1

When and Why Were Sea Walls Built?

Where This Project Started

This began as a limited survey of the relationship of clay levels to sea walls, but it developed into a wider investigation of the Deben sea walls.

Along the way, interesting findings were made. The work has raised more questions than it has answered, so findings are provisional.

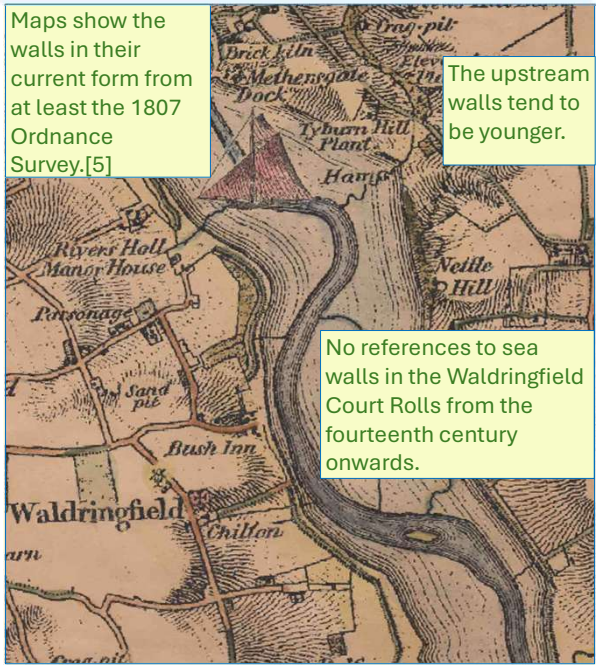
On History, W.G.Arnott says:

"If you are anxious to find out about the history of the walls you will be disappointed because there appears to be none." - George Arnott -Suffolk Estuary.

That said, he gives a good overview with dates, suggesting that the lower estuary walls are post-Norman. He mentions a 'Commissioner of Walls and Fosses' in 1478, so sea walls existed, or were being built, then.

A recent paper agrees, stating that – ***"[sea walls] have been largely neglected as archaeological features and a pervasive vagueness exists about their dating and age."*** [1]

An archaeological study [4] dates the walls between Waldringfield and Martlesham between 1540 and 1743.



Maps show the walls in their current form from at least the 1807 Ordnance Survey.[5]

The upstream walls tend to be younger.

No references to sea walls in the Waldringfield Court Rolls from the fourteenth century onwards.

Sea Walls have existed in the Deben Estuary since the Middle Ages. Before they were built, the waterway was more expansive. This image is an impression of how the area might have looked before the Norman Conquest.

Effects on Navigation

There were disadvantages of sea walls for those who used the waterway. The diminished surface area of the estuary reduced the volume and velocity of the flood and ebb. This would encourage silt deposition.

There would have been a reduction in the force of the ebb at the river mouth. This might tend to reduce depth at the bar and favour the growth of the shingle spit, further reducing the viability of the Deben as a port. So, the construction of sea walls would have contributed to the demise of the port of Goseford in the lower estuary.

Calver, who produced the 1845 Deben Survey, described the consequences of embankment in his book, albeit centuries too late to prevent it.

Historical Context

A study dates the beginning of sea wall construction to the thirteenth century, with completion by the seventeenth century. The twelfth and thirteenth centuries were periods of agricultural prosperity with rising population, land values, and produce prices. This would favour sea defence and enclosure. [1]

Climate change and the Black Death made the mid-fourteenth to the end of the fifteenth century an era of falling population and produce prices. Arable land was being abandoned; it is unlikely that any sea walls would have been built.

By the sixteenth and seventeenth centuries, prosperity and population growth had returned, and sea defence and enclosure were attractive once more. Arnott suggests that this was also the time when refugees from the Low Countries arrived; they came from an area with great expertise in sea defences.

So, we might expect the build dates to be between 1500 and 1800.

Building the Walls

Depending upon ownership, sea walls would be built where the area of land enclosed relative to the length of the wall built would have a favourable ratio. This may explain why the attempted enclosures north of Methersgate and the failed Hams and Tips wall occurred later. With longer walls, there may have been several landowners involved. How was this managed?

Another consideration would be the vulnerability of the wall to storms as it was built. Spring tides should have been avoided as the water would be high in the middle of the working day.

The relatively small 500m wall attempted between the Hams and Tips was washed away by a storm before it was finished. Some of the enclosure walls are several kilometres long, so they may have been risky projects.

Questions

- Were the large enclosures, mainly in the lower estuary, made by major landowners, and how much of a windfall was it for them?
- Was each marsh enclosed in a single operation instead of a patchwork of small enclosures?
- Why are there no signs of intermediate walls in the marshes?
- What time of year were walls built?
- How many man days per kilometre?

R.M.Crawley July 2025 v3

2

The Tide Level Problem

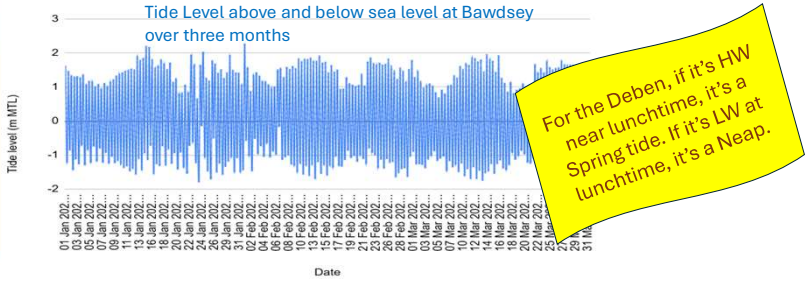
Daily Tides

Water ebbs from High (HW) to Low (LW) and back to HW about every 12h 30m

Spring and Neap Tides

Every fortnight, the higher Spring HW gradually reduces over a week to a lower Neap HW and then, over the next week, back to a Spring HW.

