1 Erosion control matting

1.1 Introduction

Erosion control matting, also known as rolled erosion control products or erosion control blankets, provide a temporary soil stabilisation solution which involves applying a mat or blanket made from either organic or synthetic material to the soil surface to protect against erosive forces (Caltrans 2003, ECTC 2008).

In foreshore restoration projects, erosion control matting is generally combined with revegetation to provide long-term bank protection and can be used to enhance a variety of other stabilisation techniques (refer to 1.7 Case Studies).

This section provides an overview of erosion control matting, the products available, selection considerations, costs and best practice guidelines for installation. As with all restoration techniques applied in areas along the foreshore, the application of the appropriate material will depend on the specific site conditions, so stabilisation approaches will vary in each circumstance.

Figure 1 Erosion control matting installed prior to installation of brush mattressing, Prisoners Point (left), and coir mesh used to protect revegetation at a restoration site in the Swan Riverside Regional Park (right)

1.2 Description

Erosion control matting is generally supplied in rolls, typically 2 m wide by 25 m long, designed to be laid over a prepared surface and anchored to the ground with staples or pins to hold soil in place while vegetation establishes (ECTC 2008, USACE 1997b).

Suitable erosion control products that allow light and water penetration can be rolled over a prepared native seed bed or seedlings can be planted into the matting once it has been correctly laid and secured to the ground.

This foreshore stabilisation technique is generally affordable and easy to install, and will provide a short-term solution to erosion if used correctly. However, in most foreshore areas requiring stabilisation it is important to consider incorporating other techniques, such as bioengineering, into the design to provide sufficient foreshore protection to allow for longer-term solutions to establish, such as revegetation.

Erosion control matting comes in many forms, and therefore can be used for a variety of different applications. In general, different types of matting are described based on the density and type of material they are composed of. This is discussed in greater detail below.

1.3 Purpose and Application

The fundamental purpose of erosion control matting is to provide temporary protection against erosion and facilitate vegetation establishment. Other benefits provided by certain erosion control products include limiting sediment entering the waterway, weed suppression, conserving soil moisture, and promoting seed germination and seedling growth. It should be noted that erosion control matting is not a suitable medium to long-term bank stabilisation technique on its own.

Erosion control matting can be used in foreshore stabilisation projects under the following conditions (WDFD 2003):

- Where predicted site conditions do not exceed the performance thresholds of a selected erosion control product (refer to the manufacturer's specifications).
- Where loose soils have a high potential for erosion during anticipated surface water runoff or stream flow.
- Where revegetation requires added protection from erosive forces to establish.
- Where hard stabilisation techniques require a bedding or filter layer to provide added protection.

Source: Syrinx Environmental PL (2012)

Figure 2 Erosion control matting (jute) and native planting with incorporated bioengineering, Success Hill, Town of Bassendean (Syrinx Environmental, 2012)

1.4 Products

There are many different types of erosion control matting available and selection must ensure that the product is suitable for the specific application and the site conditions (slope, channel, flow velocity) (Caltrans 2003, WRC 2001a).

Broadly, erosion matting is divided into two types, biodegradable or non-biodegradable, and comes in various thicknesses, suitable for different applications and site conditions.

Biodegradable products are made from natural fibres such as jute, coir or photodegradable synthetics and are designed to last 3–36 months depending on the material they are made from and site conditions (ECTC 2008, WDFD 2003). 100% biodegradable products are preferred for bank stabilisation and revegetation in natural areas and tend to function better than synthetics due to their ability to break down, absorb moisture, and create favourable growing environments for plants (F&A 2000b, WDFD 2003).

Non-biodegradable products are made from synthetic material and can last up to 10 years depending on site conditions (WDFD 2003). Caution should be taken when using certain synthetic erosion control products as they can pose an entrapment risk to aquatic fauna and the local environment as they break down.

Consideration should be given to the expected design life of the erosion control product and whether this complements the site conditions and expected design life of the overall foreshore stabilisation project being implemented. Both types come in various densities - from open weaved materials which can be used to help minimise erosion around existing vegetation to densely matted materials which can be used, for example, in wet areas without breaking down as rapidly.

Table 1 lists the types of erosion control matting available, the application and limitations for each product for foreshore restoration projects. For additional information refer to the manufacturer's specifications or seek advice from the Trust or an environmental consultant.

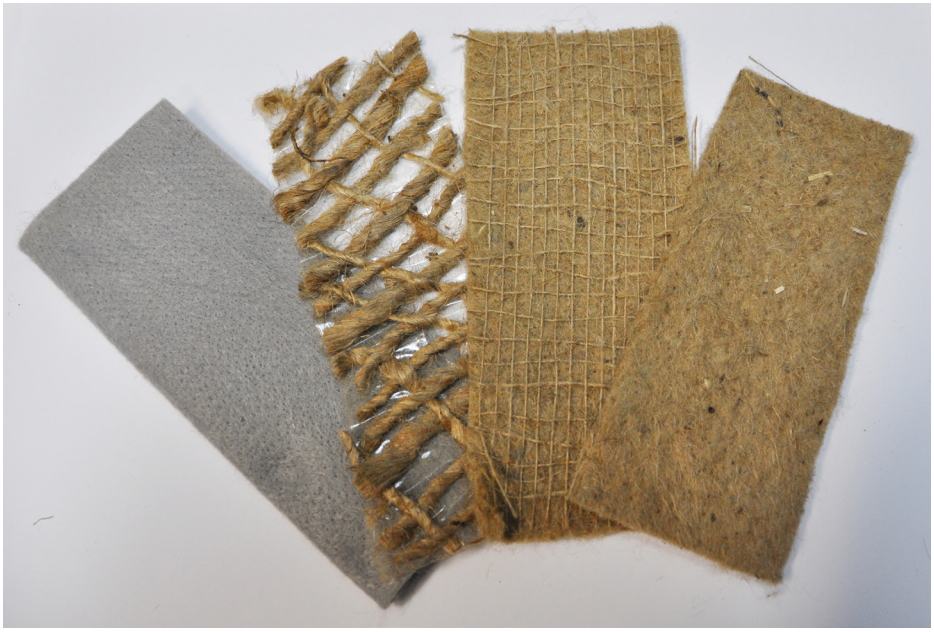


Figure 3 Erosion control matting commonly used in foreshore restoration projects in the Swan Canning Riverpark, from left Bidim® geofabric, coir mesh/coir netting, fine jute mat and thick jute mat

