

Adaptive Risk Mitigation at Stockton

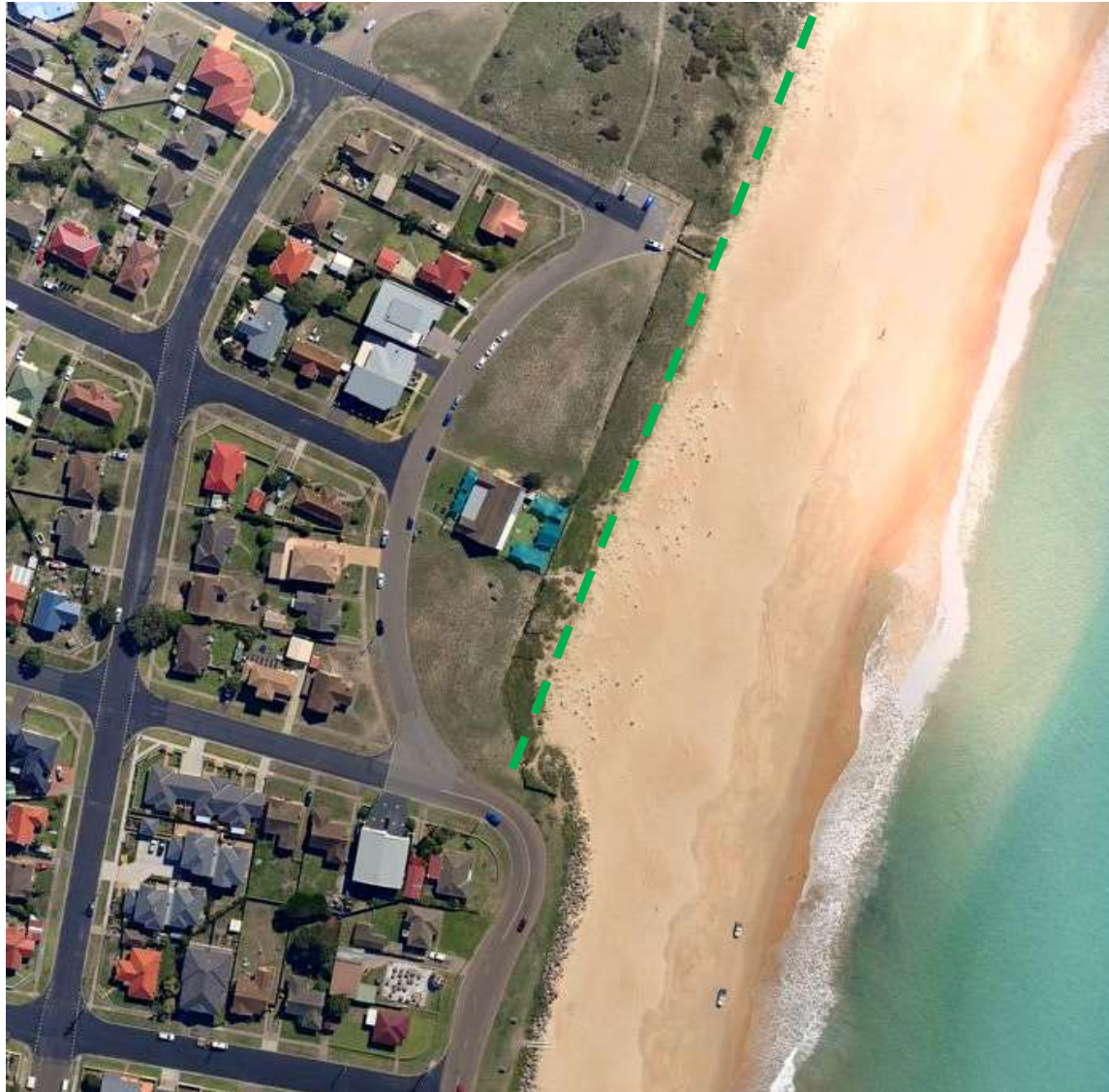
Lessons learnt from the field

June 2022

Nat Patterson (Royal HaskoningDHV)

Barrie Cres Stockton





April 2011

Royal HaskoningDHV



April 2018

Royal HaskoningDHV



January 2019

Royal HaskoningDHV



October 2019

Royal HaskoningDHV



September 2020

Royal HaskoningDHV

CMP management actions triggered



Figure 1 Nearmap image (2 Sept 2020) with 2025 ZSA hazard line (Bluecoast, 2020)

