NRA

National Rivers Authority

Anglian Region

REPORT ON ALTERNATIVE METHODS

OF RIVER BANK PROTECTION

NORFOLK DISTRICT SEPT 1992.

REPORT ON ALTERNATIVE METHODS OF BANK PROTECTION

Introduction

Since 1981 there has been co-operation between National Rivers Authority and its predecessor bodies and the Broads Authority in identifying, constructing and evaluating alternative methods of protecting the embankments in Broadland from erosion, other than the piling solution as used in the past. This report gives details of the work carried out to date and some indication as to the general direction to be taken in the future.

Background

From the time when our ancestors first embanked the Broadland rivers to protect the adjacent land from flooding, it was inevitable that the rands, that area of land between the flood wall and the river, would be eroded in places. The natural migration and accentuation of the river meanders would cause erosion on the outside of the bends, though this would tend to be balanced by accretion on the inside of the bends. With the advent of motor powered craft in the Broads, the natural erosion rates have been greatly exceeded, and the loss of up to 1.6 metres per ten years has been measured in parts of the rivers system (from aerial photographs). The result has been that in many reaches there has been the total loss of the rand and the effectiveness and stability of the flood wall have been threatened. (Photographs 0.1 0.2) Where property or agricultural land is endangered, NRA has been carrying out piling or other remedial work to prevent widespread flooding that would result from failure of the defence.

Sheet steel, wooden or composite piling, provide an efficient engineering solution to this problem, but they are unattractive and give a monotonous, canalised appearance to the river banks and they inhibit the growth of marginal vegetation. The reed dominated rands, in addition to providing an attractive natural edge to the river, also provide an important habitat for nesting birds and an alternative site for spawning fish now that the submerged water plants have been lost through the enrichment of the waterways with nitrates and phosphates. The extensive reed rands of the lower Yare and Waveney, particularly where they are still harvested, provide ideal nesting sites for birds such as Redshank, and very high densities of this speciies have been recorded. Many of the Broadland specialities originally nested, or even still nest, on the rands, birds such as the Marsh Harrier, Bittern and Bearded Tit. Many more common species so beloved by the holidaymaker are also very dependent on the fringing vegetation. Like the hedgerows on the adjoining upland, the fringing reedswamp provides corridors for wildlife moving between larger areas of semi-natural vegetation, and the decline of such species as the otter may in part reflect the breaking of these lines of communication by artificial rather than naturally vegetated banks.

In 1981 a jointly initiated programme of trials was implemented to test alternative forms of bank protection in order to see whether they would be environmentally acceptable, cheaper to install and adequate to prevent bank erosion. These trials were designed to incorporate the protection that natural vegetation gives to the banks. On the River Thames near Wallingford, Alan Bonham has shown a 2 metre strip of reed dissipated 60% of boat wash energy. The technique should also prevent under-cutting of the natural vegetation.

Under-cutting of the bank occurs along the zones of weakness, commonly the base of the rooting mat or where weaker strata are interlayered with more resistant peat deposits.

A number of different techniques have now been installed by National Rivers Authority, some with financial contributions from the Broads Authority and in one case grant aid from the Ministry of Agriculture, Fisheries and Food.

Engineering considerations.

The Broadland rivers vary considerably in depth, width, boat traffic density, tidal ranges and embankment construction. It was realised, threfore, at a very early stage that there was little possibility of one solution being found to cover every stretch of river. The engineering constraints of depths of water and tidal range on the lower reaches of the Bure and Yare (below Acle Bridge and Postwick respectively) necessitated the continued use of heavy to medium weight steel piling, and there are very few locations where alternative methods could be employed.

This has given rise to all the work so far (and in the foreseeable future) being carried out on the middle Bure, Thurne and Ant.

Many different types of material have been investigated over the past 8 years and the most promising of these have been installed for site evaluation. This is a continuing process as new materials or systems appear on the market or as existing work is modified or improved in the light of installation and performance experience.

The engineering aspects of construction have also had to be allied with the environment considerations when transplanting and/or encouraging the growth of the indigenous marginal vegetation.

To date all the construction work has been carried out outside the main holiday season, which in one respect aids construction (less wash enabling easier control and operation of floating plant), but this has led to delay and extra cost during bad weather. The off season construction has also meant that vegetation has always been transplanted during its dormant stage, which is considered at present as being beneficial to the growth of the plants during the first season.

Bank protection works installed to date.

The following data sheets give details of the systems used to date. The costs at this stage are approximate only, as they relate to relatively small trials often using techniques not previously used by the workforce involved. The costs as given are therefore all greater than could be achieved if installing considerable lengths, but nevertheless they have been given as a guide.

Traditional steel piling has also been included to give a basis for comparison if required.

A very general assessment is given for each system, but it must be appreciated that some of the works have only been installed for relatively short lengths of time. Also the performance of any system can change from one year to the next due to decay of materials, natural growth, damage etc.

The data sheets are followed by a series of photographs showing the different methods of protection in the field. Accompanying maps give the site locations.

Data Sheet	Type of bank protection
1	Heavyweight piling
2	Lightweight piling
3	Rubber tyre vertical defence
4	Asphalt matting laid to rear of toe piling.
5	Asphalt matting laid to graded bank.
6	Three dimensional plastic cellular grid.
7	Wire mesh mattresses.
8	Asphalt matting face protection.
9	Low level piling with reeds planted to rear.
10	Fascine mattress face protection.
11	Open cell concrete blocks.

(All costs are approximate 1992 prices)

Conclusions

All the trials to date except the plastic cellular grid, have been successful to a greater or lesser extent.
The main problems encountered have been the absence of reed growth into the river and the effects of boat wash lifting material away from the bank leading to loss of backfill and reed damage.

The main successes have been the sedge growth through asphalt matting used as face protection and low level piling with reeds planted behind. These have been installed in areas of low and high boat traffic density respectfully.

To prevent the lifting of the bank protection material open cell concrete blocks appear to provide the ideal solution.

It has not been possible to discover any use of open cell concrete (UK or Europe) where reeds have successfuly grown through the open cells. A trial section of blocks with different fabrics has been installed on a reed bed adjacent to the River Ant. This has shown considerable success with "armorflex" blocks laid on a Nicolon HD325 fabric (both supplied by MMG Erosion Control Systems) over reeds.

In choosing a suitable method of bank protection the following need to be taken into consideration

- depth of water and width of river
- bank material
- wave and tidal action
- boat wash (and boat density)
- bankside and emergent vegetation
- access and method of construction

It is however, not possible with the present information to give detailed design guidelines.

As a very general guide the following criteria should be used.

1. For deep water (over 2.5m) with no rand there may be no alternative to piling (although reeds could be planted on backfill as levels dictated).

2. With shallow water and low boat densities an asphalt matting protection over reeds or sedge should be considered if it is possible to provide a graded bank face.

3. Where it is possible to provide a graded bank and there is high boat density and/or wave and tidal action open cell concrete blocks with reeds growing through could be installed.

4. Where there is no probability of grading the bank and boat density is high in shallow water (1-2m) low level lightweight piling with reeds planted to the rear should be considered.

John R V Ash Sept. 1992.

TYPE	DATA SHEET
HEAVYWEIGHT STEEL SHEET PILING	1

LOCATION

VARIOUS LOCATIONS ON RIVERS YARE, BURE & WAVENEY

METHOD

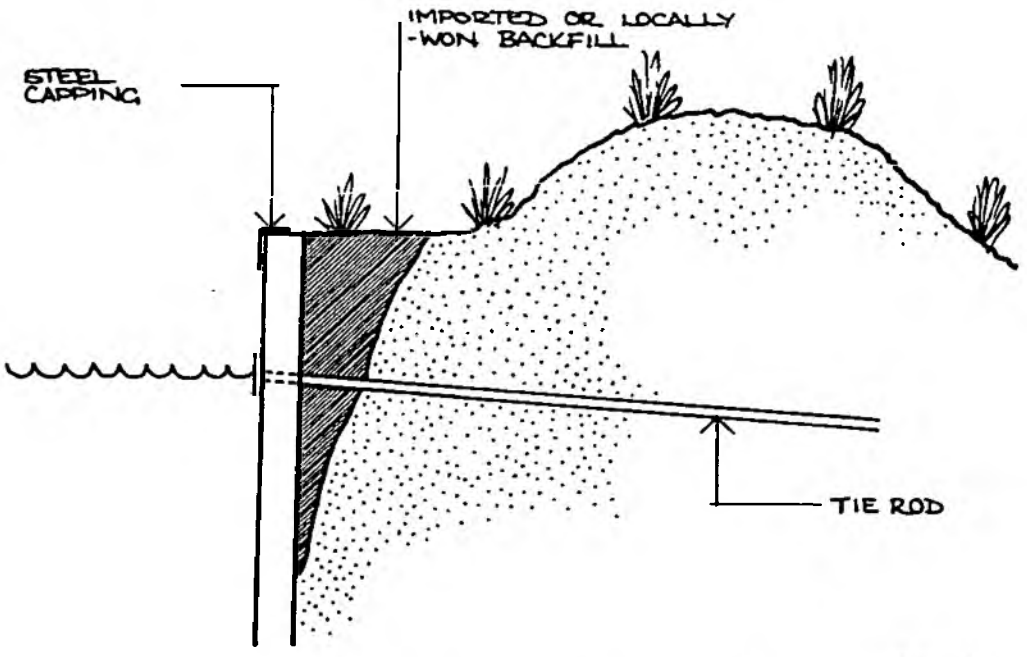
Piles driven from floating plant or from bank. Top of piles between 500-1000m above mean water. Length of piles dependent on ground conditions and depth of water. Piles anchored using tie rods and anchors and backfilled using imported or dredged material.

COST £800-£1300/m run depending on location.

COMMENTS

This piling affords a satisfactory engineering solution in areas where depth of water and ground conditions exclude the use of other methods.

PHOTOGRAPHS 1.1 **DATE INSTALLED** Mid '50's to date.