Table 1 Erosion Control Products

	PRODUCT DESCRIPTION	APPLICATION	LIMITATIONS	COST (SUPPLY ONLY)
Non-biodegradable erosion control products	**Plastics (including plastic sheeting, netting or mesh)**	Plastic sheeting: covering stockpiles or small graded areas for short periods of time. Can be used to divert runoff away from/ over embankments. Effective for short-term emergency slope protection Plastic netting and mesh: securing loose mulches to soil surfaces to establish vegetation. **Plastic netting and mesh should not be used in aquatic environments** Recycle products where possible	**Plastics are not suitable for waterway or wetland restoration projects.** Plastic sheeting results in 100% runoff and may cause erosion problems in areas receiving increased flow. The banks of water bodies require permeable material to enable through-flow Plastics are easily vandalised, photodegradable and can be hazardous to aquatic fauna, avifauna and river users These products should only be used for temporary protection and need to be removed before they may break down **Seek advice from the Swan River Trust before using any of these products**	Plastic sheeting $1-$2/m^2 $20-$30 per roll (2 m x 20 m)
	Bonded synthetic fibres Three dimensional geomatrix nylon (or other synthetic) matting which typically has more than 90% open area to facilitate root growth	Generally used for drainage outlets or swales which are to be vegetated with shallow rooted plants or on steep slopes as a temporary stabilisation method Its tough root reinforcing system anchors vegetation and protects against hydraulic lift and forces of high volume discharges Can be a cost effective, temporary substitute for hard bank protection measures such as rock rip rap	More expensive and labour intensive When using these products for temporary bank protection they will need to be removed and replaced before they may break down, which can be difficult once vegetation has established Less desirable in natural environments and not suitable for use in conjunction with revegetation projects which include deep rooted, woody plants Synthetic matting is not recommended for areas where the vegetation (eg grasses) will be mowed **Seek advice from the Swan River Trust before using any of these products.**	$5.50-$8.00/m^2 Matting dimensions vary depending on the product

	PRODUCT DESCRIPTION	APPLICATION	LIMITATIONS	COST (SUPPLY ONLY)
Non-biodegradable erosion control products	**Geofabric** Woven or non-woven polypropylene fabric Some common names for this product include Geotextile, Bidim®, Elcomax®	Suitable for high traffic areas with revegetation where jute is not suitable i.e. estuarine intertidal areas with low to moderate hydraulic wave impact. The matting is strong enough to be used on steep slopes and channelised flow and can be cut and planted into This product is also used as a substrate filter cloth with a number of hard bank protection measures	Cutting into the blanket to provide holes for planting can be difficult and time consuming Geofabrics can limit the natural recruitment of vegetation and be restrictive to plant growth as the plants mature Can be more expensive than biodegradable products, depending on the thickness of the product Runoff can occur beneath the geotextile eroding bed materials Use should be limited to rock revetments or toe protection of riverine environments	$1.50–$3.50/m^2 Matting dimensions vary depending on the product
	Combination synthetic and biodegradable erosion control products Consists of biodegradable fibres (wood, jute or coconut fibre) with a heavy propylene net stitched to the top and a high-strength continuous filament geomatrix or net stitched to the bottom Some common names for this product include Biosynthetics and MaxBio™	Designed to stabilise the soil while vegetation establishes and suppresses weeds while allowing water and some light (depending on the thickness of the mat) to penetrate	These products are not recommended for river restoration projects The biodegradable component of the matting will break down over time leaving the non-biodegradable netting component of the matting *in situ* which can be hazardous to aquatic fauna, avifauna and river users The plastic netting will need to be removed as the product breaks down. This can be difficult and will disturb the revegetation works **Seek advice from the Swan River Trust before using these products**	MaxBio™ $3.50/m^2 Matting dimensions vary depending on the product

	PRODUCT DESCRIPTION	APPLICATION	LIMITATIONS	COST (SUPPLY ONLY)
Biodegradable erosion control products	**Jute mat** Jute mat is a natural fibrous yarn product, in which the jute fibres are needle punched into a biodegradable mat Available in various sizes, thicknesses and material densities	Designed to stabilise the soil while vegetation establishes and suppress weeds while allowing water and some light (depending on the thickness of the mat) to penetrate Can be cut easily to provide holes to planting of tubestock Product lifespan varies from 6 to 36 months depending on thickness and density of material	Generally not resilient enough for channelised flow with a conservative maximum slope 1:2. Not suitable for moderate to high traffic areas or intertidal areas As with many biodegradable products, constant inundation, physical abrasion, microbial activity and UV exposure increase the decay of the matting Ensure any sewing, netting or adhesive material used to produce the jute mat is 100% biodegradable	$2.70-$3/m^2 $100 - $130 per roll (1.8 m x 25 m)
	Coconut/jute fibre mesh A thin permeable membrane made from coconut or jute fibre that is spun into a yarn and woven into a biodegradable net Also known as coir mesh, coir netting or jute mesh	Designed to stabilise the soil while vegetation establishes. Sunlight and water can penetrate the mesh allowing native plants to germinate More durable than Jute mat in harsh environmental conditions and can be cut easily to provide holes for planting or can be direct seeded	Not recommended for sites affected by high surface flows, wave action or tides as soil can be lost through the holes of the mesh. Jute matting may be more suitable Does not suppress weeds Direct seeding on the foreshore will not be practical as flow and tide can wash seeds away	$1.70-$2/m^2 $85-$100 per roll (2 m x 25 m)

	PRODUCT DESCRIPTION	APPLICATION	LIMITATIONS	COST (SUPPLY ONLY)
Biodegradable Erosion Control Products	**Curled wood fibre** Blanket machine-produced mats of curled wood fibres with the top surface of the covered with a photodegradable extruded plastic mesh Also known as Excelsior Blanket	Designed to stabilise the soil while vegetation establishes and suppress weeds while allowing water and some light (depending on the thickness of the mat) to penetrate	These three products are not recommended for waterway or wetland restoration projects Although these products claim to be biodegradable, generally the wood fibre, straw or coconut fibre component of the matting breaks down first, leaving the photodegradable plastic mesh which can be hazardous to aquatic fauna and can be difficult to remove from the site without disturbing the revegetation works **Seek advice from the Swan River Trust before using any of these products**	$2-$5/m^2 $120-$140 per roll (2 m x 25 m)
	Straw blanket Machine-produced mats of straw with a lightweight biodegradable netting top layer. The straw is attached to the netting with biodegradable thread/glue strips			
	Coconut fibre blanket (coir blanket) Machine-produced mats of 100% coconut fibre with photodegradable netting on the top and bottom. Fibres attached to the netting with biodegradable thread or glue			

