascent market demands further highlights the historical importance of this industry, warranting continued interest and exploration.

Sea Defences and Saltern Mounds: Integrated and Interconnected Earthworks

As established above, to ensure the wetland landscapes where salterns were situated were economically viable and exploitable and to ensure the sustainability of settlement, extensive embankments were essential to guard against spring tides. Saxon and medieval embankments incorporated natural barriers and, as has been identified within this study, abandoned saltern mounds. The incorporation of saltern mounds into sea defences, as previously noted elsewhere upon the Fenlands (see Owen 1984: 45-46; Green 2023: 84-85), has been identified in numerous locations between the Great River Ouse and the River Nene. This practice was not restricted to the early medieval or medieval period, as it is evident that the conveniently elevated mounds were incorporated into post-medieval sea defences.

The phenomena is apparent in Clenchwarton, where medieval sea defences appear to have incorporated abandoned and potentially Saxon saltern mounds, and in Walpole Cross Keys, where LiDAR analysis revealed additional salterns integrated into the post-medieval sea defence of *Middle Bank*. In West Lynn, excavations of a medieval embankment have produced evidence for the incorporation three probably late Saxon saltworks within the medieval Sea Bank, demonstrating how abandoned mounds became structural elements of later defences. In Terrington St Clement, LiDAR data indicates the presence of an earlier sea bank, possibly dating to the 9th century, which predates the Sea Bank. This earlier bank may have served to protect the salterns in the Orange Row complex, demonstrating how salt production played a significant and long-lasting role in shaping the landscape.

This evidence not only reinforces the well-established functional relationship between sea defences and saltworks – where the very existence of salt production likely influenced the construction of protective measures – but also highlights the significance of the salt industry in understanding the origins of these somewhat understudied sea defences predating the 11th century Sea Bank. Considering these observations, further intrusive excavation around these salterns associated with sea defences is imperative. Such investigations could reveal invaluable insights into potential middle Saxon saltworking sites, in addition to the broader socio-economic conditions and infrastructure construction efforts that shaped settlement patterns in the Fenlands.

Saltworking Between the River Nene and the River Great Ouse: A Summary

This comprehensive investigation of saltworking across Clenchwarton, Tilney, Walpole, West Walton, Terrington St Clement, and West Lynn reveals a complex landscape of economic

activity that exploited local resources and played a crucial role in regional, national and international commerce. Overall, the implications of this study extend beyond simply identifying saltworking locations; they highlight the importance of contextualising these economic activities within larger socio-political frameworks. As communities and elites navigated the complexities of resource management, landscape management, settlement establishment, and commerce dynamics, salt production emerged prominent component of the Fenland economy. Future studies, taking forward the prospection efforts of this investigation through targeted excavations and documentary analysis, are essential to broadening our understanding of the intricate dynamics between these saltworking sites and their broader economic and societal contexts.

5.2 The Limitations of LiDAR in Prospecting for Saltern Mounds in a Complex Landscape

This study also reevaluated findings from the Fenland Project, impressively validating all identified saltworks excepting one. In Terrington St Clement, two supposed saltern mounds recorded by Silvester (1988) were found, through satellite photography, to be a ditched enclosure or moat. This misinterpretation underscores the importance of a multi-faceted approach to prospecting, as these earthworks could easily be similarly mistaken for saltworks based on LiDAR alone. This raises reasonable concerns about saltern mound interpretations in this thesis, particularly in areas where aerial photography fails to detect soilmarks. Ultimately, potential salterns require intrusive investigation for confirmation, as elevation changes detected by LiDAR cannot be solely relied upon for landscape interpretation (Crutchley 2006). Misidentification, unsurprisingly, is a notable limitation of using LiDAR for saltworks prospecting. The primary cause of misinterpretation of aerial and LiDAR imagery is often the observer's expertise (Cowley and Opitz 2013; Stewart *et al* 2020; McKeague *et al.* 2020). The author's expertise is certainly not exhaustive, introducing the risk of misidentifying salterns that actually represent moot hills, roddons, windmill mounds, or other natural and anthropogenic features.

Moreover, while LiDAR is valuable for studying complex archaeological sites, its effectiveness diminishes in areas shaped by significant historical and geomorphological activity (Trier *et al* 2016; Trier *et al* 2018; Meyer *et al* 2019; Lozić and Štular 2021: 9). The Norfolk Fens exemplifies such terrain, where historical inundations and extensive marsh reclamation complicate the identification and interpretation of archaeological remains. Among the

environmental challenges in identifying saltworks, elevated roddons are particularly significant. Keen (1988) and Owen (1975) may have misidentified these geomorphological formations as relic saltern mounds, implying that many churches and historic settlements were built on former saltworks. Silvester (1988) reevaluated these claims, with the notable exception of West Lynn, arguing that the elevated areas were roddons, as indicated by their dendritic form visible from topographic analysis and fieldwalking. Silvester (1988: 165), somewhat dismissively, noted:

The danger in making fundamental pronouncements on pre-Conquest settlement origins, based on limited and superficial observations, is all too apparent in the Owens' attribution of the mounds beneath Walton, Terrington and elsewhere to the salt industry. Not only is there considerable difference in the appearance of saltern mounds and roddons, but the presence of Middle Saxon pottery at Walton and of Late Saxon pottery at Terrington and Walpole would, if the industrial origin theory is to be sustained, require a very early origin.

Notwithstanding that the early to middle Saxon saltworks near King's Lynn suggest that it is entirely plausible that *sleeching* could have such a 'very early origin', Silvester (1988) exaggerates the ease at which saltern mounds and roddons can be distinguished. Green (2024: 14) also questions the reliability of some roddon interpretations, noting that many purported roddons lack the continuous, curvilinear forms depicted in Silvester's (1988) topographic plans, appearing instead as discontinuous and disparate. This nevertheless does not entirely disprove that these elevated areas could be denuded roddons simply resembling saltworking mounds. While it is likely that the historic cores of West Walton, Clenchwarton, and Terrington St Clement are situated on roddons, intrusive investigations are needed for confirmation.

Beyond roddons, the alluviated marshland poses further challenges. In low-lying marsh and intertidal zones, sediment can conceal archaeological sites (Lobb 2016: 141). Saltern mounds in the Fenland may be buried beneath alluvial sediment, obscuring their morphology on LiDAR. For example, in the southern Lindsey Marshes, saltworking mounds were found under up to 2.00m of silt, rendering them indiscernible on LiDAR (Lane and Fielding 2024: 8). Sediment cover hinders LiDAR's ability to detect subtle topographic variations, indicating that more saltern mounds could exist between the River Nene and Great Ouse, likely identifiable only through excavation. Additionally, historical sediment deposition from tidal and riverine

processes means that some salterns identified in this study may have been misinterpreted, underscoring the need for ground-truthing.

Vegetation, particularly conifer plantations, can obscure LiDAR results, leading to lower quality DTMs and obscured archaeological features (Doneus *et al* 2008). In this study area, most land is used for arable farming, where intense ploughing significantly impacts archaeological earthworks (Risbøl *et al.* 2020). A Danish study (Vennersdorf 2017) demonstrates how ploughing erodes landscapes, affecting the visibility of historical features on LiDAR. Historical evidence also shows deliberate mound destruction by farmers, such as at Fishtoft in the 19th century (Wheeler 1896) and Bicker Haven in the 20th (Healey 1999). Consequently, many mounds in this study are morphologically indistinct and lower in height than well-preserved examples in Lincolnshire or King's Lynn, making them harder to identify and increasing the potential for misinterpretation.

Prospecting for saltworks in developed areas, such as Terrington St Clement and West Lynn, poses significant challenges. Buildings and landscaping obscure mounds and their true extents. LiDAR is most effective in rural settings, with limited application in urban historic settlements (Monterroso-Checa 2019). Although LiDAR can 'digitally remove' buildings to reveal underlying features (Bewley *et al.* 2005), construction and landscaping over time complicate detection, particularly of small features like saltworks. In such built-up areas, centuries of activity create morphologically amorphous elevations, making LiDAR less effective. Excavation is essential to confirm the presence of mounds, particularly in West Lynn's historic core and around the Orange Row complex in Terrington St Clement.