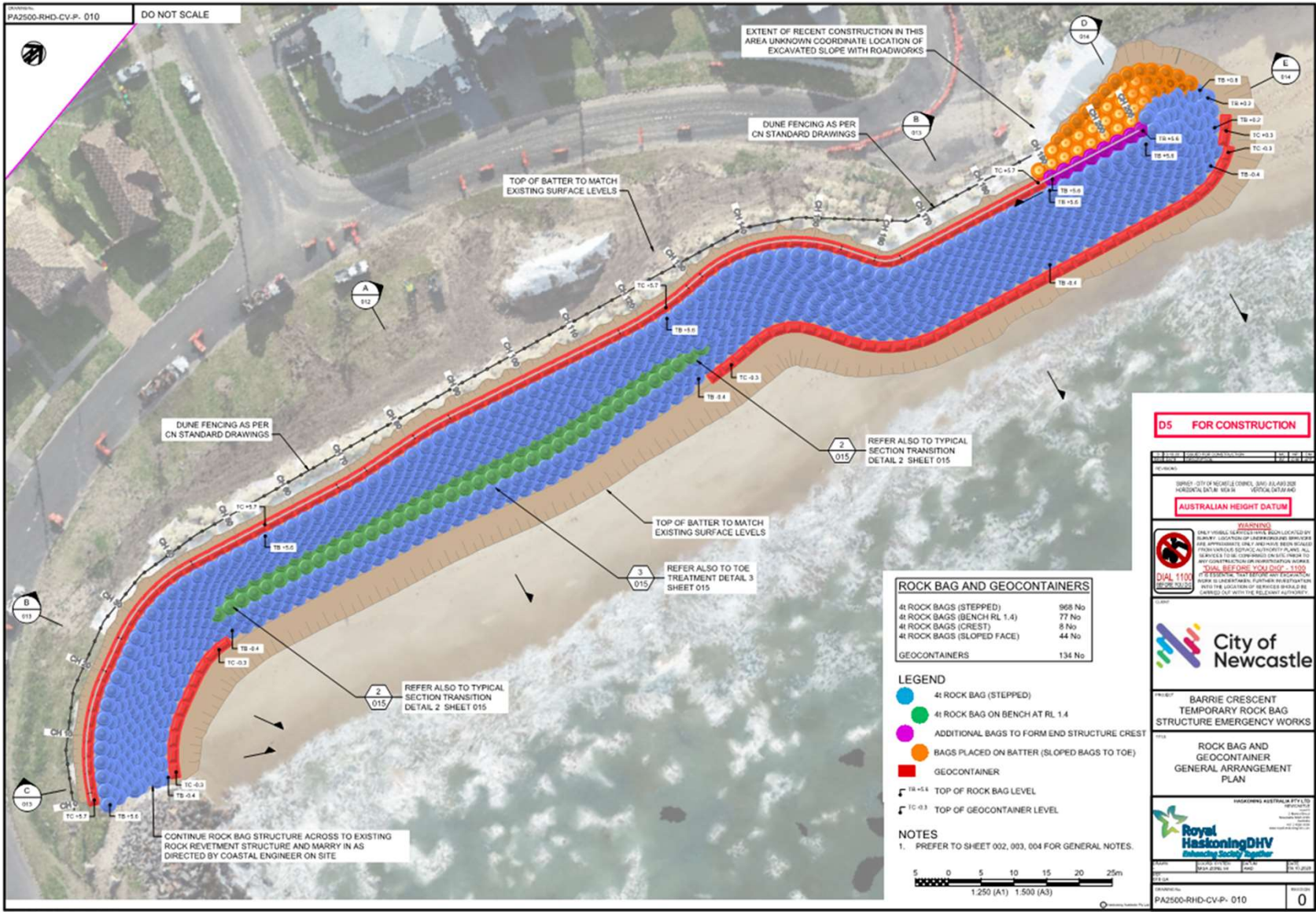
Geocontainers vs Rock Bags

Rock Bags were deemed to be the preferred option due to the following factors:

- superior **hydraulic** and **energy dissipation** performance relative to similar mass geocontainers (as noted in WRL testing of 4T Rock Bags for NZ cruise terminal);
- similar or enhanced interlocking and resistance to sliding of the Rock Bags;
- reusable;
- speed and ease of installation in this exposed environment working within tidal windows; and
- reduced vulnerability to vandalism
- reduced vulnerability to toe failure due to undercutting







