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16 August 2022

West Coast Regional Council
PO Box 66
Greymouth 7840

Attention: Kate McKenzie and Fiona Scadden

Dear Kate and Fiona

Section 92 letter RFI-Hokitika Seawall RC-2022-0039 AND RC220053

Thank you for your letter of 16 June 2022 and we respond to your questions as follows.

1. A number of reports are referenced in the application, which may assist to better understand the application if provided in full – please provide a copy of the following:

a. West Coast Penguin Trust report on Kororā

b. Civil 3D Profile survey of the Mean High Water Springs line.

The Penguin report is attached in **Attachment 1**. The MHWS contour as a shapefile is attached to the covering email (nominally shown as **Attachment 2**).

2. It is acknowledged that the application seeks consent for works within the Coastal Marine Area on the basis that the toe of the seawall will in places be below the Mean High Water Springs line. Please advise whether the applicant is aware of any significant changes to this line since the profile survey was undertaken in 2021 i.e. whether further erosion or accretion has taken place.

The Hokitika coastline is a dynamic environment where beach levels and the Mean High Water Springs (MHWS) position change frequently in response to wave and water level conditions and sediment supply.

A June 2022 post-storm visit by Beca to inspect the existing revetment noted that the temporary emergency works have helped to slow retreat of the landward scarp at the upper limit of the beach. Retreat of the scarp, where this appears to have has occurred, is estimated to be generally less than 0.25m over the past year based on observations. The visit also noted significant storm-generated deposition of sand along the upper beach for the majority of the Stafford Rd to Tudor St shoreline, although beach levels were returning to more typical levels through the post-storm period. As a result of the June conditions and post-storm beach changes, the MHWS position moved seaward and then appears to be returning towards its previous location. This has not been surveyed as beach levels and MHWS position will continue to change over time.

Actual beach levels and Mean High Water Springs position will be surveyed immediately prior to construction and survey results and the revetment design will be provided to Consent Authorities (WDC/WCRC) prior to commencement of work on site,

3. The application is not clear whether the seawall/rock material will be removed at the end of the term of consent. Please provide information regarding the proposed end of life plans for the seawall.

make
everyday
better.

In future, the structure will be dependent on the results of the dynamic adaptive pathways planning to be undertaken and may be one of the options in the resulting Adaptive Planning Strategy that covers this area. A fifteen-year consent term application has been proposed in anticipation of the outcome of that work but the applicant does not wish to pre-empt the outcome of that study by definitively stating the seawall will be rebuilt (i.e. the asset renewed with a design life consistent with the Adaptive Planning Strategy), or removed at the end of the term of consent. A separate consent will be sought for rebuilding/upgrading or removal of the revetment extension once the outcome of the adaptive planning process is known.

4. The aerial photograph in Section 2 (Figure 2.1) notes a "Provisional Extension" at the Richards Drive end of the seawall. Please confirm whether this forms part of the current application. If it does, does, this may introduce the requirement for additional consents relating to the waterway indicated in the AEE, and further assessment of the effects of this extension will also be required.

The "Provisional Extension" does not form part of the application. This has been clarified in the updated issue of the AEE (**Attachment 3**). This AEE (Rev C) replaces the AEE that was submitted with the consent application.

5. The application notes that the emergency works undertaken in the same area between 2019-2021 do not form part of this application, however the rock material, where practicable will be re-used as part of this proposed seawall. In section 3.2.3 of the application it states that there is approximately 10,000 tonnes of the 16,000 tonnes that can be re-used. Please advise what will happen to the remaining 6,000 tonnes of rock, which is presumed to be within the footprint of the proposed seawall. Will it be retained on the beach, or removed for disposal?

The remaining emergency works rock that is not used in the revetment extension will be made available for use in groyne repairs as approved by the WCRC (this is a separate activity to the revetment construction) or alternative consented projects. Any remaining rock not taken up for these uses will be disposed of to a consented landfill. The stated 10,000 tonnes is an estimate of the quantity of emergency works rock that will meet design specifications (ie allows for 6,000 tonnes to be wrong size/durability for armour or underlayer rock).

6. Section 3.23 of the AEE also notes that approximately 48,000m^3 of material will be placed in the dune area. It is assumed that a similar volume of material will be displaced. The AEE states that this sand will be replaced following excavation. Please advise what the impact of the displacement of this material will be on the beach profile.

As noted above under Question 2, beach levels along the Hokitika coastline change frequently in response to wave and water level conditions and sediment supply. The actual volume of sand to be excavated and replaced will depend on beach levels at the time of construction, which will be established by a survey and provided to Consent Authorities (WDC/WCRC) prior to the commencement of work onsite.

It is not intended to remove any natural material from the beach. Excavated beach material will be replaced on the beach and over the revetment to form a uniformly sloped profile, matching existing beach levels at approximately the mid- to low -tide position on the beach. That profile will be shown on the drawings provided to Consent Authorities (WDC/WCRC) prior to the commencement of work onsite. The coastline is a high energy environment and recontoured material will quickly be returned to equilibrium by the beach system. Material excavated from the backshore (i.e. non-sandy material) will be replaced over the revetment crest, landward revetment slope and adjacent land to match existing backshore levels approximately 10m landward of the crest.

7. Section 5.3.11 of the AEE states that the dust effects of the proposal will be less than minor. Please advise whether the activity can be carried out as a permitted activity or will require an air discharge permit under the Regional Air Quality Plan.

It is anticipated that the proposal will comply with Rule 5 EARTHWORKS, QUARRYING, MINING AND CLEANFILL OPERATIONS of the WCRC Air Quality Plan conditions (a) and (b) (as set out below) by the instigation of appropriate dust management measures such as those discussed in Section 5.3.11 of the AEE. As such, any discharge of dust will fall to permitted activity status.

a) *any discharge of smoke, dust, gas or odour is not noxious, dangerous, offensive or objectionable beyond the boundary of the subject property; or b) in the case of public amenity areas, any discharge of smoke, dust, gas or odour is not offensive or objectionable beyond the boundary or beyond 50 metres of the discharge, whichever is the lesser*.

8. Section 6.2.6 discusses the consultation that has occurred with Te Runanga o Ngāti Waewae, which includes requesting a consent condition which would require the applicant to plan for and implement an adaptive management strategy for the longer-term management of coastal hazards at Hokitika. Acceptance of such a condition by the applicant is noted. Further details of any proposed conditions to address this matter are required, in order to ensure that such a condition is not ultra vires.

The following condition is suggested:

"The consent holder shall form a joint working group to undertake an Adaptive Management Strategy for the long-term management of the coastal hazard risk within Hokitika. The Adaptive Management Strategy shall be prepared in accordance with the most up to date legislation and direction from Central Government to help guide climate change adaptation (including managed retreat) in New Zealand and be completed prior to 31 December 2030".

9. Please provide further details about the potential staging of the seawall construction. The application notes in Section 7.5 that "the more practical and effective approach to construction is to commence construction from the southern end tie in position and advance northward as funding allows". Elsewhere the application indicates that construction will take approximately 6 months. If the seawall is not fully funded, and the construction works can be expected to take place over a number of years, please provide information about the intended staging of works, including:

• If the sea wall construction was to be staged, what would be the immediate and long term effects (including access, visual impact, erosion risk) on adjoining properties and the coastal environment, while the wall is incomplete?

• Are there specific stages recommended to reduce effects on adjoining properties and the surrounding environment?

• If the sea wall construction is to be staged, what would be the maximum timeframe between stages?

• If the sea wall construction is to be staged, what would be the maximum timeframe to completion?

It is proposed to construct the seawall in a single stage. However, it is acknowledged that if funding did become an issue a staged approach may be required.

10. Section 9.3 assesses the proposal against the Regional Policy Statements however the 2000 Regional Policy Statement is no longer operative, and the 2020 West Coast Regional Policy Statement is now operative. The applicant may wish to provide a revised assessment to ensure that the current objectives and policies of the operative Regional Policy Statement have been appropriately assessed.

A revised assessment has been included in the updated AEE report provided as a separate document with this letter.

11. The AEE notes that two Taonga species listed in Schedule 97 of the Ngāi Tahu Claims Settlement Act 1998 are present and may be affected by the proposal (Kororā and Pīngao). It is noted that the AEE confirms that the applicant has agreed to a Cultural Impact Assessment being conducted. The provision of this Cultural Impact Assessment is required to better understand the potential effects of the proposal on Te Rūnanga o Ngāti Waewae cultural values.

The CIA has not yet been provided by Te Rūnanga o Ngāti Waewae but will be forwarded when available.

12. Please provide any correspondence received in response to the notice served on Te Rūnanga o Ngāi Tahu and Ngāti Toa Rangatira under Section 62(3) of the Marine and Coastal Area (Takutai Moana) Act 2011.

To date, an email has been received from Anahera Nin, Senior Policy Advisor with Ngāti Toa Rangatira and which is attached in **Attachment 4** to this letter.

13. The proposed seawall design provides for access ramps at each of the public road accesses along the length of the application area, which appears to have a GAP100 finish. Please explain how these ramps will perform over the life of the seawall (i.e. initially when sand covers the majority of the wall as opposed to if erosion of the beach material occurs and the wall is more exposed), the suitability of the proposed surface for pedestrian use, and whether a maintenance regime is proposed to ensure suitable and ongoing access.

The access ramp approach has been refined so that all accessways (for pedestrian and penguin access) are constructed from shotcrete surfacing on the revetment. The accessways and maintenance are described in Sections 6.5 and 7.3 in the Detailed Design Report (DDR, **Attachment 5**). This report replaces the Basis of Design Report that was attached to the AEE (Rev B) submitted with the consent application.

14. Tonkin and Taylor have been engaged to conduct a coastal engineering review of the application under section 92(2) of the RMA 1991. The preliminary review has highlighted a number of questions which require a response prior to the peer reviewer being able to complete their report. The questions are contained in the attached memorandum. Please provide the requested information and a response to the questions contained in this memorandum.

Please see the response in the DDR (**Attachment 5**) and **Attachment 6** attached to this letter. The table below indicates where the information and questions are addressed.

Item	Query/Clarification	Addressed by / Reference
Performance of existing seawall designed and constructed in 2013	How has this structure performed and how different/similar are the design criteria and the current design? This provides confidence both on the design criteria and performance.	Detailed Design Report Section 2.1
Long term trends	What are the long term erosion trends at this location and how will this affect scour/toe depth and beach position? While SLR has be taken into account for water level, it is unclear if beach adjustment over time including present and future trends have been considered. This speaks to the requirement of the seawall and the potential effects of the seawall both in the short and medium terms.	Detailed Design Report Section 2.2 Appendix B

Item	Query/Clarification	Addressed by / Reference
Basis of Design Report (BDR) identifies there is a detailed design report and detailed design drawings are attached to this report.	Can you provide Detailed Design Report? There are a number of matters identified in Section 6 that would be useful to see the design outcomes and process. A reverse analysis on the stability of the seawall due to less frequent events that may still occur during the design period. Using the crest of the rock revetment as the height of the impermeable structure is likely to underestimate overtopping volumes and effects. EurOtop recommends using an average (c.f. Figure 1.8)	Detailed Design Report Assessment of 2% AEP conditions included in Detailed Design Report as well as 3.25% AEP conditions The revetment extension is to be buried with the crest and backslope covered by replaced backshore material. The crest level therefore becomes the height of the impermeable structure.
Design life (BDR Section 3.2) – stated agreement with WCRC to be sought	What is the agreed design life? Speaks to the long term trend point above	Detailed Design Report Section 5.1
Material availability (BDR 4.1)	Given the same quarry is proposed as 2013, what was the quality results for the rock at that time? (additional information that would support the 2000 report information quoted).	Detailed Design Report Section 5.3. We have put considerable effort into following up more recent rock information with Council, the quarry and consultants and contractors who have used the rock in the past 10 years. The DDR contains all information sourced to date.
BDR Section 5.1 Datums)	Any comment/ consideration of Vertical Land Movement as included in recent SeaRise website? Worth a statement to consider this new information.	Detailed Design Report Sections 4.2 and 4.3.5
BDR 5.7 Geotechnical information identifies very loose to loose material of between 0.65m to greater than 2	Locations of testing not shown. What are these depths of loose material in relation to a datum and does the proposed depth and design of the revetment take this into account?	Detailed Design Report Section 4.7

Item	Query/Clarification	Addressed by / Reference
m depth overlying dense material		
AEE Section 5.4(b) effects on beach performance	No discussion on impoundment effect of the wall (and cumulative effects of this and adjacent wall) on shoreline evolution. Unless this is what you are saying in 5.4.6? With life of 10-15 years should you also consider removal as an effect?	AEE Section 5.4.6 **Attachment 6** See also response to Question 3 in this letter
No options assessment?	Some form of assessment to show that this is the preferred option from an effects basis is necessary.	**Attachment 6**

15. The construction of a sea wall on the road reserve is not listed as a permitted, controlled, restricted discretionary or discretionary activity within Part 6 of the Westland District Plan. The activity is also not a permitted activity for the underlying zone as per 8.7 of the Westland District Plan.

• Please provide assessment of Part 6 and Part 8.7 of the Westland District Plan and provide further information regarding the status of the non complying activity.

We note the Explanation in Part 6 states the following;

There are a number of activities which are acceptable throughout the District, or for which applications will be required, regardless of what zone they are situated in. These activities are mostly works associated with services or temporary activities.

Road construction where it relates to existing roads is provided for as of right throughout the District. New roads will require a resource consent, either as part of a subdivision or on their own. A number of activities with the potential to distract traffic will also require a resource consent.

It is agreed that the proposed seawall is not listed in Part 6 as a *permitted, controlled, restricted discretionary or discretionary activity* unless it is considered a "stopbank" under Rule 6.2(i*)* in which case it would be a permitted activity (there is no definition of "stopbank" in the WDP).

If the seawall is not considered a stopbank, it appears that Part 6 does not apply to activities such as a seawall. Part 6 appears to be predicated on the section applying to certain activities on road reserves in which the activities appear to be focused on road construction such as in 6.2(c) and 6.4(a). If the activity is not specifically mentioned there does not appear to be any mechanism in Part 6 which defaults the activity to a non complying activity, or even discretionary activity. While Rule 6.5 (c) states the following is a discretionary activity:

(c) Any public or network utility not being a permitted activity or exceeding the Permitted Activity standards in 6.6(B)

the seawall is not defined as a network utility in the Definitions section of the WDP and there is no definition of "public utility". There are no non -complying activities in Part 6.

In terms of Part 8, this states: *Where there is unformed legal road, the activities which may be established on that land shall be the same as those which are permitted for the zone, subject to agreement with the owner of the road unless otherwise shown in the Plan.*

Notwithstanding the above, the only other activities which may be carried out on land gazetted, granted or reserved as, or for a road are defined in Part 6 as a permitted, controlled or discretionary activity.

In respect of this, the relevant zone is the Coastal Protection Zone in which the seawall is not a permitted activity and is a restricted discretionary activity. It is agreed the proposed seawall is not defined in Part 6 as a permitted, controlled or discretionary activity, unless it is considered as a stopbank (see above). Part 8 goes onto imply that resource consent is required but does not indicate the status of activities that are not specifically mentioned. Section 87B(1)(b) of the RMA indicates that in such circumstances the activity shall be considered as a discretionary activity. Even if the activity is deemed a non -complying activity, the threshold tests of section 104D relating to minor effects and the objectives and policies of relevant plans are met as set out in the AEE.

In summary, the WDP provisions are not entirely clear, but it appears because the activity is not specifically mentioned in Part 6 (unless it is considered a stopbank) then this section is not applicable, particularly as there is no default for activities not specifically referred to.

Conversely, Part 8 does refer to activities on road reserve not specifically mentioned in Part 6. It implies that resource consent is required without stating what the status of the activity should be. The RMA indicates that an activity not classified in a plan should be treated as a discretionary activity. Even if the activity is construed as a non -complying activity, section 104D (1) is met for the reasons outlined in the AEE.

16. As per 5.2.3 of Hokitika Seawall Extension – AEE, it is noted that Little Blue Penguins breed between June and January and move around less frequently between March and May.

• Please clarify whether the proposed six months of construction works will be undertaken to avoid breeding season or utilise the time of less frequent movements being March to May.

As noted in Section 5.3.2, while construction could take some 6 months (and potentially up to 12 months if inclement weather affects construction), the sequencing of construction near known roosting areas will need to be taken into account by the contractor to avoid where practicable, the main breeding period (June to January). The mitigation set out in Section 5.3.2 states that the protocols proposed by the West Coast Penguin Trust for minimising disturbance of penguins, particularly during the breeding season (but at all times where practicable) are supported by the applicant. As set out in the proposed conditions, a Penguin Management Plan (PMP) will be prepared in consultation with the West Coast Penguin Trust prior to commencement of works onsite. The PMP will be prepared with regard to the Trust's report included as **Attachment 1**. This will include utilising the time of less frequent bird movements for works near to known roosting areas after January (and where practicable, between March and May).

17. As per 5.3.2 of Hokitika Seawall Extension – AEE, please clarify:

• What provisions will be put in place to ensure successful monitoring of the sea wall condition, post storm events?

• How will a storm event be quantified to be large enough to check the rock work?

• How soon after a storm event will a staff member be deployed to assess the potential damage to the rock work?

• What level of damage would constitute the need for remediation works?

• How will these works be carried out and how will those employed to undertake the activity be suitably qualified to do so?

• How soon after an event would these works be carried out?

When addressing the above items, please ensure practicable and specific intentions are volunteered where appropriate as this is likely to inform the conditions associated with the decision.

The questions above are addressed in Section 7.3 of the DDR (**Attachment 5**), specifically:

Questions	Reference
What provisions will be put in place to ensure successful monitoring of the sea wall condition, post storm events?	Detailed Design Report Section 7.3
How will a storm event be quantified to be large enough to check the rock work?	Detailed Design Report Section 7.3.5
How soon after a storm event will a staff member be deployed to assess the potential damage to the rock work?	Detailed Design Report Section 7.3.2
What level of damage would constitute the need for remediation works?	Detailed Design Report Sections 7.3.2 and 7.3.3
How will these works be carried out and how will those employed to undertake the activity be suitably qualified to do so?	Detailed Design Report Sections 7.3.3 and 7.3.4
How soon after an event would these works be carried out?	Detailed Design Report Section 7.3.3

The Consent holder will be required to notify the Consent Authorities (WDC/WCRC) at least 10 days prior to any required maintenance occurring and provide the following in writing:

- A detailed summary of the maintenance work
- The timeframe required to carry out the work
- The methodology for undertaking the work including any heavy traffic movements
- Details of the contractor completing the work (including contact details for the Site Manager)
- Details of any public safety precautions to be undertaken, including signage, fencing and requirements for closure of sections of the beach.

All maintenance activities will be undertaken between the hours of 8am and 6pm, Monday to Friday (no work to be undertaken on weekends or public holidays unless required to ensure public safety).

Any noise during maintenance work will be managed in accordance with NZS 6803: 1999 Acoustics-Construction Noise.

18. As per 5.3.8 of Hokitika Seawall Extension – AEE, please assess and explain:

• The potential visual impact on adjoining properties regarding the height of the sea wall, being higher than current ground height as demonstrated in Figure 3 2 Cross section of seawall higher toe height.

Figure 3-2 shows that that the difference between the lowest existing ground level and the top of the seawall is approximately 0.3 m which is considered to have an insignificant effect on adjoining properties given the following:

- The intention to tie the proposed seawall into the existing ground level as much as possible with, for example, the cross section in Figure 3-3 showing the seawall generally flush with the existing ground level. The existing ground level undulates to some degree along the length of the seawall.
- The seawall is not in the immediate foreground of the adjoining properties being approximately 25m from the adjoining property boundaries.
- The existing views from the adjoining properties are already obscured by existing vegetation, ground undulations, boundary fences and various structures on the unformed road.

19. As per 5.3.9 of Hokitika Seawall Extension – AEE, please assess and explain:

• How many vehicle movements per day are expected with a summary of heavy vehicles as well as contractor/staff/ operator vehicles.

• The type and number of heavy machinery/vehicles expected to be operating on the site.

The exact nature of the construction will be dependent on the contractor. The proposed conditions of consent include the requirement for the contractor to prepare a Construction Environmental Management Plan for the approval of the respective Councils (proposed Condition 9) and will address the type of matters raised in the query. We note the effects of construction are addressed in Section 5.3. However, at this stage it is anticipated up to two excavators would be working at any one time on the wall with a smaller one for preparation, access, and access track maintenance and a similar number of dump trucks. Figure 3-4 of the AEE shows a typical construction process. As a rough indication there could be 80-120 rock truck movements per day with two “working faces” based on a five day week and approximately 20% downtime for a six month construction period.

Figure 3-4 Installation of existing seawall showing temporary sand bund and rock stockpile

Yours sincerely

Paul Whyte

Senior Associate - Planning

on behalf of

Beca Limited

Phone Number: +64 3 374 3180
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Copy

Rachel Vaughan, James Bell, West Coast Regional Council

Scott Hoare, Onovo

Attachment 1

West Coast Penguin Trust Report on Kororā

HOKITIKA BEACH BLUE PENGUIN SURVEY AND COMMENTARY ON PROPOSED SEAWALL

For West Coast Regional Council

From West Coast Penguin Trust

June 4, 2021

Background:

The West Coast Regional Council (WCRC) are planning to build a 1150m long seawall on the North Hokitika Beach to protect road reserve and residential property from storm surge and coastal erosion. The prevailing westerly weather conditions can deliver large and regular storm patterns. The WCRC recognised the project needs to take into consideration blue penguin use of the area. The West Coast Penguin Trust (WCPT) was approached to survey the project area for blue penguin* and to create protocols that the WCRC and the seawall building contractors could adhere to. Protection of coastal land, private property and blue penguin through seawall development can occur with a collaborative approach between WCRC, WCPT and property owners.

* We refer to blue penguin in the singular when referring to the species.

Plate 1: **Hokitika Beach. Steep sand dune banks caused by coastal erosion illustrate the reason for consideration of a rock seawall and the current tenuous penguin access to foreshore habitat. Residential property behind vegetation.**

Site:

The locality is the North Hokitika Beach, the foreshore of Hokitika (Plate 3). An existing seawall stretches from the Hokitika River mouth along the beach for approx. 750m to Stafford Street. This protects the town's CBD from coastal erosion and storm surge. The size and nature of the rocks of this seawall do not provide great refuge sites for blue penguin or allow for safe travel of penguin across them. Blue penguin is not known to currently breed within the wall but, at the existing wall's northern end, where the erosion slope is shallower, they are known to go around the wall into foreshore habitat. The proposed project is to extend this seawall in a similar fashion 1150m to Richard's Drive in the north to offer protection to foreshore road reserve and residential property. This is an area where blue penguin is known to seek refuge and occasionally to nest.

Along most of the road reserve (and in many abutting residential gardens), there is suitable vegetation to provide refuge and breeding habitat for penguin. In recent years coastal erosion has steepened the dune bank and has reduced penguin accessibility to the foreshore habitat. Along the length of the project site, penguin tracks have provided evidence over recent years that penguins continue to access the foreshore habitat. (Plate 3 shows indicative sites.)

Blue penguin on the West Coast breeds from June to January. The post breeding moult can occur through to March. During this entire period, they are often ashore, and are travelling between nests and the sea regularly. At this time, they are vulnerable to disturbance from people, dogs and development. Outside this time (April – May), the penguins are ashore much less, but still come ashore to rest between foraging trips. It is not recommended by the WCPT to perform project work during the breeding or moulting period. If a project must occur outside the recommended period a weekly survey of the entire project area for penguin nests and a daily search of the current work zone to confirm blue penguin are not present can mitigate.

Plate 2: Blue penguin waiting to access refuge sands in the foreshore environment

Plate 3: Hokitika Beach seawall extension project.

Orange = seawall extension **red** = roadway alignment **blue** = penguin foreshore access

Survey:

On the morning of May 03, 2021, Matt Charteris (WCPT Ranger) visited the site. It was low tide and weather conditions were excellent for the survey. The location of the proposed seawall was investigated as was part of the existing seawall and 250m north of the northern end of the proposed seawall. Sign of penguin use on the beach and in the adjacent foreshore area was searched for. Foreshore access sites for penguin were recorded with gps. The value of a seawall to protect both the foreshore habitat suitable for blue penguin refuge and breeding, and the residential property behind, was obvious. The area to the north of the proposed seawall was seen to be used by penguin. This area may be affected negatively by water movement off the northern end of the wall.

No penguins were encountered but sign of penguin activity was observed in the penguin foreshore access areas.

The existing seawall was found to be made with rocks and in a manner not suitable for providing safe access for penguin over to the foreshore habitat, or for internal refuge sites for penguin (however noting that this site is not suitable for internal refuge due to wave action), (Plate 5). Access over the wall to the foreshore habitat is imperative if blue penguin is going to continue to breed on Hokitika Beach. If the same rock in terms of type and size will be used to extend the rock protection, safe access for penguin to suitable refuge sites in the foreshore habitat will be severely compromised. At access sites on the proposed seawall extension, suitable surface modification to the seawall rocks to allow penguin safe access to the foreshore habitat would need to be made.

Suitable refuge and breeding sites were noted in the foreshore habitat and on residential property. Buildings can be utilised by penguin for refuge and breeding, but this is not ideal for penguin, buildings or people. Buildings could be closed off to penguins by restricting access underneath. Alternative sites for penguins can be put in place by locating nest boxes in the road reserve area and, where desired by property owners in residential gardens. Nest boxes, if used for refuge and breeding by penguin, also provide protection from dogs, cats and weka.

Plate 4: **Penguin survey May 03, 2021.**

Red = survey track
Pink = approximate sites of known penguin foreshore access
Yellow = proposed additional foreshore access sites to foreshore habitat
Blue = penguin foreshore access sites to the north

Plate 5: **Existing seawall (May 2021), Hokitika Beach. Not suitable for blue penguin due to steep angle and hole size between boulders.**

Recommendations:

In terms of penguin conservation, the WCPT sees no reason that construction of the seawall should not occur if the following recommendations are adhered to.

Recommended WCPT seawall protocols that would apply to any coastal site where rock protection is being considered are shown in bold.

GENERAL SEAWALL PROTOCOL – before seawall construction, a survey to be performed and report written for consent requirements by a wildlife consultant. The survey report to be made available to WCPT for comments.

1. **PROTOCOL – construction work in blue penguin foreshore habitat to occur in daylight hours and between 16 March 15 – June 15.**

   - Seawall work to occur between March 16 and June 15 during daylight hours. We have a high degree of confidence that this is outside the penguin breeding and moulting seasons. Penguins may still be present however, so daily inspection with a torch (to look into holes) of the work area and any stockpiled rock to be performed to confirm the presence / absence of penguin. If penguins are detected, the WCPT or a DOC Ranger to be contacted to assess the situation.

