

Vasse Diversion Drain
Restoration and Landscape Concept Plan

Prepared by Calibre Consulting
for GeoCatch

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17-002231

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1 EXECUTIVE SUMMARY

This Concept Plan (the Plan) has been produced to provide direction for restoration and enhancement works along the lower sections of the Vasse Diversion Drain. The section runs from the Queen Elizabeth Road Bridge crossing through to the ocean. Although works have been suggested for the entire area, the general focus for initial works is north (downstream) of the Busselton Highway bridge crossing. The subject area can be seen in Figure C-01 and in the 2 Base Plans.

The works focus on controlling erosion, controlling weeds, revegetating with appropriate native species and managing access along the drain and its immediate surrounds. Through this work, the aim is to create enhanced natural habitat outcomes while also providing a more aesthetically pleasing landscape.

2 SUMMARY OF EXISTING ISSUES.

The main current issues are outlined below. A visual summary of the existing conditions and issues can also be seen in Figure C-01.

2.1 WEEDS

2.1.1 *Schinus terebinthifolius* (Brazilian Pepper/Japanese Pepper)

This large shrub is located at various points along the banks. As well as being a highly invasive weed, its other main issue for this site is that it tends to stop understorey species growing. In doing so, it is allowing the banks to be undercut at the toe, due to a lack of protective sedges. Water Corporation have noted they have an existing budget to remove *S. terebinthifolius* from the subject land within the next 3-6 months. Works on initial removal has been undertaken with follow up control of reshoots and seedlings to continue.

2.1.2 Perennial grasses

Perennial grasses such as buffalo, couch and kikuyu are found along the banks. These species tend to outcompete other understorey species and smother them over time, reducing biodiversity and habitat. They do provide good bank stability currently except where they extend down near the toe of the bank. In this zone the intrusion of salt water during large storm events seems to temporarily kill of the grass, allowing for erosion to occur.

2.1.3 Other weeds

Numerous other understorey weeds appear on the site, both annual and perennials. These include nasturtiums, rape, annual grasses, watsonia, cape weed and other annual broad leaf species. Other than watsonia, most of these weeds are not out competing established native species. They are however causing issues in recently revegetated areas where they are starting to re invade and smother/out compete the young seedlings. The watsonia is a good bank stabiliser and in places forms dense monocultures. In these areas, any control must include a thorough revegetation and follow up weed control program.

2.2 EROSION

The two main erosional forces are from water flowing along the toe/base and from people traversing down/up the banks.

The toe erosion is happening in areas where there is not a good cover of vegetation or rock protection. The toe erosion covers approximately 60% of the area (excluding the concrete channel area). The erosion of the sand along the base is also resulting in the collapse of the rest of the bank in some instances. The sediment plume within the channel is also directing water onto the banks, exacerbating the erosion potential of the drain.

An extreme version can also be found on the western side of the bank near the mouth. In this area the toe is also being eroded by wave action from the ocean during storm events.

There are also areas of localised erosion happening where the public is traversing over the banks to access the water. This is causing sand to be pushed downwards and death of the surrounding vegetation. The access points tend to be in areas where the vegetation is not currently dense enough to discourage traversing of the bank.

2.3 BAFFLE BOARDS

The old baffle boards are in various states of disrepair. They represent a potential injury hazard to people within the water. They do not appear to be offering erosion control in their current form and anecdotal evidence is that they have not done this in the past, especially north of the Bussell Highway where for much of the year flow is in 2 directions (due to the daily tidal movement). In their current state they are also considered not to be aesthetically pleasing.

The boards are not concreted in so should be able to be pulled out.

2.4 LACK OF HABITAT/BIODIVERSITY

Due to the fact that the drain is artificially created, the system is lacking many of the plant species and habitats found in natural waterways. There are some localised areas of rushes overhanging the water, sedges such as *Lepidosperma* creating dense stands along the top of the bank and isolated clumps of peppermints. There are also isolated other acacia and melaleuca species on the banks as well as a decent wetland ecosystem in the southern portion adjoining Queen Elizabeth Drive (near the concreted section of the drain). The current weed load is precluding natural establishment of native species over the remainder of the area. There has been some limited areas of revegetation to begin to replace the weed species with natives, predominately in the area north of the Bussell Highway on the eastern bank.

2.5 SEDIMENT

The movement of sediment down the drain, coupled with the constricting flow points under the bridge is causing a sediment plume within the middle of the drain, especially north of the Bussell Highway. This concentration of flow along the bank edges is enhancing the erosional power of the water and causing toe erosion. Removal of sediment in this area is possible but complex. The cheapest option would be to pump it out to the ocean (where it is currently naturally moving) but there would be a range of environmental approvals associated with doing this. The second option is to use an aquatic excavator to dig the centre of the channel deeper and then deposit the sediment along the banks. This has the issue of creating large areas of sediment that would then need to be stabilised, plus the potential need to check how this may affect the capacity of the drain to transport flood flows. The most expensive option is to take the sediment out of the drain and deposit off site. This will require a large number of truck movements and a suitable disposal/reuse location.