TYPE	DATA SHEET
LIGHTWEIGHT STEEL SHEET OR TIMBER PILING	2

LOCATION

VARIOUS LOCATIONS ON BROADLAND RIVERS

METHOD

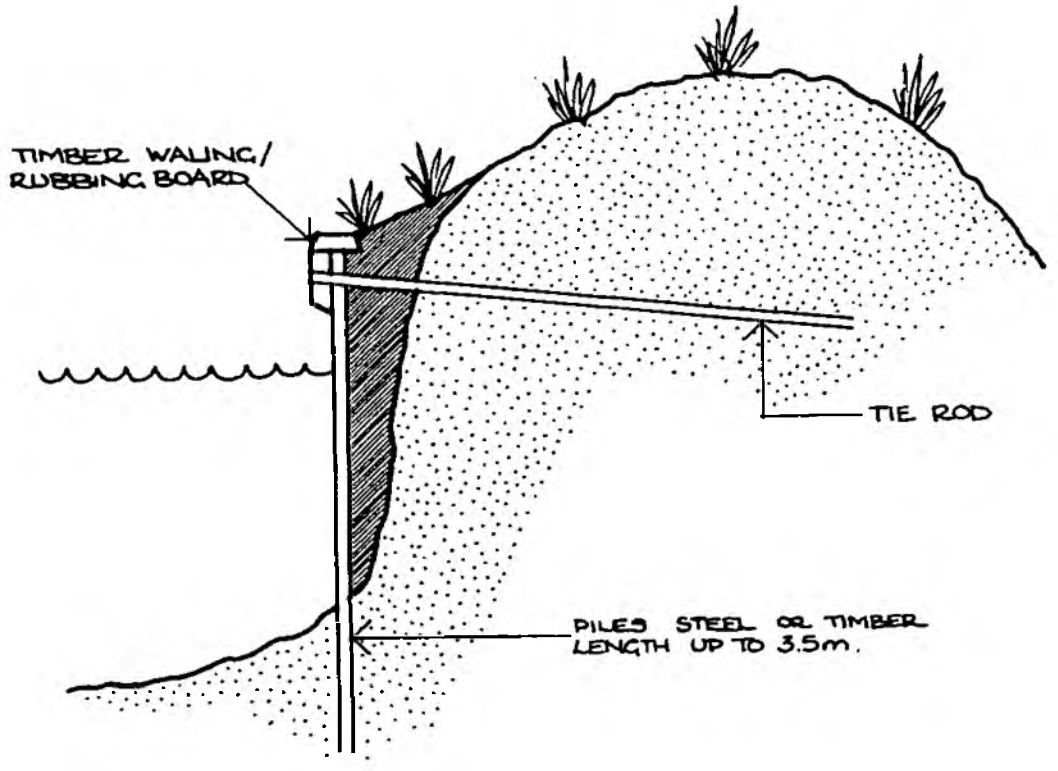
Piles usually driven from floating plant at toe of embankment with top of piles between 300-800mm above mean water level. Piles are anchored using tie rods and anchor blocks and backfilled using imported or dredged material.

COST £200-£ 500/m run depending on location.

COMMENTS

This type of piling affords a satisfactory engineering solution especially in areas where boats are moored. The piling by its very nature gives an arid canalised appearance to the waterway.

PHOTOGRAPHS 2.1 **DATE INSTALLED** Mid '50's to date.



TYPE	DATA SHEET
RUBBER TYRE VERTICAL DEFENCE	3

LOCATION

RIVER BURE, L.B. (vicinity of Sth Walsham pump)

METHOD

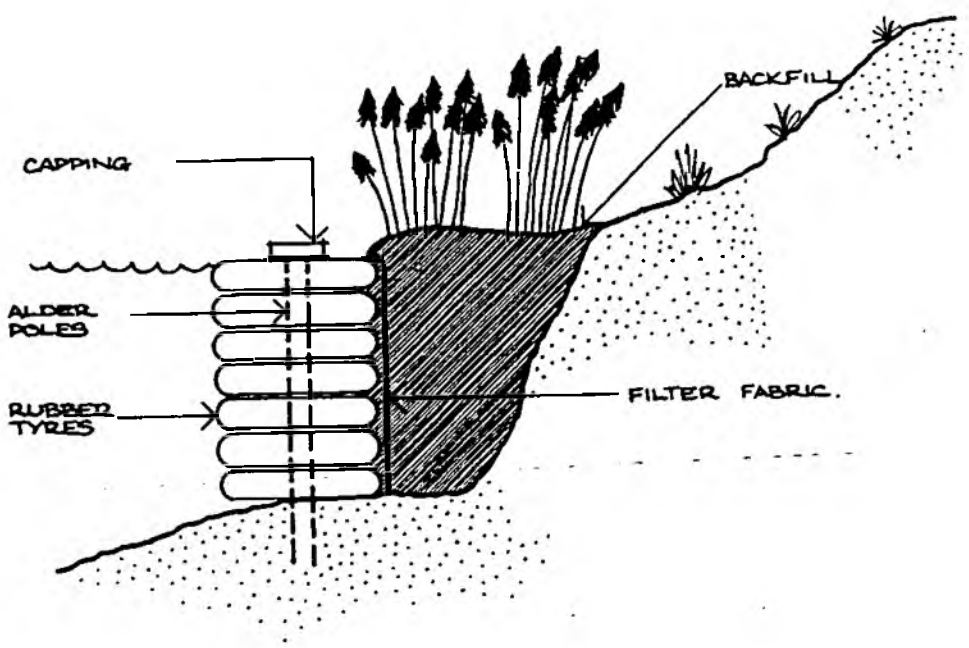
Rubber tyres threaded onto alder poles with timber capping.
Conventional anchors using tie rods and anchor blocks.
Imported fill to rear of tyres against filter fabric.

COST No data available but probably in excess of £400/m run.

COMMENTS

The tyres proved difficult to install under water. Horizontal connections couldn't be obtained and the constant movement of the tyres under wave attack has led to washout of backfill.

PHOTOGRAPHS 3.1, 3.2 **DATE INSTALLED**



TYPE	DATA SHEET
ASPHALT MATTING LAID TO REAR OF LOW LEVEL PILING	4

LOCATION

RIVER BURE L.B. At Thurne Mouth

METHOD

The location chosen was a large scour hole approx 50m in length Trench sheet piling was driven underwater to a level such that it was submerged at all but the lowest river levels. The piling was back filled with clay and then a layer of imported reed rhizomes spread on top. A 2m wide strip of Enkamat A20 was placed on the reeds, with a 2m strip of Enkamat 7220 above this following sowing with grass seed.

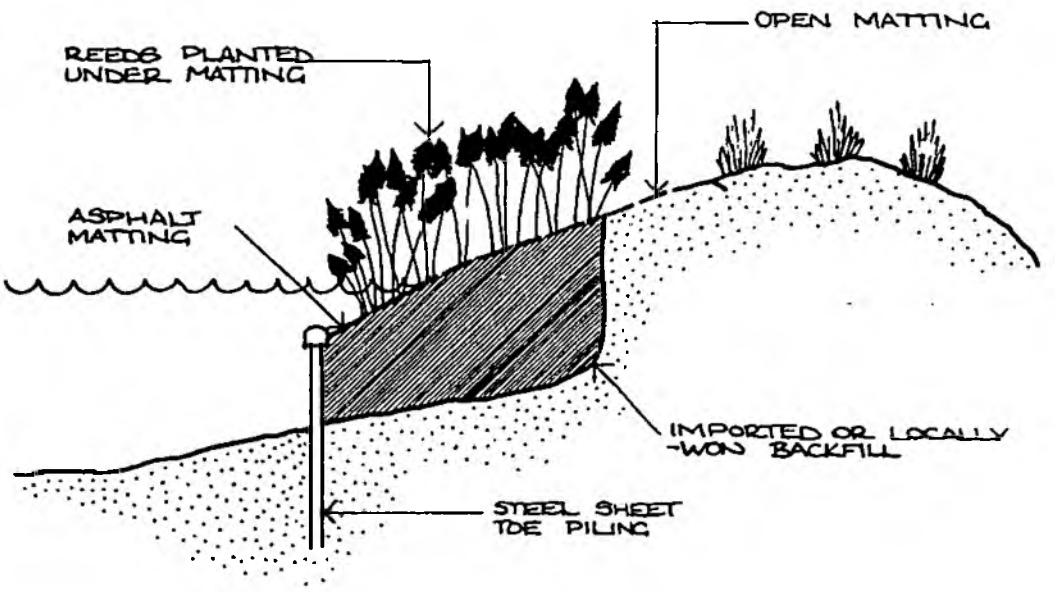
COST

Approx. £400/m.

COMMENTS

The asphalt matting was easy to lay but grading the bank underwater from a floating pontoon did prove difficult. The reed and vegetation has grown well above the water line but is not colonising at and below normal water level. Geese also proved to be a problem during the first growing season and wire netting was subsequently placed over the matting above the water line. There has been some loss of asphalt due to wash action and some loss of backfill.

PHOTOGRAPHS 4.1, 4.2	DATE INSTALLED March 1985



TYPE ASPHALT MATTING LAID TO GRADED BANK	DATA SHEET 5

LOCATION

RIVER THURNE - R.B. adjacent to Thurne Mouth.

METHOD

A scour hole approx 60m long was filled using both imported and dredged material. The slope was graded to the bed of the river at approx 1 in 4. A combination of Enkamat A asphalt mat of 5m A20 + 2m A40 was rolled down the slope, which had been spread with reed rhizomes. A 2m wide strip of Enkamat 7220 was laid above the matting following seeding. The matting was fixed in place using short iron stakes.

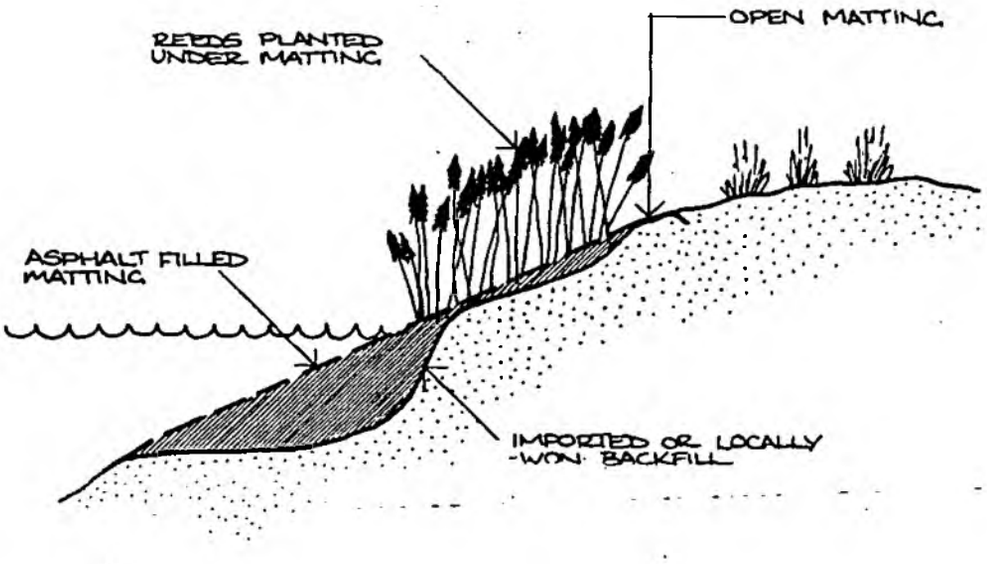
COST

Approx. £250/m.