   - If the seawall construction project must occur outside the recommended period, a survey of the entire project area for penguin nests using an appropriately trained conservation dog would be required, ideally repeated fortnightly. In addition, a daily person search, with a torch, of the current work zone to confirm blue penguins are not present would need to be performed. Access to active nests in the foreshore habitat would need to be maintained overnight, every night. This could be in a temporary fashion if required, and the WCPT should be involved in this process. The ‘searcher’ should be trained by the WCPT and have weekly contact with WCPT to discuss the penguin / project situation along Hokitika Beach.

   - Priority will always to be avoid disturbing penguin, in particular breeding penguin, and removal would only ever occur as a last resort where penguin lives are at risk,

2. **PROTOCOL – where blue penguin refuge habitat exists, access ways to be maintained**

   - At the known existing penguin access sites, shotcreted paths to be created for penguin access into the foreshore environment. Paths to be between 1-2m in width with the lower third of the rock wall path to widen to 4m. No holes to deep cavities on path edges. If steps are required, they are to be no higher than 20cm, though ideally avoided, and the path angle to be low in the north and high in the south to be against the prevailing SW sea conditions. In addition, at two or three sites where suitable foreshore habitat is present as well as if penguin sign is seen at other locations leading up to and during the construction project, similar paths to be created in conversation with WCPT and/or DOC Rangers. These angled paths will allow continued safe penguin access to refuge within the foreshore area.

3. PROTOCOL – where penguin refuge sites are compromised, additional artificial refuge sites to be put in place

- Locate nest boxes within the foreshore habitat associated with each of the existing and additional landing sites/shotcrete paths. Nest boxes to be located with the aid of the WCPT. Plantings may be necessary to shade the nest box sites. Nest boxes not to be located under buildings.

4. PROTOCOL – where seawall construction exacerbates adjacent erosion and compromises breeding penguin, discussion on possible mitigation to occur with the WCPT

- If water movement and associated erosion off the northern end of the seawall compromises the known penguin access to the north, then mitigation options to be discussed with WCPT.

5. PROTOCOL – no dogs

- No dogs on construction site

6. PROTOCOL – areas beneath buildings to be made safe from refuging blue penguin for their safety and for building health

- To discourage nesting and moulting under adjacent buildings, it is recommended that the adjacent house owners mesh or board up the understorey of their buildings

Attachment 2

Extracted MHWS contour as a shapefile-refer to email of 17/08/22

Attachment 3

Updated Assessment of Environmental Effects

See separate attached PDF file

Attachment 4

Email from Ngāti Toa Rangatira re notification under Marine and Coastal Area (Takutai Moana) Act

Sensitivity: General

From: Resource Consents <resource.consents@ngatitoa.iwi.nz>
Sent: Friday, 6 May 2022 1:42 pm
To: Graeme Jenner <graeme.jenner@beca.com>; Paul Whyte <paul.whyte@beca.com>
Cc: Resource Management <resourcemanagement@ngatitoa.iwi.nz>
Subject: RE: Hokitika MACAA Seawall Letter

> You don't often get email from resource.consents@ngatitoa.iwi.nz. Learn why this is important

Kia ora Graeme,

Thank you for the letter provided to Tā Matiu Rei. For future, please email us at resource.consents@ngatitoa.iwi.nz for any consenting matters or resourcemanagement@ngatitoa.iwi.nz for any resource management-related matters.
I assume the consent has already been lodged (the letter details the consent was going to be lodged Feb 2022) so we ask that these matters please be sent to us well in advance.

Ngā mihi

TE RŪNANGA O
TOA RANGATIRA

Anahera Nin
Senior Policy Advisor
Treaty and Strategic Relationships | Te Rūnanga o Toa Rangatira
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TE AO TŪROA | OHANGA | ORANGA | WHAI MANA | NGĀTI TOA RANGATIRATANGA

Attachment 5

Detailed Design Report

Hokitika Revetment Extension

Detailed Design Report

Prepared for West Coast Regional Council
Prepared by Beca Limited

16 August 2022

Creative people together transforming our world

Contents

Appendices

Revision History

Revision Nº	Prepared By	Description	Date
A	Hamish Dallas	For Client Comment	10.08.2022
B	Hamish Dallas/ Jennifer Hart	For Issue with Section 92 Response	16.08.2022

Document Acceptance

Action	Name	Signed	Date
Prepared by	Hamish Dallas / Jennifer Hart		16.08.2022
Reviewed by	Kane Satterthwaite		16.08.2022
Approved by	Jennifer Hart		16.08.2022
on behalf of	Beca Limited		

1 Introduction

1.1 Background

The West Coast Regional Council (WCRC) is proposing to construct an approximately 1.2km long extension of the existing Hokitika revetment between Stafford Street and Richards Drive (see Figure 1). The existing revetment is a 1000m long rock structure, that protects a portion of the township between Hokitika River mouth and Stafford Street. Temporary emergency works have been undertaken in sections to the north of Stafford Street from October 2019 up until early October 2021, with rock now placed on the upper beach for all almost the full length of the Stafford Street to Richards Drive frontage (approximately 1.2km).

The new revetment extension covered by this report extends from Stafford Street to Richards Drive (refer to Figure 1), replacing the 16,000 tonnes of rock placed as emergency works. Suitable rock from the emergency works will be re-used in the revetment extension (potentially some 8,000 to 10,000 tonnes re-used), with remaining rock removed and made available for maintenance of the existing groynes and local projects.

Areas of the Hokitika township are under threat from sea level rise and coastal erosion events. The proposed revetment extension along the Stafford Street to Richards Drive beach frontage will help to provide interim protection against coastal erosion and reduction in potential wave overtopping for the adjacent low-lying public land bordering the beach. Private properties are located between 25m and 40m from the present upper beach erosion scarp.

Figure 1: Hokitika Revetment Extension Project location

1.2 Purpose of this Report

WCRC has engaged Beca Ltd. (Beca) to undertake detailed design for the Stafford Street to Richards Drive rock revetment extension. The purpose of this detailed design report is to set out the key design assumptions and inputs, design approach and the design output. It should be read in conjunction with the Basis of Design prepared by Beca and dated 1 December 2021, which includes the design criteria.

The scope of works for the Hokitika Revetment Extension includes:

- Design of rock revetment structure
- Design of beach accessways
- Requirement for penguin accessways– this is to be considered where exposed revetment rock and penguin nesting sites are present.

1.3 Proposed Structure

The proposed design consists of a rock revetment structure for coastal erosion and inundation protection of the dunes and adjacent land along Hokitika beach. The revetment has a crest level of 5.8m New Zealand Vertical Datum 2016 (NZVD16). It is considered a medium term (10 to 15 years) solution. The medium term approach is intended to be consistent with the intent of the New Zealand Coastal Policy Statement 2010: the proposed 10 to 15-year design life is to allow time for development of a long-term adaptive planning strategy and implementation plan to address coastal inundation and erosion hazards in Hokitika, consistent with national guidance (Coastal Hazards and Climate Change Guidance for Local Government, Ministry for the Environment, 2017) .

The revetment will be constructed with embedment in sand to reduce potential for toe undermining and is located largely inshore of the present dune scarp, with the intention that it will initially be substantially buried.

The proposed works will require consents for construction and operation from both the Westland District Council (WDC) and WCRC. A consent application based on the initial issue of the detailed design for the revetment was lodged in April 2022.

2 Site Description

2.1 Existing Structures

2.1.1 Existing Rock Revetment

The existing rock revetment from the Hokitika River mouth to Stafford Street was built progressively between the early 2000s and 2019. The main section, extending some 700m south from Stafford Street, was constructed in 2013. It comprises approximately 40,000t of rock armour sourced from the Camelback Quarry over a bedding layer, geotextile, and compacted quarry waste (refer to Figure 2, from WCRC files). In 2019, a 30m section of revetment was constructed immediately north of the proposed revetment extension, extending north from the Richards Drive groyne.

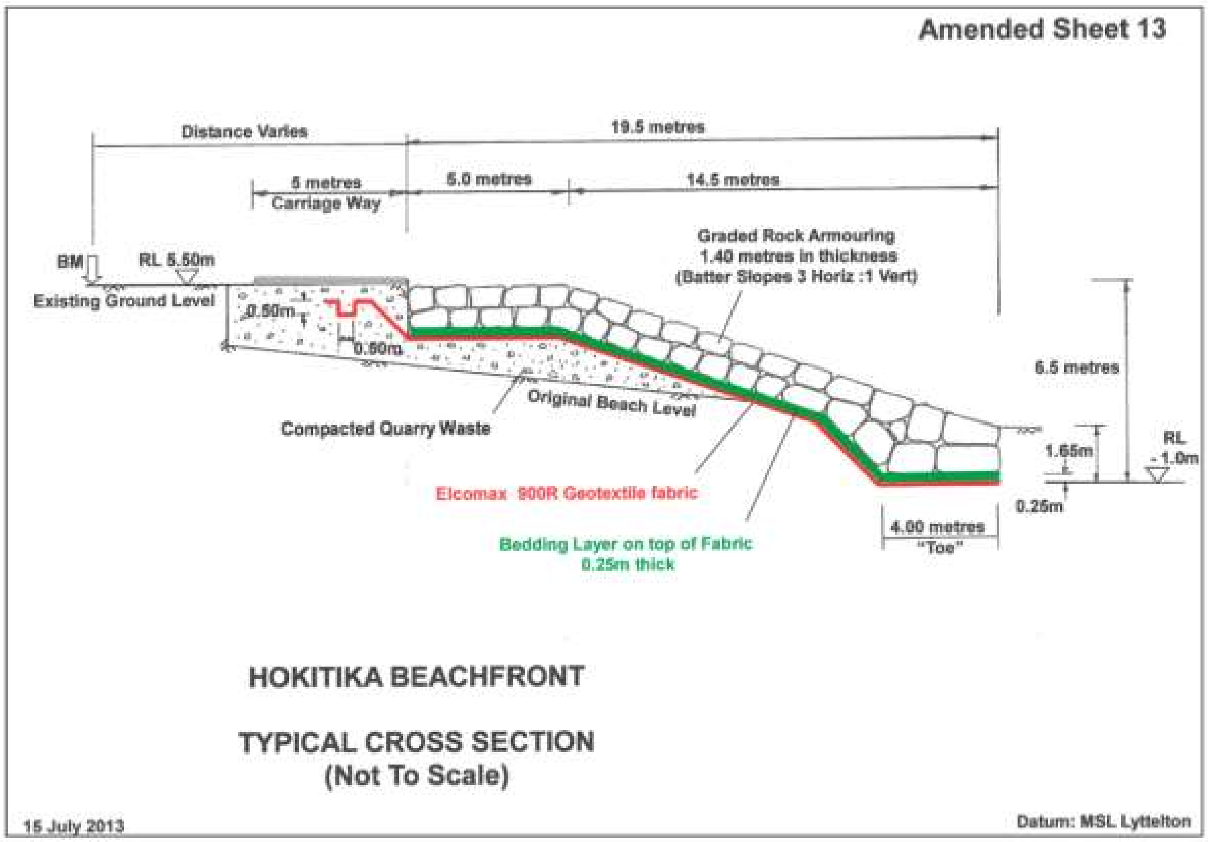


Figure 2: Typical cross section of existing revetment (WCRC)

The 2013 Hokitika revetment specification nominated a wide rock armour grading of 0.1t to 6t where 50% of the rocks were over 3t and had a nominal diameter of 1.2m or greater. These values imply an unusually low rock density (1,740kg/m^3) and do not appear to be consistent with the armour thickness shown in Figure 2. Median rock mass, M_{50}, and median nominal rock diameter, D_{n50}, were not explicitly stated. The bedding layer grading was specified as 0.1m to 0.15m nominal diameter.

The crest level of 5.5m above Lyttelton Mean Sea Level 1937 datum is equivalent to 5.15m NZVD16 (refer to Appendix A for vertical datum conversions). Coastwide Surveys Ltd advised Beca in 2020 that the crest level shown in the 2013 drawing was raised by WCRC over time from the original level of 5.15m NZVD16 to 5.5m NZVD16. The 2013 drawings show the revetment toe founded at -1m Lyttelton Vertical Datum 1937 (-0.65m

NZVD16) and with a 1.65m toe thickness. Design conditions (i.e. design wave height, wave period and water level) for the revetment are not available.

The 2013 structure shows some rock breakage and limited displacement of smaller and non-interlocked rock, although the revetment profile generally appears to have remained relatively stable (refer to Figure 3). Surveys indicate the crest level has remained at the upgraded 5.5m NZVD16 level. It would appear from debris on the structure that this crest line as overtopped or close to overtopped in some events (refer to Figure 3 photographs below).

Figure 3 Existing 2013 revetment showing rock breakage, rock displacement, profile and debris line near crest

2.1.2 Rock Groynes

Three shore-perpendicular rock groynes are located on the Stafford Street to Richards Drive coastline, opposite Hampden Street, Tudor Street and Richards Drive. The groynes are approximately 100m long. The groynes are intermittently exposed and covered by beach material as beach levels vary over time (refer to Figure 4).

The Tudor Street and Richards Drive groynes were constructed in the 1980s following reports by the Water and Soil Directorate of the Ministry of Works (A Coastal Hazard Management Plan for Hokitika, J Gibb, 1987; Hokitika Beachfront Sea Erosion, J Gibb, 1987) after a period of coastal erosion. They are presumed to have been constructed as shown in the local government funding application, comprising a 4m crest width and 2m overall depth with the groyne founded 1m below existing bed level (at the time). Design rock sizes were nominated as 4t to 8t, with 50% in the 6t to 8t range.

The Hampden Street groyne is understood to have been constructed in the 1990s, along with a groyne at Weld Street south of the proposed revetment extension site.

Figure 4: Hampden Street groyne in 2013 with lower beach levels (top photograph) and 2019 with higher beach levels (bottom photograph)

2.2 Shoreline and Beach Level Trends

The site is located in a high energy wave environment. It is subjected to cyclic erosion and accretion driven by sediment supply from the river mouth/bar, which is affected by river conditions and river mouth orientation, and wave conditions. In general terms, northward longshore transport is inferred from the prevailing south-westerly wave climate. Between the river mouth and the northern end of the site, however, beach level and shoreline fluctuations, and the absence of consistent updrift accretion / downdrift erosion at existing groynes, indicate variable longshore and cross shore transport patterns.

Historic shorelines extracted from WCRC's web-based viewer (identified from drone surveys and aerial photography), and tables and diagrams of shoreline position (Gibb, 1987) are included in Appendix B. The information shows significant shoreline fluctuations (e.g. progradation of up to 55m between 1943 and 2018; and recession of up to 25m between 2018 and 2019). Previous reports note decadal erosion and accretion cycles and rapid short-term changes including annual shoreline movements of ranging between +130m/year to -7.5m/year to -54m/year (Gibb, 1984; Gibb, 1987). The pattern is further complicated by northward movement of troughs and ridges over decadal timescales (see below). Active erosion scarps were observed along the shoreline during 2019-2022 site visits although beach levels are relatively high (refer below) and the emergency rock placement between 2019 to 2021 was undertaken in response to shoreline erosion.

Historic beach profiles from WCRC's coastal surveys are also included in Appendix B. Observations of beach profiles along this section of coastline have shown significant and rapid variations in level, both in terms of erosion events and recovery which seem to occur with the migration of troughs and ridges of up to 3m amplitude along the beach from south to north. Previous assessment concluded that while the southern groynes are not performing as intended, they may be moderating the magnitude of these effects to a degree. Consistent accumulation and retention of beach material on the updrift (southern) side of the Richards Drive groyne has been reported, indicating sustained northward longshore transport at this location.

3 Design Standards and References

The following sections list the principal design standards, guidelines and references that have been used in the detailed design of the revetment.

3.1 Design Standards and Guidelines

The design standards and guidelines used on the project are as follows:

- Allsop, W. Bruce, T. Pullen, T, Van der Meer, J. 2007. Direct Hazards from Wave Overtopping – The Forgotten Aspect of Coastal Flood Risk Assessment?
- BSI. 2013. BS 6349 - Maritime works Part 1-1: General – Code of practice for planning and design for operations
- CIRIA, CUR. 2007. The Rock Manual, The Use of Rock in Hydraulic Engineering.
- EurOtop II. 2018. Manual on Wave Overtopping of Sea Defences and Related Structures: An Overtopping Manual Largely Based on European Research, but for Worldwide Application.
- EurOtop. 2017. Wave Overtopping of Sea Defences and Related Structures: Assessment Manual.
- Ministry of the Environment (MfE). 2017. Coastal Hazards and Climate Change: Guidance for Local Government.
- United States Army Corps of Engineers (USACE). 2008-2011. Coastal Engineering Manual .
- Van Rijn, L. 2018. Local Scour near Structures.

3.2 Design References

The design references considered on this project are as follows:

- NIWA. 2016. The Climate and Weather of West Coast, 2nd edition.
- NIWA. 2019. Coastal Flooding Exposure Under Future Sea-level Rise for New Zealand.
- LINZ. 2021. Standard port tidal levels https://www.linz.govt.nz/sea/tides/tide-predictions/standard-port-tidal-levels [10/11/2021].

3.3 Other References

Other references used on the project are:

- Fowler, J.E.,1992. Scour problems and methods for prediction of maximum scour at vertical seawalls. T.R. CERC 92-16. U.S.W.E.S., Vicksburg, USA
- Kraus, N.C. and McDougal, W.G., 1996. The effects of seawalls on the beach: Part I and Part II, p. 691-701 and p. 702-713. Journal of Coastal Research, Vol. 12, No. 3
- MetOcean Solutions Ltd. 2019. Hokitika Milk Outfall Hindcast MetOcean Study
- Power, W. 2013. Review of Tsunami Hazard in New Zealand
- Steetzel, H., 1988. Scour holes near seawalls (in Dutch), Report H298 part 4, Delft Hydraulics
- Stockdon, H.F., Holman, R.A., Howd, P.A., Sallenger, A. H. Jr. 2006. Empirical parameterization of setup, swash, and runup
- United States Army Corps of Engineers (USACE). 1984. Shore Protection Manual.

4 Environmental Data

4.1 Datum

The following horizontal and vertical datums were used on the Project:

- Horizontal datum: New Zealand Transverse Mercator 2000 (NZTM2000).
- Vertical datum: NZ Vertical Datum 2016 (NZVD16).

To correctly implement datums and thus relative sea and land levels in the design, Chris J Coll Surveying Ltd. was engaged by WCRC to clarify the Hokitika vertical datums (datum conversion memorandum, dated 13 November 2020- refer to Appendix A). The relationship between NZVD16, Hokitika Chart Datum (CD) and Lyttelton Vertical Datum 1937 (LVD37) follows:

- 0.00m CD = -2.13m NZVD16.
- 0.00m LVD37 = -0.35m NZVD16
- 0.00m CD = -1.78m LVD37

4.2 Bathymetry and Topography

Bathymetric and topographic survey information is available as follows:

- Bathymetry:
  - LINZ Chart NZ 72 Cape Foulwind to Heretaniwha Point (does not include bathymetric data for the nearshore area at the site)
- Topography:
  - A GPS survey of upper beach and foredune at the site was carried out in October 2021 by Coastwide Surveys Ltd, which provides cross sections of the beach, scarp and foredune at 50m intervals.
  - A 2020 LiDAR survey has been completed and provided by WCRC in 2021. The LiDAR survey provides topographic information for the upper beach and foredune.
  - The 2021 cross section survey and 2020 LiDAR survey are not in agreement (differences of up to 0.3m inland and 2.0m foreshore). The detailed design has been based on the more conservative (i.e. lower) of the levels, with a comprehensive topographic survey undertaken on site immediately prior to construction, and the design reviewed and updated as necessary based on that survey before the contractor commences physical works on site. This practical approach is proposed because of the dynamic nature of the beach levels and shoreline at the site, which will change between design and construction.
- Beach levels and slope:
  - The lowest beach levels at the site identified from historical beach profile surveys (2000 to 2013) and topographic surveys (2016-2021) are:
    - 2.8m NZVD16 at the location of the proposed revetment toe, on the southern section of the site (chainage 0m to 850m).
    - 1.0m NZVD16 at the location of the proposed revetment toe, on the northern section of the site (chainage 850m to 1106m).
    - 2.3m NZVD16 at the toe of the erosion scarp, considering the full length of the site.
    - 0.05m NZVD16 at 25m seaward of the toe of the erosion scarp, considering the full length of the site.
  - The average beach slope identified from historical beach profile surveys and from a bathymetric survey for the Hokitika Milk Outfall is 1 vertical : 9 horizontal (upper beach) to 1 vertical : 20 horizontal (lower beach) to 1 vertical : 50 horizontal (shoreline to 1km offshore).

- Vertical Land Movement (VLM):
  - Towards the end of the design process, VLM data for New Zealand was released (searise.takiwa.co). VLM at the site is given as 0.66mm/year, or 10mm over the design life of the structure. This small change is offset by the slight conservatism in the Sea Level Rise (SLR) value adopted for design (refer to Section 4.3.5).

4.3 Water Levels

4.3.1 Tide Levels

The tide levels have been taken from LINZ (2021) Standard Port tidal levels for Westport due to the relative proximity to the site, and as these values are more conservative than the levels given at the Hokitika River Bar (where tide levels are potentially affected by the bar). The following table provides the tide levels in CD and RL:

Table 1: Tide levels for Westport (LINZ, 2021- accessed 11/11/2021)

Tide level	Level (m CD)	Level (m NZVD16)
Highest Astronomic Tide (HAT)	3.88	1.75
Mean High Water Springs (MHWS)	3.50	1.37
Mean High Water Neaps (MHWN)	2.82	0.69
Mean Sea Level (MSL)	2.04	-0.09
Mean Low Water Neaps (MLWN)	1.26	-0.87
Mean Low Water Springs (MLWS)	0.56	-1.57
Lowest Astronomic Tide (LAT)	0.18	-1.95

We note that the current Standard Port tidal levels (accessed on 11/11/2021) have increased some 0.24 to 0.33m from previous levels accessed on 23/11/2020 and also used in the Coll's datum conversion memorandum. Given the importance of these levels for the design, we have approached LINZ and received their confirmation and advice to use the tide levels accessed on 11/11/2021 as presented in Table 1.

4.3.2 Storm Surge Heights

Storm surge refers to elevated coastal water levels during storm events. It comprises barometric set-up and wind set-up components.

Surge height at Hokitika has been extracted from "Hokitika Milk Outfall Hindcast MetOcean Study (MetOcean, 2019)".

Table 2: Storm surge heights at Hokitika

AEP (%)	Storm Surge Height (m)
10% (20-year ARI)	0.48
3.25% (30.3-year ARI)	0.54
2% (50-year ARI)	0.57
1% (100-year ARI)	0.60

"Coastal Impacts of ex-Cyclone Fehi on the South Island West Coast (Neale, 2018)" refers to the tide gauge at Jackson Bay for Cyclone Fehi which recorded a storm surge of about 1.0m. The AEP of this storm surge event has not been determined.

4.3.3 Wave Set-up

Wave set-up is the increase in water level in the surf zone that is generated by wave breaking. Stockdon et al. (2006) have developed a formula from empirical measurements made on 10 natural sandy beaches on the USA and the Netherlands coastlines, as given below:

$$\eta = 0.35\,\beta_f (H_0 L_0)^{0.5}$$

where, η is the wave set-up, β is the beach slope in the breaker zone, H_0 is the deep-water wave height and L_0 is the deep water wave length.

The wave set-up was estimated assuming an average beach slope of 1 in 50 between shoreline and 1km offshore (based on available data). A sensitivity test of the beach slope was undertaken as part of the detailed design. Table 3 gives the wave set-up for the 3.25% and 2% AEP offshore wave conditions (refer to Section 4.4.1).

Table 3: Wave set-up

% AEP	Wave Set- up (m)
3.25% (30-year ARI)	0.40
2% (50-year ARI)	0.44

4.3.4 Extreme Water Levels

Extreme water levels are the result of the independent phenomena of tides and storms acting together to cause increased water levels. Tides generate the changes in water levels described in Section 4.3.1. Storms generate storm surge, as described in Section 4.3.2. Distant and local storms also generate wave set-up due to swell and wind waves, respectively (refer to Section 4.3.3).

Studies can be undertaken to model tides and storms over decades to produce extreme storm-tide water levels, and to analyse the results to determine extreme water levels and annual exceedance probabilities. Such information is not presently available for the West Coast region.

An alternative approach is to combine a selected tide level, storm surge for a given annual exceedance probability and wave set-up for a given annual exceedance probability. The approach provides a more conservative estimate of extreme water level if a higher tide level, such as Mean High Water Springs, is selected. As tide level, storm surge and offshore wave information is available for the Hokitika location, this approach has been used for the Hokitika revetment. Extreme water level scenarios and water levels are given in Table 4:

Table 4: Extreme Water Levels

Extreme Water Level Scenarios	Extreme Water Level (m NZVD16)
MHWS + 3.25% AEP storm surge + 3.25% AEP wave setup	2.31m
MHWS + 2% AEP storm surge + 2% AEP wave setup	2.38m

4.3.5 Sea Level Rise

Sea Level Rise (SLR) allowances for the revetment design life have been assessed using the Ministry for Environment's national guidance (MfE, 2017). The more conservative SLR scenarios corresponding to the Representative Concentration Pathways (RCPs) RCP 8.5M and 8.5 H* have been considered, essentially these are emissions scenarios. Table 5 shows the projections of SLR corresponding to different RCPs, relative to 0m sea level in 1986-2005.

Table 5 Sea level rise projections from the 1986-2005 baseline for the four emission scenarios (MfE, 2017)

Year	RCP 2.6 M	RCP 4.5 M	RCP 8.5 M	RCP 8.5 H*
1986-2005	0m	0m	0m	0m
2022	0.10m	0.10m	0.11m	0.13m
2032 (10 years)	0.15m	0.15m	0.17m	0.20m
2037 (15 years)	0.17m	0.18m	0.20m	0.25m

A SLR of 0.12m (= 0.25m - 0.13m) over the next 15 years (i.e. until the end of the 10-15 years design life) has been adopted.

The current New Zealand climate change guidance (MfE, 2017) is based on the 2013 Intergovernmental Panel on Climate Change (IPCC) Physical Science Basis report and the 2014 IPCC Fifth Assessment Report.

Late in the design process, new SLR projections for New Zealand developed from the IPCC Sixth Assessment Report were released. These use slightly different nomenclature for emission scenarios. The SSP5-8.5 83% scenario is approximately comparable to the RCP 8.5 H* scenario shown above. For 2037 and 2022, the equivalent SLR projections for Hokitika are 0.20m and 0.10m (searise.takiwa.co), which would give SLR of 0.10m to 2037 compared to a 2022 baseline. In this case, the RCP values tabulated above and adopted for design are slightly more conservative than the new IPCC projections.

4.4 Wave Climate

4.4.1 Offshore Wave

Offshore wave conditions are not used for the revetment design directly. However, the information is used to inform wave set-up and nearshore wave periods for design and a brief summary is therefore included below.