The average value of the Spring HW is Mean High Water Springs (MHWS). This varies by location, although we only have one reliable value.

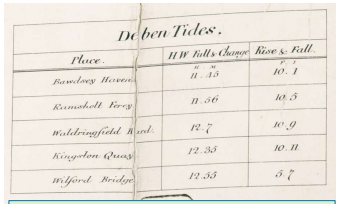


Woodbridge and the Haven Tide Values

There are published tide values only for two stations. Woodbridge and Woodbridge Haven; the latter is in the sea, not the estuary, and so not the same tidally as the Felixstowe Ferry.

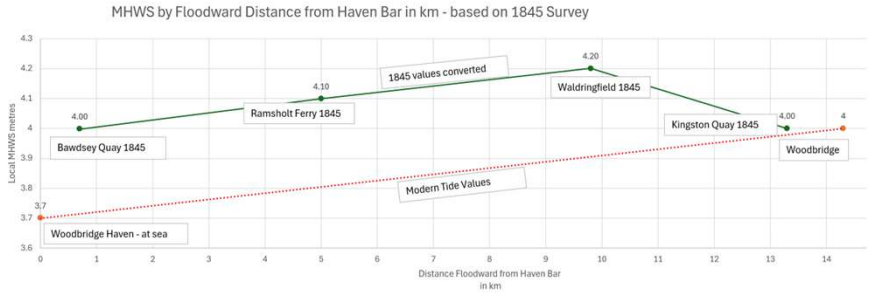
So, Woodbridge is the only reliable value for MHWS in the estuary. Values are needed for Felixstowe Ferry and Waldringfield

The absolute value of the tide is not crucial for this exercise. However, the relative tide levels along the Deben are; the likely variation is the range of 0.2m to 0.4m, which might explain the same variability in marsh elevation.



The most detailed data on tidal heights found is the 1845 Deben Survey.

Spring High Tide Levels Vary Along the Estuary



Tides?

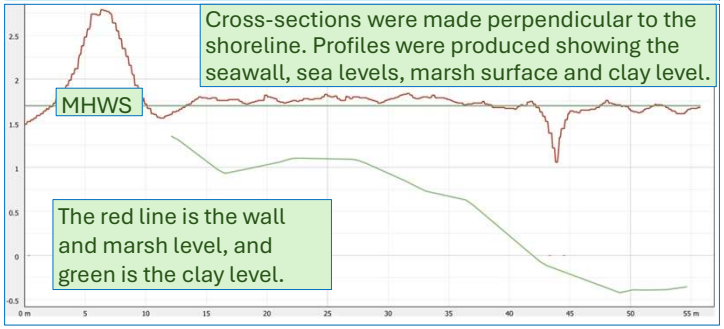
Reliable data are needed for the values of the Mean High Water Spring tide levels in the estuary.

Clay Levels and Sea Walls

This was the original question. A series of probes into the marsh was made to detect the clay layer at the Cuttings, then at Hemley Marsh. Marsh elevation was measured by LIDAR, and the depths were plotted on a map to estimate the clay contour.

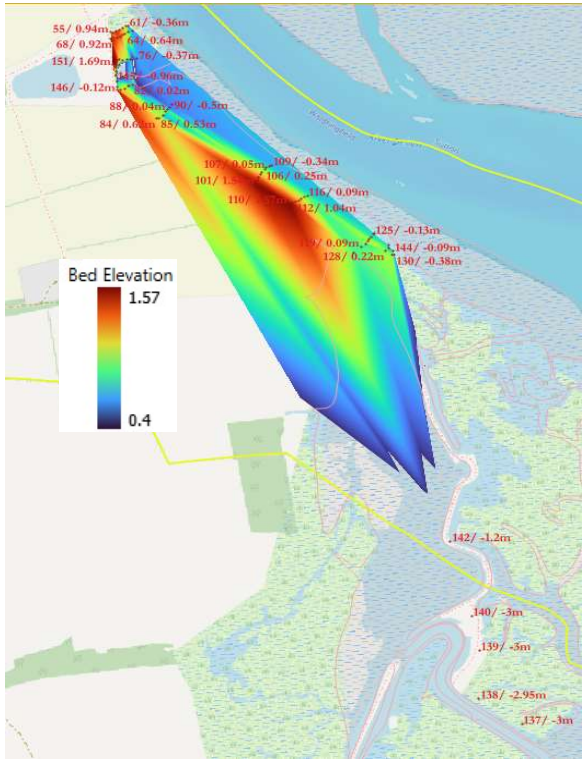
The image to the right shows the clay elevation with shading, red shallower, and blue deeper. The accuracy of the shading near the bores is fair, but where there are none, it is less reliable.

Probing for Clay Depth



Cross-sections were made perpendicular to the shoreline. Profiles were produced showing the seawall, sea levels, marsh surface and clay level.

The red line is the wall and marsh level, and green is the clay level.



Clay Above Sea Level Near Reservoir

Near the reservoir, the base of the seawall is near a clay elevation of about 1.2m AOD (roughly sea level, see page 3) and the level declines, sometimes rapidly, towards the river.
In some cases, there is a dip in the clay level near the sea wall, which may be where material was excavated for the wall. At this site, clay was accessible for wall building.

