



**CHATOYER**  
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# ANCHORING GUIDE



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SPILL RESPONSE / CONTAINMENT & BUNDING / STORM WATER MANAGEMENT  
SILT & SEDIMENT CONTROL / MARINE CONTAINMENT / SPILL RECOVERY

## INTRODUCTION

The installation and anchoring of floating booms or baffles can often be challenging and can be an area of uncertainty. As a manufacturer of silt curtains, booms and baffles, Chatoyer Environmental has had significant experience working with installers and clients in their deployment of floating systems.

Based on our experience, this document is an summary of methods for anchoring floating booms and baffles within closed waters. We provide an overview on the varying types of bank moorings and anchors, anchors effectiveness and some general rules when anchoring with the various methods.

Anchors are used in the installation of floating booms or baffles to ensure they are held in a steady position within the waterway. Given the dynamic nature of water, this position will never be static and the anchoring system needs to allow for flexibility and movement around this position. There are a number of different load factors that will affect the anchoring force required. These include hydrodynamic forces such as tidal rise and fall, current flow, wind gusts and wave action. Further, the cross sectional area of the submerged curtain, boom or baffle will affect the horizontal force load placed on the floating architecture. Finally, the degree of anchoring will also be affected by the permanency of the installation. We trust the overview below will assist in achieving a successful deployment.



## BANK MOORINGS

Floating booms and baffles will most often need to incorporate a set of bank moorings or land anchors to secure the containment system. These land based anchors can be constructed using a number of different methods that will vary to best meet the anchoring load requirements and the required permanency of the installation.

In the case where the water conditions for the deployed boom or baffle does not require strong or permanent anchoring, the mooring rope or chain running from the end of the floating boom can be tied around a solid object on the bank. This can be a natural tree or stump, but more commonly, a post or star picket is hammered into the bank (Figure 1) to form an "X". Under this anchoring design, the mooring rope or chain is looped around the 'crossing' making it secure under low strain. This method provides a fast and effective bank mooring for short term projects and are very popular for silt curtain deployments.

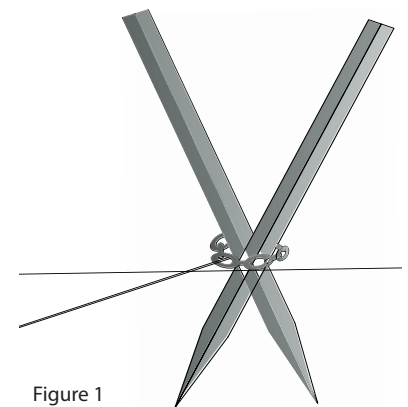


Figure 1

For more permanent bank moorings, there are a series of techniques that can be used to secure the floating boom or baffle to the bank. The type of mooring used should take into account tidal movements and of course the anticipated force load. Most permanent moorings involve some civil works to be completed and should be implemented as part of a wider project.

With respect to low tidal ranges, such as floating lagoon baffles, a Dead Man Anchor (Figure 2) or an Anchor Post (Figure 3) secured by concrete and dug into the embankment are the most common approaches. These bank moorings can be further reinforced using either a Screw Anchor or a Flat Plate as shown in Figure 4.

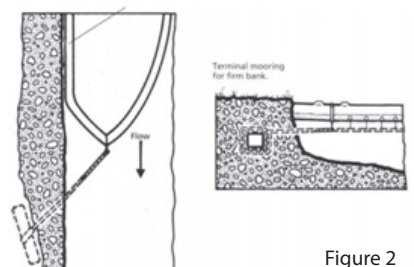


Figure 2

Where tidal ranges do need to be taken into account, a Tidal Riser attached to a solid state can be implemented. Tidal Risers can take on different forms to achieve a similar outcome, but a traditional Tidal Riser is pictured in Figure 5.