COMMENTS

The asphalt matting was easy to lay but grading the bank underwater from a floating pontoon did prove difficult. The reed and vegetation has grown well above the water line but is not colonising at and below normal water level. Geese also proved to be a problem during the first growing season and wire netting was subsequently placed over the matting above the water line. There has been some loss of asphalt due to wash action and some loss of backfill.

PHOTOGRAPHS 4.1, 4.2	DATE INSTALLED March 1985



TYPE THREE DIMENSIONAL PLASTIC GRID	DATA SHEET 6

LOCATION

RIVER BURE - R.B. upstream of Upton Mill

METHOD

The face of the existing embankment was graded to a 1:3 slope using dredged fill where necessary. There was before work commenced some marginal vegetation on the frontage between scour holes and for that reason none was imported. The 8mx2m plastic grids 'Geoweb' were placed by floating crane after weighting the toe with concrete and placing a filter fabric on the slope. They were then fixed in place using anchors and stakes and the whole length was covered with material excavated from the river.

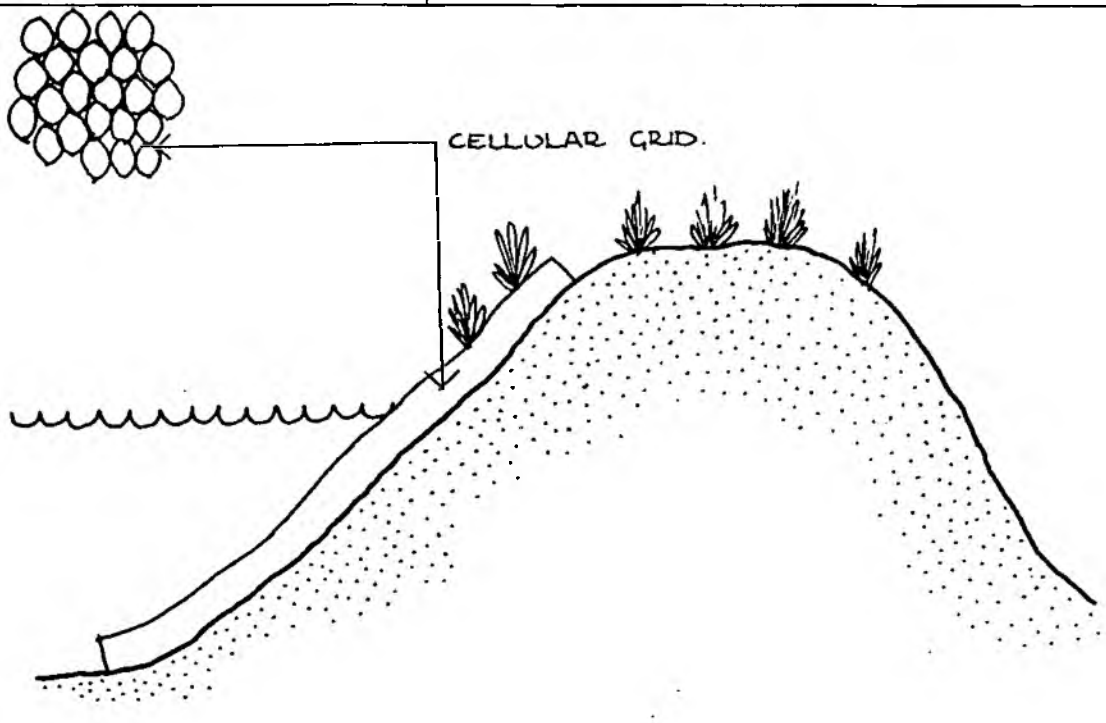
COST

Approx. £400/m.

COMMENTS

This system has not been successful. From the start difficulties were encountered devising a system to weight the toe of the grid down. It also proved difficult laying the grids to ensure they covered the whole face of the embankment. The backfill placed in the cells has not stayed in place, due to the action of the wash, and in places the welds holding the material together have broken. The main disadvantages were the material's rigidity and difficulty in anchoring on to the face of the embankment. This system has now been replaced by low level piling.

PHOTOGRAPHS 6.1, 6.2	DATE INSTALLED April 1986



TYPE WIRE MESH MATTRESSES	DATA SHEET 7

LOCATION RIVER BURE - LB Mantley
RIVER BURE - LB opp. South Walsham Pump.

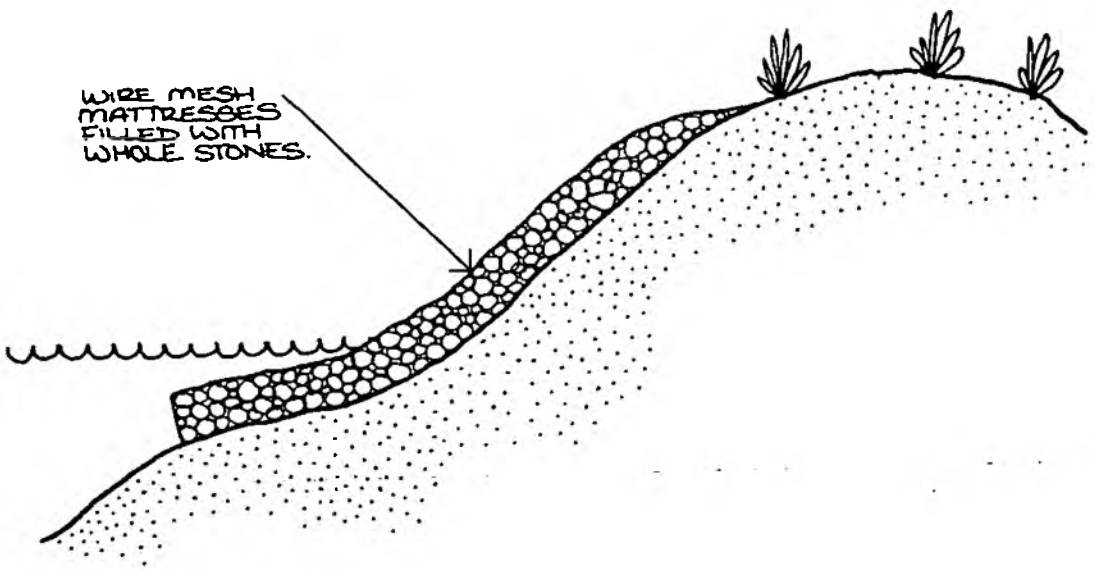
METHOD The banks were graded prior to the placing of the plastic coated wire mattresses. The site at Mantley used whole stone flints as the filling material, the other site using a lightweight plastic material.

COST Approx. £200/m.

COMMENTS These types of wire mattresses approx. 170 mm deep can only be utilised in locations where they can be placed above water level. This in practice means that the toe must be founded on a naturally formed stable ledge. Neither of the sites are supporting reed growth but they have tended to 'green' over.

PHOTOGRAPHS 7.1, 7.2

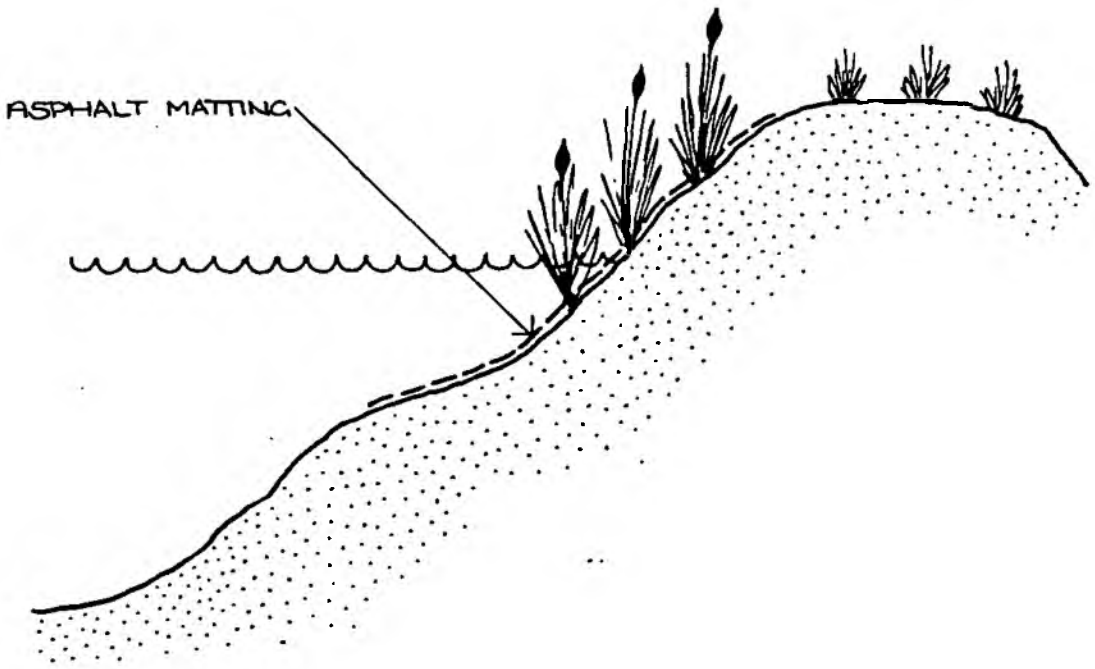
DATE INSTALLED June, 1986



TYPE ASPHALT MATTING FACE PROTECTION	DATA SHEET 8

LOCATION	RIVER ANT L.B. - Chapelfield Marsh.
METHOD	The peat embankment on this frontage is constructed on a layer of clay giving a ledge just below water level. The face of the eroded embankment was graded to a 1:3 slope and sedge roots placed on the face of the bank at the water line. The asphalt mats (similar to Enkamat A used in 3) were laid along the bank in a 2.4m wide strip and pegged down.
COST	Approx. £200/m.
COMMENTS	This system proved easy to lay using land based plant. The sedge grew quickly, completely covering the lower section of the matting in two years.