Source: Caltrans (2003); WDFD (2003) and various WA suppliers (2012)

Note: Costs sourced from various WA suppliers (2012)

1.5 Design and installation considerations

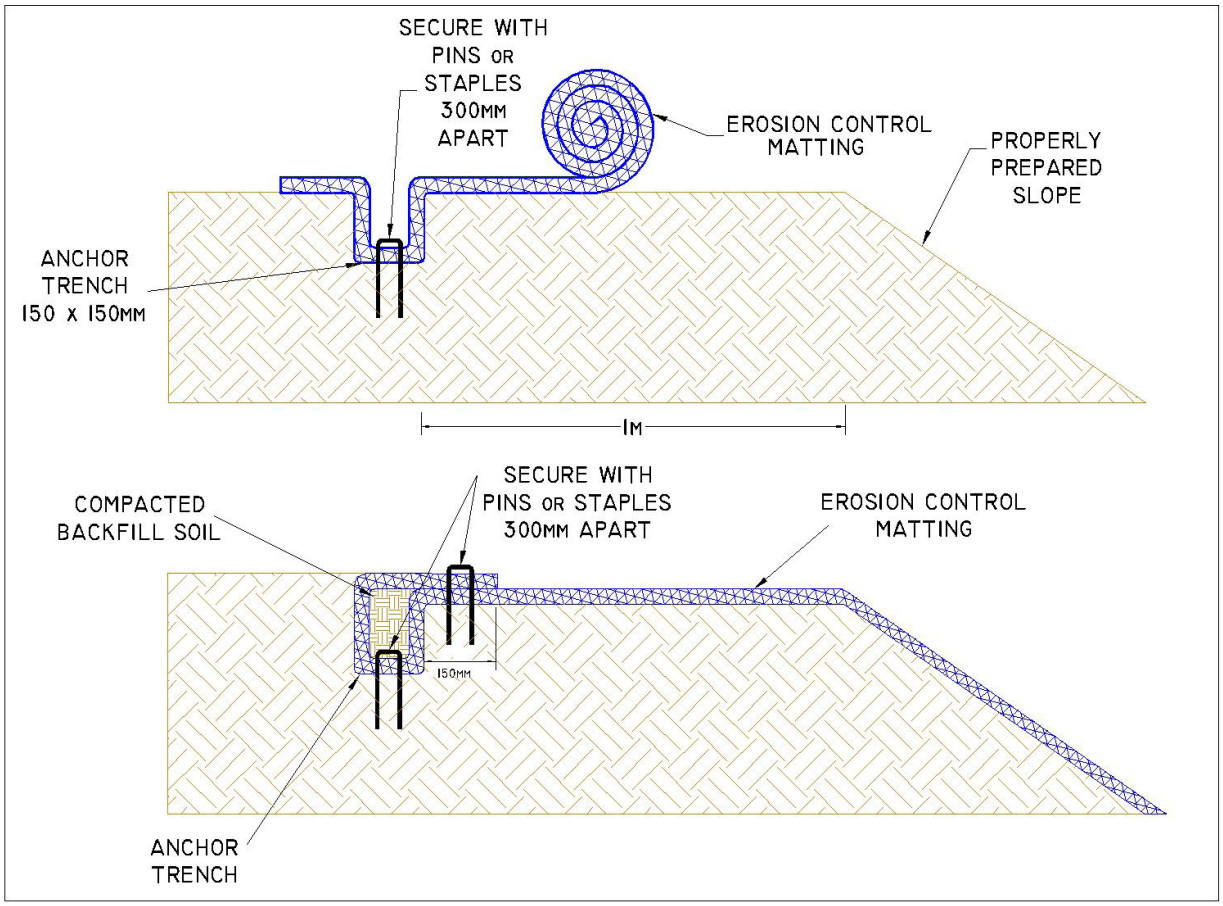
Before installing any erosion control product, careful consideration needs to be given to the site conditions and how the matting will be orientated, anchored and overlapped. The best foreshore stabilisation designs will fail if matting is not installed correctly. Inexperience can lead to poor matting contact with the soil, poor pinning techniques and overlapping in the wrong direction (WDFD 2003). These mistakes will compromise the integrity of the matting and lead to vulnerability over time, especially during high flow or storm events (WDFW 2003).

The following information is therefore provided as a guide only, as site conditions such as soil type, slope and type of matting material used will affect many factors, including depth of burial of matting edges and number of pins.

1.5.1 Anchoring

Anchoring requirements for erosion control matting may need to be adjusted depending on location and site conditions. The following anchoring recommendations are provided as a guide. Matting should be anchored appropriately based on specific site conditions and manufacturer's instructions.

Burying and anchoring the edges of the erosion control matting in a trench approximately 150-200 mm deep by 150 mm wide prevents water flowing under the matting and provides maximum erosion protection (ECTC 2008, WDFW 2003). When installing matting down a slope, it is recommended, the upstream edge is buried and anchored in a trench to provide better protection from stream flow (WDFW 2003).



Source: ECTC (2008)

Figure 4 Anchor trench detail

Matting should have good contact with the soil surface and be secured with an appropriate number of pins for degree of slope. As a general rule, matting should be secured with pins at 0.5-1 m intervals along the length of the matting and staggering pins 400-600 mm across the matting. Pins should be driven flush with the soil surface and be long enough to ensure sufficient ground penetration to resist pullout (WRC 2001a).

