

Practical Restoration Handbook

Bank Protection

by

Dave Wedd

CONTENTS

1. Introduction
2. Planning a Piling Project
3. Procedure for Small Profile Piles
4. Marking out the Site
5. Loading the Gate
6. Turning Bends
7. Ending the Run
8. Tie Bars
9. Waling and Capping
10. Back Filling
11. Plastic Piling
12. Safety
13. Equipment
14. Alternative Techniques
15. Suppliers
16. Further Reading

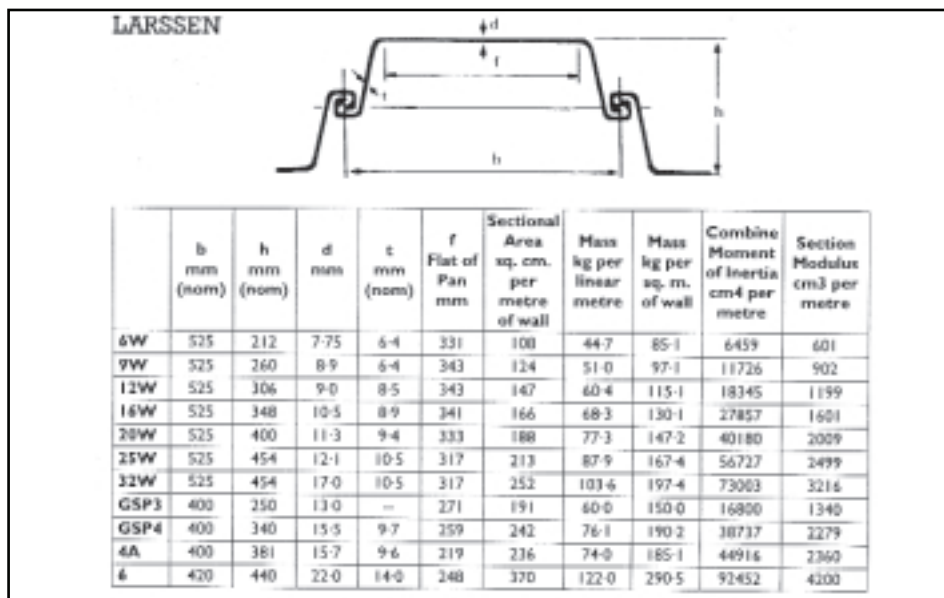
1. INTRODUCTION

- 1.1 There are three reasons for bank protection; to give sufficient structural strength to the bank, to protect the bank from erosion (both on the waterline and from the user on the path) and to prevent leaks. The traditional treatment for areas at risk is galvanised steel trench sheeting, more commonly known as piling. It is also known as “campshedding” - from the Dutch “kant schot”.
- 1.2 Steel piling is currently the most popular form of bank protection but it is not the only method. While it gives a long term structural solution that is appreciated by engineers it has many disadvantages; a high cost per linear metre, strong skilled labour is required to install it, it has low aesthetic value and rarely enhances any heritage project. Whilst the hard vertical side that piling creates may be idea for large boats to cruise and moor alongside, canoeists will find it poor for access and the wave reflections unpleasant to navigate. It is also essential to consider the ecological impacts of any bank protection carried out; a hard vertical bank not only creates a physical hazard by preventing movement between the water and the land but also deprives both flora and fauna of a habitat. The dredging of the bank edge that frequently accompanies piling also threatens the plants and ecosystems that exist in shallow waters. Naturally these problems are increased if both banks are piled.
- 1.3 It is for this reason that a section has been included on alternatives to steel piling. Some of these ideas have been around for many years but others are new. It is strongly recommended that a good hard look should be taken at the alternative techniques, outlined briefly in Section 14. They often represent a solution to bank protection that is more acceptable to more people and seen as beneficial to both man and beast than cold steel piling. Because many of these ideas have only recently been applied to navigable waterways and each waterway is unique, this is an area that is rapidly evolving. It is therefore well worth discussing your individual project with the manufacturers listed in Section 15.
- 1.4 However the final choice of which type of bank protection is appropriate (if any) will be arrived at by taking a long term view of expected use together with expert advice (both engineering and ecological). It also cannot be stressed too highly that the need for bank protection can be reduced or eliminated altogether by considering wash and speed control as an integral part of the design of all structures and landscaping of a waterway.
- 1.5 Note that almost none of these options (including piling) are waterproof without some lining (or cohesive fill material [clay!]) behind them.

2. PLANNING A PILING PROJECT

- 2.1 When planning a piling project it is necessary to remember that large numbers of piles are not usually available “off the shelf” and manufacturing will take a few days. Should you wish to have them galvanised (a common procedure for waterway schemes but unusual for most other applications) then this will add a week or so. Piles are also very heavy so transportation and delivery will a) be expensive and b) involve a lot of hauling and humping to get them to where you actually want them rather than where the wagon was willing to drop them off. Pile driving is heavy going and many a strong volunteer has flaked as a result of such a tiring process. Sufficient numbers of volunteers are essential and adequate breaks should be planned into the schedule; this will reduce the possibility of standards slipping as well as avoiding dangerous errors and mistakes. Piling is very difficult to remove and requires specialist equipment - it is best to get it right first time!

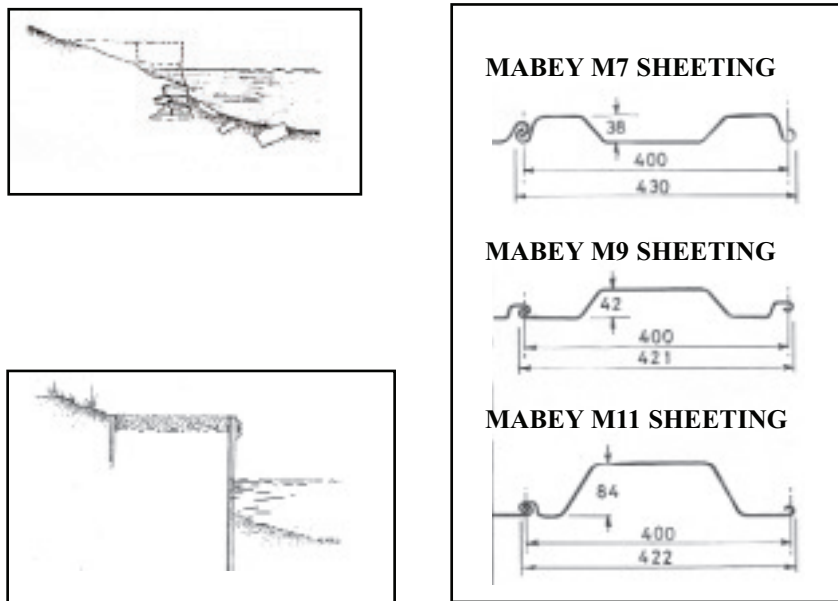
- 2.2 Where the piling forms part of a structure (cills, embankments, etc.) it is essential that the correct design calculations are made to avoid such embarrassing events as slip circle collapse (don't ask - you don't want to know!). These calculations are outside the scope of this document and are the domain of a civil engineer (The IWA's Honorary engineers can also provide assistance - contact via IWA Head Office) however most manufacturers will provide excellent advice and will design basic structures for you, especially if they think you are about to spend a fortune with them. It is important not to deviate from any design without checking with the designer first.
- 2.3 Piling comes in many sizes and it is the profile that is usually specified. Piles may be so small that a single volunteer can easily lift one into place or they may weigh several tonnes each and require specialist lifting gear. Almost all sizes have been successfully driven by volunteers (even the truly huge Larssen profile) but it is usual for volunteers to work at the smaller end of the market - and it is this technique that this document concentrates on. Although each manufacturer has a different name most profiles are much the same and it is Mabey who are the usually accepted standard for referring to pile profiles. They use M numbers (M11, M8, M7 etc.) to specify the profile and hence the performance specification of each type of pile. They are available galvanised or un-galvanised in various lengths.



