



CONSULTING EARTH SCIENTISTS

**UPDATED PROGRESSIVE CAPPING PLAN:
BREEN RESOURCE RECOVERY FACILITY
CAPTAIN COOK DRIVE, KURNELL, NSW
PREPARED FOR BREEN RESOURCES PTY LTD**

CES DOCUMENT REFERENCE: CES070607-KLF-31

REVISION: H

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Date: 28 October 2020

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DOCUMENT CONTROL

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1. INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was requested by Breen Holdings Pty Ltd in 2010 to prepare a Progressive Capping Plan for construction of the final capping of the Kurnell Landfill Facility located on Captain Cook Drive, Kurnell, NSW.

The Progressive Capping Plan was completed in 2011 (PCP2011) to consider the requirements of the Voluntary Planning Agreement (VPA) made between Sutherland Shire Council (Council), Breen Holdings Pty Ltd (novated to Breen Property Pty Ltd), Consolidated Development Pty Ltd (now renamed Breen Property Pty Ltd) and Australand Kurnell Pty Ltd (now renamed Frasers Property Australia Limited (Frasers)). PCP2011 was also prepared to address the requirements of the Environment Protection Licence for the landfill facility that was in effect at the time of preparing PCP2011 and also subsequent comments raised at the time by the NSW Environment Protection Authority (EPA).

CES has been requested to review and update PCP2011 to consider changes in requirements since 2011, and in particular the measures outlined in the Environmental Guidelines: Solid Waste Landfills (2016, Second Edition) that were introduced in April 2016; and also to consider Breen's proposal including the new Resource Recovery Facility and Marang Parklands to be established on Lot 1122 in DP 794114 (Lot 1122) and Lot 1123 in DP 794114 (Lot 1123) and Lot 5 in DP 1158627 (Lot 5) and Lot 6 in DP 1158627 (Lot 6) (together the Proposal Site) which is the subject of the NSW Planning Secretary's Environmental Assessment Requirements (SEARS) application number SSD-10412.

This Updated Progressive Capping Plan (UPCP) outlines the final capping of the site and includes a design of the cap in each area.

2. APPROACH

For the purpose of this UPCP, the Proposal Site can be divided into four areas being:

- Proposed Open Space Areas (comprising the Marang Parklands on part Lot 1122, 1123 and Lot 6).
- Proposed Recreational Playing Fields (on parts Lots 1122, 1123 and Lot 6 being constructed under existing planning approvals).

- Proposed Landscape Rehabilitation Areas (including car parks and roads) (on part Lots 1122, 1123 and Lot 6 being constructed under existing planning approvals).
- Proposed New Breen Resource Recovery Facility.

The proposed design of the capping layer differs in each area of the site and consequently each area has been addressed separately in this plan.

3. SITE DESCRIPTION

The Proposal Site is located south of and adjacent to Captain Cook Drive, Kurnell in the Local Government Area of Sutherland (Figure 1).

The Proposal Site is bounded by Captain Cook Drive and Towra Point Nature Reserve to the North, a sand-mining site to the east beyond the Lindum road reserve and Charlotte Breen Memorial Park to the west. Sydney Water's Cronulla wastewater treatment plant is located to the west and south of Lot 1122.

At the time of preparing this Updated Progressive Capping Plan, the Sporting Field No. 1 and the Skate Park have been constructed on Lot 1 in DP1101922 and are now operational. Sporting Fields No.2 and No.3 (two hockey fields) have been constructed on Lot 111 in DP 777967 and part of Lot 1123 in DP 794114 and are also now operational. To the south, the Proposal Site adjoins the Heritage Sand Dune and Cronulla State Park and further south Wanda Beach. A general site plan is shown in Figure 2.

4. CELL CONSTRUCTION AND LANDFILLING OPERATIONS

Landfill operations commenced circa 1990 with landfilling activities being undertaken in voids left by sand extraction. The site has been operating in accordance with Development Approval 269/90 and two Environment Protection Licences (EPLs), being EPL 4608 and EPL 20697. landfill was established in accordance with the provisions of Section 30 (2) of the Sydney Regional Environmental Plan No. 17 which required the restoration of sand extraction areas.

At the time of preparing this updated document, the active landfill cell (Cell B10) is located in Lot 6 and part of Lot 5. The EPA has approved future landfill Cell B11 (Stages B and C) which have been constructed in preparation for acceptance of waste and are located in the approximate centre section of Lot 5.

5. PROPOSED FINAL LANDFORM

The proposed Landscape Master Plan is provided in the Marang Parklands Embellishment Plan, Landscape Master Plan, document reference S20-0039, prepared by Clouston Associates Pty Ltd. Relevant extracts from this Master Plan are enclosed in Appendix 1. The proposed

Landform Design Sections are further shown in drawings 89913035-SK-108 prepared by Cardno (NSW/ACT) Pty Ltd that are enclosed in Appendix 2.

6. FINAL CAPPING DESIGN & CONSTRUCTION

The proposed land use for the Proposal Site is shown in Figure 3. The post closure land use and final proposed landforms will determine the design of the capping layer. The capping layers described below will be applied to the site as per final land use.

6.1 CAPPING CONSTRUCTION – OPEN SPACE AREAS

This section outlines the proposed final capping for areas of the landfill which will be rehabilitated for open space land use, namely:

- Lot 1122
- Lot 1123
- Part Lot 6 and part Lot 5.

The location of the open space areas is shown in Figure 3.

6.1.1 Design and Construction of Capping for Open Space Areas

The final capping will be constructed as shown in Figure 4 (Lots 1122 and 1123) and Figure 5 (Lots 5 and 6). The capping designs are in general accordance with the Environmental Guidelines: Solid Waste Landfills (NSW EPA, 2016).

The surface shall be revegetated with species indigenous to the Kurnell Peninsula, in accordance with the VPA. Selected vegetation will be capable of long-term survival and reproduction without the need for watering, mowing, or other intervention (these will usually be naturally occurring native plant species).

Plants proposed for revegetation have root systems which will not penetrate beyond the revegetation layer. The scheme of vegetation is proposed in the Marang Parklands Embellishment Plan, Landscape Master Plan, document reference S20-0039, prepared by Clouston Associates Pty Ltd. Relevant extracts from this Master Plan are enclosed in Appendix 1.

6.2 CAPPING CONSTRUCTION – SPORTING FIELDS

This section outlines the proposed final capping for areas of the landfill which will be rehabilitated for use as sporting fields, namely:

- Northern part of Lot 1123 (Sporting Fields No. 6, 7 and 8); and
- Part Lot 6 (Sporting Fields No. 9 and 10)

The locations of Sporting Fields No. 6 to 10 are shown in Figure 3.

6.2.1 Sporting Fields 2, 3, 6, 7 & 8

6.2.1.1 *Design and Construction of Capping for Sporting and 6, 7 & 8 in Lot 1123 (Fields 2 & 3 (already developed))*

For sporting field areas that are not excised from the Environment Protection Licence, the final capping system will be constructed as shown in Figure 7. This design is in general accordance with Environmental Guidelines: Solid Waste Landfills (NSW EPA, 2016) and Schedule 10 of the VPA.

The eastern portion of Sporting Fields 2 and 3, shown in Figure 3, that fall within Lot 111 DP 777967 are not part of the landfill and are not covered under this capping plan.

6.2.2 Sporting Fields 9 & 10

6.2.2.1 *Design and Construction of Capping for Sporting Fields 9 and 10 in Lot 6*

The final capping system will be constructed as shown in Figure 6. This design is in general accordance with Environmental Guidelines: Solid Waste Landfills (NSW EPA, 2016) and Schedule 10 of the VPA.

6.3 CAPPING CONSTRUCTION – LANDSCAPE REHABILITATION AREAS

For Landscape Rehabilitation Areas that are not excised from the Environment Protection Licence, the final capping system will be constructed as shown in Figure 8.

The surface shall be revegetated with species indigenous to the Kurnell Peninsula, in accordance with the VPA. Selected vegetation will be capable of long-term survival and reproduction without the need for watering, mowing, or other intervention (these will usually be naturally occurring native plant species).

Plants proposed for revegetation have root systems which will not penetrate beyond the revegetation. The scheme of vegetation is proposed in the Marang Parklands Embellishment Plan, Landscape Master Plan, document reference S20-0039, prepared by Clouston Associates Pty Ltd. Relevant extracts from this Master Plan are enclosed in Appendix 1.

7. STAGING OF CAPPING CONSTRUCTION

Construction of the final landform and capping of the Proposal Site will commence progressively with selected areas of the Proposal Site being surrendered or excised from the relevant Environment Protection Licence as the landform construction is completed.

Indicative stages of construction of the final capping is described below and illustrated in Figures 10 to 17. Areas referenced in the figures and in the description below are as shown in the Proposed Landform Design Sections (Drawing 89913035-SK-108) prepared by Cardno (NSW/ACT) Pty Ltd, a copy of which is enclosed in Appendix 2.

- Stage 1 – Remove intermediate cover and construct final capping in northern part of Area A1 as shown in Figure 10 in accordance with Open Space capping requirements (Figure 4).
- Stage 2 – In the northern part of Area A2, remove intermediate cover and construct capping in accordance with Open Space capping requirements (Figure 4).
- Stage 3 – Remove intermediate cover and construct final capping in Area C3 in accordance with capping for Open Space areas (Figure 4) or where applicable Landscape Rehabilitation Areas (Figure 8).
- Stage 4 – Relocate the existing concrete recycling operation and remove intermediate cover and complete construction of the final capping in Area A1 in accordance with capping for Open Space areas (Figure 4).

Commence decommissioning of existing Breen site offices and weighbridge following opening of the new Breen's Resource Recovery Facility in Area E.

- Stage 5 – In Area A2, cease the gypsum processing operations, remove intermediate cover and construct final capping layer in accordance with capping for Open Space areas. (Figure 4).
- Stage 6 – Following the relocation of the existing light waste processing operation, an application will be prepared to excise Area C2 from EPL 4608.
- Stage 7 – When Cell B11 Stages A to C are filled to an appropriate level. Remove intermediate cover and construct final capping over Areas B and C1 to capping requirements shown in Figure 7 for Sporting Fields 9 and 10, as shown in Figure 8 for Landscape Rehabilitation Areas adjacent to the sporting fields and as shown in Figure 5 for the Open Space areas of Area B.
- Stage 8 – Complete landfilling operations on Lot 5 and undertake capping construction works in Areas D1 and D2 in accordance with Open Space areas (Figure 5).

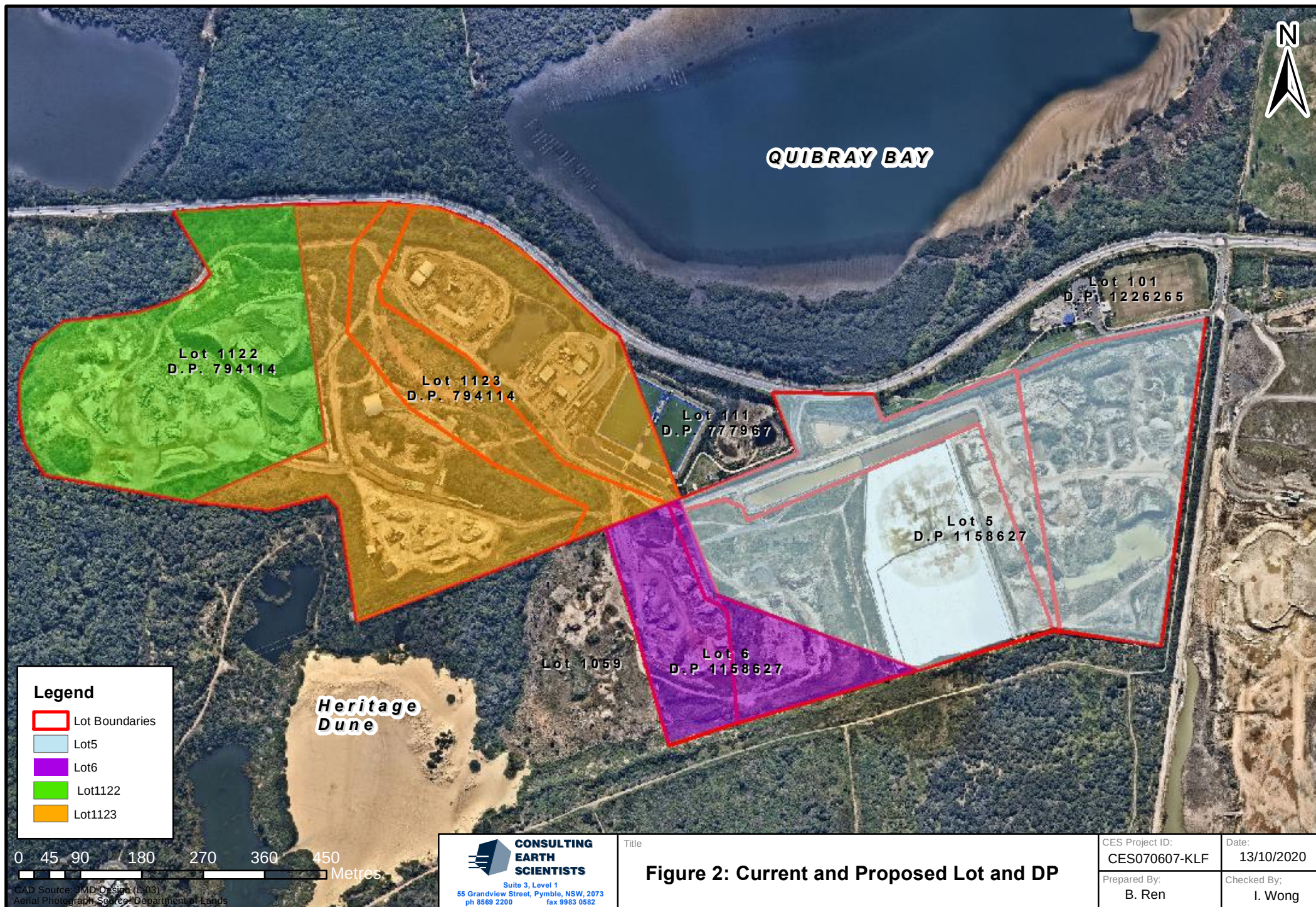
It should be noted that the timing of completion of the capping works will be dependent on *inter alia* source and availability of fill and capping materials, climate and commercial and economic conditions.

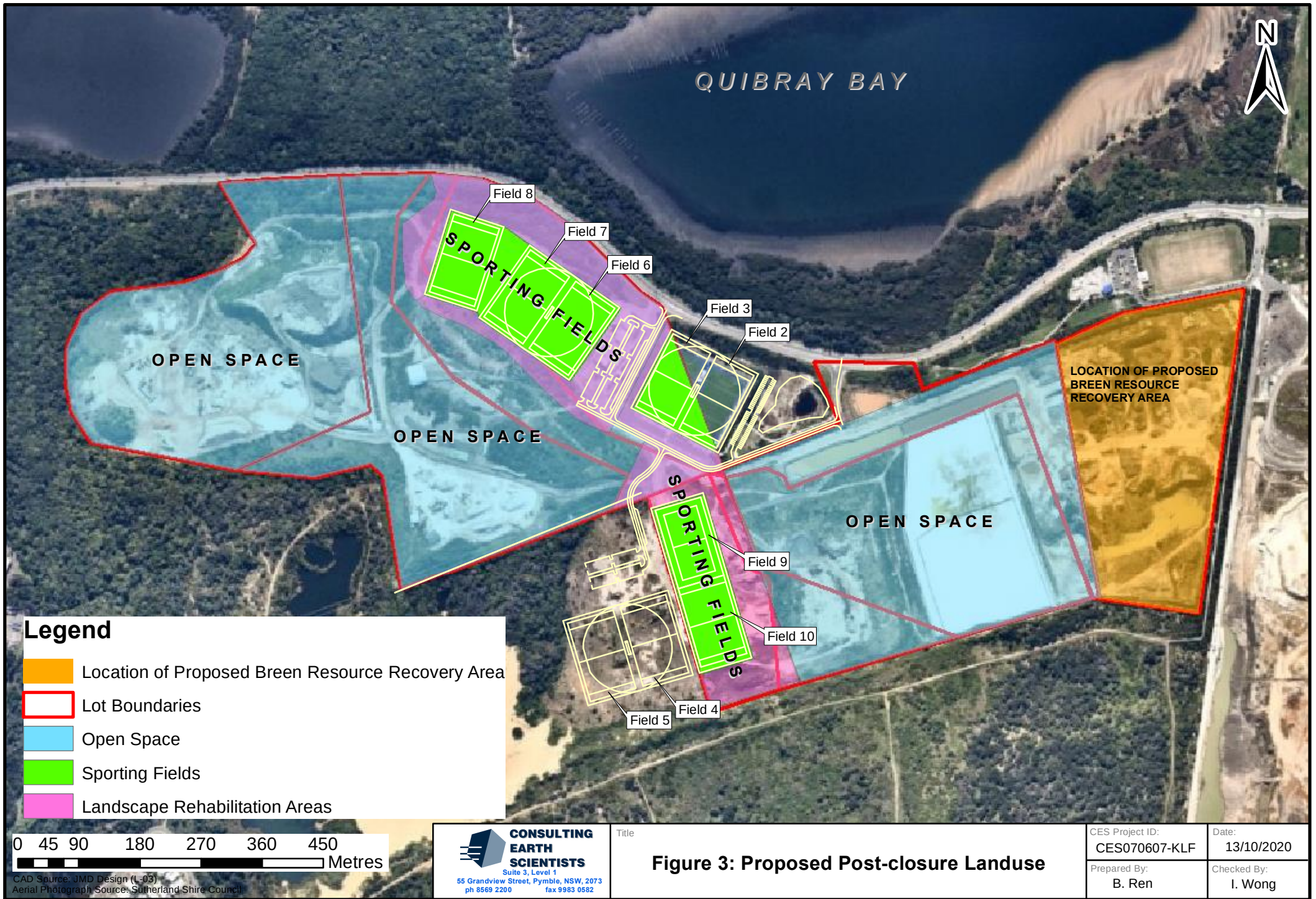
8. CAPPING CONSTRUCTION QUALITY ASSURANCE PROGRAM (CQA)

The proposed CQA plan for capping construction at the Proposal Site is presented in Table 1. At the completion of construction, a set of “as executed” drawings will be prepared and included in a CQA report that will be prepared by a suitably qualified and experienced geotechnical practitioner.

