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Report

Whakarire Ave: Coastal Protection Works Concept Design

Prepared for Napier City Council

Prepared by Beca Ltd (Beca)

20 November 2015

Revision History

Revision Nº	Prepared By	Description	Date
B	**Stephen Priestley**	Final for Council	20 November 2015

Document Acceptance

Action	Name	Signed	Date
Prepared by	**Stephen Priestley**		20 November 2015
Reviewed by	Kane Satterthwaite		20 November 2015
Approved by	Stephen Priestley		20 November 2015
on behalf of	Beca Ltd		

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1 Introduction

There is an existing seawall seaward of the Whakarire Ave residences and Council reserve. Between the seawall and the Council reserve is a lagoon which is filling with sediment and which is intertidal. The seawall is in poor condition and has been assessed as not being robust enough to protect the reserve nor residences from potential coastal erosion.

The purpose of this report is to provide a concept design for coastal protection works, comprising Option 6 (b) and Option B as put forward in the workshop report of October 2014. See Figure 1. Napier City Council (NCC) has had some preliminary discussions with local residents and a preliminary outcome was that they preferred Option 6 (b) and Option B. NCC would prefer the crest of this option were on the edge of the Council reserve and for the crest level to be as low as feasible (about RL 12.75m) so as to avoid the new works being a visual barrier. Furthermore the seawall/breakwater should remain in place to contain the sediments in the lagoon and for heritage reasons. See Figure 2 for NCC's preferred layout.

If successfully implemented it is considered that this option will meet all of the following objectives

Main Objectives

1. Protect Whakarire Ave private and public properties to the extent where the coastal hazard zone can be moved.
2. Works not to cause adverse effects on surfing conditions at Rangatira Reef compared to the existing situation.

Secondary Objectives

3. Assist in improving the state of the eastern /southern end of Westshore Beach.
4. Improve public access along/adjacent to the coastal marina area (CMA).

2 Existing Environment

Relevant tidal levels are given is Table 1, based on LINZ port standard levels for the Port of Napier.

Table 1: Tide Levels

Condition	Chart Datum (m)	Napier City Datum (m)
Highest tide on record	2.3	11.4
HAT	2.0	11.1
MHWS	1.8	10.9
MHWN	1.5	10.6
MSL	0.9	10.0

Condition	Chart Datum (m)	Napier City Datum (m)
MLWN	0.4	9.2
MLWS	0.1	9.2
LAT	0	9.1

Significant wave heights for the wave climate near Rangatira Reef are listed in Table 2. These heights are based on the predicted extreme wave heights at the Port of Napier and applying a wave transformation co-efficient of 0.45 due to the degree of sheltering. The peak wave period is taken as 12s and the maximum design wave height to significant wave height ratio as 1.8.

Table 2: Significant Wave Heights

Frequency (return period –yrs)	Significant Wave height (m)
Mean	0.4
2	1.8
5	2.0
10	2.2
25	2.4
50	2.6
100	2.8

Existing ground levels seaward of Charles Street, in the Council Reserve and the revetment crest immediately west of the Western Mole are around RL 13.0m (i.e. 3.0m above mean sea level). The existing wall/breakwater has crest levels in the range of RL 11.2 to RL 11.9m. An average value of RL 11.5m is assumed.

The existing seawall/breakwater is in poor condition but does perform as a wave break, resulting in the lagoon infilling with fine material which in itself provides some protection to the Council Reserve. In October 2015, OPUS Consultants undertook some test pits along the alignment of the proposed revetment. Generally it was found that the surface sediments in the lagoon were a mixture of sand and fine gravel and deeper sediments were pea gravel. These sediment layers generally extended to a depth of 1m below the surface where the scala penetrometer met refusal.

The observation is that the existing seawall/breakwater tends to realign the incoming wave train and focus the wave energy towards Westshore Beach. Significant erosion occurs at Westshore Beach. See photo 1.

The existing concrete blocks on Westshore Beach assist in stabilising the updrift beach but cause a 'groyne' effect downdrift (to the west) and also wave reflection which further exacerbates local erosion.

3 Concept Design

The extent of the works is from the revetment adjacent to the Western Mole of the Ahuriru Harbour entrance to the large concrete blocks on Westshore Beach. These works have been broken into two components: the area covered by the existing seawall/breakwater where it intersects Westshore Beach (Option 6(b)) and the area along Westshore Beach to the concrete blocks (Option B).