D5 FOR CONSTRUCTION

PROJECT: BARRIE CRESCENT TEMPORARY ROCK BAG STRUCTURE EMERGENCY WORKS

DATE: 15/05/2024

AUSTRALIAN HEIGHT DATUM

WARNING
 ONLY PUBLIC UTILITIES ARE TO BE LOCATED BY SURVEY. LOCATION OF UNDERGROUND SERVICES ARE APPROVED BY ONE OF THE FOLLOWING: LOCAL COUNCIL, STATE AUTHORITY PLANS. ALL SERVICES TO BE CONSIDERED UNLESS OTHERWISE STATED. **DO NOT REMOVE OR DAMAGE ANY SERVICES.**
DIAL 1100
 1800 000 000



BARRIE CRESCENT TEMPORARY ROCK BAG STRUCTURE EMERGENCY WORKS

ROCK BAG AND GEOCONTAINER GENERAL ARRANGEMENT PLAN

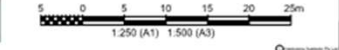


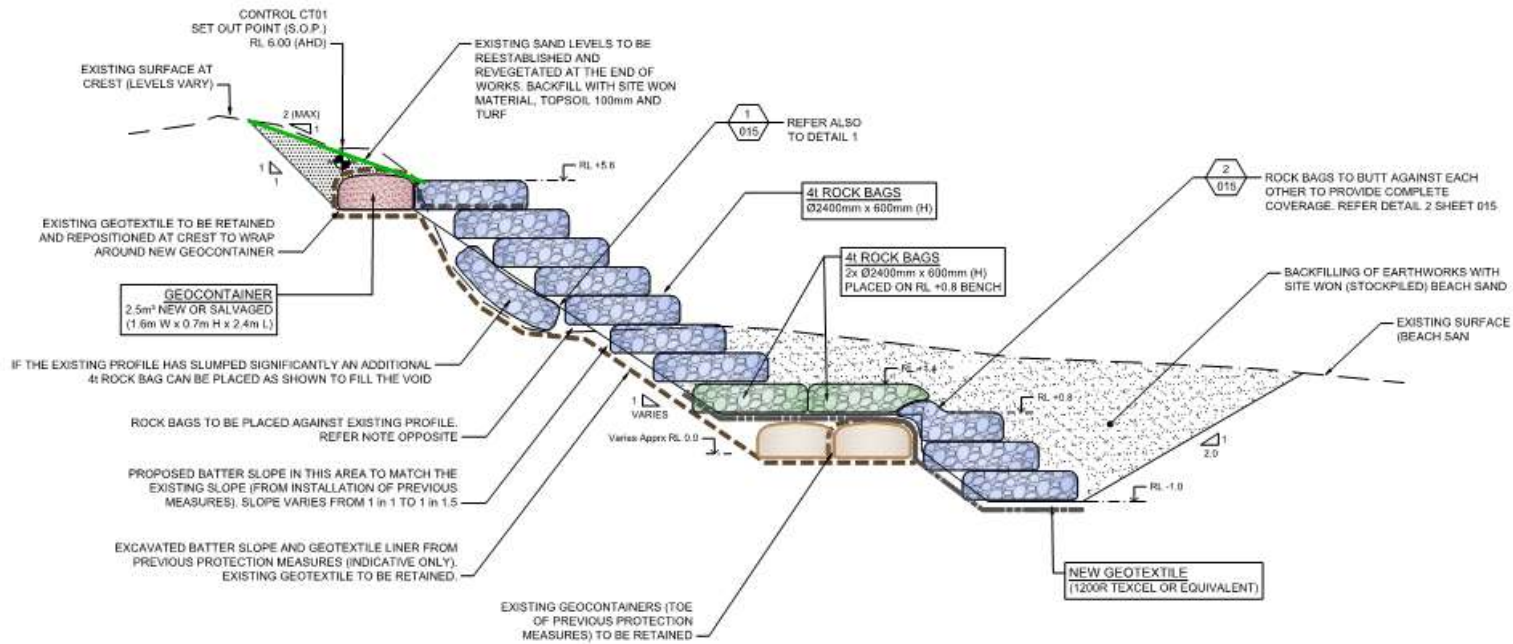
ROCK BAG AND GEOCONTAINERS

4L ROCK BAGS (STEPPED)	968 No
4L ROCK BAGS (BENCH RL 1.4)	77 No
4L ROCK BAGS (CREST)	8 No
4L ROCK BAGS (SLOPED FACE)	44 No
GEOCONTAINERS	134 No