FIGURES







CAD Source: JMD Design (L03)
Aerial Photograph Source: Sutherland Shire Council

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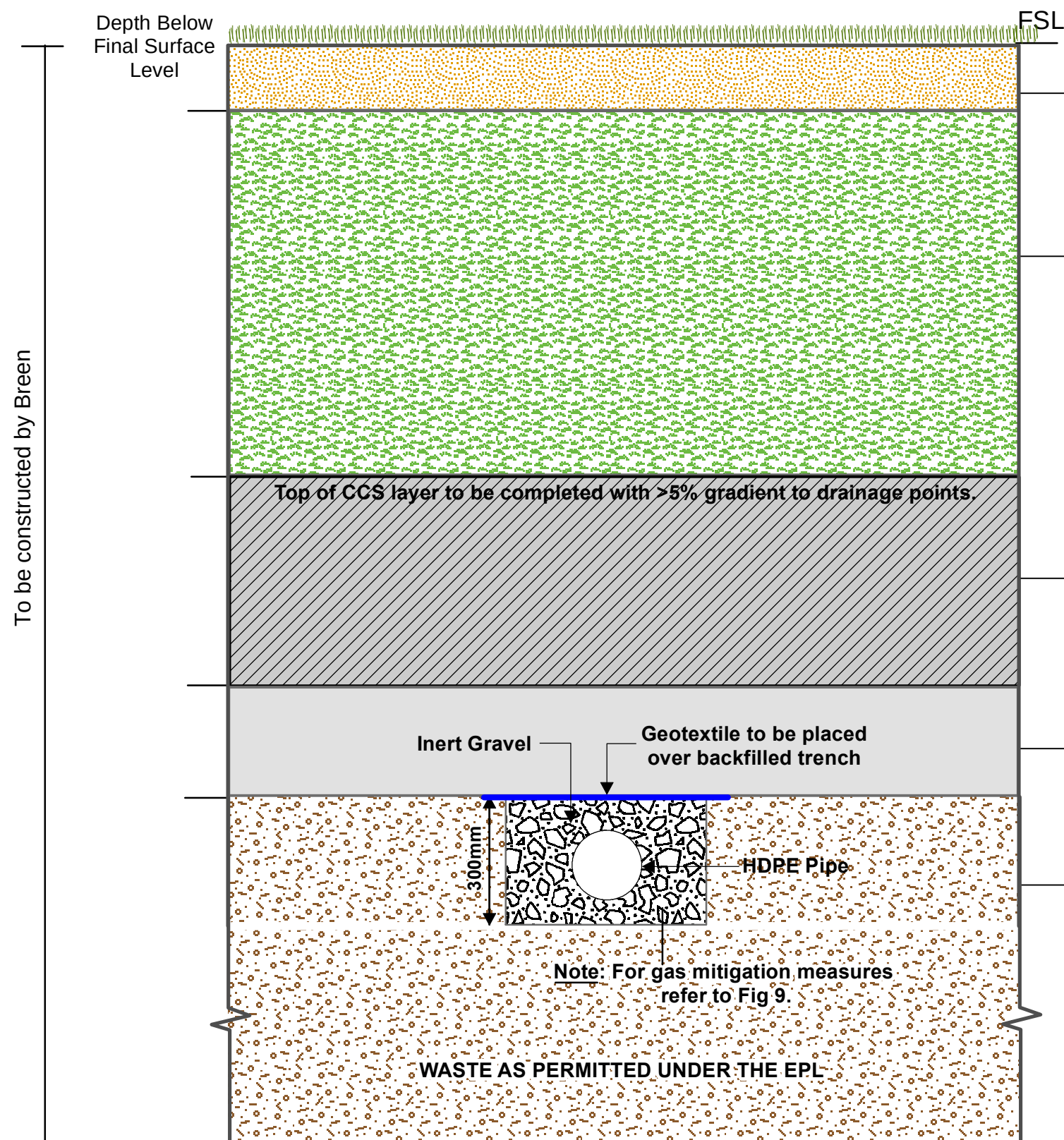
Title

CES Project ID:
CES070607-KLF

Date:
13/10/2020

Prepared By:
B. Ren

Checked By:
I. Wong



Notes:

1. Capping system to be progressively constructed in discrete manageable sections so that cap is promptly constructed and vegetation quickly established.
2. Spacing of gas mitigation measures to be determined following field testing. Gas mitigation measures will be omitted in areas where methane levels < 500 parts per million (v/v).
3. Uncompleted sections of clay capping are to be covered with plastic sheeting at the end of each working day during extended storm periods and periods of hot dry weather to maintain moisture levels within the specification.
4. Clay capping layer may be replaced with alternative sealing layer approved by the NSW EPA.
5. Following placement, contour banks or earthen bunds should be constructed along the finished slopes to ensure erosion resistance during revegetation, moisture retention and aeration of soil. Construction of banks should not penetrate > 100mm into revegetation layer.
6. Erosion and weed control measures to be implemented during construction of the cap.
7. The boundaries of differing capping types must be keyed into each other to provide a gradual transition.
8. Surface shall be revegetated with species indigenous to the Kurnell Peninsula as specified in the VPA.

TOPSOIL

Min. 200mm topsoil.

REVEGETATION LAYER (RL)

Min. 800mm approved recycled soil material (e.g. recycled soil, compost, clay, crushed rock, sand). To be compacted by track walking across slope prior to placement of topsoil.

COMPACTED CLAY SEAL (CCS)

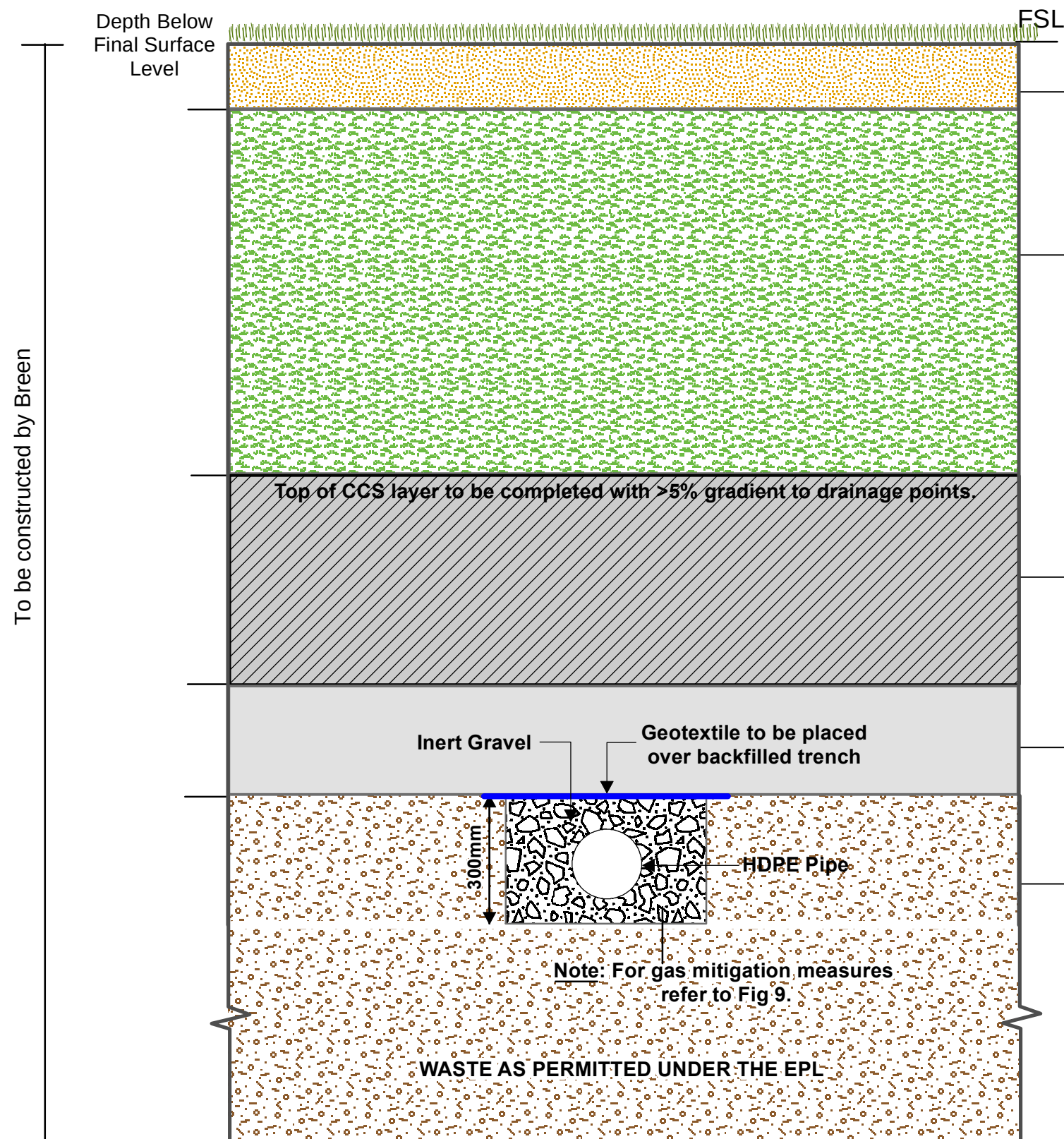
Min. 600mm clay capping material. To be placed in 200mm layers and compacted to min density ratio of 98% Standard compaction as determined by AS1289.5.11, CCS to have permeability $k < 10^{-9}$ m/s. Moisture content of fill to be in the range of Optimum Moisture Content (OMC) to OMC +2% or as suitable to achieve adequate compaction and permeability of requirements.

SEAL BEARING LAYER (SBL)

Min. 300mm VENM/other compactable fill material, permitted under the EPL. Fill to be placed in near horizontal layers of max 250mm loose thickness. Compaction to min density ratio of 95% standard compaction as determined by AS1289.5.11 and/or by test rolling to AS3798-2007. Areas which are assessed to deform excessively under test rolling shall be rectified and re-presented.

COMPACTED WASTE

VENM/other compactable fill material permitted under the EPL to 1.7m below FSL if required. Fill to be placed in near horizontal layers of max 500mm loose thickness. Compaction to min density ratio of 95% based on Standard Compaction as determined by AS1289.5.11. Alternative methods of achieving the compaction requirements such as dynamic compaction by impact rolling with associated verification testing may be considered subject to the approval of and confirmation by the Geotechnical Practitioner.



Notes:

1. Capping system to be progressively constructed in discrete manageable sections so that cap is promptly constructed and vegetation quickly established.
2. Spacing of gas mitigation measures to be determined following field testing. Gas mitigation measures will be omitted in areas where methane levels < 500 parts per million (v/v).
3. Uncompleted sections of clay capping are to be covered with plastic sheeting at the end of each working day during extended storm periods and periods of hot dry weather to maintain moisture levels within the specification.
4. Clay capping layer may be replaced with alternative sealing layer approved by the NSW EPA.
5. Following placement, contour banks or earthen bunds should be constructed along the finished slopes to ensure erosion resistance during revegetation, moisture retention and aeration of soil. Construction of banks should not penetrate > 100mm into revegetation layer.
6. Erosion and weed control measures to be implemented during construction of the cap.
7. The boundaries of differing capping types must be keyed into each other to provide a gradual transition.
8. Surface shall be revegetated with species indigenous to the Kurnell Peninsula as specified in the VPA.

TOPSOIL

Min. 200mm topsoil.

REVEGETATION LAYER (RL)

Min. 800mm approved recycled soil material (e.g. recycled soil, compost, clay, crushed rock, sand). To be compacted by track walking across slope prior to placement of topsoil.

COMPACTED CLAY SEAL (CCS)

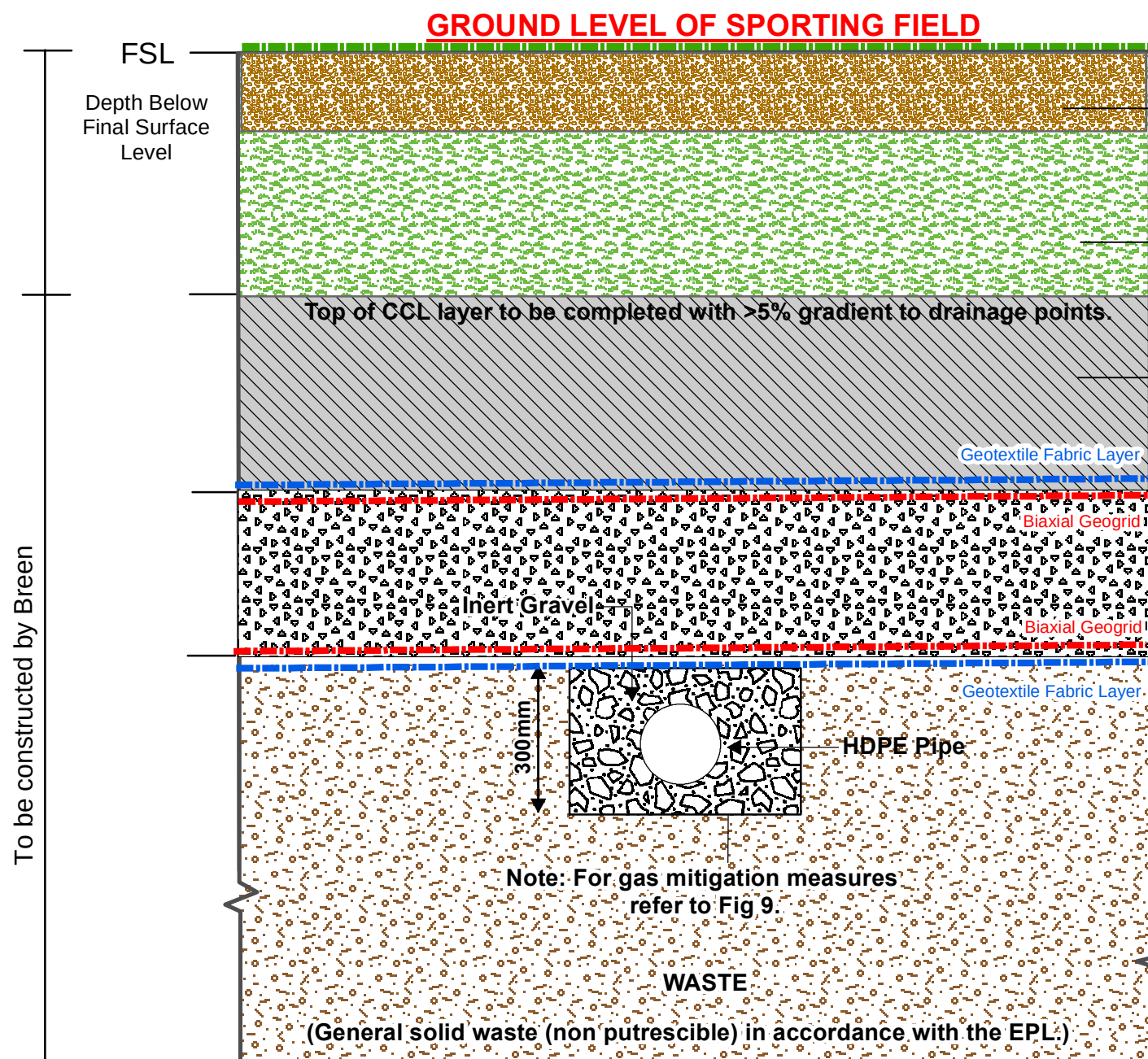
Min. 600mm clay capping material. To be placed in 200mm layers and compacted to min density ratio of 98% Standard compaction as determined by AS1289.5.11, CCS to have permeability $k < 10^{-9}$ m/s. Moisture content of fill to be in the range of Optimum Moisture Content (OMC) to OMC +2% or as suitable to achieve adequate compaction and permeability of requirements.

SEAL BEARING LAYER (SBL)

Min. 300mm VENM/other compactable fill material, permitted under the EPL. Fill to be placed in near horizontal layers of max 250mm loose thickness. Compaction to min density ratio of 95% standard compaction as determined by AS1289.5.11 and/or by test rolling to AS3798-2007. Areas which are assessed to deform excessively under test rolling shall be rectified and re-presented.

WELL COMPACTED GENERAL SOLID WASTE (NON PUTRESCIBLE) OR VENM

Well compacted general solid waste (non putrescible) or VENM as permitted under the EPL.



Notes:

1. Capping system to be progressively constructed in discrete manageable sections so that cap is promptly constructed and vegetation quickly established.
2. Spacing of gas mitigation measures to be determined following field testing. Gas mitigation measures will be omitted in areas where methane levels < 500 parts per million (v/v).
3. Uncompleted sections of clay capping are to be covered with plastic sheeting at the end of each working day during extended storm periods and periods of hot dry weather to maintain moisture levels within the specification.
4. Clay capping layer may be replaced with alternative sealing layer approved by the NSW EPA.
5. Following placement, contour banks or earthen bunds should be constructed along the finished slopes to ensure erosion resistance during revegetation, moisture retention and aeration of soil. Construction of banks should not penetrate > 100mm into revegetation layer.
6. Alternative methods of achieving the compaction requirements such as dynamic compaction by impact rolling with associated verification testing may be considered subject to approval of and confirmation by the geotechnical practitioner.
7. Erosion and weed control measures to be implemented during construction of the cap.
8. Adequate drainage to be provided for playing fields.
9. The boundaries of differing capping types must be keyed into each other to provide a gradual transition..
10. Construction quality assurance testing to be in accordance with the requirements of Schedule 4 of the VPA.

TURF ROOT ZONE (TRZ) - AS SPECIFIED IN THE VPA

Min. 225mm Sandy Soil (<30% particle size <0.25mm and <30% particle size >0.5mm) and 75mm finely cultivated compost to AS4454 that is mixed and tested offsite. Testing of soil is to be undertaken in accordance with the specifications within the VPA.

REVEGETATION LAYER (RVL) - AS SPECIFIED IN THE VPA.