Offshore wave conditions were extracted from MetOcean Solutions wave hindcast database for a location approximately 10km from the shoreline, near Hokitika (refer to Figure 5). Table 6 gives the significant wave height (H_s) and peak wave period (T_p) for that offshore location.

Table 6: Offshore wave conditions

% AEP	Significant Wave Height, H_s (m)	Peak Wave Period, T_p (s)
3.25% (30-year ARI)	10.6	14
2% (50-year ARI)	11.2	15

Figure 6 shows the wave rose at the offshore location. The dominant offshore wave direction is south westerly.

Figure 5: Location corresponding to offshore wave data

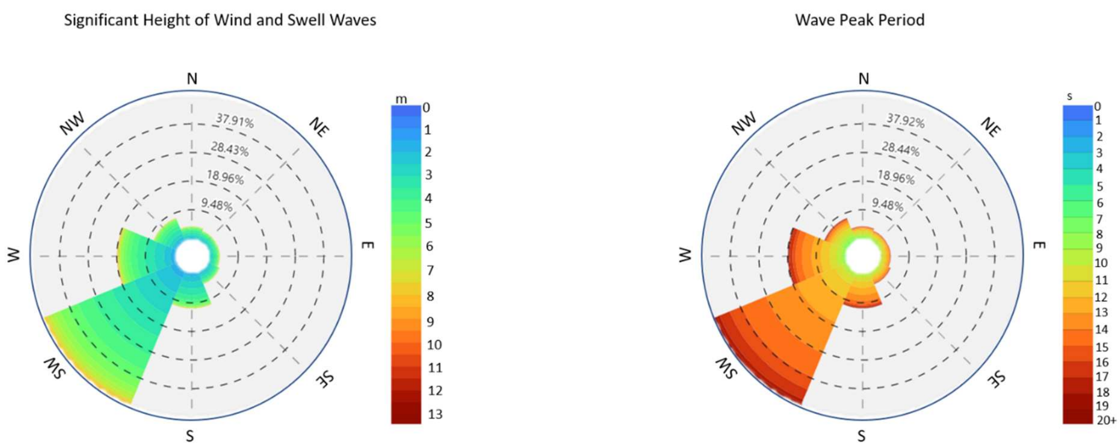


Figure 6: Offshore wave rose at Hokitika at MetOcean wave station (virtual point 42.5S, 171.0E)

4.4.2 Nearshore Wave (Design Wave)

As the offshore waves approach the shore and surf zone they break as the water shallows. This wave transformation process is referred to as depth-limited breaking, where for a given water depth a wave height cannot exceed a value related to that depth. This principle can be used to calculate the depth-limited wave height close to the revetment using the extreme water level values established above.

4.5 Currents

The revetment extension is located on the open coast and will only be partially submerged during the upper tidal cycle. Currents are therefore not considered to be a dominant load for this project.

4.6 Tsunami

Tsunami on the West Coast have been recorded, although mostly as raised water levels in tidal rivers adjacent to settlements. Locally generated effects have been documented as resulting from local earthquakes (which have the potential to generate large waves) early last century, and current studies have identified local offshore faults which have the potential to generate tsunami waves. Larger tsunami from local events cannot be ruled out, although the West Coast is not considered as exposed as other sections of the New Zealand coast to the effects of more distant events.

Detailed tsunami risk analysis for the district has not been undertaken. Review of Tsunami Hazard in New Zealand (Power, 2013) indicate that the Hokitika revetment site is similar to existing sea defence sites on the West Coast in terms of tsunami exposure.

Consistent with existing practice elsewhere on the West Coast and given the limited design life and practical challenges with designing against tsunami (e.g. scale of structure required), the revetment will not be designed for tsunami conditions. If such an event occurred, it is expected the structure would need to be repaired.

4.7 Geotechnical Information

The geology of the coastal area is comprised of young marine deposits of beach sands with some rounded beach gravel of Holocene age (<12,000 years old). Underlying these deposits, and outcropping inland, are slightly weathered glacial outwash gravels and till from the Otira glaciation period. The published geology does identify buried swamp deposits such as soft muds/silts or peat, however the distance of the hillslopes to the east suggest that it is unlikely that the site would be underlain by these. It is expected that the soil profile at the site will comprise beach sand overlying glacial derived gravels and tills. It is of note that the glacial tills comprise subrounded to subangular clasts up to boulder size in a 'tight' clayey matrix.

The GNS active faults database indicates that the nearest active fault is the Alpine Fault which lies roughly 25 km to the southeast. This fault is known as one of the world's major geological features as it is the "on-land" boundary of the Pacific and Australian tectonic plates. It has a high probability of rupturing in the next 50 years (greater than 20%), inducing significant shaking with a Magnitude up to 8.1, resulting in significant damage to the ground and overlying structures.

Geotechnical investigations were carried out by Beca on the beach at Hokitika on the 5th October 2021. These consisted of 5 Scala (Dynamic Cone) Penetrometer tests (up to 2m depth i.e. to approximately 0m NZVD16) located along the beach at the approximate toe location of the proposed sea wall. The tests recorded very loose to loose material (inferred to be sand) to depths of between 0.65m to greater than 2m below surface (i.e. approximately 1.35m to 0m NZVD16), overlying medium dense to dense material (again inferred to be sand). The density of the inferred sand appeared to increase towards the north. Scattered gravels were observed within the sands on the beach surface. Results are included in Appendix E, including the test locations plotted on the 2020 survey contours.

No deeper investigations (such as hand augers or borehole drilling) were carried out, per the scope agreed with WCRC. The inferred presence of sand is based on the surface observations and published geology. As the Scala tests terminated at 2m depth, the thickness of the sand and the underlying ground conditions were not proven.

The results of the Scala penetrometer tests and the apparent geotechnical stability of the existing 1km-long rock revetment indicate that there is likely to be adequate bearing capacity for the proposed revetment extension where it is founded in medium dense to dense sand or in glacial till (if encountered), subject to the consistency of the till. Excavation for the toe would likely encounter sand with scattered gravels, increasing in consistency from loose to medium dense to dense with depth. Loose to very loose sand is present, indicatively to the south.

Loading from the revetment extension will induce settlement of the underlying deposits. Where loose sand is present, this settlement is expected to occur immediately on loading i.e. during construction of the revetment. The contractor will be required to provide a toe and crest to the design levels, which may require the supply and placement of additional rock. A provisional sum will be included in the contract for this. It is expected that the glacial till will be over-consolidated and as such is not expected to experience any significant settlement as a result of loading from the revetment.

The revetment extension, consistent with normal practice for similar structures (e.g. existing Hokitika revetment) will not be designed to resist seismic loads. If an earthquake occurred, it is expected the structure would experience a level of damage and may need to be repaired.

Visual observations of the beach sands are that they contain little, if any fines (silt and clay) and are expected to be highly permeable. Excavations to place the toe rock are expected to encounter water, which if uncontrolled, has the potential to destabilise the excavation. There is potential for the excavations to encounter glacial gravel/till, depending on the depth of the rock toe and the elevation of the glacial deposits, which may be difficult to excavate and/or contain groundwater that is difficult to control. This is noted in the SiD register and on the drawings so that tenderers/contractors can allow for appropriate construction methods, including groundwater management measures, during construction.

5 Design Criteria

This section outlines the key design parameters and methods/guidance to be adopted for design of the revetment extension.

5.1 Design Life

As agreed with WCRC, the design life for the revetment is 10-15 years. This is less than the typical 50-year design life for rock revetments for the reasons described in Section 1. Also, as noted in Section 1, towards the end of the design life decisions will need to be made regarding the future of the structure. Dependent on the results of the DAPP and APS, either the revetment asset will be renewed (i.e. rebuilt) with a design life consistent with the APS or the asset will be removed.

Maintenance of the revetment and the backshore (public land) immediately landward of the revetment will be required during the design life (refer to Section 7.3).

5.2 Design Marine Conditions

The design marine conditions for the Hokitika revetment have been considered with reference to typical New Zealand practice for design conditions for rock revetments. A 50-year design life and a 1% AEP design condition is usually adopted for rock revetments (BS 6349 - Maritime works Part 1-1 (2013); CIRIA (2007)). The 1% AEP design condition has a 39% probability of occurrence during the 50-year design life.

For a 15-year period, consistent with the upper bound for the design life for this project (refer Section 5.1), the comparable condition is the 3.25% AEP condition. That is, a 3.25% AEP condition has a 39% probability of occurrence during a 15-year period. A For comparison, a 2% AEP condition has a 26% probability of occurrence during a 15-year period. Both 2% and 3.25% AEP storm conditions are considered in this design.

The design condition for the revetment is a combination of wave and water depth conditions. The wave height at the revetment will be depth limited i.e. dependent on the water depth (refer to Section 4.4.2). The water depth is dependent on:

- Beach level (refer to Section 4.2), with an additional 0.5m beach lowering to allow for other factors such as temporary beach lowering during storm conditions, Bruun Rule beach lowering with Sea Level Rise, increased storminess over 15-year design life, cyclical reduction in sediment supply to beach, etc.
- Extreme water level (refer to Section 4.3.4)
- Sea Level Rise (refer to Section 4.3.5).

The peak wave period at the revetment is conservatively taken as the offshore peak wave period for the design condition.

The ratio of wave height to water depth is referred to as the breaker index. A value of 0.8 has been calculated from the CIRIA (2007) using Figure 4.40 for shallow-water significant wave heights on uniform sloping foreshore.

The values adopted for design, corresponding to the 2% and 3.25% AEP storm events and for projected SLR to 2037, are set out in Table 7. The values do not include for infragravity wave effects, which may increase water level at the shoreline and overtopping. However, the design water levels used are conservative estimations of the 3.25% and 2% AEP event, combining a Mean High Water Springs tide level with a 3.25% or 2% AEP storm surge and a 3.25% or 2% AEP wave setup. The respective combinations will have an AEP of less than 3.25% or 2% (i.e. will be less frequent than a 3.25% or 2% AEP event).

Table 7: Design Conditions

Design Condition	Description	Height (m) / Level (m NZVD16)
3.25% storm event		
Beach level	Historical lowest beach level from shoreline surveys less 0.5m allowance for additional beach lowering	-0.5m NZVD16
Extreme water level including projected SLR to 2037	MHWS + 3.25% AEP storm surge + 3.25% AEP wave set-up + SLR (2037, RCP8.5H*)	2.43m NZVD16
Extreme water depth including projected SLR to 2037	Extreme water level – Beach level	2.93m
Depth-limited wave height 2037, H	0.8 x Extreme water depth	2.34m
Corresponding peak wave period, T_p	3.25% AEP wave period	14s
2% storm event		
Beach level	Historical lowest beach level from shoreline surveys less 0.5m allowance for additional beach lowering	-0.5m NZVD16
Extreme water level including projected SLR to 2037	MHWS + 2% AEP storm surge + 2% AEP wave set-up + SLR (2037, RCP8.5H*)	2.50m NZVD16
Extreme water depth including projected SLR to 2037	Extreme water level – Beach level	3.00m
Depth-limited wave height 2037, H	0.8 x Extreme water depth	2.40m
Corresponding peak wave period, T_p	2% AEP wave period	15s

5.3 Rock Properties

The Camelback Quarry site at Kowhitirangi is the nearest quarry to the site. It is located 25km southeast of Hokitika. Quarrying is reportedly able to produce large blocks of angular and subangular limestone rock up to 3m diameter.

The 2013 revetment was constructed from rock sourced from the Camelback Quarry. Some of the rock shows splitting and breakage in the 10 years since it was completed (refer to Figure 3).

Rock test results are not available from Camelback Quarry, WCRC, or local consultants or contractors. Information in

Table 8 has been sourced from the Camelback Quarry Management Plan (Camelback Quarry, 2015), GNS reports ("Mineral resource assessment of the West Coast Region, New Zealand", 2010; "Mineral Commodity Report 21 – Limestone, marble and dolomite", 2001) and "Rock and Aggregate Export Potential Survey" (Temple, 2000). The latter describes the rocks at Camelback Quarry as "excellent quality armour stone".

Table 8: Camelback Quarry rock properties

Test / Characteristic	Value (Average)	Description
Rock type		Heavily jointed limestone and banded calcareous mudstone White crystalline Kowhitirangi limestone
Compressive Strength (UCS)	71 MPa	Strong rock
Los Angeles Abrasion Test	13.6% loss	Suitable for high energy sites
Slake Durability Test	99.3% retained	Very highly durable
Sodium Sulphate Soundness Test	0.2% loss	Very high soundness
Density	2600 kg/m^3	Average density rock
Moisture Content	0.6%	Low moisture content
Rock size	0.25 tonnes to 4+ tonnes	Potentially suitable for armour and underlayer rock

The test results do not cover all the properties typically specified for armour rock and some values are below those usually specified for a 50-year design life structure.

WCRC require that the new revetment extension be designed to use the Camelback Quarry rock. While the 10–15 year design life will help to accommodate the rock quality limitations apparent in the existing revetment, it is expected that maintenance of the revetment extension will be required during the design life (refer to Section 7.3).

The rock density of 2600 kg/m^3 given above has been adopted for the revetment design.

5.4 Rock Stability for Hydraulic Loading

The design for stability of rock armour against hydraulic (wave) loading was undertaken in accordance using the van der Meer / van Gent method for shallow water given in CIRIA (2007). The design wave parameters are summarised in

Table 7. Table 9 summarizes values used for the other rock armour design parameters.

Table 9: Rock Armour Design Parameters

Design Parameter	Design Value	Source
Duration of storm event	4 hours	
Damage level parameter (slopes steeper than 1H:3H)	2	CIRIA (2007)
Notional Permeability Parameter (rock armour slope with underlayer rand geotextile; ratio of $D_{n50armour}/D_{n50underlayer}$ = 2)	0.1	CIRIA (2007)
Density of seawater	1025 kg/m^3	
Density of rock	2600 kg/m^3	Camelback Quarry data (refer to Section 5.3)

A damage level parameter of 2 represents damage of 0 – 5% (i.e. 0 – 5% of the rock in the zone of attack will be displaced by the wave action).

5.5 Underlayer and Filter

Underlayer rock has been sized in accordance with CIRIA (2007) as 1/10 of the mean armour rock mass.

A geotextile filter has been included in the design to provide separation and control wash-out of fine material from beneath the revetment.

5.6 Toe Design

5.6.1 Beach / Revetment Toe Level

The top of revetment toe level has been established as 0.5m below the historic lowest beach level at the location of the revetment toe (1.0m NZVD16 on the northern section of the site and 2.8m on the southern section of the beach, as noted in Section 4.2). This allows for a minimum of 0.5m beach sediment cover above the revetment toe under “low beach” conditions similar to those recorded over the past 20 years. The buried toe / beach sediment cover is intended to help reduce potential effects of the revetment on the beach (e.g. allows for alongshore movement of sediment on the upper beach, reduces wave energy reflected from rock surfaces).

5.6.2 Scour Depth

The foreshore consists of very loose to loose to medium/dense sand. The scala tests reached a 3m depth below the foreshore (i.e. to -2.5 to -3m NZVD16). Due to the shallow water conditions it is considered that the foreshore at the revetment is vulnerable to scour. The toe has therefore been designed for severe scour potential in accordance with CIRIA (2007).

Scour assessment methods for sloping seawalls/revetments from a number of sources (e.g. Shore Protection Manual, technical papers by Steetzel, Fowler etc) are summarised in Van Rijn (2018). These methods have been used to calculate scour depths. The scour assessment has considered the 2% AEP water level and wave height, the depth calculated as set out in Table 10.

Table 10: Scour Depths

Source	Scour Depth
Shore Protection Manual (1984)	2.40m
Steetzel (1988)	2.25m
Fowler (1992)	8.96m
Kraus and McDougal (1996)	1.80m

The design considers a maximum of scour depth adopted is 2.25m, this is middle value of the data, when excluding the Fowler (1992) value. The Fowler value bases the scour depth on the offshore wave which is not appropriate for the nearshore environment and is also not supported by observations of the existing revetment. Toe stability and scour protection design for this scour depth were undertaken in accordance with toe details from CIRIA (2007) for severe scour potential.

5.7 Crest and Wave Overtopping

Ground levels along the revetment alignment range between 5.0m NZVD16 and 6.0m NZVD16 and are typically around 5.8m NZVD16. A crest level of 5.8m NZVD16 was adopted for the revetment extension, matching existing ground levels in order to reduce effects on backshore stormwater and visual effects. This crest level is also comparable to the existing revetment crest level (5.5m NZVD16), which eases the transition between the structures.

A crest width of three armour rock units ($3D_{n50}$) has been adopted, in accordance with the minimum crest width recommended in the Rock Manual (2007).

Wave run-up and overtopping were assessed using the approach for a simple revetment structure, in EurOtop II (2018). Wave overtopping is the quantity of water from wave impact on the structure, propelling over the crest towards the hinterland, which can cause damage or safety concerns to areas behind the revetment crest. The estimated average overtopping is 9 litres/second/metre. This does not include for infragravity wave effects; however the design water level used is a conservative estimation of an extreme event as noted in Section 5.2.

Latest guidance (EurOtop II, 2018) recommends a mean overtopping limit of 5 litres/second/metre for a maintained, grass-covered crest and landward slope (wave height of 1m to 3m). EurOtop II notes, however, that large-scale testing demonstrated a good close-grassed cover is resilient to wave overtopping up to 100 litres/second/metre for wave heights less than 3m. The 5 litres/second/metre overtopping limit is based on preventing failure of a coastal dike with a high backslope and resulting sea flooding of the hinterland. The Hokitika revetment has the benefit of an armoured crest and 5m-long buried armour backslope. Earlier guidance (EurOtop, 2008; Allsop et al, 2007) recommended a limit of up to 10 litres/second/metre for no damage to a grass-covered crest and landward slope constructed in clay. It is therefore expected that overtopping will cause erosion and lowering of the backshore, which will require regular maintenance (e.g. filling and planting, refer Section 7.3). Noting the guidance and above provided that the grassed backslope and armoured crest are maintained in good condition, it is expected that the estimated overtopping associated with the 5.8m NZVD16 crest level could be managed for the limited life of the revetment (15 years).

While the area landward of the revetment extension is public land, there is not a formed pathway along the crest and backshore. Public access is confined to four 4m-wide accessways perpendicular to the coast. Discharge criteria relating to pedestrian usage have therefore not been applied as they would result in a higher crest (rather than the proposed crest matching existing ground levels) with associated landscape and visual impacts and potential penguin access impacts. The Safety in Design register (Appendix D) includes safety measures for the four accessways. The accessways, once exposed, will increase overtopping and maintenance requirements on the crest and backslope (refer to Section 6.5.3).

6 Rock Revetment Design

6.1 Introduction

The new 1160m long rock revetment is an extension to the existing Hokitika revetment from approximately Stafford Street to Richards Drive. The revetment extension will largely be constructed as a buried revetment, landward of the beach. The design incorporates two sections with two fixed toe depths (refer to Section 6.4). For both sections the crest width and height, revetment slope angle and toe lengths are all constant. The only change between the sections are the length of the slope and toe level. Design sections are illustrated in Figure 7 and Figure 8.

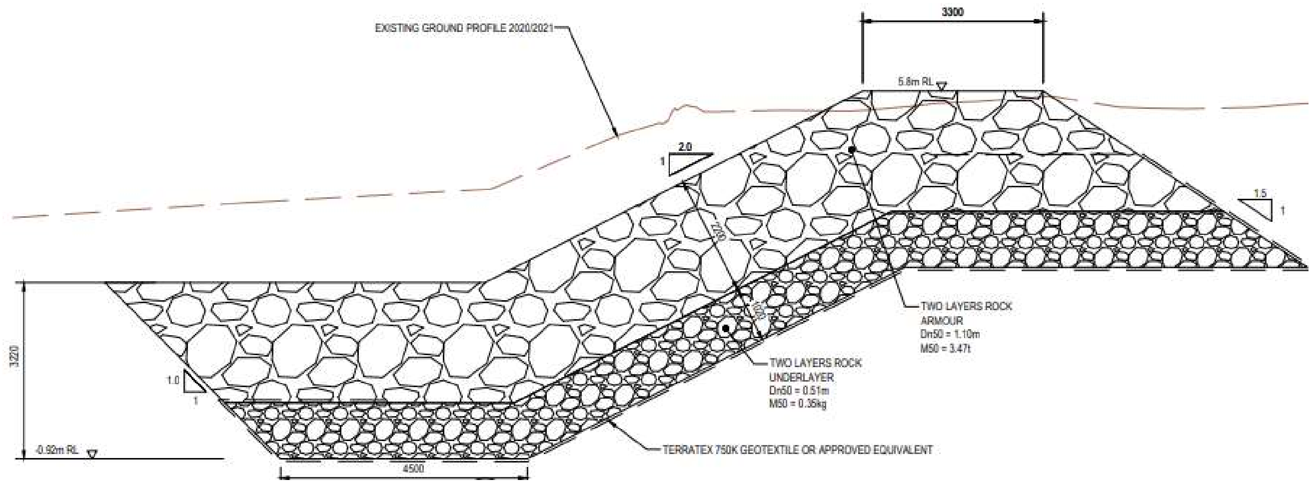


Figure 7 – Rock revetment section – higher toe level

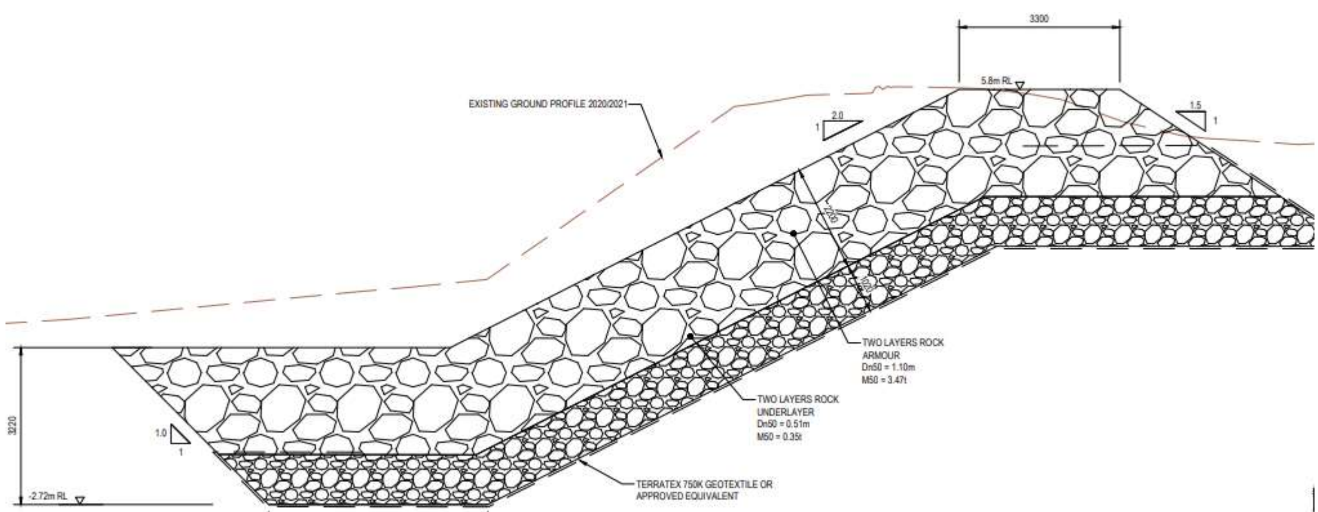


Figure 8 – Rock revetment section – lower toe level

The detailed design drawings are provided in Appendix C.

6.2 Revetment Slope

The seaward slope of the rock revetment was designed at 1V:2H. This provides stability and economy of rock use and enables a smooth transition to the existing rock revetment.

The crest back slope was designed 1V:1.5H and the toe slope was designed 1V:1H.

6.3 Rock Size

The rock sizes have been calculated as described in Section 5.4 for the design conditions set out in Section 5.2 and the revetment slope given above. The primary armour and underlayer sizes are provided in Table 11. Note that the M_{50} value is the required median mass of the rock, and D_{n50} is the equivalent median nominal rock size (cube). The layer thickness of both layers is equal to $2D_{n50}$ as outlined in CIRIA (2007).

Table 11: Rock size

Rock layer	M_{50} (kg)	D_{n50} (m)	Layer thickness (m)
Primary armour	3,470	1.10	2.20
Underlayer	350	0.51	1.02

6.4 Crest and Toe Details

6.4.1 Crest Design

The crest level and width were determined after consideration of the amount of overtopping and projected sea level rise. For a crest level of 5.8m NZVD16 the overtopping discharge has been estimated to be less than 10 l/m/s (refer to Section 5.7) for the design water level and wave conditions provided in Section 5.2. Overtopping will be increased once the accessways are formed (refer to Section 6.5).

The full length of the revetment has a minimum crest width of $3D_{n50}$ as recommended in CIRIA (2007).

6.4.2 Toe Design

The toe foundation level of the structure is to be at least 3.72m below the lowest historic beach level (equal to the depth of the structure, 3.22m, and 0.5m beach material cover/embedment). The underlayer and geotextile will extend under the primary armour, in accordance with CIRIA (2007).

The extents of the different toe foundation levels are as follows:

- The shallower southern section extends from chainage -60m to chainage 840m.
- The deeper northern section extends from chainage 860m to chainage 1106m at the Richards Dr groyne.
- Between these sections there is a 20m toe depth transition zone. The need for two sections is due to the lower beach levels at the northern extent of the beach (refer to Section 4.2).

The toe is designed for severe scour potential in accordance with CIRIA (2007):

- Toe depth (i.e. thickness of armour and underlayer rock) at least equal to the 2.25m scour depth.
- Toe width equal to twice the scour depth (4.5m).
- Toe armour and underlayer sized as for the revetment slope.
- Two layers of toe armour rock and two layers of toe underlayer rock.

6.4.3 Crest and Toe Levels

The crest level and toe levels for each revetment section are provided in Table 12.

Table 12: Crest level and width

Sections	Crest level (m NZVD16)	Toe Level (m NZVD16)
1 (chainage -60m to 840m)	+5.80m	-0.92m
Transition zone (chainage 840m to 860m)	+5.80m	Varies from -0.92m to -2.72m
2 (chainage 860m to 1106m)	+5.80m	-2.72m

6.5 Accessways

6.5.1 Public Accessways

The detailed design has considered four public accessways to the beach at Stafford Street, Hampden Street, Tudor Street and Spencer Street. A 4m wide accessway (shotcrete capping with geotextile beneath armour rock layer) will be constructed at each accessway for public use. Based on the 2020-21 surveys, it is expected that three of the accessways (Stafford Street, Hampden Street and Tudor Street) will be partially exposed and the Spencer Street accessway will be covered with reinstated beach and backshore material, although this will depend on beach and backshore levels at the time of construction.

6.5.2 Penguin Accessways

Penguin accessways from the beach to the dunes are only required where the rock revetment is exposed. The revetment design is to have the majority of the rock initially buried behind the foredune and therefore penguin accessways are not expected to be required initially.

The revetment will be monitored regularly to identify exposure of the rock armour and any penguin nesting site/s. Identification of a penguin nesting site together with exposure of armour rock and a distance of more than 120m from a public accessway will trigger construction of a penguin accessway at that location.

