Douglas Park Drive Strategic Design Stage 1

27 November 2025

Prepared for:

Wollondilly Shire Council

Prepared by:

Stantec Australia Pty Ltd

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Prepared by ______________________________
(signature)
David Ronchi

Reviewed by ______________________________
(signature)
Robert De Jong

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Abbreviations

TfNSW	Transport for New South Wales
m bgl	Meter below ground level
SRA	Slope Risk Assessment
WSC	Wollondilly Shire Council
DPD	Douglas Park Drive
HCCL	Harris Creek Cliff Line
TARP	Trigger Action Response Plan

1.0 INTRODUCTION

Stantec Australia Pty Ltd (Stantec) has been engaged by Wollondilly Shire Council (WSC) (the client) to undertake strategic design assessment to remediate existing failures and safety concerns along Douglas Park Drive, Douglas Park NSW.

The project location is provided below in Figure 1-1 below with aerial imagery from (Nearmap, 2025).

Figure 1-1– Project area

1.1 AVAILABLE INFORMATION

The following reports have been referenced while preparing this report:

- Douglas Partners "Geotechnical Inspection, Douglas Park Drive, Douglas Park" reference 20455B and dated 17 June 1999
- Douglas Partners "Geotechnical Inspection, Douglas Park Drive, Douglas Park" reference 20455B and dated 5 August 1999
- GHD Geotechnics "Appin Colliery, Area 9, Harris Creek Cliffline, Douglas Park, Geotechnical Hazard Mapping" reference 21/19715/01/BA306 Rev C and dated 20 July 2011
- South32 Illawarra Coal Appin Mine "Harris Creek Cliff Line Management Plan" reference revision 2 dated 24th August 2016.

- Coffey "Wollondilly Shire Council, Douglas Park Drive, Douglas Park, NSW, Geotechnical Investigation" reference GEOTWOLL03882AB-AARev1 and dated 8 May 2017
- SMEC "Downslope Geotechnical Assessment, Douglas Park Drive, Douglas Park NSW" reference 30012261.002 and dated 3 July 2018
- SMEC "Upslope Geotechnical Assessment, Douglas Park Drive, Douglas Park, NSW" reference 30012261.001 and dated 21 June 2018
- Ecoplanning "Review of Environmental Factors, Douglas Park Drive, Douglas Park, NSW" reference 2019-023 dated 31st May 2019.
- SMEC "Construction Completion Report, Douglas Park Drive Remediation" reference 30012261-043 and dated 14 October 2020
- SMEC "Geotechnical Concept Design Development, Downslope Areas, Harris Creek Cliff Line, Douglas Park Drive" reference 30012261.007 and dated 11 August 2023
- SMEC "Geotechnical Factual Report, Douglas Park Drive CH320" reference 3001261 and dated 25 October 2023
- SMEC Geometric Concept Design Development drawings dated 6 May 2024
- SMEC "Douglas Park Drive – Staging of works with split up of Council costing", 2024
- Stantec "Douglas Park Drive Peer Review" reference 304001630.06 dated 3rd December 2024.
- Stantec "Douglas Park Drive: Management Plan and Trigger Action Response Plan (TARP)" reference 304001630-001 dated 26th February 2025.
- Heritage significance email correspondence:
  - Peter Kabaila to Peter Nunn dated 1th September 2024, "Subject: Heritage Significance of Historic Stone Retaining Walls at Douglas Park".
  - Peter Kabila to Ebony Bambridge dated 14th March 2019, "Subject: Stone Retaining Wall Remediation Works".

2.0 SCOPE OF WORKS

The Harris Creek Cliff Line (HCCL) is a stretch of road which extends from Nepean River causeway to Blades bridge and traverses a steeply sloping area. The road has been under investigation for over 10 years and is subject to ongoing subsidence predictions and assessment due to the proximity to longwall mining operations. Currently part of the road is under traffic control given the narrow clearance, active downslope failure mechanisms and subsequent pavement deformation. The road contains historical drystone walls for long stretches and despite being in very poor condition in places, are now known to be of heritage value and will heavily impact any remediation strategy which causes disturbance. There is significant residential and industrial land development in the area which will increase the traffic volumes currently experienced by the road in the future.

The purpose of this engagement is to provide strategic design services to enable council to select a preferred remediation strategy considering all the appropriate project stakeholders and completing sufficient options assessments of feasibility for constructability and cost.

The following scope of works is presented for the engagement:

- Stage 1:
  - Assimilation of a comprehensive set of data that has already been provided and reviewed at high level. The available data generally includes borehole logs, orthomosaic aerial photography, photogrammetry point cloud, digital surface model, LiDAR survey and slope risk assessments. Interrogation of this data prior to a planned review of the current Slope Risk Assessments (SRA) was undertaken to gain a better understanding of each of the sites.
  - Site visit for SRA mapping to ensure that we have current data on the high risk elements of the slope to enable targeted remedial efforts. In addition, will gain an appreciation of the defects, current condition, site constraints and stakeholder interest.
  - Draft Options Identification: Following the site visit, we will reassess the data collected to date and start to develop the high level options presented in the peer review. We will share the development of these options with WSC progressively. When considering the potential options for each of the sites, cognisance of the requirements of *Technical Direction GTD 2018/001 – RMS 18.746* will be taken. In addition to this technical direction, our approach to options selection and consideration will largely follow the guidance provided in TfNSW's '*Technical Guide for The Selection of Treatments for Slopes and Retaining Structures Reference C-G-002 (GEO 4383)',* a document which we are familiar with and have referred to on numerous past projects. Prepare a Draft Options Identification report that presents strategic options for the sites with limited design and constructability assessments to confirm viability of each of the options. Prepare qualitative cost estimates as a Rough Order of Costs (Very Low to Very High) to allow for comparison of different options.
  - Finalise list of options presented in peer review:
    - Option 1 – Close the road including any associated decommissioning cost, emergency access and ongoing maintenance.
    - Option 2 – Undertake only necessary remediation to stabilise the high risk downslope areas only maintaining the existing road width ensuring that any remediation is compatible with any future widening efforts.
    - Option 3 – Widen the road geometry via construction of new cantilevered section of road supported on the piles (as presented in Coffey report) in combination with upslope rock cutting where feasible.
    - Option 4 – Widen road geometry via deconstruction of historical wall, stabilisation and widening of the road and rebuilding of historical wall as a façade in front of stabilised slopes/new retaining walls.
    - Option 5 – Relocation/realignment of the road.
  - Stantec to support the options assessment workshop with WSC and relevant stakeholders to carry out a Multi Criteria Assessment (MCA). The outcomes are to be included in the Final Options Identification and Assessment Report that will shortlist the options for further consideration**.**
  - WSC will confirm the selected options, and we will be required to prepare a revised cost estimate to complete the next stage of the study.
- Stage 2:
  - Finalise strategic designs, inclusive of geotechnical interpretation, preparation of typical sections, alignment and any other supplementary information.
  - Identify any required additional geotechnical investigation.
  - Prepare a property impact statement.

- Prepare a strategic project cost estimate (P50 & P90) in accordance with TfNSW Project Estimating Manual (we intend to use Commercial & Infrastructure to assist us with this work). As part of this exercise, we will investigate and consider whole of life costs associated with the preferred options.
- Identify future monitoring and maintenance requirements over the design life of the remedial solutions.
- Undertake a constructability assessment.
- Implement Safety in Design procedures.
- Consider environmental impacts.
- Stantec to run an options assessment workshop with WSC and relevant stakeholder to carry out a Multi Criteria Assessment (MCA). The outcomes to arrive at a preferred option for the road.
- WSC will confirm the preferred option.

2.1 ROAD GEOMETRY

WSC representatives have confirmed that the target widened road comprising an 8.65m width from toe of slope as indicted in Figure 2-1 comprising the following:

- 1.0m toe drain.
- 0.5m upslope shoulder.
- 2 x 3.0m travel lanes.
- 0.5m downslope shoulder.
- 0.65m capping beam for installation of guardrail. This detail will depend on the selected option for any widening and may be subject to change.

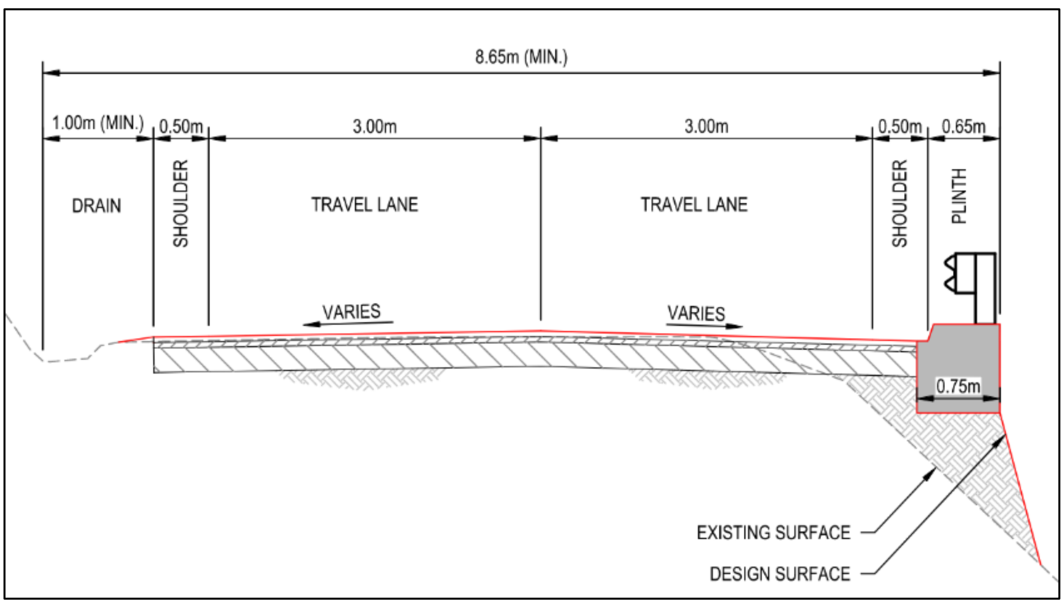


Figure 2-1– Design road geometry for widening

2.2 TRAFFIC VOLUMES

Traffic count completed in 2024 indicate the following:

- AADT 7-day average ranging from 1822 to 1849.
- Average 7-day light vehicles ranging from 1710 to 1733
- Average 7-day heavy rigid ranging from 108 to 113.
- Average 7-day heavy articulated ranging from 2.9 to 3.3.

3.0 SITE DESCRIPTION

3.1 GEOLOGY

Reference to the MinView spatial geology (NSW Department of Primary Industries and Regional Development, 2025) indicates the site is underlain by:

- **Twia:** Ashfield Shale, comprised of black to light grey shale and laminite.
- **Tuth:** Hawkesbury Sandstone medium to coarse grained quartz sandstone with minor shale and laminate lenses with series of massive, graded and cross-bedded sandstone beds.

The regional geology map of the investigation location is presented in Figure **3-1** below.

Figure 3-1– Regional geology

3.2 GEOMORPHOLOGY

Harris Creek is an ephemeral watercourse that drains from a plateau area around the village of Douglas Park to the Nepean River. The Creek becomes deeply incised within the landscape as it approaches the Nepean River. The catchment is predominantly rolling hills associated with the Wianamatta Shale geological unit. At locations the creek becomes narrow and incised it cuts down into the Hawkesbury Sandstone. The cliff-line shape and characteristics are therefore controlled by the cliff-forming units of the Hawkesbury Sandstone. The shape predominantly controlled by regional orientation of joint sets and local bedding defects. The Hawkesbury Sandstone at the base of the creek has a stepped nature due to the pervasive sub-horizontal bedding planes and vertical natural fractures within the rock mass.