Min. 775mm highly cultivated VENM. Compaction to min density ratio of 90% based on Standard Compaction as determined by AS1289.5.11 tested by a NATA accredited laboratory. Testing of soil is to be undertaken in accordance with the specifications in the VPA.

COMPACTED CLAY LAYER (CCL)

Min. 600 mm clay capping material. Compaction to min density ratio of 98% Standard compaction as determined by AS1289.5.11 tested by a NATA accredited laboratory. CCL to have permeability $k < 10^{-9}$ m/s. Moisture content of fill to be in the range of Optimum Moisture Content (OMC) to OMC +2% or as suitable to achieve adequate compaction and permeability requirements.

BRIDGING LAYER (BL)

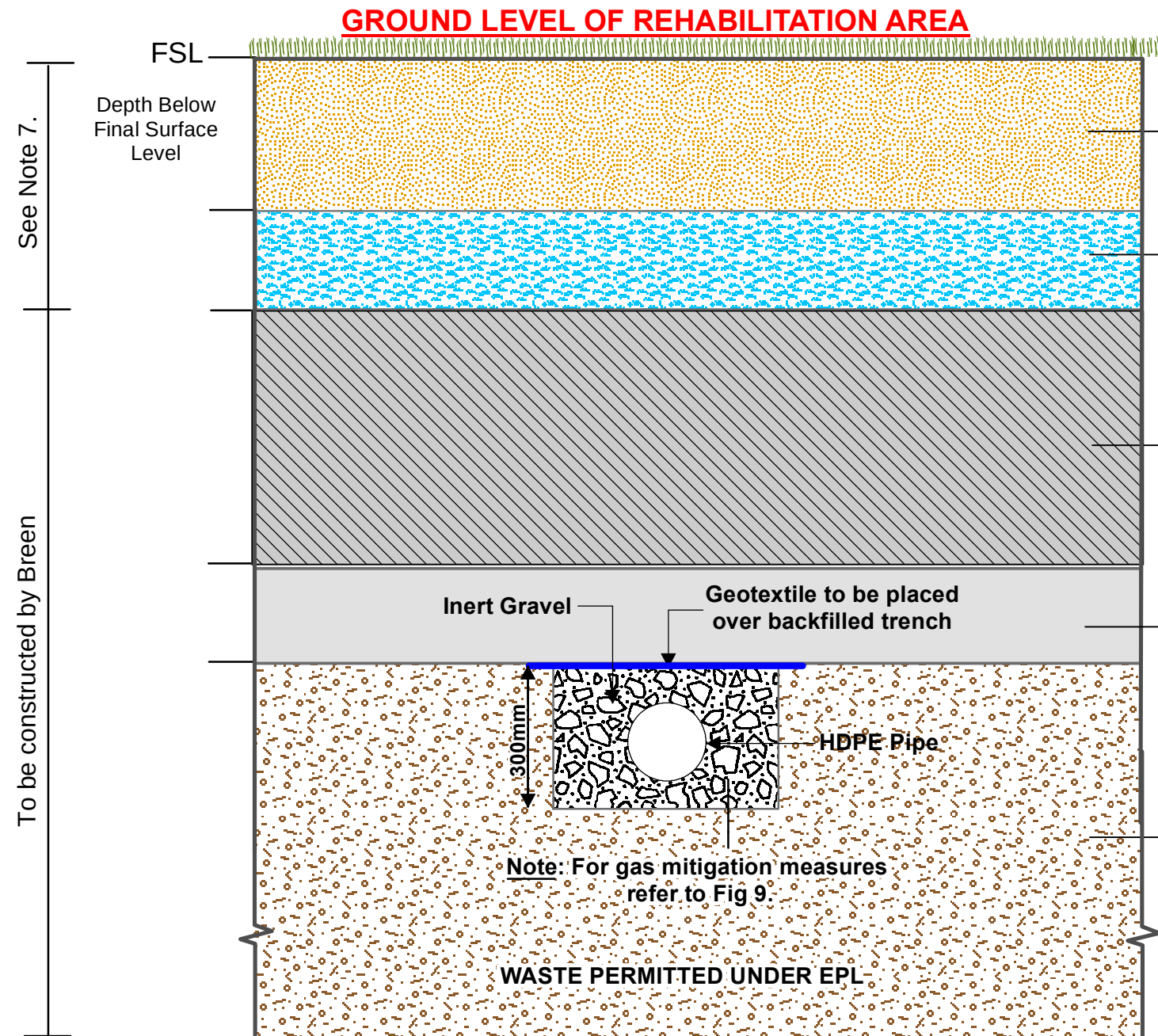
Min. 500mm crushed recycled brick/concrete (max particle size 40mm) reinforced with 2 layers of Tensar SS30 (or equivalent) biaxial geogrid and 2 layers of Bidim A34 (or equivalent) geofabric as a separation layer above and below the bridging layer.

WELL COMPACTED GENERAL SOLID WASTE (NON PUTRESCIBLE) OR VENM

Well compacted general solid waste (non putrescible) or VENM as permitted under the EPL.

Notes:

1. Capping system to be progressively constructed in discrete manageable sections so that cap is promptly constructed and vegetation quickly established.
2. Spacing of gas mitigation measures to be determined following field testing. Gas mitigation measures will be omitted in areas where methane levels < 500 parts per million (v/v).
3. Uncompleted sections of clay capping are to be covered with plastic sheeting at the end of each working day and during extended storm periods and periods of hot dry weather to maintain moisture levels within the specification.
4. Clay capping layer may be replaced with alternative sealing layer approved by the NSW EPA.
5. Following placement, contour banks, or earthen bunds should be constructed along the finished slopes to ensure erosion resistance during revegetation, moisture retention and aeration of soil. Construction of banks should not penetrate > 100mm into revegetation layer.
6. Erosion and weed control measures will be implemented during construction of the cap.
7. The boundaries of differing capping types must be keyed into each other to provide a gradual transition.
8. US, SM and dedicated access road to fields 6, 7 & 8 to be constructed by Breen. Other roads & carparks to be constructed by others in



UPPER STRATUM (US)/ROADS AND CARPARKS AS SPECIFIED IN THE VPA

US is min. 200mm medium textured soil high in composted organic matter, to consist of a blend of crushed sandstone, topsoil and composted organic matter. To be free of any foreign materials including brick, tiles, road base, concrete, plastic, timber, glass or metal. To be free of weed seed and propagules. The finished upper soil surface is to be covered in a layer of mulch to reduce erosion, maintain moisture and prevent the establishment of weeds. Testing of soil is to be undertaken in accordance with the VPA. Roads and carparks to be constructed in accordance with VPA Schedule 4 Cl. 2.1 and 2.2.

SUBGRADE MATERIAL (SM) - AS SPECIFIED IN THE VPA

Min. 800mm coarse subgrade material low in organic matter. To consist of VENM/other compactable fill material permitted under the EPL (max 150mm particle size). Compact fill to min. density ratio of 95% standard compaction as determined by AS1289.5.11 and/or by test rolling to AS3798-2007.

COMPACTED CLAY SEAL (CCS)

Min. 600mm clay capping material. To be placed in 200mm layers and compacted to min density ratio of 98% Standard compaction as determined by AS1289.5.11. CCS to have permeability $k < 10^{-9}$ m/s. Moisture content of fill to be in the range of Optimum Moisture Content (OMC) to OMC +2% or as suitable to achieve adequate compaction and permeability requirements.

SEAL BEARING LAYER (SBL)

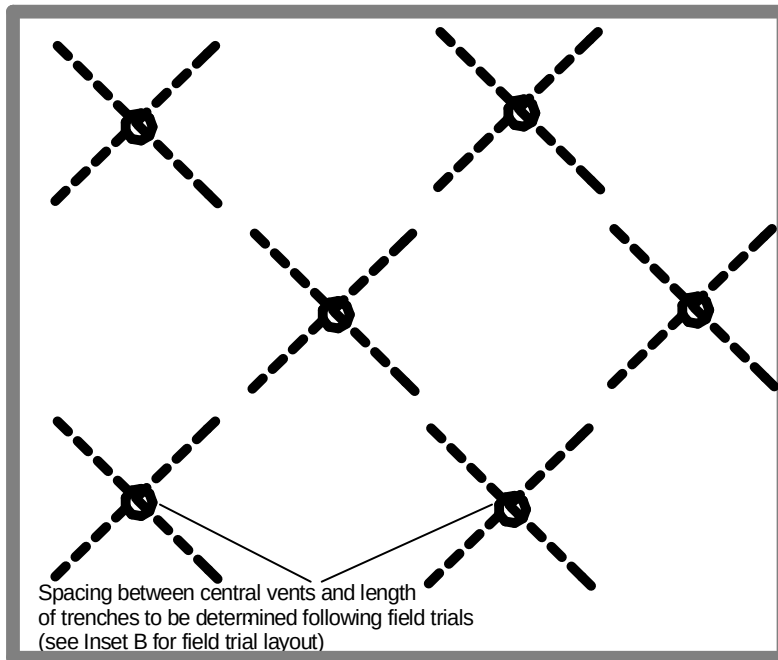
Min. 300mm VENM/other compactable fill material. Fill to be placed in near horizontal layers of max 250mm loose thickness. Compaction to min density ratio of 95% standard compaction as determined by AS1289.5.11 and/or by test rolling to AS3798-2007. Areas which are assessed to deform excessively under test rolling shall be rectified and re-presented.

COMPACTED WASTE

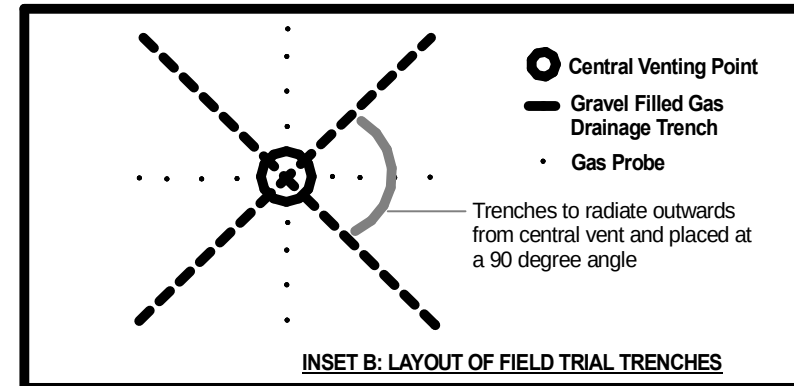
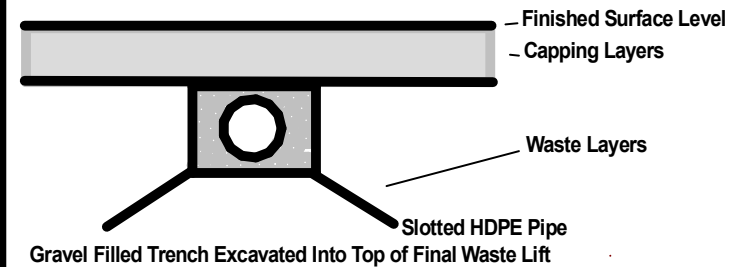
VENM/other compactable fill material permitted under the EPL to 1.2m below FSL if required. Fill to be placed in near horizontal layers of max 500mm loose thickness. Compaction to min density ratio of 95% based on Standard Compaction as determined by AS1289.5.11. Alternative methods of achieving the compaction requirements such as dynamic compaction by impact rolling with associated verification testing may be considered subject to the approval of and confirmation by the Geotechnical Practitioner.

PROPOSED LAYOUT OF GAS MITIGATION SYSTEM

- 
Central Venting Point
 (initially passive system installed, Points to be connected to blower / flare for active collection if required)
- 
Gravel Filled Gas Drainage Trench
 (see Inset A for cross-sectional view)
- 
Waste Boundary



INSET A: CROSS-SECTION OF GRAVEL TRENCHES



Note:

- Gas drainage trenches will be installed with slotted HDPE pipe and backfilled with inert gravel.
- A layer of geotextile will be placed over the backfill gravel trench to reduce the potential for intrusion and clogging of the underlying soil.



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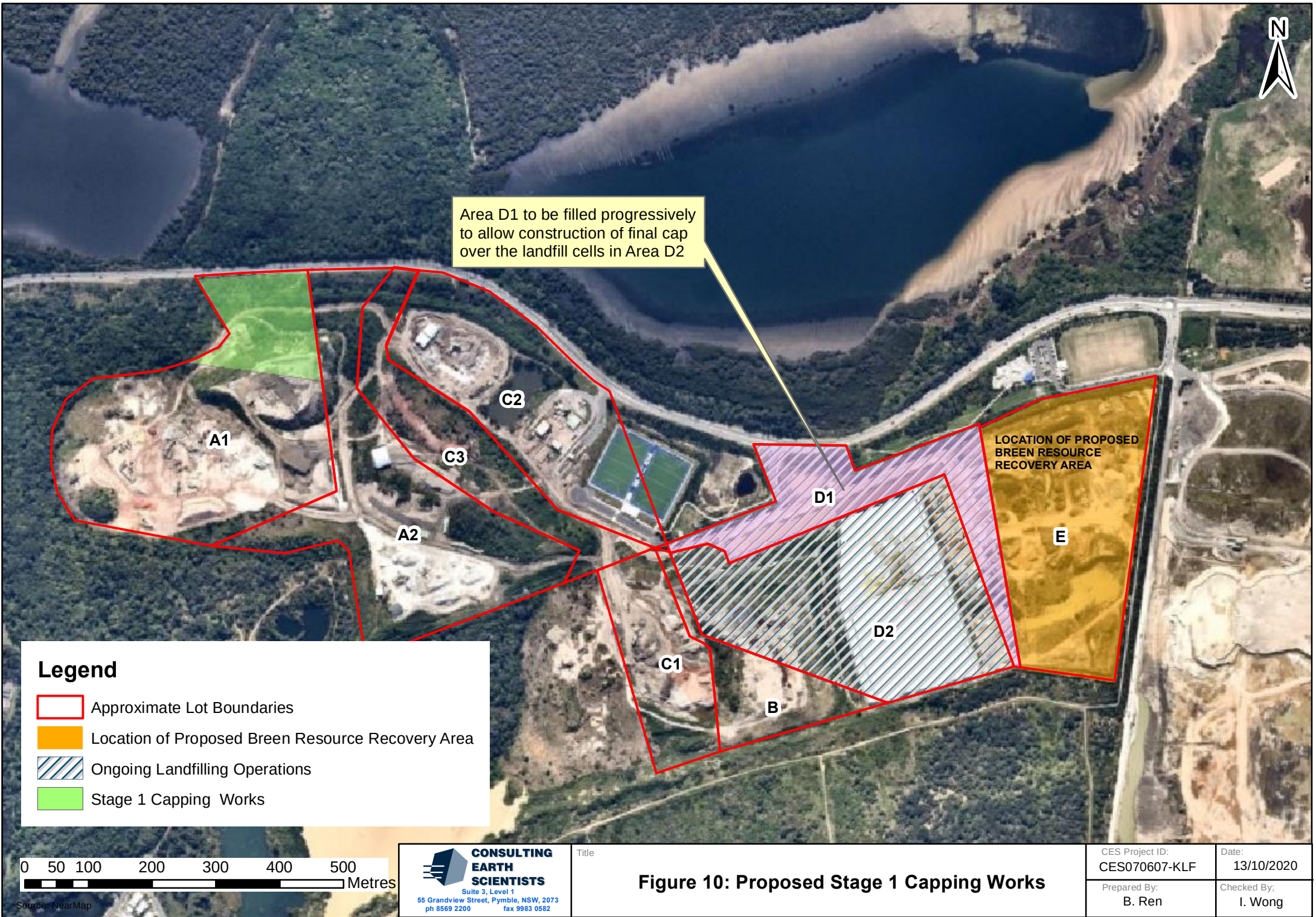
Figure 9: Proposed Layout of Gas Mitigation System

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13/10/2020

Prepared By:
B. Ren

Checked By:
I. Wong



Area D1 to be filled progressively to allow construction of final cap over the landfill cells in Area D2

LOCATION OF PROPOSED BREEN RESOURCE RECOVERY AREA

Legend

- Approximate Lot Boundaries
- Location of Proposed Breen Resource Recovery Area
- Ongoing Landfilling Operations
- Stage 1 Capping Works