Each penguin accessway will be constructed as a shotcreted path (1m-wide shotcrete capping) to allow access up the revetment. Appropriate locations for such paths will not become evident until rockwork becomes exposed. It is anticipated that up to four penguin accessways may be constructed between the public accessways (i.e. accessways at approximately 120m spacing if all eight accessways are constructed).

6.5.3 Overtopping and Accessway Operation

Once any public or penguin accessway is constructed and exposed, overtopping at that location will increase significantly due to the reduced porosity and roughness of the revetment slope. For this reason, accessways are limited to four public accessways of 4m wide and four penguin accessways of 1m wide.

The accessways will require regular maintenance as the shotcrete will be displaced over time by wave attack. Increased maintenance of the crest and grassed backshore will be required at the accessways due to the increased overtopping.

Monitoring, management and maintenance are outlined in Section 7.3.

7 Other Design Considerations

7.1 Safety in Design Risk Assessment

A Safety in Design (SiD) Risk Assessment was undertaken for the project during the design development. The SiD Risk Assessment has been updated based on the detailed design and is provided in Appendix D.

7.2 Sustainability and Resilience in Design

Sustainability and resilience in design are incorporated by the following means:

- Incorporating the effects of climate change and SLR on water level and wave heights in accordance with MfE (2017) guidelines, and taking into consideration IPCC 6th Assessment Report and VLM projections.
- Considering re-use of materials subject to technical performance, durability and constructability requirements. This includes rock from the existing revetment. This reduces waste and also reduces requirements for new rock.
- Considering local sources for rock, stone and hardfill subject to technical performance and durability requirements.
- The interim nature of the revetment provides time for Dynamic Adaptative Pathways Planning and preparation of an Adaptive Pathways Strategy for the Hokitika coastline, for long term resilience.

7.3 Inspection and Maintenance During Operation

The new structures will require regular inspection and maintenance, as for any assets. This should be allowed for in future budgets and formalised in an Operation and Maintenance Plan. The Plan is to set out a condition-based maintenance management strategy based on the monitoring, inspection, maintenance and repair guidance in the Rock Manual (CIRIA, 2007). An outline of the plan contents follows in this section.

The frequency of maintenance will be dependent on a number of factors including actual wave climate and rate of SLR and VLM over the design life, and the quality of the rock sourced for construction.

7.3.1 Purpose

The purpose of the inspections is:

- To monitor performance and condition of the revetment including toe scour and to identify maintenance requirements.
- To monitor the condition of the immediate backshore and identify maintenance requirements.
- To monitor the exposure of the revetment, and to identify when penguin accessways need to be constructed.
- To monitor the condition and maintenance requirements for accessways.

The purpose of the maintenance is:

- To address damage to the revetment including toe and crest, immediate backshore and accessways.

7.3.2 Inspections

Inspections are to be undertaken as follows:

- Six-monthly and post-storm inspections of the revetment, accessways and backshore (public land) to be undertaken by a WCRC or local civil engineer, in accordance with a visual inspection checklist and with reference to current and previous photographs of fixed locations on the revetment.

- Two-yearly and post-major storm inspections (refer to Section 7.3.5) of the revetment, accessways and backshore to be undertaken by an experienced Coastal/Maritime Engineer, in accordance with a visual inspection checklist and with reference to the As Built and Issue for Construction drawings, and current and previous photographs of fixed locations on the revetment.
- Photographs are to be taken at fixed locations on the revetment to allow for comparison of the revetment profile, rock displacement and size, revetment exposure, condition of accessways and backshore, etc.
- Inspections are to be undertaken by foot from the top of the revetment and the beach, with appropriate measures for working adjacent to water and in a public area.
- Post storm / major storm inspections are to be undertaken within one week of the event.
- Inspection reports are to include summaries and recommendations addressing the areas listed under Section 7.3.1 (i.e. summaries of the performance and condition of the revetment, accessways, public land backshore, maintenance recommendations for these, and recommendations on construction of penguin accessways). Maintenance recommendations are to consider an intermediate level of damage as set out in the Rock Manual (CIRIA, 2007), to be defined in the Operation and Maintenance Plan. Reports are to be provided to the WCRC within 2 weeks of the inspection date.

7.3.3 Maintenance

Maintenance will be undertaken based on the inspection recommendations (refer last bullet point in Section 7.3.2) and is expected to include:

- Relocation of displaced rock armour to restore the design profile.
- Addition of new rock in the event of rock breakage or loss from structure (e.g. event of exceeding design conditions or due to the quality of quarry rock), or to augment the crest height or width.
- Replacement of concrete at accessways.
- Filling/topsoiling and replanting of backshore (public land) to address material eroded by overtopping.
- Removal of storm debris from the revetment, accessways and backshore (public land).

Maintenance is expected to be undertaken from the top of the revetment and from the beach, with beach access via a temporary ramp constructed on the 2013 revetment (e.g. heavy duty geotextile and quarry run material to create a ramp angled across the revetment; the temporary ramp to be removed after maintenance). Appropriate measures are required for working adjacent to water and in a public area

The frequency of maintenance depends on the actual wave climate and storm events, SLR and VLM, and on sediment supply to the beach from the river and bar system. Accessways and the backshore may require annual maintenance, while the revetment may require maintenance three- to five-yearly although this will depend on actual conditions during the revetment design life. Debris removal will be determined by storm events.

Maintenance is to be completed within two months of the issue of any inspection report identifying maintenance requirements, unless recommended otherwise by the report.

The Consent holder will be required to notify the Consent Authorities (WDC/WCRC) at least 10 days prior to any required maintenance occurring and provide the following in writing:

- A detailed summary of the maintenance work
- The timeframe required to carry out the work
- The methodology for undertaking the work including any heavy traffic movements
- Details of the contractor completing the work (including contact details for the Site Manager)
- Details of any public safety precautions to be undertaken, including signage, fencing and requirements for closure of sections of the beach.

All maintenance activities will be undertaken between the hours of 8am and 6pm, Monday to Friday (no work to be undertaken on weekends or public holidays unless required to ensure public safety).

Any noise during maintenance work will be managed in accordance with NZS 6803: 1999 Acoustics-Construction Noise.

7.3.4 Responsibilities

The WCRC is responsible for funding and arranging inspections and maintenance.

The inspections are to be undertaken by WCRC engineers or a local civil engineer engaged by the WCRC, and experienced Coastal/Maritime engineers engaged by the WCRC, as set out in Section 7.3.2.

Maintenance is to be undertaken by WCRC maintenance contractors (debris removal, accessway and backshore maintenance) and contractors with marine construction experience engaged by the WCRC (rock works).

7.3.5 Definitions of Storm Events and Major Storm Events

A storm event is defined as an event that results in overtopping of the revetment.

A major storm event is defined as an event that triggers a MetService | Te Ratonga Tirorangi orange or red sea storm or heavy swell warning for Hokitika, in addition to resulting in overtopping of the revetment.

8 Revetment Construction Sequence

The indicative overall revetment construction sequence is expected to be similar to construction of the 2013 revetment, as follows:

- Remove and dispose of existing vegetation.
- Remove existing emergency rock structure and sort and stockpile rock for re-use in the revetment (as approved by the Engineer), for groyne maintenance (as approved by the WCRC; this is a separate activity to the revetment construction), or for disposal to consented alternative projects or landfill.
- Excavate beach material to allow construction of the revetment, and place beach material to form a bund seaward of the worksite. The worksite (working face) open at any time during construction will be limited to a confined length (e.g. 50m) to limit exposure to damage.
- Excavate backshore material to allow construction of the revetment and store excavated material onsite.
- Place geotextile, underlayer and armour rock, including re-used rock.
- Construct accessways, placing concrete over backslope, crest and the seaward slope of the revetment.
- Place excavated beach material and sandy backshore material over the seaward face of the revetment to form the finished ground level (noting that this will vary depending on beach levels at the time of construction), matching to the existing beach level at low tide mark and the southern end of the site. Place excavated backshore material on the crest and landward face of the revetment, matching to the existing ground level at the site boundaries. Topsoil the backshore material and replant with native coastal vegetation.
- Dispose of any unsuitable material to a consented landfill.

A

Appendix A – Vertical Datum Conversion Memorandum

Memorandum

To *Jennifer Hart, Beca*
Ian Goss, Beca
Brendon Russ, West Coast Regional Council
From *Chris Coll, Chris J Coll Surveying Ltd*
Date *13th November 2020*
Re *Hokitika Vertical Datums*

Introduction

New Zealand Vertical Datum 2016 (NZVD2016) is the current official national vertical datum in New Zealand. Generally and for the present, LINZ-recommended best practice requires updating and transforming levels from "old" datums (such as local chart datums, MSL Lyttelton 1937 etc.) so they are in terms of NZVD2016.

Chart Datum

Westport and Greymouth have had reliable, long term records from their harbour and fishing ports. Their chart datums (also often referred to as "harbours datums") have a zero reduced level that was adopted to closely match the lowest astronomical tide level likely to be reached during a 19 year recording at each location. I have been unable to find reliable chart datum or tide gauge records for Hokitika. However, Westport and Greymouth chart or harbour datum values agree within <0.05m with each other and could be used to transform sea level values at Hokitika.

MSL Lyttelton 1937

Until about 2009, LINZ recommended using MSL Lyttelton 1937 (Lyttelton 1937) as the datum for the mid-half of the South Island and this included the West Coast of the South Island.

Benchmarks and trigs that have heights available in terms of Lyttelton 1937 are available in the LINZ Geodetic Database but these need to be carefully scrutinised before adoption. The "order" of vertical accuracy is a necessary first consideration and the dates of any updates need to be examined.

From about 2000 to 2016, we used Lyttelton 1937 as the vertical datum for all our work on West Coast Regional Council projects. In 2009, LINZ introduced a new datum called New Zealand Vertical Datum 2009 (NZVD2009). This was an official nationwide vertical datum until 2016 but there were so many technical problems it was abandoned and superseded by NZVD2016.

New Zealand Vertical Datum 2016

NZVD2016 is a transformation surface that transforms heights obtained with GPS/GNSS as ellipsoidal heights to orthometric heights i.e. the heights that we would obtain using surveying instruments like total stations or level and staff.

From about 2016, we have used NZVD2016 as the vertical height datum for all West Coast Regional Council projects. We have had to transform data from being in terms of other datums into NZVD2016.

Transformations

During the conversion of data that we use have used along the coastal margins of the West Coast, we have encountered some interesting findings.

Buller District – Westport Harbour

We have found that to convert Westport Harbour Chart Datum levels to NZVD2016, we take the Chart Datum levels and apply a negative correction of 2.13m in order to determine a final reduced level in terms of the "nationally consistent" datum.

i.e. 0.00m in terms of Westport Harbour Chart Datum = -2.13m in terms of NZVD2016.

In the case of the recently constructed protection rock wall at Westport Airport, the top of the wall was set in the specifications for the project at a reduced level of 5.00m in terms of NZVD2016. This height in terms of Westport Harbour Chart Datum would be 7.13m. In order to "reverse" the transformation to see what the height would be in terms of Westport Harbour Chart Datum, we apply a positive correction of 2.13m i.e. 5.00m + 2.13m = 7.13m.

To convert Lyttelton 1937 levels to NZVD2016, we apply a negative correction of 0.35m to obtain reduced levels in terms of NZVD2016.

Grey District – Greymouth Harbour

We have found similar correction values are required to convert from Greymouth Harbour Chart Datum to NZVD2016 and from Lyttelton 1937 to NZVD2016.

In and around the Greymouth Harbour/Port area, to convert Chart Datum levels to NZVD2016, we take the Chart Datum levels and apply the same negative correction of 2.13m in order to determine final reduced levels in terms of NZVD2016.

To convert Lyttelton 1937 levels to NZVD2016, it is necessary to apply a negative correction of 0.31m in order to determine a final reduced level in terms of NZVD2016.

Westland District – Hokitika River Mouth and WCRC Cross-sections

In the absence of a harbour or port authority tide gauge that has been used to develop a localised datum as in the case of Westport and Greymouth Harbours, the best method of getting all the levels in the same terms is to transfer the same conversion method to the levels in Hokitika by transforming/converting them all into NZVD2016.

To convert tide table Chart Datum levels into NZZVD2016, it is necessary to apply a negative correction of 2.13m in order to determine final reduced levels in terms of NZVD2016.

To convert Lyttelton 1937 levels into NZVD2016 terms, it is necessary to apply a negative correction of 0.34m in order to determine final reduced levels in terms of NZVD2016.

In the course of finding a standard "average" conversion value for transforming Lyttelton 1937 levels to NZVD2016 values, we discovered several anomalies in the LINZ Geodetic Database that we have queried with LINZ. Some of the conversions from NZVD2016/Lyttelton 1937 seem to have had their positive/negative corrections reversed. For example, Trig 5092 (LINZ Geodetic Code: AP6E) located at the mouth of the Hokitika River on the true left (south) bank has a positive correction of 0.39m applied to convert from Lyttelton 1937 to NZVD2016. Trig EA (LINZ Geodetic Code: A8KF) has a positive correction of 0.35m applied to convert from Lyttelton 1937 to NZVD2016. Trig J Blue Spur (LINZ Geodetic Code: 1421) has a positive correction of 0.41m applied to convert from Lyttelton 1937 to NZVD2016.

Conclusion

Ian will recall a project we were associated with at the Fox River mouth where some bach owners and Buller District Council were looking at closing some legal road adjoining the sea. I provide expert witness evidence relating to the line of Mean High Water Springs (MHWS). At Westport Harbour (and consequently, Westport), MHWS is determined as being 3.25m above the local Chart Datum. This then converts as being 1.12m in terms of NZVD2016 and 1.47m in terms of Lyttelton 1937.

In order to obtain a reduced level in any of the datums discussed, the following table can be used to guide conversions.

Conversion Table

*NB: Ensure that the **positive or negative sign** is correct when applying the correction.*

	Chart Datum	Lyttelton 1937	NZVD2016
Mean Low Water (MLW)	0.00	-1.78	-2.13
Mean Sea Level (MSL)	+1.75	-0.03	-0.38
Mean High Water Springs (MHWS)	+3.25	+1.47	+1.12
Typical Sea Wall (e.g. Westport Airport)	+7.13	+5.34	+5.00

Murray Marsh has correctly applied the correction for transformations in the Hokitika Sea Wall area. I think that all datums (Chart, Lyttelton 1937, any assumed datums etc.) should be transformed to standardise on a common datum i.e. NZVD2016. In the future, this will become easier and more familiar. This will make comparisons of structures and topography along the West Coast more straightforward. All local authorities, mining companies, agricultural and river control works would benefit from the adoption of a common, universal vertical datum. The obvious choice is LINZ's NZVD2016 as this would provide additional benefit if data is input or output form national systems and databases.

If you would like to discuss anything covered in this memorandum, please do not hesitate to contact us.

Yours faithfully,

CJColl.

Chris Coll
FNZIS, RPSurv., Licensed Cadastral Surveyor, Regd. Surveyor,
DIP. SURV., NZCE(Civil), COC Mine Surveyor

B

Appendix B – Historic Shoreline Locations & Profiles

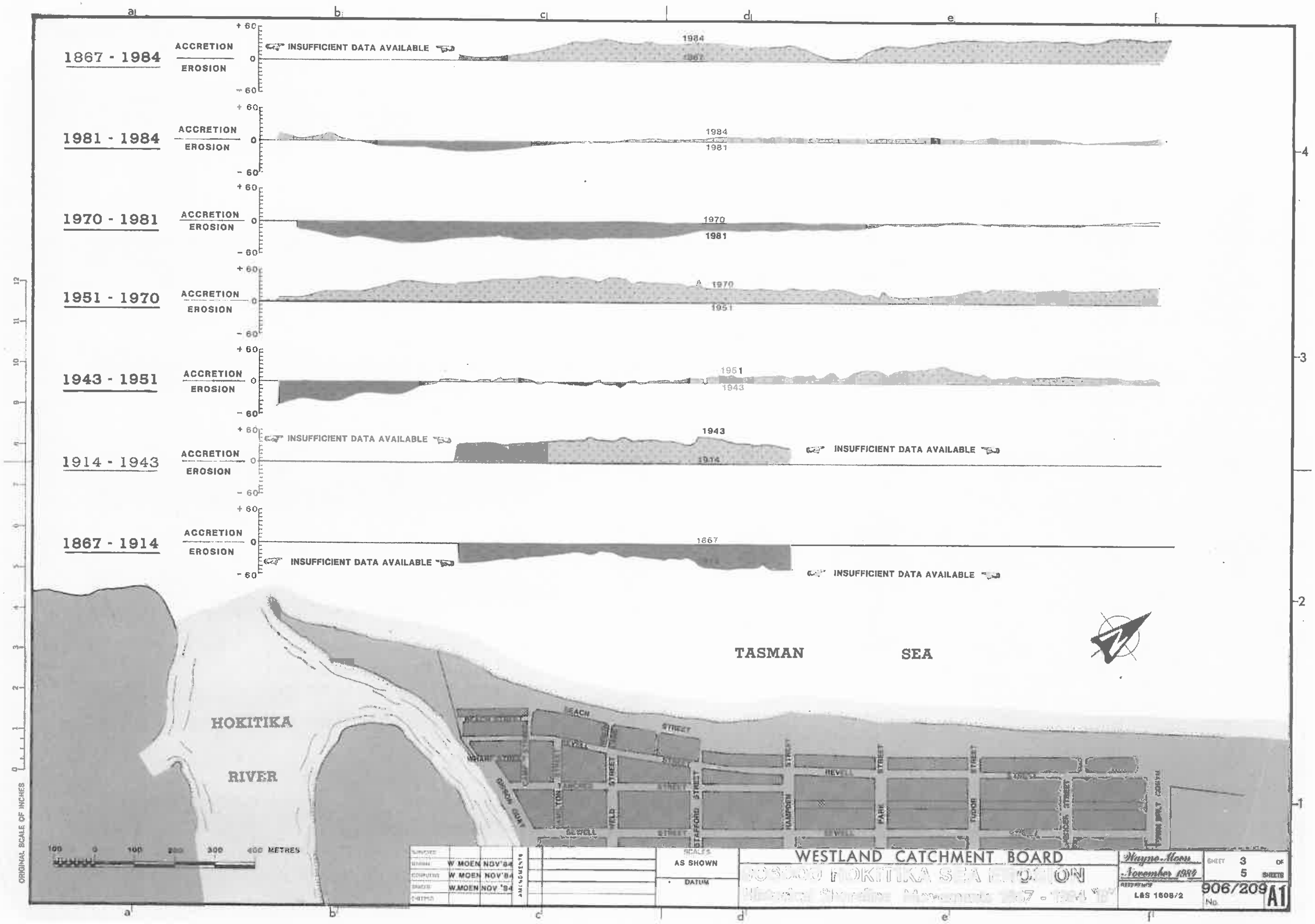


FIGURE 10: Diagram showing both long-term (1867-1984) and short-term fluctuations (six survey periods) of the Hokitika shoreline. Diagram is compiled from Department of Lands and Survey Aerial Plan No 1608 A&B.

TABLE 1 Long-term and short-term erosion-accretion data for 14 selected Westland Catchment Board (WCB) beach profile sites along the Hokitika foreshore. All measurements of accretion (+) and erosion (−) are in terms of WCB beach profile bench marks. ND = No data. Net rates are for entire survey periods which range from 1867-1986 for profiles 3 to 14 and from 1943-1986 for profiles 1 and 2.

	1 RIVER MOUTH	2 GRAVEL CRUSHER	3 BEACH ST. HOUSES	4 CAMP STREET	5 CENTRAL MOTORS	6 WELD STREET	7 SOUTHLAND HOTEL	8 STAFFORD STREET	9 STAFFORD ST. NORTH	10 HAMPDEN STREET	11 TUDOR STREET	12 RICHARDS DRIVE	13 MOSS FACTORY	14 SETTLING PONDS	DATA SOURCE
KM NORTH	0	0.2	0.47	0.55	0.66	0.764	0.892	1.00	1.128	1.228	1.684	2.148	2.672	3.781	
SURVEY YEARS															
1867	ND	ND	+24	+10	−9	−16	−2	+10	+20	+26	0	−13	−47	+20	AP 1608 A, B
1878.9	ND	ND	+13	+39	ND	+47	ND	ND	ND	ND	ND	ND	ND	ND	GR 1035
1880.7	ND	ND	+71	+79	ND	+85	ND	ND	ND	ND	ND	ND	ND	ND	GR 1358
1891	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	−14	ND	AP 1608 A, B
1911.8	ND	ND	+4	+40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	GR 5133
1912.5	ND	ND	−13	+41	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	GR 5133
1914	0	0	−20	−30	−35	−45	−40	−35	−20	−20	−25	−20	ND	ND	Local Inform.
1914.83	ND	ND	−12	−25	−30	−33	−38	ND	ND	ND	ND	ND	ND	ND	AP 1608 B
1932	ND	ND	+75	+67	ND	+28	ND	ND	ND	ND	ND	ND	ND	ND	GR 5133
1933	ND	ND	+70	+56	ND	+66	ND	ND	ND	ND	ND	ND	ND	ND	GR 4725
1937	ND	ND	+64	+67	ND	−7	ND	ND	ND	ND	ND	ND	ND	ND	GR 5133
1943.5	+63	+66	+26	+20	+24	+20	+16	+11	+12	+7	−22	−14	−22	−20	AP 1608 A, B
1951.3	+12	+38	+33	+26	+15	+10	+20	+24	+26	+25	−8	−6	−14	ND	AP 1608 A, B
1958	ND	ND	ND	+33	+35	+30	+37	+42	ND	ND	ND	ND	ND	ND	AP 1608 A, B
1971	+36	+63	+88	+80	+76	+72	+70	+65	+63	+56	+33	+38	+20	ND	AP 1608 A, B
1979.4	ND	ND	+54	+70	ND	+64	ND	+52	ND	+44	+41	+25	ND	ND	N.Z.F.S.
1981.9	+14	+28	+51	+40	+36	+35	+35	+48	+45	+43	+24	+27	+7	ND	AP 1608 A, B
1983.6	+60	+27	+44	+35	+37	+38	+33	+45	+56	ND	ND	ND	ND	ND	WCB
1984.3	+22	+28	+20	+26	+36	+36	+42	+57	+58	+52	+45	+30	+6	ND	AP 1608 A, B
1984.8	+18	+14	+27	+15	+15	+20	+21	+37	+43	+37	+35	+18	+29	+49	WCB
1985.5	+82	+125	+125	+100	+90	+75	+50	+35	+22	+16	+26	+19	+44	+50	WCB
1985.9	+115	+135	+150	+145	+112	+75	+58	+45	+26	+11	0	+15	+15	+59	WCB
1986.8	+130	+155	+180	+170	+110	+85	+60	+70	+45	+35	-2	+6	+9	+35	WCB
CUMULATIVE DISTANCE (m)	+67	+89	+156	+160	+119	+101	+62	+60	+25	+9	-2	+19	+56	+15	
NET RATE m/yr	+0.56	+0.75	+1.31	+1.34	+1.0	+0.85	+0.52	+0.50	+0.21	+0.08	−0.02	+0.16	+0.47	+0.13	

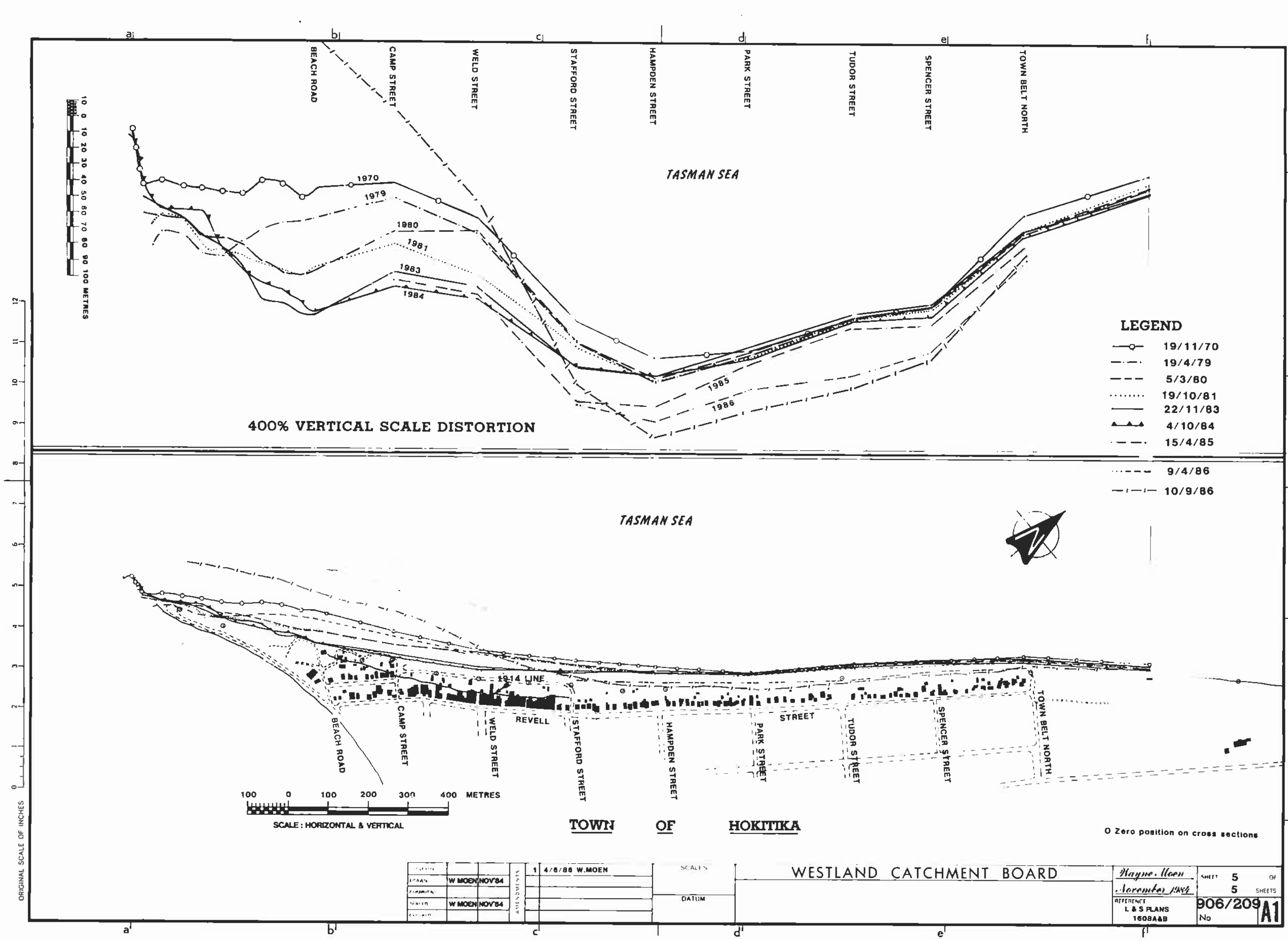
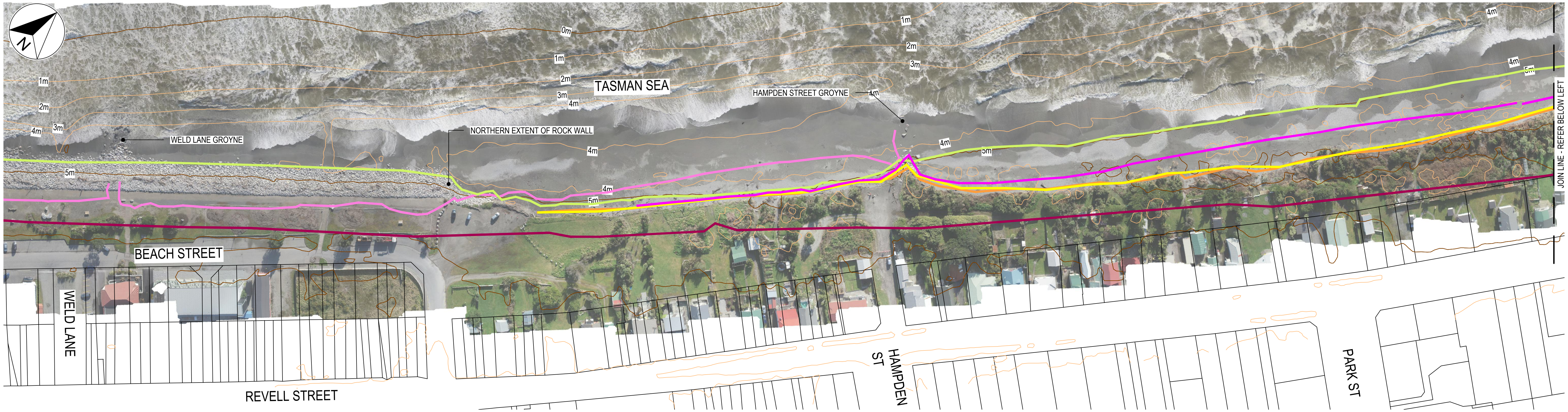


FIGURE 12: Diagram showing the onset of the present erosion phase at Hokitika in the 1970s, followed by the onset of accretion at southern Hokitika after April 1985. The diagram is compiled from both Westland Catchment Board surveys and from vertical sequential aerial photographs. The position of the 1914 erosion scarp is also indicated.