The project area is bounded on the west by the south-eastern limits of Douglas Park Township and to the east by the Hume Highway. The upstream limit for the project is Blades Bridge (Moreton Park Road) and the downstream limit is its confluence with the Nepean River. The depth of the Harris Creek gorge (creek line to plateau) varies from about 50m at the Nepean River cliff-line to about 20m depth at Blades Bridge.

The height of the cliff-line above the roadway of Douglas Park Drive similarly varies from 47m to 6m, between the Nepean River cliff-line and Blades Bridge respectively. As the height of cliff above the road decreases, towards Blades Bridge, the height of cliff or embankment below the road increases. Blades Bridge is elevated across Harris Creek at a height of about 15m. Douglas Park Drive traverses the cliffline on the western bank of Harris Creek.

3.3 HERITAGE DRYSTONE WALLS

WSC has received the following advice from Black Mountain Projects Pty Ltd from Peter Kabaila in an email dated 11th September 2024 regarding the historical drystone retaining wall in the area:

“Given their potential heritage value, it would be prudent for both the Council and the community to treat these walls as heritage assets. I recommend two potential approaches for their conservation:

1. ***Retention and Repair:*** *Where feasible, retaining and repairing the original stonework coursing should be the first option.*
2. ***Reconstruction with Reinforced Support:*** *If the walls are unstable or have lost structural integrity, and a new reinforced concrete retaining wall is necessary, the original stone blocks should be carefully numbered, set aside, and reinstalled as a facing for the new concrete wall. This approach retains the historic appearance while ensuring structural stability.”*

The drystone walls vary from 1m to 6m in height and can be found from CH220 to CH530 intermittently. Review of the 3d model has identified the following wall extents and heights:

- CH230-270, maximum height of wall 6m.
- CH350-380, maximum height of wall 1.5m.
- CH380-440, maximum height of wall 4.0m.

- CH450-470, maximum height of wall 6m.
- CH480-515, maximum height of wall 6m which includes a counterfort drystone wall placed in front of the original wall.

4.0 SLOPE RISK ASSESSMENT

Simplified Slope Risk assessment was undertaken by Stantec on 31st March and 1st April 2025. The site was divided into 13 zones based on geological features, retaining structures and typical geometry.

The ARL for any given site is determined by using the following parameters:

- P(d) = Probability of Detachment
- P(t) = Travel Distance (interaction with road)
- L = Likelihood = P(d) x P(t)
- T = Temporal Probability (from AADT)
- V = Vulnerability
- C = Consequence Category ARL = Assessed Risk Level

For any one slope area, the Assessed Risk Level is the lowest overall score (highest risk returned).

Typically, RMS adopt a staged management for each increased Assessed Risk Level, comprising:

- **ARL5** – (Best) Expectation of a new road. No action taken. Observe as part of annual maintenance
- **ARL4** – Minimum expectation of a new road. Observe / Inspection as part of annual maintenance
- **ARL3** – Hazards present that have higher potential to develop. Investigation and monitoring program considered and often applied. Some remedial treatment applied. Review SRA regularly.
- **ARL2** – Under close watch an on-priority list for formal remedial treatment to reduce ARL to 4 or better
- **ARL1** – (Worst) Requires immediate remediation

4.1 DRYSTONE WALLS

Based on the SRA Version 4 the following guidance is provided for assessing drystone walls:

- *Masonry walls, particularly when unmortared (“drystone”), are prone to brittle failure under load. Walls of this type were commonly used to retain road embankments in the 19th and early 20th centuries and were still being constructed in some areas until about 1960.*
- *For cases where the mechanism is triggered by live loading by traffic – eg some retaining structures, especially unmortared masonry (“drystone”) walls and some embankments - a different approach is required, as the element at risk is necessarily present (to act as the trigger) and the equivalent of P(t) is therefore 1. P(d) in this case is a compound probability with two components:*

- *Probability that a load at a given point will trigger a failure – P(d1)*
- *Annual probability that the load will be present at that point – P(d2)*
- *The potential for failure under live loading depends critically on the location of the load.*

SRAs have considered the above guidance when assessing ARLs.

4.2 RESULTS

An SRA was undertaken for the 13 zones, which are summarised in table 4.1 below. The associated sketches and photos for this slope feature are provided in Appendix A.

Table 4-1: SRA Results

Zone	Chainage (m)	ARL	Comments
1	0-160	ARL4	2 lanes
2	160-225	ARL4	2 lanes
3	225-270	ARL3	1 lane
4	270-315	ARL4	1 lane
5	315-330	ARL1	1 lane
6	330-340	ARL4	1 lane
7	340-370	ARL5	1 lane
8	370-430	ARL3	1 lane
9	430-450	ARL1	1 lane
10	450-470	ARL5	1 lane
11	470-480	ARL2	1 lane
12	480-515	ARL1	1 lane
13	515-530	ARL3	1 lane

The following hazards were noted:

- Historic drystone wall showing signs of minor to significant stress ranging from cracked sandstone blocks to bulging and sliding mechanisms.
- Historic "second skin" drystone wall between chainage 485-510 appears to be sliding downslope away from the original drystone wall, based on observations of installed crack monitors.
- A privet tree was growing in the upper section of drystone wall which will eventually lead to blocks being dislodged through root jacking in one particular location. There are also numerous trees which have established at the base of the wall.
- Downslope sandstone cave features showed signs of significant stress with cracking and evidence of previous failure through bedding planes.
- Pavement stress evident along the carriageway including slumping and cracking.

Additional observations that were noted include:

- WSC have implemented traffic segregation measures including placement of a concrete berm in one location and several areas partitioned off using flexible bollards bolted into the road surface to delineate traffic off the crest of the embankment.
- A 3-tonne gross weight limit is currently imposed across the site due to the causeway crossing the Nepean River. It should be noted however, up to class 10 vehicles have been detected in traffic count data.
- Culverts appeared working and relatively free of debris.
- No underground services were identified in a Before You Dig Australia search, however one white conduit was identified from CH550 to CH530 and may be associated with ongoing subsidence monitoring.
- Centreline markings stop at chainage CH236 where signals control the one-way flow of traffic up to chainage CH545.
- Scour on the toe drain was observed.
- Large voids under the main sandstone overhang section were observed

4.3 FAILURE MECHANISM

- Drystone walls are prone to brittle failure under load. The likelihood of a retaining wall failing under live loading is relative to the ratio of the load distance from the toe of the wall. It should be mentioned that all drystone walls were measured with a batter angle at or below 80 degrees, with 80 degrees typically being the point where walls become subject to overturning.
- Root jacking occurs when a tree begins to grow between drystone blocks or in defects of a rock mass. This is evident at CH436 where a privet with an established root system was identified to be growing in a void in the drystone wall within the upper section of wall. There are also numerous trees which have established at the base of the wall.
- Potential for translational failure between fill and colluvium.

4.4 FUTURE TRAFFIC VOLUMES

WSC have advised that ongoing land development in the Wilton/Appin area will likely result in increased road traffic volumes on Douglas Park Drive that have not been considered with the current SRA assessment. Allocation of temporal probability rating based on traffic volumes is provided in Table 4-2 below.

Table 4-2: Allocation of Temporal Probability Rating by Traffic Volumes

Traffic volumes (Vehicles/Land/Day)	Temporal Probability Rating
0 – 30	T5
30 - 270	T4
270 - 2,600	T3
2,600 - 17,500	T2
>17,500	T1

The temporal probability is in turn used with the vulnerability to obtain the consequence category and ARL as indicated in Table 4-3 and Table 4-4 below.

Table 4-3: Vulnerability ratings for embankment failures

Table 41. Extended Vulnerability Table - Vehicles Impacting Voids or Stepped Surfaces			
Void or Surface Type	**Posted Speed Limit**		
	Highway Speeds (100 – 110 km/hr)	**Urban Speeds (60 – 80 km/hr)**	**Low Speeds (≤ 50 km/hr)**
Deep, narrow void	V1	V2	V3
Shallow void (0.2 – 0.5 m step)	V2	V3	V4
Stepped surface (0.1 – 0.2 m steps)	V3	V4	V5
Irregular surface (steps < 0.1 m)	V5	V5*	V5*
Shallow void with guardfence or wire rope barrier	V4	V4	V4

Table 4-4: Consequence matrix and ARL matrix

	Table 46. Consequence Matrix for Risk to Life				
	Temporal Probability of an Individual Being Present at the Time of Failure				
Vulnerability	**T5**	**T4**	**T3**	**T2**	**T1**
V1	C4	C3	C2	C1	C1
V2	C4	C3	C2	C1	C1
V3	C5	C4	C3	C2	C2
V4	C5	C5	C4	C3	C3
V5	C5	C5	C5	C4	C4

	Table 47. Assessed Risk Level Matrix				
	Consequence Class				
Likelihood	**C5**	**C4**	**C3**	**C2**	**C1**
L1	ARL3	ARL2	ARL1	ARL1	ARL1
L2	ARL4	ARL3	ARL2	ARL1	ARL1
L3	ARL5	ARL4	ARL3	ARL2	ARL1
L4	ARL5	ARL5	ARL4	ARL3	ARL2
L5	ARL5	ARL5	ARL5	ARL4	ARL3
L6	ARL5	ARL5	ARL5	ARL5	ARL4

A high level sensitivity analysis has been carried out to confirm at what point traffic volumes impact the final Assessed Risk Level (ARL) and is presented in Table 4-5 below.

Table 4-5: SRA sensitivity to traffic volume increase

Zone	Chainage	Existing geometry Current traffic volume (Vehicles/Lane/Day)	Current ARL	Anticipated total volume (Vehicles/Lane/Day) to increase ARL	Resultant ARL from traffic volume increase
1	0-160	925	ARL4	2600	ARL3
2	160-225	925	ARL4	2600	ARL3
3	225-270	1849	ARL3	2600	ARL2
4	270-315	1849	ARL4	2600	ARL3
5	315-330	1849	ARL1	2600	ARL1*
6	330-340	1849	ARL4	2600	ARL3
7	340-370	1849	ARL5	2600	ARL4
8	370-430	1849	ARL3	2600	ARL2
9	430-450	1849	ARL1	2600	ARL1*
10	450-470	1849	ARL5	2600	ARL4
11	470-480	1849	ARL2	2600	ARL1
12	480-515	1849	ARL3	2600	ARL2
13	515-530	1849	ARL1	2600	ARL1*

* No increase as risk level at maximum already

In administering the TARP, any increased traffic volumes and subsequent increase in ARL would need to be reflected in the TARP.

In lieu of the above assessment due to potential traffic increase in the future, the following sections of report are discussed in relation to the current ARLs assessed.

5.0 SLOPE DOMAINS

Options assessment has required slope domains to be created to group similar features and opportunities for treatment.