Clay Below Sea Level at Hemley

Approaching Hemley, the clay is deeper at about 3m below sea level and inaccessible. The walls in this region were probably built with mud, but they have not lasted well.

Clay Levels?

It might be possible to bore on the land side, Dairy Marsh and Garden Field, perhaps.
Ideally, more bores could be taken between 0m and 10m from the seawall base. This should give a better overall profile surface for the clay layer.
It would be useful to acquire the British Geological Survey (BGS) data set to establish if it has relevance.

3

Salt Marshes and Sea Walls Briefing

Salt Marshes

As the sea floods in, it carries silt. When it ebbs out, silt settles where the flow is weakest, on the inside of bends, indents and flat areas.

When the silt reaches the upper part of the intertidal zone, salt-tolerant plants can grow. Over time, this growth can form a salt marsh.

So, the elevation of the salt marsh is related to the value of MHWS. However, values of MHWS along the estuary are debatable.

Sea Wall Height

Sea Walls must be high enough to resist most levels of flood, about 1m higher than the MHWS level.

Woodbridge Tide Gauge shows a maximum height of tide recorded 3.35m above OD (AOD), but typically less than 2.67m AOD.

Deben sea walls vary in elevation, from 3.1m to 4.1m AOD. The sea is rising by about 0.3m per Century, so the sea wall height must be increased periodically.

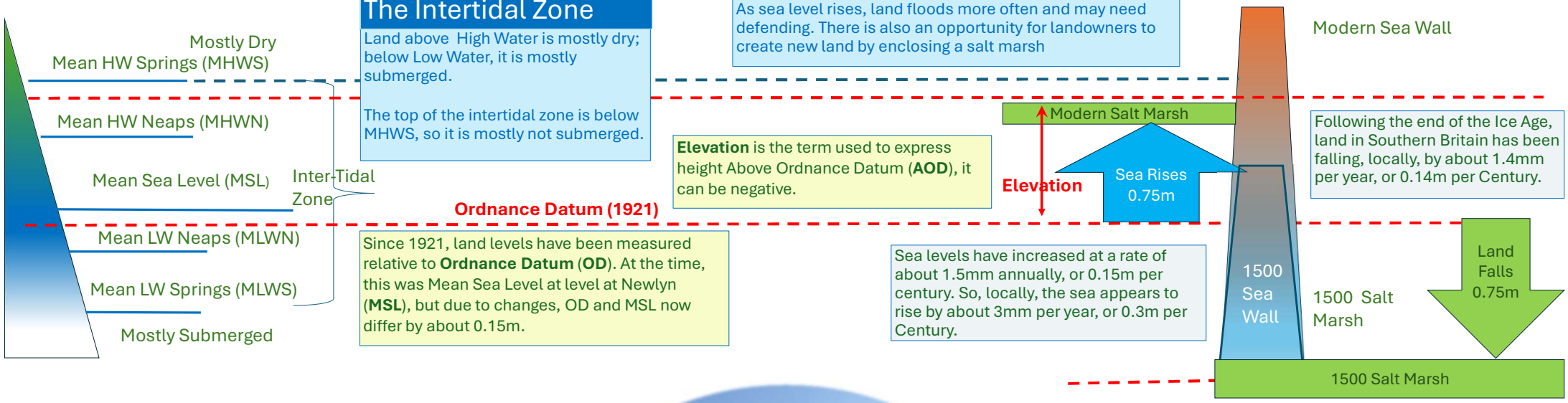
The Intertidal Zone

Land above High Water is mostly dry; below Low Water, it is mostly submerged.

The top of the intertidal zone is below MHWS, so it is mostly not submerged.

Response to Sea Level Rise

As sea level rises, land floods more often and may need defending. There is also an opportunity for landowners to create new land by enclosing a salt marsh



Elevation is the term used to express height Above Ordnance Datum (**AOD**), it can be negative.

Following the end of the Ice Age, land in Southern Britain has been falling, locally, by about 1.4mm per year, or 0.14m per Century.

Since 1921, land levels have been measured relative to **Ordnance Datum** (**OD**). At the time, this was Mean Sea Level at level at Newlyn (**MSL**), but due to changes, OD and MSL now differ by about 0.15m.

Sea levels have increased at a rate of about 1.5mm annually, or 0.15m per century. So, locally, the sea appears to rise by about 3mm per year, or 0.3m per Century.

Dating Sea Walls

Arnott mentions a method for gauging the approximate build date. A more formal treatment by Richard Steward and Robin Whittle [3] suggested that, to estimate age, the difference between salt marsh elevation and enclosed land elevation is found.

This value is divided by the sum of the annual changes in the land elevation, Mean Sea Level (MSL) and tidal range. This results in a duration and hence a date.

The technique makes sense, although the assumptions made may not always hold.

This area of marsh shows the difficulty in measuring a precise elevation.

Measuring Salt Marsh Elevation

Given the equipment and skills, elevation could be measured with conventional survey equipment or high-precision RTK GPS. There is the issue of accessibility; marshes are not easy to get to, and permissions may be needed.

LIDAR data are produced as part of a Government survey. An aircraft scans the area, and the data are made available after sophisticated, almost magical, processing.