3 CONCEPT WORKS

The types and areas of potential works are shown visually in Figures C-01 and C-02.

The works generally focus on erosion control, access control, weed management and revegetation with native species. Other works such as signage and pathways are also considered. The baffle boards are also to be removed.

3.1 EROSION CONTROL

Due to costs, accessibility and the aim of creating increased habitat, the erosion control will be predominately through soft engineering and targeted revegetation.

This soft engineering will include:

- Coir logs along the toe of the banks with revegetation
- Pallisading on the steep banks with revegetation
- Brushwood matressing with revegetation on the banks/dunal systems with revegetation

In localised areas, limestone rock will be used to protect the toe of the banks. Current access points may also be covered with large limestone rocks. This will address the erosion caused by people walking down the banks.

Near the northern pedestrian bridge on the western side (both north and south of the bridge), the existing rock and geofabric placement area, a program of revegetating amongst the rocks may add extra stability and habitat.

Details of the erosion control methods can be seen in Figure C-03

3.2 ACCESS CONTROL

Pedestrian access is partly addressed above, due to its effect on localised bank erosion.

To provide the public with opportunities to interact with the local area, while controlling erosion, a viewing platform is identified. The suggested location is immediately south of the pedestrian bridge, on the western bank.

This platform is to be constructed of treated pine with a modwood deck. The platform would be linked to the existing path network with a sealed bitumen path, to allow for easy accessibility and effort is to be made to make it wheel chair accessible. A seat and rail is also to be included in the viewing platform.

The platform to be designed so that it does not impede flow of all events up to the 1%AEP flood..

Due to poor water quality within the drain, access to the water is generally to be discouraged. This will be achieved in the short term using a post and wire fencing, similar in nature to that used during dune rehabilitation (eg treated pine post and 3 white wire lines). The revegetation program will include dense planting of sedge species such as *Lepidosperma gladiatum*. Once established this will make it difficult to traverse the bank and therefore discourage people from going over the banks to the water. The fencing will be semi permanent in nature and only removed once the City deems it necessary or desirable.

3.3 PATH NETWORK, SIGNAGE AND VIEW POINTS

A dual use pathway (assumed to be red asphalt 3-3.5m wide over compacted crushed limestone) is also shown in areas where there is not currently a path system. This pathway will assist with managing people movement through the area and allowing access for maintenance. The path network is to match in with a broader bicycle network for the City.

Interpretive signage (including Q-codes for further information eg update for next lot of works/busy bee days, historical photos etc) could provide an interesting addition to the current path network and activities around the drain.

A possible bird hide/viewing platform is also suggested in the area adjoining the wetlands, which would add another level of interest to the walk trail and general area. The viewing point would also take in the concrete channel section, which would provide an interesting place for information on both the natural wetland systems and historical information on the need for drainage to manage flooding. Signage on these aspects could be included in the structures/pathways.

The current fence blocking the Water Corporation reserve on the western side of the drain, north of Bussell Highway is to be removed at the appropriate time. This will be undertaken in consultation with the Caravan Park owner who adjoin the reserve. The timing would likely coincide with later work stages, where large scale activities are happening on this bank including the installation of the informal path system.

Other signage may also be erected. Where the public may potentially access or come in contact with the water, signage related to potential hazards are to be erected. These relate primarily to the changing water quality of the system which may present a risk for human contact.

Signage related to the funding source will also be needed at key spots. The location of these signs will be determined after the Stage 1 works are determined. This information may also be included on the interpretive signs, if these are erected.

Signage related to the general works and need to keep of the revegetation areas will also be needed. These are likely to be placed on the temporary fencing.

3.4 BAFFLE BOARD REMOVAL

The baffle boards are to be removed before or at the time of adjoining works. The removal is to be complete, including the below ground posts. As the boards and posts are not concreted in, they should be able to be removed through a direct upward pull. The type of machinery to be used will be determined as part of detailed design and the other machinery options being used on the site.

3.5 WEED MANAGEMENT

Weed management is to be undertaken in a staged approach and consider both the weed and native species present in the location being targeted.

The understorey weed control will generally be via broad spectrum herbicides (eg Glyphosate) or selective herbicides (eg Fusilade for grasses and 2,2DPA for watsonia). The weed control needs to be undertaken at least 6 months prior to any revegetation program (ideally 12 months). Follow up weed control should also be undertaken for 3 years post revegetation. The follow up weed control may include hand pulling of isolated weeds as well as herbicide control.

Outside of the areas that regularly flood, jute matting and mulch may also assist with ongoing weed control during the first 3 years of native plant establishment.