5.3 Terrington St Clement: A Case Study for the Investigation of Early Saltworking

If one was to cursorily analyse the Domesday Book, one would get the impression that salt production in this area was relatively insignificant compared to the extensive works in King's Lynn and Lincolnshire; however, the Domesday entries reflect the state of the industry in 1086 and do not capture developments that occurred in the preceding and proceeding centuries. Additionally, many upland saltworks recorded, too far inland to be viable, likely represent land ownership dynamics rather than actual production (Owen 1975a); upland lords often acquired lowland industrial land for resources (Roffe 2005: 10). A fuller understanding of the Saxon salt industry requires the synthesis of documentary evidence, excavation findings, and landscape-scale data.

The broad chronology of *sleeching* in the Fens, and the lack of intrusive excavations or radiocarbon dating (Lane and Fielding 2024), hinder the development of a clear timeline for the industry and dating of individual salterns. However, the aforementioned excavations near King's Lynn and the spatial analysis of known saltern mounds in relation to the Sea Bank offer some insight into this chronology. Hallam (1965: 6) to this end relied, in part, on the since disproved assumption that salterns adjacent to the Sea Bank represented those recorded in the Domesday Book. The pitfalls of such assertions are underscored by the claims of Owen (1984: 46), who argued that active salterns could not exist landward of a sea bank, a claim undermined by recent excavations at Terrington St Clement (Podbury 2023) and King's Lynn (Clarke 2023). Owen (1984), overlooking the known timber-framed culverting and sluicing of the Sea Bank during the mid-13th century near Wisbech (Taylor 1977) and overestimating the impracticality of water management in this context, was working on the hypothesis that the further inland the saltern mound is situated, the earlier the saltworking site. This, nevertheless, remains a logical and plausible theory for the morphological development of the industry, especially when considering the way in which salterns contributed to the gradual reclamation of marshland (Silvester 1999; Rippon 2009; Simmons 2014; Simmons 2017; Simmons 2018). During the King's Lynn excavations this hypothesis was tested; however, no clear pattern was evident. The earliest saltwork encountered at Marsh Lane, dated to 758-887 cal AD, was the most landward; however, broadly contemporaneous middle Saxon mounds were also located in proximity to the coastline, while those dated to the 10th-12th centuries were positioned further inland.

Using the expansive Orange Row saltern complex in Terrington St Clement as a case study, we can assess the possibility of middle Saxon origins for *sleeching* in the region. Fieldwalking at Orange Row during the Fenland Project (Silvester 1988) and excavations at Belmont Nursery (Hutcheson 1998) and Beacon Hill (Podbury 2023) predominantly yielded medieval pottery, in addition to a few Saxo-Norman sherds. While this limited evidence does not evidence earlier saltworking, it does not rule it out either; indeed, the excavations at Beacon Hill were shallow, only reaching the top of an alluvial layer that could have sealed earlier saltworking evidence (Podbury 2023). Crucially, the morphology of the Orange Row complex and its spatial relationship to the prospected middle Saxon bank, including *Church Bank*, lend circumstantial support to the hypothesis that some of the salterns were active during the

middle Saxon period. If this sea defence existed in the middle Saxon era, it would have provided the necessary protection for salt production prior to the construction of extensive defences during the high medieval period. This could explain the preservation of significantly landward salterns at Terrington St Clement.



Plate 5.1: The distribution of middle Saxon pottery and the roddon system and Hay Green, south of Terrington St Clement

To investigate the possible early origins of *sleeching* in Terrington St Clement, it is crucial to consider the nearby middle Saxon settlement at Hay Green. Fieldwalking at Hay Green revealed an extensive middle Saxon occupation area, with around 1,000 Ipswich-type ware sherds recovered from a single field (Field K; Plate 5.1), significantly exceeding similar finds in Norfolk's upland estates (Rogerson and Silvester 1986). Hutcheson's (2006) research on pre-Norman wealth control upon the Fens posits that settlements like Hay Green might have overseen valuable resources, including salt. Middle Saxon settlements, such as Hay Green, were central to the emerging regional economies of the Fens, engaging in both agriculture and specialised craft production (Oosthuizen 2011; Pickles 2020). These communities often practiced estate-based ownership, with estates playing a pivotal role in managing local economic activities, land, and resources (Jones 1993). Hay Green fits into the broader pattern of middle Saxon settlements in Marshland, strategically located along key routes and near resource-rich areas, suggesting a potential role in overseeing salt production (Rogerson 2003). Given the substantial evidence of occupation at Hay Green, it is plausible that this settlement operated as an estate hub that managed a now largely unrecognised middle Saxon salt industry; however, further excavations at both Orange Row and Hay Green are needed to confirm this theory conclusively.

5.4 The Potential of Future Archaeological Inquiry

This study, and recent research (Lane 2018; Clarke 2023; Green 2023; Lane and Fielding 2024), demonstrate the utility of LiDAR for investigating Saxon and medieval saltworks. While the publicly available LiDAR data from the Environment Agency's National LIDAR Programme is effective, higher-resolution imagery would enable more nuanced and accurate interpretations. Contemporary LiDAR technology allows point densities exceeding 60 points per m², offering significantly more detailed imagery (Shaw and Corns 2011; Lozić and Štular 2021). In contrast, the data used here consists of only one point per m² (NLS 2024), providing lower resolution (Plate 5.2). Enhanced resolution would improve non-intrusive investigation of sites, particularly those in West Lynn and Terrington, and help verify whether the denuded earthworks prospected indeed represent salterns. It would also facilitate detailed analysis of microtopographic features, including the water channels that supported saltworking. However, higher-resolution LiDAR remains financially prohibitive for large landscapes like this one (Shaw and Corns 2011).

In the reemerging field of early medieval and medieval salt archaeology, driven by advances in LiDAR and recent excavations near King's Lynn, several specific topics warrant further inquiry – some of which have been outlined above. Key among these are the roles of monastic and lordly ownership in shaping saltworking sites, and the relationship between salt-making and the construction and management of the sea banks essential for managing wetland landscapes. Significantly, growing evidence suggests that *sleeching* originated in the middle Saxon period, raising questions about the industry's continuity over centuries and the early origins of known saltern mounds in the Norfolk and Lincolnshire Fens, a topic of inquiry advocated by Lane (2022; 2023). Too numerous to outline here, a comprehensive series of relevant research topics and questions are presented in Appendix 5.

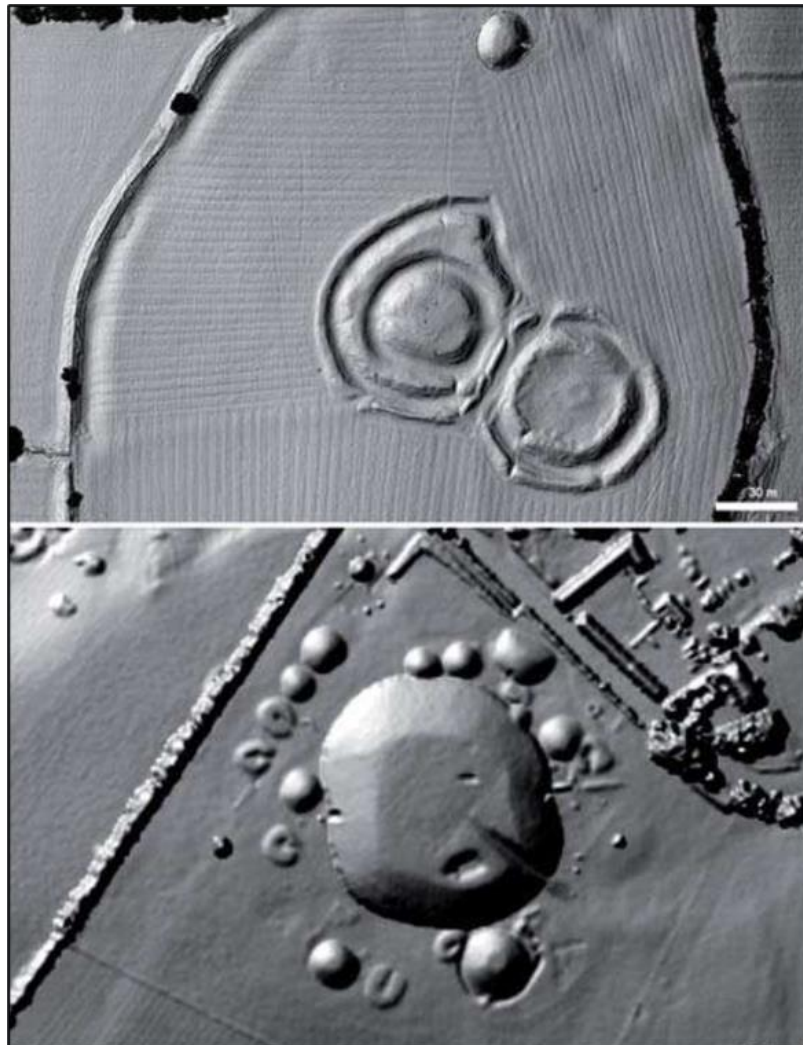


Plate 5.2: Top extract showing LiDAR imagery of the Hill of Tara in Ireland, illustrating the level of detail possible in a DSM generated from 12.5cm resolution data (60 point per m²). Bottom showing LiDAR imagery the Brú na Bóinne DSM generated from 1m resolution data (1 point per m²) (Shaw and Corns 2011: 82).