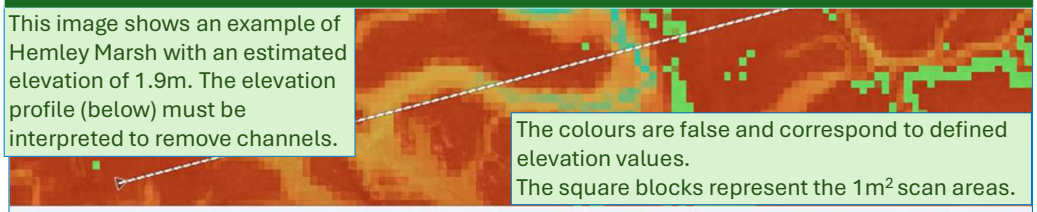
LIDAR digitally removes vegetation and averages the elevation. It provides the elevation of $1m^2$ squares for the local area, accurate at worst +/- 0.15m and mainly +/-0.05m.

4

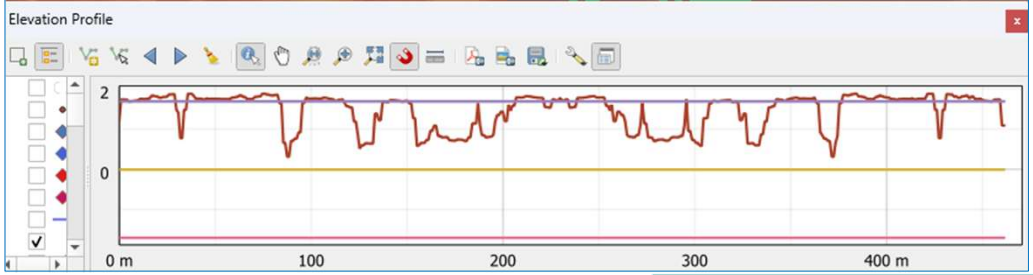
Dating Sea Walls by Salt Marsh Elevation

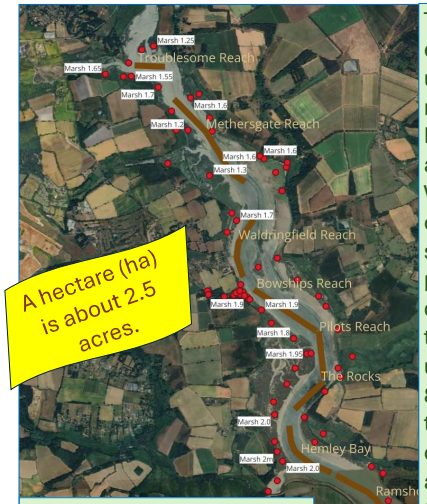
Marsh and Wall Elevation from LIDAR

This image shows an example of Hemley Marsh with an estimated elevation of 1.9m. The elevation profile (below) must be interpreted to remove channels.



The colours are false and correspond to defined elevation values.
The square blocks represent the 1m² scan areas.





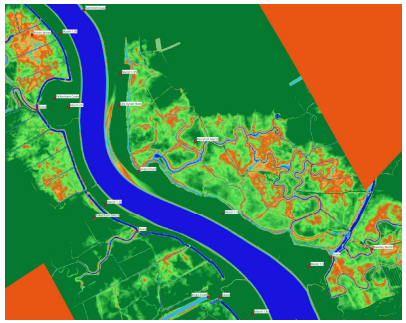
A hectare (ha) is about 2.5 acres.

The land gained by enclosure in the upper estuary has mainly been at Martlesham (16ha) and Burrell's Long Wall (22ha); the others are relatively small, probably primarily for defence, and bring the total for the upper part to about 80ha. In the centre, the enclosure of the onetime Brightwell and Shottisham tributaries amounts to around 160ha.

At the seaward end of the estuary, the land is lower with gentler slopes, which might favour marsh growth; these areas appear to have been enclosed first. The total for the lower estuary below Kirton Creek amounts to about 1100ha, far more than the rest of the estuary combined.

Obstacles to Dating

Some of the reasons for the dating method failing include: Breaches; Defensive walls built on land, not salt marsh; Freshwater input.



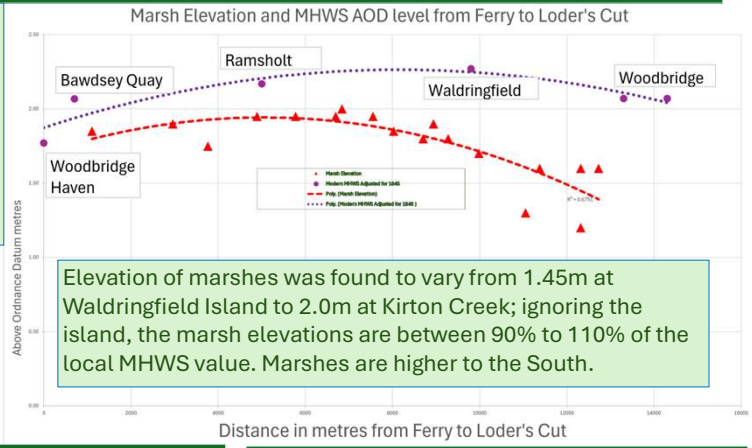
Detail from LIDAR

False colours in the LIDAR image can be applied to detect small elevation changes. This allows detail to be detected. The image above shows some depressions in the lower estuary, which confound the dating system, unless they are old enclosures.

Marsh Elevation along the Estuary

The MHWS values from the 1845 Survey are a better fit with marsh elevation than a simple interpolation from the Haven to Woodbridge.

The tide levels need confirmation, however.



Elevation of marshes was found to vary from 1.45m at Waldringfield Island to 2.0m at Kirton Creek; ignoring the island, the marsh elevations are between 90% to 110% of the local MHWS value. Marshes are higher to the South.