The main woody weed present is *Schinus terebinthifolius* (Brazilian Pepper/Japanese Pepper). The control is to be via cutting the stems at ground level and immediately painting the stumps with glyphosate or a woody weed herbicide. Any regrowth is to be treated in the same way. The ground under the *S. terebinthifolius* tends to be bare. For this reason, the ground should be covered with jute matting and pinned immediately following removal of the shrub. *Juncus kraussii* should be planted along the toe of the bank (where the bare area extends to the water line) as soon as it possible to help with stabilising the bank. This toe protection may also include the use of pinned coir logs if the bare area is greater than 5m along the bank. The rest of the bank is to be revegetated by planting through cut slits in the jute matting in the following June.

3.6 REVEGETATION

Revegetation is to be closely linked to other works. The area of revegetation needs to be carefully considered so that the required preparation and follow up works can be undertaken within the resources available.

The revegetation can generally be divided into 3 zones; toe of bank, bank sides and top of bank. Toe planting should generally be undertaken in September or at the same time as disturbance works. This is due to the permanent presence of water along the toe. The bank sides and top of banks should be planted in June ideally, once weeds are adequately controlled. This will allow for the plants to establish during winter and spring with minimal to no watering.

All plants should be grown in air pruning tubes. This will provide the best root system for establishment and longterm survival, while minimising costs.

Some tanker irrigation of plants along the top of the bank may be undertaken if the summer and autumn are exceptionally dry. This will assist with survival in the first and second year.

Table 1 provides an indicative list of plants for this general bank planting

Table 1: Bank Planting Species

Area	Species	Comments
Toe of Bank		
	<i>Juncus kraussii</i> (Shore rush)	
	<i>Sporobolus virginicus</i> (Native couch)	
	<i>Frankenia pauciflora</i> (Sea heath)	
	<i>Sarcoconia blackiana</i> (Samphire) or similar species	Put in as a trial close to the ocean to determine if successful in this location
	<i>Halosarcia pergranulata</i> (Samphire)	Put in as a trial close to the ocean to determine if successful in this location
Bank side		
	<i>Melaleuca viminea</i> (Mohan)	Plant at least 10m apart to allow for sight lines to be retained. Will need to be within 1m of the water.
	<i>Melaleuca cuticularis</i>	Plant at least 10m apart to allow for sight lines to be retained. Will need to be within 1m of the water.
	<i>Lepidosperma gladiatum</i> (Coast sword sedge)	Plant in dense clumps to provide habitat
	<i>Acacia littorea</i> (Wattle)	
	<i>Viminaria juncea</i> (Swish bush)	Plant at least 10m apart to allow for sight lines to be retained. Short lived eg 5-8 years so may need to remove stems for aesthetics later on. Is a good pioneer species.
	Anthocercis littorea - Yellow tailflower	
	<i>Melaleuca lateritia</i> (Robin redbreast)	In more sheltered areas and close to the water only
	<i>Rhagodia baccata</i> - Berry saltbush	
	<i>Spyridium globulosum</i> - Basket bush	
	<i>Ficina nodosa</i> (Knotted club rush)	
Top of bank		
	<i>Agonis flexuosa</i>	Plant at least 10m apart to allow for sight lines to be retained.
	<i>Lepidosperma gladiatum</i>	Plant as dense stands to deter access over bank

	<i>Ficinia nodosa (knotted club rush)</i>	Only in areas where through access is not an issue and soil is sandy
Dune	TBA	
Note: other species may be added or changed, depending on area being revegetated. The above list is specifically suited to north of the Bussel Highway.		

There is also a small area of wetland revegetation in the southern portion of the site (adjoining the concrete drain area) on the eastern side. The revegetation in this area is focused on new habitat creation using an overstorey of melaleuca species and an understorey of sedges. Figure c-02 shows this area of planting. Table 2 provides an indicative species list

Table 2: Wetland Planting

Layer	Species
Overstorey/shrub layer	
	<i>Melaleuca raphiophylla</i> (Swamp Paperbark)
	<i>Melaleuca viminea</i> (Mohan)
	<i>Melaleuca incana</i> (Grey Honey myrtle)
	<i>Eucalyptus rudis</i> (Flooded gum)
	<i>Melaleuca lateritia</i> (Robin redbreast)
	<i>Taxandria linearifolia</i> (Swamp peppermint)
Understorey/ sedge layer	
	<i>Baumea juncea</i>
	<i>Gahnia trifida</i>
	<i>Juncus kraussii</i>
	<i>Juncus subsecundus</i>

Two lines of *Agonis flexuosa* are also shown in the old depot site (western bank, south of the Bussell Highway). These are to be spaced at least 5m apart so that grass can be adequately controlled underneath by slashing in the long term. The general idea for this area is to keep the area relatively open so that the fire risk is not significantly increased. The open planting of *A. flexuosa* will do this while providing some habitat and shade values to the area.