Figure 3

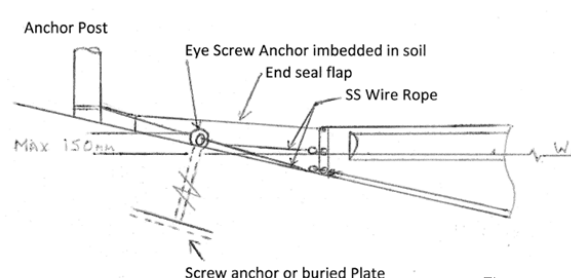


Figure 4



Figure 5

## SEA/RIVER BED MOORINGS

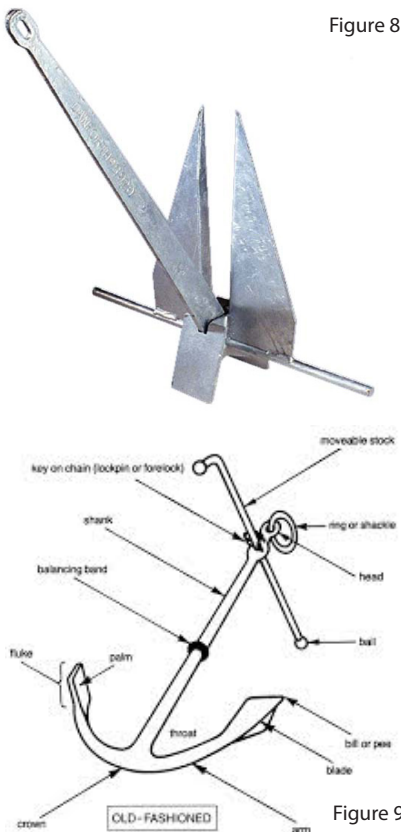
For longer lengths of floating boom or silt curtain, moorings within the waterway will be required to maintain the system in position. The anchoring strength of these sea or river bed anchors need to exceed the calculated force being placed on the boom while in operation. Consideration must also be taken of the composition of the sea floor as different materials will require different anchor systems. Below is a snapshot of three different forms of water based anchoring systems for either permanent or temporary moorings.

## DEAD WEIGHT ANCHOR

A Dead Weight anchor is generally any object with a large weight that relies solely on its weight to anchor the floating boom or curtain. Due to the necessary weight that these anchors must be, they are often used for more permanent installations as they need to be deployed and retrieved with a crane or other mechanical device.

Due to the buoyancy of items within water, it is essential that a factor of 10 or more is applied to the anchor weight in order to deliver the correct anchoring force. For example, if 300kgf is required for anchoring purposes, then at least a 100kg Dead Weight will need to be used. This type of anchor could take many forms and include iron sinkers (Figure 6), concrete blocks (Figure 7), sand bags or old train wheels to name a few.

As a Dead Weight anchor rests on the bottom of the sea or river bed and achieves its anchoring function purely through weight, the composition of the sea floor is not overly important but suction into the seabed may increase if the anchor become buried in softer material such as mud or soft sands.



## DANFORTH ANCHOR

The Danforth Anchor (Figure 8) is was designed by Danforth in the 1940s for ease of handling and rapid deployment due to its light weight and compactness. It is therefore suitable for temporary anchoring.

As the anchor relies on two triangular flukes to bury themselves, this anchor type is used in soft floor environments such as mud, sand and clay. The anchor should generate more anchoring force as the floating object pulls on it.

In environments with high tidal ranges and therefore varying flow directions, the Danforth Anchor will not be suitable as the flukes will not be under tension when the flow is reversing.

## ADMIRALTY/BOAT ANCHOR

The Admiralty or Boat Anchor (Figure 9) is used on hard or rocky floors. When the anchor lands on the bottom, it will generally fall over parallel to the seabed. As tension is applied to the anchor, it will drag along the bottom and with one of the flukes catching where possible.

Smaller Boat Anchors can be easily used for temporary silt curtain deployments.



## ANCHOR HOLDING STRENGTH

Danforth and Boat Anchors form the best means of mooring in flowing waterways, a typical anchor package is shown in Figure 11. Concrete Blocks and Iron Sinkers also make convenient and reliable mooring points, however the reliability of these anchors is dependant on their weight in air being at least ten times the expected load, to compensate for their reduced weight in water.

The exact holding power of anchors is difficult to calculate; The Boat Anchor works better on rocky bottoms and the Danforth is more effective on sand and mud substrates. If the water bed is extremely soft, Danforth Anchors may not be effective and the use of a Dead Weight could be preferable. The approximate holding power of Danforth type anchors in various sediment types is given in the table below.

### DANFORTH ANCHOR

Anchor Weight (kg)	Holding Strength (kg force)		
	Mud	Sand	Clay
15	200	250	300
25	350	400	500
35	600	700	700

### CONCRETE ANCHOR

Anchor Weight in air (kg)	Max Holding Strength (kg Force)
300	100
900	300
3000	1000



## MOORING ROPE

A mooring rope connects the end of the boom with the anchor. The length of the mooring rope between boom and anchor should be approximately five times the maximum water depth. In tidal waters, the depth of water at high tide should be taken into account. It is recommended that a floating buoy be attached to the end of the mooring rope near the floating boom connection. This provides an anchoring buffer in tidal ranges or where the flow velocity puts additional strain on the anchoring system.