Table 5-1: Slope Domains

Domain	Chainage from	Chainage to	Length (m)
1	225	280	55
2	280	315	35
3	315	330	15
4	330	370	40
5	370	430	60
6	430	570	140
		Total	345

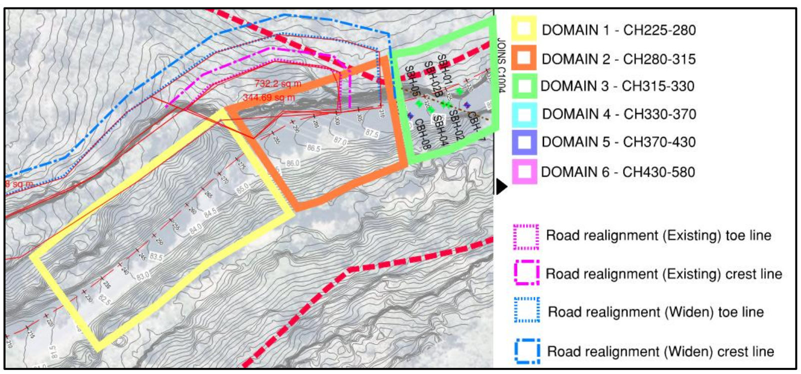


Figure 5-1– Slope domain 1, 2 & 3

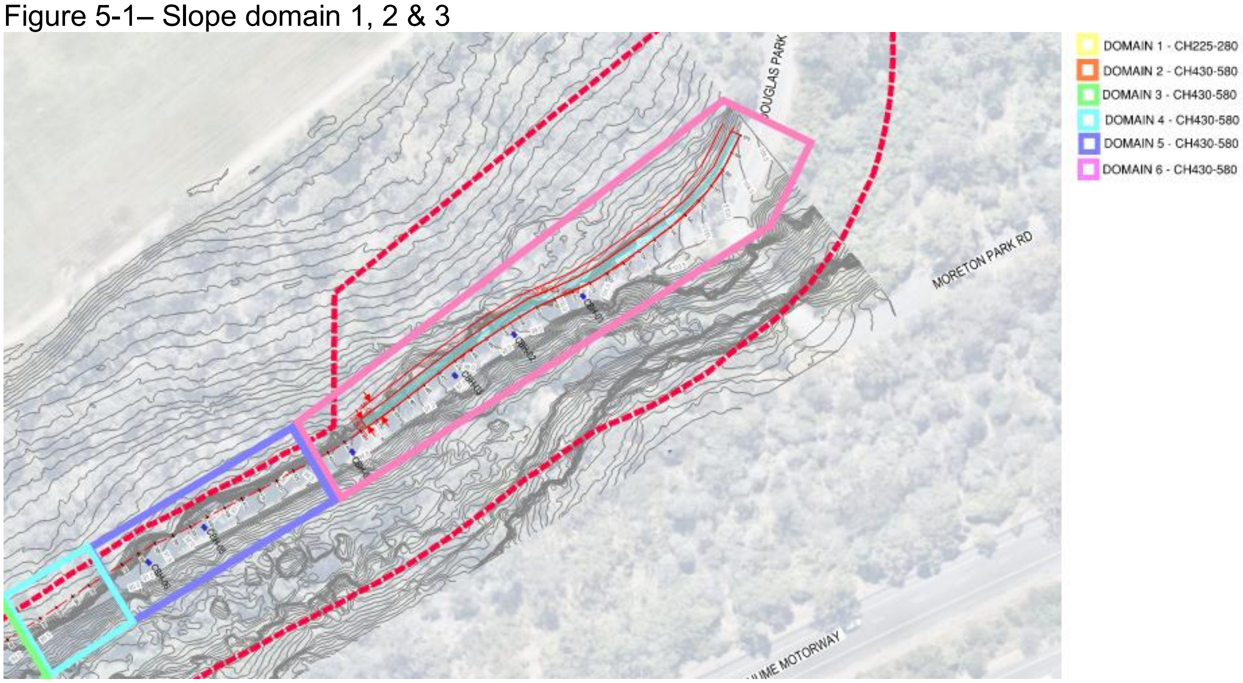


Figure 5-2– Slope domain 4, 5 & 6

5.1 DOMAIN 1

This slope domain contains SRA zones 3 and comprises maximum **ARL3**. Start of single lane road at chainage CH225 with downslope embankment comprising fill placed on colluvial material which overlays sandstone. The embankment is heavily vegetated with ferns and small trees which will help anchor soil and reduce erosion.

This domain is immediately downslope of the existing track upslope and presents favourable conditions for an upslope widening. The existing geometry largely achieves the target widening geometry of 8.65m currently.

5.2 DOMAIN 2

This slope domain contains SRA zones 4 and comprises maximum **ARL4**. Some pavement cracking previously noted at CH 270-290, suggesting some slope creep may be present. The existing geometry largely achieves the target widening geometry of 8.65m currently.

The upslope access track terminates prior to starting this domain and steep sandstone cliffs up to 20m in height slope at 75 to 80 degrees.

5.3 DOMAIN 3

This slope domain contains SRA zones 5 and comprises and **ARL1.** Previous assessments in the area identified an abrupt change in the underlying ground conditions caused by a *'buried cliff line'*. Fill material comprised steeply sloping and, in some cases, undercut boulder stacks are in direct contact with vertical sandstone outcrop.

The upslope domain comprises steep sandstone cliffs up to 20m in height slope with large sandstone overhangs.

Figure 5-3– Previously interpreted buried cliffline

5.4 DOMAIN 4

This slope domain contains SRA zones 6 and 7 and comprises maximum **ARL4**. A single lane embankment which appears constructed on sandstone rockfill approximately 6m high transitioning to a dry-stone wall with typical height of approximately 2-2.5m.

The upslope domain comprises and steep sandstone cliffs up to 15m in height slope with large sandstone overhangs.

5.5 DOMAIN 5

This slope domain contains SRA zones 8 and 9 and comprises of dry-stone wall with typical height of approximately 2-2.5m and around 60-70 degrees. There is a small bulge in the wall around CH420, and some blocks are cracked.

The upslope domain comprises and steep sandstone cliffs ranging in height from 10 to 15m with large sandstone overhangs grading to slopes with angles up to 80 degrees.

5.6 DOMAIN 6

This slope domain contains SRA zones 10 and 13 and comprises of dry-stone wall starting at approximately 2m in height and increase with chainage to typical heights of approximately 4 to 6m and around 60-70 degrees. Drystone wall transitions to approximately 3m of sandstone block fill between carriageway and underlaying cave feature. A cave features protrudes 1.5m, with an overhang weighing approximately 45 tonnes observed with some brittle tensile cracking through the overhung section.

The upslope domain comprises and steep sandstone cliffs ranging in height from 5 to 10m with slope angles ranging from 60 to 80 degrees.

6.0 STRATEGIC DESIGN OPTIONS

The preferred options from the peer review were identified as follows:

- Option 1 – Close the road including any associated decommissioning cost, emergency access and ongoing maintenance.
- Option 2 – Undertake only necessary remediation to stabilise the high risk downslope areas only maintaining the existing road width ensuring that any remediation is compatible with any future widening efforts.
- Option 3 – Widen the road geometry via construction of new cantilevered section of road supported on the piles (as presented in Coffey report) in combination with upslope rock cutting where feasible.
- Option 4 – Widen road geometry via deconstruction of historical wall, stabilisation and widening of the road and rebuilding of historical wall as a façade in front of stabilised slopes/new retaining walls.
- Option 5 – Relocation/realignment of the road.

Additional combinations have been considered where considered feasible based on slope mapping and interrogation of the 3D model to enable for comparison of options. The final list of options considered in the MCA for Stage 1 strategic design is as follows:

- Option 1 – Close the road including any associated decommissioning cost, emergency access and ongoing maintenance.
- Option 2 – Undertake only necessary remediation to stabilise the high risk downslope areas only maintaining the existing road width ensuring that any remediation is compatible with any future widening efforts.
- Option 3 – Widen the road geometry via construction of new cantilevered section of road supported on the piles (as presented in Coffey report) or soil nails in combination with upslope rock cutting where feasible.
- Option 4 – Relocation/realignment of the road (single lane).
- Option 5 – Relocation/realignment of the road (dual lane)

6.1 OPTION 1 – CLOSE THE ROAD

There will be ongoing maintenance for a close road option and decision about whether it would remain open to pedestrian traffic and the level of upkeep and maintenance on the heritage drystone walls would need to be assessed. Preliminary pricing has been carried out including decommissioning cost. Preliminary discussions have indicated that emergency access may be required. This likely isn't feasible and should emergency vehicle access be required, remediating high risk options as per option 2 as a minimum should be selected.

Full closure would pose a risk of diverting traffic elsewhere that may increase traffic volume onto other roads and also result in a diversion of approximately 11km.

6.2 OPTION 2 – MAINTAIN EXISTING GEOMETRY AND REMEDIATE HIGH RISK AREAS

This options is to maintain the existing road geometry and stabilise the high risk zones. Only the high risk zones from the most recent mapping with ARL1 or ARL2 are considered for remediation as presented in Table **6-1**.

Table 6-1: High risk zones

Zone	Domain	Chainage (m)	ARL	Length (m)
5	3	315-330	ARL1	15
9	6	430-450	ARL1	20
11		470-480	ARL2	10
13		515-530	ARL1	15
			Total	60

There are multiple sub options for treatment strategies as discussed below.

6.2.1 Upslope cutting

Broadly, the existing upslope cutting has been grouped based on existing geometry comprising the following features:

- Vertical cliff heights up to 20m in height between CH280 and CH315. (Domain 2).
- Significant rock overhangs and cliff heights up to 15m between CH320 and CH430. (Domain 3,4 and 5)

Given the significant constraints for any upslope widening works based on the geometry, no upslope cutting work has been nominated in these domains (Domain 2, 3, 4 and 5). The option for upslope cutting work is limited to Domain 1 (CH225-280) and Domain 6 (CH430-570) as the cutting heights reduce below 10m and the slope geometry tends to be laid back more gently with the natural slope behind the existing crest conducive to cutting works. There are no high risk zones within Domain 1 so no upslope cutting option is presented for maintaining the existing road geometry. Within Domain 1, the upslope profile is the downslope for the existing unfinished track upslope. Locations of these domains have been presented in Figure **5-1** and Figure **5-2**.

Within Domain 6, the following considerations have been made:

- Widen upslope 2.5m to recreate the existing road geometry for single lane to avoid the high-risk downslope hazards.
- Preliminary slope angle of 0.5H:1V (63 degrees) has been assumed although following more detailed rock mapping and stability assessments, could be stood up steeper and estimated rock volumes reduced.
- For avoidance of high risk features it isn't readily feasible to widen upslope over discrete lengths and likely that the whole length in Domain 6 will need to be widened to avoid the high-risk areas.

The mapped cave features downslope of the road would still need to be remediated given the active mechanisms present and would require either steel props or mass grouting to stabilise.

6.2.2 Soil nail retaining walls

Broad assumptions as follows:

- Typically nails will be 1.5m x 1.5m vertical and horizontal spacing.
- Shotcrete shall be used to pin the face during progressive removal of drystone wall blocks and replacement of sandstone blocks to be attached to the shorcrete face via brick ties or similar.

6.2.3 Piled slab

It is expected that installation of any piles will need to be carried a minimum distance from any drystone wall to prevent damage will possible piled combinations including the following:

- Soldier pile wall with 600mm diameter reinforced piles to be utilised in areas where no drystone wall was observed or has been damaged beyond the point of repair.
- Piled slab with cantilever over any existing drystone wall.