3.7 BINS, SEATS AND OTHER GENERAL ENHANCEMENT INFRASTRUCTURES

To complement the other works happening, and provide better overall facilities for the area, indicative locations for a range of infrastructure has been shown on Figure C-01 and C-02. Bins are located at places where the public is likely to enter or exit the area as well as places where rubbish is likely to be generated such as near fishing or picnicking spots. The bins may also include Dog bag dispensers. Bin locations are also in places where they can be easily accessed for collection of rubbish.

Potential park bench locations are also noted and are generally in areas of shade or view points.

There is also the possibility of the Water Corporation upgrading the northern end of the old depot site to create a more formal carpark and picnic area. The exact infrastructure for this is unknown but may include park benches and a shade structure.

General other landscaping may be undertaken in the reserves adjoining the drain as part of future works.

3.8 SEDIMENT REMOVAL

Although the current configuration of the sediment plume is noted as contributing to the bank erosion, the logistics and cost of sediment removal mean it is unlikely to be undertaken within the currently available funding. There may be value however in putting some focus now into determining the suitability of pumping the sediment out to the mouth or further into the bay. This would require investigations into the quality and type of sediment and potential environmental impacts on the Bay. It is worth noting that the sediment is generally moving into the Bay now. It should also be noted that the sediment configuration's effect on bank erosion is likely to be contributing more sediment to the Bay, as the eroded material is washed out. It may therefore be determined that removing a channel of sediment through the middle is the best longterm solution to managing sediment movement to the Bay and reducing long term erosion of the banks.

Another option is to place the sediment on the channel banks, however this would then require extensive erosion control methods on the bare material, as well as remodelling of the channels capacity to safely convey flood flows.

A further option is to truck the material off site, however this would be expensive compared to pumping to the Bay as well as requiring a suitable disposal site.

4 STAGING

Due to the size of the area, the amount of works that could be feasibly coordinated and the currently available budget, the works will need to be staged. The following is a break down of the likely staging.

4.1 STAGE 1

Stage 1 is generally focused north of the Busselton Highway Bridge. The exception to this is the small areas where *Schinus terebinthifolius* (Brazilian Pepper/Japanese Pepper) are growing in the southern portions.

Stage 1 works will generally focus on the eastern bank and follow on from the current weed control and revegetation works being undertaken by the High School. There may also be a focus around both sides of the footbridge area. Weed control and revegetation will also take place on the western bank. A viewing platform and surrounding works are also likely to be included subject to final costs.

The degraded baffle boards are also to be removed from areas where other works are to happen and ideally, all boards will be removed over the entire area, while machinery is on site. Fencing is also to be erected to manage public access down the 2 bank, where works take place. The dual use path on the western side is unlikely to take place as part of Stage 1.