6 CONCLUSIONS

Saxon and medieval saltworking upon the Fens reflects a complex interplay of environmental exploitation, industrial processes, and socio-economic demand. This thesis highlights how the region's unique geography – characterised by tidal marshes, spring tides, creeks, and nearby peatlands – facilitated large-scale salt production. The construction of embankments like the Sea Bank exemplifies significant landscape management efforts essential for saltworking and occupation more. These early defences highlight the strategies communities employed to manage the challenges of the dynamic wetland environment, attesting to the broader socio-economic systems that underpinned salt production and its role in the local and regional economy.

Excavations have revealed the scale and longevity of saltworking upon the Fens. Discoveries of clay-lined features, hearths, and stratified deposits highlight the complex processes of *sleeching*, which systematically desalinated tidal silts and resulted in the creation of preserved earthworks within the landscape. The key advancement of this thesis is nevertheless the demonstrated utility of LiDAR for prospecting and analysing saltworking sites. The ability of LiDAR to detect subtle topographical anomalies has been crucial in locating salterns, especially where traditional methods like fieldwalking and aerial photography are hindered by unfavourable conditions or poor coverage. It enables relatively accurate mapping of low, degraded earthworks, facilitating the reconstruction of saltworking landscapes when integrated with other data sources. This synthesis has uncovered previously undocumented saltern mounds and refined our understanding of their spatial organisation and functionality. For instance, LiDAR reveals intricate relationships between saltworks and environmental features like tidal creeks and embankments, offering insights into the factors shaping saltworking in the region.

The potential middle Saxon origins of *sleeching* saltworks in this landscape represent a significant consideration of this thesis. Current evidence suggests that by the 8th century, Fenland communities were engaged in widespread saltworking, predating the more extensively documented later medieval activity. The middle Saxon period, characterised by industrial intensification (Hamerow 2007), likely marked the initial exploitation of the resources of the Fenland for saltworking. The presence of early embankments and associated settlement patterns supports the notion that saltworking was a key driver of economic and

settlement trends in the region. While existing evidence alludes to early saltworking, this remains an emerging field of inquiry, necessitating further research to clarify how these practices evolved and contributed to prominence of this region in salt production during the later medieval period.

Ultimately, by reassessing established interpretations and analysing new data, this thesis reveals that the landscape between the River Great Ouse and Nene was an important centre for salt production. By employing a multi-faceted approach, this research not only advances our understanding of salt production during the period but also sets an already nascent precedent for future inquiry.

7 BIBLIOGRAPHY

- Adams, D. (2011). *Archaeological Evaluation at Harvey House, 50 Ferry Road, West Lynn, Norfolk*. Unpublished Report: NPS Archaeology.
- Adams, D. (2013). *Archaeological Trial Trench Evaluation at King's Lynn Sewage Treatment Works New Liquid Sludge Reception Transfer Main, West Lynn, Norfolk*. Unpublished Report: NPS Archaeology.
- Albone, J. (1999). *Archaeological Excavation Report: A late medieval or early post-medieval saltern at St Michael's Lane, Wainsflett St Mary, Lincolnshire*. Unpublished report: Pre-Construct Archaeology.
- Albone, J., Massey, S., & Tremlett, S. (2007). *The Archaeology of Norfolk's Coastal Zone: Results of the National Mapping Programme*. Dereham: English Heritage Project No: 2913.
- Alessandri, L., & Attema, P. (2022). 'From briquetage to salterns in protohistoric central Italy. Research of a fundamental subsistence commodity'. *IpoTESI di Preistoria*, 14(1), 161-168.
- Bamforth, M. (2002). *Land at West Drove North, Walpole St Peter*. Unpublished Report: Archaeological Project Services.
- Barlow, G. (2010). *Land West of 36 Smallholdings Road, Clenchwarton, Norfolk. Archaeological Evaluation*. Unpublished Report: Archaeological Solutions.
- Bell, A., Gurney, D., & Healey, H. (1999). Lincolnshire Saterns. Excavations at Helpringham, Holbeach St Johns and Bicker Haven. *East Anglian Archaeology*.
- Bewley, R. H., Crutchley, S. P., & Shell, C. A. (2005). 'New light on an ancient landscape: lidar survey in the Stonehenge World Heritage Site'. *Antiquity*, 79(305), 636-647.
- Biddulph, E. (2016). 'The Roman Salt Industry in South-Eastern Britain'. In D. Bird, *Agriculture and Industry in South-Eastern Roman Britain*. Oxford: Oxbow Books.
- Blackbourn, K. (2019). *Late Saxon to Early Medieval Salterns at Lynnsport 1: Land South of Aconite Road, King's Lynn, Norfolk: PXA and UPD*. Unpublished Report: Oxford Archaeology.
- Blomefield, F. (1808). *An Essay Towards a Topographical History of the County of Norfolk VIII-IX*. London: William Miller.
- Bridbury, A. R. (1955). *England and the Salt Trade in the Middle Ages*. Oxford: Clarendon Press.
- Brown, P. J. (2023). *Meteorological Disasters in Medieval Britain (AD 1000–1500): Archaeological, Historical and Climatological Perspectives within a Wider European Context*. Berlin: Walter de Gruyter GmbH.
- Brownrigg, W. (1748). *The Art of Making Common Salt*. London: C. Davis, A. Millar and R. Dodsley.
- Brunning, E., & Freeman, J. (2023). *Land at Rose Hall Farm, Walpole Bank, Norfolk. Geophysical Survey*. Unpublished Report: Archaeological Services WYAS.

- Bull, M. (2011). *Archaeological Watching Brief at St Clement Church, Terrington St Clement, Norfolk*. Unpublished Report: NAU Archaeology.
- Carus-Wilson, E. (1962). 'The Medieval Trade of the Ports of the Wash'. *Medieval Archaeology*, 182-201.
- Chase, A. F., Reese-Taylor, K., Fernandes-Diaz, J. C., & Chase, D. Z. (2016). 'Progression and Issues in the Mesoamerican Geospatial Revolution: An Introduction'. *Advances in Archaeological Practice*, 4(3), 219-231.
- Chase, A. Z., Chase, D. Z., & Chase, A. F. (2017). 'LiDAR for Archaeological Research and the Study of Historical Landscapes'. In N. Masini, & F. Soldovieri, *Sensing the Past: From Artifact to Historical Site* (pp. 89-100). Cham: Springer International Publishing .
- Christy, M., & Dalton, W. H. (1925). 'Two Large Groups of Marsh-Mounds on the Essex Coast'. *Transactions of the Essex Archaeological Society*, 18(1), 27-56.
- Clarke, G. (2016a). *A Late Saxon to Medieval Saltern at Marsh Lane, King's Lynn, Norfolk: Archaeological Excavation*. Unpublished Report: Oxford Archaeology.
- Clarke, G. (2016b). *A Late Saxon to Medieval Saltern at Marsh Lane, King's Lynn, Norfolk: PXA and UPD*. Unpublished Report: Oxford Archaeology.
- Clarke, G. (2017a). *Lynnsport 4 & 5: Land adjacent to Greenpark Avenue, King's Lynn, Norfolk*. Unpublished Report: Oxford Archaeology.
- Clarke, G. (2017b). *Lynnsport 4 & 5: Middle to Late Saxon Salterns on Land Adjacent to Greenpark Avenue, King's Lynn, Norfolk*. Unpublished Report: Oxford Archaeology.
- Clarke, G. (2018a). *Lynnsport 1: Land South of Aconite Road, King's Lynn, Norfolk*. Unpublished Report: Oxford Archaeology.
- Clarke, G. (2018b). *Lynnsport 3: Land South of Front Way, King's Lynn, Norfolk*. Unpublished Report: Oxford Archaeology.
- Clarke, G. (2018c). *Land north of Greenpark Avenue, King's Lynn, Norfolk*. Unpublished Archaeology: Oxford Archaeology.
- Clarke, G. (2018d). 'Saxon salt-making works exposed by excavations along Salter's Waie, King's Lynn'. *Medieval Archaeology*, 62(2).
- Clarke, G. (2023). Salt-Winning on the Lyn: Anglo-Saxon and Medieval Industry at Gaywood's North Marsh, King's Lynn. *East Anglian Archaeology* 180.
- Clarke, G., & Clarke, R. (2018). 'A Tale of Two Salterns: Recent Excavations at Walpole St Peter and Gaywood, King's Lynn'. *Norfolk Archaeology*, XLVIII, 1-24.
- Clarke, R. (2009). *Medieval and Later Saltworking and Channel Management at Walpole St Peter, Norfolk. Post-Excavation Assessment*. Unpublished Report: Oxford Archaeology.
- Cockin, G. (2006). *Clenchwarton Road, West Lynn, Nr. King's Lynn, Norfolk. Archaeological Evaluation Report*. Unpublished Report: Oxford Archaeology.
- Cooper, O. (2008). *Archaeological Evaluation Report. Walpole Electricity Substation, Walpole St Peter, Norfolk*. Unpublished Report: Northern Archaeological Associates.
- Cooper, S. (2002). *Crown Farm, Walpole St Andrew, Norfolk. An Archaeological Watching Brief*. Unpublished Report: Cambridgeshire County Council Archaeological Field Unit.