For the concept design, the following approach was taken:

a) A range of off-shore design wave heights were considered from 1.0m to 5.0m, with a peak wave period of 12s.

b) Design water level of RL 11.7m based on:

- MHWS RL 10.9m
- Storm surge 0.5m
- Sea level rise (SLR) 0.3m

The MHWS + storm surge of RL 11.4m corresponds to the highest water level on record. Allowance for SLR of 0.3m covers a period of 30 to 50 years. The New Zealand Coastal Policy Statement requires consideration of SLR over 100 years which approximately equates to about 1.0m to 2115.

The approach here is to monitor SLR and if it exceeds 0.3m then the revetment would have another layer of rock to protect it for a more elevated design water level.

c) There are 3 conditions which could be assumed for the existing seawall:

- It remains in place and acts as a wave break
- Over time the wall is ineffective but the sediment in the lagoon remains
- Over time the wall is ineffective but the sediment in the lagoon is removed down to a firm layer, 1.0m below the existing surface.

d) Some overtopping of the new revetment will be inevitable. It will be important be able to drain any overflows to the CMA. It is proposed to achieve this by having a permeable structure with rock armour occupying the entire cross-section. Furthermore, as an additional fuse, a 1.0 x 1.0m box culvert will be provided as a release point at the northern end. It is intended to provide rock to the entire revetment cross-section and to bed in the toe detail as scour protection. At the interface of the rock and the existing ground some scouring will occur from time-to-time with overflow events. This will need to be monitored and managed.

e) Limestone rock will be used for the revetment as it is readily available and used as rock armour in the region. Depending on the specific rock properties, this rock is generally classified as being "poor" to medium" quality for use as rock armour (CIRIA/CUR, 2007). On-going monitoring and management of the revetment will be necessary to maintain its performance. It is assumed that the rock has a specific gravity of 2.2 tonnes/m^3 which will require confirmation from the actual rock source when selected.

In order to estimate the wave height in front of the structure, the offshore wave was transformed, allowing for shoaling, wave breaking, energy dissipation and reformation using the energy balance relationship (USBR, 1993). It was found that the extreme waves breaking offshore created the most overtopping because, even though the wave broke and reformed, the wave set-up caused by the event created elevated water levels. A smaller event whereby the wave broke just in-front of the structure could have a similar wave height but was associated with a lower water level. Nevertheless, the structure will experience regular overtopping/spray events. A summary of the wave analyses, including for wave transformation, wave overtopping, and approximate rock sizes are given in Table 3.

Table 3: Summary of Wave Analyses

Condition	Design wave height (m)	Design Water level (RL-m)	Overtopping rates (L/s/m)		Revetment slope (1:X)	Rock Size (D_{50} mm)
			Front Edge	Back Edge		
Existing wall in place	0.4	11.7	19	0.001	3	300
Wall removed but sediment remains	0.9	12.0	148	3	3	600
Wall and sediment removed	1.6	12.0	415	76	3	1000
Wave spending beach	1.4	12.2	70	8	7	800 for structure; 300 for beach.

Notes: 1) Crest Level at RL 12.75m
2) Crest width of 3m.
3) Design water level includes MHWS+storm surge+ SLR +wave set-up.
4) Roughness coefficient as used in the overtopping relationship is 0.4 for permeable structure
5) Armour design based on Van der Meer relationship with S_d=2.0 for rock armour and 17 for beach material. Structure permeability P=0.4 and no. of waves =5000. Rock density for limestone armour ρ_r=2200 kg/m^3 and greywacke beach material ρ_r=2700 kg/m^3.

From the analysis presented in Table 3, several issues arise:

- Acceptable overtopping rates for a revetment are 200 L/s/m (CIRIA/CUR, 2007) assuming the land behind the structure is protected, with no significant damage with overtopping volumes less than 0.5 L/s/m.. This means the crest should be extended out to marry into the existing landform, wherever feasible. This will also assist in drainage behind the wall. Where it is not feasible some drainage issues and damage to land could be expected.
- If it were assumed that the existing wall and sediment were removed then the overtopping rates are too high. The wall would need to be raised to RL 13.25m to achieve an overtopping rate of 200 L/s/m. This could create a visual barrier.
- It is a dangerous for pedestrians if the overtopping rate is greater than 0.1 L/s/m. Therefore the revetment will need, at the very least, sign posting of this hazard.

- The option of leaving the sediment in place appears to provide a reasonable solution but will require the existing wall to form a sill to hold the sediment in place. This will need to become part of the monitoring and maintenance requirements for the project.
- The design of the wave spending beach is based on the profile become mobile under the design wave event. Some alteration in the profile could be expected. It is intended that the beach be formed of rounded greywacke cobbles which can be obtained from local river sources and which will be easier to traverse over. If the source of rock cobbles (300mm) cannot be obtained some smaller rock could be used but the beach will become more mobile.
- Wave reflectivity of the new structures should be less than the existing arrangement so as to not interfere with surfing conditions.
- Monitoring and management plans should be prepared to cover the condition of existing seawall as a sill for sediment retention, the condition of the limestone rock armour, overtopping scour behind the revetment/embankment, and mobility of the wave spending beach.
- Rock sizes are subject to detailed design.