The backfill material is expected to comprise coarse grained materials and is likely to comprise cobbles and boulders which may dislodge and push the wall out if adequate confinement is not provided. Consideration needs to given to installation of a micropile on the line of piles closest to the drystone wall at closer spacing and larger diameter pile on the line of piles furthers from the drystone wall.

6.2.4 Downslope rockfill

Option of downslope rockfill is proposed within existing boulder stack wall in Domain 3 to but up against the rock outcrop. Other structural treatments considered above will encounter significant constructability challenges with the bouldery nature of the material. This remediation technique will require further acceptance from WSC as may not provide required factor of safety however it is considered to be a robust option for this area given the self-healing nature of the rock. Risk based approach is recommended with site specific design strategy to consider maintenance for any scour events which may require topping up of rockfill.

Further assessment of scour potential at toe of rockfill are required.

6.3 OPTION 3 – WIDEN EXISTING GEOMETRY

This option is provided to widen the existing geometry to the nominated road with of 8.65m as confirmed by the council. A hybrid upslope/downslope option has been proposed in some domains depending on the slope domain to suit the existing slope profile and inferred subsurface profile.

6.3.1 Upslope cutting

Broadly, the existing upslope cutting has been grouped as per discussion above for option 2. Whilst there are no high-risk zones within Domain 1, there is an opportunity here for an upslope cutting option given the favourable upslope conditions. Within Domain 1, the upslope profile is the downslope for the existing unfinished track upslope.

Within Domain 1 and 6, the following have been considered:

- Widen upslope 5m to provide the target road geometry of 8.65m and avoid the downslope high-risk hazards.
- Preliminary slope angle of 0.5H:1V (63 degrees) has been assumed although following more detailed rock mapping and stability assessments, could be stood up steeper and estimated rock volumes reduced.
- For avoidance of high risk features it isn't readily feasible to widen upslope over discrete lengths and likely that the whole length in Domain 6 will need to be widened to avoid the high-risk areas.

The mapped cave features downslope of the road would still need to be remediated given the active mechanism here and would require either steel props or mass grouting.

6.3.2 Soil nail retaining walls

Broad assumptions as follows:

- Typically nails will be 1.5m x 1.5m vertical and horizontal spacing
- Shotcrete shall be used to pin the face during progressive removal of drystone wall blocks and replacement of sandstone blocks.
- Following shotcrete, extension of bars and progressive mass fill with concrete to be undertaken and refix the drystone wall to mass fill concrete.

6.3.3 Pile option

It is expected that installation of any piles will need to be carried a minimum distance from any drystone wall to prevent damage/destabilisation with possible piled combinations including the following:

- Soldier pile wall with 600mm diameter reinforced piles to be utilised in areas where no drystone wall was observed or has been damaged beyond the point of repair.
- Dual pile and reinforced slab option (bridge deck) to be considered where widening over existing drystone wall is required. May need to revise target road width geometry in these areas to minimise works where possible.
- Further refinement of constructability will be required at Stage 2 to consider rig loadings and upslope rock overhang access constraints.
- Piled slab with cantilever over any existing drystone wall.

The backfill material is expected to comprise coarse grained materials and is likely to comprise cobbles and boulders which may dislodge and push the wall out if adequate confinement is not provided. Consideration needs to given to installation of a micropile on the line of piles closest to the drystone wall at closer spacing and larger diameter pile on the line of piles furthers from the drystone wall.

For preliminary pricing purposes, a single soldier pile wall has been considered.

6.3.4 Downslope rockfill

Option of downslope rockfill is proposed within existing boulder stack wall in Domain 3 to but up against the rock outcrop. Other structural treatments considered above will encounter significant constructability challenges with the bouldery nature of the existing embankment material. This remediation technique will require further acceptance from WSC as it may not provide required factor of safety however, it is considered to be a robust option given for this area given the commercial and simple construction benefits as well as the self-healing nature of the rock. Risk based approach is recommended with site specific design strategy to consider maintenance for any scour events which may require topping up of rockfill.

Further assessment of scour potential at toe of rockfill associated with Harris Creek would be required.

6.4 OPTION 4/5 – RELOCATION/REALIGNMENT OF THE ROAD

An existing track and road corridor exists extending east from the intersection of Camden Road and Nepean Street in an easterly direction before swinging to a northerly direction. The following comments are provided for this option:

- Approximate chainage for the upslope track on Douglas Park Drive extends from CH140 to CH310.
- Track width ranges from 6 to 7m starting at the existing council street intersection and terminates approximately 6.5m above the adjacent road level of DPD at approximate chainage CH270.
- General down grade is 10H:1V generally consistent with DPD grading up. Continuing this down grade would intersect with DPD at approximate CH300.

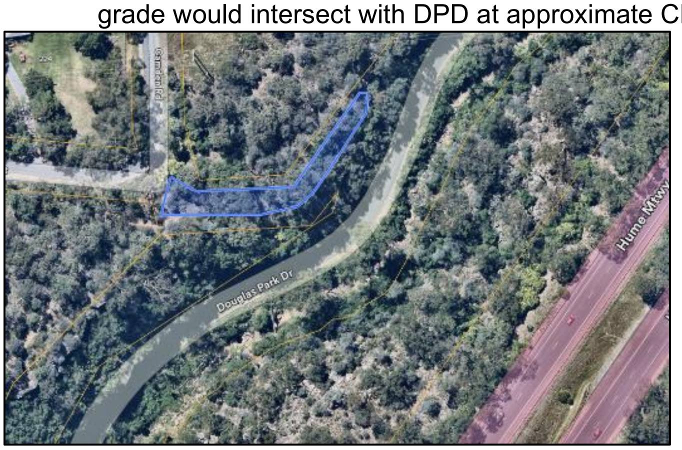


Figure 6-1– Existing track from intersection of Camden Road and Nepean Street.

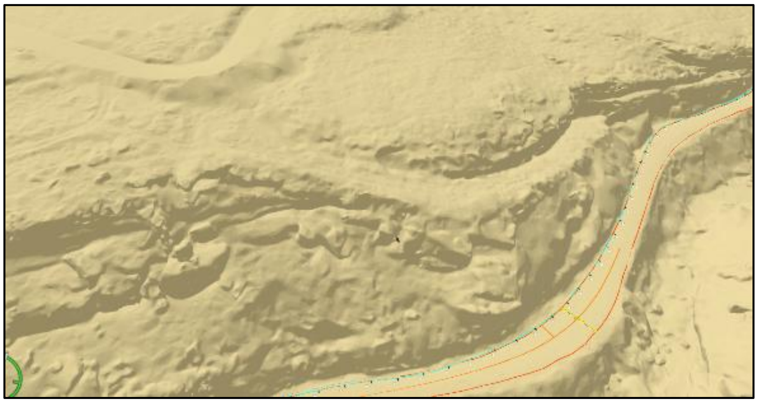


Figure 6-2– Existing track cutting oblique ground model – looking north

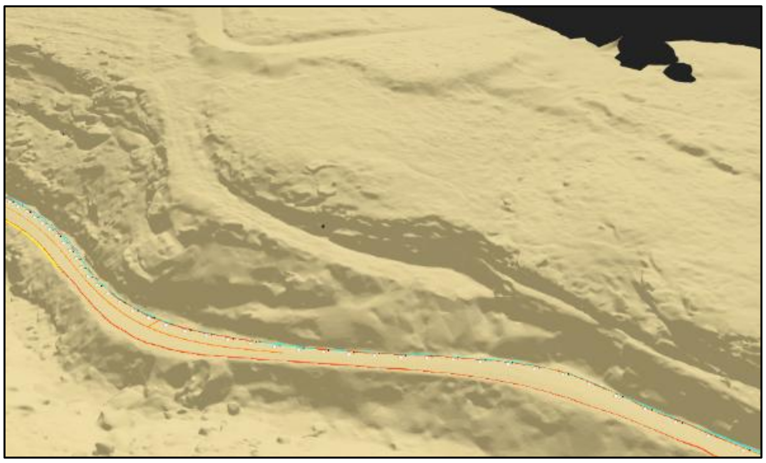


Figure 6-3– Existing track cutting oblique ground model – looking west

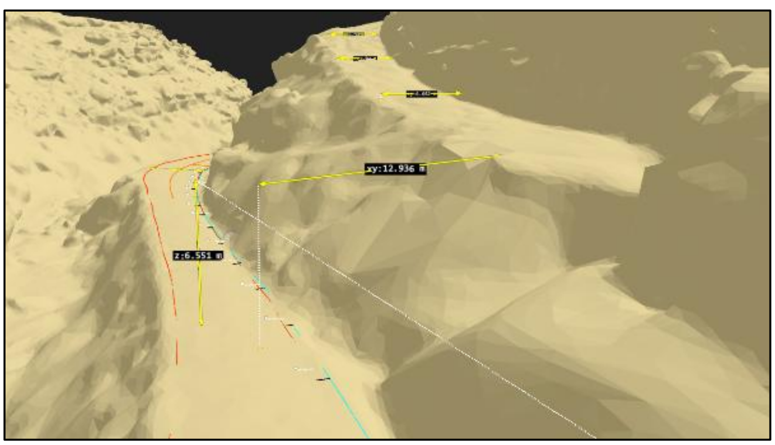


Figure 6-4– Existing track end relative to DPD

7.0 DRAINAGE STRUCTURES

Culvert at chainage CH270 recently cleaned out constructed from sandstone blocks with sandstone lintel known to have partially collapsed.

All drainage structures to be reviewed and replaced where necessary.

8.0 COMMUNITY IMPACT

The following inputs will require consideration for assessing impact of any of the options above on the community:

- It is understood that a significant portion of the road traffic using Douglas Park Drive are not Wollondilly LGA rate payers, rather other people travelling from e.g. Wollongong to Camden.
- Resident vs. non-resident benefits.
- Closure of road community impacts include:
  - traffic flows would increase on alternate routes and would need to be assessed. This has been considered in the road safety impact criteria.
  - Loss of access to heritage walls for maintenance and repair.
  - Consideration for keeping the route open as a shared cycle/pedestrian way to provide access to the river.

9.0 ROUGH ORDER OF COSTS ESTIMATES

A summary of qualitative cost comparison for options is presented in Table 9-1 below. These costs are preliminary in nature and an appropriate level of contingency is indicated in the table. Detailed cost estimates on shortlisted options shall be carried out during stage 2.

Table 9-1: Cost estimates

Option	Description	Contingency (%)	Cost rating
1	Road closure	10	Very Low
2	Maintain existing geometry	30	Low
3	Widen existing geometry	50	Very High
4	Realignment (one lanes)	25	Medium
5	Realignment (two lanes)	25	High

The following broad assumptions were made:

- No piled slab with pile pairs has been considered at this stage and all pile options have assumed a single soldier pile option, this price can be refined at stage 2.

10.0 MAINTENANCE AND REMEDIATION MEASURES

Grout voids or propping as for cave structures on the downslope.

Regular maintenance of slopes in accordance with TfNSW SRA and the site specific TARP should be undertaken with increased frequency of monitoring recommended for higher risk (ARL) slopes.