- Cowley, D. C., & Opitz, R. S. (2013). *Interpreting Archaeological Topography: 3D Data, Visualisation and Observation*. Oxford: Oxbow Books.
- Cranstone, D. (2012). 'The Panhouse as Cradle of Industry: Coastal Saltmaking and the 'Long Industrial Revolution''. In H. Harnow, D. Cranstone, P. Bedford, & L. Host-Madsen, *Across the North Sea: Later Historical Archaeology in Britain and Denmark, c.1500-2000 AD*. Odense: University Press of Southern Denmark.
- Craven, J. (2024). *Crown Farm, Mill Road, West Walton, Norfolk: Watching Brief*. Unpublished Report: Wardell Armstrong.
- Crowson, A., Lane, T., Penn, K., & Trimble, D. (2005). *Anglo-Saxon Settlement on the Siltland of Eastern England*. Heckington: Lincolnshire Society for Archaeology and History.
- Crutchley, S. (2006). 'Light Detection and Ranging (lidar) in the Witham Valley, Lincolnshire: an Assessment of New Remote Sensing Techniques'. *Archaeological Prospection*, 13, 251-257.
- Darby, H. C. (1952). *The Domesday Geography of Eastern England*. Cambridge : Cambridge University Press.
- Darby, H. C. (1977). *Domesday England*. Cambridge: Cambridge University Press.
- Devereux, B. J., Amable, G. S., & Crow, P. (2008). 'Visualisation of LiDAR terrain models for archaeological feature detection'. *Antiquity*, 316, 470-479.
- Diderot, D., d'Alembert, J., & de Jaucourt, L. (1765). *Édition Numérique Collaborative et Critique de l'Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*. Volume XIV. ARTFL Project: University of Chicago.
- Donald, N. (1996). *Report on a Watching Brief at Church Farm, Tilney All Saints, Kings Lynn*. Unpublished Report: NAU Archaeology.
- Dransfield, N., & Tibber, J. (2013). *Walpole Electricity Substation, Walpole St Peter, Norfolk, Archaeological Mitigation Report*. Unpublished Report: Wessex Archaeology.
- Doneus, M., Briesse, C., Fera, M., & Janner, M. (2008). 'Archaeological prospection of forested areas using full-waveform airborne laser scanning'. *Journal of Archaeological Science*, 35(4), 882-893.
- Duncan, H. (1812). 'On the Mode of Manufacturing Salt from Sea-sand or Sleaf Practised in Annandale, along the Coast of the Solway Firth'. In W. Singer, *General View of the Agriculture, State of Property and Improvements in the County of Dumfries*. Edinburgh: John Ballantyne and Co.
- Farrell, A. (2022). *Evaluation at Walpole Bank Solar Farm*. Unpublished Report: Archaeological Project Services.
- Fitzpatrick, R. (2008). *Walpole Electricity Substation, Walpole St Peter, Norfolk. Report on a Programme of Archaeological Works*. Unpublished Report: Wessex Archaeology.
- Fletcher, T. (2014). *Early Medieval Industry East of the "Sea Bank", Waterlees Road, Wisbech*. Unpublished report: Oxford Archaeology.
- Forsythe, W., McConkey, R., & Breen, C. (2018). 'Persistence and risk: salt production in post-medieval Ireland'. *World Archaeology*, 50(4), 603-619.

- Forsythe, W., McConkey, R., & Breen, C. (2021). 'The Archaeology of Salt Production in Post-Medieval Ireland'. *Post-Medieval Archaeology*, 55(1), 91-108.
- Forsythe, W., McConkey, R., & Breen, C. (2023:). Towards an Archaeology of Salt Production in Ireland. In M. Alexianu, R. G. Curcă, O. Weller, & A. A. Dumas, *Mirrors of Salt: Proceedings of the First International Congress on the Anthropology of Salt* (pp. 161-168). Oxford: Archaeopress Publishing Ltd.
- Frere, S. S. (1961). 'Reviews: Lincolnshire Architectural and Archaeological Society Reports and Papers'. *The Antiquaries Journal*, 41(1-2), 104-105.
- Galloway, J. A. (2013). 'Coastal flooding and socioeconomic change in eastern England in the later Middle Ages'. *Environment and History*, 19(2), 173-207.
- Gardiner, M. (2005). 'Archaeological evidence for the exploitation, reclamation and flooding of salt marshes'. In J. Klapste, *Ruralia V: Water Use and Management in Europe* (pp. 73-83). Prague: Institute of Archaeology.
- Gilbert, M. (2017). *The Changing Landscape and Economy of Wisbech Hundred 1250-1550*. PhD Thesis: University of Leicester.
- Glasscock, R. (1975). *The Lay Subsidy of 1334*. London: British Academy
- Glazebrook, J. (1997). *Research and Archaeology: A Framework for the Eastern Counties: Resource Assessment*. East Anglian Archaeology Occasional Paper 3.
- Glennie, C., Carter, W., Shrestha, R., & Dietrich, W. (2013). 'Geodetic imaging with airborne LiDAR: the Earth's surface revealed'. *Reports on Progress in Physics*, 76(8).
- Grady, D. (1998). 'Medieval and post-medieval salt extraction in north-east Lincolnshire'. In R. Bewley, *Lincolnshire Archaeology from the Air*. Occasional Papers in Lincolnshire History and Archaeology No.11.
- Green, C. R. (2023). *Land on the Edge: The Landscape Evolution of the Lincolnshire Coastline*. Louth: Caitlin R. Green.
- Greenwood, J. (2011). 'The changing technology of post-medieval salt production in England'. *The Sea: Heritage, Uses and Representations* (pp. 1-22). Porto: CITCEM Conference.
- Greenwood, J. (2012). 'The Changing Technology of Post-medieval Salt Production in Hampshire'. *Proceedings of the Hampshire Field Club and Archaeological Society*, 67(2), 366-378.
- Griffin, N., Barber, L., Gale, R., & Sibun, L. (2024). *An Archaeologically Excavated Medieval Saltern in the Ouse Estuary, Newhaven, East Sussex*. Unpublished Report: Archaeology South-East.
- Hall, D., & Coles, J. (1994). *Fenland Survey: An essay in landscape and persistence*. Swindon: English Heritage Publishing.
- Hallam, H. E. (1960). 'Salt-making in the Lincolnshire Fenland during the Middle Ages'. *Lincolnshire Architectural and Archaeological Society Reports and Papers*, 8, 85-112.
- Harding, A. (2021). *Salt: White Gold in Early Europe*. Cambridge: Cambridge University Press.
- Härke, H. (2011). 'Anglo-Saxon Immigration and Ethnogenesis'. *Medieval Archaeology*, 55(1), 1-28.