Dating Results

Location	LIDAR Land Elevation	LIDAR Marsh Elevation	Year of Breach	Known Age	LIDAR Marsh - Land Elev	LIDAR Method Age	LIDAR Method Year
Loder'sCut	0.00	1.60			1.60	532	1468
Martlesham Creek Middle	0.51	1.55			1.04	346	1654
Martlesham Creek West	0.58	1.55			0.97	322	1677
Martlesham Creek East	0.62	1.70			1.08	359	1641
Martlesham Creek Inner	1.47	1.70			0.23	76	1923
1845 Enclosure South	1.65	1.30	1953	1845	-0.19	-65	Error
1845 Enclosure North	1.65	1.60	1953	1845	0.11	35	1964
Hill Farm	0.90	1.20	1954		0.45	150	1849
Hams and Tips	1.70	N/A	1845				
Ham River	1.00	1.60			0.25	83	1916
Waldringfield Point	1.35	1.70			0.35	116	1883
Waldringfield Island	0.00	1.45			1.45	4833	-2834
Stonnor Point	0.40	1.80			1.40	465	1534
Hilton Creek Reservoir	1.53	1.90			0.38	125	1875
Burrell's Long Wall	0.60	1.80			1.20	399	1601
Hemley Marsh	1.60	1.90	1937		0.51	169	1831
Hemley Marsh Lower	1.67	1.95	1937		0.49	164	1836
Shottisham Creek	0.40	1.85			1.45	482	1518
Upper Ramsholt	0.79	1.95			1.16	385	1614
Kirton Creek	0.50	2.00			1.50	498	1501
Lower Ramsholt	0.92	1.90			0.99	327	1672
Lower Ramsholt Lowest	0.00	1.90			1.90	631	1368
Kirton Marsh	0.24	1.90			1.67	553	1446
Kirton Marsh Lowest	-0.25	1.90			2.15	714	1285
Falkenham Marsh	0.54	1.75			1.21	402	1598
Falkenham Marsh Lowest	-0.06	1.75			1.81	601	1398
Felixstowe Marsh	0.55	1.90			1.35	449	1551
Felixstowe Marsh Lowest	0.32	1.90			1.58	525	1475
Ferry Enclosure	1.30	0.00					
Ramsholt Marsh	0.21	1.80			1.59	528	1471
Bawdsey Marsh	0.17	1.95			1.78	591	1408
Bawdsey Marsh Lowest	-0.10	1.95			2.05	681	1318
Boyton Marsh	-0.03	1.42		1525	1.45	482	1518
Butley Marsh	-0.10	1.38		1525	1.48	492	1508
Winstone's marsh	0.86	1.60		1535	0.74	246	1754
Ten Acre marsh	1.05	1.60		1535	0.55	183	1817

Testing the Method

Land enclosed before 1350 should now have an elevation of about 0.04m below Ordnance Datum (OD). There are values in this range in the lower estuary, but surrounded by higher land, making them island enclosures and difficult to explain. Marshes enclosed in 1500 should have an elevation of around 0.42m, and there are several near this value.

On the Butley River, where dates were known, the technique agreed well. Marshes near Alderton showed that, in some cases, the method does not work at all.

Results for the Deben were mixed. The method does work, but only in favourable circumstances.

Marsh Formation?

- Why does marsh elevation vary along the river? Are marshes lower upriver because of less silt, lower salinity, tide levels, and clay levels?
- How do salinity and silt load vary?
- If the true MHWS value were known, how would the marsh elevation relate?
- Could all factors be linked in an expression to predict marsh elevation?

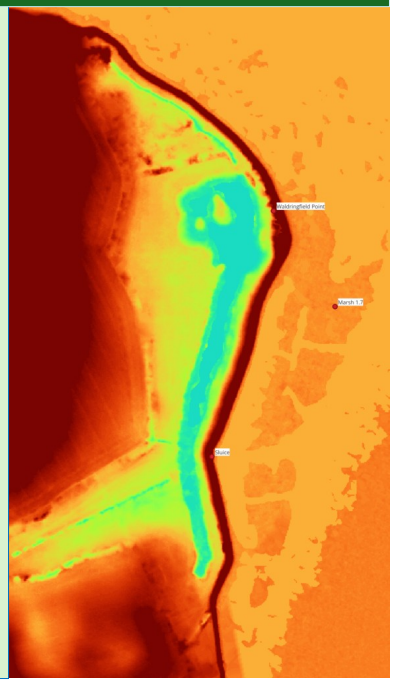
R.M.Crawley July 2025

5

Sea Walls Near Waldringfield

Waldringfield Point

The sea wall pre-dates the 1839 Tithe Map, which shows three separate landowners, Lacey, Leach and Waller.
Judging by the contours, this may be an example of sea defence of low-lying land rather than the enclosure of marsh; in 1500, the wall would have protected only about 7ha from severe floods, and the wall adds less than this in enclosed marsh.
The low elevation of the sea wall at the southern end, before the quay was built, allowed Dairy Marsh to the West and North to flood given a tide only 0.6m above MHWS, so it would be marsh-like.
We know the wall dates back to before 1807. The area is fed by a stream, which makes it unsuitable for the dating method. Date by LIDAR 1883, clearly wrong.