11.0 CONSTRUCTABILITY ASSESSMENT

11.1 KEY CONSTRUCTABILITY CONSTRAINTS

- From assessment of the exposed Sandstone in HCCL, a suitable piling rig with capacity to penetrate the Sandstone would likely be height constrained to between CH380 to CH550 (low overhanging cliff line between CH320 to CH380). Large plant also has the potential to destabilise the existing dry-stone walls.
- Reconstruction for the drystone walls for any widening works is considered extremely costly and time consuming considered some recent examples of this type of remediation for a culvert located in the Hawkesbury council area. This would likely require all blocks to be numbered and placed back to the same position relevant to other blocks and would required staged stabilisation efforts to be undertaken. This would likely to be soil nailing of the temporary exposed batter following stripping of the blocks and widening of the road, then reattachment of the blocks to the front of the soil nail wall.
- Soil nailing into voided blocky material behind existing drystone walls may result in significant grout loss and leakage to surrounding environment presenting an challenge to manage during construction.
- Pile installation may also be problematic with potential for sharp changes in subsurface strength, e.g. loose colluvial material, then high strength blocks of sandstone. This may result in spinning and inability to maintain design pile alignments. The smaller the piles, typically the less risk involved with the above. Collapse during drilling or blocks falling in from pile sidewall may also be problematic for removal from the hole and cause significant installation delays. As noted in the sections above, the larger footprint of standard piles also may carry as risk of destabilising drystone walls and specific design as to how they would interact with these elements would be required.

12.0 SAFETY IN DESIGN

Safety in design register will be carried out at Stage 2.

13.0 ENVIRONMENTAL IMPACT

The environmental aspects have been identified through a desktop assessment and will be considered during the detailed design for this Proposal. The 'Review of Environmental Factors – Douglas Park Drive, Douglas Park NSW' report (Ecoplanning, 2019) (herein referred to as Douglas Park Drive REF) was also reviewed to understand the potential environmental constraints that may be present at the proposal site. It should be noted that this assessment is over six years old, and the information provided by it may no longer be accurate due to changes in the existing environment and changes in legislation. The Study

Area used for the Douglas Park Drive REF also does not overlay all of the Proposal Area for the options discussed in this report, see Figure 13-1.

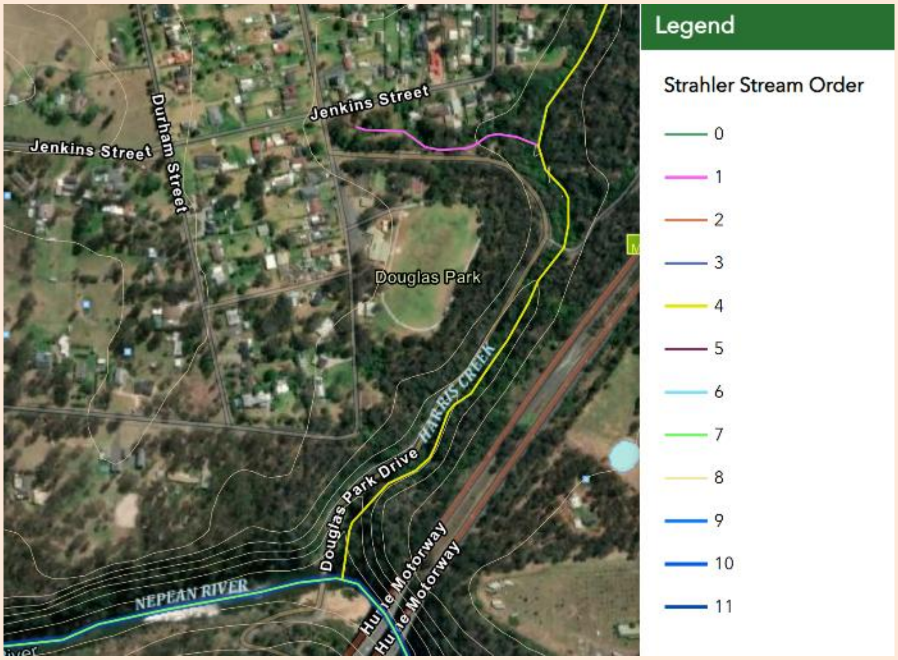
Figure 13-1 Study area from the Douglas Park Drive REF (Ecoplanning, 2019)

The results of the Desktop Assessment and review of the Douglas Park Drive REF have been presented in Table **13-1** below. Following the table, a summary of high risk constraints has been provided.

Table 13-1 Environmental considerations

Utility Type	Impact Considerations	Next Step
Traffic and access	The Proposal Area comprises a section of Douglas Park Drive, an unclassified local road managed by Council, from the causeway (south) crossing the Nepean River to just south of Blades Bridge (north), which is about 550m in length. It is currently managed by traffic signals and water barriers, which are currently empty for higher risk sections. No driveways are apparent within the Proposal Area, however one driveway at 224 Camden Rd, occurs close to the area for Option 4 and 5. Consideration should be made to ensure access is not impacted for this property if either of these options is chosen as the preferred option. Option 1 would involve the closure of the road, and would require commuters that utilise the road to take a detour of approximately 10 minutes. Access to properties would not be impeded by the Option. Options 2 to 5 would likely impact commuters during the construction works due to the requirement for partial and/or full road closures. There would also be an increase to traffic associated with movement of equipment and materials, and construction personnel to the site, however changes to traffic conditions as a result would likely be minor. A Traffic Management Plan would be required for these options.	Traffic Management Plan (TMP) to be prepared if Option 2, 3, 4 or 5 is chosen

Utility Type	Impact Considerations	Next Step
	All options would likely provide an improvement to safety of commuters either through the closure of a potentially dangerous route or through the stabilisation of the road. Not undertaking any option could potentially put users of the road at risk.	
Noise and vibration	Proposed works are yet to be confirmed but understood that standard construction hours of 7am-6pm Monday to Friday would be in place. The closest sensitive receivers to the Proposal are located northwest of the site, along Nepean St and Camden Rd. For the work sites associated with Options 2 and 3, the closet sensitive receiver would be located approximately 100m away, and for Option 4 and 5, would be 50m. The sensitive receivers that may be impacted are residential, with no schools, care centres or business identified nearby. Options 1 would not have any noise or vibration impacts as construction works are not proposed for this option. Any impacts from this option would only be from any ongoing maintenance works which would be minimal considering the road won't be experiencing usage, reducing the need for repairs. The works proposed for Option 2 are considered to be fairly minor. Given the distance to any sensitive receiver and the smaller scale of these works, noise or vibrations impacts are anticipated to be less than Options 3, 4 and 5. Option 3 is located the same distance away from sensitive receivers as Option 2, however, has the potential to generate noise and vibrations at a greater level due to the scale of works proposed, resulting in a greater impact. Depending on the scale of rock cutting that is proposed to take place in the northern section for Option 3, noise generate may reach a level which would require specific mitigation measures, such as restrictions on operating times. Options 4 and 5 would have the greatest impact due to their proximity to sensitive receivers and the works that are proposed. Vegetation clearing and earthworks at Nepean St would result in greater noise generated compared to the other options, in proximity to the residents located along the street and neighbouring streets. Mitigation Measures would be recommended to be implemented in order to reduce the impact the Proposal has upon nearby sensitive receivers. Consultation would be required with the residence that are adjacent to the site and notification to the wider community, regarding work times and expected impacts, would be required prior to the commencement of the works.	Noise and Vibration Assessment to be undertaken for the options to determine the impacts upon sensitive receivers. Consultation with any nearby residence and notification to these wider community, regarding work times and expected impacts, prior to the commenceme nt of any works

Utility Type	Impact Considerations	Next Step
Water quality and hydrology	 **Figure 13-2 Strahler Stream Order** The Proposal Area runs upslope, adjacent to Harris Creek (4^{th} Stahler order) which is a tributary to the Nepean River (7^{th} Stahler order) (shown in Figure 13-2). The Nepean River is also mapped as Riparian Land. Introduction of people, chemicals, vehicles and machinery and the undertaking of works including vegetation clearing and earthworks along Douglas Park Rd could impact the watercourse and water quality through erosion, sedimentation, and introduction of pollutants, and would require the relevant controls to mitigate these impacts. A search of the BOM Atlas of Groundwater Dependent Ecosystems (GDEs) showed that the Proposal Area overlays with areas mapped as 'high" to 'low' potential for GDE's. Option 1 is unlikely to have an impact on the watercourses or water quality, unless it is not maintained and experience significant deterioration. As a result, increased erosion and the potential collapse of the road could occur. Ongoing maintenance would be required as part of this option to prevent this possibility. Considering the scale of works proposed for the remaining options, Option 2 would likely have a minor impact as stabilisation works would only be carried out in areas of need. Option 3 would potentially have the greatest impact as works would occur for a larger section of the road than Option 2, and involve large amount of work down slope of the road, potentially directly impacting the watercourse. Option 4 and 5 would have impacts due to stabilisation works occurring within the road corridor and earthworks on the upslope for the connection into Nepean St, with Option 5 having a greater impact than Option 4 due to the larger area required to accommodate the additional lane.	Erosion and Sedimentation site Controls/ Management Plan installed and developed in accordance with Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines (the Blue Book)

<table>
<tr><th>Utility Type</th><th>Impact Considerations</th><th>Next Step</th></tr>
<tr>
<td>Biodiversity</td>
<td>Option 1 is not likely to have an impact upon biodiversity, provided the road is maintained to prevent erosion and potential collapse. Therefore, it is not discussed further in this section. Vegetation

A review of the State Vegetation Type Mapping (SVTM) was undertaken as part of the desktop Assessment to identify the Plant Community Types (PCTs) that are mapped within the Proposal Area, with the results provided in Table 13-2 below.

Table 13-2 PCTs identified within the Proposal Area based on the SVTM

<table>
<tr><th>PCT ID</th><th>PCT Name</th></tr>
<tr><td>3145</td><td>Cumberland Bangalay x Blue Gum Riverflat Forest</td></tr>
<tr><td>3321</td><td>Cumberland Shale-Sandstone Ironbark Forest</td></tr>
<tr><td>3615</td><td>Sydney Hinterland Apple-Blackbutt Gully Forest</td></tr>
<tr><td>3616</td><td>Sydney Hinterland Grey Gum Transition Forest</td></tr>
<tr><td>4086</td><td>Sydney Coastal Sandstone Riparian Scrub</td></tr>
</table>

While these are the potential PCT at the proposal site based on the most recent mapping (SVTM – version updated in November 2024), the vegetation communities within the Proposal area have previously been ground truthed during the ecology survey for the Douglas Park Drive REF. The results of this survey should be considered over the current SVTM online mapping because they have been ground truthed, so these results are discussed below.

Two native vegetation communities were identified within the Study Area, the Shale Sandstone Transition Forest (SSTF) and the Western Sandstone Gully Forest (WSGF). One additional vegetation community, the Shale Plains Woodland (SPW), previously identified by Ecoplanning in 2017, is located to the north-west of the Study Area (Ecoplanning, 2019). The area of these ground-truthed vegetation communities is shown in Figure 13-3 below.</td>
<td>Undertake a Ecology Assessment of the Proposal Area to determine the presence of threatened communities and species and the likelihood of significant impact.