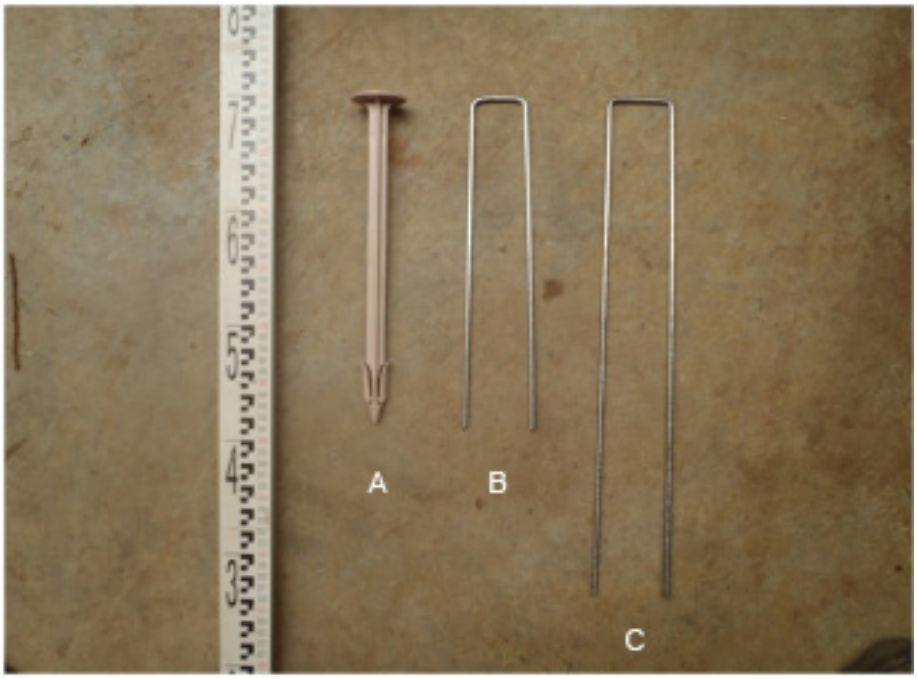
Table 2 Minimum recommended quantity of pins/staples for different slopes

Type of slope	Gradient (v:h)	Minimum pins/m^2
Steep slopes	1:1 – 1:2 or greater	6 to 8
Moderate slopes	1:2 – 1:3	4 to 6
Gentle slopes	1:4 or less	4

Source: Caltrans (2003); Syrinx Environmental PL (2012)

Site conditions will determine which anchors are appropriate for the restoration site. Table 3 provides a list of pin types for different site conditions.

In natural areas where biodegradable matting products are used, biodegradable pins are recommended. BioGrippers are made from cornstarch and are 100% biodegradable. However, in some instances starch pins may need to still be removed, especially in areas where the biodegradable matting used has broken down and the pins have become an aesthetic and safety issue. These pins are not as robust as wire staples and care needs to be taken when hammering them into the ground so they are not broken, particularly in sites that have heavy clay soils.



Source: Syrinx Environmental PL (2012)

Figure 5 An assortment of commonly used pins for securing erosion fabric in foreshore areas. (A) BioGripper 280 mm; (B) U-shaped wire staple 300 mm; (C) U-shaped wire staple 450 mm

On sites where biodegradable pins may not be suitable 11 gauge U-shaped staples of various lengths with a 50mm crown can be used to secure the matting. Be mindful that as the matting degrades, the wire staples will not break down and the site will need to be monitored over time and wire staples will need to be removed.

Table 3: Site conditions and recommended anchors

Site conditions	Recommended pin
Typical soil conditions, all but loose sandy soils	BioGrippers 280 mm
Loam to sandy soils or high velocity channel applications	BioGrippers 280 mm
Very loose soils containing fine silt, sand or soft mud	U-shaped wire staples 450 mm
Hard compact sand, silt or clay	U-shaped wire staples 300 mm or less

Source: ECTC (2008); WRC (2001a); Syrinx Environmental PL (2012)

Note: Where possible BioGrippers are preferred. However, in some instances the soil may be too hard and wire staples of equivalent or greater lengths can be used

1.5.2 Matting overlap

The correct overlapping technique helps to prevent water flowing underneath the matting and washing out the soil. Before rolling out the matting consider how the adjoining rolls of matting will be installed across the project site to allow for overlap by identifying the most influential forces acting on the matting (eg gravity on the upper-slope or hydraulic flow in the inter-tidal area). The number of joins in the matting should be minimised to increase the integrity of the matting and provide the strongest structure

In channels, the upstream edge should overlap the downstream edge by at least 100 mm (Caltrans 2003; ECTC 2008). Refer to overlap detail in Figure 6. For added protection, the downstream edge can be anchored in a 150-200 mm by 150 mm anchor trench and covered and secured with the upstream edge (Caltrans 2003; ECTC 2008).

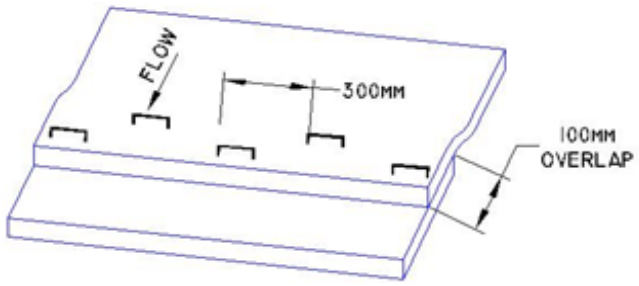


Figure 6 Overlap detail for channels and areas subject to in stream or surface water flow

As a general rule, if the fabric will be inundated at times (within the inter-tidal zone or subject to flow), overlap the vertical edges of adjacent rolls of matting ensuring the upstream layer overlaps the downstream layer by 100 mm (Figure 6) and secure with pins on the centre of the overlap (T. Schwarten, A. Johnston, [Syrinx Environmental PL] 2012, pers. comm., 22 November). Strong flows will lift the matting if the downstream edge is placed over the upstream edge. This is not as important on the upper-slope because it is not influenced by river flows.

To splice the matting down the slope, ensure the down slope end overlaps the up slope end and secure the overlap with one row of pins staggered 200-300 mm apart (T. Schwarten, A. Johnston, [Syrinx Environmental PL] 2012, pers. comm., 22 November). Refer to the overlap detail in Figure 7. In some circumstances, particularly at sites where high surface water flow or sheeting is expected down the slope, the up slope end of the matting should overlap the down slope end (Caltrans 2003; ECTC 2008).

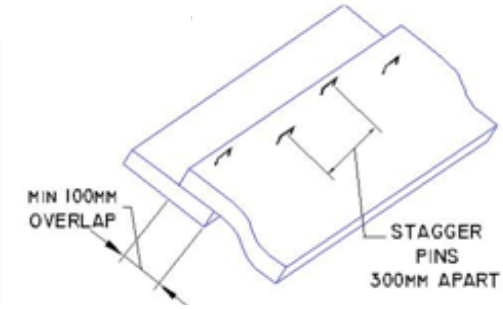


Figure 7 Overlap detail to splice down the slope when high surface flow or sheeting is not expected

If the matting punctures or tears significantly during or following installation it is recommended that the damaged section be removed and replaced with new erosion control matting. The replaced section of matting should be secured sufficiently to maintain integrity, which may require a greater number of pins if the section is relatively small.