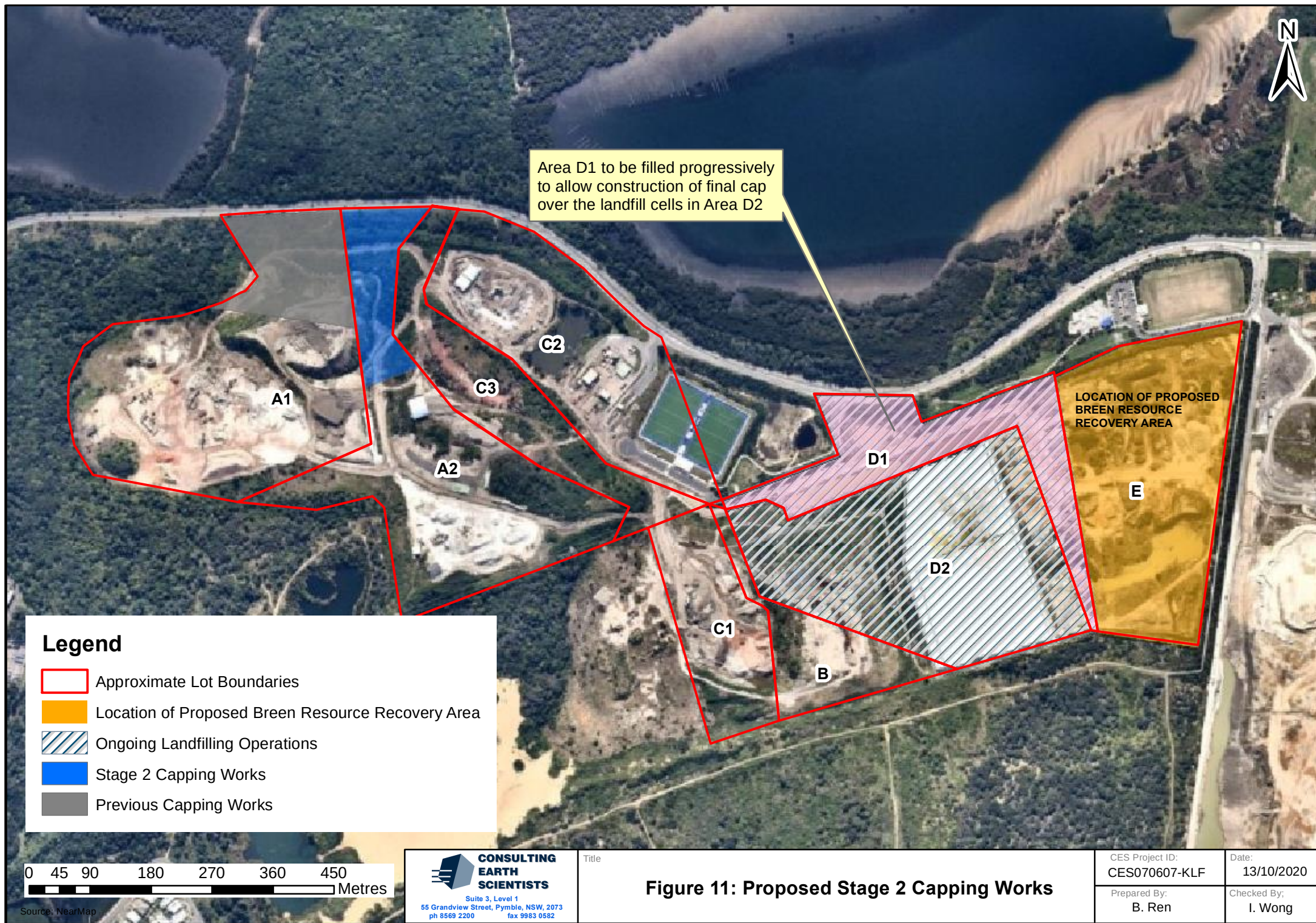
0 50 100 200 300 400 500 Metres

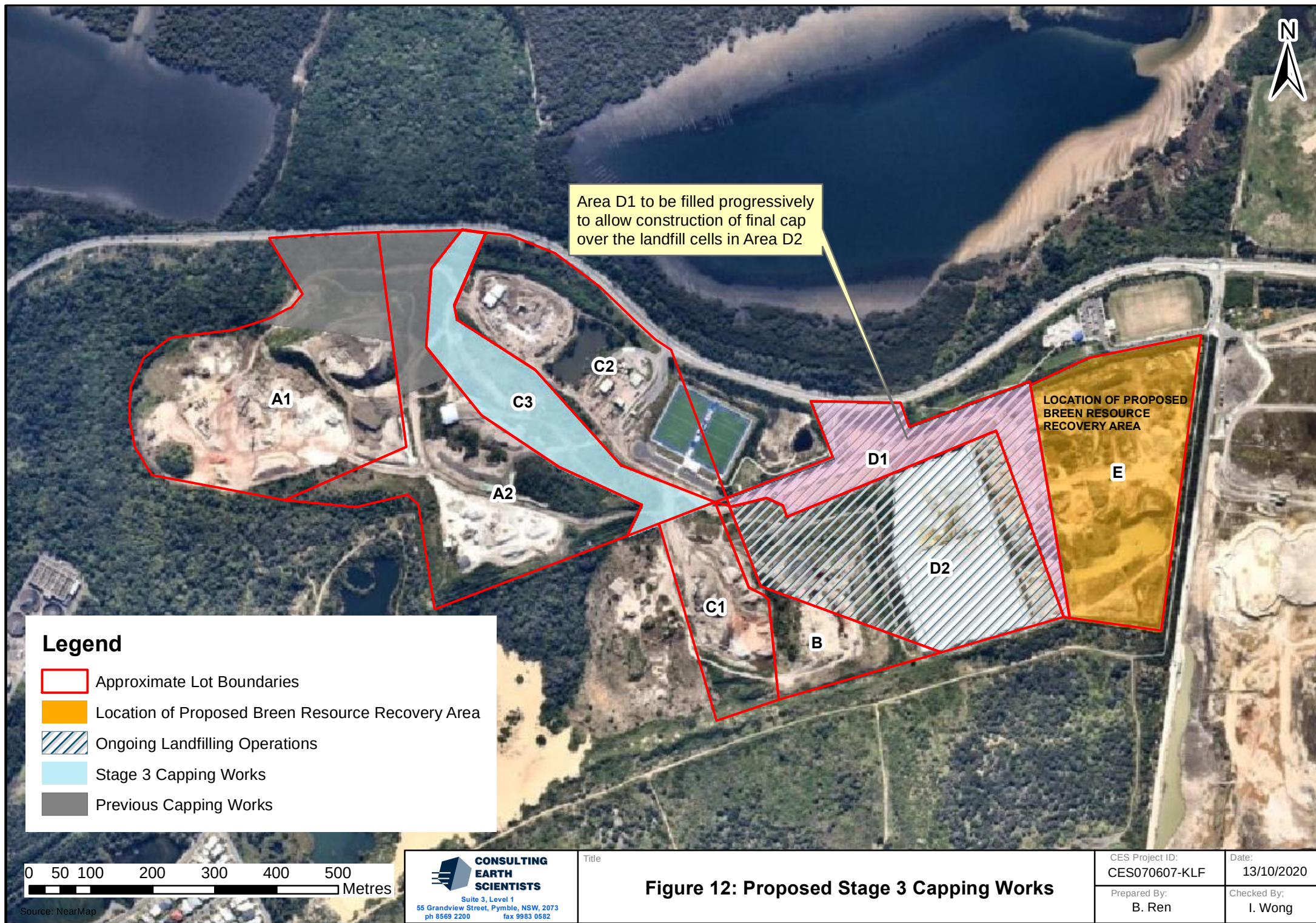
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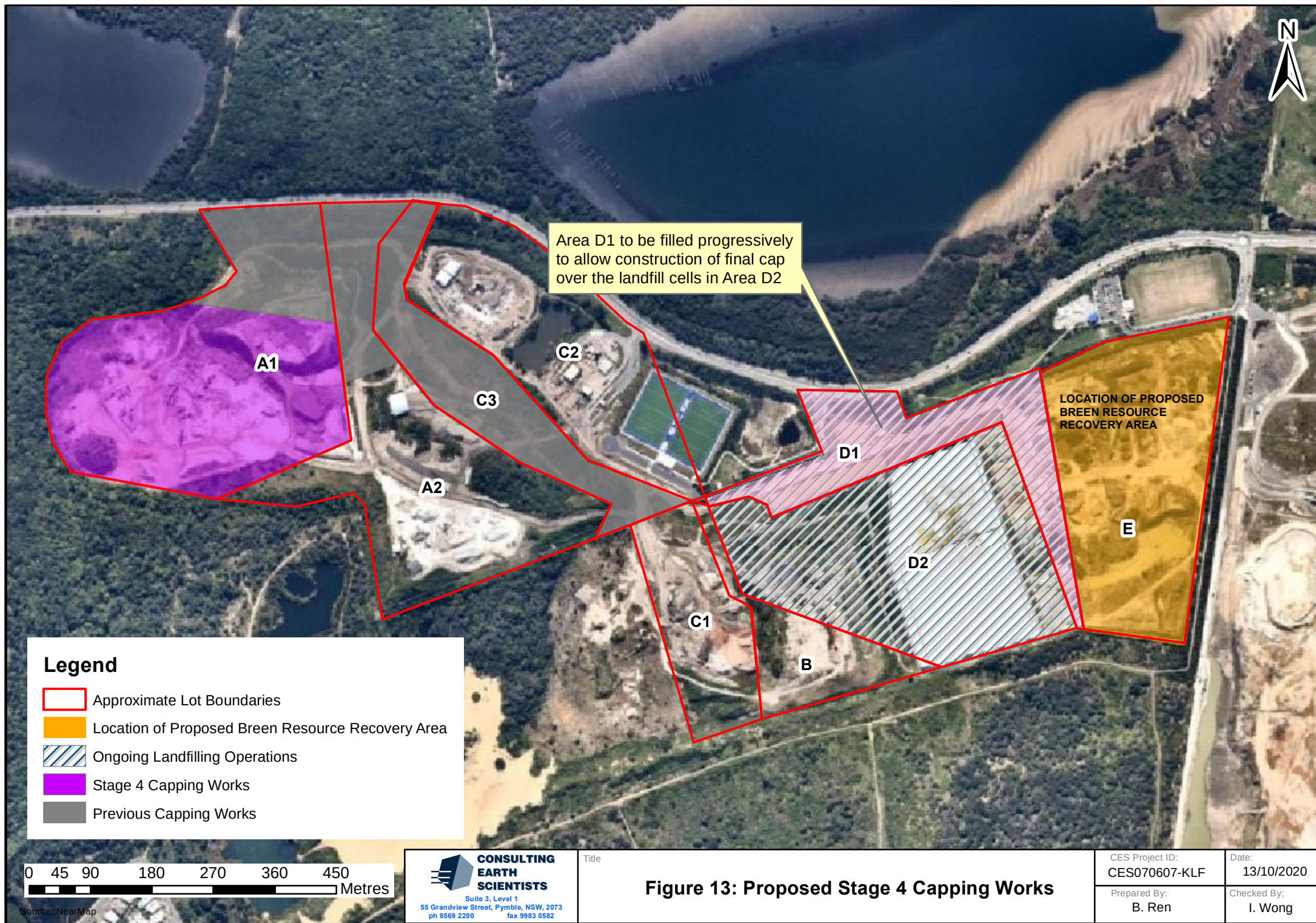
Title

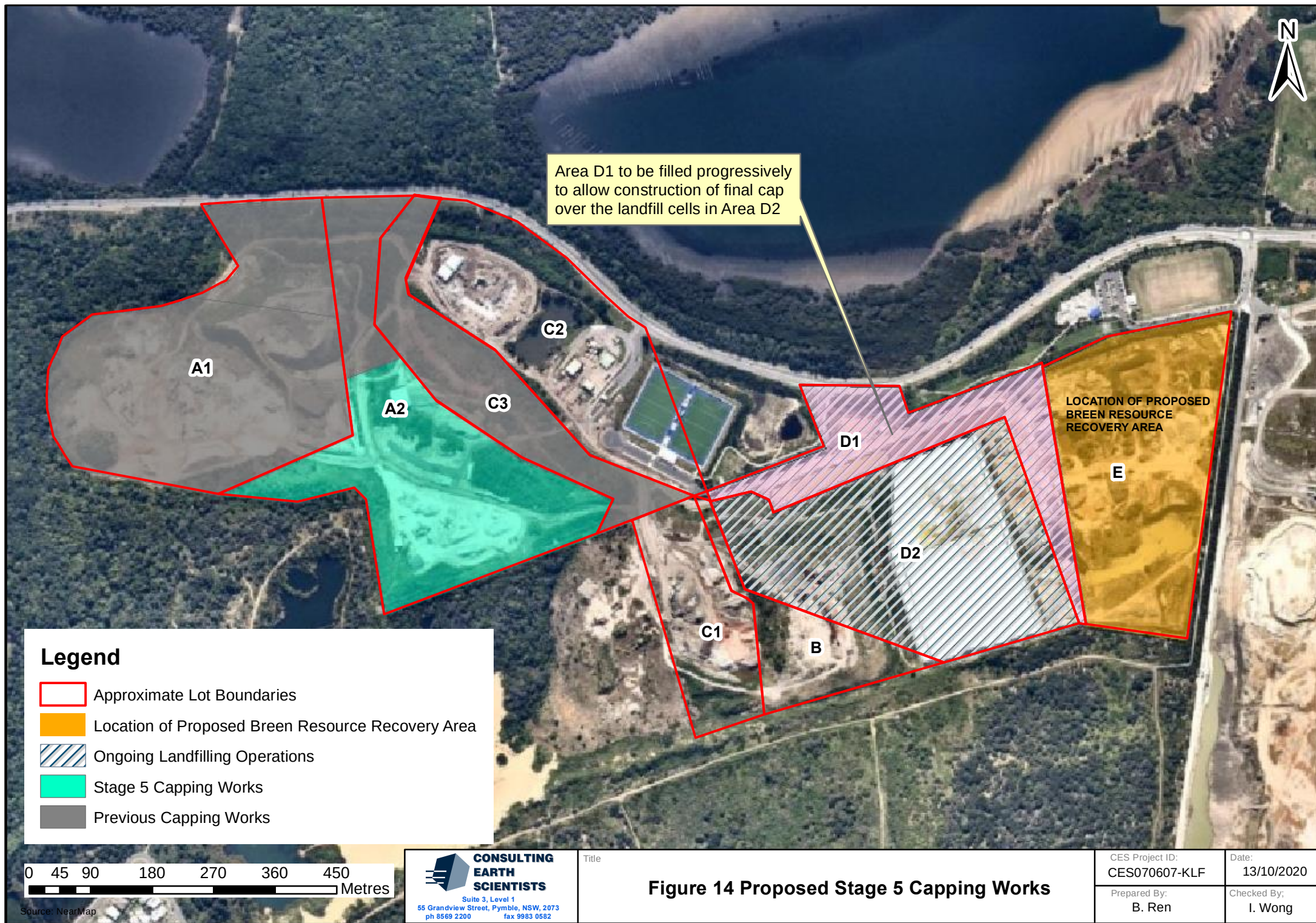
Figure 10: Proposed Stage 1 Capping Works

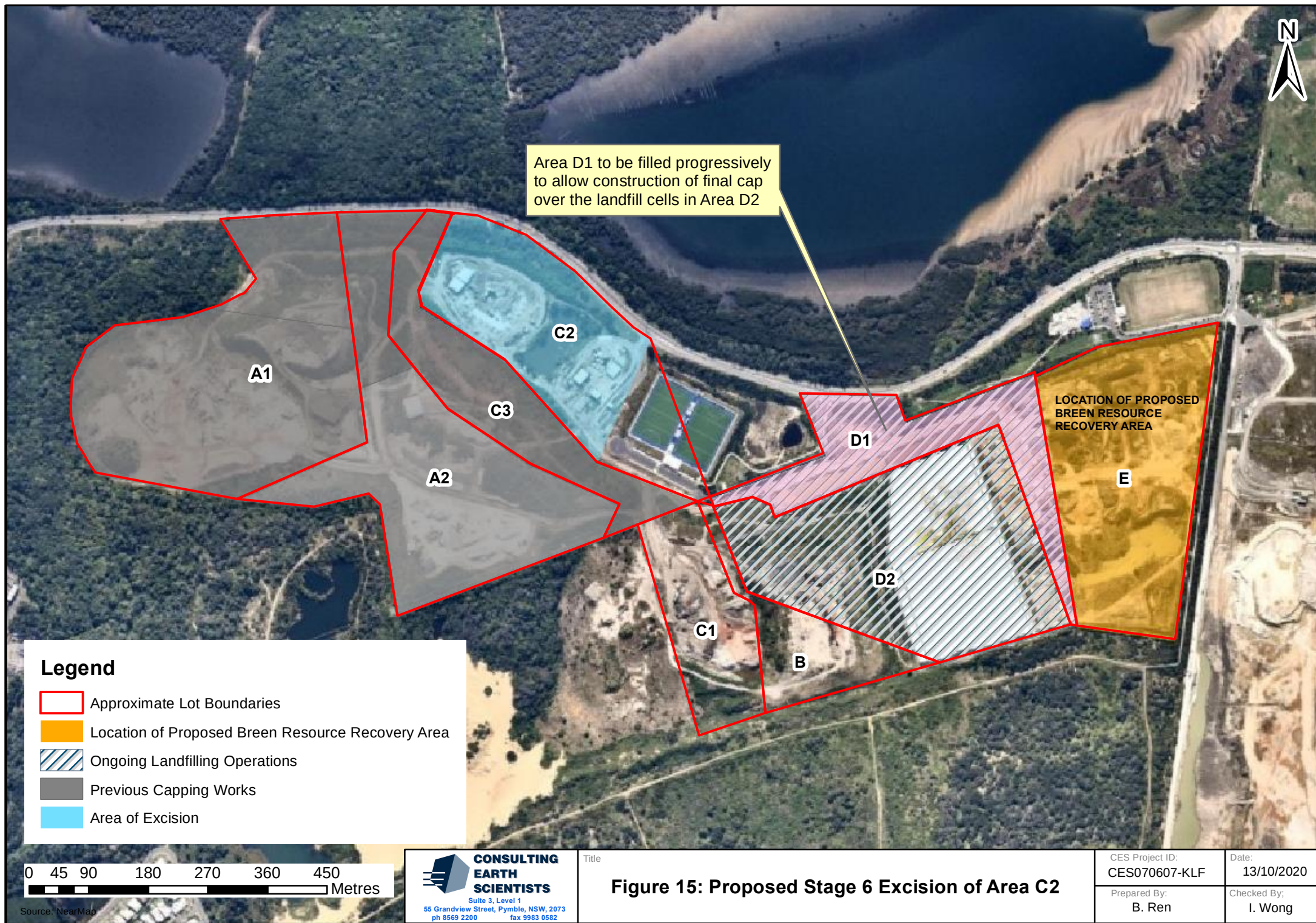
CES Project ID: CES070607-KLF	Date: 13/10/2020
Prepared By: B. Ren	Checked By: I. Wong