Erosion and Sedimentation site Controls/ Management Plan

Potential assessment and Fisheries Permit (DPI)

Weed Management measures to be considered during construction</td>
</tr>
</table>

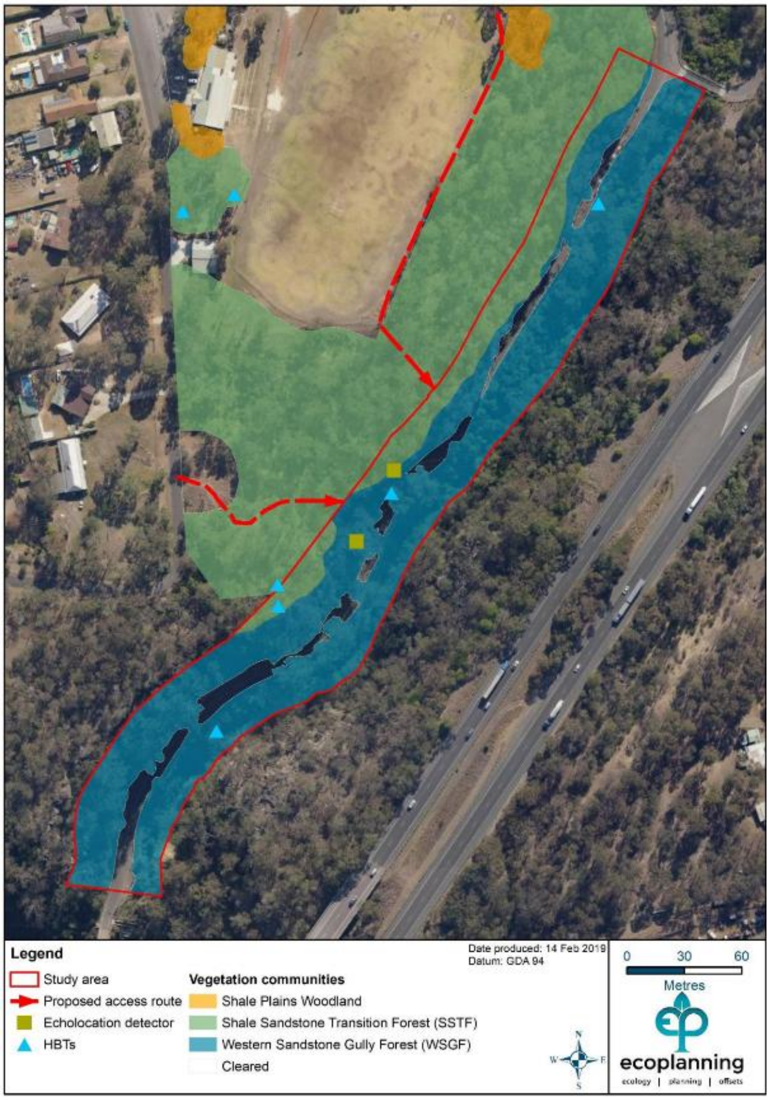


Figure 13-3 Vegetation Communities within the Study Area (Ecoplanning, 2019)

The SSTF ecological community is listed as Critically Endangered under the Biodiversity Conservation Act (BC Act) and the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The SPW vegetation community forms part of the Cumberland Plain Woodland ecological community which is also listed as Critically Endangered under the BC Act and EPBC Act (Ecoplanning, 2019). The relationship between the vegetation communities and threatened ecological communities under the BC Act and EPBC Act is summarised in Table 13-3.

Table 13-3 Associated TEC and legislative listing

Vegetation Community	BC Act	EPBC Act
SSTF	Critically Endangered – Shale Sandstone Transition Forest in the Sydney Basin Bioregion	Critically Endangered – Shale Sandstone Transition Forest in the Sydney Basin Bioregion

Utility Type	Impact Considerations	Next Step

SWP	Critically Endangered – Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered – Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
WSGF	Not listed	Not listed

Works associated with Option 2 to 5 would likely require the clearing of vegetation with the potential to impact on the WSGF vegetation community and the SSTF vegetation community with its associated TECs. Option 2 would likely require the clearing of the least amount vegetation with impacts limited to the WSGF vegetation community, however this is still to be determined as areas to be stabilised as part of Option 2 have not been finalised.

Options 3, 4 and 5 would require the clearing of relatively larger areas, impacting both the WSGF and SSTF vegetation communities and TEC associated with the SSFT, however, total quantities are yet to be determined. The SPW vegetation community is not likely to be impacted by any of the options.

It is recommended that significant impacts to TECs should be avoided, otherwise the requirement for a BDAR and/or EIS could be triggered.

Flora and fauna

As part of the Desktop assessment, a search of the BioNet Atlas was undertaken to identified protected and threatened species under the BC Act. The search identified 297 protected fauna species of which 35 are listed as threatened and 84 protected flora species of which 13 are listed as threatened.

A Protected Matters Search Tool (PMST) was also undertaken a part of the desktop assessment, and identified the following Matters of National Environmental Significance (MNES) within 5km buffer of the Proposal Area:

- 10 TECs
- 68 Threatened Species
- 11 Migratory Species

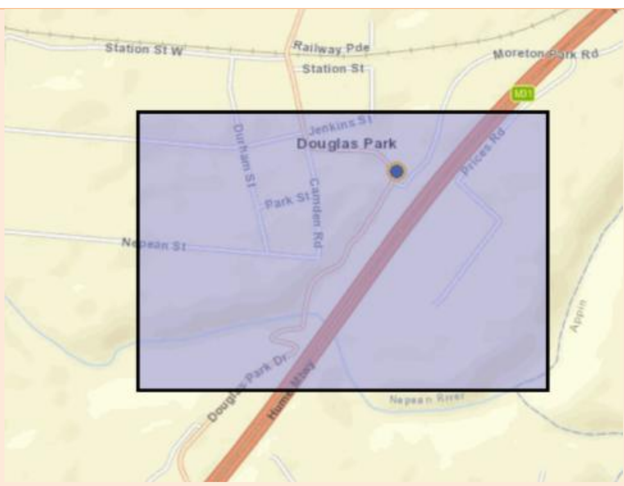
The Douglas Park Drive REF did not identify any threatened flora within the Study Area, however it was noted that the timing of the survey did not coincide with the flower period of the *Pterostylis saxicola* (BC and EPBC Act listed threatened species), a cryptic terrestrial orchid which can only reliably be detected when flowering. The Study Area was noted as containing areas of potential habitat for this species within the SSTF vegetation community. Options 3, 4 and 5 therefore have the potential to impact this species, provided it is present, with Option 5 anticipated to have the largest footprint within potential habitat.

The Douglas Park Drive REF, as part of targeted surveys, identified 3 three bat species listed as vulnerable under the BC Act within the Study Area. No other threatened species were identified, although surveys were limited to opportunistic observations, with the exception of the targeted surveys for the microbats. The threatened bat species observed included the Eastern Freetail Bat (*Micronomus norfolkensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*).

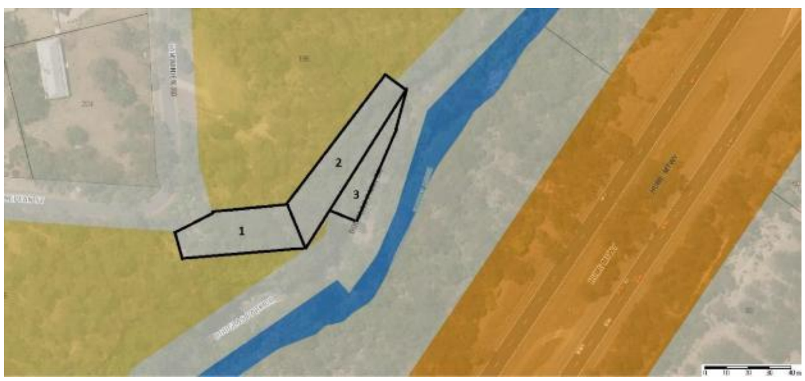
The Douglas Park Drive REF identified that the Study Area contains fauna habitat values of intact woodland including mature hollow-bearing trees, fallen woody

Utility Type	Impact Considerations	Next Step
	debris, rocky outcrops, sandstone caves, crevices and overhangs. 5 hollow bearing trees (HBT) were identified within the Study Area. The Douglas Park Drive REF, based upon their results identified the following threatened species have been identified as potentially utilising habitat within the Study Area and have potential to be impacted by the by options 2 to 5: • Varied Sittella (Daphoenositta chrysoptera) • Little Lorikeet (Glossopsitta pusilla) • Dusky Woodswallow (Artamus cyanopterus cyanopterus) • Koala (Phascolarctos cinereus) • Eastern Freetail Bat (Micronomus norfolkensis) • Large-eared Pied Bat (Chalinolobus dwyeri) • Eastern Bentwing-bat (Miniopterus schreibersii oceanensis) Clearing of vegetation may impact these protected and threatened fauna species through the reduction of potential habitat and therefore should be avoided as much as possible. Option 2 would likely have the least impact on flora and fauna (after Option 1) given the small area of work, followed by Option 3 which would require clearing of a large portion of habitat potentially including HBTs. Options 4 and 5 would have the greatest impact, with Option 5 being the greater of the two. This is due to a large portion of vegetation, potentially including HBTs, that would be cleared in order to connect the road with Nepean St. The new road would likely also create a barrier effect on fauna movements between potential habitat. **Aquatic biodiversity** The Nepean rivers is mapped as being habitat to the threated Fresh water Macquarie Perch and could be impacted from sedimentation associated with any earthworks (see Watercourses and Water Quality section for discussion on sedimentation associated with the options). Any works that occur within the Nepean river that block or impede fish movements would require a Permit to be obtained from the Department of Primary Industries (DPI), as the watercourse is classified as Key Fish Habitat (KFH). Regardless of which option is chosen, consideration must be made for the fish passage at the weir across the Nepean River. **Validity of the existing survey** Although an ecology assessment as part of the Douglas Park Drive REF was previously undertaken, works associated with options would extend past study area of the REF. The ecology survey is also considered to no longer be valid as the industry accepted period for the validity of an ecology assessment is five years. If construction under an REF has not commenced within five years of the ecology survey then it will generally need to be re-assessed for currency. The REF and background report does provide relevant and important information to assist in developing the option by providing ground truthed data which identifies site constraints.	

Utility Type	Impact Considerations	Next Step
Utilities	Information provided through a Before You Dig requires indicates that Sydney Water Utilities are present within the area for Option 5, along Nepean St and Camden Rd.	Utilities to be considered by design. Consultation to be undertaken if works occur in proximity and should Utilities be impacted by works, approval with the Utility owner for impact on the Utility would be required.
Waste management and Contamination	A search of the EPA Contaminated Land Record conducted on the 03 of April 2025 did not identify any contaminated land records nor sites that have been notified to the EPA within proximity the Proposal Area. The Proposal Area and surroundings are not mapped within the NSW Acid Sulfate Soils Risk Map (Naylor et al 1998). Option 1 involves the closure of Douglas Park Road, and if the road were to not be properly maintained, may fall into disrepair. Potential impact could arise from road material being eroded or collapsing into the nearby watercourses, including the weir located across the Nepean River. Waste generated associated with options 2 to 5 would likely include trees and vegetation material, rock fragments and sediment, waste generated from construction staff and packing materials associated with machinery and equipment utilised onsite. With the exception of options for the reuse of clean mulched vegetation and rock fragments, all waste generated onsite is to be disposed of at an approved facility. Given the scope of Option 1, minimal waste is anticipated to be generated by this option.	Unexpected Contamination Finds Procedure could be prepared for in the event contaminated material is encountered. Consideration of quantities and types of waste associated with each option should be made during the designing phases.
Socio-economic and Property	Socio-economic impacts that result from the options is mainly a result of the detours that would be required, either during construction or operation of the road. Closure of Douglas Park road at the site could require commuters to take an approximately 10 minutes detour. Whether this detour is considered significant would depend on if its temporary or permanent and the frequency at which commuters typically use this route. Based in the current assumed footprint for the options, property acquisitions could be required for Option 4 and 5 as works may occur within private owned lot 4/4/DP1320, although this could likely be avoided when designing the intersection between Nepean St, Camden Rd and Douglas Rd. The Proposal Area associated with Options 3, 4, and 5 extends into Lots 1/DP436803, 2/DP436803, and 3/DP436803 which are Crown Lands. Consultation with Crown lands would need to take places if access is required within these	Assess the need for property acquisition if Option 3, 4 or 5 are chosen Undertaken Consultation with Crown Lands if Options 3, 4, or 5 are chosen, and acquire