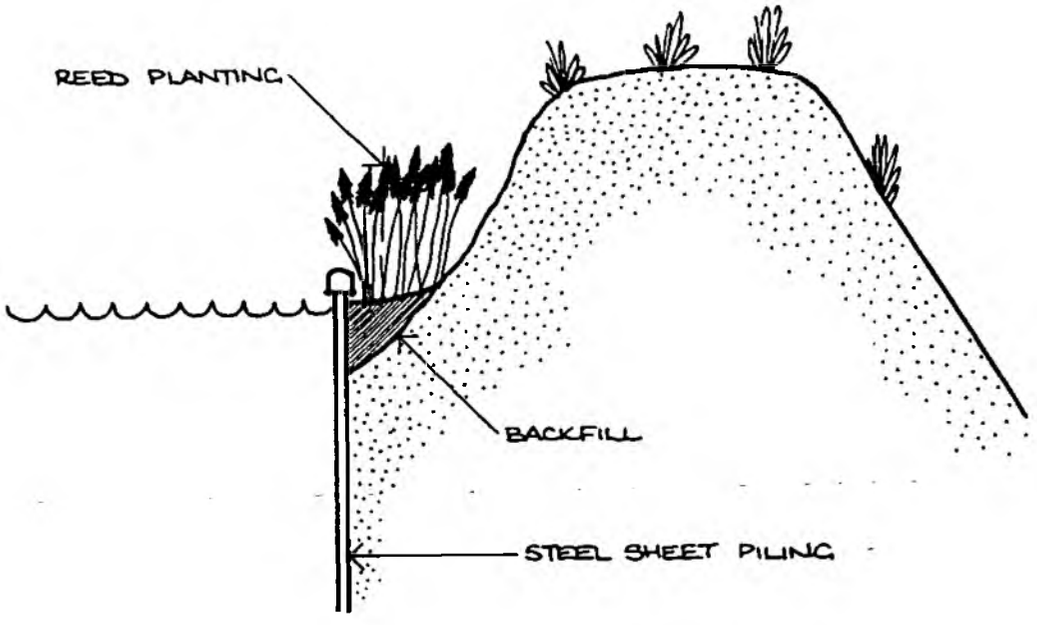
PHOTOGRAPHS 8.1, 8.2	DATE INSTALLED February, 1987



TYPE	DATA SHEET
LOW LEVEL PILING (WITH REEDS PLANTED TO REAR)	9

LOCATION	RIVER BURE - R.B. upstream of Upton Mill.
METHOD	Steel piling is driven to within 150mm of normal summer water level. If conditions allow no anchors are installed. The area to the rear of the piles is backfilled with dredged material and a layer of reed rhyzomes spread on the surface.
COST	Approx. £200-£300/m.
COMMENTS	This technique was developed from the toe piling trial installed at Thurne mouth. The piling is not a hazard to navigation and is cheaper to install. The reed growth gives a reed margin to the river and in time tend to camouflage the piling.

PHOTOGRAPHS 9.1, 9.2	DATE INSTALLED June, 1990 to date.



TYPE	DATA SHEET
FASCINE MATTRESS FACE PROTECTION	10

LOCATION

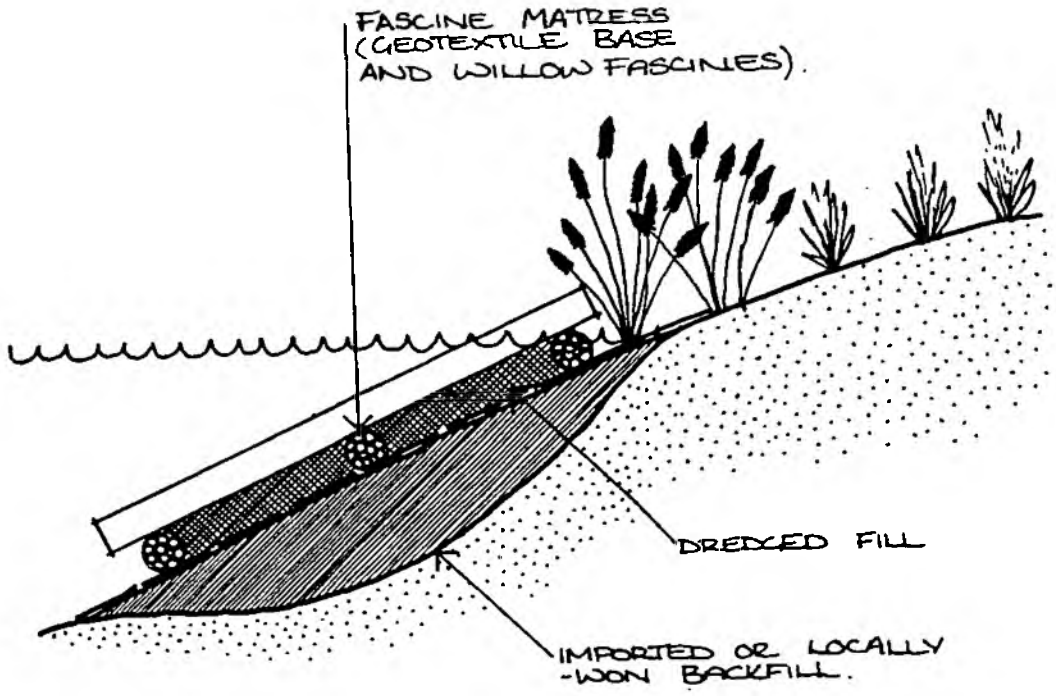
RIVER THURNE - L B downstream of Lion Dyke.

METHOD The front face of the eroded rand was filled with dredged material and overlain with a fascine mattress manufactured from a geotextile and willow. This was then filled with dredged material.

COST Approx. £150-£250/m run

COMMENTS The reed growth has not as yet migrated into the mattress. Some of the fill is being worked out and may need replacing in future years If used on a larger scale it would be beneficial to weight the toe with whole stones.

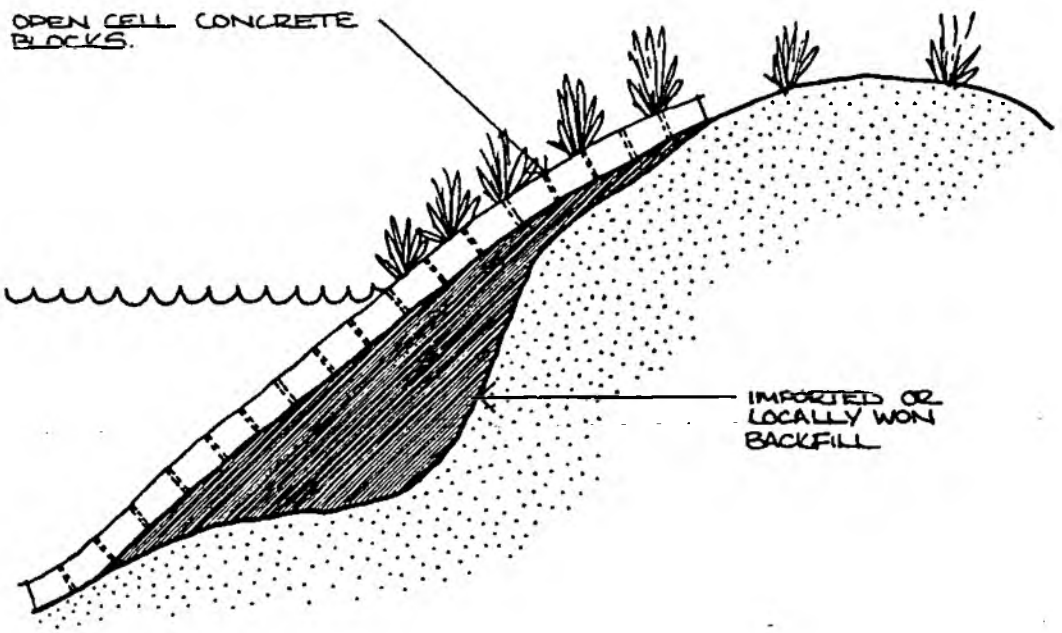
PHOTOGRAPHS 10.1, 10.2	DATE INSTALLED March 1990



TYPE OPEN CELL CONCRETE BLOCKS	DATA SHEET 11

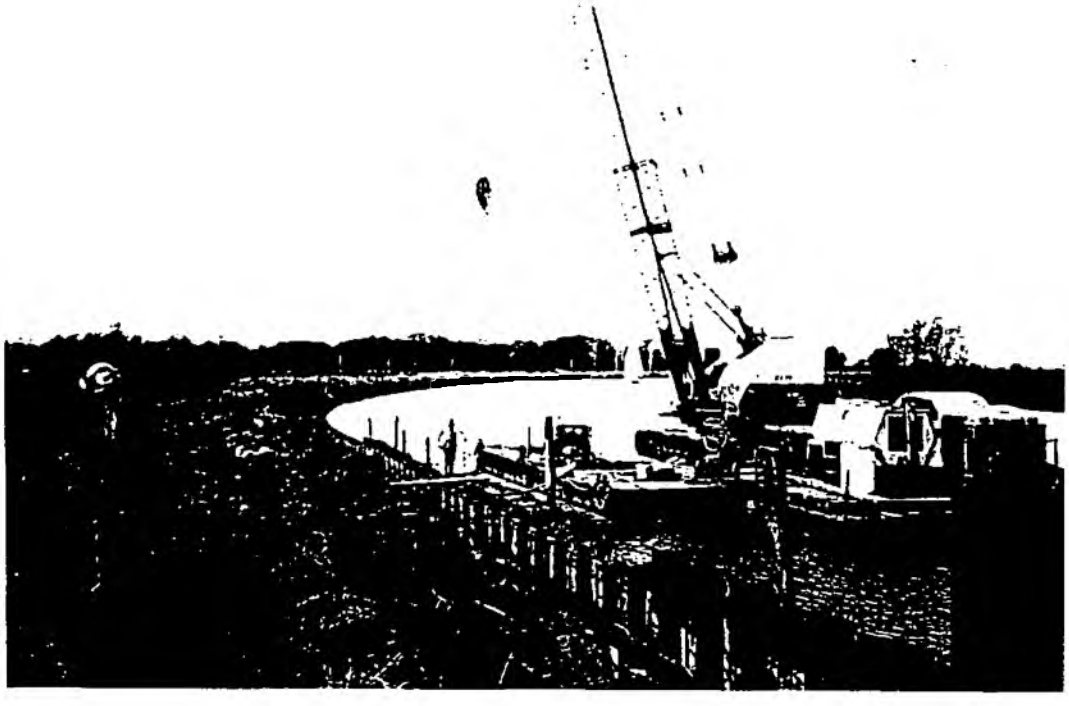
LOCATION	RIVER BURE - R.B. Bure Loop. RIVER YARE - L.B. Nth Breydon.
METHOD	The front face of the embankment is filled and graded to approx 1:3 or 1:4. The blocks were laid in mat form on Bure Loop and singly on Nth Breydon - on a Filter fabric.
COST	Approx. £40 -£80 /m2
COMMENTS	The 2 locations are at the downstream end of the river systems subject to wave action, and salt water. No reeds were planted under the blocks. They have greened over with grass and other vegetation. A small scale trial in underway which has successfully grown reeds through the geotextile and the cells in the blocks.