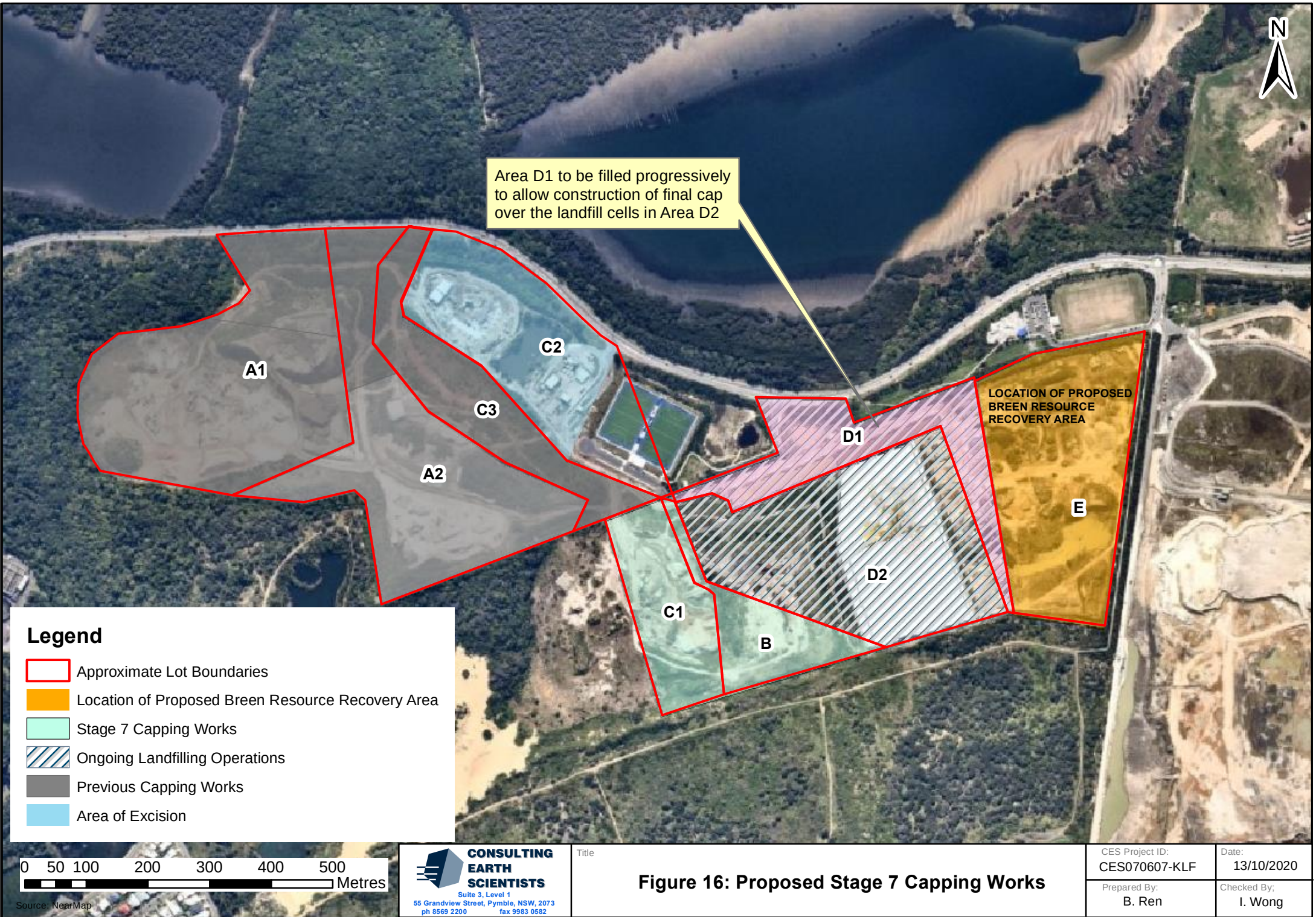












Area D1 to be filled progressively to allow construction of final cap over the landfill cells in Area D2

LOCATION OF PROPOSED BREEN RESOURCE RECOVERY AREA

Legend

Approximate Lot Boundaries

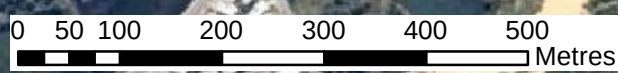
Location of Proposed Breen Resource Recovery Area

Stage 7 Capping Works

Ongoing Landfilling Operations

Previous Capping Works

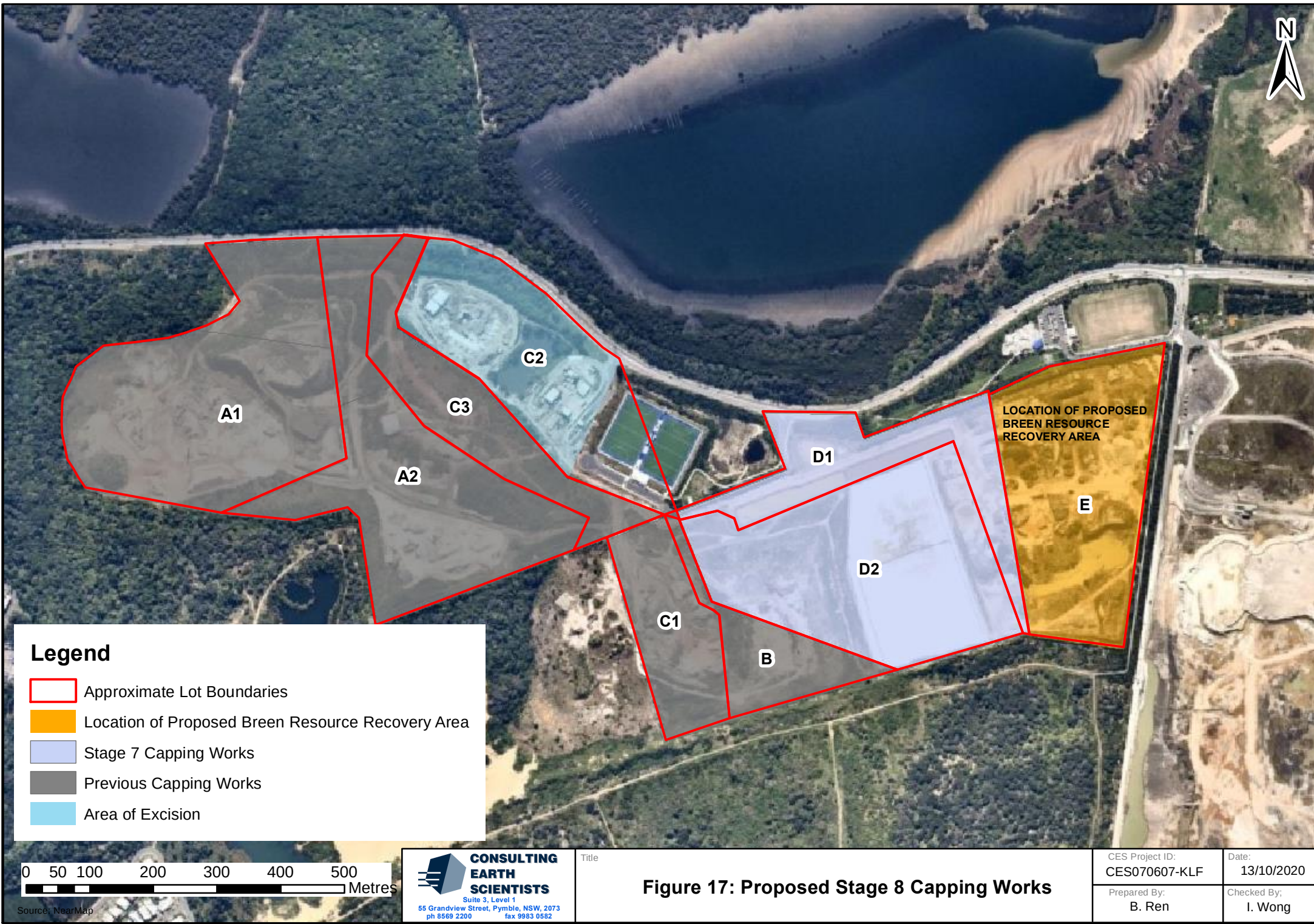
Area of Excision



Source: NearMap

**CONSULTING EARTH SCIENTISTS**
Suite 3, Level 1
55 Grandview Street, Pymble, NSW, 2073
ph 9569 2200 fax 9963 0582

Title	Figure 16: Proposed Stage 7 Capping Works		CES Project ID: CES070607-KLF	Date: 13/10/2020
			Prepared By: B. Ren	Checked By: I. Wong



TABLES

TABLE 1 - CAPPING CONSTRUCTION QUALITY ASSURANCE PROGRAM

Capping Layers (Refer to Fig. 4 to 9)	CONSTRUCTION REQUIREMENTS	TESTING/ INSPECTION REQUIREMENTS	TESTING FREQUENCY	RESPONSIBILITY
Compacted Waste (Lot 1122 and 1123)	<u>Conventional Compaction:</u> Fill to required level. Compact fill to min. density ratio of 95% Standard compaction as determined by AS1289.5.11.	>95% min. density ratio AS 1289 5.8.1/ 5.5.1/ 5.3.1/ 5.3.2	1 test per 500mm layer per 10,000m ²	Breen and Geotechnical Testing Authority
	<u>Dynamic Compaction:</u> Fill to required level. Compact fill to min. density ratio of 95% standard compaction as determined by AS1289.5.11 using impact roller.	>95% min. density ratio Method of testing to be determined by a suitably qualified Geotechnical Practitioner and may comprise one or a combination of the following: - Field Density Test; - Geophysics; - Cone Penetration Test; - Other similar methods as agreed by a Geotechnical Practitioner	To be determined by a Geotechnical Practitioner	Breen and Geotechnical Practitioner
	Survey surface level	Surface level at elevation to meet final landform requirements	1 per area	Surveyor (Note 1)
Seal Bearing Layer (SBL)	Min. 300mm of VENM/other compactable fill material approved by the Geotechnical Practitioner	Source Description	1 test per 2,500m ³	Breen and Geotechnical Practitioner
		Survey - Thickness requirement (min. 300mm)	Following placement of layer	Surveyor
	Compact fill to min. density ratio of 95% standard compaction as determined by AS1289.5.11 and/or by test rolling to AS3798-2007	>95% min. density ratio Areas which are assessed to deform excessively should be rectified and represented for rolling	1 test per 2500m ³	Breen and Geotechnical Practitioner
Gas mitigation System	Inert Gravel	Particle Size Distribution (16 – 32mm particle size)	1 for each star shaped mitigation installation	Breen and Geotechnical Testing Authority
		Calcium Carbonate Content (<10%)	1 for each star shaped mitigation installation	Breen and Geotechnical Testing Authority
		Visual Inspection (Clean and rounded)	1 for each star shaped mitigation installation	Geotechnical Practitioner
	High Density Polyethylene (HDPE) pipes to be inserted in gravel filled trench	Test results from manufacturer or independent laboratory demonstrating that material is fit for purpose	1 test per batch delivered to site	Supplier
		Visual Inspection	1 for each star shaped mitigation installation	Geotechnical Practitioner
	A geofabric as a separation layer at the top of gravel trench (BIDIM A34 or equivalent)	Trapezoidal tear strength – 21kN/m AS3706.3	1 per 5,000 m ² including the first and last rolls (based on production order): minimum of two tests	Supplier
		CBR Burst Strength – 3600 N AS3706.4		
		Grab Tensile Strength – 1350 N AS 3706.2b		
		Pore size – ASTM D6767		
		Permittivity – AS3706.9		

TABLE 1 - CAPPING CONSTRUCTION QUALITY ASSURANCE PROGRAM

Capping Layers (Refer to Fig. 4 to 9)	CONSTRUCTION REQUIREMENTS	TESTING/ INSPECTION REQUIREMENTS	TESTING FREQUENCY	RESPONSIBILITY
		Visual assessment during installation and photographs	1 for each star shaped mitigation installation	Geotechnical Practitioner
Seal Bearing Foundation Layer (SBFL)	Min. 500 mm crushed recycled brick and/or concrete with < 10% calcium carbonate by weight to prevent encrustation. If crushed concrete is used it should be mixed with brick/inert material & tested to confirm compliance. (NOTE: Playing Fields 9 & 10 only)	Calcium Carbonate Content (<10%)	1 test per 2,500m ³	Breen and Geotechnical Testing Laboratory
		Source Description	1 test per 2,500m ³	Breen and Geotechnical Testing Laboratory
		Survey - Thickness requirement (min. 300mm)	Following placement of layer	Surveyor
Compacted Clay Seal (CCS)	Min., 600 mm thick compacted clay seal tested to a permeability of less than $K = 10^{-9}$ m/s and compacted to min. density ratio of 98% standard compaction as determined by AS1289.5.11. The clay should have high plasticity and a suitable particle size distribution with no particles greater than 50mm in any dimension. Compacted Clay sealing layer may be replaced with an alternative sealing layer approved NSW EPA (Separate CQA plan would be prepared from any alternative)	>98% min. density ratio and OMC +/- 2% AS 1289 5.8.1/ 5.5.1/ 5.3.1/ 5.3.2	1 test per 200mm thickness per 2500m ²	Contractor and Geotechnical Testing Laboratory
		Permeability Testing (not greater than 10^{-9} m/s)	1 test per 2,500m ³ to demonstrate that 98% relative compaction provides permeability of < 10^{-9} m/s	
		Survey - Thickness requirement (min. 600mm)	Following placement of layer	Surveyor
	Gradient (NOTE: Open Space land use areas only, namely Lot 1122, Lot 4, Part Lot 2 & Part Lot 5)	Survey: Minimum 5 % grade to drainage points	Following placement of layer	Breen and Surveyor
Bridging Layer (BL)	Min. 500 mm of crushed brick and/or concrete with max. particle size of 40mm	Particle Size Distribution (max size 40 mm)	1 test per 2,500m ³	Breen and Geotechnical Testing Authority
		Source Description	1 test per 2,500m ³	
		Survey - Thickness requirement (min. 500mm)	Following placement of layer	Surveyor
		Visual Inspection and Photographic Records	Regular intervals during construction	Geotechnical Practitioner
	2 layers of biaxial geogrid within the bridging layer (TENSAR SS30 or equivalent)	Unit Mass – 330 g/m ²	Each Batch delivered to site	Supplier and Independent Testing Laboratory
		Thickness – 5 mm		
		Max Tensile Strength – 30kN/m		
		Inspection during installation and photographs	Regular intervals during construction for each layer of geogrid placed	Geotechnical Practitioner
	2 layers of geofabric separation layer (above and below the bridging layer) (BIDIM A34 or equivalent)	Trapezoidal tear strength – 21kN/m AS3706.3	Each Batch delivered to site	Supplier and Independent Testing Laboratory
		CBR Burst Strength – 3600 N AS3706.4		
		Grab Tensile Strength – 1350 N AS 3706.2b		
		Pore size – ASTM D6767		

TABLE 1 - CAPPING CONSTRUCTION QUALITY ASSURANCE PROGRAM				
Capping Layers (Refer to Fig. 4 to 9)	CONSTRUCTION REQUIREMENTS	TESTING/ INSPECTION REQUIREMENTS	TESTING FREQUENCY	RESPONSIBILITY
		Permittivity – AS3706.9		
		Inspection during installation and photographs	Regular intervals during construction for each layer of geogrid placed	Geotechnical Practitioner
Subgrade Material (SM)	Min. 800mm coarse subgrade material low in organic matter. To consist of VENM/other compactable fill material (max 150mm particle size). Compact fill to min. density ratio of 95% standard compaction as determined by AS1289.5.11 and/or by test rolling to AS3798-2007.	>95% min. density ratio Areas which are assessed to deform excessively should be rectified and represented for rolling	1 test per 2500m ³	Breen and Geotechnical Practitioner
		Source Description/Visual Inspection (local VENM/other compactable fill material)	1 test per 2,500m ³	Geotechnical Practitioner
		Survey - Thickness requirement (min. 800mm)	Following placement of layer	Surveyor
Upper Stratum (US)	Min. 200mm medium textured Upper Stratum Soil high in composted organic matter in accordance with Schedule 4 of the VPA	Visual Inspection (to consist of a blend of crushed sandstone, topsoil and composted organic matter, free of any foreign materials, weed seed and propagules. Max particle size 50mm)	1 test per 2,500m ³	Supplier
		Composted materials shall conform to AS4454		
		Particle Size Distribution (Silt or Clay component < 5% per volume, max particle size 50mm)		
		Salt Levels (< an electrical conductivity of 2.5dS/m)		
		Phosphorus Levels (< 10mg/kg – Olsen sodium bicarbonate procedure)		
		Upper stratum shall generally meet physical and chemical requirements of AS4419 Soils and Landscaping for Garden Use		
		Survey - Thickness requirement (min. 200mm)	Following placement of layer	Surveyor

Note 1: At the completion of construction, a set of “as executed” drawings will be prepared by the surveyor showing that the cap was installed in accordance with the design.