A layout of the preferred option is shown in Figure 3 with cross-sections shown in Figures 4 and 5.

4 References

CIRIA/CUR (2008), The Rock Manual: The use of Rock in Hydraulic Engineering

USACE (1993) “Wave attenuation over reefs”, Coastal Engineering Technical Note.

Photo 1: Beach Erosion on Westshore Beach

Photo 2: Existing Wall/Breakwater at Low Tide

Photo 3: Existing Wall/Breakwater during Sea Storm

Photo 4: Alignment along Council Reserve

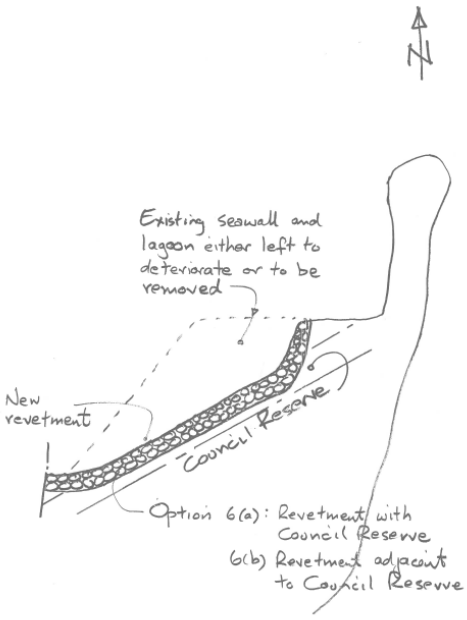

FIGURE 5
OPTION 6

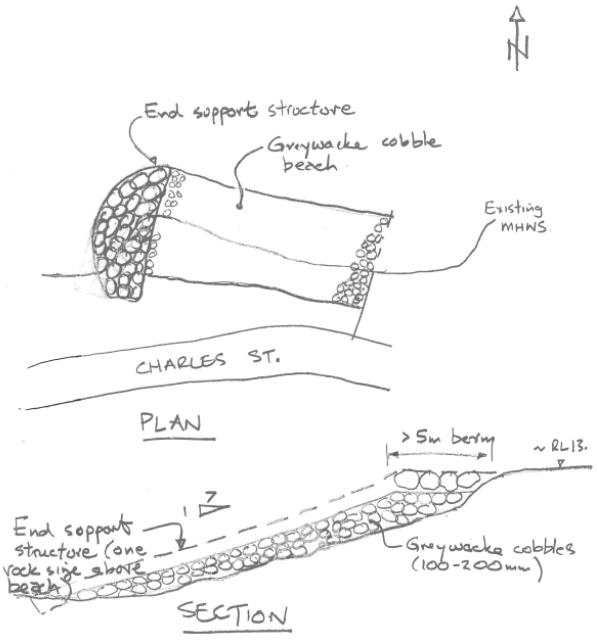

FIGURE 7
OPTION B

FIGURE 1


CARPARK
Carpark reconfigured as shown with drainage swale to emphasize environmental values and provide a buffer.
POSSIBLE FUTURE ADDITIONAL CARPARK
Parking area at head of cul-de-sac near to main entrance. Area to include bioswale for stormwater treatment. Planting suggested to provide shade and amenity. Main 2m wide walkway to extend past this parking area. Suggest mixed native hardwood plantings including taramakers such as Kowhai and Pohutukawa.
PARKING
Provision for 20 more parking provided off Charles Street. Area to include bioswale for stormwater treatment. The main walkway should adjoin the parking area.
TOILET BLOCK
Approximate position of new toilet block.
WHAKARIRE AVENUE
CHARLES STREET
WHAKARIRE AVENUE BREAKWATER
WEEKS ASSET Dept
HASTER CITY COUNCIL
APPROVED DOCUMENT
WHAKARIRE AVENUE PROPOSED LANDSCAPING
PR7
SHEET 1 of 1 SHEETS

FIGURE 2

FIGURE 3

NOTES:

1. ROCK SIZES ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
2. ROCK TO BE LOCAL LIMESTONE. WAVE SPENDING BEACH TO BE GREYWACKE COBBLES.
3. EXISTING SEAWALL TO BE LEFT IN PLACE BUT NOT REPAIRED UNLESS SEDIMENT IN LAGOON IS LOST.