PHOTOGRAPHS 11.1, 11.2	DATE INSTALLED 1988, 1989.



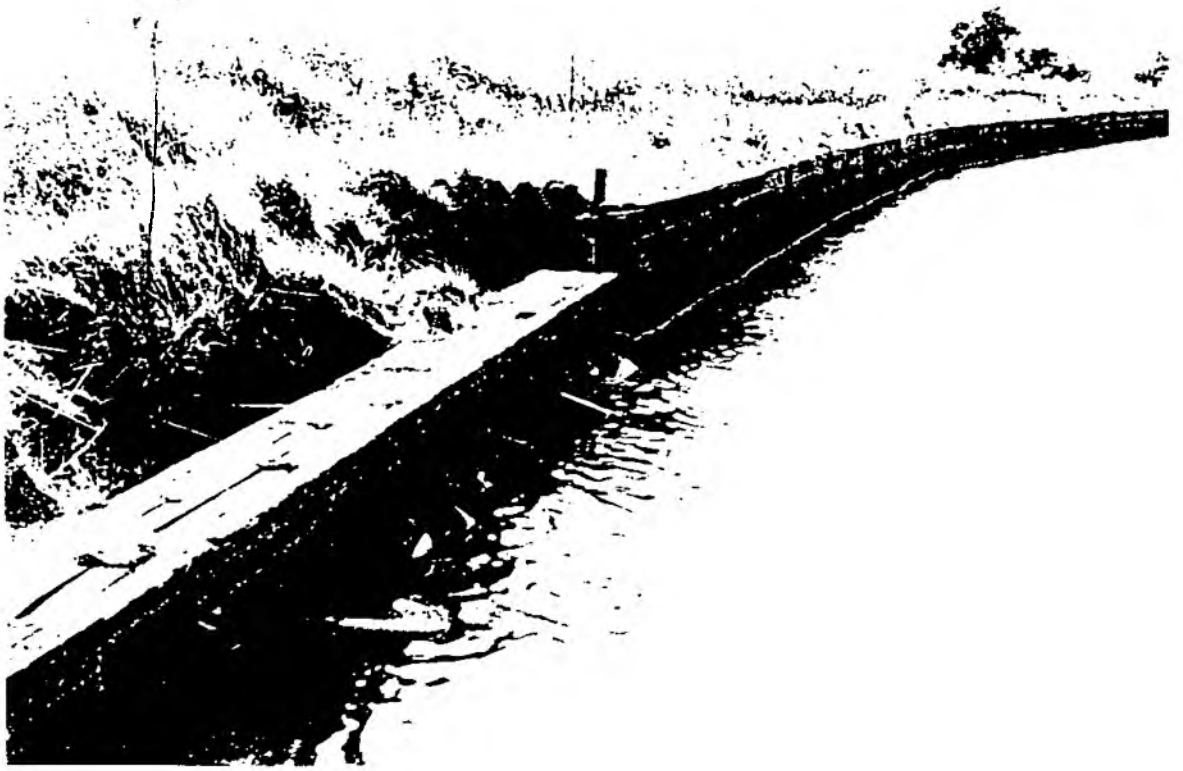
0.1

0.2
RIVER BANK EROSION THREATENING STABILITY OF FLOOD DEFENCE

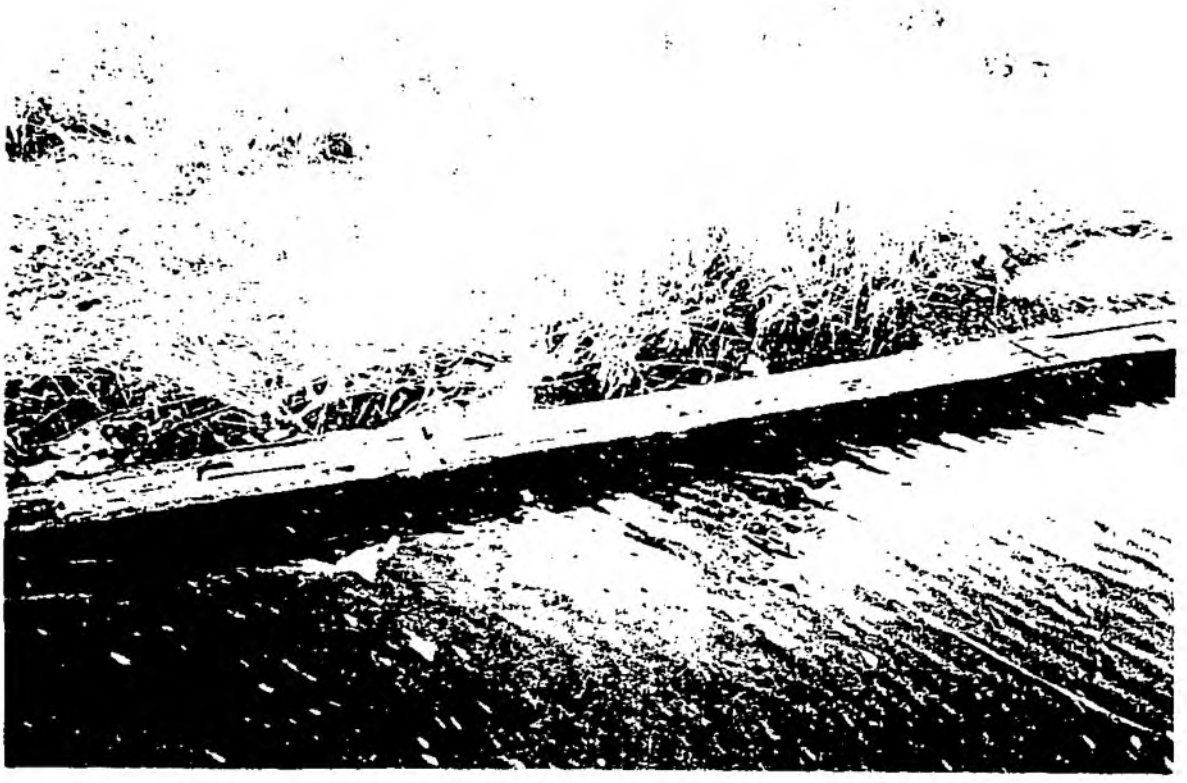


1.1
HEAVYWEIGHT PILING

2.1
LIGHTWEIGHT PILING

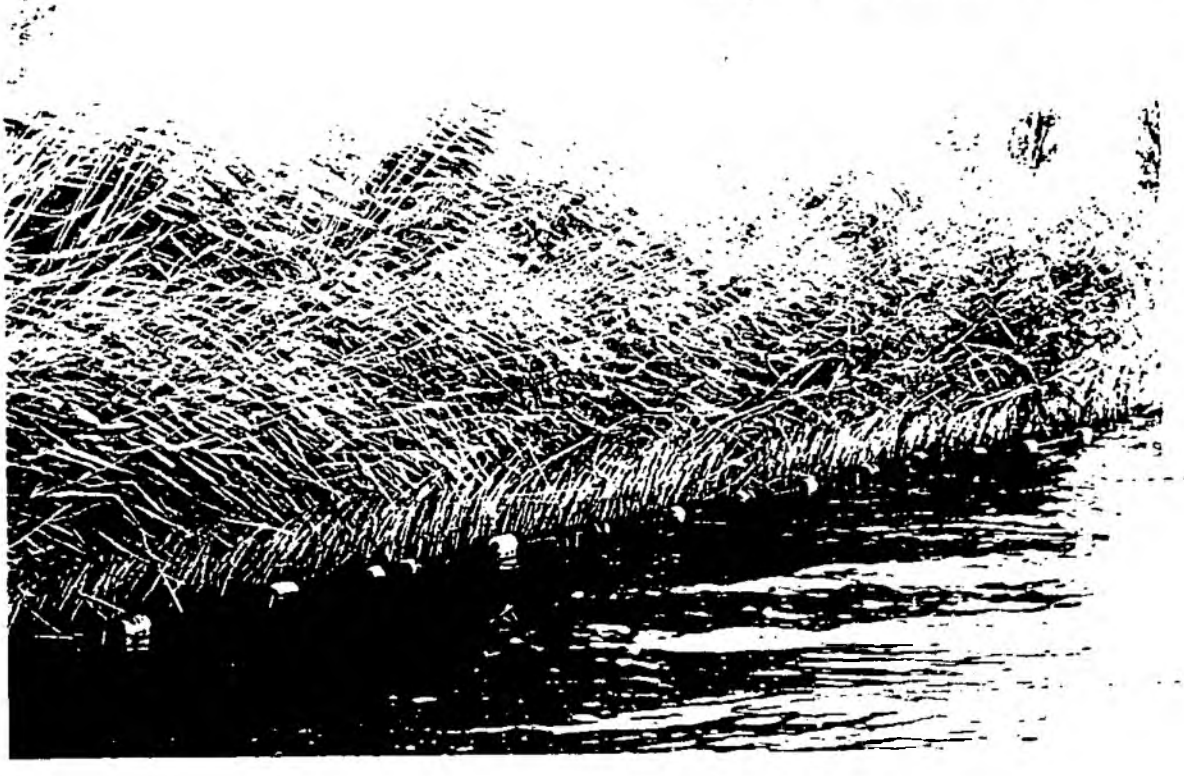


3.1



3.2
RUBBER TYRE VERTICAL DEFENCE

4.1