- LEGEND**
- 4L ROCK BAG (STEPPED)
 - 4L ROCK BAG ON BENCH AT RL 1.4
 - ADDITIONAL BAGS TO FORM END STRUCTURE CREST
 - BAGS PLACED ON BATTER (SLOPED BAGS TO TOE)
 - GEOCONTAINER
 - ┆ TB -0.4 TOP OF ROCK BAG LEVEL
 - ┆ TC -0.3 TOP OF GEOCONTAINER LEVEL

NOTES
 1. REFER TO SHEET 002, 003, 004 FOR GENERAL NOTES.

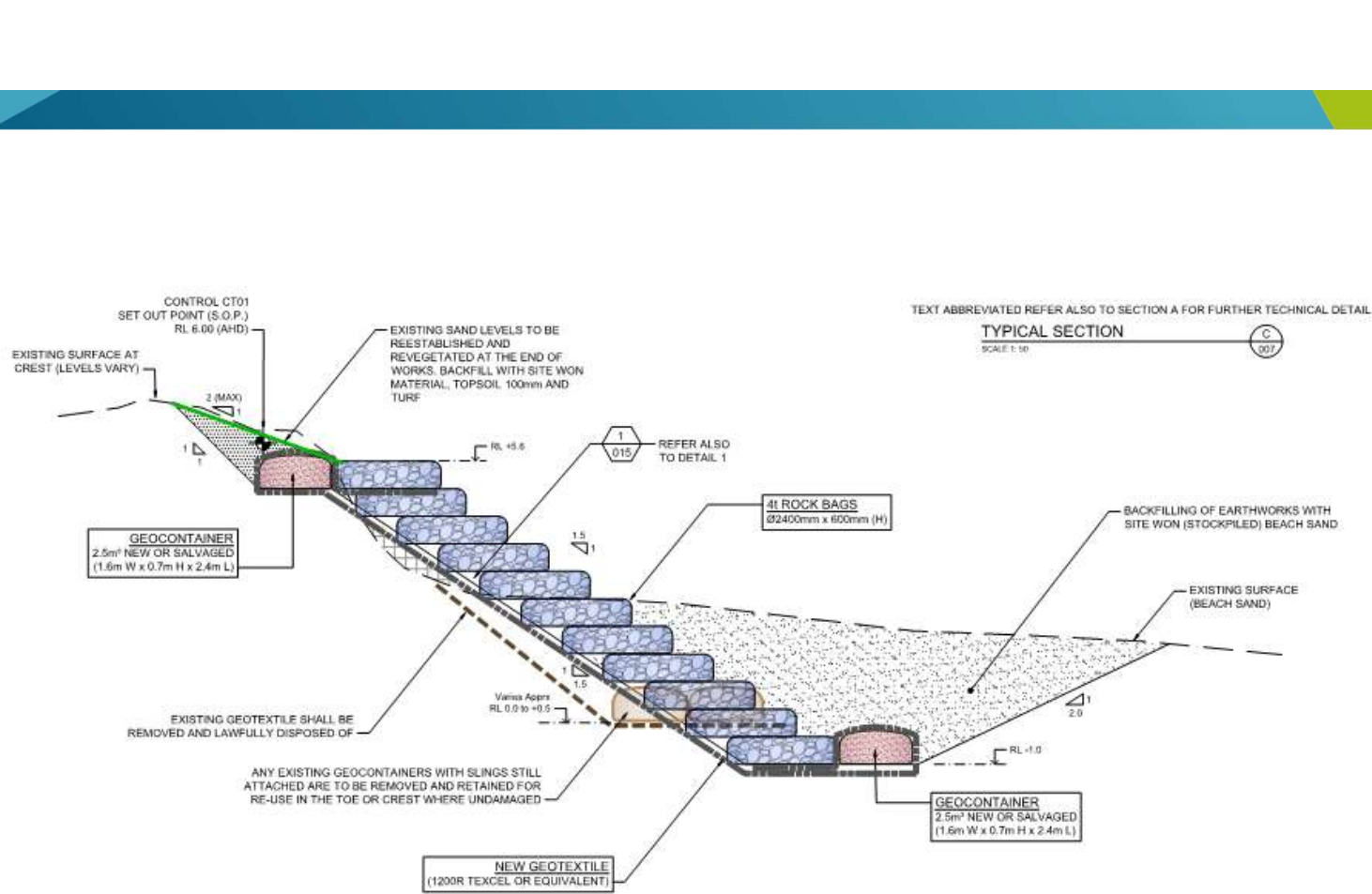







LEGEND

-  EXISTING GEOCONTAINER
-  EXISTING GEOTEXTILE LINER AND BATTER