Small cuts can be fixed by using a higher density of pins or by threading offcuts underneath the cut and securing these with additional pins.

1.5.3 Transition

The weak points for erosion control matting can be the transition between adjacent bank-stabilisation techniques, treated or untreated areas or between fabric edges and existing trees or infrastructure (WDFW 2003). Adequate planning and well considered designs are necessary to ensure correct orientation and installation of the matting.

1.5.4 Storage of erosion control matting

Care should be taken when storing and transporting rolls of matting to ensure the matting is not damaged. Many products degrade when exposed to harsh conditions and should be stored in a dry, covered area. Before purchasing erosion control matting, check that the supplier or contractor stores their products appropriately. Incorrect storage can shorten the life of the product and consequently, the design life of the project.

1.5.5 Toe protection

Erosion control matting installed to protect an eroding riverbank or shoreline, as a general rule, should extend 0.6 m past the toe or below the low water mark and be anchored in a trench (ECTC 2008). Added rock toe protection may be required on steep slopes and in areas subject to waves and high water flow velocities. The toe protection approach will be site specific and determined by hydraulic impact, soil type, tidal influence and water levels and must be integrated with the erosion control matting used.

1.5.5 Direct seeding

In some conditions, the area to be protected can be direct seeded before installing the erosion control matting. It is important to note that direct seeding is not a common practice in foreshore restoration projects because the project area is often affected by tides or river flow that can wash the seed away. Direct seeding should not be considered below the high water mark or areas impacted by tidal influence. The use of direct seeding on very steep slopes requires additives such as tackifier to ensure seed sticks to the ground long enough to germinate (T. Schwarten, A. Johnston, [Syrinx Environmental PL] 2012, pers. comm., 22 November).

If site conditions are suitable, seed the prepared area with local provenance seeds appropriate for the site conditions and soil type. Choose an erosion control product that is suitable for this purpose that allows light and water to penetrate the blanket, such as jute or coir mesh.

Note: If using coir mesh that requires soil filling, seed the area after installation of the mat and before filling the mat with soil (Caltrans 2003). When backfilling with soil, use shovels and brooms. Do not drive machinery over the matting.

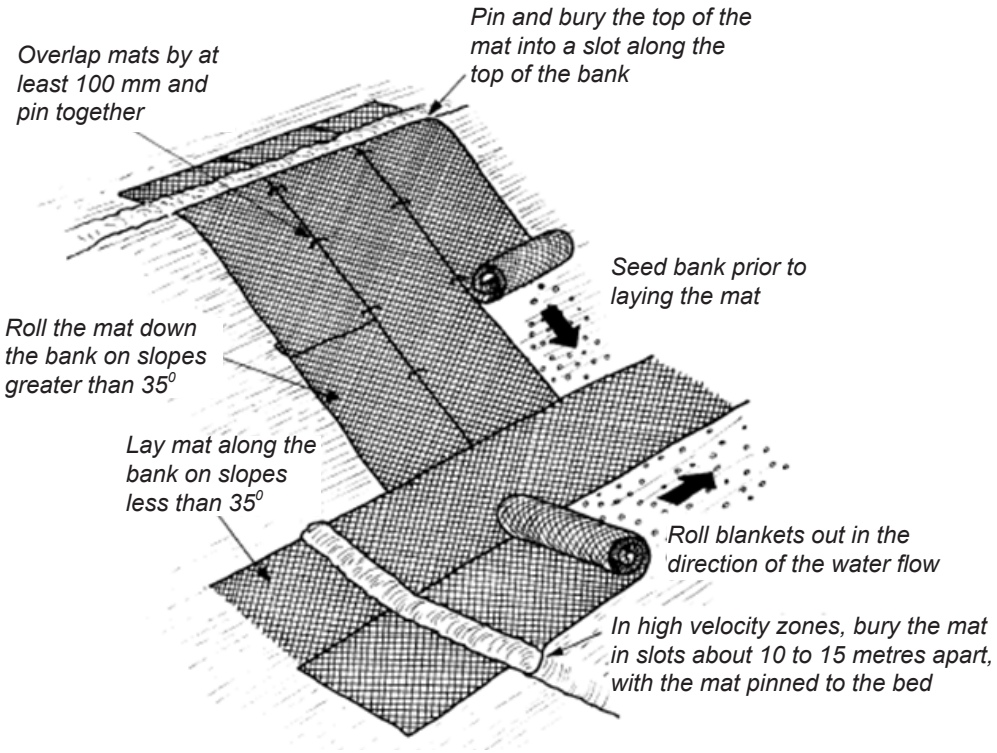
1.6 Installation

Correct installation of erosion control matting is critical for a successful project. This section provides best practice installation guidelines and should be read in conjunction with the installation specifications from the manufacturer.

Refer to section 1.5 for recommendations on anchoring, overlapping, transitioning between the rehabilitation area and untreated areas, toe protection, direct seeding, and storage and handling of the matting.

Erosion control matting is typically laid by beginning at the top of the slope and rolling the matting down slope. However, matting can be orientated in different directions to achieve maximum erosion protection depending on site conditions such as direction of river flow and foreshore erosion. For example, the installation requirements will differ when installing the erosion control matting on slopes as opposed to channels and some manufacturers allow for horizontal installation on short slopes to avoid extra handling and cutting of the matting. The number of joins in the matting should be minimised to increase the integrity of the matting and provide the strongest structure.

As a general rule, if the degree of slope is greater than 1V:3H it is recommended matting is rolled down the slope. For a degree of slope less than 1V:3H the matting should be rolled across the slope (WRC 2001a) (Figure 8).



Source: WRC (2001a)

Figure 8 Orientation of matting on slopes and channels

Regardless of direction, to ensure effectiveness of the matting it is recommended that the upper edges of the matting on top of the embankment are secured in an anchor trench (refer to section 1.5.1 Anchoring) to resist lift and provide direct contact with the soil. If more than one width is required it should overlap the matting previously installed.

Digging should be avoided on slopes to prevent further destabilisation. If the degree of slope is greater than 1V:3H it is recommended the anchor trench be installed at least 1 m from the crest of the embankment.