INSTALLATION OF ASPHALT MATTING OVER REED RHYZOMES

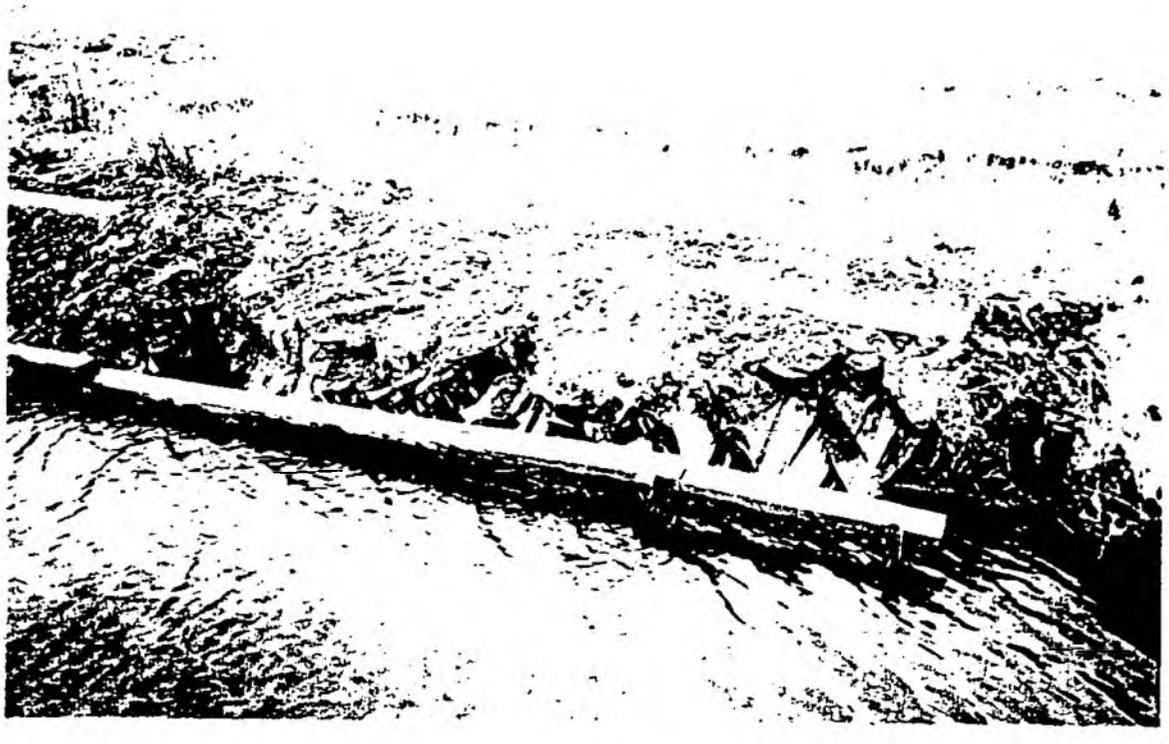


4.2
REED GROWTH AFTER 3 YEARS

5.1
REED GROWTH THROUGH ASPHALT MATTING LAID ON GRADED BANK

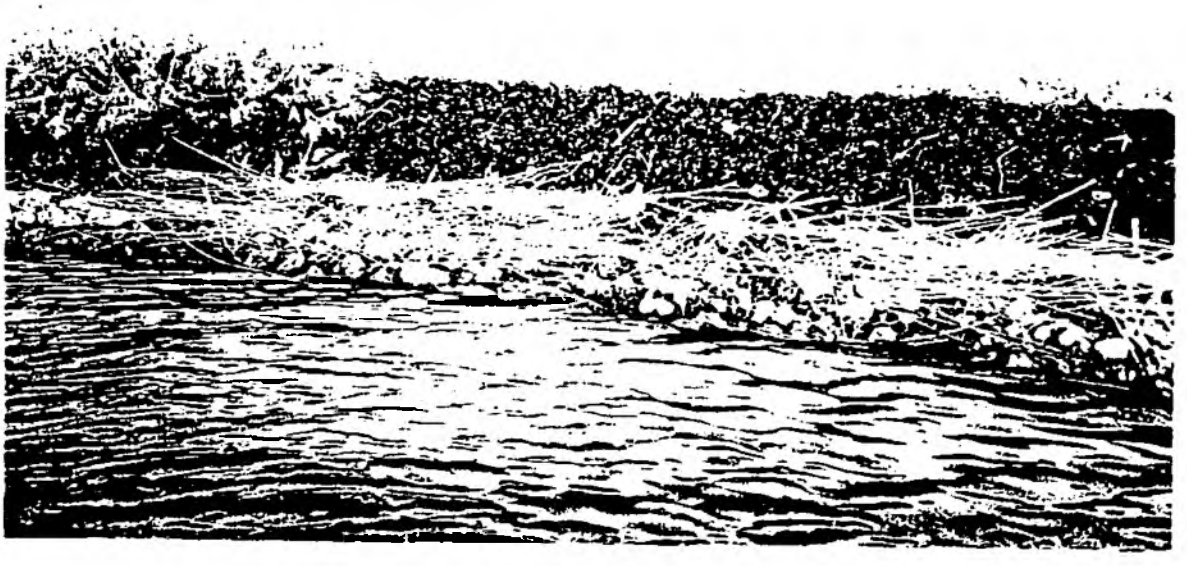
5.2

6.1
GEOWEB INSTALLED ON RIVER BANK



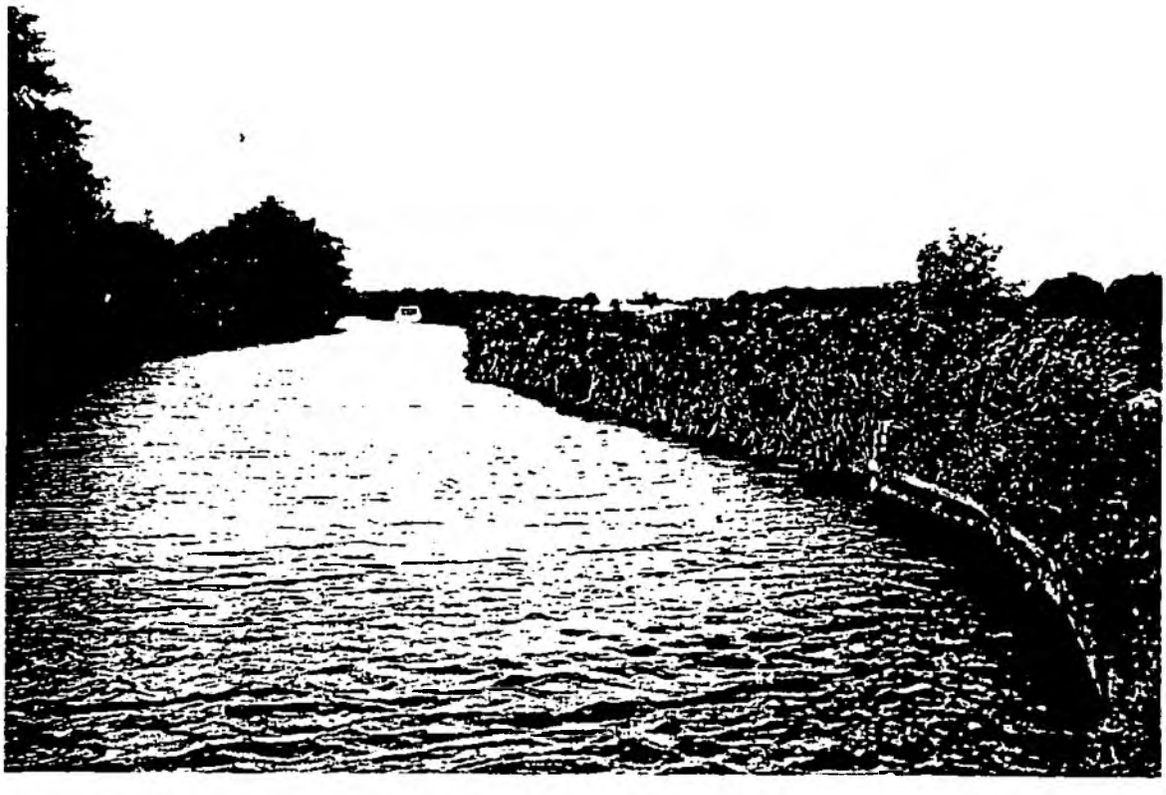
6.2
BREAKING OF WELDS AND FAILURE OF SYSTEM