It is important to ensure the mooring rope is not too long. If the mooring rope is too long, its elasticity may allow the boom to move outside its profile. If this occurs in the flow of current, the drag forces will cause the boom to form a deep cusp (Figure 10).

The centre of the cusp, which is located away from the shoreline can cause the contained contaminants to collect in the area with the fastest current. This is likely to allow the containments to escape through the entrainment and/or drainage. In turn, this causes additional loading and stress on the boom which may lead to failure.

If the mooring rope is too short the boom can be dragged beneath the water. The anchor may be 'tripped' out (Figure 11) because the mooring rope will not stay horizontal. The chain/rope running off the anchor needs to be as horizontal as possible.

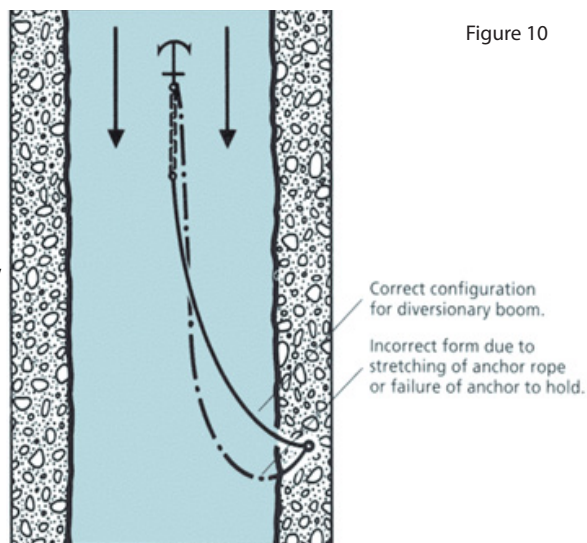
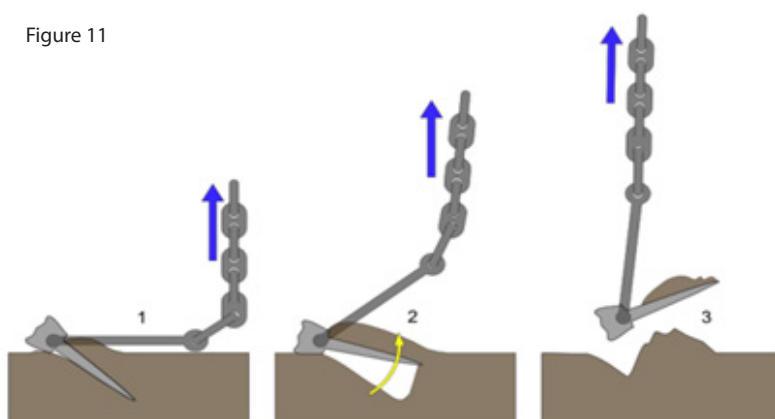


Figure 10

Figure 11



## ANCHOR SET UP

The insertion of a buoy in a mooring rope helps to maintain horizontal pull on the boom, thereby reducing the tendency to submerge the leading boom module. The distance between boom and buoy should be about a quarter of the water depth. Figures 12 & 13 show the general arrangement of this type of mooring.

A clump is a weighted sinker that keeps the chain pulling off the anchor horizontally, this ensures the anchor stays embedded in the ground. Figure 12 shows a mooring rope connected to a ballast chain, this practise is more common in ocean boom anchoring where the sea state is heavier.