Utility Type	Impact Considerations	Next Step
	areas. If road infrastructure is built within their lands, agreement and approval would be required from Crown Land, for works within Crown Land.	approval is relevant
Air Quality	Options 1 is unlikely to impact air quality as construction works are not proposed for this option. Any impacts from this option would only be from any ongoing maintenance works which would be minimal considering the road won't be experiencing usage, reducing the need for repairs. Option 2 would have an impact on air quality, however, is considered to be minor given the scale of proposed works. Equipment required to undertake the stabilisation works would likely generate only a minor amount of dust during such works and is considered negligible. Due to the works proposed for Option 3, is it expect that it would have a greater impact on air quality. Road widening works and rock cutting would require additional larger machinery resulting in greater dust generated which could impact the nearby receivers. Implementation of the appropriate mitigation measures should be undertaken to reduce these impacts. Option 4 and 5 would have the greatest impact as a result of the scale of the works and its proximity to sensitive receivers. Significant vegetation clearing and earthworks at Nepean St would result in the generation of dust and greenhouse gases, and would need to be mitigated with the correct controls to prevent impacts on this sensitive receivers.	Dust suppression measures to be considered during construction.
Aboriginal Heritage	 A basic search of the Aboriginal Heritage Information Management System (AHIMS) indicated that there is 1 AHIMS site located near the intersection of Douglas Park Rd and Moreton Park Rd, which is at the northern end of the Proposal Area. Options 1, 4 and 5 would likely have no impact upon the AHIMS site provided decommissioning of the road does not requires any construction works nearby the site. The road should also be maintained to prevent collapse, which may impact the site Option 3 would have the greatest potential to impact the site due to widening of the road potentially occurring within the area of the site. Areas of the road that would be stabilised under Option 2 are not yet confirmed, however, it is not anticipated that the works would go outside the already disturbed area of the road, and therefore is unlikely to impact the site. If the AHIMS site is likely to be impacted by the works, an Aboriginal Heritage Impact Permit (AHIP) would be required.	If Options 3,4 or 5 are chosen, an Aboriginal Cultural Heritage Due Diligence Assessment should be undertaken to assess the likelihood for impact to the AHIMS site, and identify any additional heritage. AHIP would be required if impact are to occur to the AHIMS site, or any additional Aboriginal Heritage items discovered during the ACHA An Unexpected Heritage Finds Procedure to be in place for in the event

Utility Type	Impact Considerations	Next Step
	Through the guidance of the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (Department of Environment, Climate Change and Water NSW, 2010), a desktop analysis was done to assess if landscape features that indicate the likely existence of Aboriginal objects, were at or in proximity to the Proposal Area. The Proposal Area is within 200m of a watercourse, may be 200m below and above cliff faces, and from past experience on projects within the area, is possibly 20m from rock shelters due to the frequency these have been found in the nearby area. As these features are nearby (or likely nearby) there is a greater chance the area was utilised by Aboriginal people in the past, and has a higher likelihood of containing Aboriginal objects. For Options 3, 4 and 5, where works would occur on land that is undisturbed, there is a greater chance for impacts to Aboriginal Heritage, Although it should also be noted that a larger portion of the Proposal Area is a steep slope, with these areas being less likely to contain objects as they would have been less desirable locations to camp. Option 2 is unlikely to have an impact as works would occur with the disturbed area of the road, and for Option 1, no construction works are proposed. Given the potential for Aboriginal heritage to be present and the proximity of the AHIMS site, an Aboriginal Cultural Heritage Due Diligence Assessment should be undertaken if the Proposal proceeds with Options 3, 4 or 5. For Options 1 and 2, an assessment is not likely required, although an unexpected heritage finds procedure should be in place for in the event objects are discovered during works.	objects are discovered during works.
Non – Aboriginal Heritage	A review of State Heritage Inventory (NSW DCCEEW) found that no State or Local Heritage was mapped within the Proposal Area of the proposed Options. The closest item, located over 500m to the north, was the Railway Cottage (Listing No. I69), and is listed as Local Heritage. Indirect impacts from vibrations to this item is very unlikely given the distance from the works. Advice provided by Council from Kabalia in September 2024 indicated that along sections of Douglas Park Rd are historical stone retaining walls likely built in the late 19th century or early 20th century. Given the potential heritage value of these walls, it was recommended that it be treated as a heritage asset. Option 1 would likely have no or very minimal impacts from any construction works to the stone walls. However, if the road is not maintained and falls into disrepair, there is the potential for impact to the walls resulting from erosion and landslips. Ongoing works would be required to maintain the walls in their current condition. Options 2, 3, 4 & 5 all have a likely degree of impact to these walls from their construction. Option 3 is projected to have the greatest impacts resulting from the widening of the road, requiring the deconstruction of the wall. Option 4 and 5 would require ongoing maintenance of the section of closed road to ensure that the walls are not damaged from erosion and landslips. For whichever option is decided upon, options for conservation of the walls proposed by Kabalia in September 2024 included: • Retention and repair of the original stonework coursing where possible as the first option. • Reconstruction with reinforced support if the walls are unstable or have lost structural integrity. Original stone blocks should be removed and reinstall following construction as a facing for the new wall allowing for the historic appearance to be retained.	Determine the best method for conserving the Stone Wall and the Harris Creek Cliffs Wagon Trail. Assess the impact that Option 4 and 5 would have upon Harris Creek Cliffs Wagon Trail and if it can be retained.

Utility Type	Impact Considerations	Next Step
	Although the item is not heritage listed, Council should consider if they wish to undertake a heritage assessment to determine the age, heritage value of the stone wall, and if it should be retained. This assessment may also be able to advise on appropriate management for the removal and reinstatement of the wall. The Douglas Park Drive REF also discuss findings the report ‘Heritage Act 1977 - Heritage assessment significance statement’ (Kabaila P, 2019). A historic transport trail, The Harris Creek Cliffs Wagon Trail, was found to at occur in the Study Area. The trail is in three intact sections (shown in Figure 13-4) with the top section along the cliff line without retaining walls, the middle section being a steep ramp with 1 to 3 m high retaining walls, and the low section being a steep ramp along the cliff base. This trail is considered to have moderate landmark value, aesthetic value, and technical value in road engineering heritage. conservation of this historic transport trail is mandatory under the EP&A Act (Kabaila 2019). Several methods to conserve the trail were proposed by Kabaila (2019), however it is not known if this would be possible if Option 4 or 5 is chosen, given that the alignment of the new road would occur through the trail. The degree of impact that Option 4 and 5 would have is not known at this stage and should be assessed if it is going to be considered for the Proposal.  **Figure 13-4 Harris Creek Cliffs Wagon Trail section location (Kabaila 2019)**	

Utility Type	Impact Considerations	Next Step
Landscape Characteristics and Aesthetics	The Proposal Area consists of a road that runs down, along the side the gully of Harris Creek, and crosses the Nepean River at the base. Along the route is a large quantity of likely native vegetation, and several cliff sides. The area is mostly natural in its appearance, with the exception of the road and areas of the slope carved out. The road is not understood to visible to any of the residents, being only visible to road users. Option 1 would retain most of the landscape characteristics and aesthetic values along the road, due to the minimal works prosed for this option however, as road would be closed off, the site would no longer be visible to the public. Option 2 would have impacts associated with the construction phase of the proposal. However, impacts are likely to be minimal and only associated with construction as the stabilised sections are on the downslope, not visible to road users Option 3 would result in impacts to the landscape characteristics and aesthetics during construction and operation. Road widening would likely require removal of vegetation and earthworks. Rock cutting done for this option would also result in impacts to the northern section of the Proposal Area. Options 4 and 5 are expected to have the greatest impact on the landscape's characteristics and aesthetic values due to the extensive work needed to connect Douglas Park Road to Nepean Road. This options would involve clearing a significant number of trees and undertaking substantial earthworks to accommodate the new road alignment. The works and the operation of one of these options would have negative impacts on the residents of Nepean St and Camden Rd, as they would be in line of site.	Design should be considerate of visual impacts

13.1 KEY ENVIRONMENTAL CONSTRAINTS

Based on the desktop assessment of the options in regard to environmental factor, the following key environmental constraints have been identified which could be impacted by the proposal or pose a risk to the proposal.

- Shale Sandstone Transition Forest in the Sydney Basin Bioregion TECs associated with the SSTF vegetation community. Significant impact to TECs would require a BDAR and potentially an EIS to be undertaken. – *relevant to Option 3, 4 and 5.*
- Potential habitat for threatened flora and fauna – relevant to *Option 2, 3, 4 and 5.*
- Historical Stone Retaining Walls along Douglas Rd. - relevant to all options.
- The Harris Creek Cliffs Wagon Trail – *relevant to Option 4 and 5*
- Potential for property acquisition of private land for lot 4/4/DP1320 – *relevant to Option 4 and 5*
- AHIMS Site and potential for Aboriginal objects within and nearby the Proposal Area. Impacts to Aboriginal heritage would require an AHIP. – relevant to *Option 3, 4 and 5.*
- Potential for consultation with, and/or approval from Crown Lands regarding works within:
  - 1/DP436803 – relevant to *Option 3, 4 and 5*
  - 2/DP436803 and 3/DP436803 – *relevant to Option 4 and 5*

14.0 MULTI CRITERIA ASSESSMENT

The following criteria have been assessed:

- Relative cost - Relative cost includes, material procurements, delivery, associated cost with access track, construction materials and procurement. Appropriate level of contingency is required and detailed cost estimates are required to confirm.
- Environmental impact - assess the environmental impact of the chosen options footprint.
- Constructability access - requirement of access track, requirement of platforms/temporary work design, difficulty of construction.
- Maintenance - potential requirements of maintenance after any accidents, any ongoing monitoring requirements
- Road safety impact - includes, impact of alignment curvature reduction or increase, sight distances, guard rails
- Time frame of delivery - includes time for design completion, time required for material procurement, time required for any permits (where required)
- Community Impact (WSC LGA resident) - The impact of remediation on community, road closure requirement, extend of road closure, time frame the road closure is required, impact of increased traffic through suburban streets
- Community Impact (non-resident) - The impact on current road uses from outside of the LGA.

Based on the above assessments, the following scores for different options have been assessed as presented in table below with a higher score awarded for a better project result. For Option 1, no associated score has been assessed for certain criteria where results would be skewed and not enable sufficient comparison of options.

Table 14-1: MCA assessment

Considered Factors	Weight Factor	Option 1 - road closure	Option 2- maintain existing geometry	Option 3- widen existing geometry	Option 4- road realignment (one lane)	Option 5- road realignment (two lanes)
Relative Cost	20%	10	8	0	7	3
Environmental Impact	10%	8	7	3	5	3
Constructability	15%	-	6	3	4	3
Maintenance	5%	6	4	7	6	6
Road Safety Impact	10%	-	3	8	0	7
Time Frame of Delivery	10%	-	7	3	5	3
Community Impact (WSC LGA resident)	25%	10	5	3	5	3
Community Impact (non-resident)	5%	0	5	10	5	10
Total	100%	**5.6**	**5.9**	**3.5**	**4.8**	**3.9**

15.0 FURTHER INVESTIGATIONS

Further design and investigation may be required to confirm a preferred option during Stage 2.