APPENDIX 1



LEGEND

- Project Boundary
- Landscape Boundary
- Landform contours
- Shared pathways
- Recycled sculptures/ Interpretative trail
- Kurnell Dune Forest
- Coastal Dune Heath
- Modified Kurnell Dune Heath (Low Heath)

- Informal native grass (Indicative Area)
- Managed native grass (Indicative Area)
- Trees
- Picnic shelters (x3)
- Picnic tables (x11)

KEY

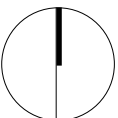
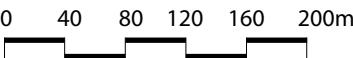
- 1. Amphitheatre
- 2. Potential Installation Art
- 3. Village green
- 4. Drop off, turn around area & coach parking
- 5. Disabled parking
- 6. Pedestrian entry zone
- 7. Main plaza
- 8. Panoramic lookout
- 9. Stabilised embankment
- 10. Slide
- 11. Lookout/ peak
- 12. General carparking
- 13. Open grassed picnic area
- 14. Nature play/trail connection
- 15. Playground
- 16. Vehicular access point
- 17. Pedestrian access points
- 18. Picnic facilities
- 19. Future amenities block
- 20. Existing amenities block
- 21. Infiltration area



Client:



1:5000 @ A3

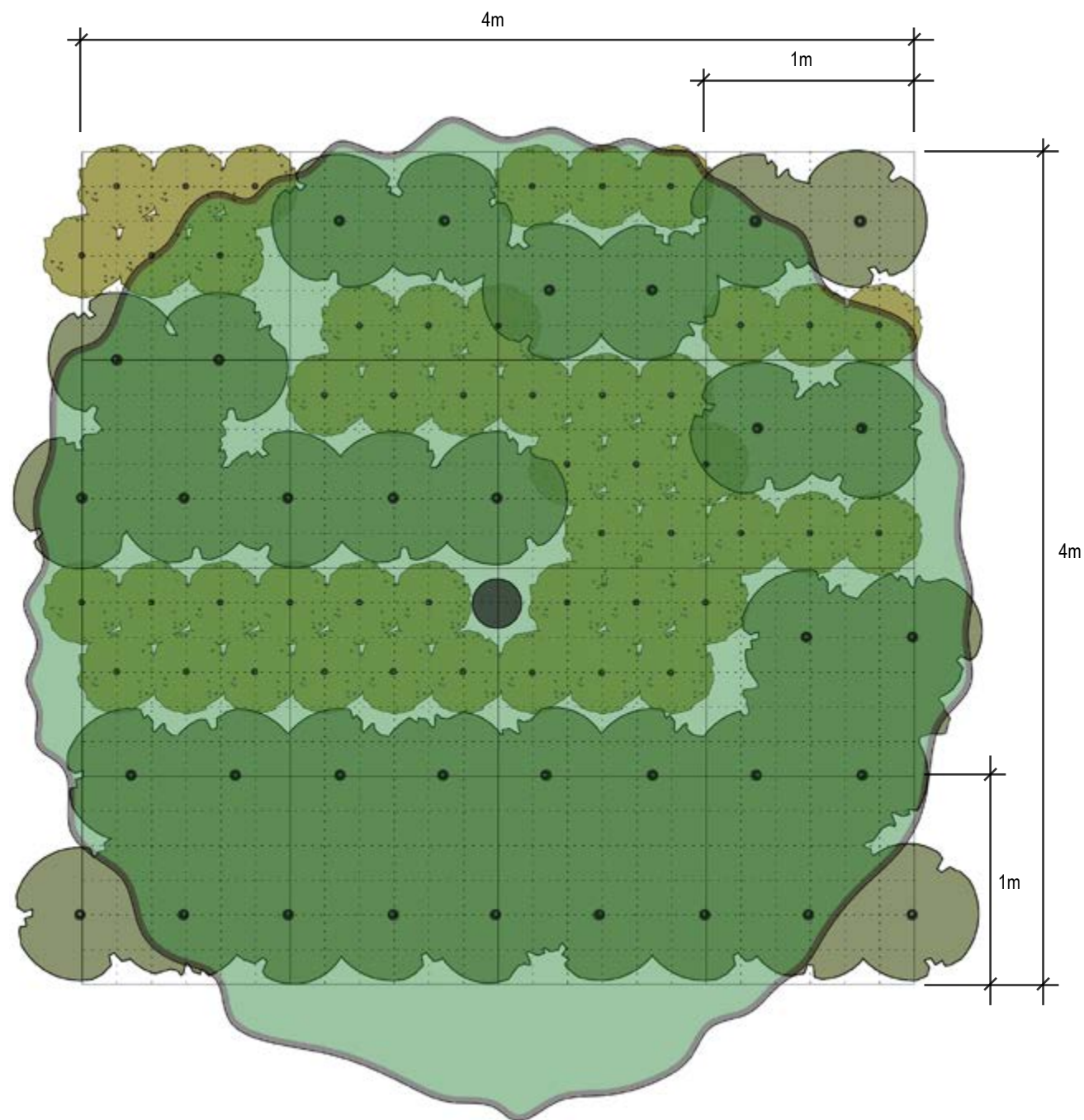


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LANDSCAPE MASTER PLAN

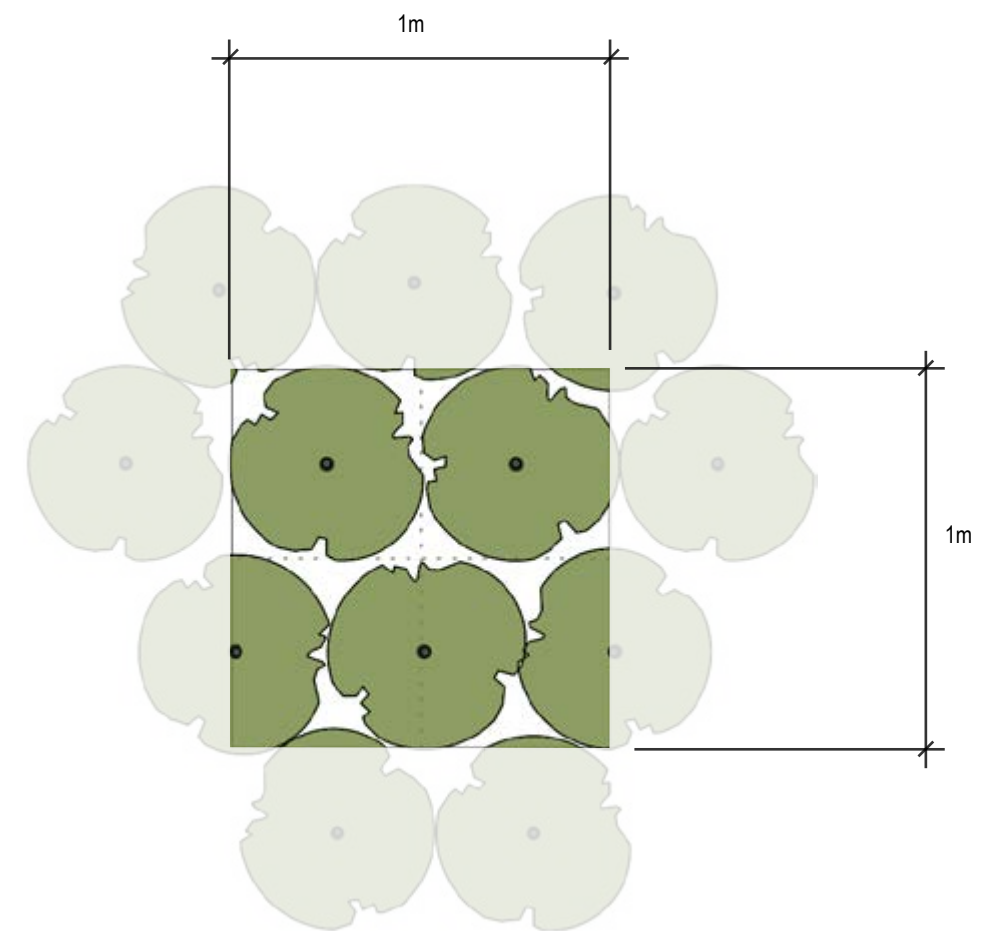
Figure 7

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Kurnell Dune Forest - Typical Arrangement

Vegetation Type	Quantity	Area Coverage	% of Total Coverage
Trees	1	1 per 16m ²	n/a
Shrubs	32	2 per 1m ²	40%
Grasses & Groundcovers	48	3 per m ²	60%



Kurnell Dune Heath - Typical Arrangement

Vegetation Type	Quantity	% of Total Coverage
Shrubs	4 tubestock per 1m ²	50%
Grasses & Groundcovers		50%

General Notes for Planting:

- Refer to "Proposed Native Plant Species List" (Drawing No. SK27) for typical species selection.
- Tubestock to be used for all proposed plants.

PLANTING STRATEGY

The Marang Parklands provide an ideal opportunity to re-establish native plant communities that would have been present on this dune landscape prior to the mining era.

The planting strategy therefore focuses on an integration of coastal heath and Kurnell Dune Forest communities, Employing canopy species to provide shelter over time that will foster further natural revegetation.

The resulting landscape will comprise areas of tree canopy (probably windswept in form) informally framing open areas of the coastal heath planting and open lawn areas.



Westringia fruticosa



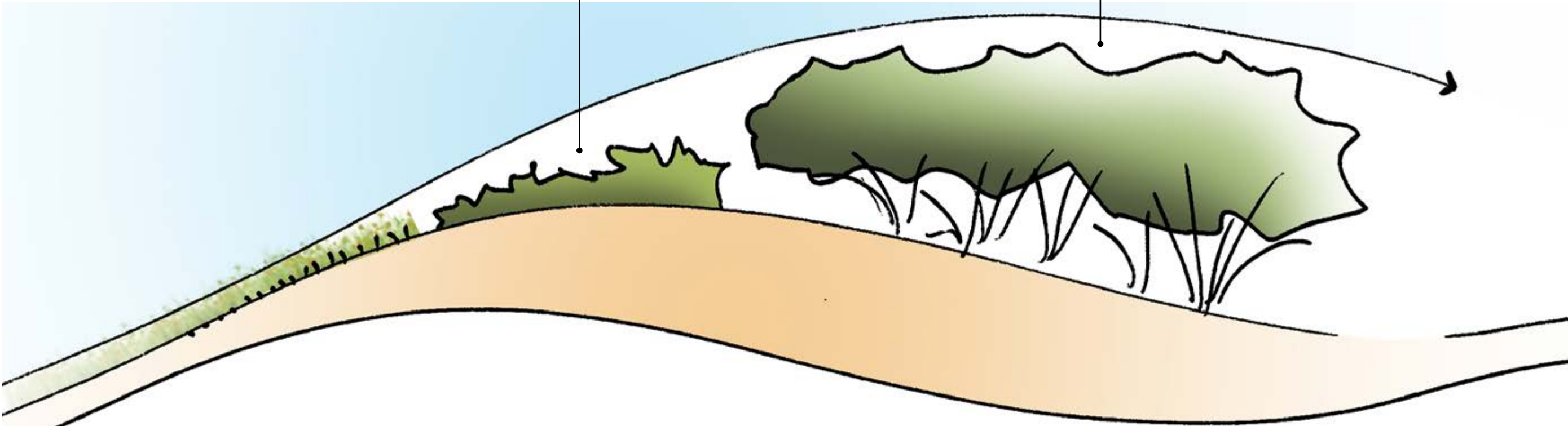
Banksia integrifolia



Eucalyptus botriodes



Eucalyptus sp



Kurnell Dune Forest Coastal Dune Dry Schlerophyll Forest & Associated Plant Communities						
Botanical Name	Common Name	SC	B & S	CPB	CBR	CA
TREES						
<i>Acmena smithii</i>	Lillypilly				✓	✓
<i>Allocasuarina littoralis</i>	Black She-oak		✓	✓	✓	✓
<i>Angophora costata</i>	Sydney Red Gum	✓	✓	✓		✓
<i>Banksia serrata</i>	Old Man Banksia		✓	✓	✓	✓
<i>Banksia integrifolia</i>	Coastal Banksia		✓	✓	✓	✓
<i>Casuarina glauca</i>	Swamp Oak			✓		✓
<i>Corymbia gummifera</i>	Red Bloodwood		✓			✓
<i>Cupaniopsis anacardioides</i>	Tuckeroo	✓		✓	✓	✓
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	✓				✓
<i>Endiandra sieberi</i>	Hard Corkwood	✓				✓
<i>Eucalyptus botryoides</i>	Bangalay	✓		✓		✓
<i>Eucalyptus pilularis</i>	Blackbutt					✓
<i>Eucalyptus robusta</i>	Swamp Mahogany			✓		✓
<i>Glochidion ferdinandi</i>	Cheese Tree	✓		✓		✓
<i>Livinstona australis</i>	Cabbage Palm		✓			✓
<i>Melaleuca quinquenervia</i>	Broad Leaved Paperbark			✓		✓
<i>Rapanea variabilis</i>	Muttonwood	✓			✓	✓
<i>Syzygium oleosum</i>	Blue Cherry					✓
<i>Syzygium paniculatum</i>	Magenta Brush Cherry					✓
SHRUBS						
<i>Acacia longifolia</i>	Coastal Wattle		✓	✓	✓	✓
<i>Acacia myrtifolia</i>	Red-stemmed Wattle			✓		✓
<i>Acacia sophorae</i>	Coastal Wattle			✓	✓	✓
<i>Acacia suaveolens</i>	Sweet Scented Wattle		✓	✓		✓
<i>Acacia terminalis</i>	Sunshine Wattle		✓		✓	✓
<i>Acacia ulicifolia</i>	Prickly Moses		✓	✓		✓
<i>Aotus ericoides</i>	Eggs and Bacon	✓	✓	✓		✓
<i>Banksia ericifolia</i>	Heath Banksia	✓	✓	✓		✓
<i>Breynia oblongifolia</i>	Coffee Bush	✓	✓		✓	✓
<i>Clerodendrum tomentosum</i>	Downy Chance	✓			✓	✓
<i>Correa alba</i>	White Correa		✓			✓
<i>Correa reflexa</i>	Native Fuchsia		✓			✓

Botanical Name	Common Name	SC	B & S	CPB	CBR	CA
SHRUBS						
<i>Epacris longiflora</i>	Native Fuchsia Heath		✓			✓
<i>Dillwynia retorta</i>	Egg and Bacon Pea					✓
<i>Dillwynia glaberrima</i>	Smooth Parrot Pea					✓
<i>Eustrephus latifolius</i>	Wombat Berry	✓			✓	✓
<i>Leptospermum laevigatum</i>	Coastal Tea-Tree	✓	✓	✓	✓	✓
<i>Leucopogon lanceolatus</i>	Lance Beard Heath					✓
<i>Leucopogon parviflorus</i>	Coast Beard Heath	✓			✓	✓
<i>Macrozamia commuis</i>	Burrawang		✓			✓
<i>Monotoca elliptica</i>	Heath Broom	✓			✓	✓
<i>Notelia longifolia</i>	Native Olive	✓			✓	✓
<i>Pimelia linifolia</i>	Slender Rice Flower	✓	✓	✓	✓	✓
<i>Ricinocarpus pinifolius</i>	Wedding Bush		✓			✓
<i>Xylomelum pyriforme</i>	Woody Pear		✓			✓
<i>Xanthorrhoea glauca</i>	Grass Tree					✓
<i>Zieria pilosa</i>	Hairy Zieria		✓			✓
FERNS, GROUNDCOVERS AND HERBS,						
<i>Actinotus helianthi</i>	Flannel Flower	✓	✓			✓
<i>Commelina cyanea</i>	Scurvy Weed		✓		✓	✓
<i>Dichondra repens</i>	Kidney Weed			✓	✓	✓
<i>Geranium homeanum</i>	Northern Cranesbill		✓		✓	✓
<i>Gonocarpus teucrioides</i>	Germander Raspwort					✓
<i>Pteridium esculentum</i>	Bracken		✓		✓	✓
<i>Scaevola calendulacea</i>	Scented Fan Flower		✓		✓	✓
GRASSES AND GRASS-LIKE PLANTS						
<i>Dianella caerulea</i>	Blue Flax Lily			✓		✓
<i>Imperata cylindrica</i>	Blady Grass			✓		✓
<i>Hypolaena fastigiata</i>	Tassle Rope Rush					✓
<i>Lepidosperma laterale</i>	Variable Sword Sedge	✓				✓
<i>Lomandra longifolia</i>	Spiny-headed Mat Rush	✓	✓	✓	✓	✓
<i>Lomandra glauca</i>	Blue Mat Rush		✓			✓
<i>Oplismenus imbecillis</i>	Basket Grass				✓	✓
<i>Microlaena stipoides</i>	Weeping Grass				✓	✓
<i>Themeda australis</i>	Kangaroo Grass			✓	✓	✓

Botanical Name	Common Name	SC	B & S	CPB	CBR	CA
CLIMBERS						
<i>Cissus antarctica</i>	Kangaroo Vine	✓			✓	✓
<i>Cissus hypoglauca</i>	Water Vine	✓				✓
<i>Clematis aristata</i>	Old Man's Beard	✓				✓
<i>Clematis glycinoides</i>	Old Man's Beard				✓	✓
<i>Hardenbergia violacea</i>	False Sarsaparilla		✓	✓	✓	✓
<i>Hibbertia scandens</i>	Twining Guinea Flower	✓	✓	✓	✓	✓
<i>Kennedia rubicunda</i>	Dusky Coral Pea		✓	✓	✓	✓
<i>Maclura cochinchinensis</i>	Cockspur Thorn	✓			✓	✓
<i>Pandorea pandorana</i>	Wonga Wonga Vine	✓	✓		✓	✓
<i>Parsonsia staminea</i>	Monkey Vine	✓			✓	✓
<i>Smilax australis</i>	Lawyer Vine	✓				✓
<i>Stephania japonica var. discolor</i>	Snake Vine	✓			✓	✓

- KEY:**
- SC** Scientific Committee final destination of Kurnell Dune Forest Characteristic Species.
 - B&S** Joseph Banks & Dr Daniel Solander original plant species list
 - CPB** Cronulla Business Park (Sutherland Shire Council recommended plant species list)
 - CBR** Charlotte Breen Reserve (Sutherland Shire Council recommended plant species list)
 - CA** CLOUSTON Associates recommended plant species list



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PROPOSED NATIVE PLANT SPECIES

Figure 27

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Coastal Dune Heath & Associated Plant Communities					
Botanical Name	Common Name	B&S			CA
SHRUBS					
<i>Acacia sophorae</i>	Coastal Wattle		✓	✓	✓
<i>Acacia suaveolens</i>	Sweet-scented Wattle	✓	✓		✓
<i>Allocasuarina distyla</i>	Scrub She-oak	✓			✓
<i>Aotus ericoides</i>	Eggs and Bacon	✓	✓		✓
<i>Astroloma pinifolium</i>	Pine Heath	✓			✓
<i>Banksia aemula</i>	Wallum Banksia				✓
<i>Banksia ericifolia</i>	Heath Banksia	✓			✓
<i>Banksia serrata</i>	Old Man Banksia	✓	✓	✓	✓
<i>Bossiaea ensata</i>	Sword Bossiaea				✓
<i>Bossiaea heterophylla</i>	Variable Bossiaea	✓			✓
<i>Ceratopetalum gummiferum</i>	Christmas Bush				✓
<i>Darwinia fascicularis</i>	Clustered Scent Myrtle	✓			✓
<i>Dillwynia retorta</i>	Egg and Bacon				✓
<i>Epacris longiflora</i>	Native Fuchsia Heath	✓			✓
<i>Hakea teretifolia</i>	Dagger Hakea	✓	✓		✓
<i>Kunzea ambigua</i>	Tick Bush		✓		✓
<i>Lambertia formosa</i>	Mountain Devil	✓			✓
<i>Leptospermum laevigatum</i>	Coastal Tea-Tree	✓	✓	✓	✓
<i>Leucopogon lanceolatus</i>	Lance Beard Heath				✓
<i>Leucopogon parviflorus</i>	Coast Beard Heath				✓
<i>Monotoca elliptica</i>	Heath Broom			✓	✓
<i>Ricinocarpus pinifolius</i>	Wedding Bush	✓			✓
<i>Sprengelia incarnata</i>	Pink Swamp Heath				✓
<i>Westringia fruticosa</i>	Coastal Rosemary	✓	✓		✓
<i>Woolisia pungens</i>	Snow Wreath	✓			✓
<i>Xanthorrhoea resinosa</i>	Grass Tree				✓