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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	BA	SJP		13.11.15

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Original Scale (A1) 1:500	Design	SJP	03.11.15	Approved For Construction*
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Client: NAPIER CITY COUNCIL

Project: WHAKARIRE AVENUE COASTAL PROTECTION WORKS

Title: FIGURE 3: LAYOUT PLAN

Discipline: CIVIL

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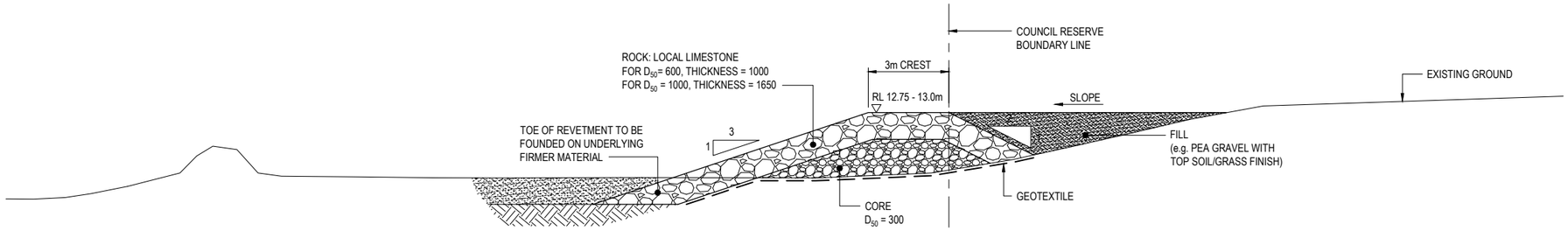

TYPICAL REVETMENT SECTION IN COUNCIL RESERVE
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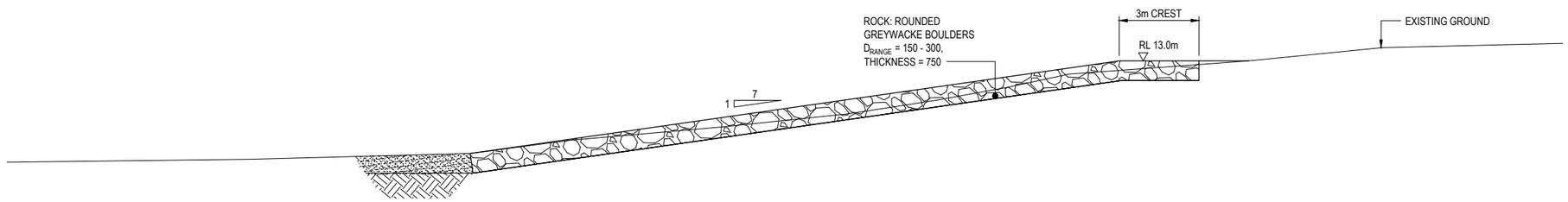

TYPICAL WAVE SPENDING BEACH SECTION
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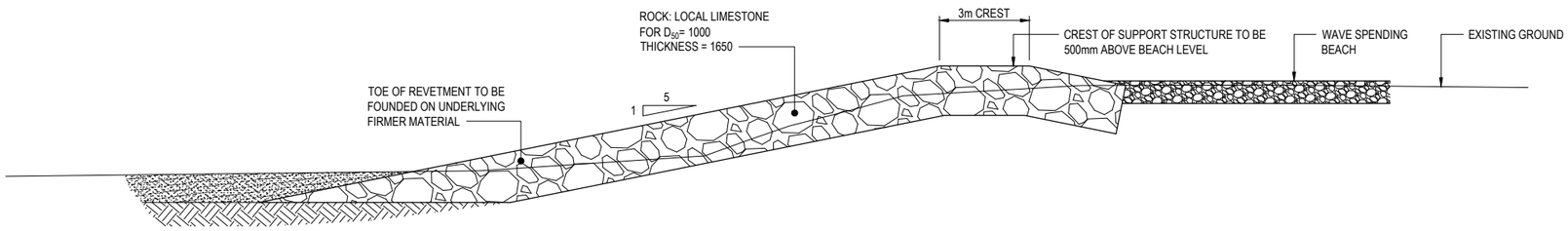

TYPICAL BEACH SUPPORT STRUCTURE SECTION (IN EAST WEST DIRECTION)
1:200 (A3)

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Title: FIGURE 4: TYPICAL SECTIONS