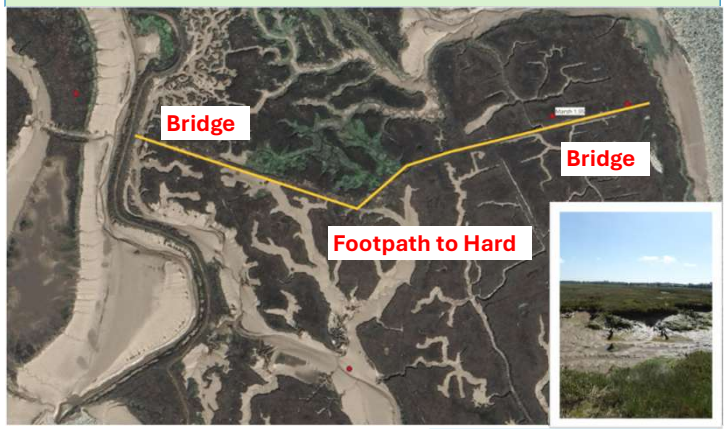
Modern Quay area on 1845 Survey.

This area is of interest because of the lack of a sea wall before the quay was built. On the 1839 Tithe map, the land was shore or saltings occupied by Lacey. The 1845 Deben survey also shows a marsh.
There was a cement works on the site from about 1865, with some form of quay; it had taken its current form by 1875.
The only area largely unchanged from that era is the Work's Manager's House; the 2.2m land elevation is slightly higher than one would expect from a marsh enclosed in the later nineteenth century (around 1.66m). However, this is more reasonable if the values from the 1845 Survey are used.

The Sea Walls at Waldringfield amount to only about 2km, most of which is breached. They were the least interesting in terms of dating, as each had factors which frustrated the dating method. However, other items of interest were found.

Hemley Marsh, perhaps Waldringfield Ferry?

Most of Hemley Marsh is in Waldringfield. It has several interesting features. Near the small loop, in 1902, was a footpath extending beyond the wall to a hard. Surely, this was the location of a ferry to Ramsholt or Girling's Hard. It was not marked in 1845; a likely explanation is that it served the workforce of the cement works or coprolite industry, both active in the late nineteenth century. The walk along the seawall would not have been easy at night or in Winter.
As the footpath to the hard is generally at or above MHWS, it was usable at most states of the tide, only covered at Spring tides, around midday or midnight. The only settlement of any size nearby on the east bank was Shottisham. There are the remains of some pilings from bridges across the channels.



Remains of Bridge to Hard

The small loop is a modern repair. The large loop seems to be original and may have bypassed a soft area. The clay level is too deep to have been used to build the wall, so, presumably, it was built from mud. This could have contributed to its collapse due to a flood in 1937.
Given the earlier enclosure on the opposite bank, as well as downstream at Kirton, the marsh may well have grown out into the river over the centuries since the sea walls were built. Breaches in the wall spoil dating, Date by LIDAR 1836.

Burrell's Long Wall

W.G. Arnott suggests that this was from the sixteenth century and built by William Burwell (sic) of Sutton. There is an indent formed by Stonnor Point and Shottisham Point that probably encouraged the growth of marsh. The wall protected an area with a relatively gentle slope that would have suffered limited flooding. The marsh gained would have been a bonus; a straight wall was efficient in this case. Date by LIDAR 1601.

The Sea Wall by the Reservoir?

The insignificant 150m wall near the reservoir may prove to be the most interesting find of all. However, certain aspects have to be confirmed.

Questions?

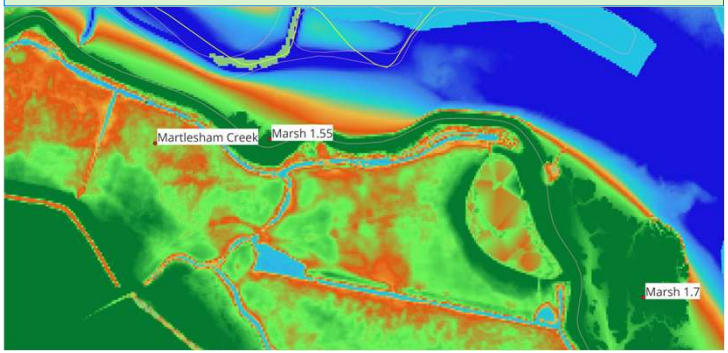
- The marsh at Hemley that has, presumably, grown since enclosure is larger than the original. How long did this take to grow, and why wasn't it subsequently enclosed?
- Why was the loop construction favoured? At least one was a repair.
- How much longer do clay walls endure than mud?

5a

Sea Walls in the Deben Estuary

Martlesham Creek

The relatively gentle slope of the land contours and the convex bend suggest that this was a marsh that gradually grew and was subsequently enclosed, thus gaining land. Date by LIDAR 1654.

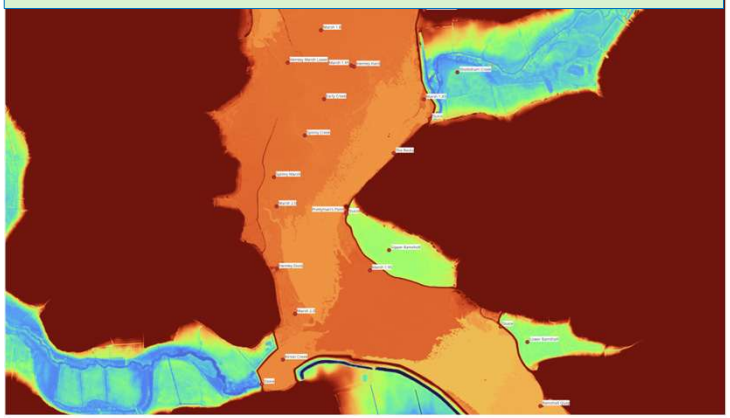


Shottisham Creek and Upper Ramsholt

Shottisham Creek - The 1845 Survey shows a seawall at the creek, although, according to Robert Simper, the complete walling off at Shottisham Creek was twentieth century. A large-scale 1801 Thames Estuary Chart shows a sizeable opening there, so perhaps the enclosure was early nineteenth century. There are mentions of a mill here at the end of the nineteenth century. The calculated age seems too early; possibly the freshwater has confounded the calculation. Date by LIDAR 1518.