- 2.4 One firm (Beaver 84) makes a pile that is wider than normal i.e. fewer piles to a linear metre; these obviously will be quicker to drive (assuming that the ground does not present too much resistance) but are, of course, heavier to move around.
- 2.5 It is worth remembering that although piling should be a dry, "on land" occupation, British Waterways would never dream of attempting a piling job without at least one set of chest waders.
- 2.6 Where towpath piling is undertaken it is also important to consider safe passage past the works for members of the public. Piling is also incredibly noisy and whilst you may be happy to be on site driving piling at 9.00am on a Sunday your immediate neighbours may not be so pleased.

3. PROCEDURE FOR THE SMALL PROFILE PILES (M11, etc.)

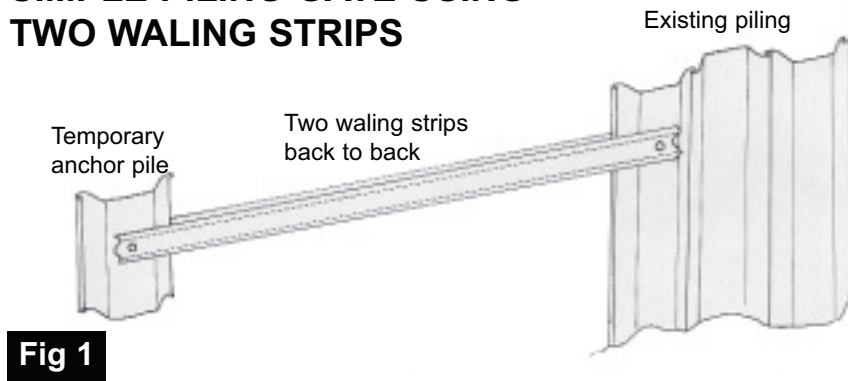
- 3.1 It is essential with any bank piling to make a gate to hold the piles straight when actually driving them. For M11 piles a gate can be constructed using two railway sleepers and two baulks of 6in x 6in timber of about 7ft minimum length. The railway sleepers should be laid parallel with each other, the thickness of the pile apart, plus about 2mm clearance to stop the pile binding. The baulks of timber should then be bolted on top of, and at right angles to, the railway sleepers. To use the above, you will need at least four strong navvies, or eight weaker ones. For piles with smaller profile than M11, i.e. M7, M8 etc. a gate of lighter construction may be sufficient. One simple technique for a gate is to use two sections of waling (qv) back to back. One end is bolted to the end of the existing run of piling and the other end is held apart using a short anchor pile to provide the appropriate spacing. Fig 1 shows the technique which is much faster than the conventional timber gate.



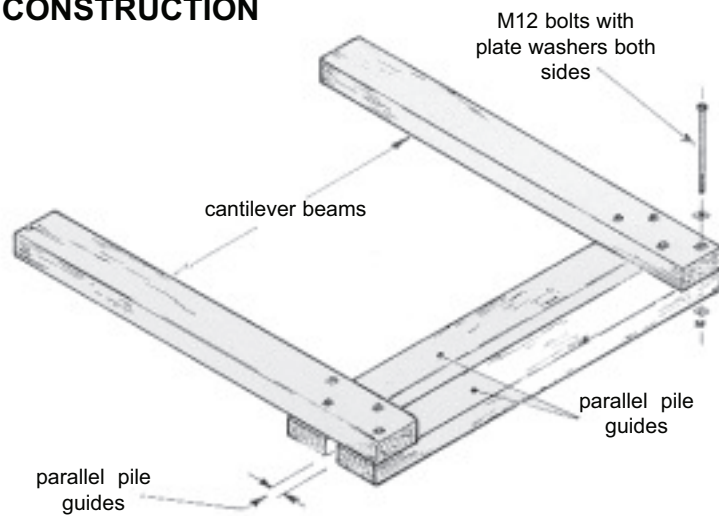
4. MARKING OUT THE SITE

- 4.1 Take a very long piece of string, and then insert a stake either vertically in the canal bed, the distance required from the bank, or horizontally in the canal bank. If a bank wall, or similar, previously existed then it may be worthwhile checking and excavating along the line you wish to follow as it is incredibly difficult to pile through even minor debris. It is possible to push the line of piling further into the channel to avoid such rubble but it is important to ensure that you do not encroach too far into the available channel width.
- 4.2 Tie one end of the string to the stake, and stretch to a similar stake at the end of the length to be piled, or to a convenient length if the string is too short. The run should be as long as possible, or you could get a longer bit of string. (Lasers are no good for this purpose.)
- 4.3 It helps if the string is at the height required, but this is not essential. (Don't trust a string for the height, as it will bow unless tight enough.) Remember, water is the ideal level and it is seriously recommended that if water is not obtainable at the bottom of the piles then a little excavation is done every 10 piles or so to make it obtainable. Other measurements will accumulate errors, water is flat the world over!