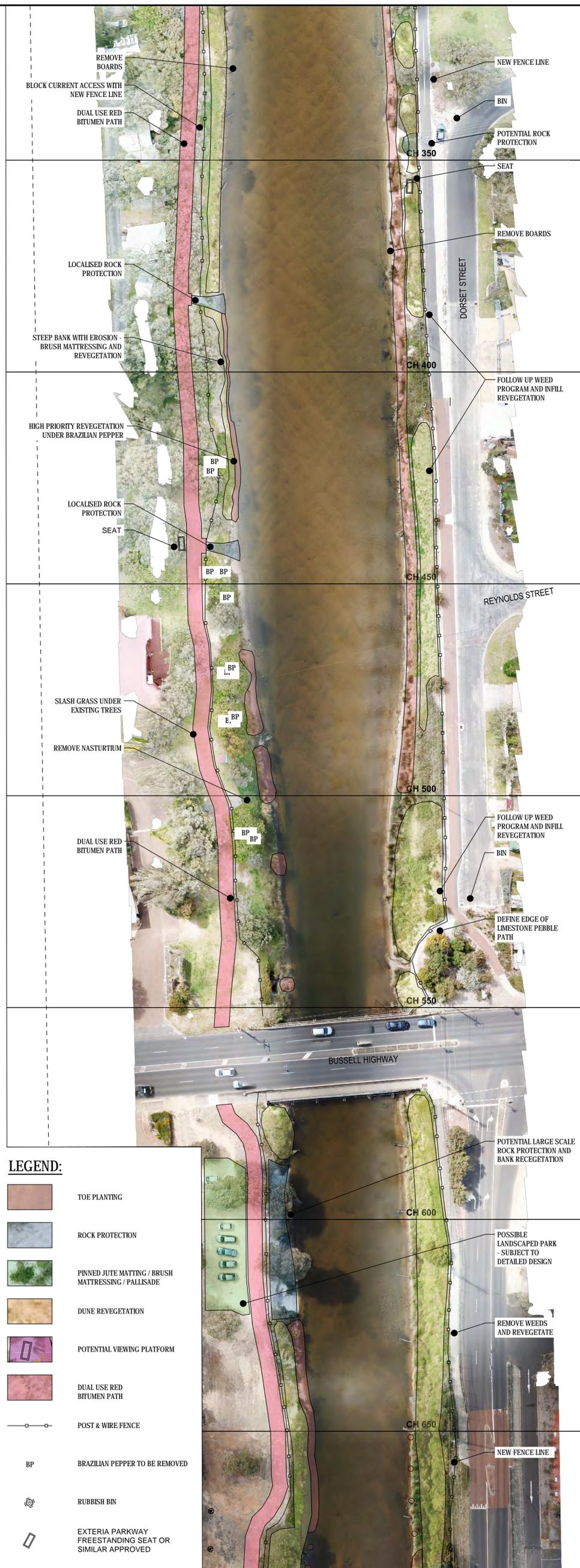
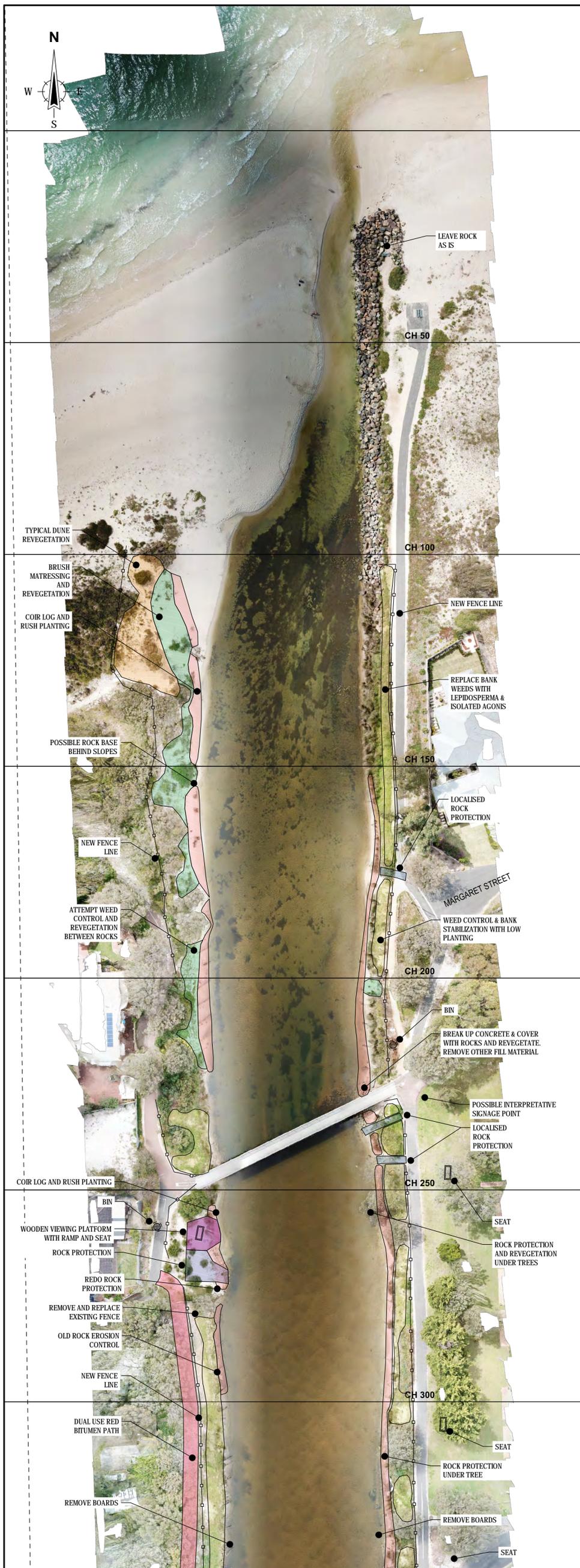
Subject to funding, there may also be a focus on the western bank near the mouth of the drain, where it cuts through the fore dune area. The works will predominately consist of toe of bank revegetation and erosion control, coupled with side of bank and top of bank dense low plantings. Here a combination of processes may be used. These include: rock armouring, palisading (pinning logs into bank), coir log protective barriers with back planting, general jute matting on steep slopes and inter planting. This will be combined with fencing to manage public access.

4.2 FUTURE STAGES

Future Stages will be subject to funding and other resources.

It is likely that the works will generally progress from north to south, with Stage 2 being the finalisation of works on the western bank, north of the Bussell Highway.

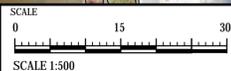
Stage 2 may also include spot works that deal with particular issues or match in with particular funding sources.