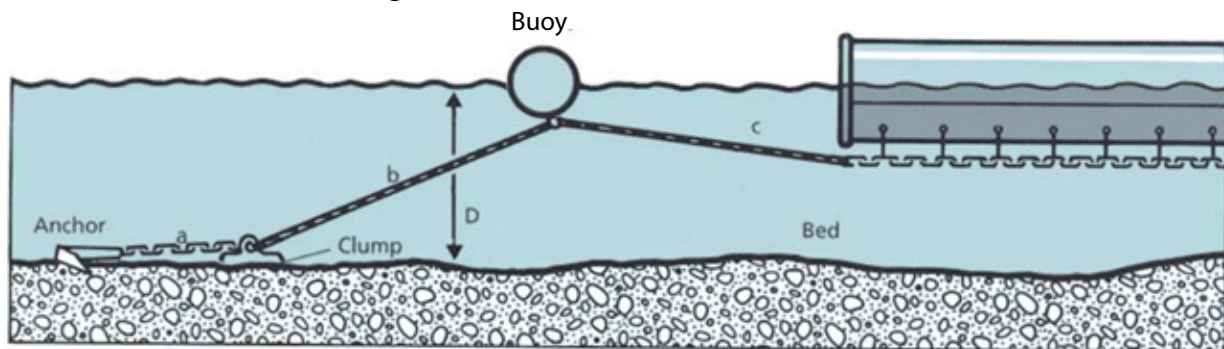


Figure 12

$D = \text{water depth (max)}$   
Chain  $a = D/4$     Rope  $b = 5D$     Rope  $c = D/4$

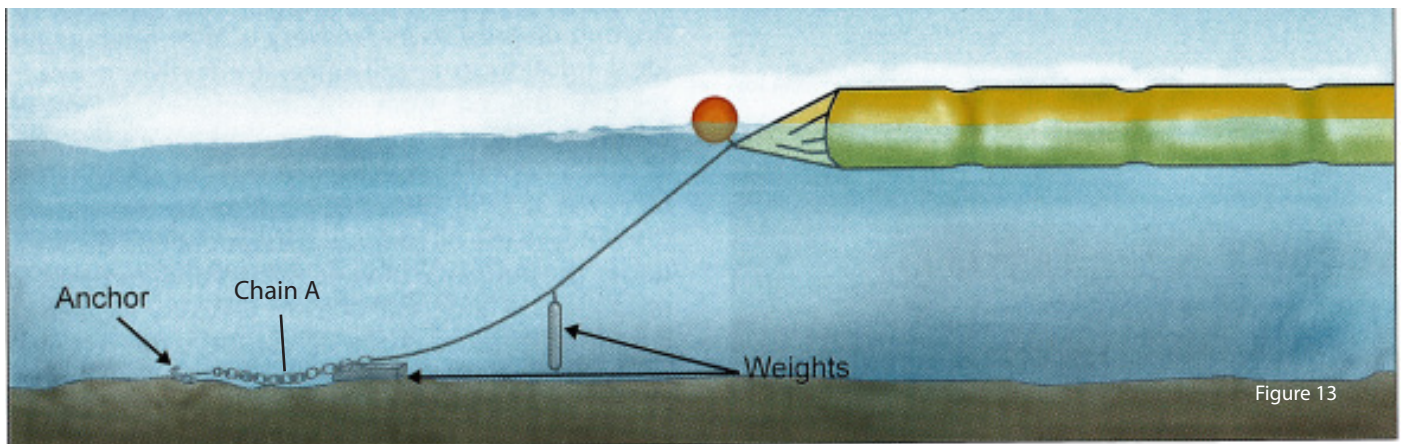


Figure 13

The set up shown in Figure 13 is to be used when implementing a Concrete or Iron Weighted Block instead of a Danforth or Boat Anchor. In this instance, there would be no need to keep chain A (Figure 13) horizontal, the Dead Weight and chain could be removed from the anchoring system; the remainder of the rules would still apply.

## ANCHORING IN A POND

The installation of a Floating Baffle or other floating architecture within in a lined pond will require a different form of anchoring so as to not damage the liner. Concrete anchoring blocks will naturally move minimally under the water which will result in the edges or roughness of the concrete damaging the liner. A common approach to anchoring in lined ponds is to deploy rubber tyres filled with concrete (Figure 14). The rubber casing will decrease the potential damage from concrete rubbing against the geomembrane.



Figure 14

## DISCLAIMER

The information contained in this document has been prepared by Chatoyer Environmental. While all efforts are taken to ensure this document is true and correct Chatoyer Environmental takes no responsibility for installation or anchoring of curtains, unless we have specifically been contracted to do so. This document is provided as an overview of possible anchoring techniques and is not a Manual or provision of instructions on how to anchor floating booms or baffles.

Please contact Chatoyer Environmental and we will assist directly or forward you to one of our qualified install Contractors.

## REFERENCE SOURCES

Response to Marine Oil Spills, 2nd Edition, The International Tanker Owners Pollution Federation Limited (ITOPF)  
Unique Challenges of booming fast flowing rivers by Carl J Oskins DOWCAR Environmental Management



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