SIMPLE PILING GATE USING TWO WALING STRIPS



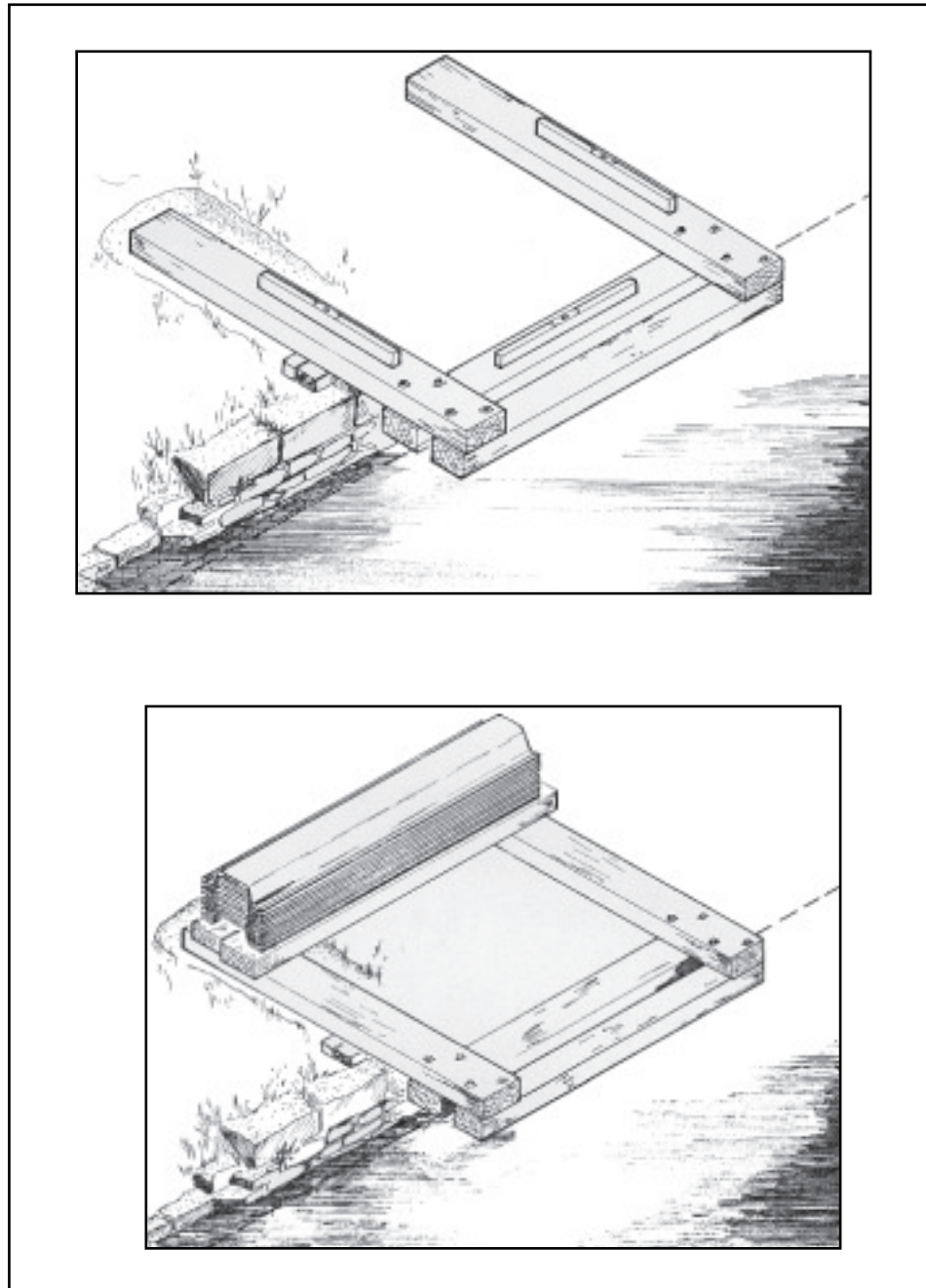
GATE CONSTRUCTION



- 4.4 Lay the gate on the ground with the railway sleepers parallel to the bank. Ease out over the canal until the string is in line with the front edge of the bank-side sleeper. A spirit level should then be used to get the gate horizontal in both planes by means of wedges and chocks. If possible the gate should be set at a lower level than required. If this is impractical, e.g. height of water or bank, then set at about 9in (225mm) above. The final driving to height will then have to be done afterwards.
- 4.5 Once alignment has been completed, a counter-balance should be placed on the baulks of timber at the back of the gate. This may be made up of a number of piles, or other heavy weights, sufficient to stop the gate moving when holding a piling gun and standing on the bit over the canal.

5. LOADING THE GATE

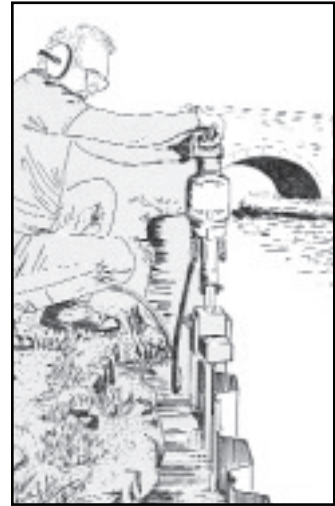
- 5.1 Take the first pile and place it in the gate with the hole at the top, and, in all cases, with the hole nearest the canal so that the waling (edging) can be bolted tight to it. Using the spirit level set the pile dead vertical in both planes.
- 5.2 To keep it vertical use wedges between the pile and the sleepers and waste pieces of timber nailed across the slot in the sleepers tight against each end of the pile. Place cap and piling gun on top of the pile and



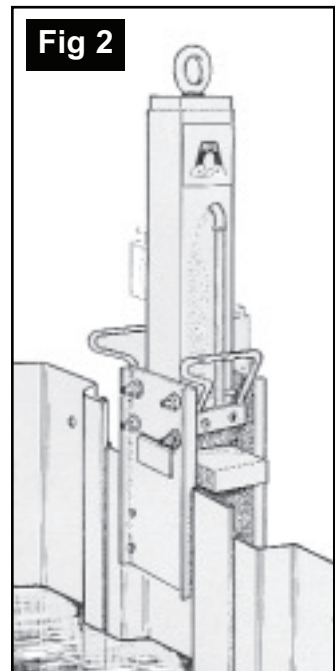
drive two or three inches (50-75mm). An alternative to the wedge technique is the use of “lorry” style ratchet straps. These can be attached to the pile that is being driven (using the hole in the pile) and once the other end is attached to an immovable object (the gate, say) the ratchet can be adjusted to provide just the right amount of tension in the appropriate direction. It is obviously essential that both ends of the strap are fixed securely.

- 5.3 Check again for vertical in both planes. If it has altered use strong bodies or levers to push in the appropriate direction and drive another two or three inches (50-75mm).
- 5.4 Continue this procedure until you have driven about a foot (300mm). If you can't get it right on this one, pull it out and start again - there may be a stone underneath. The authors at this stage would like to point out that it is not advisable to have a swear box on this job as you won't have any beer money left at the end of the day!