Upper Ramsholt - It seems likely this would be an older wall, Date by LIDAR 1471. There appears to be a freshwater scrape behind the wall, so this merits a closer look.

Kirton Creek - There is fresh water in the area, which is all rather boggy. This confuses the method, but the date seems reasonable. This wall closes off what was once the Brightwell, or Mill, River, thus ending any navigability. Date by LIDAR 1446



1 to 9500 Hemley Shottisham Ramsholt -1 to 3m OD

The gains in land by enclosure in the upper estuary have mainly been at Martlesham (16ha) and Burrell's Long Wall (22ha); the others are relatively small, probably primarily for defence, and bring the total for the upper estuary to about 80ha. In the centre, the enclosure of the onetime Brightwell and Shottisham tributaries is around 160ha.

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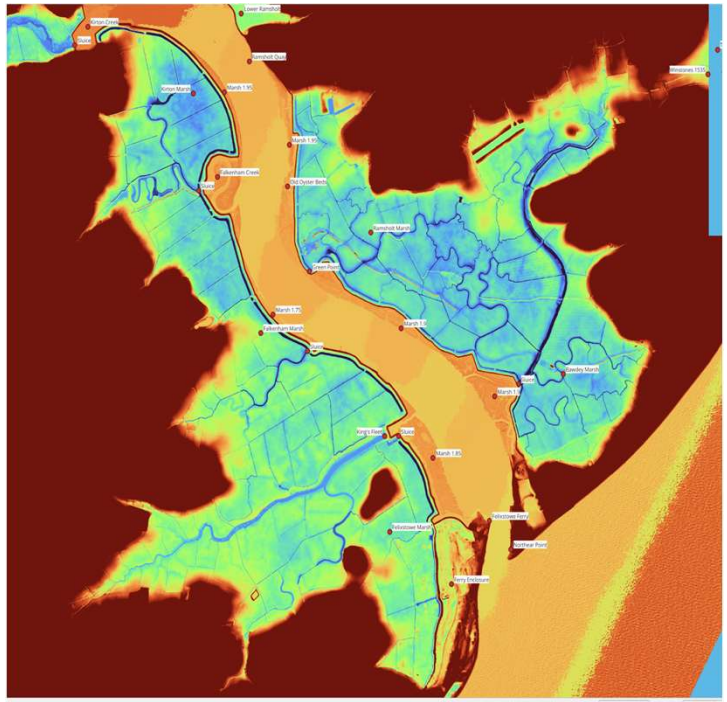


Lower Sea Walls

Felixstowe Marsh and Area Near Ferry

A small area at Felixstowe Ferry was enclosed in the twentieth century, much later than the main marsh to the north. Perhaps this was related to the growth of the shingle spit.

Ramsholt and Bawdsey Marshes

It seems likely that the walls further downriver would be older. Ramsholt, 1471. Bawdsey, 1408. Two artefacts show on the LIDAR, one is a windfarm cable, and the other may be a cable or pipeline. No remains of intermediate walls were obvious.

Lower Ramsholt

Lower Ramsholt

The owner of estates in Bawdsey, Ramsholt and Hollesley appointed Prior William as 'Commissioner of Walls and Fosses' in 1478, suggesting either that sea walls existed by then, or that a programme of wall building was being established. Date 1672, may be too young; the depressed area gives a date of 14C/15C.

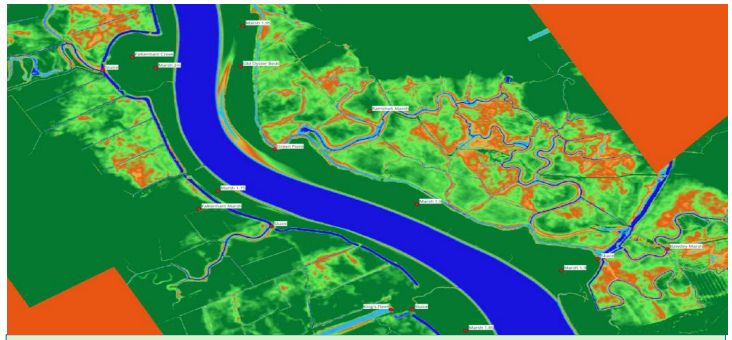
Kirton Marsh

Date 1446; the depressed area gives a date of 13C/14C.

Falkenham Marsh

The Duke of Norfolk had marshes 'inned' at Falkenham in the sixteenth century. Marshland at Goseford Haven needed repair in 1554, so it clearly existed some time before this. At Kingsfleet, the walls needed repair by 1500. These dates are earlier than the dating method suggests of 1598. The depressed area gives a date of 15C/14C. The Walton and Felixstowe marshes were in place by at least 1592.

Depressions confuse Dating by LIDAR



In the lower estuary, there are areas which are up to 0.5m lower than the surrounding enclosure. This will give a date up to 200 years earlier in the worst case (Falkenham). The areas are shown above, with blue being the lowest, through red to green, which is the highest elevation. The range of colours is chosen to enhance detail.

Questions?

- Can more documents be found relating to wall age?
- Were the lower marshes enclosed piecemeal, or in a single attempt? Who owned them?