Botanical Name	Common Name	B&S			CA
HERBS,					
<i>Actinotus helianthi</i>	Flannel Flower	✓			✓
<i>Actinotus minor</i>	Lesser Flannel Flower	✓			✓
<i>Dampiera stricta</i>	Blue Dampiera	✓			✓
GRASSES AND GRASS-LIKE PLANTS					
<i>Aristida ramosa</i>	Wiregrass				✓
<i>Caustis flexuosa</i>	Curly Sedge				✓
<i>Caustis pentandra</i>	Thick Twist Rush				✓
<i>Caustis recurvata</i> var. <i>recurvata</i>	Caustis				✓
<i>Dianella caerulea</i>	Blue Flax Lily		✓		✓
<i>Dianella revoluta</i>	Blue Flax Lily				✓
<i>Egrostis brownii</i>	Common Love-grass				✓
<i>Entolopia stricta</i>	Wiry Panic		✓	✓	✓
<i>Hypolaena fastigiata</i>	Tassle Rope-rush				✓
<i>Imperata cylindrica</i>	Blady Grass		✓	✓	✓
<i>Lepidosperma laterale</i>	Variable Sword Sedge				✓
<i>Lomandra longifolia</i>	Spiny-headed Rush	✓	✓	✓	✓
<i>Poa labillardiera</i>	Tussock Grass			✓	✓
<i>Themeda australis</i>	Kangaroo Grass		✓	✓	✓
GROUNDCOVERS AND CLIMBERS					
<i>Carpobrotus glaucescens</i>	Pig Face			✓	✓
<i>Cissus antarctica</i>	Kangaroo Vine			✓	✓
<i>Cissus hypoglauca</i>	Water Vine				✓
<i>Clematis aristata</i>	Old Man's Beard				✓
<i>Clematis glycinoides</i>	Old Man's Beard			✓	✓
<i>Commelina cyanea</i>	Scurvy Weed	✓		✓	✓
<i>Hibbertia scandens</i>	Twining Guinea Flower	✓	✓	✓	✓

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Client:



PARKLANDS EMBELLISHMENT PLAN • Kurnell

PROPOSED NATIVE PLANT SPECIES

Figure 28

28/10/2020 Issue C

Kurnell Dune Forest Coastal Dune Dry Schlerophyll Forest & Associated Plant Communities



Leptospermum laevigatum



Macrozamia communis



Eucalyptus botryoides



Westringia fruticosa



Glochidion ferdinandi



Cupaniopsis anacardioides



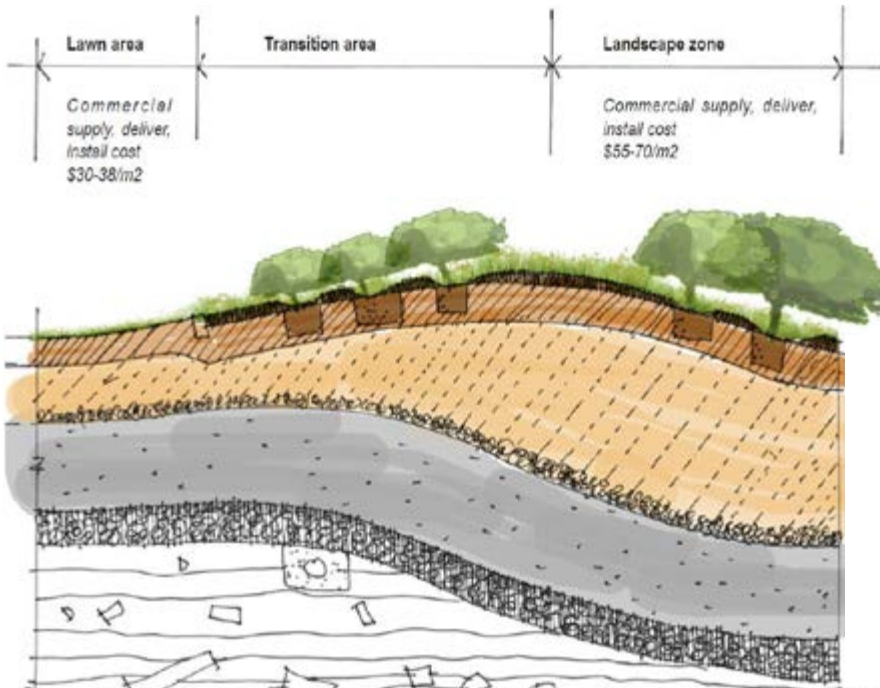
Banksia integrifolia



Monotoca elliptica



Banksia ericifolia



Coastal Dune Heath & Associated Plant Communities



Acacia sophorae



Aotus ericoides



Xanthorrhoea resinosa



Hibbertia scandens



Carpbrotus glaucescens



Lomandra longifolia



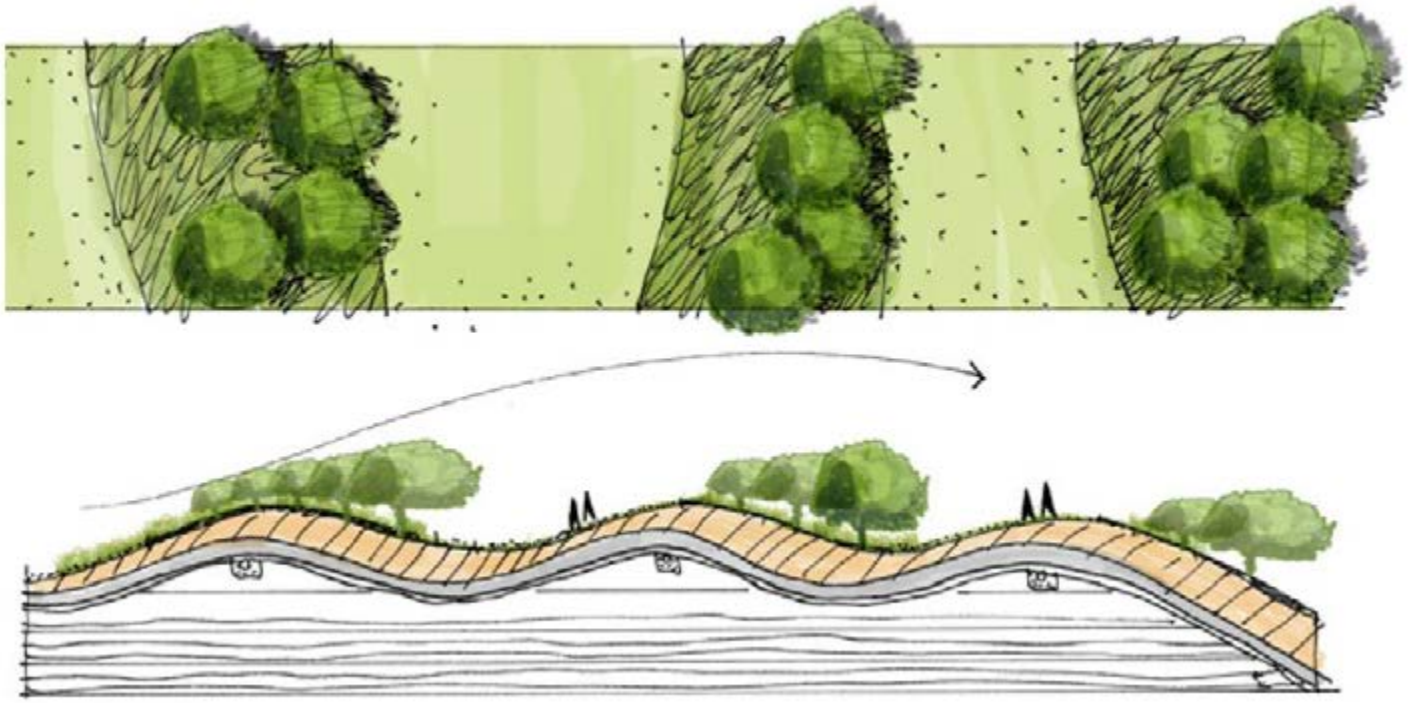
Westringia fruticosa



Dianella caerulea

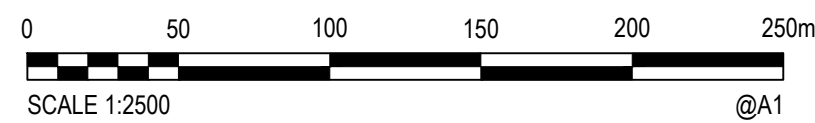
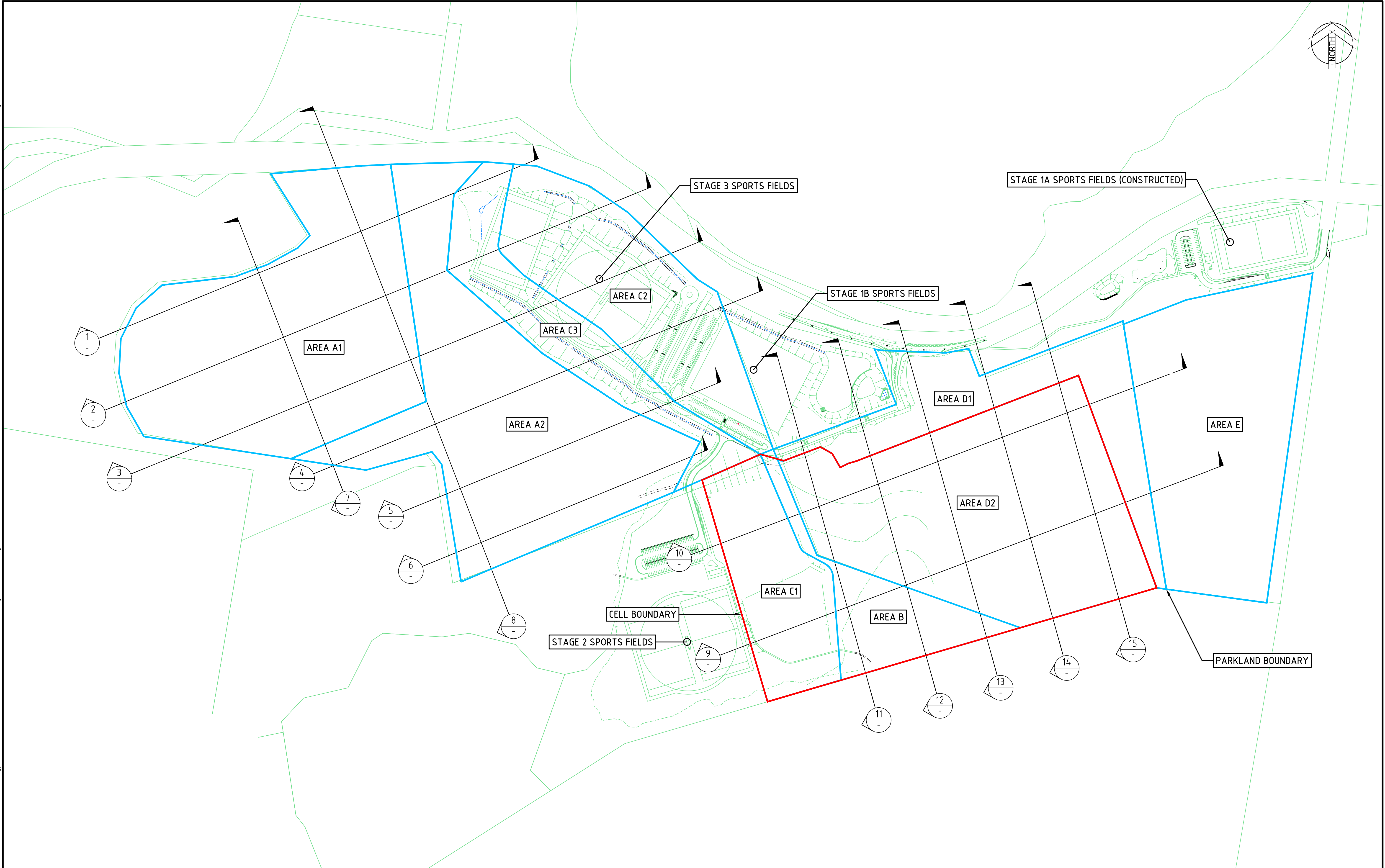


Poa labillardiera



APPENDIX 2

XREFs: KLF VOLUMETRIC SURVEY, JUNE 2016, m; ACAD-XREF-Cadastral for Green with excess bdy, 170707 DEPTH TO FSL TO CCL; 170707 DEPTH TO FSL TO CCL AREA D
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DATE PLOTTED: 26 August 2020 4:01 PM BY: HAYDEN DAVENPORT



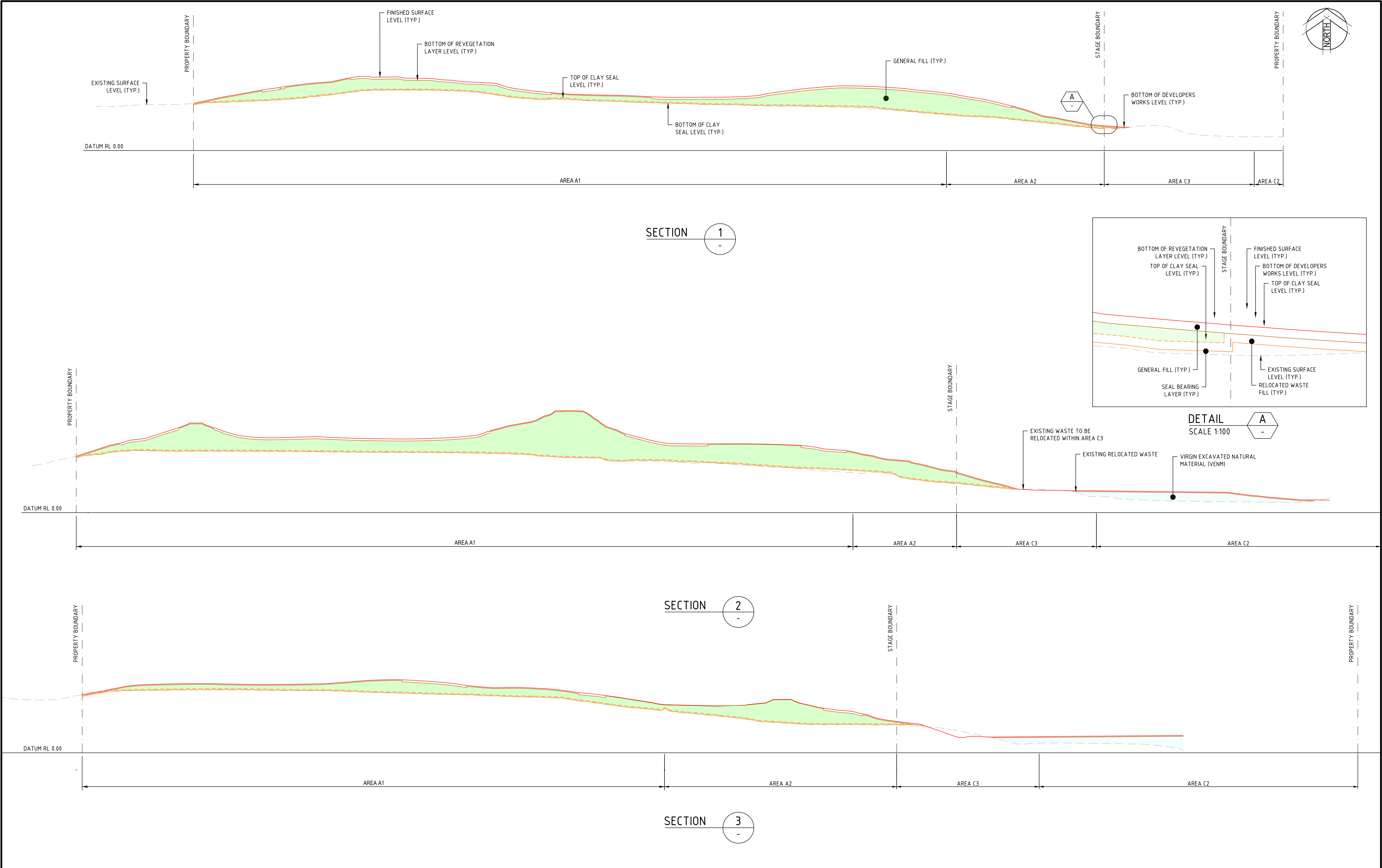
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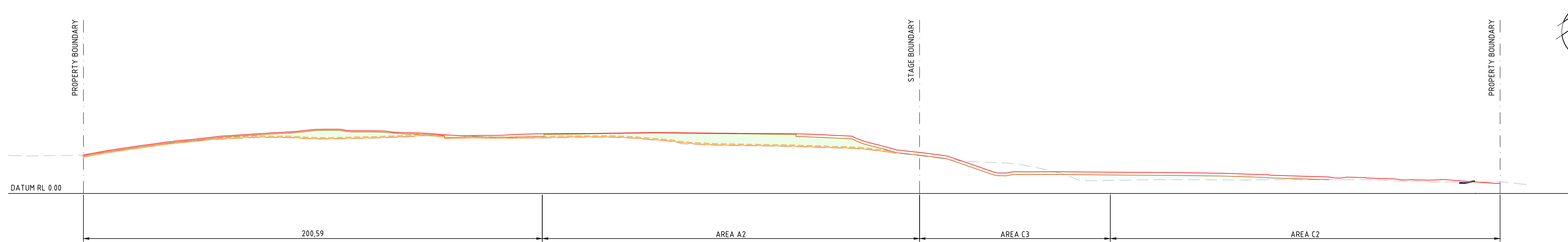
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Drawing Number				Revision
89913035-SK-108				2