- 5.5 Having got the first pile correctly driven down to the correct level, remove the nailed waste timber, and load enough piles to fill the gate, if you are able to safely reach this height. Ensure that the clutches (the curled bits on the side of each pile) are slotted together.
- 5.6 Note that the hole should be at the top of each pile, in case you need to pull it out, but with some types of pile the hole may be at the back of the piling on alternate piles.
- 5.7 Before being driven, each pile should be made vertical by means of wedges and/or pushing. It is usually most successful to drive the last pile in the gate first (i.e. the one furthest away from the existing run of piles) as once this is in vertical it limits the tendency of the others to lean. When the full gate has been driven to height, the gate counter-weights should be taken off, and the gate re-positioned ensuring again that the gate is level in all planes.



- 5.8 The clutch of the last driven pile should be visible in the slot of the gate to ensure that the clutch of the next pile to be driven can be engaged. Repeat procedure as before.
- 5.9 All piles should be checked for vertical after they have been driven two or three inches (50-75 mm) and any corrections made as described above. When the length has been driven, remove gate and, if piles have not been driven to the final level, this can now be done without using the gate.
- 5.10 You may need to use planks to stand on to do this safely. This stage should be done with care, because a piling gun is very heavy to get out of the water after you and it have fallen in! Piling guns also cost a lot of money.



- 5.11 Lucky navvies who do this job sometimes find a dry canal to do it in. You can then use quick-erect scaffold towers in the canal bed to assist in loading the gate. You may even be able to dispense with the cantilevered gate, by laying the sleepers (or just scaffold boards) on the bed of the canal, and holding them in place with stakes. This will control the position of the toe of the pile, but you may find it difficult to find a safe way to control the angle at the top, without having someone standing underneath the piling gun, which could obviously be very dangerous.
- 5.12 Note that piles will usually tend to lean forwards along the line, so it may be an advantage to start by leaning slightly the other way. As a special case of Sod's Law, you may then find that the slope gets progressively worse that way instead!
- 5.13 If the piles are starting progressively to lean along the line, you may be able to recover the situation by loading the gate and driving the last pile first, and then working backwards, to finish with the pile nearest to the leaning ones. You will have to produce a kink in order to remove a large error, so don't let errors get large! You will soon get a feel for exactly how the pile responds to the friction of a pile's clutch on

one or both sides. It is also unlikely that your piling hammer will strike the piling cap, and hence the pile, evenly and so this will also promote any lean that is occurring.

- 5.14 When using the spirit level, make sure you don't hold it across irregularities in the pile, such as curled tops, or blobs of galvanizing. If piles will not drive to level, then the top will have to be cut off.
- 5.15 It can not be emphasized too much that it is essential regularly to check the "big picture" i.e. to stop and walk back to the start of the run and look along the whole length to check you are still heading in the direction you want to !

6. TURNING THE BENDS

- 6.1 This will need to be a series of straight lines, (unless some idiot (sorry, genius) wants to make a curved gate!) Bear in mind that piling usually attracts boats, which require a straight length equal to that of the boat to moor to.
- 6.2 First mark the curve using string and as many stakes as required to obtain an even curve. Set the gate in line with the string as before, using as many piles as will match the string.
- 6.3 The gate does not necessarily have to be filled, but it will be seen that the easiest curve will be one that uses a series of straight lines, each equal to the length of the gate. For sharp bends you will need to put a pile in freehand, and drive to depth, then set up the gate as normal for the next straight section. An alternative technique is to anchor a piece of string in the bank and use it to "draw" a radius for you to follow.

7. ENDING THE RUN

- 7.1 The last two or three piles should be turned in towards the bank to reduce erosion from breaking wash reaching the end of the run of piles, unless there are plans to continue the length at a later date. When turning into the bank the ground is likely to be harder, so it may be necessary to use one or two shorter piles (cut with a Stihl radial saw with metal cutting disc).

8. TIE BARS

- 8.1 Tie bars go through the hole in the pile and through the waling and back to an anchor point in the bank. They consist of a length of 20mm dia. mild steel bar which is threaded at each end. Nuts and washers usually come with the tie bars. The anchor point is usually a piece of pile about 1 metre long (with a hole in the top), depending on the ground it is going into.
- 8.2 Anchor points are required every 5 piles or so. The exact spacing is determined by the spacing of the holes in the waling and it is usual for every other hole in the waling to be used for a tie bar, with the remainder simply being filled with a nut, washer and bolt. The anchor piles are driven into the bank at a distance slightly less than the tie bar, to allow for the nuts, washers and the thickness of the waling.

- 8.3 The anchor point should not be vertical, but angled slightly back from the canal, and its top should be about an inch below that of the pile. This may require some work with a mattock and shovel so that the tie bar can lie correctly without being bowed. It will probably be necessary to remove earth when the anchor is at ground level to allow piling equipment to drive it to level, and also for a hole to be dug to allow access to the hole in the anchor to put the nut on the end of the tie bar.
- 8.4 It is unusual to tie back M11 piles of more than 2 metres in length, as they are intended to be self-supporting if the ground is reasonably firm.

9. WALING AND CAPPING

- 9.1 The waling is the piece of hardwood timber or steel that is bolted to the front of the piling to protect both piling and boats, and also to add rigidity to the piling. Although the act of fitting this waling will pull in minor bulges and even out curves do not expect it to work miracles - get the job right in the first place. The capping, if fitted, is a piece of timber that is usually nailed on top of the waling and resting across the top of the piles. This is mainly decorative, and, of course, is only fitted with timber waling.
- 9.2 Note that metal waling is designed to overlap and it is best to guess the main direction of boat traffic and ensure the overlap is set to minimise any damage to a boat travelling in that direction. Waling can be “pulled in” round gradual corners using the tie rods but sharper corners will require partial cutting through of the waling and then bending round a tree stump or similar.

10. BACK FILLING

- 10.1 If piling has been carried out on an embankment, or where the ground is about the same level as the canal, then the gap between the piles and bank should be filled with clay if possible to make it as water-tight as possible. Clay should be free from rubble and other contaminants, it is also considerably easier to work with in dry powder form but this will depend on your supplier. If piling is at the foot of a bank, the back-fill should be of rubble or similar (so that the bank can drain in wet weather) and the top 2 or 3 inches filled with ordinary soil. If the holes in the piling are more than about 3 inches above water level, then drainage holes about 2 inches dia. should be cut in the piles just above water level and about 6 feet apart. Back filling will settle and the project plan should allow for a return visit some months later to refill and landscape. If the fill is dangerous (i.e. deep mud) then it should be fenced off and signed as dangerous.