-  4t ROCK BAG (STEPPED)
-  4t ROCK BAG ON BENCH AT RL 1.0
-  ADDITIONAL BAGS TO FORM END STRUCTURE CREST
-  BAGS PLACED ON BATTER (SLOPED BAGS TO TOE)
-  GEOCONTAINER
-  GEOTEXTILE
-  BEACH SAND BACKFILLING
-  SITE WON BACKFILL FOR LANDSCAPING

Typical section retro fitted on existing structure



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Typical section new structure

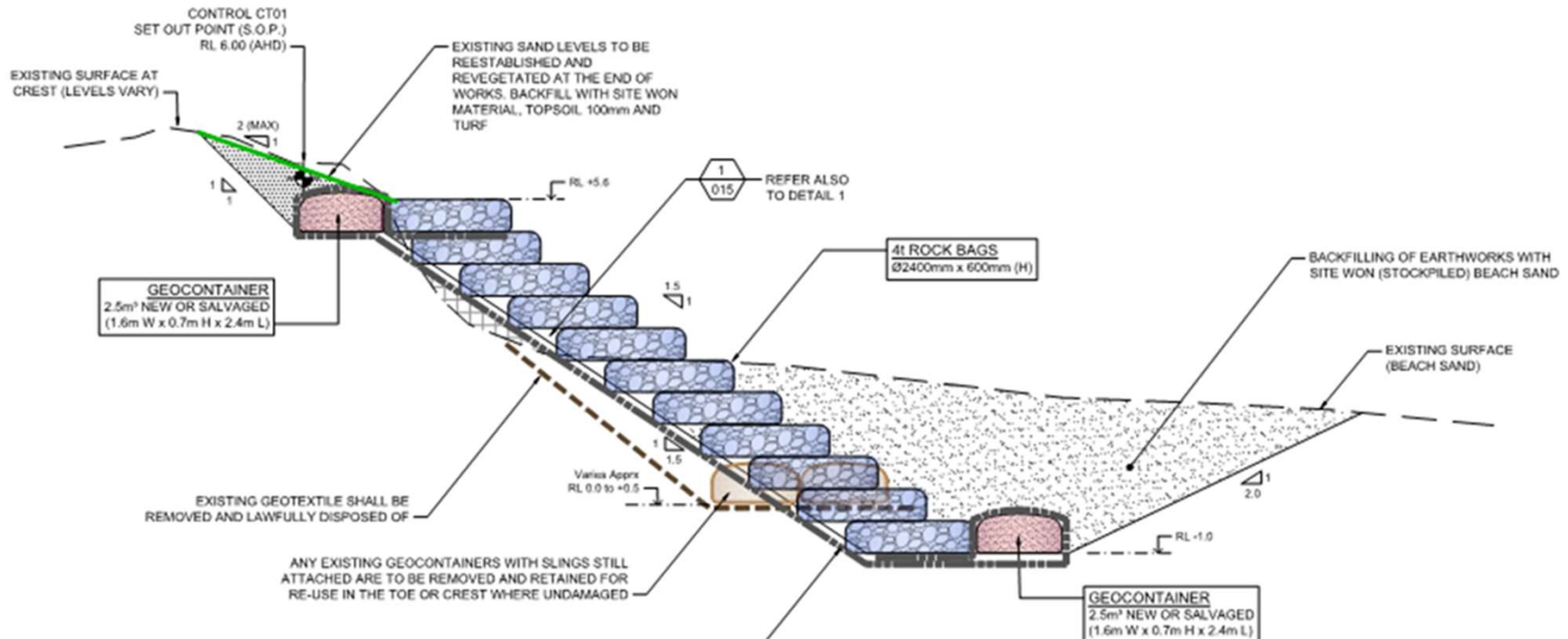
Rock Bag filling...