The following recommended installation procedures provide a guide to some of the more typical applications under which erosion matting can be applied and have been adapted from Caltrans (2003), CBBEL (1999), ECTC (2008), and WRC (2001a).

If unsure, refer to the manufacturer's specifications and seek professional advice from an environmental consultant.

1.6.1 Installation on moderate (1V:3H-1V:2H) to steep slopes (>1V:2H)

1. Prepare the site by grading and shaping to a relatively smooth profile that is free of weeds, rocks, roots and sticks to ensure the matting will have complete contact with the soil. Some remaining debris/litter is acceptable to be covered and large rocks should only be removed if this does not cause excessive disturbance. Removal of root structures from any existing native vegetation may further destabilise the site and lead to erosion, therefore the roots of surviving trees should not be damaged or disturbed. All native vegetation present on the slope should also be retained where possible and matting installed around the vegetation. Note: If vegetation needs to be removed, seek advice from the Swan River Trust as a permit may be required.

2. Begin at the top of the slope and prepare an anchor trench 150-200 mm deep by 150 mm wide along the length of the area to be protected by matting. It is recommended the matting be anchored to a minimum of 1 m beyond the crest of the slope or as far beyond the crest as site conditions allow. In situations where this is not possible, the matting should be anchored above the high water mark at a minimum.

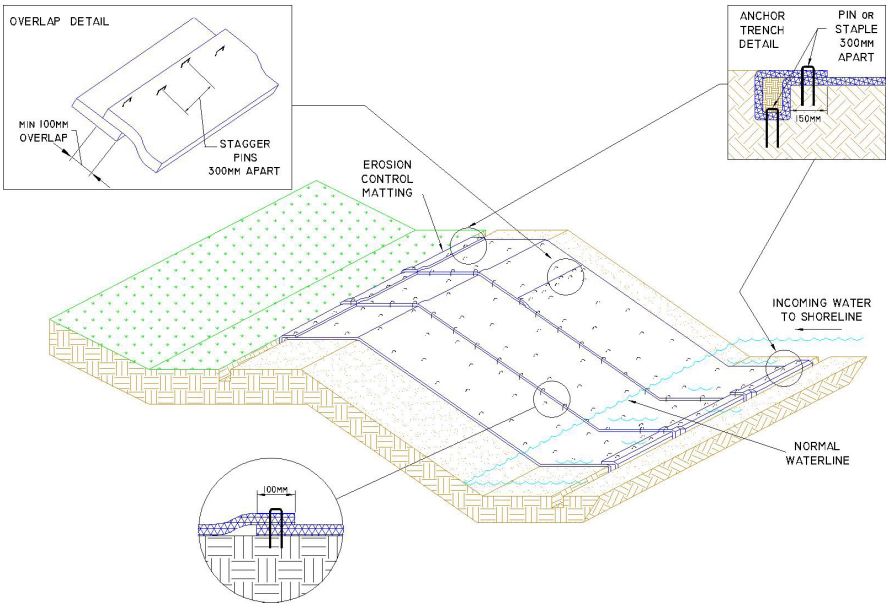
3. Roll the matting over the prepared anchor trench securing it to the bottom of the trench with pins approximately 300 mm apart ensuring the pins are flush with the surface. Be sure to leave enough matting on the landward side of the anchor trench to cover it once it has been backfilled. Refer to anchor trench detail in Figure 9.

4. Backfill the anchor trench, compact the soil and cover the backfilled trench with the remaining end of the matting and secure with pins 300 mm apart.

5. Unroll the matting down the slope and gently pull the matting to take out any slack every 5-6 m being careful not to stretch it. Ensure the matting has direct contact with the soil surface.

6. Secure the matting in place with pins at 0.5-1 m intervals along the vertical edges and staggering pins horizontally approximately every 400-600 mm across the matting. Note, the matting must remain taut and have sufficient contact with the soil surface as it is pinned. This should be a major consideration when determining the number of pins to use. Table 2 provides the recommended number of pins for degrees of slope.

7. Matting should continue below the low water mark and appropriate toe protection considered (refer to section 1.5.5).



Source: Adapted from ECTC (2008) and Syrinx Environmental (2012)

Figure 9 Diagram for installation on slopes showing overlap and trench details

1.6.2 Installation on gentle slopes (<1V:4H) or channels

1. Prepare the site by grading and shaping to a relatively smooth profile that is free of weeds, rocks, roots and sticks to ensure the matting will have complete contact with the soil. Some remaining debris/litter is acceptable to be covered and large rocks should only be removed if this does not cause excessive disturbance. Removal of root structures from any existing native vegetation may further destabilise the site and lead to erosion, therefore the roots of surviving trees should not be damaged or disturbed. All native vegetation present on the slope should also be retained where possible and matting installed around the vegetation. Note: If vegetation needs to be removed, seek advice from the Swan River Trust as a permit may be required.

2. Beginning at the upstream edge of the project site, prepare anchor trench for the matting perpendicular to the water or across the channel 150-200 mm deep by 150 mm wide. When installing matting in a channel or waterway, to prevent a seam going down the centre of the channel or in areas of concentrated water or wave action, it is recommended the centre of the roll of matting be positioned in the centre of the channel or area of concentrated water flow or wave action.

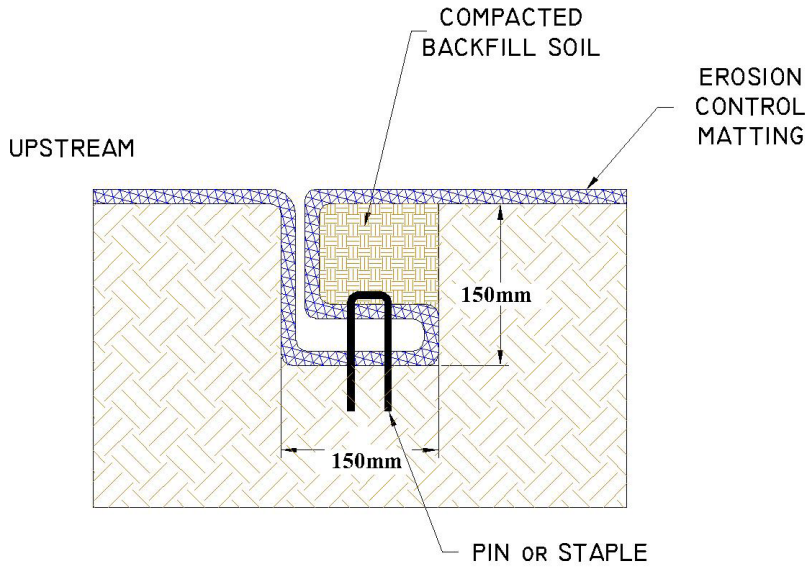
3. Roll the matting over the prepared anchor trench securing it to the bottom of the trench with pins approximately 300 mm apart ensuring the pins are flush with the surface. Be sure to leave enough matting on the landward side of the anchor trench to cover it once it has been backfilled. Refer to anchor trench detail in Figure 9.