11. PLASTIC PILING

- 11.1 This has been a new development and British Waterways and Environment Agency have experimented quite extensively; they found it did not meet their normal requirements - it was difficult to drive and not “boat proof” enough. However, it is recognised that its many advantages; lighter, 100% recycled, longer lasting, cheaper and quieter to drive mean that once it works it will be a very popular technique. And it will be available in a range of colours ! At the time of writing one firm (H L Plastics) claim to have cracked the drawbacks of plastic, working in conjunction with Aldridge Piling equipment (APE) to develop a hammer that drives them. They are based in Derby.

- 11.2 Wooden piling is also a possibility (particularly in high saline canals where corrosion is a worry) but it is very difficult to drive.

12. SAFETY

- 12.1
- Make absolutely certain there are no electricity cables or other buried services in the line of the piling.
 - Take very great care to properly assess the Piling operation with regard to Lifting and Handling. Excessive reaching with heavy loads is a particular risk.
 - **EAR DEFENDERS MUST BE WORN AT ALL TIMES WHEN ACTUALLY DRIVING PILES.** This still applies when the gun has a muffler, or silencer built-in. Goggles are also recommended.
 - When piling, the gun will slide around on the cap. This must be steadied by holding the gun itself. Do not hold the yoke in the end of the gun, and do not steady it by putting your foot on the cap, as yoke shafts occasionally break owing to metal fatigue.
 - Wear steel toe-caps as piles and the equipment are heavy and toes are easily broken, and limping navvies are not so effective.
 - To avoid accidentally pressing the trigger, keep fingers under the lever, or well away from it, when moving the gun.
 - Wear gloves to prevent white finger. Piles are also notorious for having sharp edges and lumps of galvanising. They are also very cold for most of the year.
 - Take care not to over-reach yourself when loading the piles into the gate.
 - Ensure air has been isolated and released before changing/fitting yokes.
 - If flame or other form of heat is used for cutting galvanised piles, beware of fumes. **ZINC (GALVANISING) PRODUCES HIGHLY TOXIC FUMES AND CAN BE VERY DANGEROUS.**

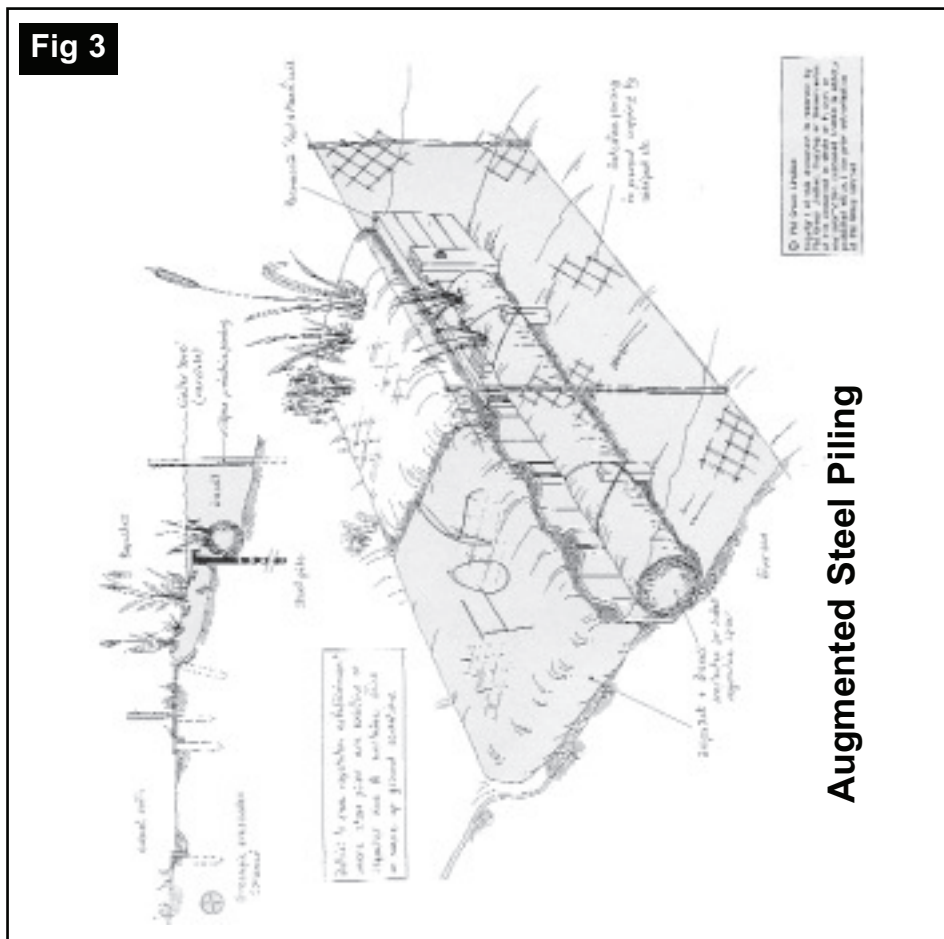
13. EQUIPMENT

- 13.1
- One air compressor of not less than 100 c.f.m. (cubic feet per minute)
 - Air hoses to suit distance required.
 - Piling caps and yokes (also known as dollies and shoes). (Can be hired from Mabey's, who have depots throughout the country.)
 - Air hammers (jack hammers) (may have silencers built-in).
 - Gate, as described above.
 - Assortment of putlogs and crowbars, and sledge hammers.
 - Lubricant for the air hammer (usually hydraulic oil possible including antifreeze in cold weather).
- 13.2 If work is taking place in the Midlands, Aldridge Piling Equipment hire out a very good 2 cwt piling gun which obviates the need for piling caps, yokes, and jack hammers, as it clamps itself to the top of the pile. This hammer is highly recommended by most WRG groups as the safest and most effective machine around. An illustration is given in Fig 2 - page 9.

- 13.3 It has a handle either side for carrying and guidance, and a lifting eye at the top. This would ideally be lifted by a small crane or excavator, but a useful substitute is a scaffold pole as a lever, with the fulcrum on the roof of a narrowboat. If using this, you will require 5 strong slaves, as it gets heavy after a while. Ear defenders are essential when preparing a meal in the galley!