Drawing Plotted: 15 Jan 2020 12:08 PM



PLAN - TOP VIEW

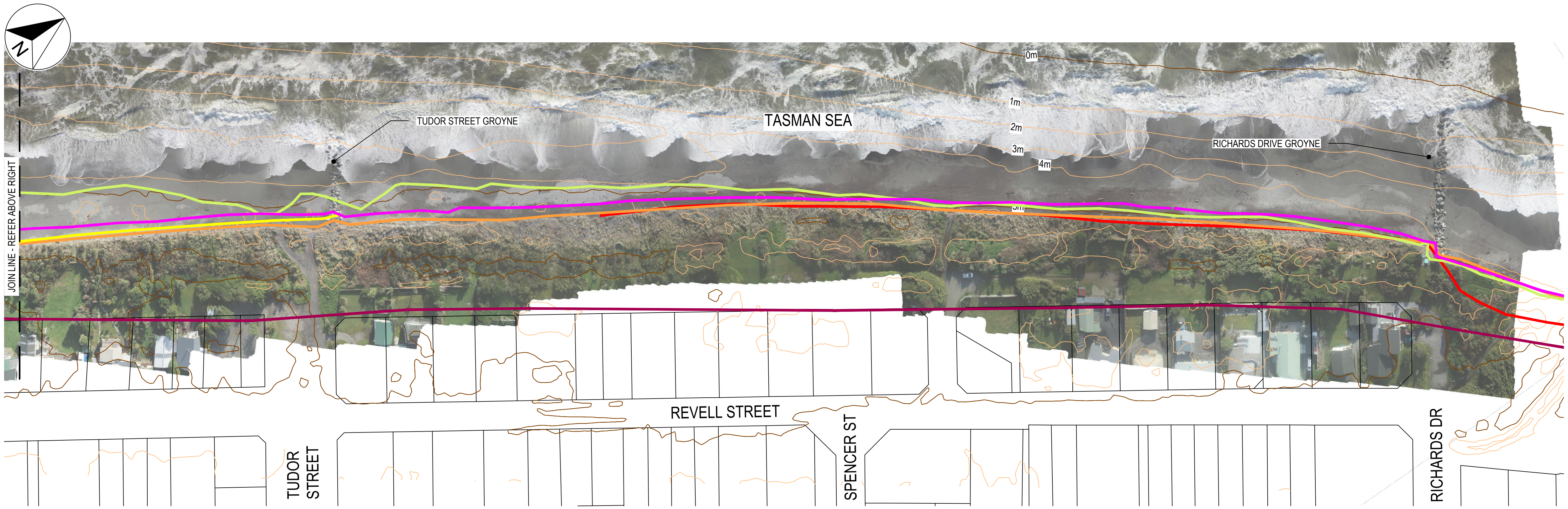
LEGEND:

HOKITIKA BEACH HISTORIC SHORELINES

DATE 24th MAY 1943
DATE 25th JULY 2013
DATE 14th MARCH 2018
DATE 19th JUNE 2019
DATE 1ST AUGUST 2019
DATE 8th AUGUST 2019
DATE 7th OCTOBER 2019

LiDAR CONTOURS

0m MAJOR CONTOUR
1m INTERMEDIATE CONTOUR



PLAN - BOTTOM VIEW

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1:2000 (A3) 0 40 80 120m

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No.	Revision	By	Chk	Appd	Date
A	FOR REPORT	RAS	IG		

Drawing Originator: Beca

Original Scale (A1) 1:1000	Design	I Goss	12.19
	Drawn	R Simpson	12.19
Reduced Scale (A3) 1/2 SCALE	Dsg Verifier		
	Dwg Check		

Approved For Construction*
Date
* Refer to Revision 1 for Original Signature

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA GROYNE FIELD STATUS REVIEW

Title: GROYNE LOCATIONS AND HISTORIC SHORELINES SHEET 2

Discipline: CIVIL

Drawing No. 3335909-CA-200

Rev. A

Document No. 3335909-CA-100.DWG

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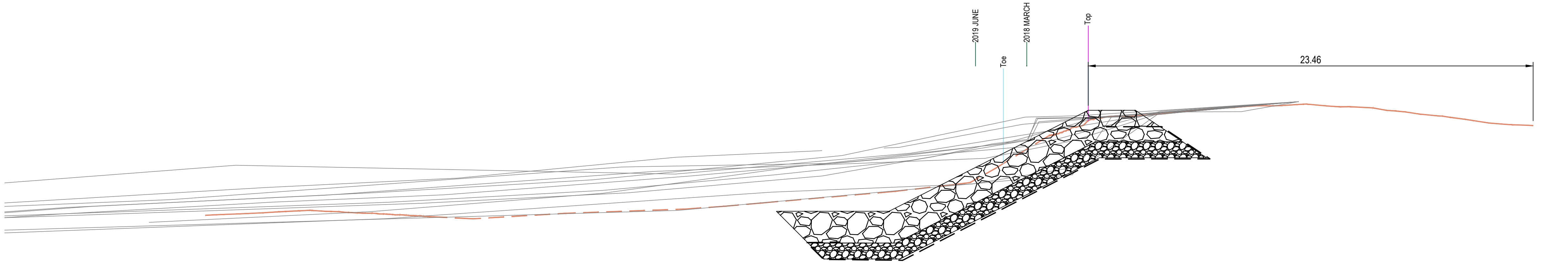

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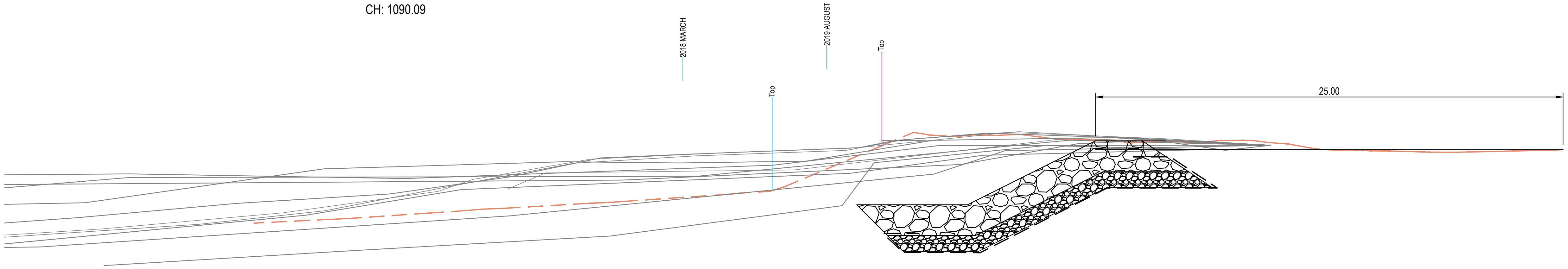
CH: 1090.09



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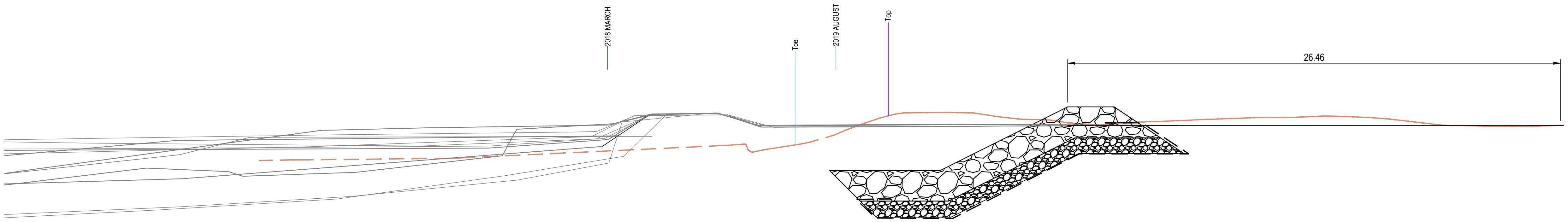
CH: 650.00



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EXISTING LEVELS	2.92	2.96	3.05	3.91	5.48	5.28	4.86	5.07	5.22	5.22	4.79	4.81
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CH: 200.00

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Drawing Originator: Beca

Original Scale (A1) 1:50
Reduced Scale (A3) 1:100

Design	HD
Drawn	HD
Dsg Verifier	
Dwg Check	

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Approved For Construction*

Date

Client:

Project: HOKITIKA SEAWALL

Title: HOKITIKA TYPICAL CROSS SECTION

Discipline: CIVIL ENGINEERING

Drawing No. SECTION 3

Rev. A

Document No. HOKITIKA CROSS SECTION_RECOVER.DWG

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C

Appendix C – Detailed Design Drawings

LOCALITY PLAN
NTS

DRAWING LIST		
DRAWING NO.	REV	DRAWING TITLE
3325253-CA-000	A	COVER PAGE, LOCALITY PLAN AND DRAWING LIST
3325253-CA-001	A	HOKITIKA REVETMENT PLAN SHEET 1
3325253-CA-002	A	HOKITIKA REVETMENT PLAN SHEET 2
3325253-CA-003	A	HOKITIKA REVETMENT PLAN SHEET 3
3325253-CA-004	A	HOKITIKA REVETMENT PLAN SHEET 4
3325253-CA-005	A	TYPICAL CROSS SECTIONS SHEET 1
3325253-CA-006	A	TYPICAL CROSS SECTIONS SHEET 2
3325253-CA-007	A	SOUTHERN REVETMENT ACCESSWAYS
3325253-CA-008	A	NORTHERN REVETMENT ACCESSWAYS
3325253-CA-009	A	ROCK ARMOUR SPECIFICATIONS

Beca

CIVIL ENGINEERING

Project No 3325253

HOKITIKA REVETMENT EXTENSION

DETAILED DESIGN

Prepared for

THE WEST COAST REGIONAL COUNCIL

By
Beca

16 AUGUST 2022

ORIGINAL DRAWING IN COLOUR

DETAILED DESIGN
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Drawing No.	Rev.
3325253-CA-000	A

Document No. 3325253-CA-000.DWG

Drawing Plotted: 16 Aug 2022 4:41 pm

NOTES:

1. DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. HORIZONTAL COORDINATE SYSTEM IS IN NZTM 2000
3. VERTICAL LEVEL TO NZVD 2016 AND REFERRED TO AS REDUCED LEVEL (RL).
4. SET-OUT LINE REFERS TO FRONT OF PROPOSED REVETMENT CREST. REFER TO DRAWINGS CA-003 AND CA-004.
5. SET-OUT POINTS ARE INDICATIVE AND ACTUAL SET OUT TO SUIT SHORELINE, TO BE CONFIRMED ON SITE BY THE ENGINEER.
6. SURVEY RECEIVED FROM WCRC & LINZ (2020, 2021, SURVEYS COMBINED)
7. FOR CLARITY OF NEW REVETMENT EXTENT BEACH SAND MATERIAL COVER NOT SHOWN ON LAYOUT.

KEY

- TOP OF EXISTING REVETMENT
- TOE OF EXISTING REVETMENT
- CADASTRAL BOUNDARIES
- NEW REVETMENT EXTENT
- REVETMENT SLOPE
- SET OUT POINT
- LINZ SURVEY CONTROL POINT

SET OUT POINTS

POINT	EASTING	NORTHING
SP1	1433173.02	5268820.08
SP2	1433220.83	5268842.76
SP3	1433251.36	5268868.15
SP4	1433277.25	5268895.83
SP5	1433400.85	5269049.09
SP6	1433496.73	5269179.20
SP7	1433592.62	5269323.38
SP8	1433615.19	5269353.53
SP9	1433749.82	5269553.16
S10	1433865.96	5269720.92
SP11	1433880.51	5269731.85

LINZSURVEY CONTROL POINT CO-ORDINATES

POINT ID	EASTING	NORTHING
CP1	1433928.535	5269693.572
CP2	1433790.606	5269491.454
CP3	1433659.813	5269299.772
CP4	1433530.412	5269108.413
CP5	1433392.849	5268921.882
CP6	1433203.631	5268793.961

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No.	Revision	By	Chk	Appd	Date
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Drawing Originator: Beca

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	Drawn	HD	1.04.22
Reduced Scale (A3) 1:1000	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA REVETMENT PLAN SHEET 1

Discipline: CIVIL ENGINEERING

Drawing No. 3325253-CA-001 Rev. A

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Document No. 3325253-CA-001-004 HOKITIKA PLAN.DWG

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7. FOR CLARITY OF NEW REVETMENT EXTENT BEACH SAND MATERIAL COVER NOT SHOWN ON LAYOUT.

KEY

- TOP OF EXISTING REVETMENT
- TOE OF EXISTING REVETMENT
- CADASTRAL BOUNDARIES
- NEW REVETMENT EXTENT
- REVETMENT SLOPE
- SET OUT POINT
- LINZ SURVEY CONTROL POINT

SET OUT POINTS

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LINZSURVEY CONTROL POINT CO-ORDINATES

POINT ID	EASTING	NORTHING
CP1	1433928.535	5269693.572
CP2	1433790.606	5269491.454
CP3	1433659.813	5269299.772
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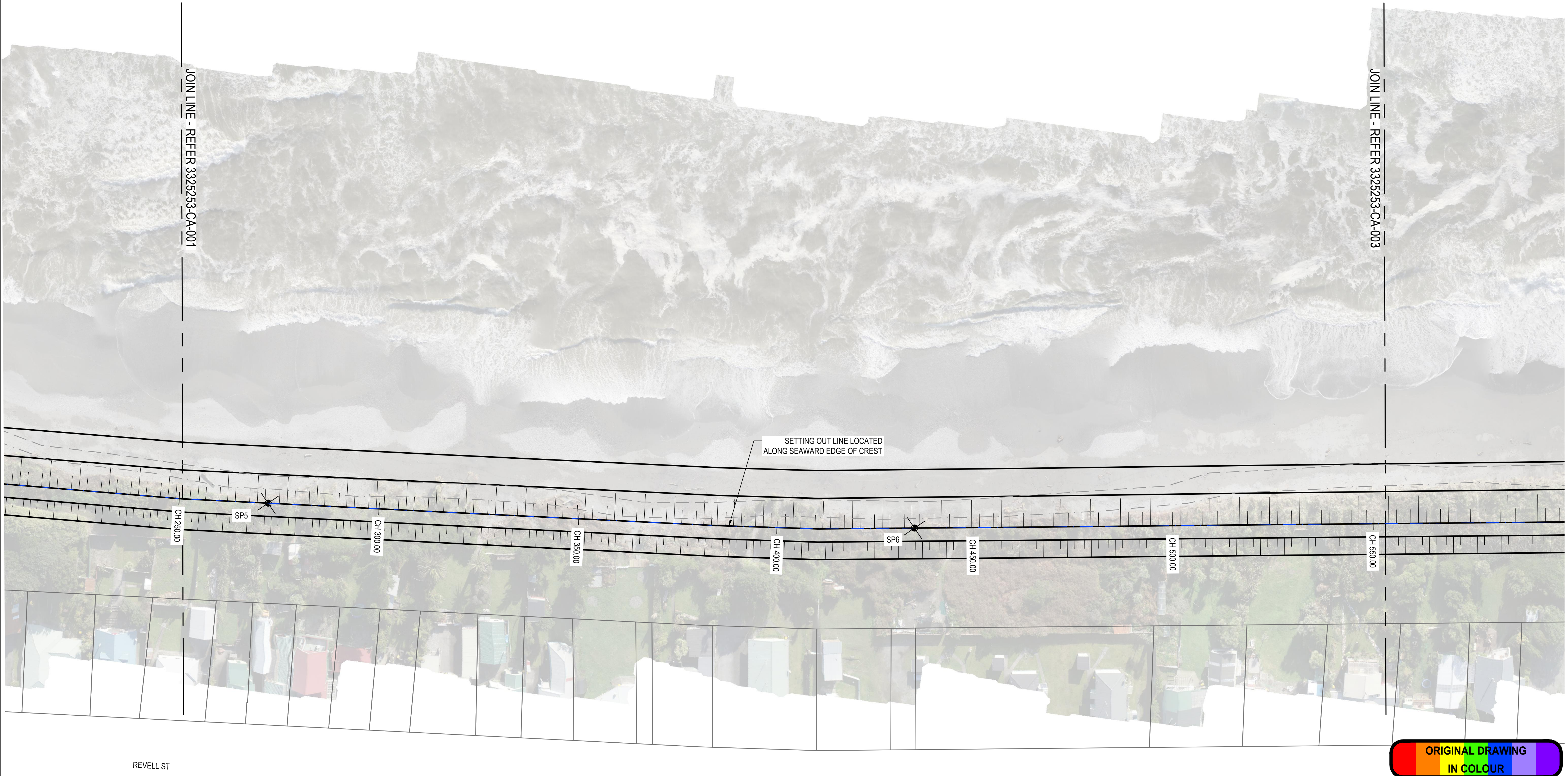

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A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

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Reduced Scale (A3) 1:1000	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA REVETMENT PLAN SHEET 2

Discipline: CIVIL ENGINEERING

Drawing No. 3325253-CA-002 Rev. A

Drawing Plotted: 16 Aug 2022 4:41 pm

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3. VERTICAL LEVEL TO NZVD 2016 AND REFERRED TO AS REDUCED LEVEL (RL).
4. SET-OUT LINE REFERS TO FRONT OF PROPOSED REVETMENT CREST. REFER TO DRAWINGS CA-003 AND CA-004.
5. SET-OUT POINTS ARE INDICATIVE AND ACTUAL SET OUT TO SUIT SHORELINE, TO BE CONFIRMED ON SITE BY THE ENGINEER.
6. SURVEY RECEIVED FROM WCRC & LINZ (2020, 2021, SURVEYS COMBINED)
7. FOR CLARITY OF NEW REVETMENT EXTENT BEACH SAND MATERIAL COVER NOT SHOWN ON LAYOUT.

KEY

- TOP OF EXISTING REVETMENT
- TOE OF EXISTING REVETMENT
- CADASTRAL BOUNDARIES
- NEW REVETMENT EXTENT
- REVETMENT SLOPE
- SET OUT POINT
- LINZ SURVEY CONTROL POINT

SET OUT POINTS

POINT	EASTING	NORTHING
SP1	1433173.02	5268820.08
SP2	1433220.83	5268842.76
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SP9	1433749.82	5269553.16
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SP11	1433880.51	5269731.85

LINZSURVEY CONTROL POINT CO-ORDINATES

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CP1	1433928.535	5269693.572
CP2	1433790.606	5269491.454
CP3	1433659.813	5269299.772
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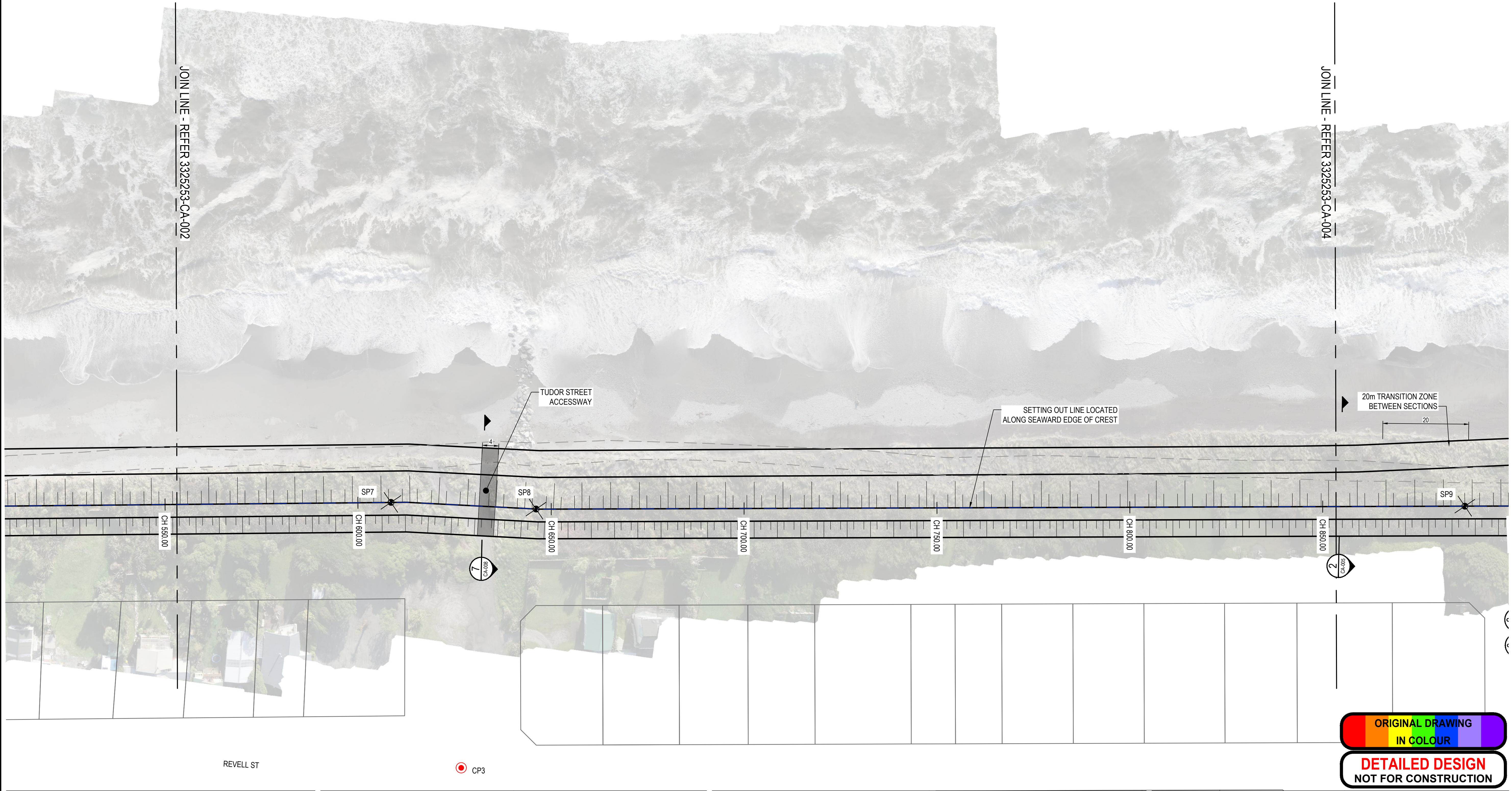

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No.	Revision	By	Chk	Appd	Date
A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

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Reduced Scale (A3) 1:1000

Design	HD	1.04.22
Drawn	HD	1.04.22
Dsg Verifier	KS	16.08.22
Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA REVETMENT PLAN SHEET 3

Discipline: CIVIL ENGINEERING

Drawing No. 3325253-CA-003

Rev. A

Document No. 3325253-CA-001-004 HOKITIKA PLAN.DWG

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3. VERTICAL LEVEL TO NZVD 2016 AND REFERRED TO AS REDUCED LEVEL (RL).
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6. SURVEY RECEIVED FROM WCRC & LINZ (2020, 2021, SURVEYS COMBINED)
7. FOR CLARITY OF NEW REVETMENT EXTENT BEACH SAND MATERIAL COVER NOT SHOWN ON LAYOUT.