7.1
RENO MATTRESSES INSTALLED ON R. BURE (MAUTBY)

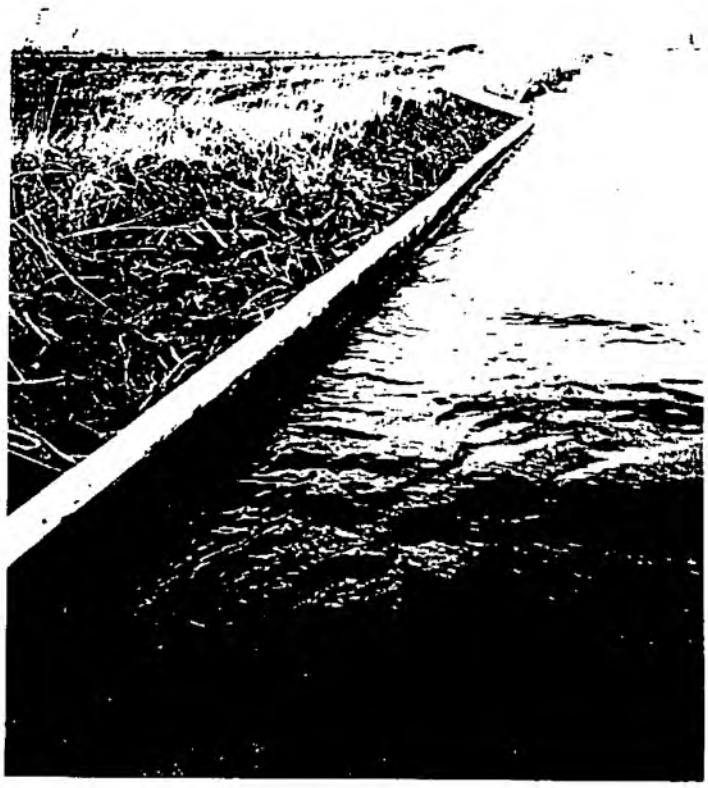


7.2
RENO MATTRESES INSTALLED ON R. BURE.

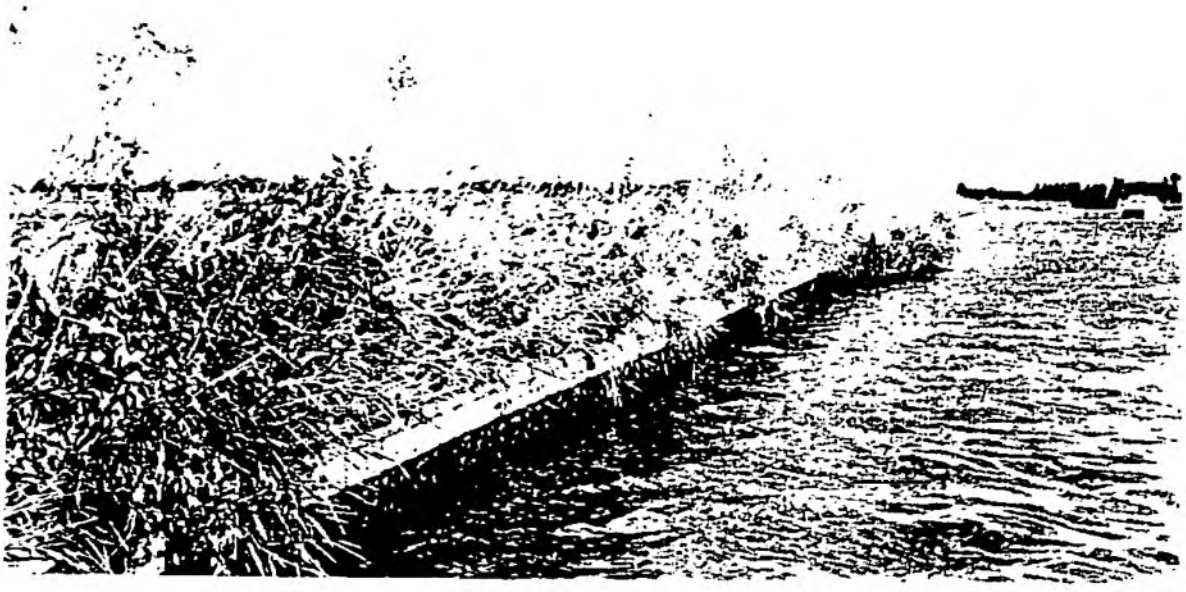
8.1
ASPHALT MATTING FOLLOWING INSTALLATION



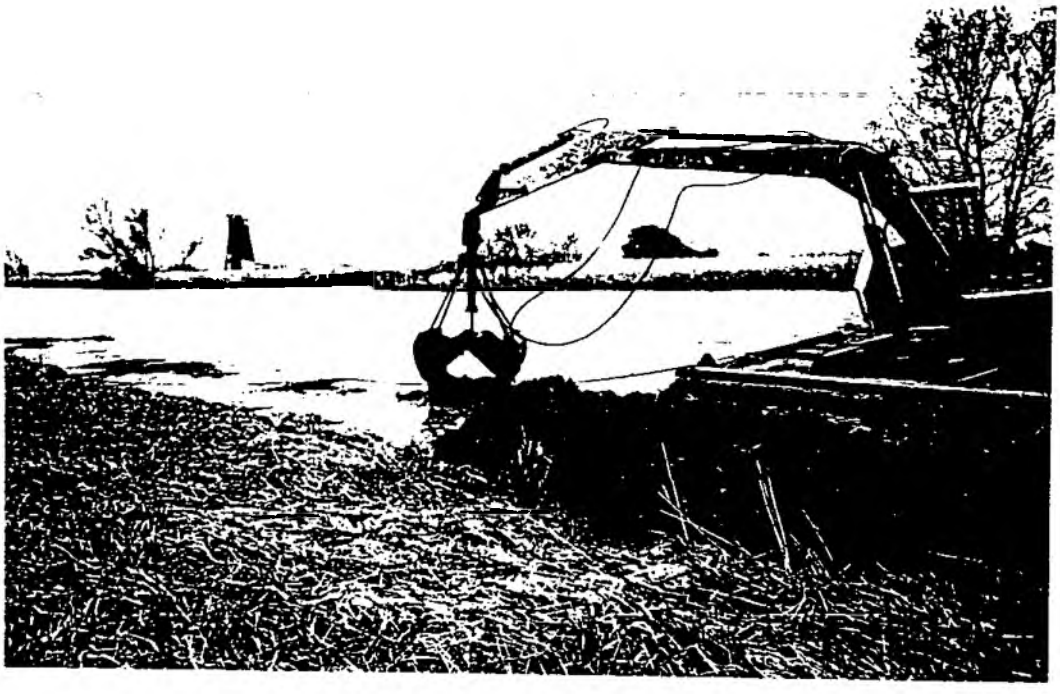
8.2
THE SITE AFTER 2 YEARS.



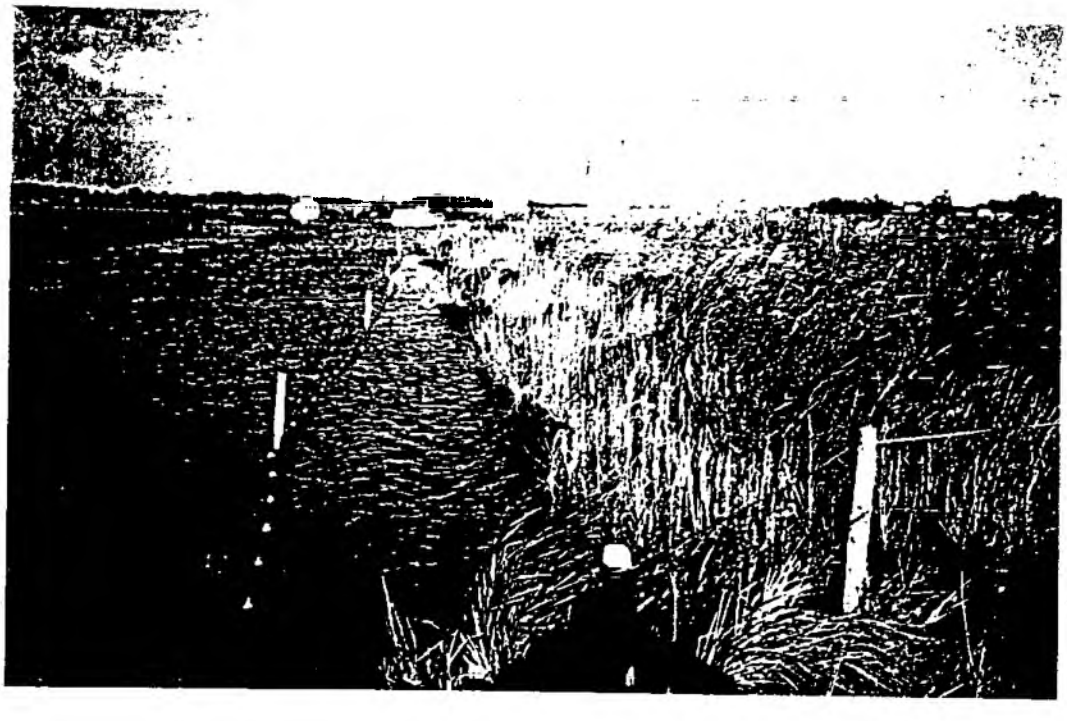
9.1
LOW LEVEL PILING SHOWING REED RHYZOMES