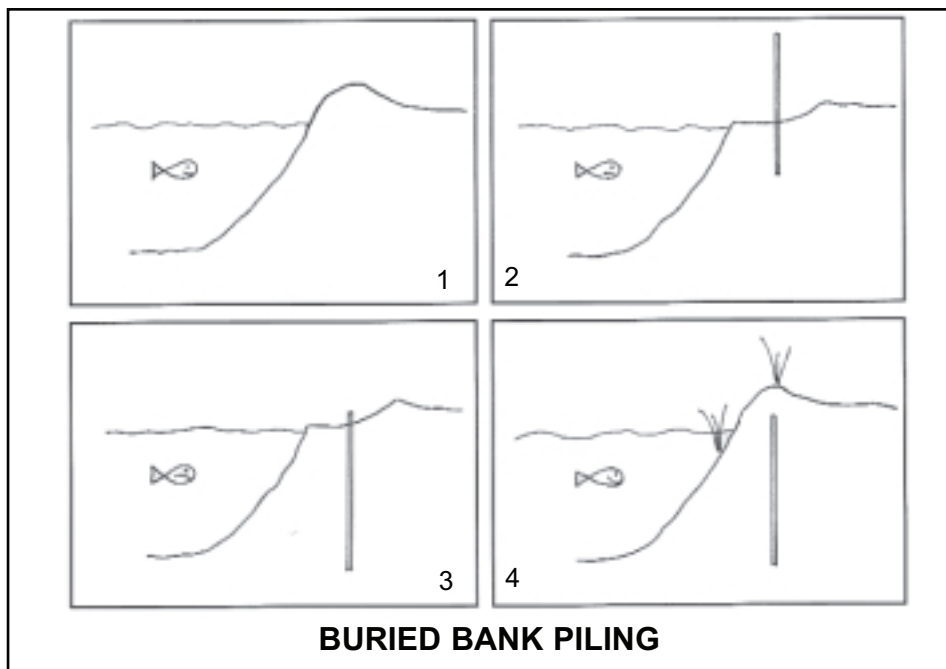
14. ALTERNATIVES

- 14.1 The suitability of these techniques depends on the requirements of the project. Factors such as bank slope angle, drainage requirements, access, erosion, aesthetic and environmental requirements, current and future possible use should all be carefully considered. It must be stressed that one big advantage of many of these techniques over traditional piling is that they permit a more ecologically acceptable solution to the problem of bank protection. Careful use of the techniques described here can result in a system of bank protection that does not harm the existing bio-diversity and can actually promote it. This is particularly relevant in the light of recent legislation (e.g. water voles joining the protected species listing). Each technique has strengths and weaknesses depending on what type of flora or fauna you are trying to encourage. “Pre-seeded” versions of many of the techniques discussed below exist but very careful thought should be given as to whether they are appropriate or desirable. They may well harm the bio-diversity that we are trying to protect and enhance in the first place. In particular alternative techniques should be considered where existing conventional bank protection needs to be enhanced or repaired. Figure 3 (below) shows how steel piling can be augmented and “greened up” by new techniques. One new development being used extensively by British Waterways on the Montgomery restoration is to excavate the bank down to near waterline, pile along the bank to just above the waterline and then replace the bank so that the piling is completely buried in the bank. This gives somewhere for the wildlife to live



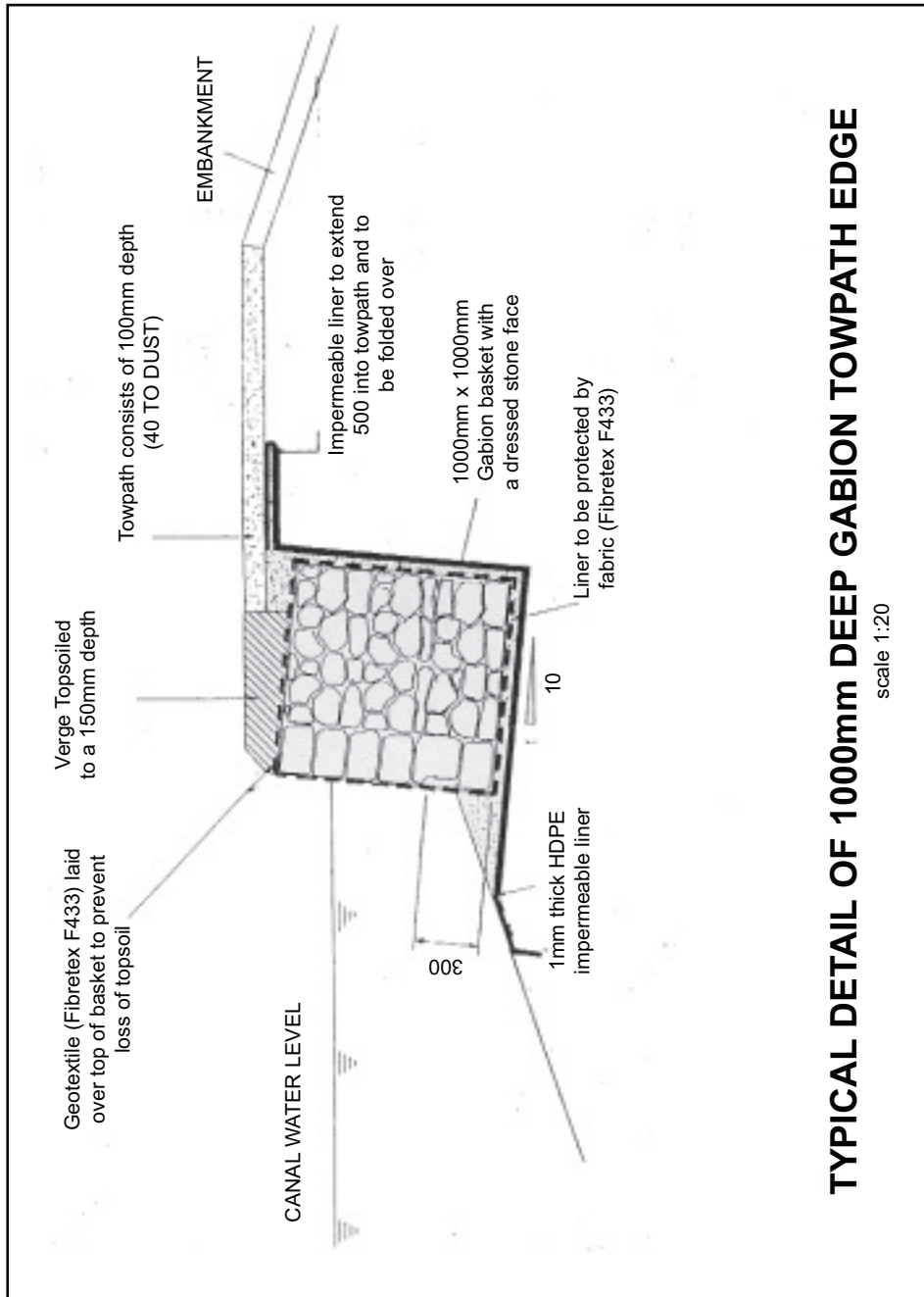
yet still offers many of the engineering advantages of “proper piling”. Aesthetically it is a vast improvement on the steel lined channels so many engineers insist on to minimise maintenance costs and water losses. It also does not encroach on channel width. However it does create a buried hazard and so it is particularly suited to protection of the offside bank. Figure 4 illustrates the sequence. It cannot be stressed too highly that for all techniques involving the construction of a wall or similar (gabions, blocks, bricks, etc.) it is the preparation before the installation that determines the long term success of the construction. For a neat, structural, regular bank edge it is essential that the base upon which the blocks are laid to be well prepared.