Discipline: CIVIL

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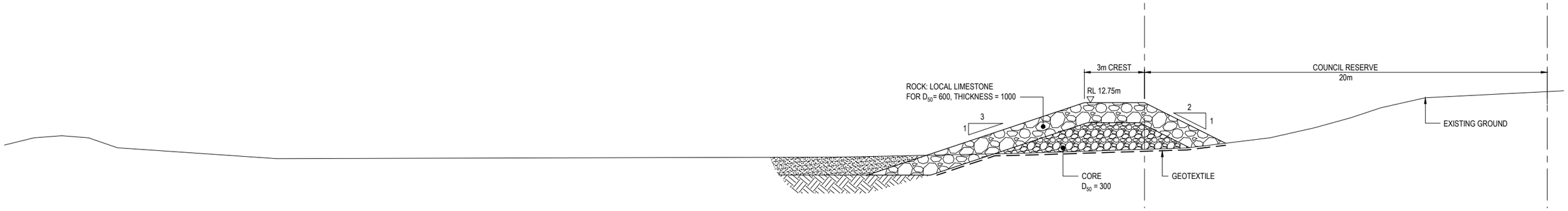
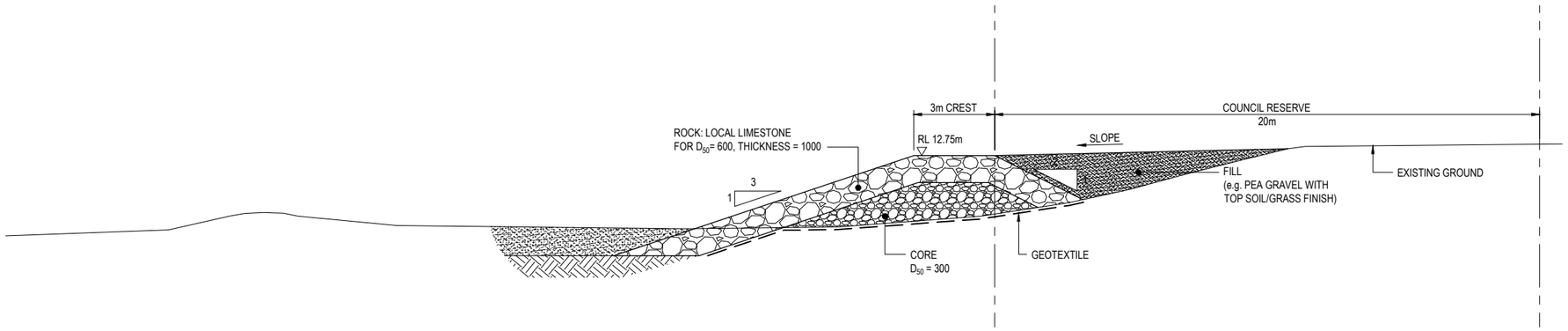


3 CE-001 REVETMENT SECTION
1:200 (A3)



2 CE-001 REVETMENT SECTION
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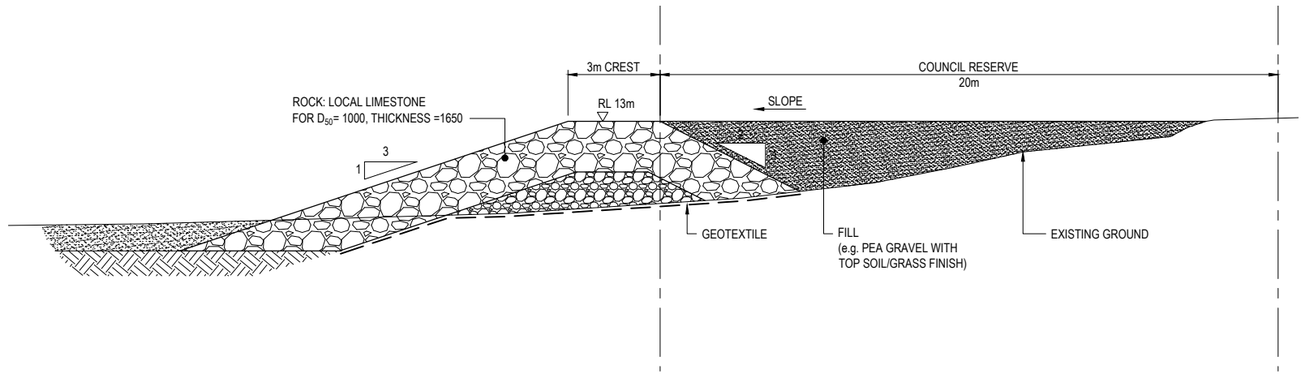

1 CE-001 REVETMENT SECTION
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Project: WHAKARIRE AVENUE COASTAL PROTECTION WORKS

Title: FIGURE 5: SECTIONS

Discipline: CIVIL

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