9.2
LOW LEVEL PILING 1 YEAR AFTER INSTALLATION

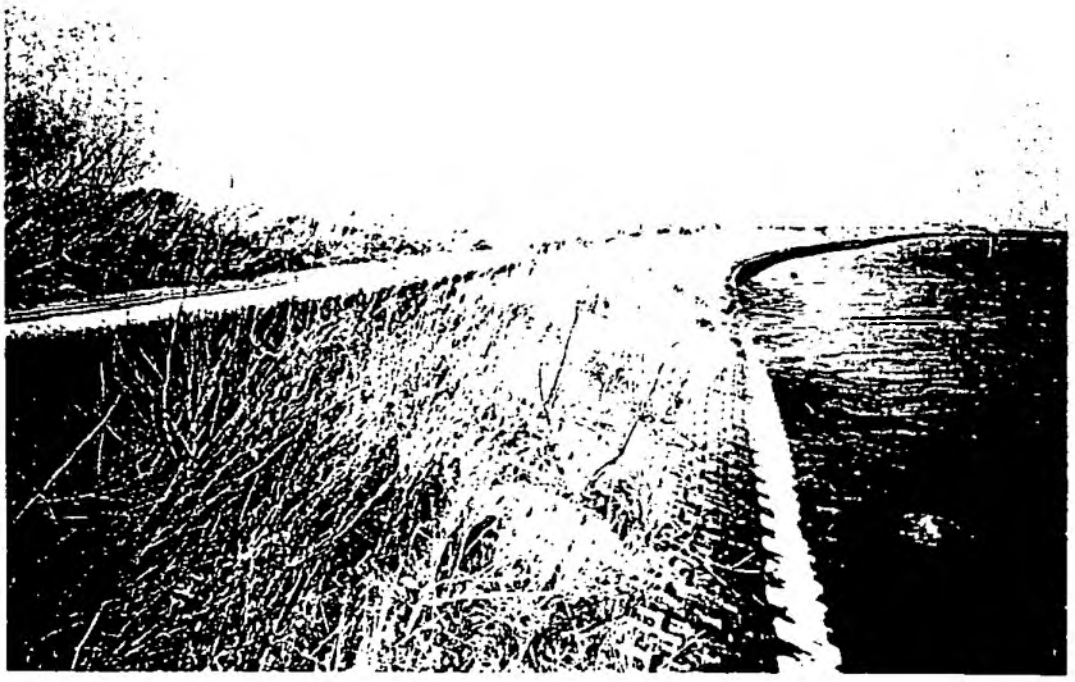


10.1
MATTRESS BEING BACKFILLED

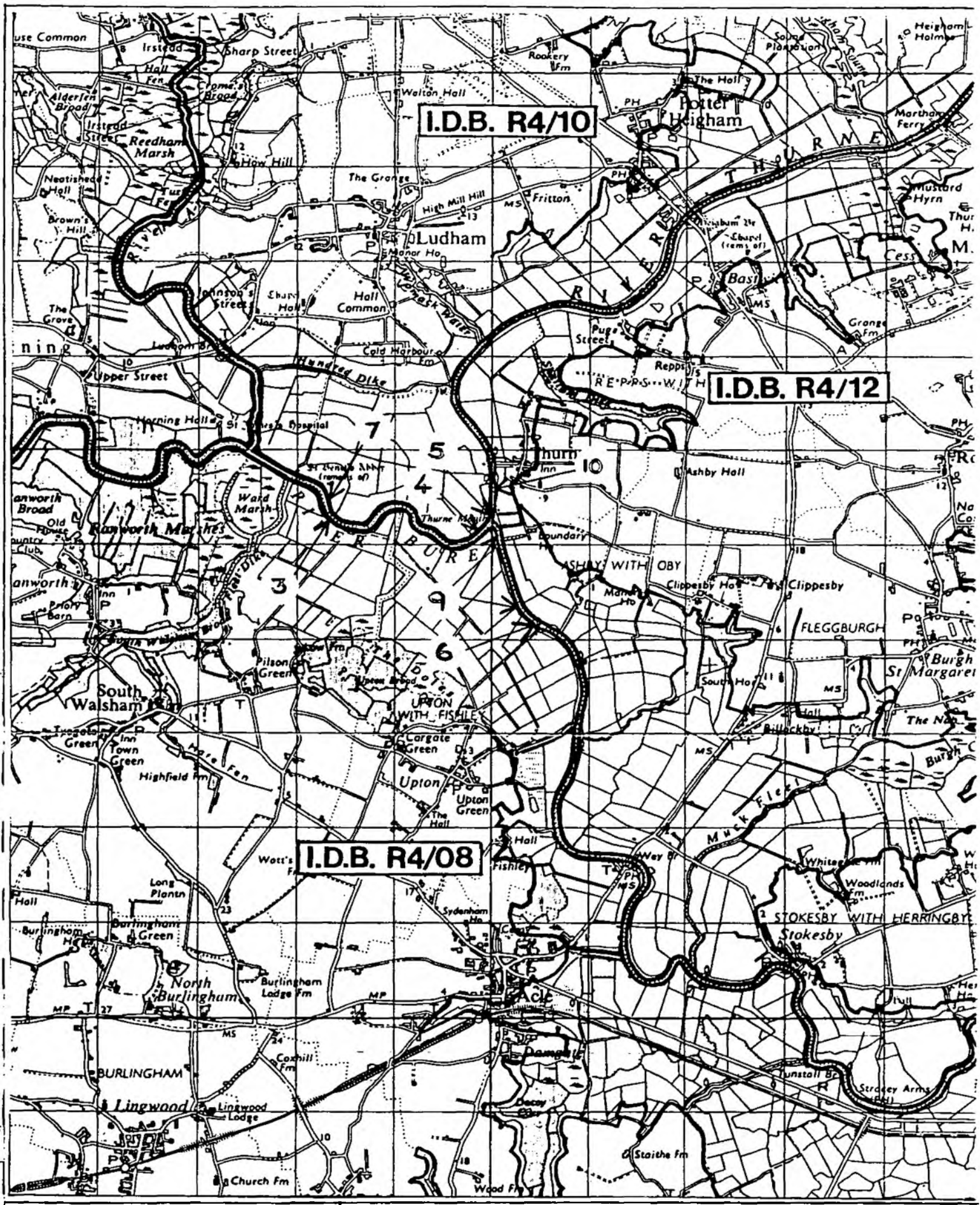


10.2
THE SITE AFTER 1 YEAR

11.1
OPEN CELL CONCRETE BLOCKS (R. BURE)



11.2
OPEN CELL CONCRETE BLOCKS (R. YARE)



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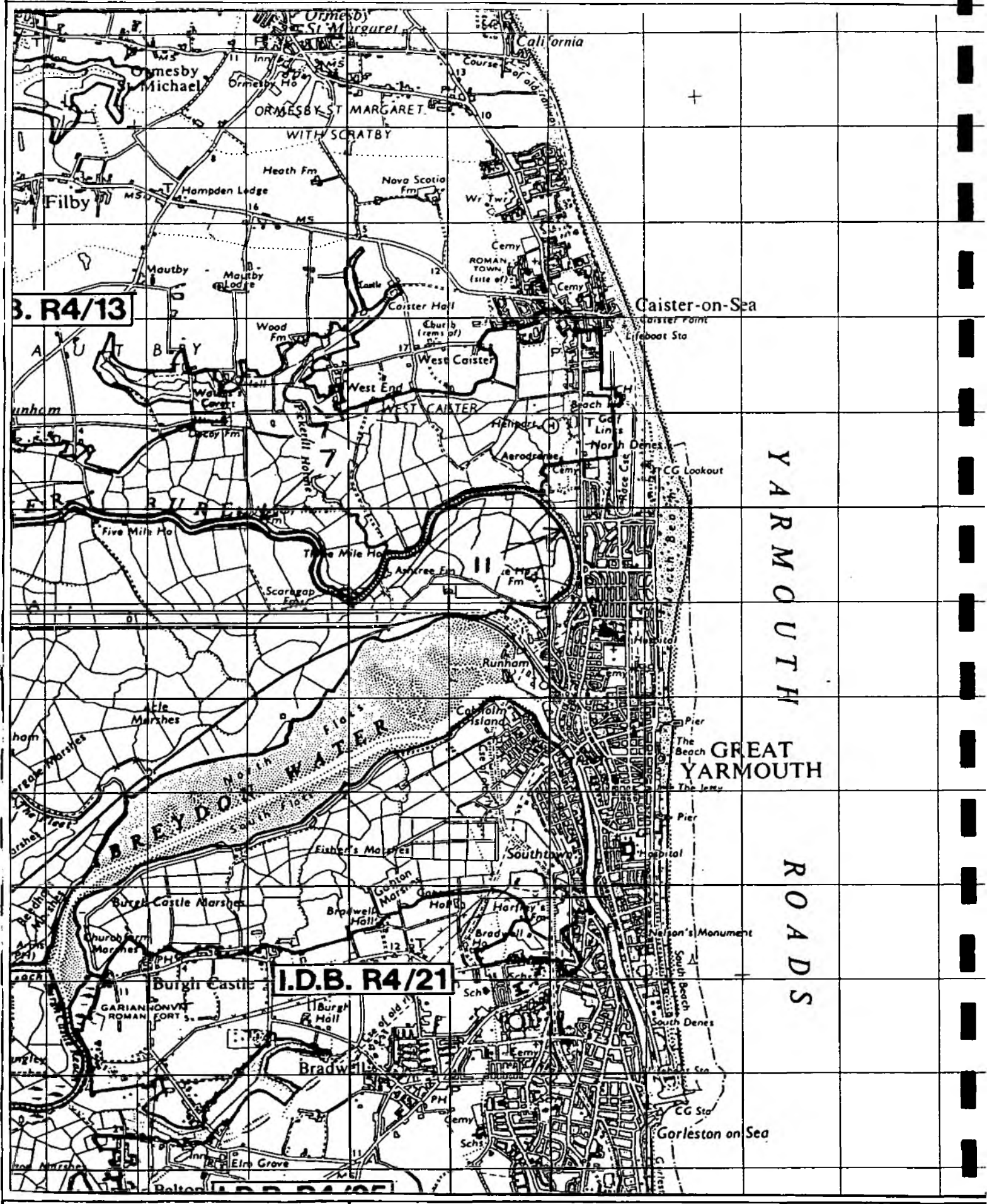
ALTERNATIVE METHODS OF BANK PROTECTION

SITE NOS. REFER TO DATA SHEET NOS.



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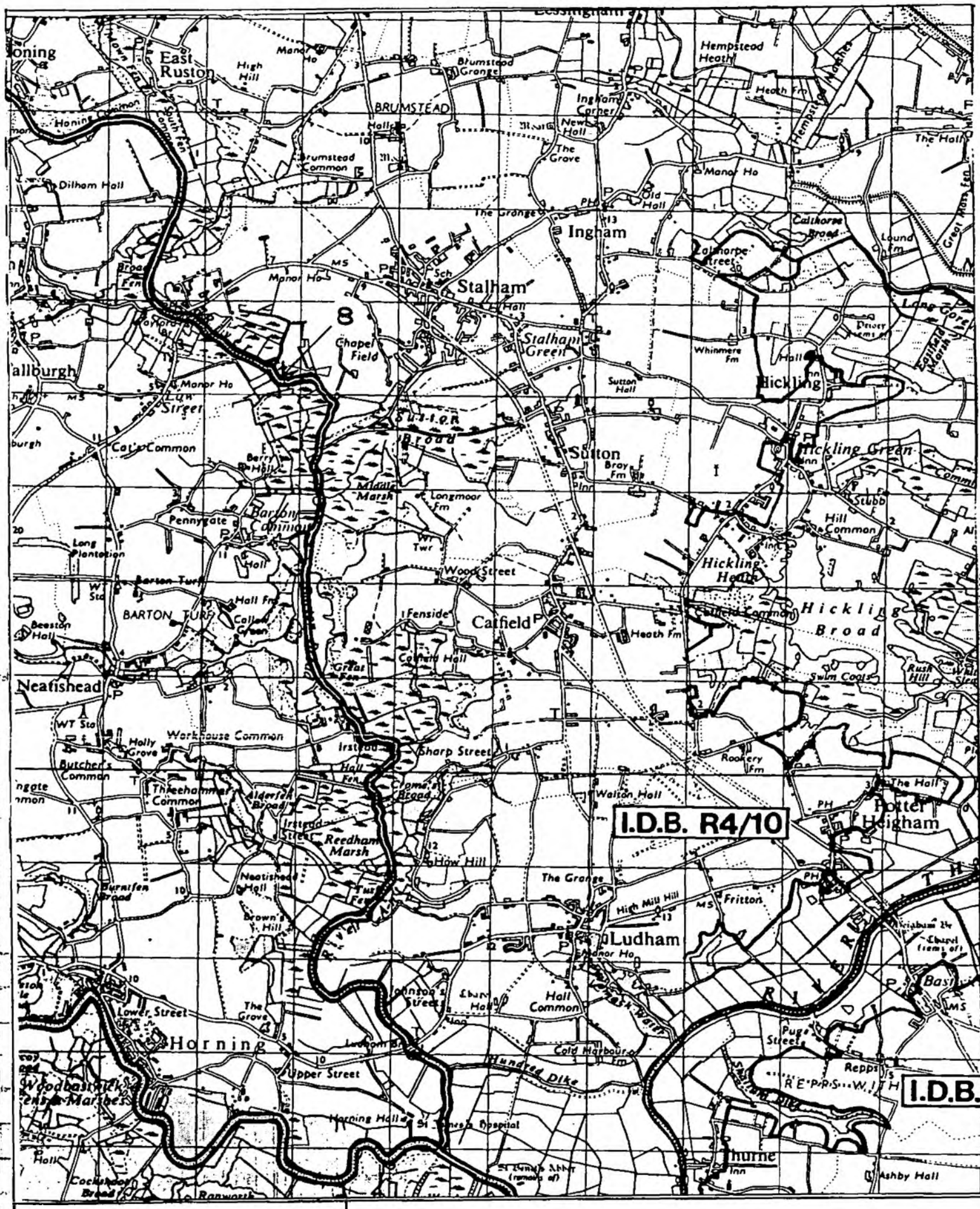
SITE NOS. REFER TO DATA SHEET NOS.



NRA
National Rivers Authority
Anglian Region

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