- 14.2 **Gabions:** These are simple wire baskets, supplied as a “flat pack”. They are wired together and filled with a stone/earth mix in situ. They are simple to install, effective and, if appropriately designed, green but are labour intensive. Costs depends on fill material which can be selected to be most appropriate to the site concerned. They can be installed with water in the channel but it is certainly recommended that the level is significantly lowered. They are a long term solution as the bank and vegetation grow around it but they are poor for moorings as pins cannot be easily driven. The wire will eventually corrode away and it is essential that vegetation is established before this happens. However this corrosion may well take 50 years or so. Neat laying of stone will minimise collapse when the wire does eventually corrode away. Very flexible as many shapes can be made up from basic boxes. For very hostile environments the wire can be galvanised or even PVC coated. (See Fig. 5, page 15, shows a typical installation specification, note that the gabions are used to hold down a waterproofing liner - a common technique).

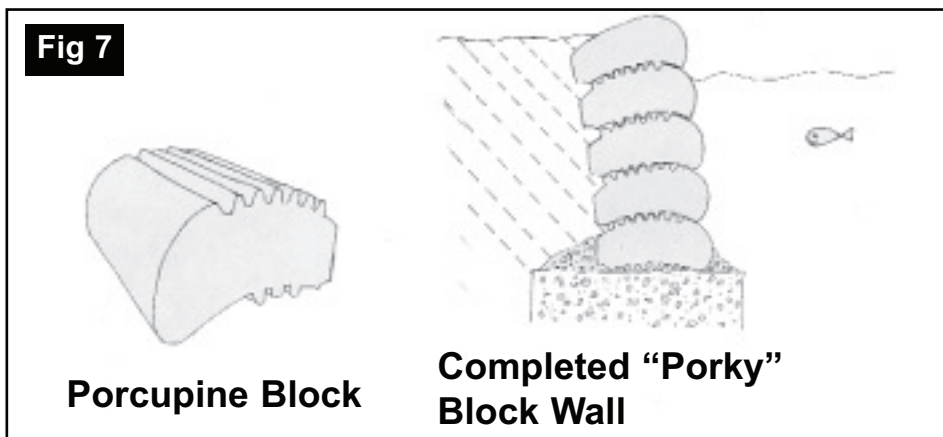
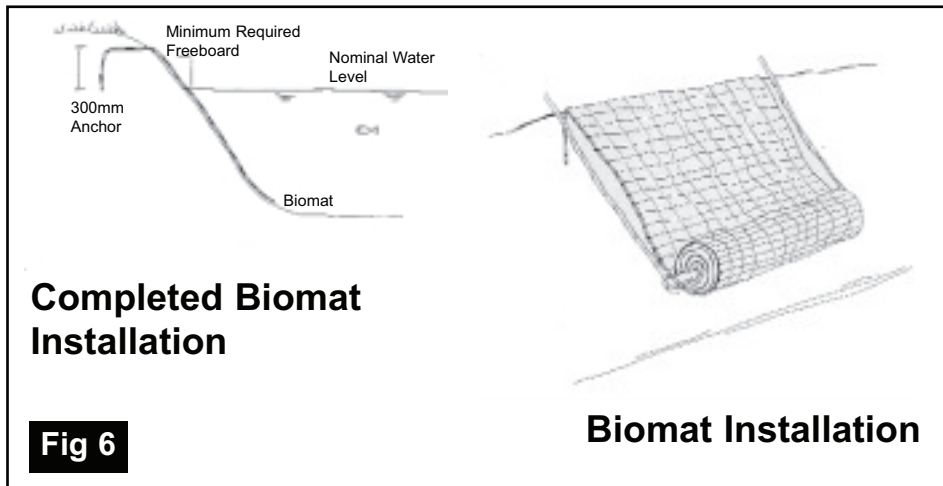


- 14.3 **Biomats:** More properly known as ECRM (Erosion Control Revegetation Materials). These are geotextiles with a very loose weave designed to hold earth and promote vegetation growth. They exist in many different forms and designs. Easy to install (but big rolls mean mechanised handling may be required) but no real strength - it is an erosion prevention technique. It requires at least one growing season without wash to green up and so is not an instant solution. They come in a very wide range of duties from lightweight to very heavy weight. The same technique exists as “rolls” and “mattresses” (they tend to compress down and settle over six months or so, so it is best to order extra). Not green if “preseeded biomat” is used as it will introduce non indigenous species. It can however follow any curve you want and so is the least visible of all the solutions. Some versions are constructed using jute or similar

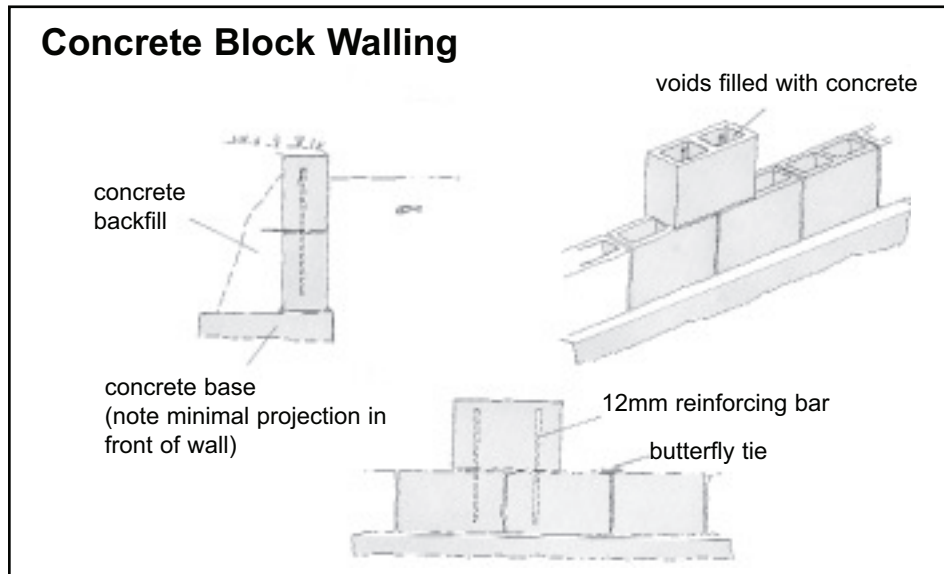
and are designed for the initial mat to decompose over several years leaving only the established vegetation. They are good if installed during a restoration as they actually catch silt and sediment stirred up by other restoration works; this helps build up the bank and keeps the water quality up (see fig 6, page 16). Note that some versions (especially the preseeded types) do require immersion in water within 24 hours of delivery and, once installed, need to be kept covered by approx. 100mm of water for the first growing season. This may present initial handling problems and prevent other restoration works occurring on sections where they are planted for the first few months after installation.