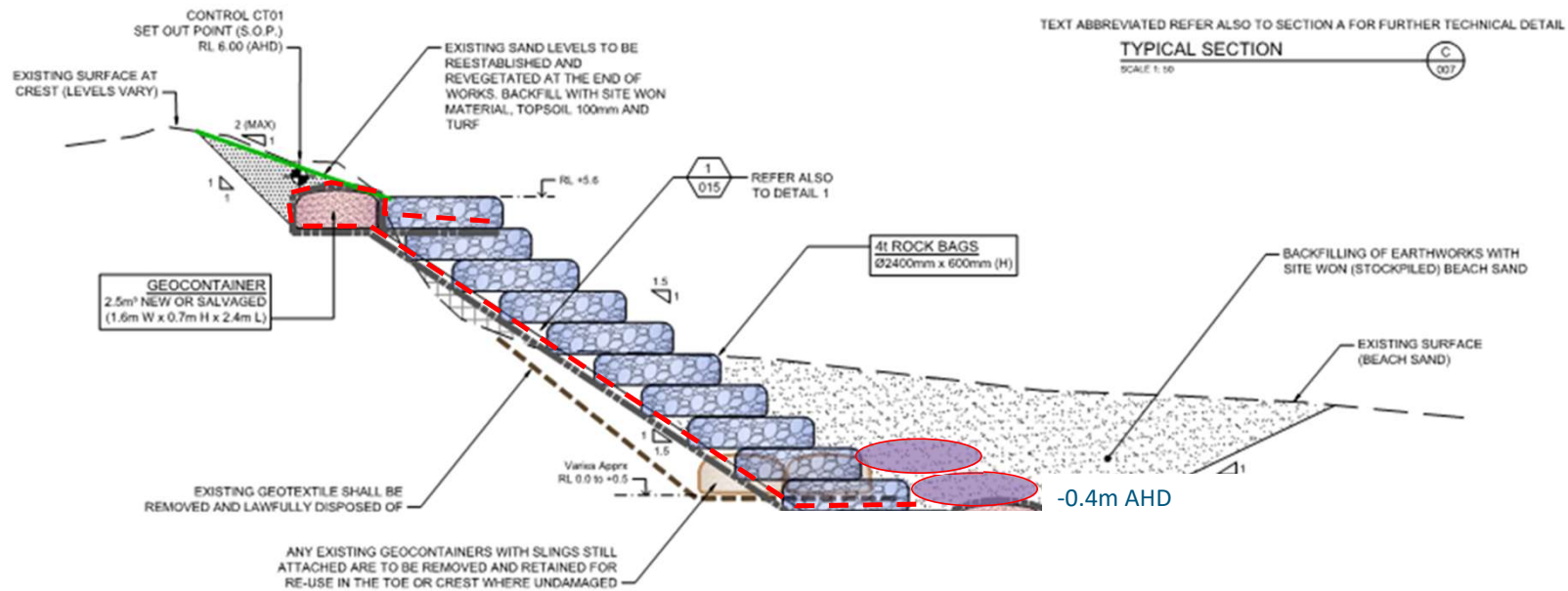
Construction commences at existing geocontainers structure...



Storm imminent – toe design modification



Storm imminent – toe design modification















As the tide comes in....



June 2021



Articulating wrapped crest anchor

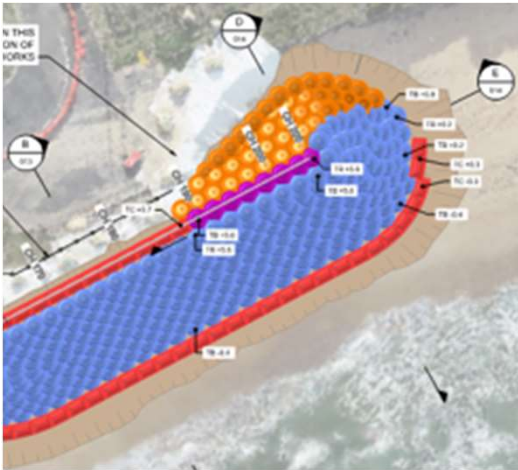




Daily protection and uncovering of leading edge of works



Roundhead construction



Roundhead



PROJECT: PA2500-RHD-CV-P-011

DO NOT SCALE

Pedestrian beach accessway



NOTE: ALL DISTURBED AREAS TO REINSTATE TO PRE-CONSTRUCTION CONDITION (TOPSOILED AND TURFED)