- Harmon, J. M., Leone, M. P., Prince, S. D., & Snyder, M. (2006). 'Lidar for Archaeological Landscape Analysis: A Case Study of Two Eighteenth-Century Maryland Plantation Sites'. *American Antiquity*, 71(4), 649-670.
- Harris, S. (2003). 'Ælfric's Colloquy'. In D. Kline, *Medieval Literature for Children*. New York: Routledge.
- Harrison, C., & Budd, C. (2010). *Lincolnshire Offshore Windfarm, Norfolk Cable Route Onshore Section. Archaeological Watching Brief Report*. Unpublished Report: Wessex Archaeology.
- Hathaway, S. (2008). 'Take it with a Pinch of Salt? Thinking about the Cultural Significance of Producing and Consuming Salt'. In S. Baker, M. Allen, S. Middle, & K. Poole, *Food and Drink in Archaeology I. University of Nottingham Postgraduate Conference 2007* (pp. 47-56). Totnes: Prospect Books.
- Healey, H. (1988). 'Bicker Bends'. *Fenland Research*, 5, 44-45.
- Healey, H. (1999). 'A medieval salt making site at Bicker Haven'. In A. Bell, D. Gurney, & H. Healey, *Lincolnshire Salterns, Excavations at Helpringham, Holbeach St Johns and Bicker Haven* (pp. 82-101). East Anglian Archaeology 89.
- Hobson, M. S. (2008). *An Archaeological Evaluation at Churchgate Way, Terrington St Clement, Norfolk*. Unpublished Report: NAU Archaeology.
- Hudson, W. (1910). 'The 'Norfolk Taxation' of 1254 so far as relates to the Diocese of Norwich'. *Norfolk Archaeology*, 17, 46-157.
- Hughes, E. (1925). 'The English Monopoly of Salt in the Years 1563-71'. *The English Historical Review*, 334-350.
- Hutcheson, A. (1998). *Report on an Archaeological Evaluation at land adjacent to No 74 New Roman Bank, Terrington St Clement*. Unpublished Report: NAU Archaeology.
- Hutcheson, A. R. (2006). 'The Origins of King's Lynn? Control of Wealth on the Wash Prior to the Norman Conquest'. *Medieval Archaeology*, 50(1), 71-104.
- Jones, R. H. (2016). *Archaeological Watching Brief Report: No.2 Islington Hall Cottages, Tilney All Saints, Kings Lynn, Norfolk*. Unpublished Report: Allen Archaeology.
- Jones, S. (1993). 'Transaction Costs, Institutional Change, and the Emergence of a Market Economy in Later Anglo-Saxon England'. *The Economic History Review*, 48(4), 658-678.
- Keen, L. (1987). 'Medieval Salt-working in Dorset'. *Proceedings of the Dorset Natural History and Archaeological Society*, 109, 25-28.
- Keen, L. (1988). 'Coastal salt production in Norman England'. In A. R. Brown, *Anglo-Norman Studies XI: Proceedings of the Battle Conference* (pp. 133-179). London: Boydell & Brewer.
- Knight, T., & Clarke, G. (2019). *Late Saxon to Early Medieval Salterns on Land North of Greenpark Avenue, King's Lynn, Norfolk: PXA and UPD*. Unpublished Report: Oxford Archaeology.

- Kowaleski, M. (2016). 'The Early Documentary Evidence for the Commercialisation of the Sea Fisheries in Medieval Britain'. In J. Barrett, & D. Orton, *Cod and Herring: The Archaeology and History of Medieval Sea Fishing* (pp. 23-41). Oxford: Oxbow Books.
- Kwiatkowska, M. (2020). *Late Saxon to Early Medieval Saltern at Lynnsport 3: Land South of Front Way, King's Lynn, Norfolk: PXA and UPD*. Unpublished Report: Oxford Archaeology.
- Lane, T. (2018). *Mineral from the Marshes: Coastal Salt-making in Lincolnshire*. Lincoln: (Lincolnshire Archaeology and Heritage Reports Series 12) Heritage Trust of Lincolnshire.
- Lane, T. (2022). 'Salterns in Lincolnshire: the Drip of New Information'. *Saltcote*, 10, 5-6.
- Lane, T., & Fielding, A. (2024). 'Three millennia of salt production: Briquetage and salt structures on the east coast of Lincolnshire, England'. *Quaternary Science Reviews*, 334.
- Lane, T., & Morris, E. L. (2002). *A Millennium of Saltmaking: Prehistoric and Romano-British salt production in the Fenland*. Lincoln: (Lincolnshire Archaeology and Heritage Reports Series 4) Heritage Trust of Lincolnshire.
- Lane, T., Hogan, S., Robinson-Zeki, L., Fryer, V., Irving, A., & Perrin, R. (2019). 'Excavations of Salterns at Fenland Way, Chatteris and Camel Road, Littleport, Cambridgeshire'. *Proceedings of the Cambridge Antiquarian Society*, 108, 51-72.
- Lewin, J. (2010). 'Medieval environmental impacts and feedbacks: The lowland floodplains of England and Wales'. *Geoarchaeology*, 25(3), 267-311.
- Lewis, C. (2007). 'New avenues for the investigation of currently occupied medieval rural settlement: preliminary observations from the Higher Education Field Academy'. *Medieval Archaeology*, 51.
- Liddle, W. (2014). *The Virtue of Place in Late Medieval Lynn*. PhD Thesis: Queen's University Belfast.
- Livingstone, M. (2015). 'A Snapshot in Time: The Weather as Seen in the Record of the Nonae (1339-41)'. In M. Kowaleski, J. Langdon, & P. R. Schofield, *Peasants and Lords in the Medieval English Economy: Essays in Honour of Bruce M.S. Campbell* (pp. 325-376). Turnhout: Brepols.
- Lobb, M. A. (2016). *Developing Terrestrial Laser Scanning of Threatened Coastal Archaeology with Special Reference to Intertidal Structures*. University of Southampton: PhD Thesis.
- Lozić, E., & Štular, B. (2021). 'Documentation of Archaeology-Specific Workflow for Airborne LiDAR Data Processing'. *Geosciences*, 11(1), 1-26.
- McAvoy, F., Healey, R. H., Mould, Q., & Thompson, A. (1994). 'Marine Salt Extraction: The Excavation of Salterns at Wainfleet St Mary, Lincolnshire'. *Medieval Archaeology*, 38(1), 134-163.
- McKeague, P., Corns, A., Larsson, Å., Moreau, A., Posluschny, A., van Daele, K., & Evans, T. (2020). 'One Archaeology: A Manifesto for the Systematic and Effective Use of

- Mapped Data from Archaeological Fieldwork and Research'. *Information*, 11(222), 1-30.
- Mellor, V. (2003). *Archaeological Evaluation on Land at Clenchwarton Road, West Lynn, Norfolk*. Unpublished Report: Archaeological Project Services.
- Mellor, V. (2004). *Archaeological Excavation on Land at Clenchwarton Road, West Lynn, Norfolk*. Unpublished Report: Archaeological Project Services.
- Meyer, M., Pfeffer, I., & Jürgens, C. (2019). 'Automated Detection of Field Monuments in Digital Terrain Models of Westphalia Using OBIA'. *Geosciences*, 9, 109.
- Monterroso-Checa, A. (2019). 'Geoarchaeological Characterisation of Sites of Iberian and Roman Cordoba Using LiDAR Data Acquisitions'. *Geosciences*, 9(5).
- Mortlock, D. P., & Roberts, C. V. (1985). *The Popular Guide to Norfolk Churches: No.3 West and South-West Norfolk*. Cambridge: Acorn Editions.
- Moulis, C. (2010). *Archaeological Evaluation on Land At Bell House, Tilney All Saints, Norfolk*. Unpublished Report: Archaeological Project Services.
- National Library of Scotland (NLS). (2024). *Using LiDAR layers for landscape research*. Retrieved September 2024, 9, from National Library of Scotland: <https://maps.nls.uk/guides/lidar/>
- Oosthuizen, S. (2016). 'Culture and identity in the early medieval fenland landscape'. *Landscape History*, 37(1), 5-24.
- Owen, A. E. (1975a). 'Medieval Salt Making and the Coastline in Cambridgeshire and North-West Norfolk'. In K. W. de Brisay, & K. A. Evans, *Salt: The Study of An Ancient Industry - Report on the Salt Weekend Held at the University of Essex* (pp. 42-45). Colchester: Colchester Archaeological Group.
- Owen, A. E. (1975b). 'Hafdic: a Lindsey name and its implications'. *Journal of the English Place Name Society*, 7, 45-56.
- Owen, A. E. (1984). 'Salt, sea banks and medieval settlement in the Lindsey coast'. In N. Field, & A. White, *A Prospect of Lincolnshire : Being Articles Collected on the History and Traditions of Lincolnshire in Honour of Ethel H Rudkin* (pp. 46-49). Lincoln: Field & White.
- Owen, A. E. (1993). 'Beyond the sea hank: sheep on the Huttoft outmarsh in the early thirteenth century'. *Lincolnshire History and Archaeology*, 28, 39-41.
- Pickles, T. (2020). 'Why should we write about Anglo-Saxon farms and farming?' *Early Medieval Europe*, 28(3), 466-482.
- Podbury, L. (2023). *Beacon Hill, Terrington St Clement, Norfolk: Research and Archive Report*. Unpublished Report: Wardell Armstrong .
- Podbury, L. (forthcoming). 'A Saxo-Norman to Medieval Salt Production Site at Beacon Hill, Terrington St Clement'. *Norfolk Archaeology*, 3(1).
- Powell, K. (2009). *Excavation of a Medieval Site at West Wick, Weston-Super-Mare, Somerset*. Unpublished Report: Oxford Archaeology.