KEY

- TOP OF EXISTING REVETMENT
- TOE OF EXISTING REVETMENT
- CADASTRAL BOUNDARIES
- NEW REVETMENT EXTENT
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- SET OUT POINT
- LINZ SURVEY CONTROL POINT

SET OUT POINTS

POINT	EASTING	NORTHING
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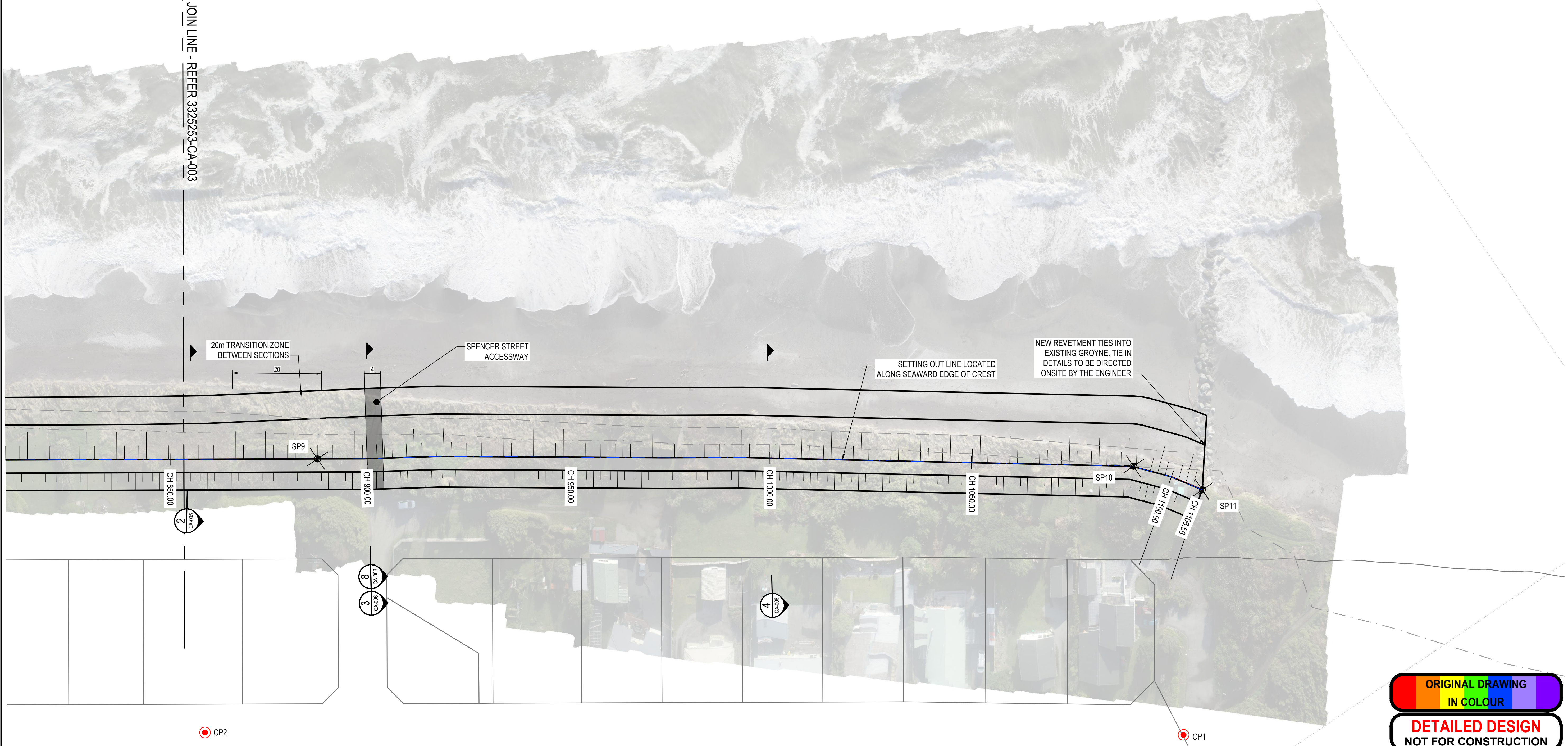
SP9	1433749.82	5269553.16
S10	1433865.96	5269720.92
SP11	1433880.51	5269731.85

LINZSURVEY CONTROL POINT CO-ORDINATES

POINT ID	EASTING	NORTHING
CP1	1433928.535	5269693.572
CP2	1433790.606	5269491.454
CP3	1433659.813	5269299.772
CP4	1433530.412	5269108.413
CP5	1433392.849	5268921.882
CP6	1433203.631	5268793.961



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DETAILED DESIGN
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No.	Revision	By	Chk	Appd	Date
A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

Original Scale (A1) 1:500 Reduced Scale (A3) 1:1000			
	Design	HD	1.04.22
	Drawn	HD	1.04.22
	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA REVETMENT PLAN SHEET 4

Discipline: CIVIL ENGINEERING

Drawing No. 3325253-CA-004

Rev. A

Document No. 3325253-CA-001-004 HOKITIKA PLAN.DWG

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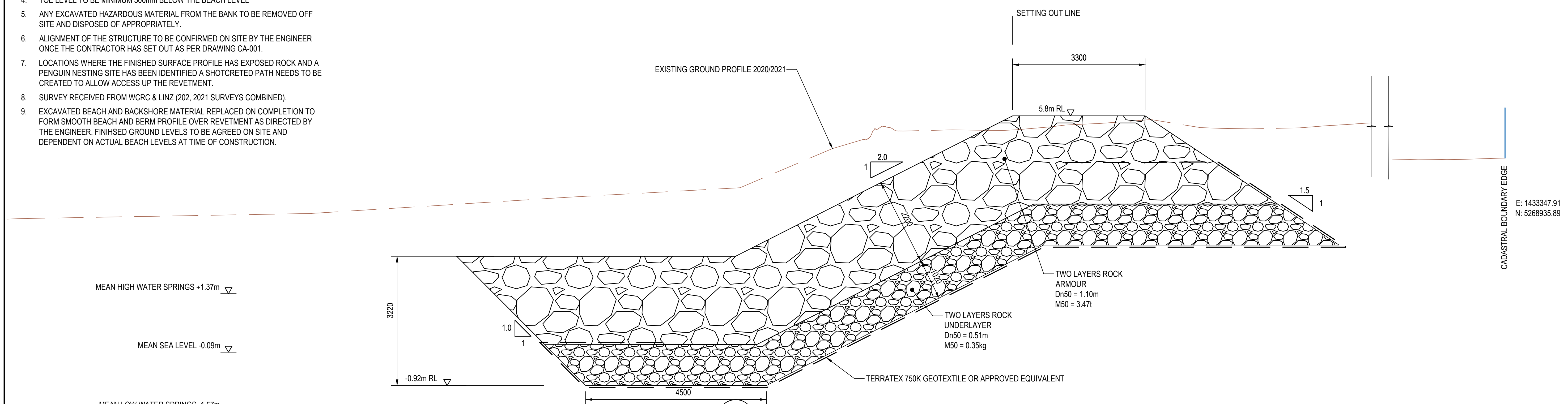
NOTES:

1. DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. LEVELS ARE IN TERMS OF NZVD16 AND REFERRED TO AS REDUCED LEVEL (RL).
3. TO BE READ IN ACCORDANCE WITH THE ROCK SPECIFICATION. REFER TO DRAWING CA-009.
4. TOE LEVEL TO BE MINIMUM 500mm BELOW THE BEACH LEVEL
5. ANY EXCAVATED HAZARDOUS MATERIAL FROM THE BANK TO BE REMOVED OFF SITE AND DISPOSED OF APPROPRIATELY.
6. ALIGNMENT OF THE STRUCTURE TO BE CONFIRMED ON SITE BY THE ENGINEER ONCE THE CONTRACTOR HAS SET OUT AS PER DRAWING CA-001.
7. LOCATIONS WHERE THE FINISHED SURFACE PROFILE HAS EXPOSED ROCK AND A PENGUIN NESTING SITE HAS BEEN IDENTIFIED A SHOTCRETED PATH NEEDS TO BE CREATED TO ALLOW ACCESS UP THE REVETMENT.
8. SURVEY RECEIVED FROM WCRC & LINZ (202, 2021 SURVEYS COMBINED).
9. EXCAVATED BEACH AND BACKSHORE MATERIAL REPLACED ON COMPLETION TO FORM SMOOTH BEACH AND BERM PROFILE OVER REVETMENT AS DIRECTED BY THE ENGINEER. FINIHSED GROUND LEVELS TO BE AGREED ON SITE AND DEPENDENT ON ACTUAL BEACH LEVELS AT TIME OF CONSTRUCTION.



1 CA-001 REVETMENT CROSS SECTION CH 150
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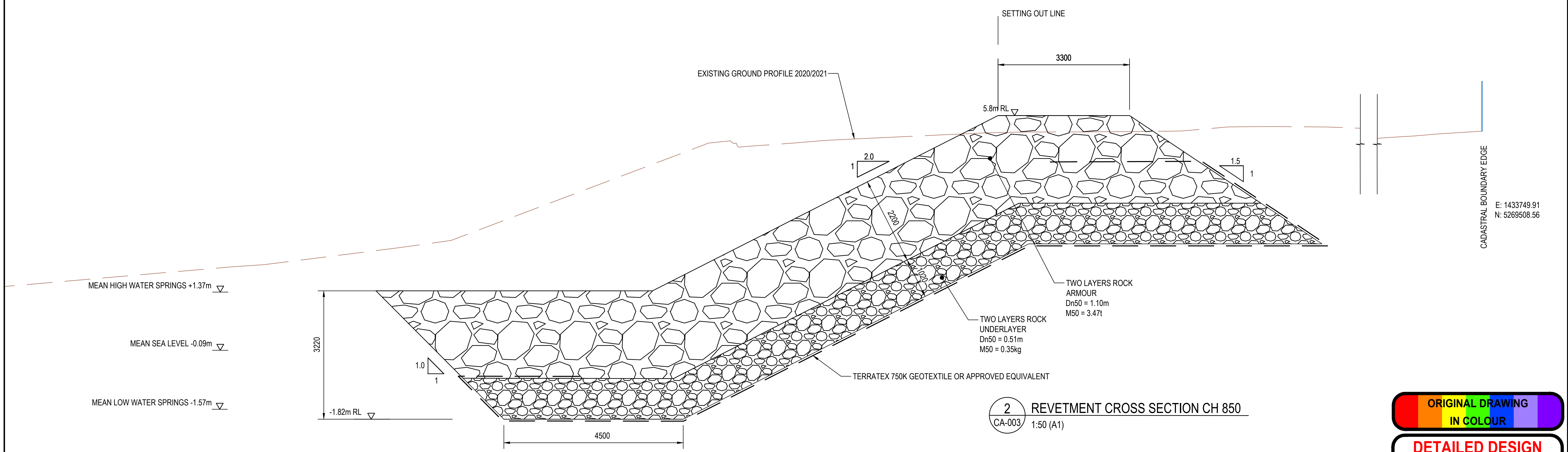

2 CA-003 REVETMENT CROSS SECTION CH 850
1:50 (A1)

ORIGINAL DRAWING IN COLOUR

DETAILED DESIGN
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No.	Revision	By	Chk	Appd	Date
A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

Original Scale (A1) 1:50	Design	HD	1.04.22
Reduced Scale (A3) 1:100	Drawn	HD	1.04.22
	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA TYPICAL CROSS SECTION SHEET 2

Discipline: CIVIL ENGINEERING

Drawing No. 3325253-CA-005 Rev. A

Document No. 3325253-CA-005-008 HOKITIKA CROSS SECTIO...

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NOTES:

1. DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
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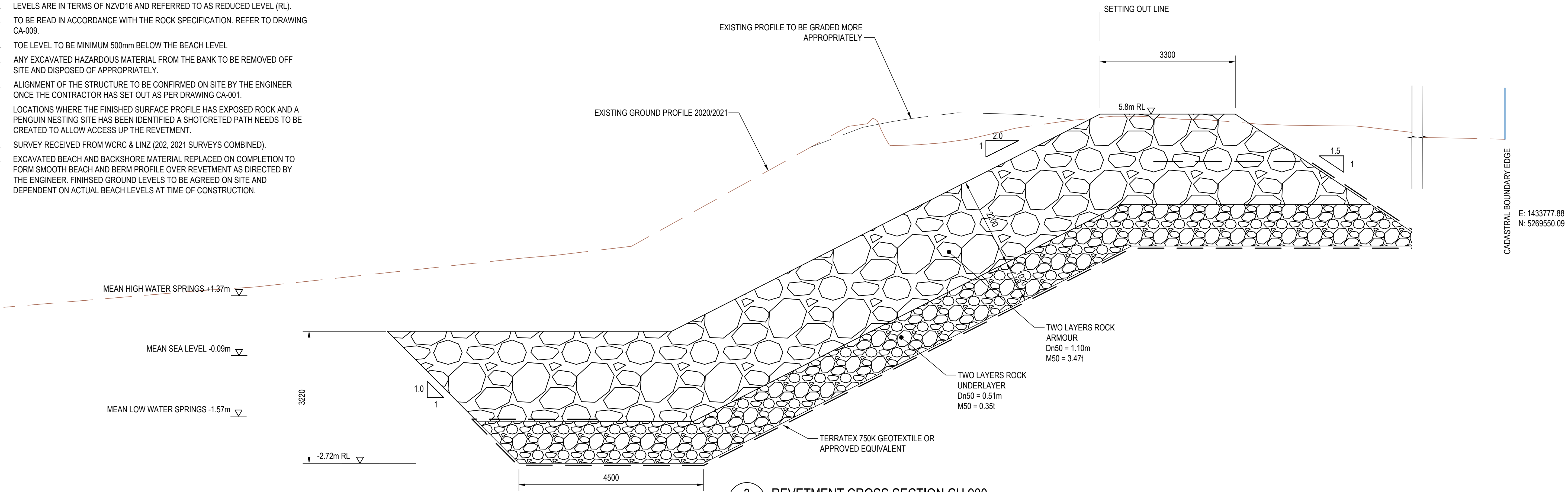

3 CA-004 REVETMENT CROSS SECTION CH 900

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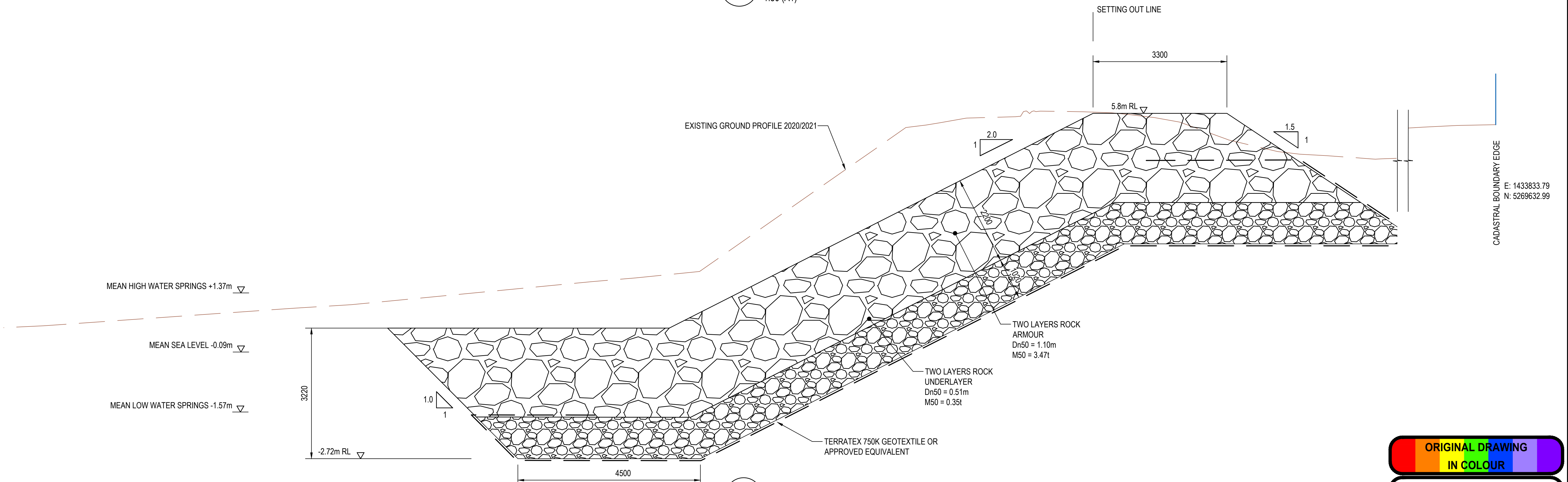

4 CA-004 REVETMENT CROSS SECTION CH 1000

1:50 (A1)

ORIGINAL DRAWING IN COLOUR

DETAILED DESIGN
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No.	Revision	By	Chk	Appd	Date
A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

Original Scale (A1) 1:50	Design	HD	1.04.22
Reduced Scale (A3) 1:100	Drawn	HD	1.04.22
	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA TYPICAL CROSS SECTION SHEET 1

Discipline: CIVIL ENGINEERING

Drawing No.: 3325253-CA-006 Rev. A

Document No. 3325253-CA-005-008 HOKITIKA CROSS SECTIONS

NOTES:

1. DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. LEVELS ARE IN TERMS OF NZVD16 AND REFERRED TO AS REDUCED LEVEL (RL).
3. TO BE READ IN ACCORDANCE WITH THE ROCK SPECIFICATION. REFER TO DRAWING CA-009.
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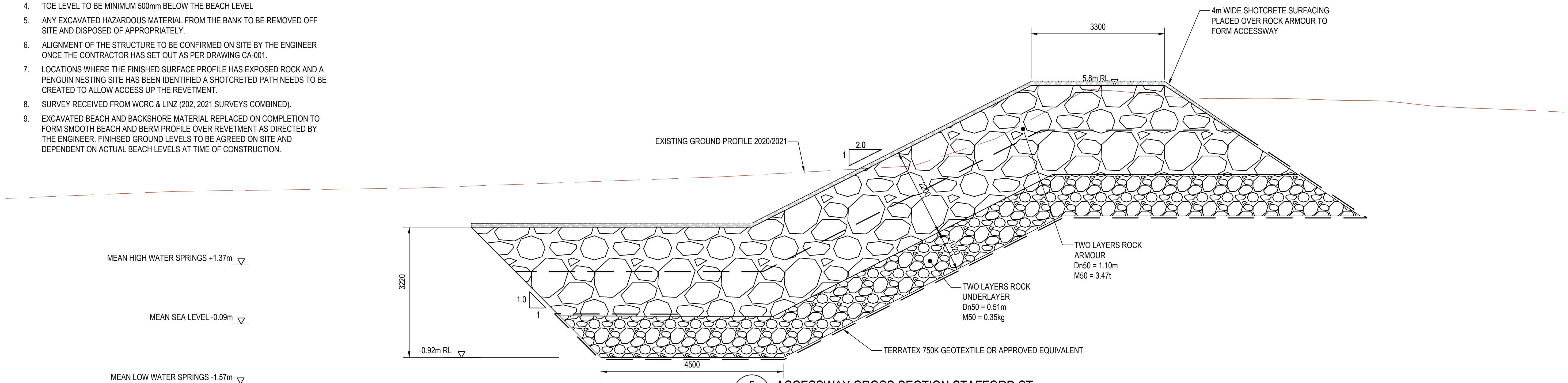
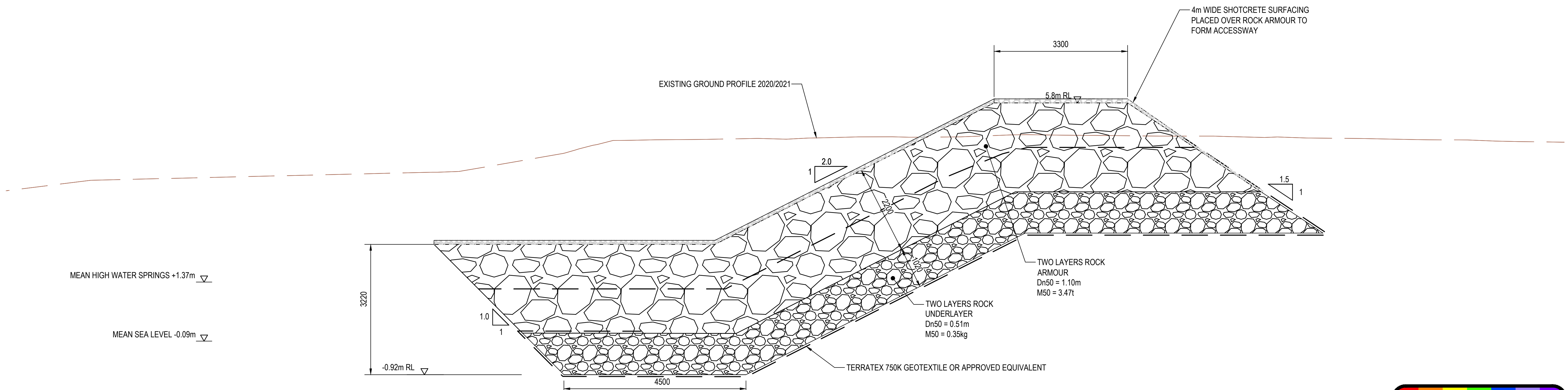


5 CA-001 ACCESSWAY CROSS SECTION STAFFORD ST
1:50 (A1)



6 CA-001 ACCESSWAY CROSS SECTION HAMPDEN ST
1:50 (A1)

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No.	Revision	By	Chk	Appd	Date
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Drawing Originator: Beca

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	Design	HD	1.04.22
	Drawn	HD	1.04.22
	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA SOUTHERN ACCESSWAYS CROSS SECTIONS

Discipline: CIVIL ENGINEERING

Drawing No. 3325253-CA-007 Rev. A

Document No. 3325253-CA-005-008 HOKITIKA CROSS SECTIONS

Drawing Plotted: 16 Aug 2022 4:42 pm

NOTES:

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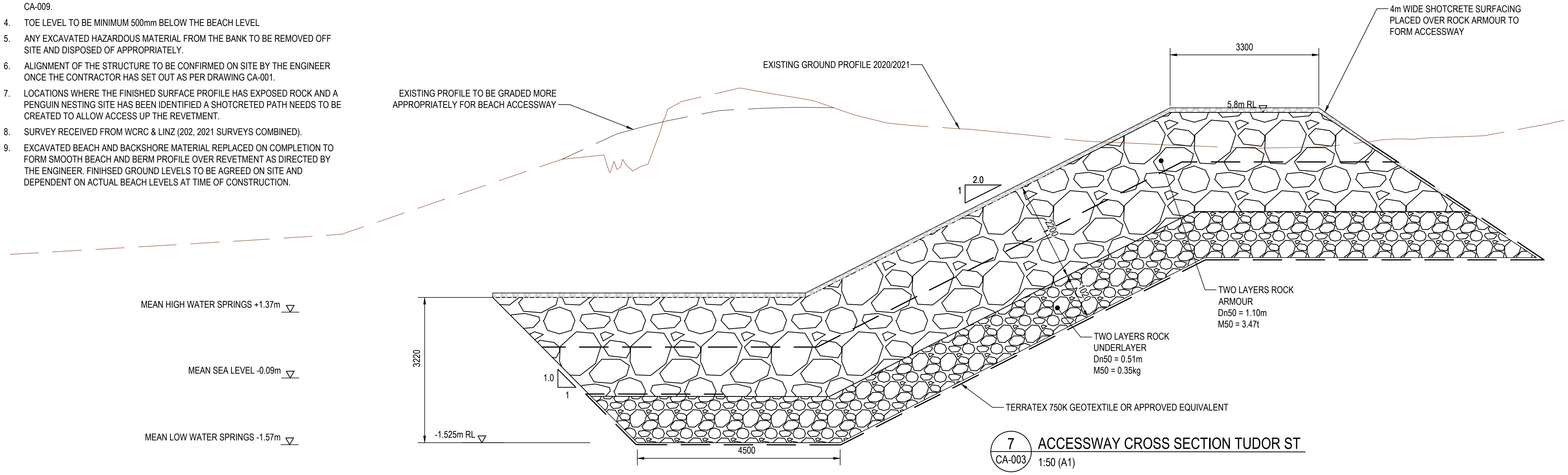
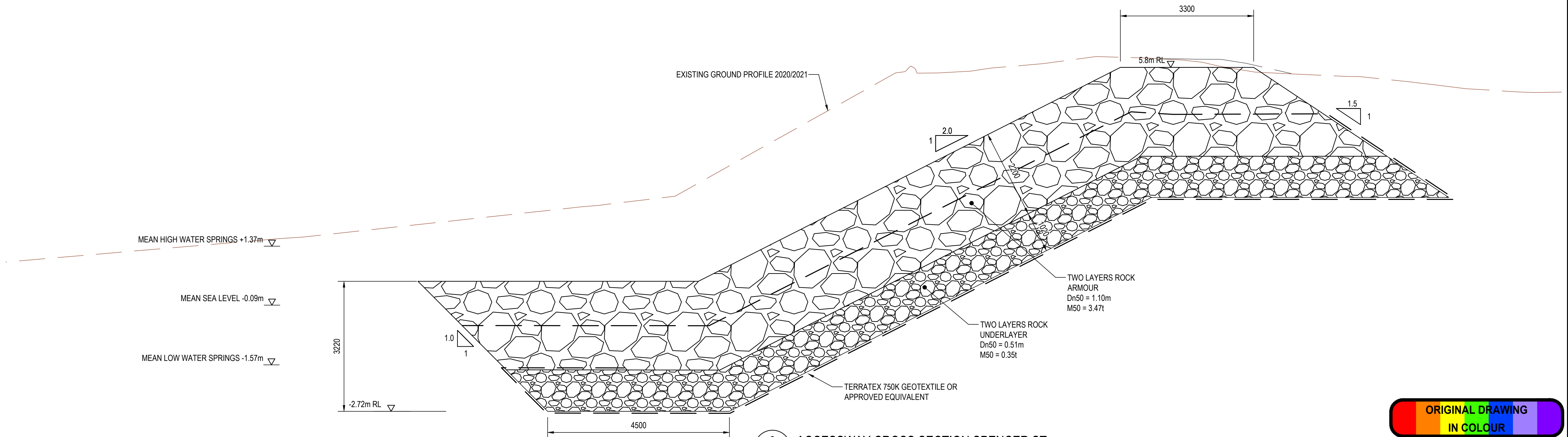


7 / CA-003 ACCESSWAY CROSS SECTION TUDOR ST
1:50 (A1)



8 / CA-004 ACCESSWAY CROSS SECTION SPENCER ST
1:50 (A1)

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No.	Revision	By	Chk	Appd	Date
A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

Original Scale (A1) 1:50	Design	HD	1.04.22
Reduced Scale (A3) 1:100	Drawn	HD	1.04.22
	Dsg Verifier	KS	16.08.22
	Dwg Check	SS	16.08.22

Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: HOKITIKA NORTHERN ACCESSWAYS CROSS SECTIONS

Discipline: CIVIL ENGINEERING

Drawing No.: 3325253-CA-008 Rev. A

Document No. 3325253-CA-005-008 HOKITIKA CROSS SECTIONS

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ARMOUR ROCK SPECIFICATION:

GENERAL

THIS SPECIFICATION SHALL BE READ IN CONJUNCTION WITH THE STANDARD "CIRIA C683 THE ROCK MANUAL - THE USE OF HYDRAULIC ROCK IN ENGINEERING, 2007" AND ALL MATERIALS AND WORKMANSHIP SHALL COMPLY WITH THIS STANDARD UNLESS EXPRESSLY NOTED OTHERWISE.

THE CONTRACTOR SHALL PREPARE A METHOD STATEMENT FOR THE ENGINEER'S REVIEW INCLUDING SOURCES OF MATERIAL AND QUARRYING, HOW THE SPECIFIED GRADINGS WILL BE ACHIEVED, TRANSPORT AND STOCKPILING, ROCK PLACEMENT, SURVEY TECHNIQUES, HEALTH AND SAFETY AND ENVIRONMENTAL MATTERS, EMERGENCY PLANS FOR STORM AND NATURAL HAZARD EVENTS, WEATHER AND WAVE CLIMATE FORECASTING AND WARNING SYSTEMS. THE WORK METHOD STATEMENT SHALL ALSO ADDRESS MEASURES TO CONTAIN MATERIALS DURING CONSTRUCTION AND TO PREVENT LOSS OF MATERIALS IN ADVERSE CONDITIONS.