DATE PLOTTED: 26 August 2020 4:01 PM BY: HAYDEN DAVENPORT
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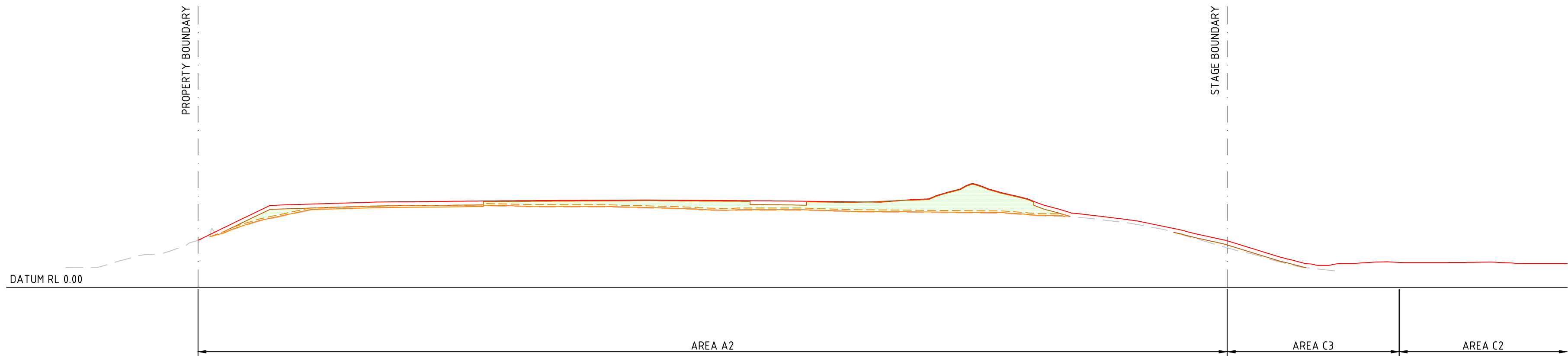


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Drawing Number 89913035-SK-108					

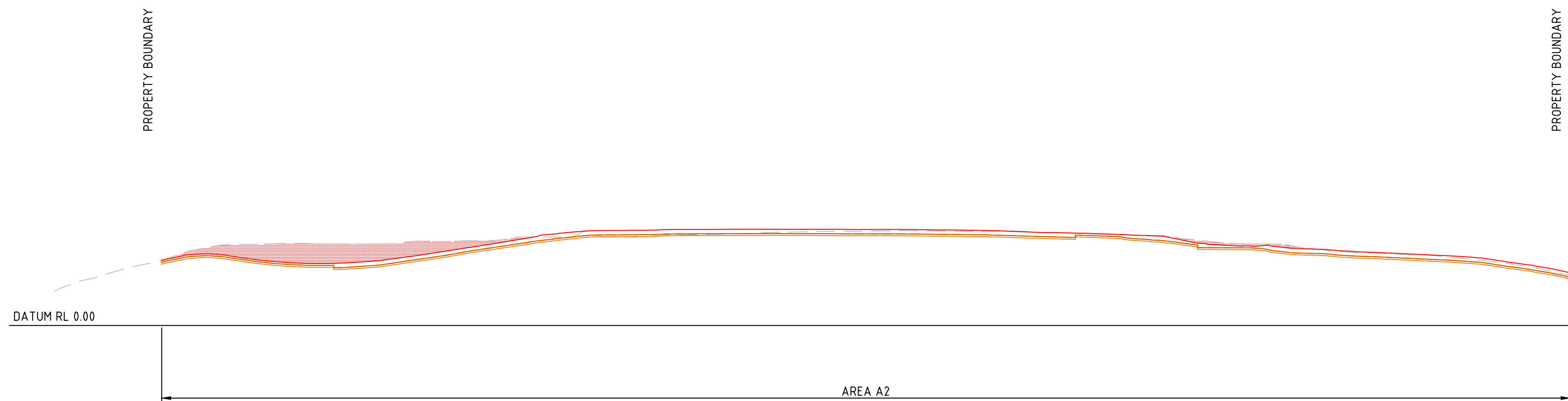
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SECTION 4



SECTION 5



SECTION 6

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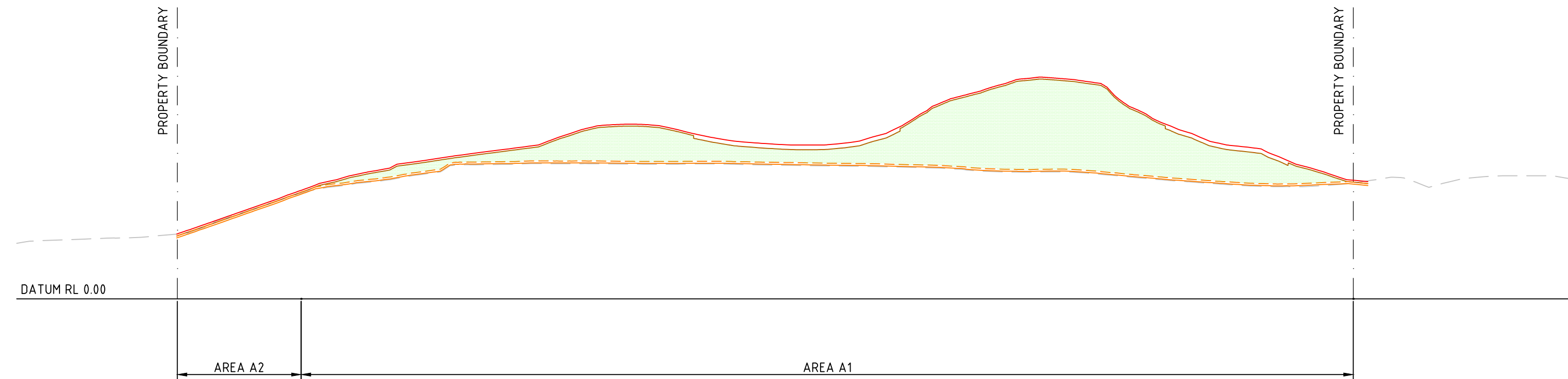
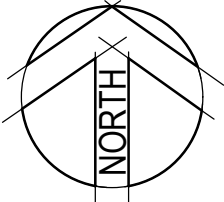


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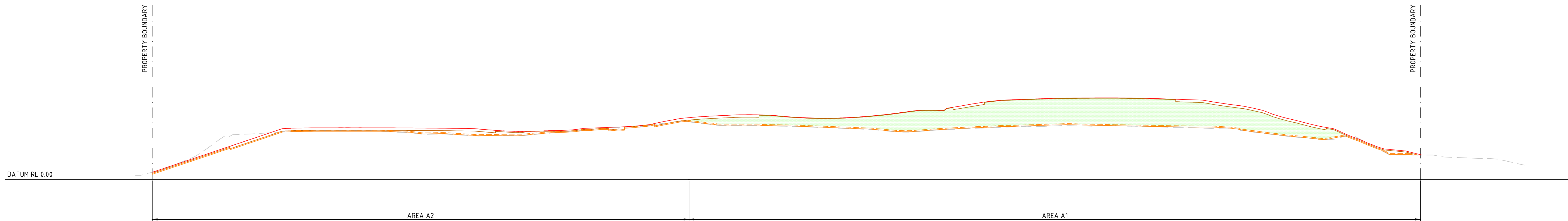
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KURNELL PENINSULA			
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Drawing Number			Revision
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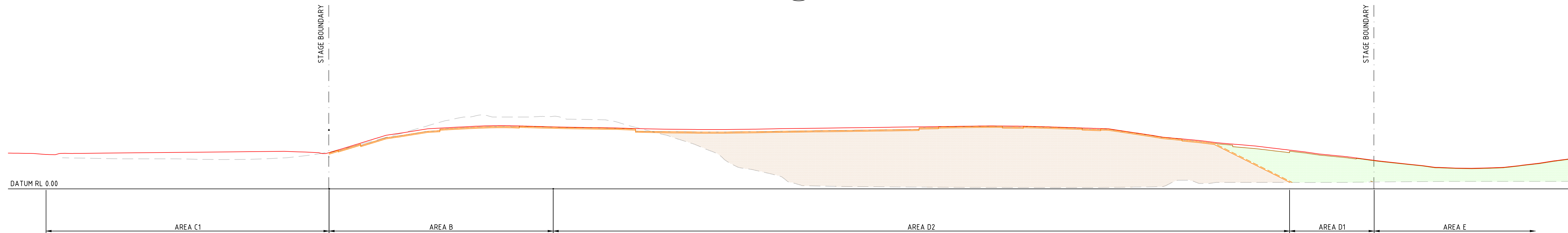
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SECTION 7



SECTION 8



SECTION 9

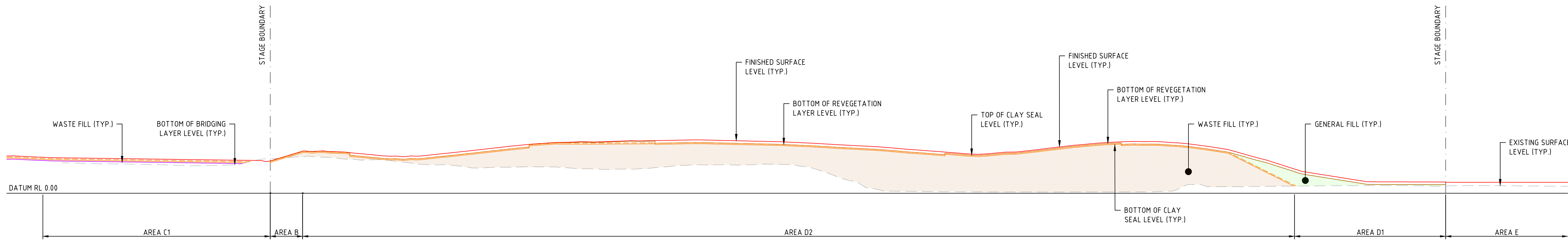
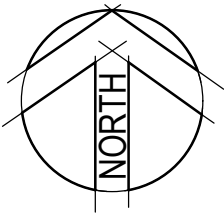
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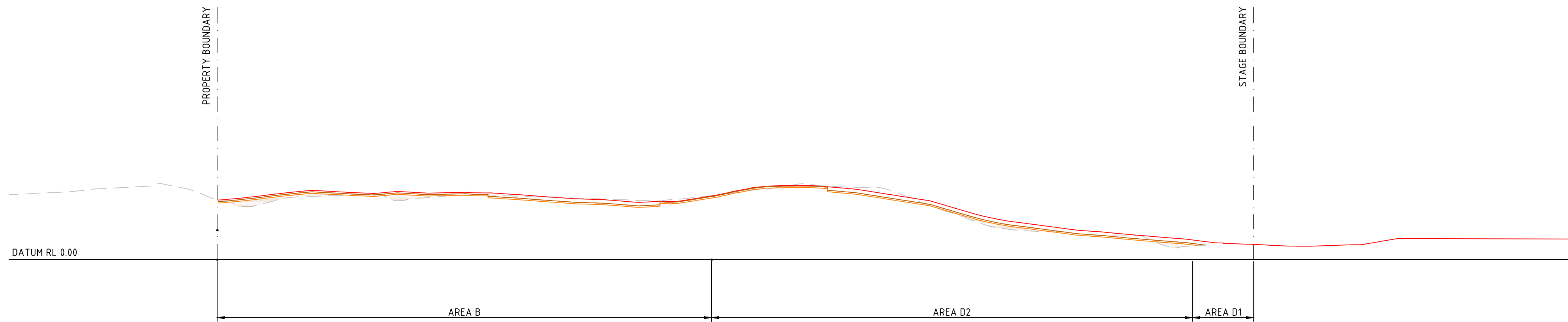
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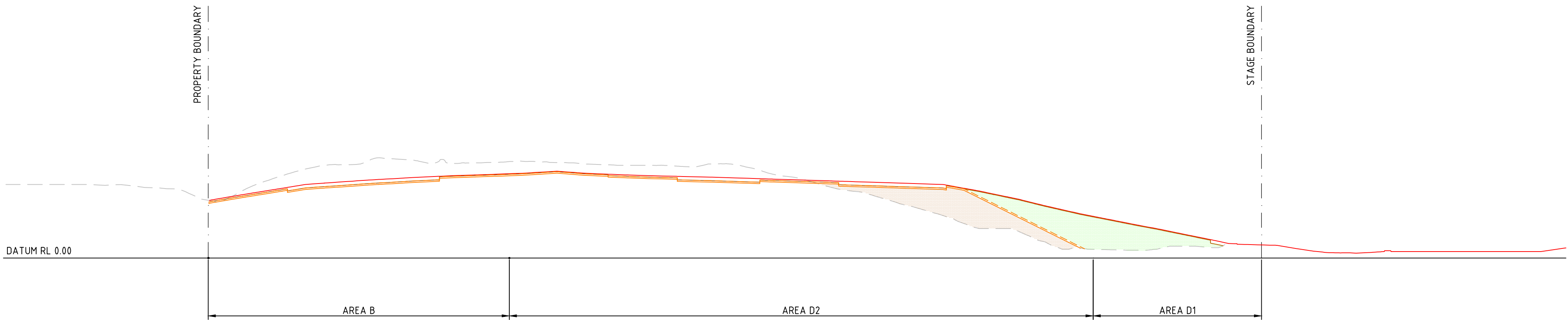
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SECTION 10
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SECTION 11
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SECTION 12
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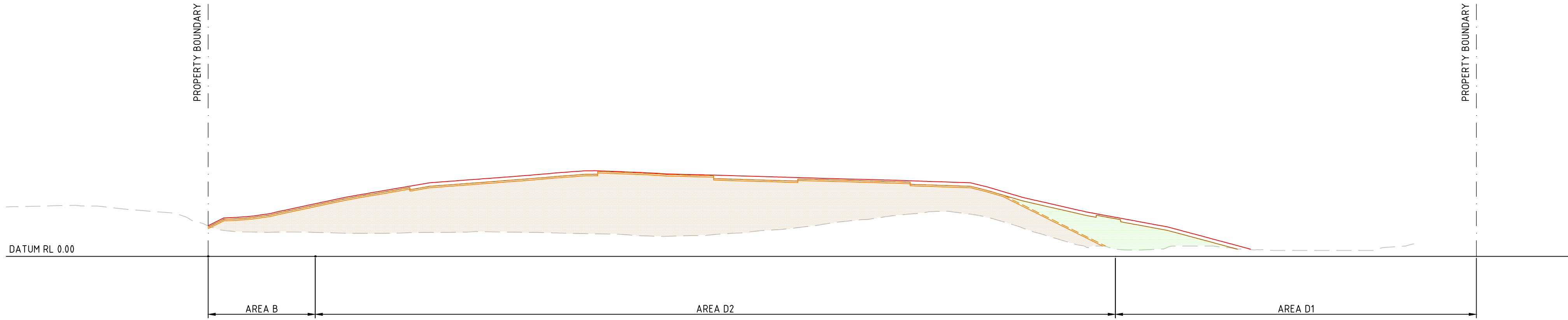
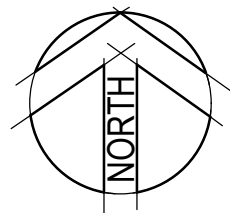
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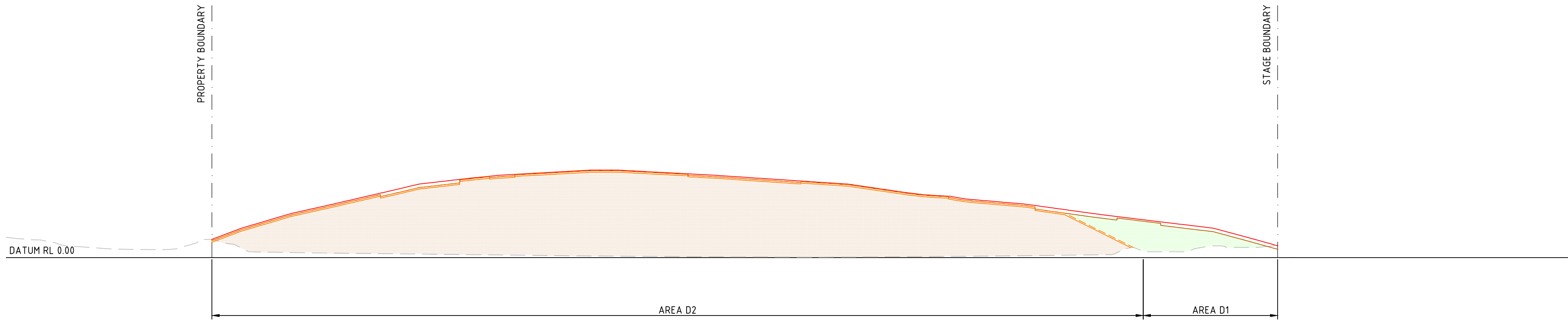
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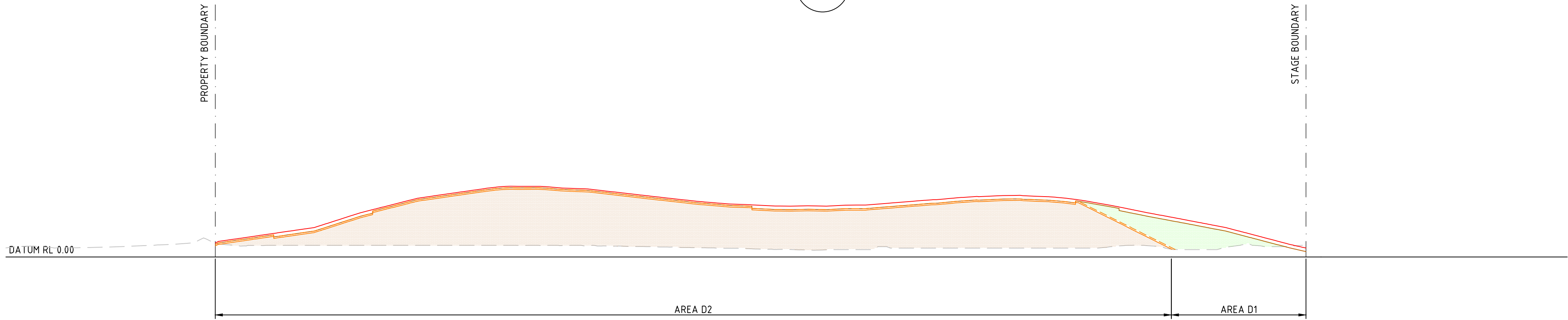
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SECTION 13
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SECTION 14
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SECTION 15
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KURNELL PENINSULA SITE SECTIONS SHEET 5			
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