- Pye, K. (1992). 'Saltmarshes on the barrier coastline of North Norfolk, eastern England'. In J. Allen, & K. Pye, *Saltmarshes – Morphodynamics, Conservation and Engineering Significance* (pp. 41-62). Cambridge: Cambridge University Press.
- Redding, M. (1999). *An Archaeological Watching Brief at 'Charnwood', Ingleborough, West Walton, Norfolk*. Unpublished Report: Archaeological Services.
- Ridgeway, V. (2000). 'A Medieval Saltern Mound at Millfields Caravan Park, Bramber, West Sussex'. *Archaeological Collections*, 138, 135-152.
- Rippon, S. (1999). 'The Rayleigh Hills in South East Essex: patterns in the exploitation of rural resources in a "woodland" landscape'. In S. Green, *The Essex Landscape: in Search of its History* (pp. 20-28). Chelmsford: Essex County Council.
- Rippon, S. (2009). 'Uncommonly rich and fertile' or 'not very salubrious'? The Perception and Value of Wetland Landscapes'. *Landscapes*, 10(1).
- Risbøl, O., Langhammer, D., Mauritsen, E. S., & Seitsonen, O. (2020). 'Employment, Utilization, and Development of Airborne Laser Scanning in Fenno-Scandinavian Archaeology—A Review'. *Remote Sensing*, 12(9).
- Roberts, J. (2017). *An Archaeological Evaluation Land South of The Old Police House, Walpole Saint Peter, Norfolk*. Unpublished Report: Groundworks Archaeology.
- Roffe, D. (2005). The Historical Context. In A. Crowson, T. Lane, K. Penn, & D. Trimble, *Anglo-Saxon settlement on the Siltland of Eastern England*. Lincolnshire Archaeology and Heritage Report Series No 7.
- Rogerson, A. (2003). 'Six Middle Anglo-Saxon Sites in West Norfolk'. In T. Pestel, & K. Ulmschneider, *Markets in Early Medieval Europe: Trading and 'Productive' Sites, 650-850* (pp. 110-121). Oxford: Oxbow Books.
- Rogerson, A., & Silvester, R. J. (1986). 'Middle Saxon occupation at Hay Green, Terrington St Clement. Norfolk'. *Norfolk Archaeology*, 39(3), 320-322.
- Rudkin, E. H., & Owen, D. M. (1960). 'The Medieval Salt Industry in the Lindsey Marshland'. *Lincolnshire Architectural and Archaeological Society Reports and Papers*, 8, 76-84.
- Ruffano, L. (2002). *The Bowling Green, West Drove North, Walpole St Peter*. Unpublished Report: Soke Archaeological Services Ltd.
- Sevnik, J., de Neef, W., Alessandri, L., van Hall, R. L., Ullrich, B., & Attema, P. A. (2020). 'Protohistoric briquetage at Puntone (Tuscany, Italy): principles and processes of an industry based on the leaching of saline lagoonal sediments'. *Geoarchaeology*, 36(1), 54-71.
- Shannon, W. D. (2023). 'Sleech Salt Making from the Solway to the Mersey in the Medieval and Early-Modern Period'. *Northern History*, 60(1).
- Shaw, R., & Corns, A. (2011). 'High resolution LiDAR speciically for archaeology: are we fully exploiting this valuable resource?'. In D. C. Cowley, *Remote Sensing for Archaeological Heritage Management: Occasional Publication of the Aerial Archaeology Research Group No.3* (pp. 77-86). Brussels: Europae Archaeologia Consilium (EAC).

- Silvester, R. J. (1985). 'West Walton: the development of a siltland parish'. *Norfolk Archaeology*, 39(2).
- Silvester, R. J. (1988). 'The Fenland Project Number 3: Marshland and the Nar Valley, Norfolk'. *East Anglian Archaeology* 45.
- Silvester, R. J. (1999). 'Medieval reclamation of marsh and fen'. In T. Williamson, & H. Cook, *Water Management in the English Landscape*. Edinburgh: Edinburgh University Press.
- Simmons, I. G. (2014). 'Creating dry land in S.E. Lindsey (Lincolnshire, England) before AD 1550'. *Water History*, 6(1), 211-225.
- Simmons, I. G. (2015). 'The landscape development of the Tofts of south-east Lincolnshire 1100–1650'. *Landscape History*, 36(1), 9-24.
- Simmons, I. G. (2017). 'Fen and Sea: Medieval and Early Modern Landscape Evolution in South-East Lincolnshire Before 1700'. *Landscapes*, 18(1), 37-54.
- Simmons, I. G. (2018). Monasteries and Coastal Evolution in South-East Lincolnshire, AD 1100–1500. *Midland History*, 43(2), 155-173.
- Smith, R. A. (1918). 'Essex Red Hills as Salt-Works'. *Proceedings of the Society of Antiquaries of London*, 30, 35-63.
- Stephens, C. (2006). *Geophysical Survey Report. Walpole Electricity Substation, Walpole St. Peter, Norfolk*. Unpublished Report: Geophysical Surveys of Bradford (GSB Prospection).
- Stewart, C., Labrèche, G., & Lombraña González, D. (2020). 'A Pilot Study on Remote Sensing and Citizen Science for Archaeological Prospection'. *Remote Sensing*, 12(2795), 1-16.
- Taylor, A. (1977). "'Roman Bank": a Medieval Sea-Wall'. *Proceedings of the Cambridge Antiquarian Society*, 67(1), 63.
- Thompson, M. W. (1956). 'A Group of Mounds on Seasalter Level, near Whitstable, and the Medieval Imbanking in this Area'. *Archaeologia Cantiana*, 70, 44-67.
- Tremlett, S. (2000). *Report on an Archaeological Watching Brief at Wisbech Road, Walpole St Andrew*. Unpublished Report: NAU Archaeology.
- Trier, Ø. D., Cowley, D. C., & Waldeland, A. U. (2018). 'Using deep neural networks on airborne laser scanning data: Results from a case study of semi-automatic mapping of archaeological topography on Arran, Scotland'. *Archaeological Prospection*, 26, 165-175.
- Trier, Ø. D., Salberg, A. B., Pilø, L. H., Tønning, C., Johansen, H. M., & Aarsten, D. (2016). 'Semi-automatic mapping of cultural heritage from airborne laser scanning using deep learning'. *Geophysical Research Abstracts*, 18, 159-186.
- Trimble, G. (2003). *A Report on an Archaeological Evaluation at 103 St Peter's Road, West Lynn, Norfolk*. Unpublished Report: Norfolk Archaeological Unit.
- Vennersdorf, M. (2017). 'Den lille (terræn-)forskæl: Danmarks Højdemodel som kilde til erosion og slid på arkæologiske lokaliteter i dyrket mark'. *Arkæologisk Forum*, 37, 8-18.

Webster, M. (2015). *Marsh Lane, King's Lynn, Norfolk*. Unpublished Report: Oxford Archaeology.

Wheeler, W. H. (1896). *A History of the Fens of South Lincolnshire*. Cambridge: Cambridge University Press.