MATCH BACKFILLING TO TOP OF EXISTING GEOTEXTILE LINED EMBANKMENT

PEDESTRIAN ACCESSWAY DETAILS TO BE CONFIRMED ON COMPLETION OF WORKS

DUNE FENCING AS PER CN STANDARD DRAWINGS

BACKFILLING LANDWARD OF ROCK BAGS TO INCLUDE 100mm TOPSOIL AND TURF

MATCH BACKFILLING TO TOP OF EARTHWORKS BATTER SLOPE

ENSURE BACKFILLING IN THIS AREA FILLS THE VOID BETWEEN ROCK BAGS AND GEOCONTAINERS

BEACH LEVELS TO BE REINSTATE TO PRE-CONSTRUCTION LEVELS. EXCESS STOCKPILED MATERIAL TO BE EVENLY SPREAD OVER THE BACKFILLING AREA.

DUNE FENCING AS PER CN STANDARD DRAWINGS

MATCH BACKFILLING TO EXISTING ROCK ARMOUR

BACKFILLING VOLUME
VOLUME OF MATERIAL PLACED ON EXCAVATED SURFACE: 3,360m³
ROCK BAGS OR GEOCONTAINERS TO OBTAIN LEVELS AS SHOWN ON PLAN.

- LEGEND**
- 4t ROCK BAG (EXPOSED)
 - GEOCONTAINER (EXPOSED)
 - ▨ BACKFILL USING SITE WON BEACH SAND

- NOTES**
- REFER TO SHEET 002, 003, 004 FOR GENERAL NOTES.
 - NO ALLOWANCE HAS BEEN MADE FOR FILLING VOIDS BETWEEN BAGS IN THE BACKFILLING VOLUME. AS SUCH THE TOTAL VOLUME SHOWN SHALL BE CONSIDERED THE MINIMUM AMOUNT REQUIRED.



D5 FOR CONSTRUCTION

WARNING

ONLY PERMITTED OPERATIONS SHALL BE CONDUCTED BY QUALIFIED PERSONNEL. OPERATIONS SHALL BE SUPERVISED BY A QUALIFIED PERSON. ALL OPERATIONS SHALL BE CONDUCTED IN ACCORDANCE WITH THE RELEVANT AUTHORITY.