THE CONTRACTOR SHALL NOMINATE AT THE TIME OF TENDER, THE SOURCE AND MATERIAL TYPE FOR THE ROCK. SOURCE TESTING AND GRADING IS REQUIRED FOR EACH OF THE TESTS DESCRIBED BELOW UNDER ROCK QUALITY AND ROCK GRADING AND RESULTS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO THE COMMENCEMENT OF WORKS AND DURING THE WORKS AS SET OUT BELOW. WORKS, INCLUDING STOCKPILING OF ROCK ON SITE, MUST NOT COMMENCE UNTIL THE ROCK DETAILS AS ABOVE AND THE FULL SET OF TEST RESULTS HAVE BEEN PROVIDED TO THE ENGINEER AND REVIEWED BY THE ENGINEER. TESTING IS TO BE UNDERTAKEN AT AN IANZ ACCREDITED LABORATORY.

THE CONTRACTOR SHALL CONDUCT A TRIAL TO DEMONSTRATE HOW THE PROPOSED WORK METHODS AND RESOURCES WILL RESULT IN THE REVETMENT BEING BUILT IN FULL ACCORDANCE WITH THE SPECIFICATION. THE TRIAL SHALL EXTEND OVER THE FULL LAYER HEIGHT IN A SINGLE PASS AND MINIMUM WIDTH OF 10m. PROVIDED THE TRIAL MEETS THE SPECIFICATION, THE TRIAL PANEL MAY BE INCORPORATED INTO THE PERMANENT WORKS.

THE CONTRACTOR SHALL CARRY OUT PRE AND POST WORK SURVEYS, SURVEYS TO MONITOR SETTLEMENT OF THE ROCK STRUCTURE AND MEASUREMENT SURVEYS TO SUPPORT PROGRESS PAYMENT APPLICATIONS. SURVEY OF ROCK SHALL BE CARRIED OUT USING A PROBE WITH A SPHERICAL END OF DIAMETER 0.5Dn50, WHERE Dn50 IS THE SIZE OF THE CUBE WITH EQUIVALENT VOLUME TO THE BLOCK WITH MEDIAN WEIGHT. ALTERNATIVELY, A DGPS SYSTEM RIGGED TO CONSTRUCTION EQUIPMENT MAY BE USED. THE PROPOSED SURVEY SYSTEM IS TO BE INCLUDED IN THE CONTRACTOR'S WORK METHOD STATEMENT FOR REVIEW BY THE ENGINEER.

THE CONTRACTOR'S WORK METHOD STATEMENT FOR REVIEW BY THE ENGINEER.

ROCK QUALITY

EACH TEST SPECIFIED BELOW SHALL COMPRISE A MINIMUM OF THREE SAMPLES.

1. ARMOUR AND UNDERLAYER ROCK SHALL BE HARD, DURABLE, ANGULAR-SHAPED, CRUSHED, QUARRIED OR NATURAL ROCK FREE FROM DUST, CLAY, ORGANIC MATTER AND OTHER DELETERIOUS MATERIAL. THE ROCK SHALL BE FREE FROM LAMINATIONS AND CLEAVAGES AND SHALL NOT DISINTEGRATE ON EXPOSURE TO WEATHERING.
2. THE SOLID DENSITY (SSD) OF ARMOUR AND UNDERLAYER ROCK SHALL BE AT LEAST 2.6 t/m^{C1}3;, TESTED IN ACCORDANCE WITH NZS 4407:2015.
3. THE ARMOUR AND UNDERLAYER ROCK SHALL HAVE A WATER ABSORPTION LESS THAN 3.0%, TESTED IN ACCORDANCE WITH NZS 3111:1986.
4. THE ARMOUR AND UNDERLAYER ROCK SHALL HAVE A LOS ANGELES ABRASION VALUE NOT MORE THAN 25% LOSS IN WEIGHT, TESTED IN ACCORDANCE WITH NZS 4407:2015.
5. THE QUARRY ROCK USED FOR ARMOUR AND UNDERLAYER SHALL HAVE A WEATHERING QUALITY INDEX OF AA, AB, BA, TESTED IN ACCORDANCE WITH NZS 4407:2015.
6. ARMOUR AND UNDERLAYER ROCK SHALL HAVE A CRUSHING RESISTANCE NOT LESS THAN 150kN TO PRODUCE A MAXIMUM OF 10% FINES, TESTED IN ACCORDANCE WITH NZS 4407.

ROCK GRADING AND SHAPE

1. THE ARMOUR AND UNDERLAYER ROCK GRADING IS AS FOLLOWS:

ROCK GRADING						
M_{50}	D_{n50}	LAYER THICKNESS	MAX	<15% PASSING	MIN	Dn_{85}/Dn_{15}
(kg)	(m)	(m)	(kg)	(kg)	(kg)	-
3,470	1.10	2.20	2 x M_{50}	0.65 x M_{50}	0.45 x M_{50}	<1.5
350	0.51	1.02	2.2 x M_{50}	0.5 x M_{50}	0.3 x M_{50}	<1.5

2. M50 IS THE MEAN MASS, M = SSD x Dn 3

   Dn IS THE NOMINAL DIAMETER CONSIDERING THE ROCK AS A CUBE.

   D IS THE SIEVE SIZE AND USED FOR ON SITE MEASUREMENT, CONVERSION TO BE CONFIRMED ON CONFIRMATION OF ROCK SUPPLY.

3. ROCK SHAPE : ARMOUR AND UNDERLAYER ROCK SHALL HAVE A LENGTH (L) TO WIDTH (W) RATIO OF LESS THAN 3. FIFTY PERCENT (50%) OF ROCKS SHALL NOT HAVE A L/W RATIO GREATER THAN 2. ALL ROCK SHALL BE ESSENTIALLY EQUI-DIMENSIONAL WITH ELONGATED OR THIN SLABS OF ROCK BEING UNACCEPTABLE. SAMPLING AND TESTING SHALL BE ACCORDING TO CIRIA C683, THE ROCK MANUAL, USING AT LEAST 50 PIECES TAKEN AT RANDOM FROM ROCKS GREATER THAN THE MINIMUM MASS. BLOCKS OF QUARRY ROCK IN HEAVY GRADINGS SHOWING CLEAR SIGNS OF SIGNIFICANT EDGE OR CORNER WEAR OR OF SEVERE ROUNDING SHALL NOT BE ACCEPTED.

TEST FREQUENCY

1. ROCK SOURCE, ROCK QUALITY PROPERTIES AND GRADING AND SHAPE TO BE TESTED AND RESULTS SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO WORK COMMENCING.
2. ROCK QUALITY PROPERTIES AND GRADING AND SHAPE TO BE RE-TESTED IF MATERIAL SOURCE CHANGES. TEST RESULTS TO BE SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO WORKS COMMENCING USING ROCK FROM THE NEW SOURCE.
3. ROCK QUALITY PROPERTIES AND GRADING AND SHAPE TO BE TESTED AT A FREQUENCY OF 1 ROUND OF TESTING FOR EVERY $2000m^3$ OF ROCK TO BE SUPPLIED FOLLOWING INITIAL PRE-CONSTRUCTION TESTING. TEST RESULTS FOR EACH $2000m^3$ OF ROCK TO BE SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO WORKS COMMENCING USING THAT $2000m^3$ OF ROCK.

CONSTRUCTION

1. PLACING OF EACH LAYER SHALL COMMENCE AT THE TOE AND SHALL PROCEED UPWARDS TOWARDS THE TOP, CONSTRUCTING THE FULL LAYER THICKNESS IN A SINGLE PASS.
2. ROCKS SHALL BE PLACED TO:

a. ACHIEVE A WELL KEYED, DENSELY PACKED STRUCTURE WITH A TARGET BULK DENSITY OF 1.64 t/m^3 WITH A TOLERANCE OF ±0.1 t/m^3. WHERE THE CONTRACTOR USES A HIGHER ROCK DENSITY (SSD) THAN $2.6t/m^3$; THEY SHALL SPECIFY THE REVISED ROCK DENSITY AND ADJUST THE TARGET PLACED DENSITY PRO-RATA.

b. ACHIEVE EFFECTIVE INTERLOCKING, SO THAT EACH ROCK IS SECURELY HELD IN PLACE BY ITS NEIGHBOURS AND DOES NOT DEPEND ON FRICTIONAL RESISTANCE FOR STABILITY PRIOR TO PLACING FURTHER ROCKS.

c. ACHIEVE A FINISHED LAYER AT LEAST TWO ROCKS THICK UNLESS SHOWN OTHERWISE ON THE DRAWINGS.

d. AVOID FORMING, WITHIN THE OVERALL THICKNESS OF THE LAYER, SEPARATE LAYERS IN THE PLANE PARALLEL TO THE SLOPE OF THE UNDERLYING MATERIAL.

e. MINIMISE ANY DISTURBANCE TO ALREADY-PLACED ROCK.

f. AVOID DAMAGE TO ANY EXISTING STRUCTURES.

3. UNDERLAYER AND ARMOUR ROCK SHALL BE PLACED AS SOON AS PRACTICABLE TO PROTECT THE UNDERLYING MATERIAL. MATERIAL ERODED BY WAVE ACTION OR ANY OTHER CAUSE SHALL BE MADE GOOD BY THE CONTRACTOR, AT THE CONTRACTOR'S OWN EXPENSE BEFORE PLACING THE APPROPRIATE PROTECTIVE LAYER.
4. ROCK SHALL BE DEPOSITED CAREFULLY SO THAT GEOTEXTILE FABRIC IS NOT PUNCTURED. MAXIMUM DROP HEIGHT OF THE ROCK SHALL BE LIMITED TO 0.5m. ARMOUR ROCK SHALL BE INDIVIDUALLY PLACED PIECE BY PIECE INTO THE STRUCTURE TO ACHIEVE A MINIMUM 3-POINT SUPPORT.

TOLERANCES

1. VERTICAL TOLERANCE FOR TRIMMED SLOPE FOR ROCK REVETMENT CONSTRUCTION TO BE ±100mm.
2. HORIZONTAL TOLERANCE FOR ROCK RIPRAP, UNDERLAYER AND ARMOUR TO BE ±0.30m.
3. VERTICAL TOLERANCE FOR UNDERLAYER TO BE ±0.10m AND FOR RIPRAP AND ROCK ARMOUR ±0.15m.

GEOTEXTILE

1. GEOTEXTILE SHALL COMPLY WITH AS 3706: GEOTEXTILES.
2. THE GEOTEXTILE FABRIC SHALL BE PLACED AT THE LOCATIONS SHOWN ON THE DRAWINGS. THE SITE SHALL BE PREPARED BY CLEARING AND GRADING THE AREA REQUIRED. ALL SHARP OBJECTS AND ROCKS SHALL BE REMOVED. GEOTEXTILES SHALL BE PLACED JUST AHEAD OF ASSOCIATED ADVANCING CONSTRUCTION WORK AND BE COVERED BY THE UNDERLAYER WITHIN 48 HOURS OF BEING PLACED AND WITHOUT PUNCTURES OR TEARS.
3. GEOTEXTILE SHALL BE STABILISED AGAINST ULTRAVIOLET LIGHT AND SHALL NOT BE PERMANENTLY IMPAIRED BY TEMPORARY EXPOSURE TO DIRECT SUNLIGHT DURING CONSTRUCTION.
4. GEOTEXTILE SHALL BE KEPT IN ITS PROTECTIVE WRAPPING ON THE SITE AND STORED OUT OF DIRECT SUNLIGHT SO IT IS NOT EXPOSED TO ULTRA-VIOLET LIGHT PRIOR TO INSTALLATION. GEOTEXTILE THAT IS NOT IMMEDIATELY COVERED AFTER INSTALLATION SHALL BE COVERED WITH AN APPROVED MATERIAL OF SUFFICIENT THICKNESS TO PROTECT IT FROM ULTRA-VIOLET LIGHT.
5. GEOTEXTILE THAT IS DAMAGED SHALL BE REJECTED AND REMOVED FROM SITE.
6. THE MINIMUM LAP WIDTH OF ADJACENT STRIPS OF GEOTEXTILE SHALL BE 1000mm.

HARDFILL

1. ROCK IS TO BE ANGULAR OR SUB-ANGULAR.
2. GRADING IS TO BE GAP100 WITH LESS THAN 5% FINES.

GAP100 GRADING	
SIEVE SIZE	PERCENTAGE PASSING
100mm	100
75mm	80-92
63mm	70-85
37.5mm	54-75
19.0mm	39-60
9.5mm	27-46
4.75mm	20-34
2.36mm	15-25
1.18mm	10-18
600µm	6-13

3. CRUSHING RESISTANCE ≥ 120kN.
4. WEATHERING QUALITY INDEX TO BE AA, AB, AC, BA, BB, OR CA.
5. HARDFILL SHALL BE COMPACTED WITH A VIBROCOMPACTOR WEIGHING LESS THAN 75kg.

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No.	Revision	By	Chk	Appd	Date
A	DETAILED DESIGN	HD	RS	KS	16.08.22

Drawing Originator: Beca

Original Scale (A1) NTS
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Design	HD	1.04.22
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Dsg Verifier	KS	16.08.22
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Client: THE WEST COAST REGIONAL COUNCIL

Project: HOKITIKA REVETMENT EXTENSION

Title: ROCK ARMOUR SPECIFICATION

Discipline: CIVIL ENGINEERING

Drawing No.: 3235521-CA-009 Rev. A

Document No. 3325253-CA-009.DWG

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Appendix D – Safety in Design Register

Safety in Design Risk Assessment Register

Author (Role): **Beca** Job No: **3325253**
Project Name: **Hokitika Revetment Extn** Date **16 August 2022**
Revision: **2** Stage of Design/Project: **Detailed design**
(Note: minimum of 2 reviews per project)

RISKS ASSOCIATED WITH DESIGN ELEMENTS				Risk Matrix			PROPOSED & APPROVED MITIGATION MEASURES	Mitigated Risk & Resolution							RESIDUAL RISK	
Ref	Hazard (Guideword)	Cause & Outcome	Existing controls, if any	L	C	LR	Proposed Control (1 Eliminate, 2 Substitute, 3 Reduce, 4 Control)	L	C	LR	Risk Owner	Client Approved	Design Status	Date	Risk Owner	Action Required
1	**Construction Phase**															
1.01	*Natural Environment*	Weather and marine events affecting safety during construction (i.e. storms, large swells)		3	3	H	4 Control - Monitor weather forecasts to indicate the possibility of extreme weather events. Contractor to take into account the risk of adverse weather conditions. 4 Control - Planning for an extreme event. Emergency plan in place in case of an extreme event.	3	2	M	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.02	*Natural Environment*	Beach becomes inundated during high tide. Risk to personnel, risk of equipment damage and material loss due to waves.		4	4	E	1 Eliminate - Contractors to move equipment and staff in time before high tide. Plan work around daily tide predictions.	4	2	M	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.03	*Natural Environment*	Waves during high tide change pore pressure of sand/ground and hence stability of the foreshore (affecting the placement of rocks and movement of construction vehicles).		4	4	E	4 Control - Place rocks of revetment during summer season (if possible) and low tide.	4	2	M	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.04	*Natural Environment*	Excavated material (which will be deposited on site) washed away by wave, high tide or storm, exposing site to inundation and wave action		3	4	H	4 Control - Contractor to manage construction and be aware of conditions when undertaking a section of work..	3	2	M	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.05	*Natural Environment*	Underconsolidated ground conditions (loose/very loose sand) causes settlement of structure or plant during construction		3	3	H	4 Control - Geotechnical information provided to Contractor; Contractor's work methodology to allow for loose/very loose sand encountered during construction, including pre-work assessment and onsite identification of risk areas (e..g marking), placement of plant and personnel, monitoring and management of structure settlement.	3	2	M	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.05	*Load / Force / Energy*	Accident and resulting injuries to construction workers carrying out construction works or handling of units (e.g. from use of heavy equipment, poorly maintained plant and equipment, inappropriate lifting or poor execution plans).		4	3	H	3 Reduce - Reputable Contractors to be invited to Tender. Tender assessment to include check of health and safety record of Tenderers and subcontractors. 4 Control - Ensure that the contractors undertake works in accordance with reviewed Safe Work Method Statements. 4 Control - Provision for site amenities for contractors required with first aid kit for emergencies. Site office in secure location on site.	2	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.06	*Egress / Access*	Vehicle movements to and from site, i.e. exiting site with additional hazards of sun strike, restricted sight lines, railway crossings, en-route interactions with other vehicles and users of the State Highway and site access roads.		4	3	H	4 Control - Review of contractor construction methodology and lifting plan. 3 Reduce - Practice safe driving speed, use of indicators. Use of sunblock and sunglasses.	1	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.07	*Egress / Access*	Limited emergency routes during construction.		3	3	H	4 Control - Emergency routes to be clearly provided by the contractor before construction commences. Minimal distance for access roads to be identified. 4 Control - Planning and high-ground evacuation in the event of an earthquake/tsunami.	1	1	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.08	*Size / Shape*	Construction noise, dust, construction debris etc. affecting nearby residents and general public		2	2	L	4 Control - Notify local residents about construction period prior to commencement of works. 3 Reduce - Avoid construction during night time.	1	1	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.09	*Interfaces External to the Project*	Unauthorised or unexpected vehicles accessing the construction area causing collision during construction works resulting in injury to staff or damage to equipment.		3	2	M	3 Reduce - Clearly barricade construction site and erect signs stating no access to unauthorised vehicles.	1	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.10	*Interfaces External to the Project*	Members of public accessing the construction area, exposed to moving plant and vehicles, construction activities.		3	3	H	3 Reduce - Clearly fence construction site and erect signs stating no access to public; undertake public awareness campaign; construction spotters and managers monitor for public access and address breach of site area, plant locked securely while not working	1	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.11	*Ergonomics*	Working schedule, manual handling of material and equipment, personnel discomfort, fatigue, stress, insufficient PPE, visibility, slips, trips, etc.		4	2	M	4 Control - To be considered during design stage. Review of contractor Health & Safety plan.	1	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.13	*Heights / Depths*	Excavation depth with risk of excavation seawall/rock collapsing		2	2	L	3 Reduce - Staged excavation I.e. in few strips at a time, use of appropriate benching. 4 Control - Contractor to have safety fall protection . I.e. barriers.	1	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.14	*Load / Force / Energy*	Truck tipping of rock on unstable/uneven ground and/or controlling backing and turning movements.		2	3	M	3 Reduce - Contractor to ensure no site personnel are close to the truck while material is being dumped. Dump material/units on even ground. 4 Control - Ensure that the contractors undertake works in accordance with reviewed Safe Work Method Statements. 4 Control - Vehicle with warning alarm while backing up.	2	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.15	*Load / Force / Energy*	Overhead powerline clearance and the risk of truck decks being mistakenly being kept up.		2	2	L	3 Reduce - Ensure sufficient clearance for all vehicles enetring and exiting the site. 4 Control - Ensure that the contractors undertake works in accordance with reviewed Safe Work Method Statements. Contractor to secure vehicles and site at end of each working day/night.	2	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.
1.16	*Site Environment*	Blue penguins nesting/located in/immediately adjacent construction site		3	3	H	1 Eliminate - Daily inspection with a torch (to look into holes) of the work area and any stockpiled rock to be performed to confirm the presence / absence of penguins. 2 Substitute - Where penguin refuge sites are compromised, additional artificial refuge sites to be put in place. 3 Reduce - Construction work in blue penguin foreshore habitat to occur in daylight hours and in conjunction with advice from Penguin Trust. 4 Control - Ensure that the contractors undertake works in accordance with reviewed Safe Work Method Statements. Contractor to secure vehicles and site at end of each working day/night.	2	2	L	Contractor		N/A		Contractor	Mitigation actions to be addressed during construction by Contractor.

Safety in Design Risk Assessment Register

Author (Role): **Beca**
Job No: **3325253**
Project Name: **Hokitika Revetment Extn**
Date **16 August 2022**
Revision: **2**
Stage of Design/Project: **Detailed design**
(Note: minimum of 2 reviews per project)

RISKS ASSOCIATED WITH DESIGN ELEMENTS				Risk Matrix			PROPOSED & APPROVED MITIGATION MEASURES	Mitigated Risk & Resolution							RESIDUAL RISK	
Ref	Hazard (Guideword)	Cause & Outcome	Existing controls, if any	L	C	LR	Proposed Control (1 Eliminate, 2 Substitute, 3 Reduce, 4 Control)	L	C	LR	Risk Owner	Client Approved	Design Status	Date	Risk Owner	Action Required
2	**Operation & Maintenance Phase**															
2.01	*Natural Environment*	Natural hazards pose safety risks during operation and maintenance (i.e. wave overtopping, tsunami, cyclones, earthquakes). Resultant risks include risk of injury from overtopping discharges, or from rock movement associated with failure of revetment.		4	4	E	3 Reduce - Design to meet agreed requirements and make allowance for appropriate natural hazards (i.e. extreme waves and water levels) in design. 2 Mitigation - Provide safety signage, especially at accessways and monitor overtopping. 2 Mitigation - Inspect structure after events and maintain as required	2	2	L	WCRC, Beca		Design compl	16.8.22	WCRC	To manage residual risk
2.02	*Egress / Access*	Accidents/incidents from insufficient access routes or manoeuvring for maintenance vehicles.		3	3	H	3 Reduce - Provide temporary access ramp for maintenance vehicles if required for major maintenance from beach level. Provide temporary backshore access for minor crest-level maintenance. Provide adequate parking and manoeuvring area for maintenance vehicles on site for unloading material.	1	3	M	WCRC		N/A		WCRC	To manage residual risk
2.03	*Timing*	Inspections and maintenance not undertaken leading to unsafe structure and potential for injury to public (e.g. slip/trip on deteriorated shotcrete surfacing on accessway)		2	3	M	3 Reduce - Design revetment for design life, document design conditions. 4 Control - Provide Operation and Maintenance Plan (outline included in Detailed Design Report).	2	1	L	WCRC, Beca		Design compl	16.8.22	WCRC	To manage residual risk
2.04	*Egress / Access*	Limited access to the beach for the public, may attempt to go over rock structure risk of falls, entrapment in gaps.		2	3	M	2 Mitigation - Provide shotcreted accessways, safety signage and monitor degree of exposure of rock wall.	1	3	M	WCRC		N/A		WCRC	To manage residual risk
3	**Demolition Phase**															
3.01	*Movement / Direction*	AS FOR CONSTRUCTION PHASE					AS FOR CONSTRUCTION PHASE				WCRC		N/A		WCRC	To manage risks

Key:

C= Consequence 1) Low 2) Moderate 3) Significant 4) Major 5) Critical

L= Likelihood 1) Rare 2) Unlikely 3) Possible 4) Likely 5) Almost Certain

LR = Level of I L) Low M) Medium H) High E) Extreme

Notes: Hazards / risks considered are those that are project / site specific, non-standard / bespoke designs, special processes, high hazard risks (e.g. non 'business as usual' hazards) that have been identified at the time of the review(s). Other risks will continue to appear during the design life of the project and should be assessed and managed by appropriate parties.

E

Appendix E – Geotechnical Investigations


Hokitika Beach Topo Survey
Scale 1:3000 @ A2 size
survey date 30 Sept - 5 Oct 2020
contour interval 0.20m
boundaries are indicative only
extent of emergency rock wall
RICHARDS
DRIVE GROYNE
DCP04
beach
access
Richards Drive
DCP03
beach access
Spencer Street
DCP02
Tudor Street
(beach access)
end of emergency rock wall
Park Street
PROPOSED SEAWALL
EXTENSION
1100M APPROX
DCP05
EXISTING
SEAWALL
shed
Hampden Street
(beach access)
DCP01
access track
Stafford Street
end existing rock wall
Weld Lane

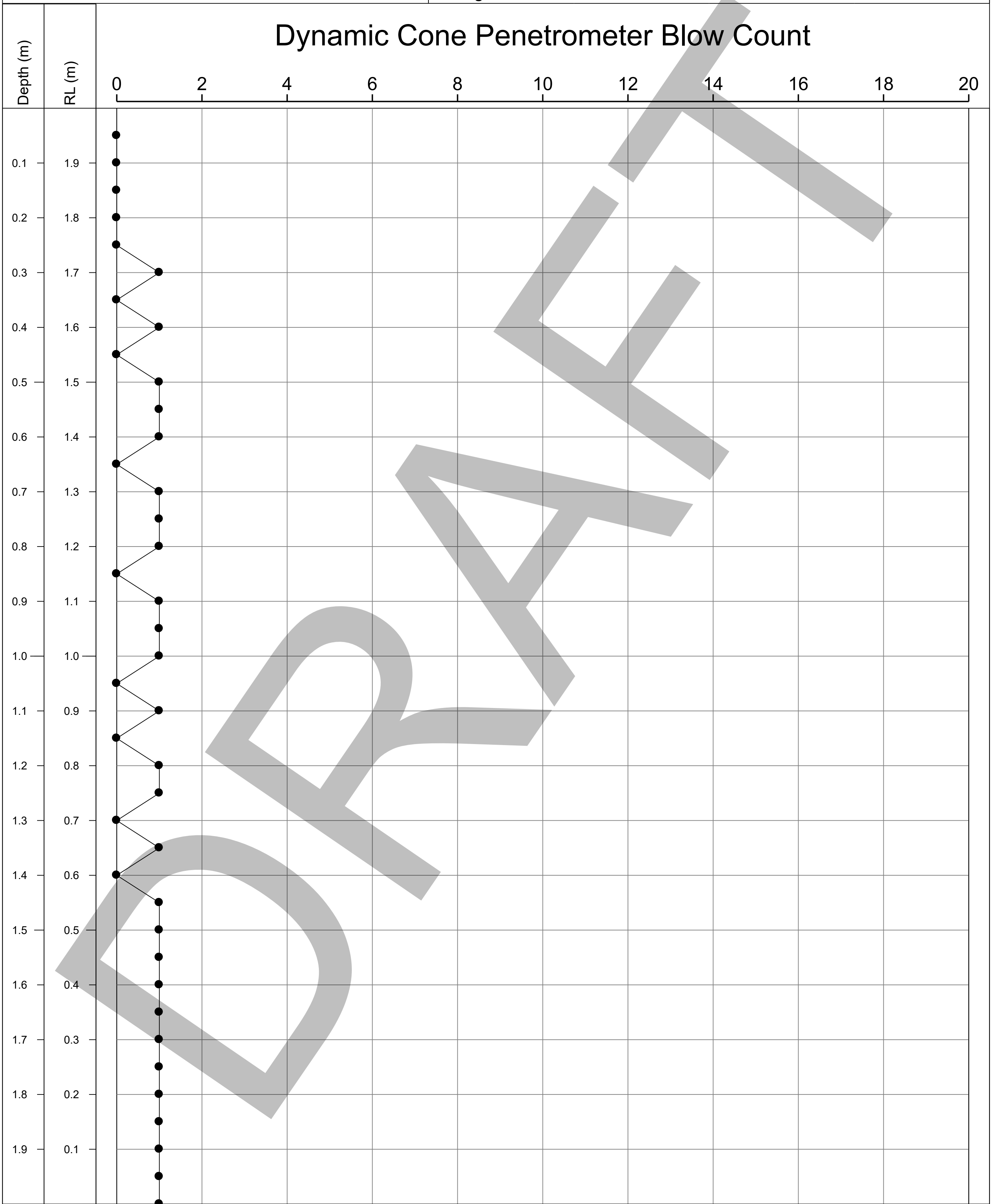
DCP Report

Borehole ID: DCP01

Sheet 1 of 1

Project:	Hokitika Sea Wall	**Project number:**	3325253
Site location:	Hokitika Sea Wall	**Client name:**	West Coast Regional Council

Location:	Hokitika Seawall Extension	**Coordinate system:**	NZTM2000	**Vertical datum:**	NZVD 2016
		Northing:	5268848.0	**Ground level (mRL):**	2.00
		Easting:	1433212.0	**Location method:**	HHGPS



Date started:	05/10/2021	**Date end:**	05/10/2021
Logged by:	JB	**Tested by:**	
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

Comments:
Coordinates obtained via handheld GPS in terms of NZTM2000 to an accuracy of +/-5m. Elevation obtained from topographic maps to an accuracy of +/-5m.