LEGEND:

- TOE PLANTING
- ROCK PROTECTION
- PINNED JUTE MATTING / BRUSH MATRESSING / PALLISADE
- DUNE REVEGETATION
- POTENTIAL VIEWING PLATFORM
- DUAL USE RED BITUMEN PATH
- POST & WIRE FENCE
- BP
- RUBBISH BIN
- EXTERIA PARKWAY FREESTANDING SEAT OR SIMILAR APPROVED

2	18/01/18	UPDATED CONCEPT	JV	BO/JV	BO
1	18/10/17	UPDATED CONCEPT	JV	BO/JV	BO
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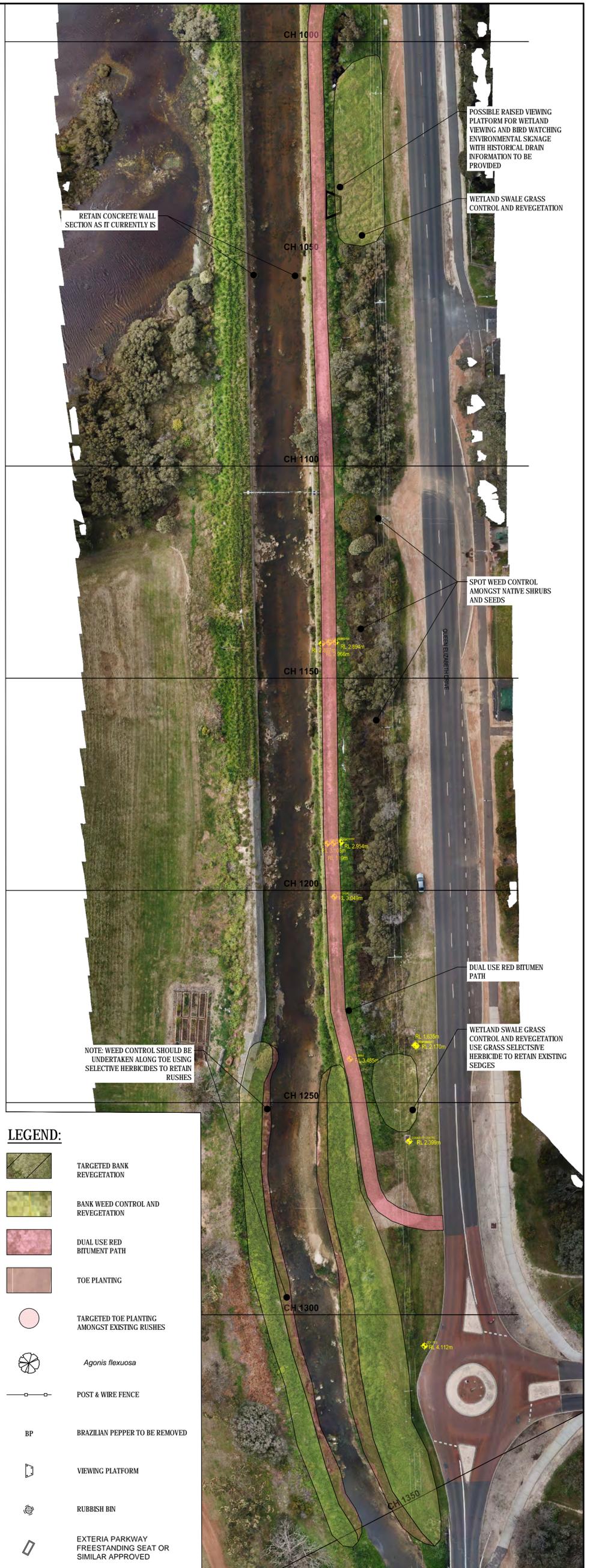


PROJECT
**VASSE DIVERSION DRAIN
ENHANCEMENT PROJECT**

BUSSELTON

DRAWING TITLE CONCEPT DESIGN BASE PLAN PAGE 1 CH 0 to CH 650		
PROJECT No. 17-002231	DRAWING No. C-01	REVISION 0

Contours have been generated from UAV captured aerial photography that merges vegetation and landform. This may cause contour anomalies due to large areas of vegetation obscuring natural surface. Contours above RL 3.5m have been removed.