R.M.Crawley July 2025 v3

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Waldringfield's Mystery Cuttings

Uncertain Origins

The cuttings south of Waldringfield Sailing Club are barely a century old, yet their history is unknown.

They do not seem interesting until one wonders why there are no similar cuttings on the East Coast and what they were for. The North and South cuttings are different, not made at the same time and divided by the remains of an irregular central creek predating the cuttings. Maps from various dates show their progression.

This area was chosen for investigation of clay levels, discussed elsewhere, for its accessibility. The site has an SSSI sign, although not shown as such on the Government SSSI map.

North Cuttings

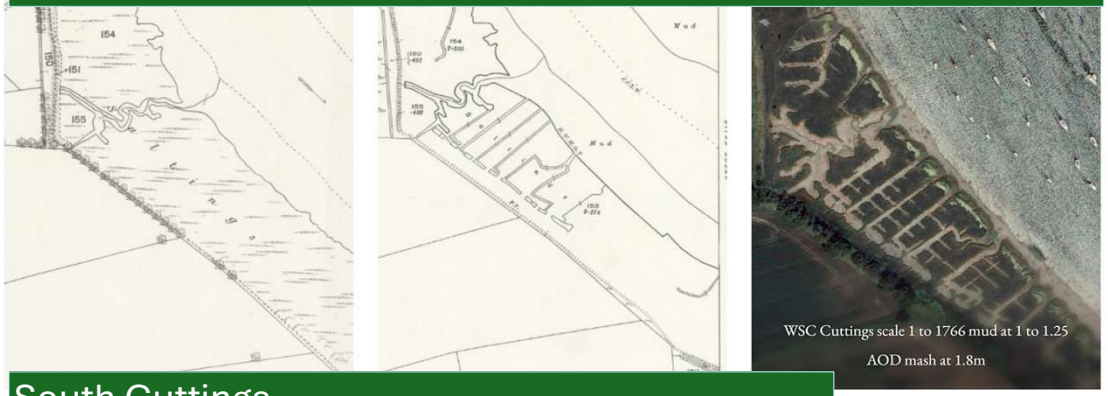
The more irregular North cuttings are different to the southern ones. The spine channel was cut between 1902 and 1925, with the tributaries between 1925 and 1945. Since 1945, the shape has softened, but no new channels have been dug. The side-by-side view shows the development.

What were the North Cuttings for?

Why was the spine channel cut and then, at some later time, the straight tributaries? An explanation could be removing material, probably clay, for reinforcing seawalls: although there is no nearby construction that can be connected, the nearby reservoir dam was constructed later, in the 1960s.

South Cuttings on Ordnance Survey six-inch from NLS and Google Earth

1881 | 1925 | Modern



South Cuttings

The Ordnance Survey shows that the central creek existed in the nineteenth century, but that the cuttings were not visible in 1881 or 1902; they were visible in 1925, and, at some point between 1925 and 1962, secondary channels were cut perpendicular to the main channels.

What were the South Cuttings for?

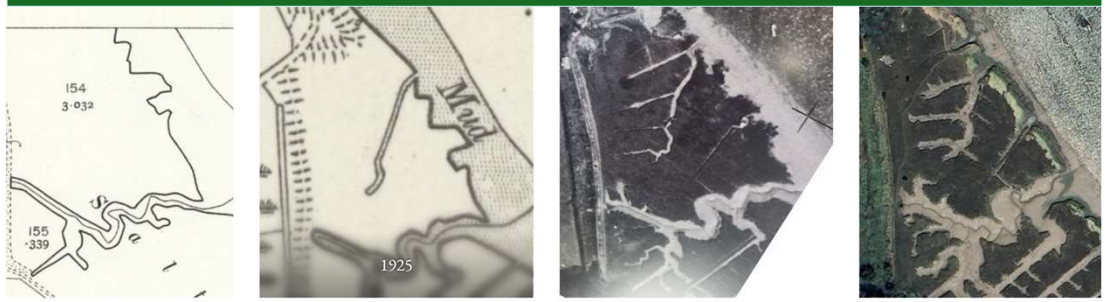
- The construction of the Dummy Landing Craft was once suggested, but these were built in 1944 on the current Dinghy Park.
- Mud digging for the Cement Works? – The total volume of mud removed is very small, and as the cement works closed in 1907, a connection with cement is improbable.
- Oyster or shellfish beds? – There are no similar cuttings on the East Coast.
- Boat storage has been suggested, but this would not be workable in this form in a tidal estuary.
- We know that clay is near the surface in this area, so extraction may have been the reason, but for what?

Questions

It is still not certain why these cuttings were made, nor who made them: it would be good to know, but the answer will probably be rather dull.

North Cuttings on Ordnance Survey six-inch from NLS and Google Earth

1902 | 1925 | 1945 | Modern



North Cuttings 1902, 1925, 1945, Modern

References and Acknowledgements

Images

- LIDAR Data –2008 25cm DTM (latest 25cm) & 2020 1m DTM -- Department for Environment, Food & Rural Affairs
- Tide Data Panel – 1845 Deben Survey, Admiralty Archive.
- Deben Soundings – Bawdsey Tide Gauge.
- Ordnance Survey Extracts – 'Reproduced with the permission of the National Library of Scotland'
- 1837 Colby OS map – personal collection.
- Deben Photo post images – various contributors.

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- Bailey, Mark, Peter Wain, and David Sear. 'THE TRANSFORMATION OF THE SUFFOLK COAST c.1200 TO c.1600: FROM ORFORD NESS TO GOSEFORD'.
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Comments, Observations, Questions?

Please feel to add your own comments and observations. Preferably, leave a contact email.