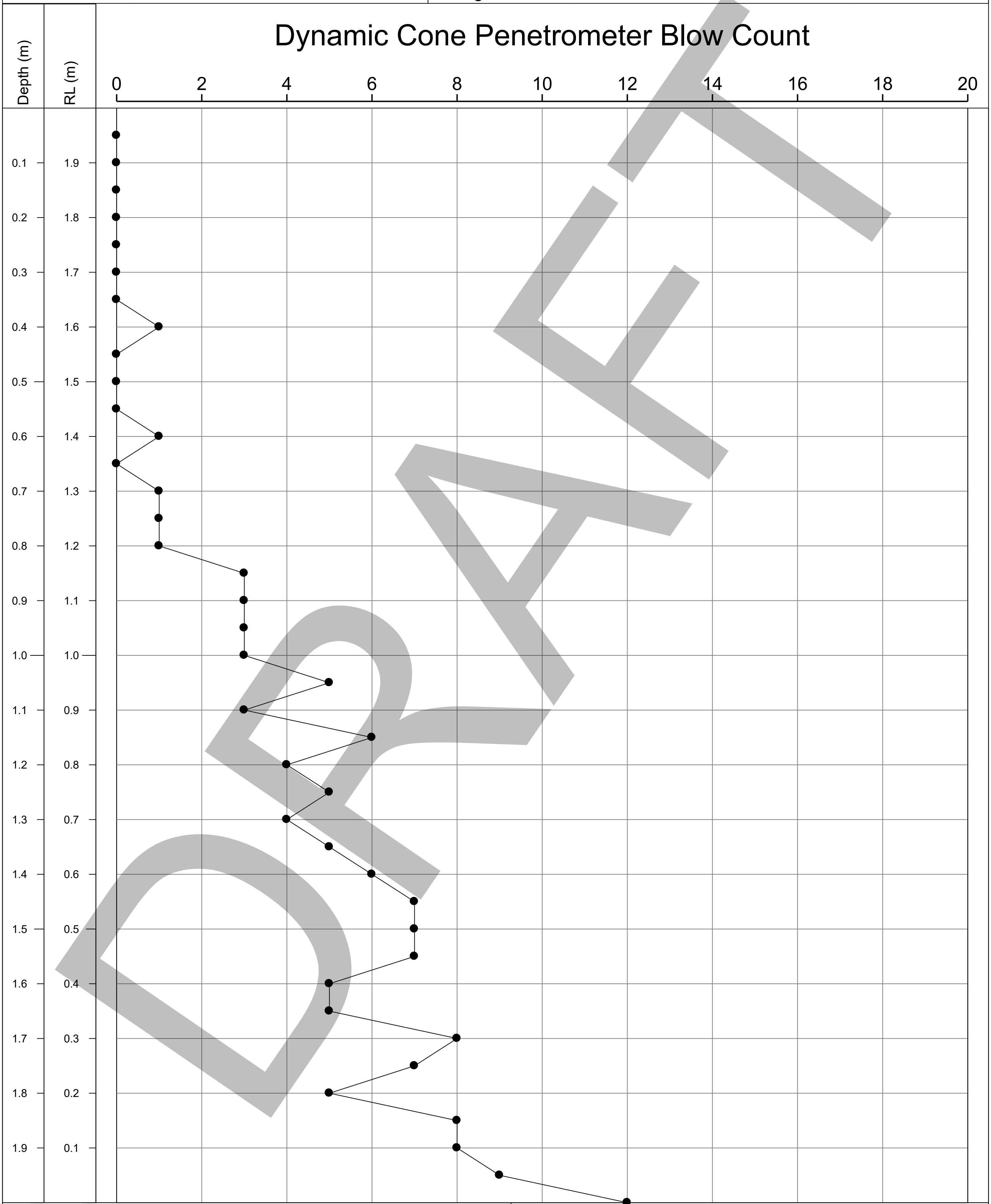
For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: DCP02

Sheet 1 of 1

Project:	Hokitika Sea Wall	**Project number:**	3325253
Site location:	Hokitika Sea Wall	**Client name:**	West Coast Regional Council
Location:	Hokitika Seawall Extension	**Coordinate system:** NZTM2000	**Vertical datum:** NZVD 2016
		Northing: 5269374.0	**Ground level (mRL):** 2.00
		Easting: 1433595.0	**Location method:** HHGPS



Date started:	05/10/2021	**Date end:**	05/10/2021
Logged by:	JB	**Tested by:**	
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

Comments:
Coordinates obtained via handheld GPS in terms of NZTM2000 to an accuracy of +/-5m. Elevation obtained from topographic maps to an accuracy of +/-5m.

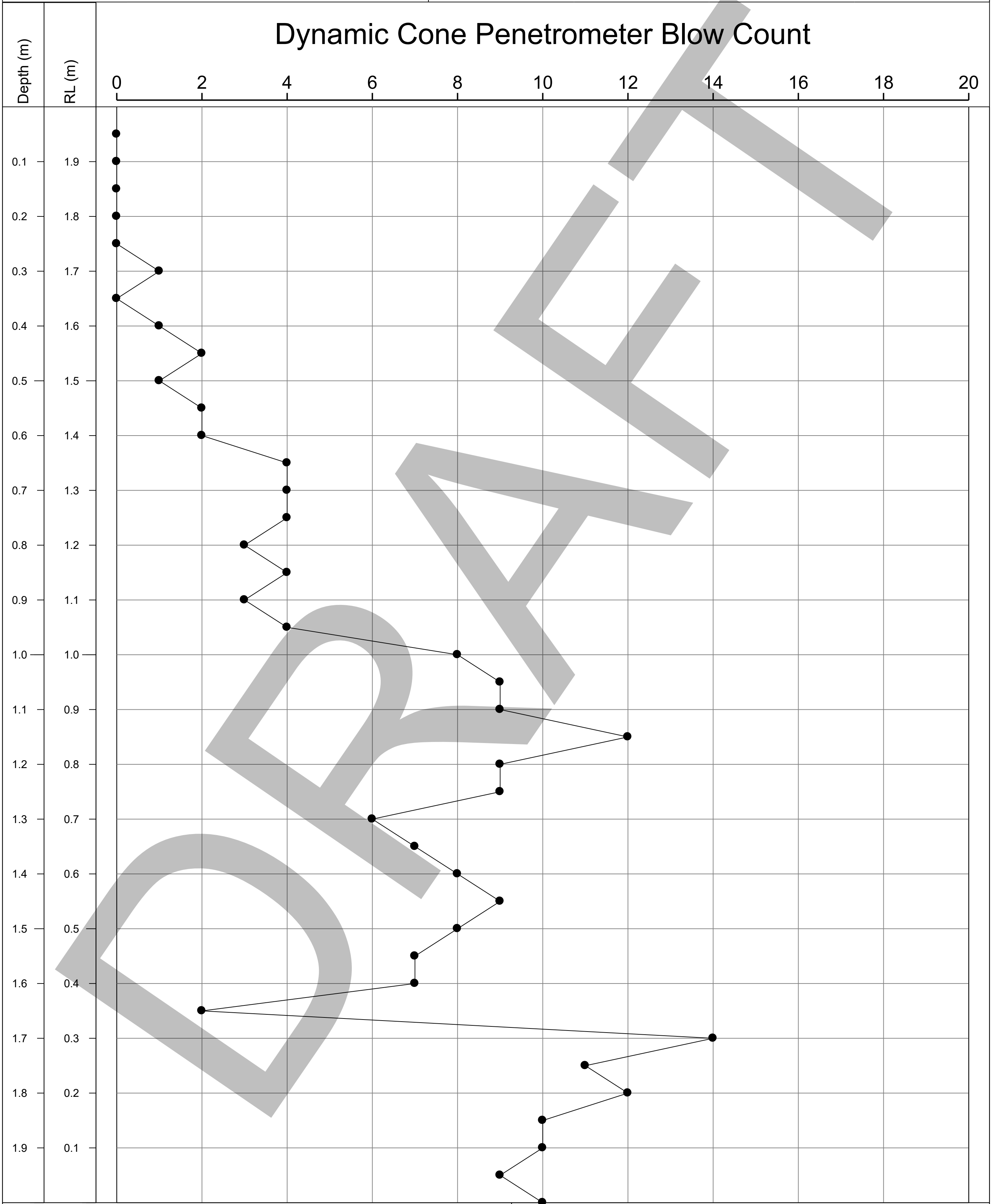
For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: DCP03

Sheet 1 of 1

Project:	Hokitika Sea Wall	**Project number:**	3325253
Site location:	Hokitika Sea Wall	**Client name:**	West Coast Regional Council
Location:	Hokitika Seawall Extension	**Coordinate system:**	NZTM2000
		Vertical datum:	NZVD 2016
		Northing:	5269574.0
		Ground level (mRL):	2.00
		Easting:	1433742.0
		Location method:	HHGPS



Date started:	05/10/2021	**Date end:**	05/10/2021
Logged by:	JB	**Tested by:**	
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

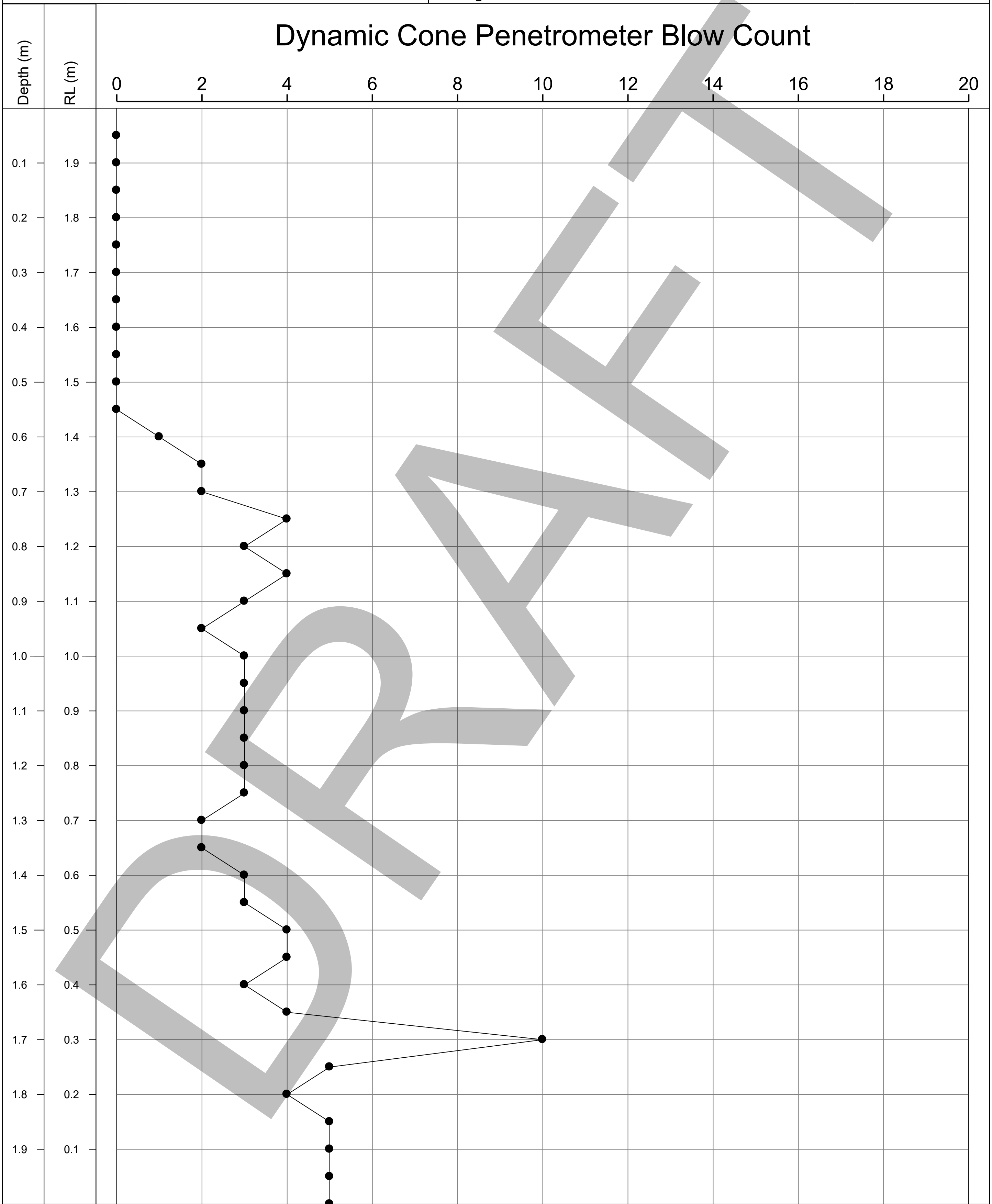
Comments:
Coordinates obtained via handheld GPS in terms of NZTM2000 to an accuracy of +/-5m. Elevation obtained from topographic maps to an accuracy of +/-5m.

For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: DCP04
Sheet 1 of 1

Project:	Hokitika Sea Wall	**Project number:**	3325253
Site location:	Hokitika Sea Wall	**Client name:**	West Coast Regional Council
Location:	Hokitika Seawall Extension	**Coordinate system:**	NZTM2000
Vertical datum:	NZVD 2016	**Northing:**	5269730.0
Ground level (mRL):	2.00	**Easting:**	1433857.0
Location method:	HHGPS		



Date started:	05/10/2021	**Date end:**	05/10/2021
Logged by:	JB	**Tested by:**	
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

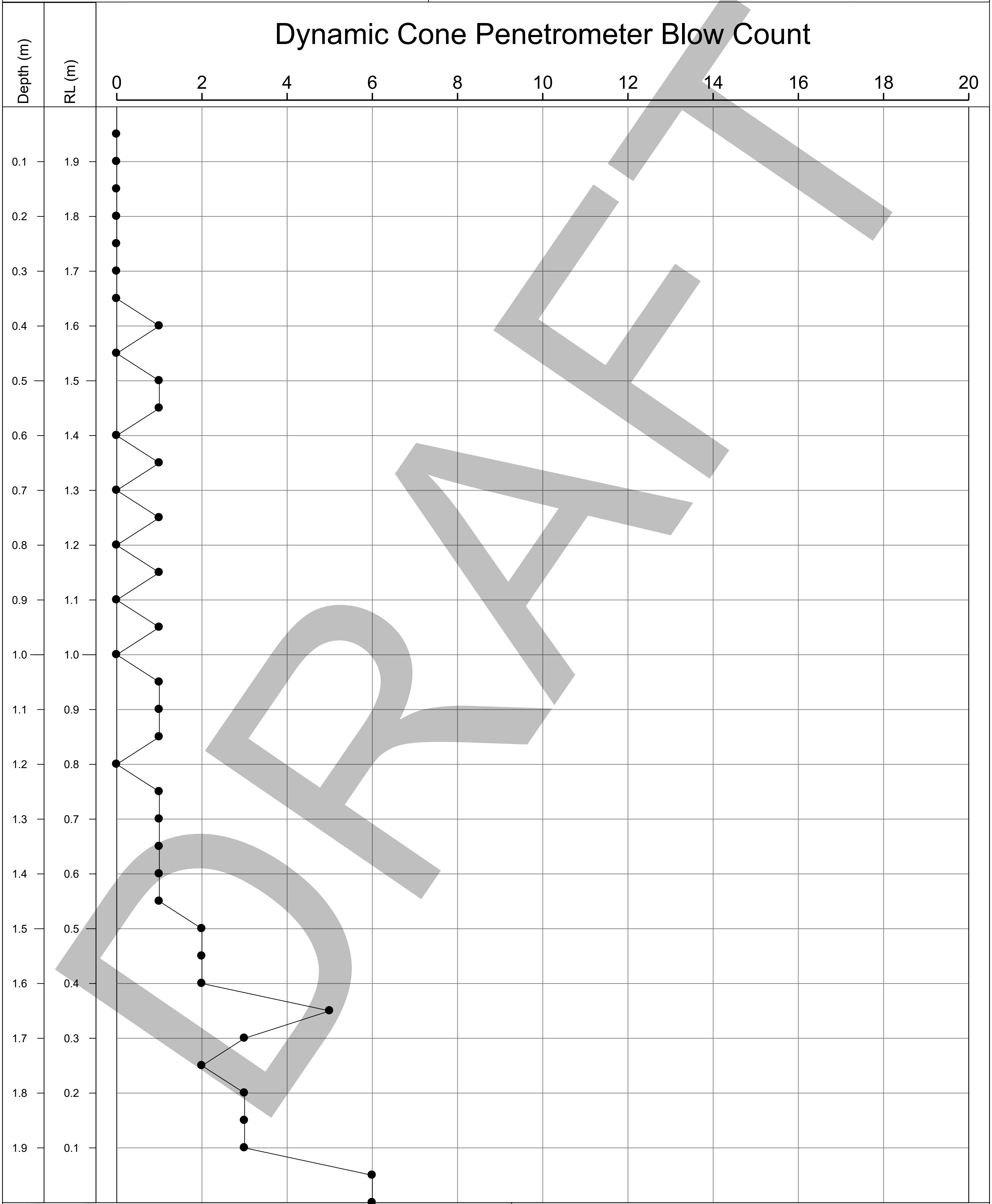
Comments:
Coordinates obtained via handheld GPS in terms of NZTM2000 to an accuracy of +/-5m. Elevation obtained from topographic maps to an accuracy of +/-5m.

For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: DCP05
Sheet 1 of 1

Project:	Hokitika Sea Wall	**Project number:**	3325253
Site location:	Hokitika Sea Wall	**Client name:**	West Coast Regional Council
Location:	Hokitika Seawall Extension	**Coordinate system:** NZTM2000	**Vertical datum:** NZVD 2016
		Northing: 5269036.0	**Ground level (mRL):** 2.00
		Easting: 1433370.0	**Location method:** HHGPS



Date started:	05/10/2021	**Date end:**	05/10/2021
Logged by:	JB	**Tested by:**	
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

Comments:
Coordinates obtained via handheld GPS in terms of NZTM2000 to an accuracy of +/-5m. Elevation obtained from topographic maps to an accuracy of +/-5m.

For Explanation of Symbols and Abbreviations See Key Sheet

Attachment 6

Addendum to AEE

Impoundment effect of the proposed revetment extension and cumulative effects of this and adjacent wall) on shoreline evolution.

As described in the AEE and DDR, the revetment extension will initially be covered with replaced beach material to allow coastal processes to continue to operate as at present in the near term (onshore/offshore and alongshore movement of sand under wave action; dune-building by onshore winds). It is anticipated that the revetment extension will be exposed by erosion events during the 15 year design life. Once the revetment extension is regularly exposed, it will interrupt the supply of backshore material to the beach and the storage of beach material in the dunes/backshore, as well as protecting the backshore from significant erosion (although storm overtopping will erode and lower the backshore, requiring regular maintenance as described in the DDR). Backshore supply of sediment to the beach has varied between 5 and 50 m^3 / m length of beach / year based on 2018-19 shoreline movements and ground levels. Net backshore supply to the beach will be some 75% to 90% of this quantity as not all the material is sand or gravel. This compares with estimated higher bound erosion rates from the combined beach and backshore of 260 m^3 / m length of beach / year based on 1984-1985 erosion given in the Coastal Management Plan for Hokitika (Gibb, 1987). The backshore appears to be a moderate source of sediment to the beach at times, in the central section of the revetment extension.

The existing revetment presently interrupts the supply of backshore sediment in the area south of the proposed revetment extension. Site observations and historical satellite images indicate beach narrowing/ lowering/ steepening through the central and northern sections of the existing revetment and beach widening/ increase in levels/ flattening at the southern beach (refer to Figure 1a, 1b). As noted above, while the revetment extension remains covered with beach material, coastal processes are expected to continue as at present and cumulative effects of the existing and proposed revetments are expected to be similar to the existing revetment effects.

Once the revetment extension is regularly exposed, the cumulative effects of the existing revetment and proposed extension are expected to result in continued fluctuations in beach levels, with the beach trending towards a steeper, narrower, lower profile due to reduced sediment supply and increased wave reflection. The combined revetments potentially reduce the volume of sediment available to the net northerly longshore transport (Gibb, 1987), which may result in shoreline retreat and rollback of the coastal barrier north of the site. Based on shoreline movements between Stafford Street and Richards Drive over the 2013 to 2021 period following construction of the existing revetment, such effects might extend some 900m north of the proposed revetment extension.

Figure 1a: Existing revetment, December 2012 (from GoogleEarth)

Figure 1b: Existing revetment, April 2021 (from GoogleEarth)

Assessment to show that this is the preferred option from an effects basis is necessary.
Section 7 of the AEE describes alternative coast management strategies, sea defence measures and alignments. An effects-based assessment for the alternatives is summarised in the table below, based on the information in the AEE.

Alternative	**Summary of Effects-based Assessment**
Coastal Management Strategies	
Do Nothing / No Active Intervention	- Continued retreat of scarp/rollback of upper beach and erosion of public land along coastline providing sediment supply to beach and supporting slightly higher beach levels and continuity of coastal processes between beach and backshore/dunes. Erosion will reduce width of public land and potential public access along the coastline. - Continued overtopping of backshore with loss of vegetation. - Continued risk of erosion and overtopping damage to public land and landward private property.
Managed Retreat	- As for Do Nothing / No Active Intervention with a long-term reduction in risk of damage to private property as dwellings and structures are relocated to new sites away from coast. - Significant enabling works (e.g. removal of utilities and buildings) required.

Hold the Line (long term)	- Steepening, narrowing, and lowering of beach, ultimately leading to loss of high tide beach at revetment due to increased wave reflection and reduction in backshore sediment supply associated with revetment extension. - Reduced risk of erosion and overtopping damage to public land and landward private property; however increasing maintenance and upgrading costs in the long term due to climate change.
Hold the Line (short term) and Dynamic Adaptive Pathway Planning (long term)	- Potential for short term steepening, narrowing, and lowering of beach due to increased wave reflection and reduction in backshore sediment supply associated with revetment extension. Noting that a limited beach remains seaward of existing revetment, which has been in place for 10 years, it is expected that a steeper, narrower, lower beach would largely remain for a 15 year period. - Short term reduction in risk of erosion and overtopping damage to public land and landward private property. - Does not preclude future options; allows management of erosion and overtopping risks while a long-term DAPP approach is developed, considering community and cultural values and objectives, vulnerability, natural and built environment, climate change risks, etc.
Do Nothing / No Active Intervention (short term) and Dynamic Adaptive Pathway Planning (long term)	- As for Do Nothing / No Active Intervention in short term - Does not preclude future options; no active management of erosion and overtopping risks while a long-term DAPP approach is developed.
Advance the Line	Not relevant for Hokitika
Limited Intervention and Accommodation	- Beach/dune renourishment and planting would assist in sustaining beach processes. It provides limited reduction of overtopping and erosion risk given rapid historical erosion rates on unarmoured coastline (Gibb, 1987, reports up to 54m/year and surveys since 2000 indicate 16m/year on occasion). Regular renourishment and re-planting anticipated, with associated operational expenditure. Renourishment material likely sourced from coastal environment with potential for further effects. - Raising existing buildings above overtopping levels would reduce risk of damage to property, at a cost to private individuals.
Preferred Option	Hold the Line (short term) and Dynamic Adaptive Pathway Planning (long term) selected as it allows for development of a well-considered long-term strategic approach and does not preclude future options, while managing risk to public and private property in the short-term, with relatively moderate and reversible effects on the beach.
Sea Defence Measures	
Soft Protection	- Beach/dune renourishment and planting would assist in sustaining beach processes. - Provides limited reduction of overtopping and erosion risk given rapid historical erosion rates on unarmoured coastline (Gibb, 1987, reports up to 54m/year and surveys since 2000 indicate 16m/year on occasion). - Renourishment material likely sourced from coastal environment with potential for further effects. - Regular renourishment and re-planting anticipated. - No removal required at end of design life.

Vertical/Near Vertical Hard Protection (concrete, grouted rock seawalls)	- Smaller footprint hence less area affected by construction compared to sloping rock revetment or renourishment. - Increased toe scour and beach lowering due to increased wave reflection from smooth, vertical face, compared to sloping rock structure or beach berm/dune. - Potentially could be buried; interrupts sediment supply leading to beach steepening, narrowing, and lowering once exposed. - Provides erosion and overtopping protection to hinterland; may require recurve wall / raised crest to reduce overtopping compared to sloping rock revetment. - Limited maintenance anticipated provided design conditions not exceeded. -Removal and reuse of seawall materials is more difficult than for sloping rock revetment.
Sloping Rock Revetment	- Larger footprint hence more area affected by construction compared to vertical seawall. - Reduced toe scour and beach lowering due to increased energy dissipation and reduced wave reflection from porous sloping rock face, compared to vertical seawall. - Can be buried to reduce initial effect on coastal processes; interrupts sediment supply leading to beach steepening, narrowing, and lowering once exposed. - Similar to existing revetment, hence greater confidence in performance and predicted effects. - Provides erosion and overtopping protection to hinterland. - Uses local materials, as for existing wall, from established consented source. - Limited maintenance anticipated provided design conditions not exceeded. -Removal and reuse of revetment rock is easier than for vertical seawall (important for short term Hold the Line strategy).
Rock or Timber Groynes	- Longer and more substantial groynes than existing required to trap sediment effectively. Will interrupt longshore sediment movement rapidly causing downcoast beach erosion (lowering, narrowing and steepening). - Do not provide direct protection against erosion and overtopping. - Higher maintenance demands than seawall and rock revetment as groynes located in surf zone. -Removal and reuse of groyne rock/timber more difficult than for sloping rock revetment as groynes located in surf zone and re-use of timber after 10-15 years marine exposure will be minimal.
Preferred Option	Sloping rock revetment selected as it provides erosion and overtopping protection while initially being largely buried, reducing effects on coastal processes, Increased energy dissipation and reduced wave reflection compared with vertical seawall. Removal and reuse of materials are more practicable than for other hard defence options.