4. Backfill the anchor trench, compact the soil and cover the backfilled trench with the remaining end of the matting and secure with pins 300 mm apart.

5. Unroll the matting in the direction of the water flow and gently pull the matting to take out any slack every 5-6 m, being careful not to stretch it. Ensure the matting has direct contact with the soil surface.

6. Secure the matting in place with pins at 0.5-1 m intervals along the length of the matting and staggering pins 400-600 mm across the matting. Table 2 provides the recommended number of pins for degrees of slope.

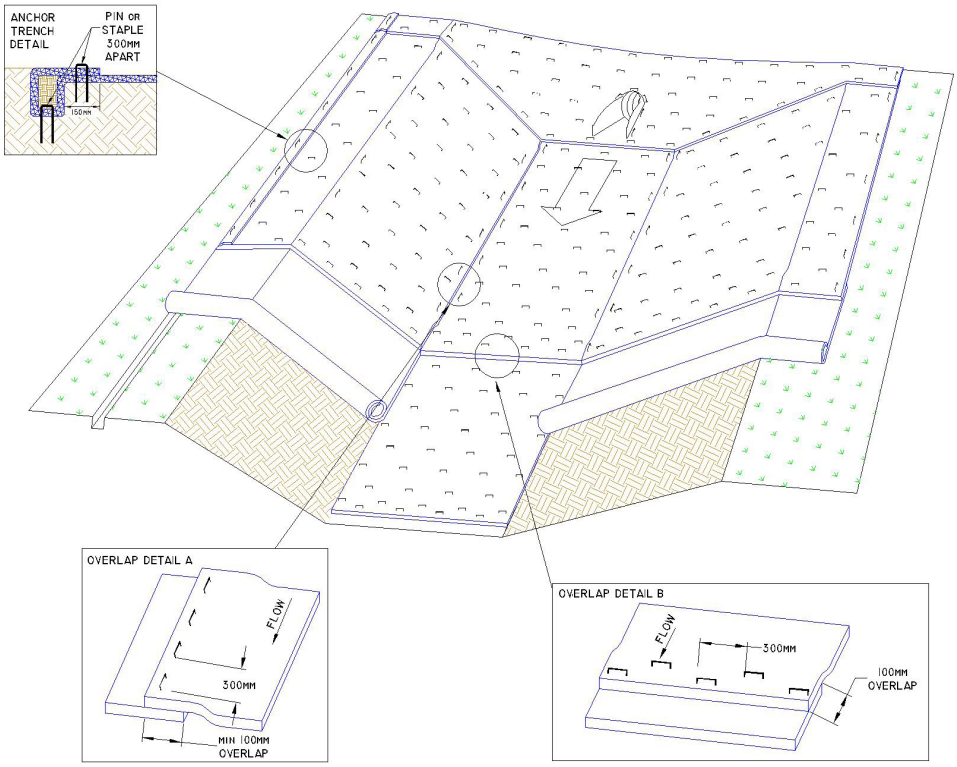
7. In areas with high flow velocity, it is recommended to install “check slots” perpendicular to flow to resist hydraulic lift. Such check slots can be prepared 150 mm deep by 150 mm wide every 8-10 m along the length of the channel or project site (refer to Figure 10).



Source: ECTC (2008)

Figure 10 Check slots to be installed in channels every 8-10 m for sites affected by high flows

8. Secure the terminal end and edge of the matting at the top of the channel/slope in a pre-prepared anchor trench using the same methods detailed in steps 3 and 4 above.



Source: Adapted from ECTC (2008)

Figure 11 Installation in channels showing overlap and flow direction

1.7 Monitoring and Maintenance

Following installation, the matting should be visually inspected periodically, particularly after significant storm surge, tidal or rainfall events. Maintenance should be conducted as required to repair washout or breakage, reinstate matting, replace plants, control weeds or remove old wire and non-biodegradable staples as the matting degrades (Caltrans 2003, CBBEL 1999).

Areas protected with erosion control matting should be monitored and maintained to provide adequate erosion control until plant establishment.

Monitoring should include visual inspection and photographs of:

- Plant establishment and health
- Presence of weeds
- Contact of the matting with the soil
- Impacts of informal traffic – wear and tear
- Erosion
- Integrity of the anchoring trench and pins
- Vandalism
- Presence of washout or breakage.