LEGEND:

- TARGETED BANK REVEGETATION
- BANK WEED CONTROL AND REVEGETATION
- DUAL USE RED BITUMEN PATH
- TOE PLANTING
- TARGETED TOE PLANTING AMONGST EXISTING RUSHES
- Agonis flexuosa*
- POST & WIRE FENCE
- BRAZILIAN PEPPER TO BE REMOVED
- VIEWING PLATFORM
- RUBBISH BIN
- EXTERIA PARKWAY FREESTANDING SEAT OR SIMILAR APPROVED

2	18/01/18	UPDATED CONCEPT	JV	BO/JV	BO
1	18/10/17	UPDATED CONCEPT	JV	BO/JV	BO
0	13/10/17	ISSUED FOR INFORMATION	SE/JV	BO/JV	BO
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PROJECT
**VASSE DIVERSION DRAIN
ENHANCEMENT PROJECT**

BUSSELTON

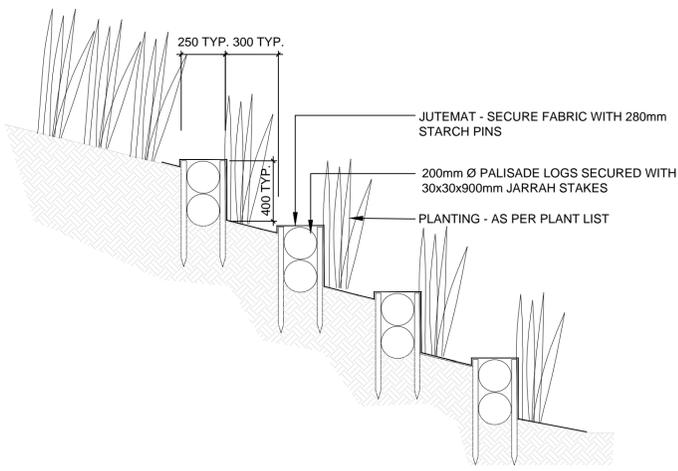
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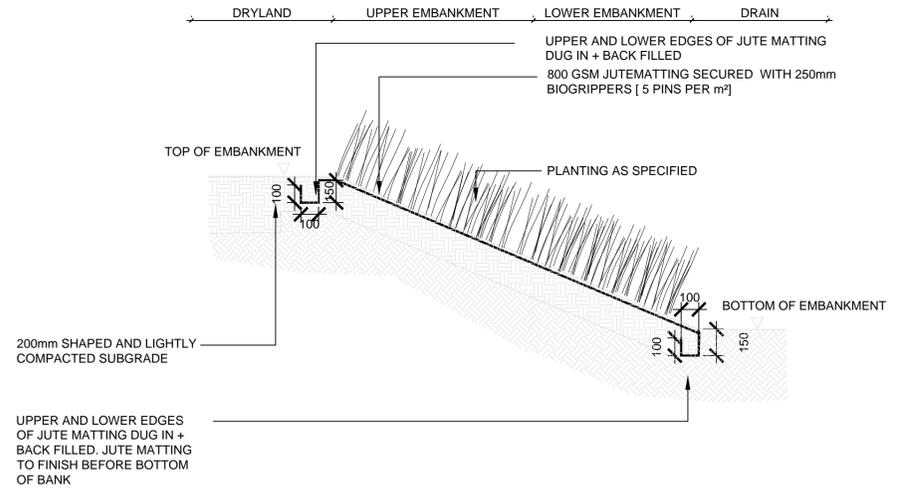
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PROJECT TITLE
**CONCEPT DESIGN
BASE PLAN PAGE 2
CH 650 TO CH 1350**