APPENDIX 1: THE SLEECHING PROCESS OF SALT PRODUCTION

The method employed for salt production in the low-lying Fens during the early medieval and medieval period, contrasting with the arguably more efficient solar evaporation method more commonly used in southern Europe (Cranstone 2012; Forsythe *et al* 2018; Forsythe *et al* 2021), is referred to as 'sand-washing', *muldefand* or *sleeching*. Despite its name, the primary raw material used in this process was actually relatively coarse silt. This salt-making process involved three main stages: gathering the silt, filtering it, and crystallizing the resulting brine (Owen 1975a; Grady 1998; Albone 1999; McAvoy 1994; Ridgeway 2000). The below narrative, in addition to the results of excavations, is drawn from historic accounts of the salt-winning methods used, such as the descriptions of William Brownrigg (1748), Diderot *et al* (1765), and Henry Duncan (1812).

This process necessitates substantial quantities of various raw materials, all of which were available upon The Fens. Fuels, turf, silt, clay, and other essential resources were regularly transported from nearby foreshores and the surrounding landscape using oxen (Miller and Hatcher 2014). Land grants for grazing, likely intended for oxen, are frequently documented alongside saltworks (Hall and Coles 1994: 143-145). The functional and spatial relationship between pasture and saltworks was explicitly outlined in a 12th century grant to Waltham Abbey in Wrangle, Lincolnshire (Hallam 1965; Miller and Hatcher 2014: 76), which stipulated that each saltwork required six oxen to operate effectively.

After heavily salt-encrusted silts were gathered from the nearby foreshore following fortnightly spring tides, they were deposited into specially constructed filtration units lined with peat or turf (Plate A). These units, typically featuring a flat-based shallow bed connected via a narrow channel to a deeper, circular collection tank, were lined with clay (McAvoy 1994; Grady 1998; Albone 1999; Clarke 2018). Within the shallow filtration beds, the layer of turf or peat served as the filtering medium (McAvoy 1994; Grady 1998; Albone 1999; Albone *et al* 2007; Fosberry 2016). The salt-impregnated silts were laid into the turf-lined filter bed before introducing saltwater. The resulting percolated brine solution then flowed across the inclined base of the filter bed and into the deep collection tank.

For the filtration process to occur effectively, a nearby and accessible water source was crucial. Managed channels, creeks, ponds, or sumps were commonly utilized to supply the salterns with water. While seawater was readily available and often used in filtration,

freshwater was preferred to produce higher quality, whiter salt (Holden and Hudson 1981: 124; Sturman 1984: 51; Ridgeway 2000). To accommodate the volume of water needed for filtration and brine production, the construction of convenient clay-lined storage tanks was often necessary (Plate B).

The concentrated brine resulting from the filtration process was then condensed through evaporation using hearths. These hearths could be sizable and relatively complex structures (Plate C), or simple and small hearths fired directly upon the ground (Plate D). Significant amounts of fuel, typically peat, were required for this brine-boiling process, which is known to have caused significant environmental changes in the landscapes surrounding salt production sites (Akridge 2008). Typically, brine was boiled in lead pans over sheltered hearths housed within structures known as salt-houses or salt-cotes (Cope-Faulkner 2014). Complete lead pans from this process rarely survive intact, but remnants, such as offcuts and melted globules resulting from repair attempts, are occasionally unearthed through metal detection (Cope-Faulkner 2014; Albone 1999).

This salt-making process led to the formation of extensive mounds and layers in the landscape, comprising a complex stratigraphy of desalinated silts and hearth waste deposits (Plate E). Excavations often reveal clay-lined structures and features associated with this process, which are frequently cut into and sealed by these waste deposits. These mounds and layers bear witness to the gradual accumulation of waste across multiple seasons of salt production, forming significant earthwork mounds that persist in the landscape to this day. These archaeological remains serve as tangible evidence of historical salt production practices and their environmental impact.



Plate A: Examples of silt filtration unit and their circular water tanks from saltern sites in A: Terrington St Clement (Podbury 2023) and B: King's Lynn (Clarke 2017)



Plate B: *Examples of a brine or water tanks from Beacon Hill in Terrington St Clement
(Podbury 2023)*



Plate C: *An example of a relatively sizable and complex hearth excavated at a saltern site
outside of King's Lynn (Knight and Clarke 2019)*



Plate D: An example of a simple hearth excavated at a saltern site in Terrington St Clement
(Podbury 2023)

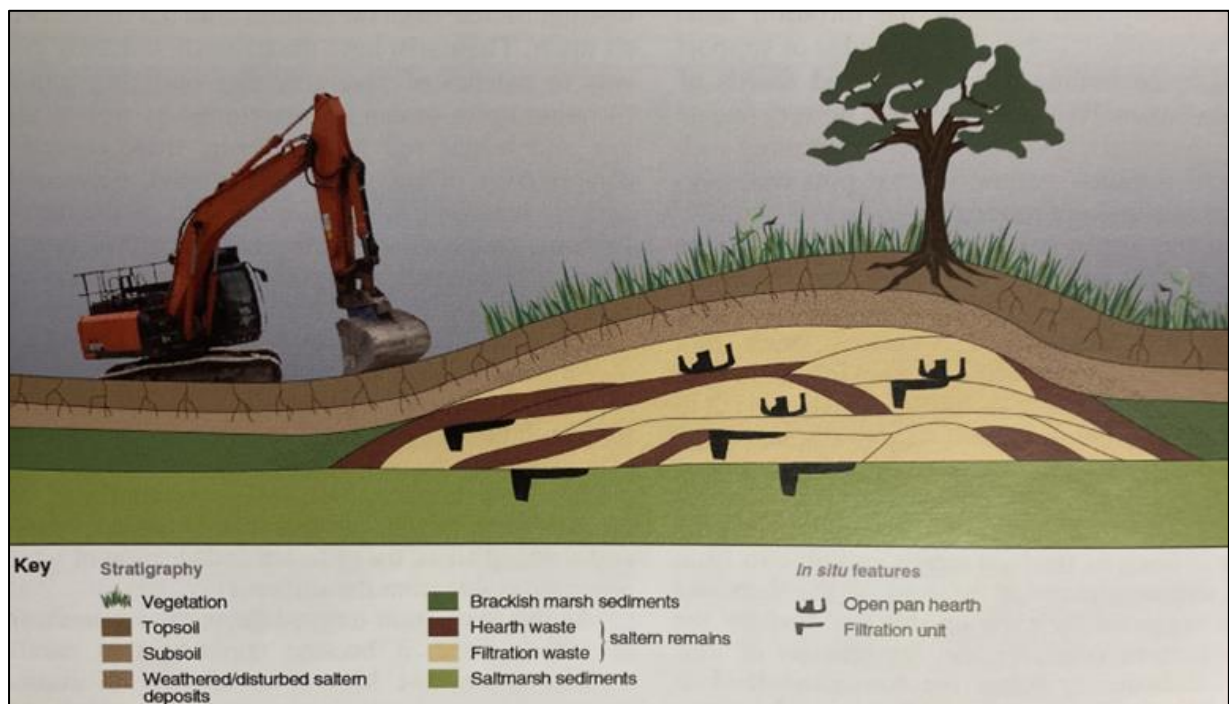


Plate E: A generic cross section of a saltern (Clarke 2023)

APPENDIX 2: HER SEARCH PARAMETERS

Utilising *FISH Terminologies: Monument Type Thesaurus* (FISH 2021), the below classifications of monument and find types have been employed within the Historic Environment Record (HER) for this thesis. These feature classifications have been subdivided into types, those that have already been interpreted as being directly associated with the salt production (Type 1); those that may potentially represent saltern mounds or their related by-products, but have not hereto been interpreted as such (Type 2); and landscape features, both natural and anthropogenic, that have a relationship with the production of salt (Type 3).