DIAL 1100

BEFORE YOU DIG - 1100



BARRIE CRESCENT TEMPORARY ROCK BAG STRUCTURE EMERGENCY WORKS

BACKFILLING PLAN

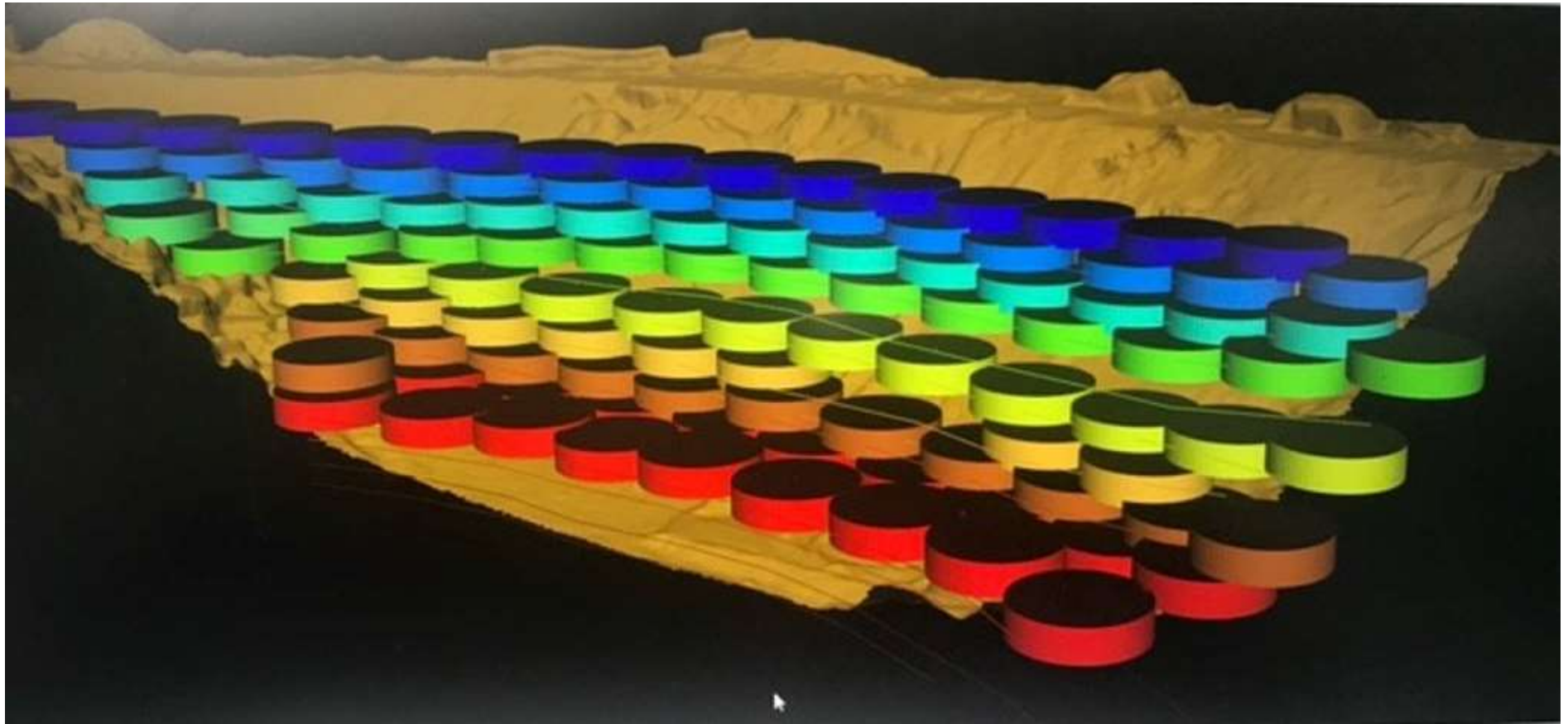


PROJECT: PA2500-RHD-CV-P-011

Royal HaskoningDHV

Pedestrian beach accessway





Lessons learnt in the field...

- Dewatering - Pump fixed to excavator works well in exposed location where spear points were not feasible
- Profile slope changes effective height of bags
- Curves are challenging, stretcher bond difficult to maintain and can change effective height of bags
- To maintain stretcher bond pattern often need to work a few rock bags ahead then 'fit' rock bags in between to avoid accumulating horizontal creep of joints
- Rock bags can be flattened by dropping another Rock Bag onto it with crane/excavator

Lessons learnt in the field...

- Need to cover edge of works with something easily removable at end of each day (if exposed site) such as geocontainers with slings to reduce time wasted carefully uncovering works (though it is still time consuming).
- Difficult to get a flat toe bedding if below water table. Can correct within next row though to achieve backward leaning structure.
- Much more moldable/flexible than sand filled geocontainers in terms of fitting into odd spaces.
- As Rock Bags will sift vertically down through sand, redundant bags can be used as toe protection if deep toe level can't be practically achieved.




Design Summary

- Rock Bags: 4t Kyowa 2.4m diameter, 0.6m high
- Structure length: approx. 220m
- Crest level: 5.4m AHD
- Toe level: -0.4m AHD with 3 additional Rock Bags in berm
- No. rows of bags: 11
- Effective height of bags placed: 0.5 to 0.55m
- No. bags placed: approx. 1200

Timing

- Filled bags at 80/ day (up to 100/day)
- Construction period 12 weeks for 1200 bags ie. 20 bags/day on average
- 60 bags/day max

Cost

- Rock Bag filling: \$1070/filled bag
(based on supply \$800/4T bag, \$50/tonne for rock, 2 x 30t excavators, 2 labour, 1 supervisor, \$5500/day, based on 80 bags filled per day)
- Construction cost: \$1.8 mill or \$8,000/m or \$1,500/bag
- **Rate/m: \$8000/m + \$5900/m = \$14,000/m**
- **Rate/bag: \$2,500 placed**
- **Potential for increased placement efficiency and construction cost optimization**
- **E.g if 60 bags/day could be achieved, total cost**  **from \$2500/bag to \$1500/bag**



Completed works

Royal HaskoningDHV

Following April 2022 storm events



Thank you... Questions??

<https://youtu.be/HgVBWRvIreU>

Swansea channel - <https://youtu.be/2Fj0g5W783k>