- 14.4 **Armatex:** this technique has the same features as Biomat but requires manual filling of its many hexagonal pockets (usually with soil/seed mix but sometimes a lean mix of concrete is placed first to partially fill each pocket) (also known as honeycomb geotextile).



- 14.5 **Porcupine blocks:** ingenious engineering make these spined blocks very flexible and easy to install by unskilled labour, they can be angled back to suit the bank (7.5-22.5 degrees from vertical) and can form curves (3m min. radius). They are however heavy (26kg each!) and they must be placed on a firm level base (which usually means the expense and inconvenience of draining down and laying concrete). Quite expensive but moderately green as holes can be left for animals and vegetation. Aesthetic appearance is acceptable after a year or two of weathering. Many other versions of this type of “modular construction system” exist but “Porky blocks” seem to be the market leader (see fig 7).
- 14.6 **Sandbagging:** this is an old fashioned technique but can still be effective although its appearance is not the most desirable. Bags can be filled with either concrete (structural solution) or soil (environmental solution). It has significant mass and so can be structural but only if it has a firm and stable base.
- 14.7 **Concrete blocks:** closely allied to the sandbagging technique and a dear favourite of early works on the Stratford Canals. The hollow blocks are laid as brick bond and reinforcing rod is placed vertically through the perforations in the block. Wet concrete is then poured into the gaps. It is also usual to backfill with concrete. Where it cannot be seen this is an acceptable (and fast) technique but again it requires a structural base; however where a durable vertical wall is required it is a solution. It is also intrinsically waterproof once backfilled.
- 14.8 **Brickwork:** is, of course, a preferred option to concrete blocks on aesthetic grounds (it is also better for long term maintenance reasons). But it too requires a firm base and is the most skilled type of bank protection. It is also waterproof once backfilled.



- 14.9 **Stone walling:** this may be an appropriate local solution. For further details see IWA Practical Restoration Handbook "Towpath Construction".
- 14.10 **Willow screens ("revetments") and other such olde worlde stuff:** there is still a place for these techniques, particularly in this overengineered world that the navigation authorities seem to want us to inhabit. For further information Chaplin has a lot of ideas and this book is recommended as further reading. Phi Group Ltd also have considerable experience in the "revetment" field.
- 14.11 **Waterproof lining:** although not strictly bank protection this may well need to be considered as even seemingly solid banks with no need for conventional bank protection can be eroded by a leak causing a costly and inconvenient breach. The two main options are the traditional puddle clay - machine intensive for large expanses and reliant on materials being available, but very suitable for small patches installed manually by volunteers. Two tips - firstly; always dig out more than you think you need i.e. until you can be absolutely sure that you have reached continuous existing puddle and secondly; work the new clay very well (known as punning) either by excavator bucket or by good old fashioned puddling boots. The second main option is a flexible liner. Butyl Rubber (usually 1mm) is used for maximum flexibility whereas cheaper but more rigid High Density Polyethelene (HDPE - 2.5mm) is used for straighter, simpler runs. They are produced in sheets up to 15m wide and if a longer run is required they are welded together in-situ using an electric "waffle iron". Both types need to be installed in clean, dry conditions and while it has been proven that volunteers can install flexible liners (Aston Nature Reserve is entirely lined in Butyl Rubber) it is often installed by professionals. The liners can be keyed into existing and new structures but this must be designed by a competent designer. Liners also need protection from boat collisions, boat poles, herons, voles, fisherman, etc.

15. SUPPLIERS (listed in alphabetical order):

Hire/supply of piling equipment:

Aldridge Piling Equipment (Hire) Co. Ltd.,
Conduit Road,
Conduit Industrial Estate,
Norton Canes,
Staffordshire.
Tel: 01543 277680

Suppliers of steel trench sheeting:

British Steel Narrow Strip (Offices all over the country),
Ayrton Steel Products,
Whitehead Works,
Mendalgief Road,
Newport,
Gwent.
NP7 2WX
Tel: 01633 244000

Beaver 84 Ltd (Offices all over the country)
Beaver House
Crompton Close
Basildon
Essex
SS14 3AY
Tel: 01268 530888

Mabey Ltd. (Offices all over the country)
Head Office
1 Railway Street
Scout Hill
Ravensthorpe
Dewsbury
W. Yorks.
WF13 3EJ
Tel: 01924 460601

SGB Groundforce (Offices all over the country)
Dolphin House
Windmill Road
Sunbury on Thames
TW16 7HT

Suppliers of alternative products

Butyl Products - Waterproof liners (including installation)

11 Radford Crescent

Billericay

Essex

CM12 0DW

Tel: 01277 653281

HL Plastics - Plastic piles

Duffield Road Industrial Estate

Little Eaton

Derby

DE21 5EH

Tel: 01332 832389

Maccaferri-Gabions, ECRM, Geotextiles etc.

7400 The Quorum

Oxford Business Park North

Garsington Road

Oxford

OX4 2JZ

Tel: 01865 770555

MMG - Porcupine blocks, ECRM, Geotextiles, etc.

St Germans

Kings Lynn

Norfolk

PE34 3ES

Tel: 01553 617791

Phi Group - Gabions, ECRM, Modular Construction Systems, Geotex, etc.

Harcourt House

Royal Crescent

Cheltenham

Glos.

GL50 3DA

Tel: 01242 510199

www.phigroup.co.uk

16. FURTHER READING

Any or all of the above manufacturers' free catalogues and guides. In particular Maccaferri, MMG and Phi Group produce excellent literature (including installation guides) and are very helpful.

“Waterway Conservation” Peter H. Chaplin published by Whittet Books ISBN 0-905483-72-3.

“Waterway Architecture - an economic return from conservation” Inland Waterways Amenity Advisory Council, 1985.

Illustrations by Keith Wilcox and Mike Palmer.

Except Figure 3 copyright Phi Group Ltd.

IWA “Towing Path Policy Document” and
“Towpath Construction” - IWA Restoration Handbook
Inland Waterways Association
3 Norfolk Court
Norfolk Road
Rickmansworth
WD3 1LT