Monument Type	
Type	Search Parameters
Type 1	Monument type BRINE CISTERN (Post Roman)
	Monument type BRINE PIT (Post Roman)
	Monument type SALTERN (Post Roman)
	Monument type SALTERN (all)
	Monument type SALTWORKS (Post Roman)
	Monument type SALTWORKS (all)
	Monument type SLEECHING SALT WORKS (Post Roman)
Type 2	Monument type BURNT MOUND (all)
	Monument type EARTHWORK (all)
	Monument type MOUND (all)
	Find type BRIQUETAGE (Post Roman)
	Find type BRIQUETAGE (all)
Type 3	Monument type BANK (EARTHWORK) (all)
	Monument type FLOOD DEFENCES (all)
	Monument type RIVER DEFENCES (all)
	Monument type TRACKWAY (all)
	Monument type WATERCOURSE (all)
Additional	Word 'salt' in record Summary or Description

APPENDIX 3: WORKFLOW DIAGRAM

Flow Work Diagram



APPENDIX 4: FUTURE RESEARCH TOPICS AND QUESTIONS

- As demonstrated in relation to the Lynnsport 4 and 5 site, the study of ‘historic’ LiDAR data also has some utility. In addition to analysing now destroyed saltworking sites, such as those at the Walpole Electricity Substation, a comparative study of early and recent LiDAR data could assess the impact of agricultural practices on saltern mounds over time and the loss of this significant archaeological resource – perhaps in a similar way to that undertaken in Denmark (Vennersdorf 2017).
- The methodologies employed in the excavation of saltern mounds has hitherto been somewhat experimental (Clarke 2023). Given their stratigraphic complexity, developing best practices is crucial to ensure accurate recording and interpretation of these sites. Lessons need to be learned from the King’s Lynn excavations.
- Echoing the calls of Lane and Fielding (2024), with datable artefactual material being sparse, radiocarbon dating of saltworking sites needs to be more widely employed. This has the potential to accurately date salterns, potentially identifying further middle Saxon works, as it did during the King’s Lynn excavations. As succinctly noted by Lane and Fielding (2024), “...knowing the precise locations of hundreds of sites is one thing but understanding exactly how they functioned, and when precisely they were operating, is another matter altogether”.
- As noted by Lane (2023), there needs to be a revaluation of the chronological development of saltern sites across Norfolk and Lincolnshire in light of the recent identification of middle Saxon salt-working north of King’s Lynn. Further archaeological investigation, both intrusive and non-intrusive, is required. The hypothesis that earlier, potentially early to middle Saxon salterns were situated further landward within later sea defences needs to be tested. Such a morphology and chronology of saltern complexes was postulated during the recent King’s Lynn excavations (Clarke 2023).
- The way in which saltworking sites, recorded in the Domesday Book as owned by tenants-in-chief and lords across manors, including areas unsuitable for salt production, requires further investigation. This will provide additional context for accurate prospecting, but more importantly provide further insight into socio-economic organisation of the medieval economy.

- The relationship between early, potentially early to middle Saxon, upland or Fen edge settlements needs to be investigated in relation to the salt production industry. This is particularly true in the case of the relationship between the notable middle Saxon upland complex at Hay Green (see Rogerson and Silvester 1986) and the saltworking complex at Orange Row in Terrington St Clement. Indeed, Hutcheson (2006: 74-75) postulates that in the 7th or 8th century, Hay Green, the apparent precursor of Terrington St Clement, controlled a hitherto unidentified middle Saxon salt-production industry in the area. Upland estates likely controlled the exploitation of salt production in the Fens, with this dynamic eventually leading to the formation of permanent settlements such as Terrington St Clement (Crowson et al 2005: 213-30).
- Excavations also need to be undertaken on the isolated and often seaward saltern mounds, none of which have been intrusively studied to date. Numerous pertinent questions arise from their isolated nature. Were they ephemeral and temporary and, if so, what caused their abandonment? Did they employ the same methods and use the same infrastructure than the larger complexes? What was their relationship with tidal creeks? How did they function in relation to the inevitable tidal inundation in these areas? Are these saltern mounds of early medieval or medieval origins?
- Excavations around the Sea Bank must continue, but investigations into sea defences, which may have incorporated relic salt mounds that may indeed be particularly early, are also necessary. In Norfolk, this phenomena remains a hypothesis largely supported by circumstantial evidence, with the exception of limited work conducted in West Lynn.
- A comprehensive and multi-faceted study on the collapse of the salt-washing industry, thought to have occurred around the late 16th and 17th century, upon the Fens and beyond is required – perhaps considering cheap imports from the solar saltworks of southern Europe (see Hughes 1925; Bridbury 1955; Forsythe *et al* 2018), and industrial advancements in sourcing salt domestically (see Greenwood 2011; Greenwood 2012), successive flooding and changes in the environment (see Galloway 2013; Simmons 2015; Simmons 2017; Gilbert 2017; Simmons 2018). Medieval and post-medieval documentary sources, both from Britain and the Continent, would provide considerable insight to these ends.

- Again, echoing the calls of Lane and Fielding (2024), further experimental archaeological experiments are required. Accurately replicating the medieval salt production method would reveal significant findings. Such experiments could provide valuable insights into fuel and resource requirements, potential salt output, the construction and maintenance of saltworking infrastructure, the chronological formation of saltern mounds, factors affecting salt quality and its value, and the labour involved in salt production. These findings would significantly enhance our understanding of the industry.
- Significantly more detailed interrogation of early medieval and medieval documentary sources is required, like the recent work of Simmons (2022) – particularly in Norfolk. What historical research into the organisation of the industry during the medieval period has been done predominantly comes from monastic charters from the 12th or 13th century (Cranstone 2012); these efforts need to continue. Specifically, further documentary work is required in relation to the Terrington St Clement salterns. In Terrington St. Clement, the Bishop of Ely's salt was converted into a monetary tax known as the *Little Moll* (Norfolk Record Office Ref: NRS8099; NRS8143; NRS8146; NRS8147; NRS8149; NRS8171A; NRS8176; NRS26976) and the *Great Moll* (Norfolk Record Office Ref: NRS8102; NRS8114; NRS8114; NRS8115; NRS8177; NRS8142; NRS8151; NRS8154; NRS8158; NRS8160; NRS8167; NRS8170; NRS8172), which was collected by an official referred to as the *moleman* or *malmen*; a yet untapped resource of information of the salt industry. In addition to the records of the Bishop of Ely, 16th and 17th century litigation documents also refer to salt rent in Terrington St Clement (National Archives Ref: E134/37Eliz/Hil6; E134/8Jas1/Hil16; E134/17Chas1/East9). Similarly, the rental records of the manors of West Walton, Walpole, Walsoken, Terrington, Tilney, and Old Lynn (West Lynn) all have potential to provide insights into the salt production industry.
- Although self-evident, further excavations of saltern complexes beyond centres such as those near King's Lynn and the industrial centres in Lincolnshire; however, as noted by Lane and Fielding (2024), this is largely dependent on excavations arising from development under the formal planning process. When these excavations do occur, experts are required to study saltern sites, including those skilled in excavation, survey, landscape interpretation, palaeoenvironmental studies, and environmental

reconstruction. Additionally, there is a need for ceramicists who can rigorously analyse briquetage, as it is crucial for advancing our understanding of these industrial sites.

- Comparative analysis with similar European sites, particularly in regions within the Low Countries and in Ireland where sand-washing was likely employed, can offer valuable context. Such studies could reveal similarities and differences in salt production techniques and provide a broader understanding of regional practices and influences. Recent work by Forsythe *et al* (2018; 2021; 2023) has studied the Irish post-medieval salt industry in the context of the wider Atlantic world; something which the somewhat inward-looking British archaeologists have failed to do, with the notable exception of Bridbury (1955), Carus-Wilson (1962), and to a lesser extent Clarke (2023).
- Supplementing the work of many archaeologist (e.g. Bridbury 1955; Carus-Wilson 1962; Keen 1988; Barney 1999; Galloway 2013; Simmons 2022), further work is required on the domestic and international networks of trade – potentially with a focus on trade in salt from the prominent ports at King’s Lynn and at Boston in Lincolnshire.
- Further investigation is needed into industries linked to early medieval and medieval saltworking. Although existing studies have touched on some industrial and commercial connections, there is a need for more detailed research on associations with lead production, peat cutting, pottery manufacturing, clay extraction, fisheries, and the management of oxen and sheep.
- Further work is required into environmental reconstructions (e.g. paleoenvironmental and geoarchaeological studies) to understand the impact of climate fluctuations, sea-level changes, and flooding on salt production sites.
- Beyond LiDAR, ground-penetrating radar (GPR) could be particularly effective in the study of saltworking sites. As GPR can penetrate the multiple layers of alluvial and desalinated silts and reveal stratigraphic details without disturbing the saltworking site. This technology has the potential to map the extent of saltworking sites, map water channels, identify the clay-lined structures and hearths typical of the industry that are not visible on the surface. To date, in Britain, it does not appear that GPR has been specifically utilised in the study of saltworking sites; however, in Italy, it has recently been effectively

utilised in combination with magnetometer surveying to study protohistoric saltern sites (Ullrich and Attema 2020; Sevnik et al 2020; Sevnik *et al* 2021).