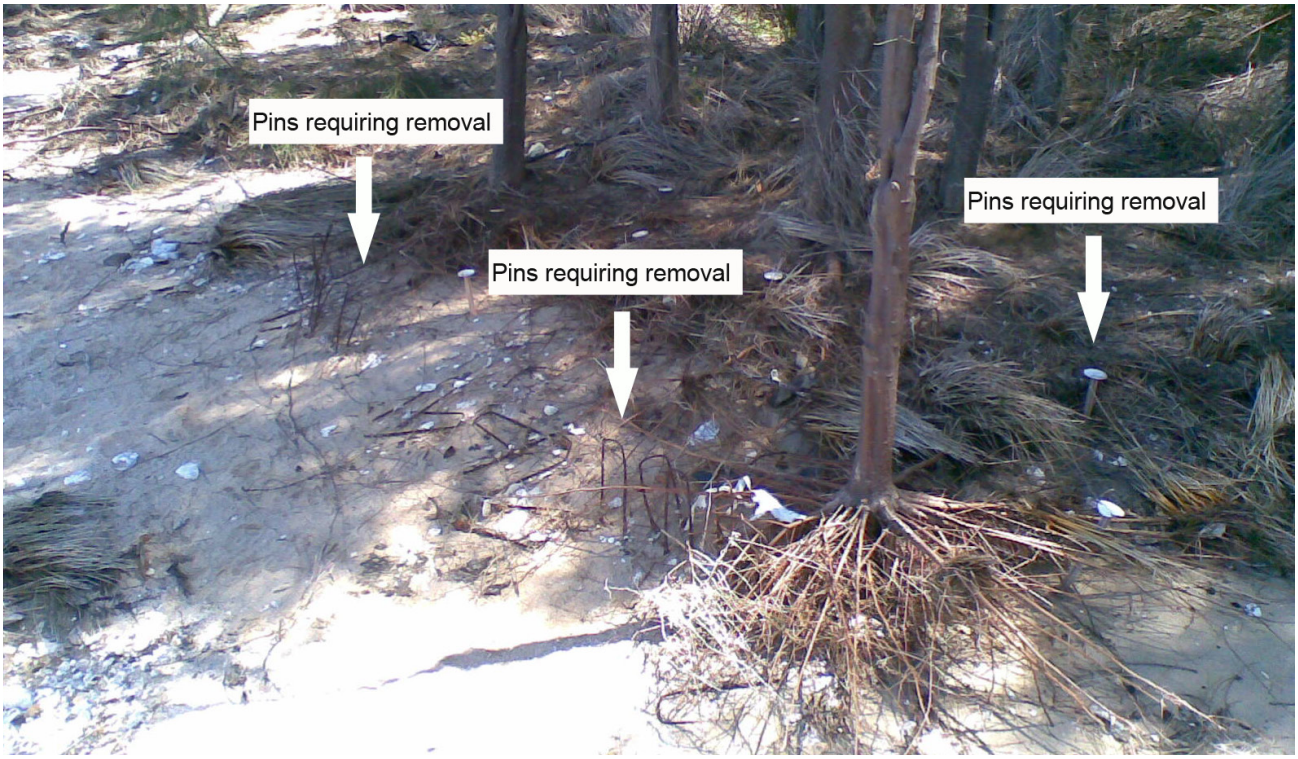


Figure 12 Wire staples and BioGrippers requiring removal after matting has degraded

Source: Syrinx Environmental PL (2012)

Figure 13 Example of failing matting requiring repair

For the majority of foreshore restoration projects, erosion control matting is a temporary stabilisation solution and it is necessary to have a revegetation plan that includes appropriate monitoring and maintenance activities to ensure the success of the revegetation for long-term bank stabilisation (WDFW 2003). More information relevant to developing revegetation plans is available in the Swan River Trust's *Guidelines for developing revegetation plans for the Swan and Canning Rivers 2011*.

1.8 Case studies

Erosion control matting is frequently used along the foreshore of the Swan and Canning rivers to provide added protection to revegetation and other stabilisation techniques. This section outlines examples of different types of erosion matting *in-situ* along the Swan and Canning rivers.

Jute matting is the most commonly used biodegradable erosion control product and geofabric is the most commonly used non-biodegradable erosion control product in foreshore stabilisation projects on the Swan and Canning rivers.

Many of the techniques described in this manual have a geofabric filter cloth component, including gabions, groynes and headlands, log brush mattressing, log walling, limestone walling and revetments. Refer to the relevant chapters of *Best Management Practices for Foreshore Stabilisation* for more information about these techniques and their appropriate application.

The following case studies have been provided to demonstrate the types of materials available for foreshore restoration projects, and how the materials used will vary significantly based on site conditions and application.

Como Foreshore, South Perth

On the Como Foreshore in South Perth coir mesh was used to protect against erosion from wind and surface water runoff and stabilise the soil while vegetation established. Figure 14 shows coir mesh, corn starch (biodegradable) pins and native planting. In this instance, the coir mesh assisted with plant growth as the wide weave allowed for water penetration but still provided some protection against wind and water runoff in the sandy soils. The coir will break down over time as plants establish. Cornstarch pins can last in some soils for up to 10 years so further maintenance on this site may be required to remove the pins if the mesh breaks down more rapidly.

Source: Syrinx Environmental PL (2012)

Figure 14 Coir mesh matting, protective fencing and planting. Como foreshore, City of South Perth

Ashfield Parade and Success Hill, Bassendean

Biodegradable jute matting was used to stabilise soil and reinforce the riverbank for revegetation at the Ashfield Parade and Success Hill project sites in the Town of Bassendean.

At these sites, jute matting was laid in conjunction with horizontal log palisades on the steep slope which is predominantly clay soil (Figure 15). The palisades created a stepped structure which softened the steepness of the slope and limited the loss of fine clay and soil materials to downhill sheeting water and soil erosion. The brush mattress on the lower slopes is a bioengineering technique designed to reduce erosion and deposit growing materials among the brush material.

The jute mat was secured with steel pins which may need to be removed over time as they will not break down and can become unsightly or a safety risk if left *in situ*. However, it is expected that the dense planting with soil binding roots will successfully block access to the site and provide long-term erosion control as the jute breaks down in 2-4 years. Therefore, pin removal may not be necessary. The palisades will also act as a long-term solution to limit sheet erosion and help to accumulate soils and growing medium on the slope.

Source: Syrinx Environmental PL (2012)

Figure 15 Success Hill foreshore restoration works, Town of Bassendean

Garvey Park, Belmont

The erosion control works at Garvey Park in Belmont used a combination of erosion control matting and bioengineering techniques to stabilise the riverbank (Figure 16).

Source: Syrinx Environmental PL (2011)

Figure 16 Log brush mattressing and rip rap, Garvey Park, City of Belmont (Syrinx Environmental PL, 2012)

Geofabric and jute matting were the erosion control matting products chosen for this site. The geofabric was installed along the toe because it can withstand exposure to inundation for longer periods without degrading. Jute matting was used further up the bank where the foreshore was less likely to be inundated. Jute matting was more suitable for soil stabilisation and revegetation in this instance because it was easier to plant into and will degrade over time as the vegetation establishes. Jute matting is also less expensive. Figure 17 shows the erosion control matting exposed on site prior to planting and bioengineering techniques applied.

The erosion control matting was used underneath the log brush mattress and densely planted with native rushes to treat site specific foreshore erosion. The technique encompassed erosion control, wave impact absorption, soil accretion, habitat creation and vegetation establishment. The technique was combined with limestone rock rip rap which also assisted with erosion management and reducing wave impact.

Source: Syrinx Environmental PL (2011)

Figure 17 Erosion control matting installed prior to the installation of brush mattressing, Garvey Park, City of Belmont (Syrinx Environmental, 2011)

1.9 References

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