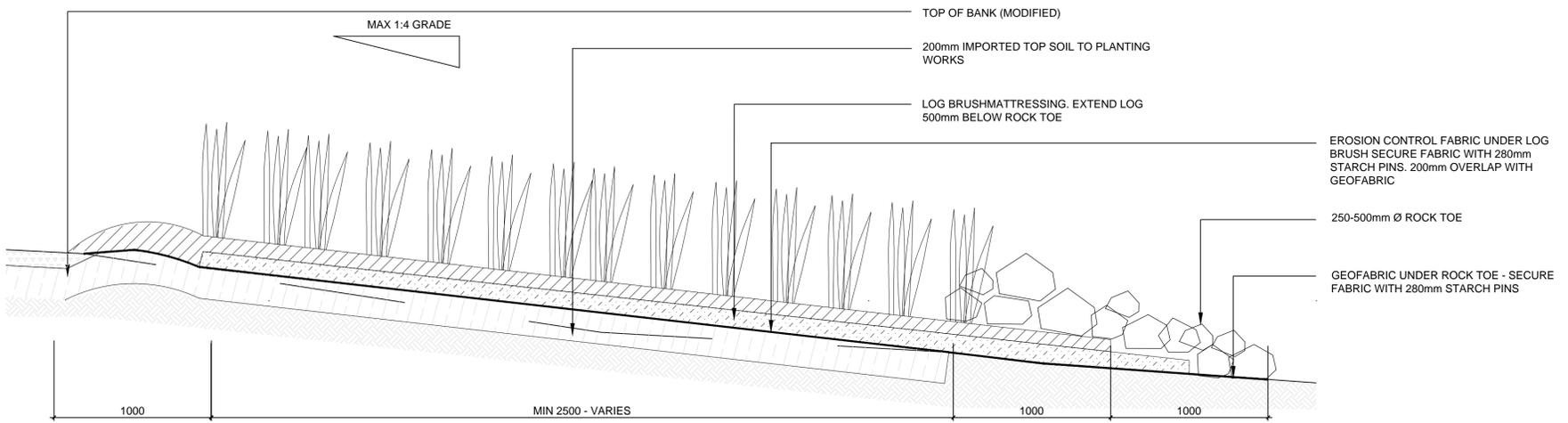
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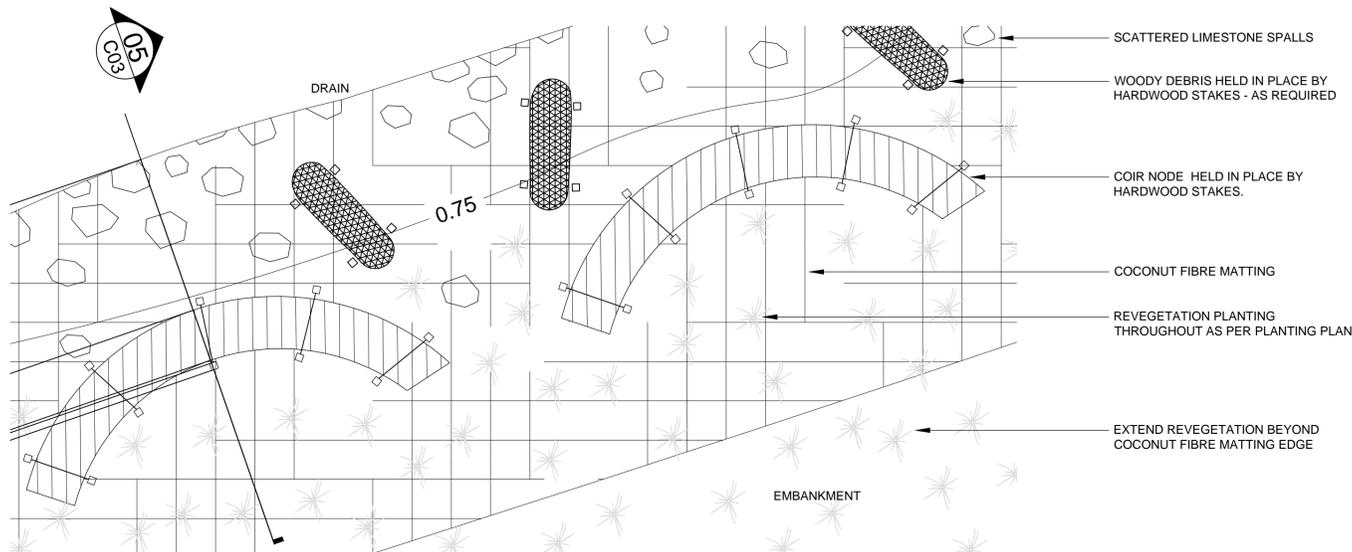
PALISADE
TYPICAL DETAIL SCALE 1:20 **01**
C03



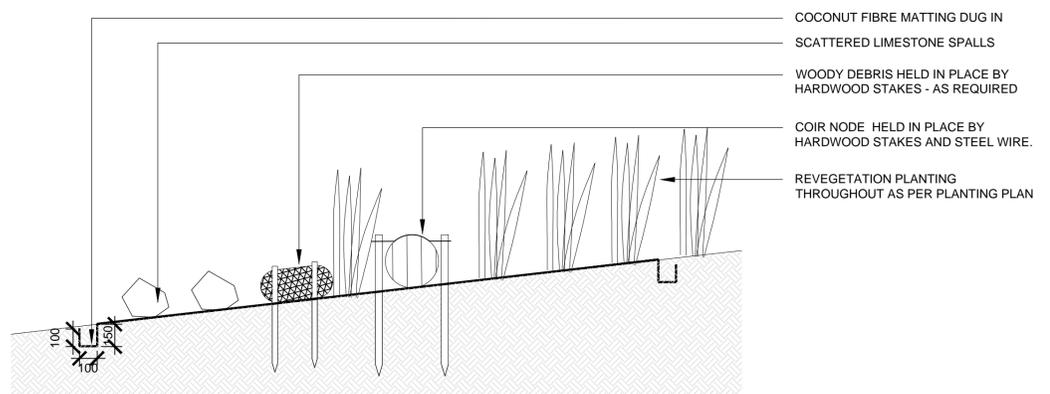
EMBANKMENT REVEGETATION
TYPICAL DETAIL SCALE 1:20 **02**
C03



BRUSH MATTRESSING
TYPICAL DETAIL SCALE 1:20 **03**
C03



COIR NODE
TYPICAL PLAN DETAIL SCALE 1:20 **04**
C03



COIR NODE
TYPICAL DETAIL SCALE 1:20 **05**
C03

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