16.0 UNCERTAINTIES AND OUTSTANDING ITEMS

This report presents landslide remediation options, and the following actions are recommended to enable the following stages of the project:

- Continued / Additional survey monitoring to confirm extents of treatment and any further regression of slope prior to detailed design.
- The assessments presented within this report were based on existing geotechnical investigation and site mapping observations. In the further stages of the design any assumptions provided within this report should be validated.
- Detailed design considering any temporary stability situations dependant on the selected final design solution.
- Preliminary slope angle of 0.5H:1V (63 degrees) has been assumed although following more detailed rock mapping and stability assessments, could result in a steeper angle.

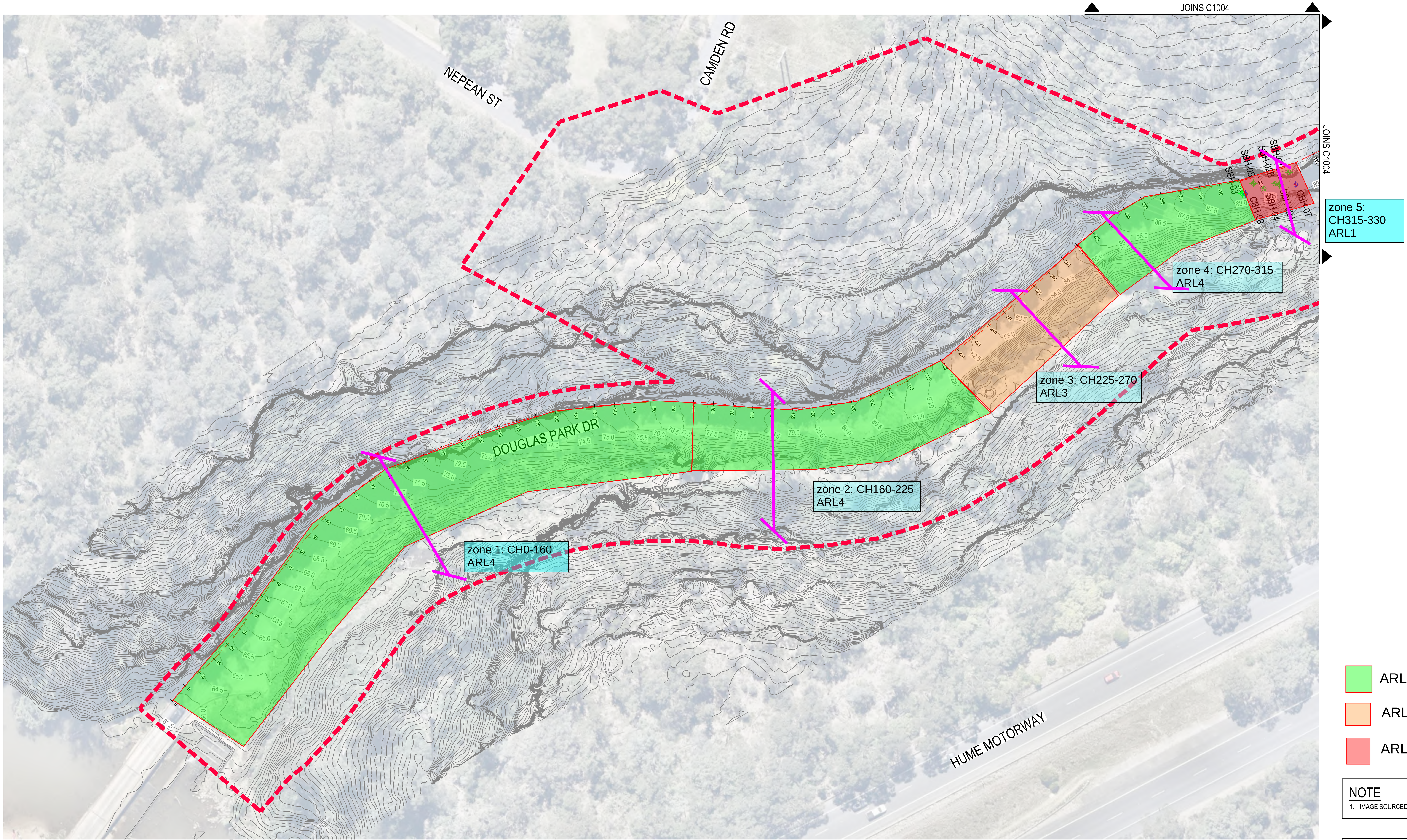
17.0 REFERENCES

Nearmap. (2025, April 29). *Nearmap*. Retrieved February 24, 2025, from https://www.nearmap.com/au/en

NSW Department of Primary Industries and Regional Development. (2025, April 30). *MinView*. Retrieved April 2, 2025, from https://minview.geoscience.nsw.gov.au/

RMS. (2018). *Technical Direction - Geotechnology - GTD 2018/001 Geotechnical Design for Remediation of Existing Slopes and Embankments.* RMS.

Appendix A SRA MAPPING



NOTE

1. IMAGE SOURCED FROM NEAR MAP (MAR, 2025)

LEGEND

- PROPOSED WORKS BOUNDARY
- 2023 SMEC BOREHOLES
- 2017 COFFEY BOREHOLES
- EXISTING CONTOURS (0.5m)
- INTERPRETED/ANNOTATED GEOTECHNICAL CROSS SECTION

REMEDIATION AREA - SOUTH

SCALE 1:500

0 10 20 30 40 50m
SCALE 1:500 (A1), 1:1000 (A3)

Rev	Description	By	Appd	Date
A	ISSUED FOR APPORVAL	EJK	DR	02/04/2025
Issued/Revision		By	Appd	DD.MM.YYYY

Issue Status
S0
INITIAL FILE BEING DEVELOPED

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Coordinate System
MGA-2020
Datum
mAHD

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Client/Project
XXXX

DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

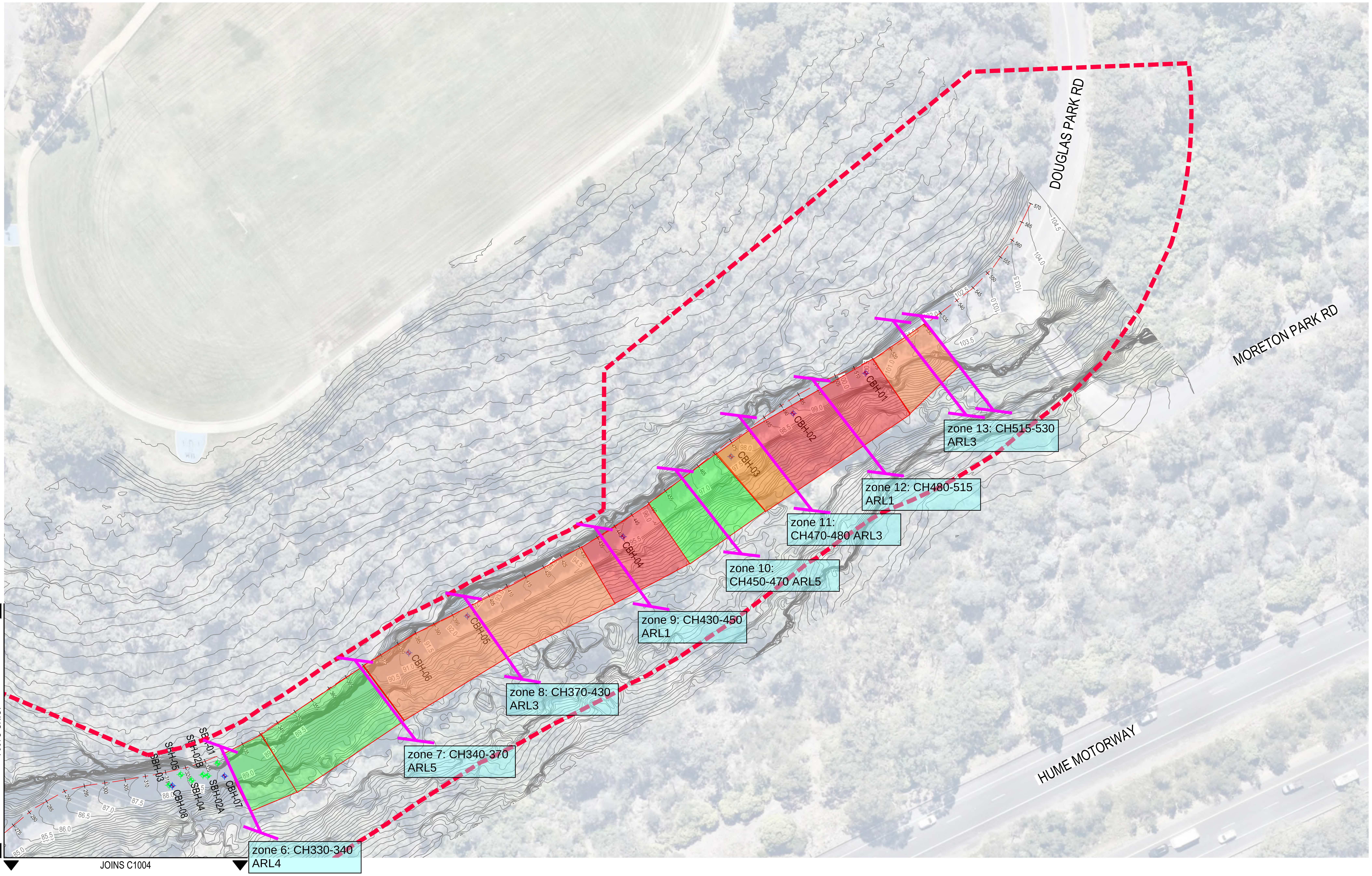
DOUGLAS PARK

EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

Title
REMEDIATION AREA
SOUTH

Project No. 304001630
Scale at A1 1:500
Drawing No. 304001630-01-C1004
Revision A

ORIGINAL SHEET - ISO A1



ARL4/ARL5

ARL3

ARL1/ARL2

REMEDIATION AREA - NORTH

SCALE 1:500

NOTE

1. IMAGE SOURCED FROM NEAR MAP (MAR, 2025)

LEGEND

- PROPOSED WORKS BOUNDARY
- 2023 SMEC BOREHOLES
- 2017 COFFEY BOREHOLES
- EXISTING CONTOURS (0.5m)
- INTERPRETED/ANNOTATED GEOTECHNICAL CROSS SECTION

0 10 20 30 40 50m

SCALE 1:500 (A1), 1:1000 (A3)

Rev	Issued/Revision	By	Appd	DD.MM.YYYY
A	ISSUED FOR APPORVAL	EJK	DR	02/04/2025

Issue Status

S0

INITIAL FILE BEING DEVELOPED

This document is suitable only for the purpose noted above. Use of this document for any other purpose is not permitted.

Coordinate System
MGA-2020
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mAHD

Colour Disclaimer

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Client/Project
XXXX

DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

DOUGLAS PARK

Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY
EJK		DR	DR	02/04/2025

Title
REMEDIATION AREA NORTH

Project No.
304001630

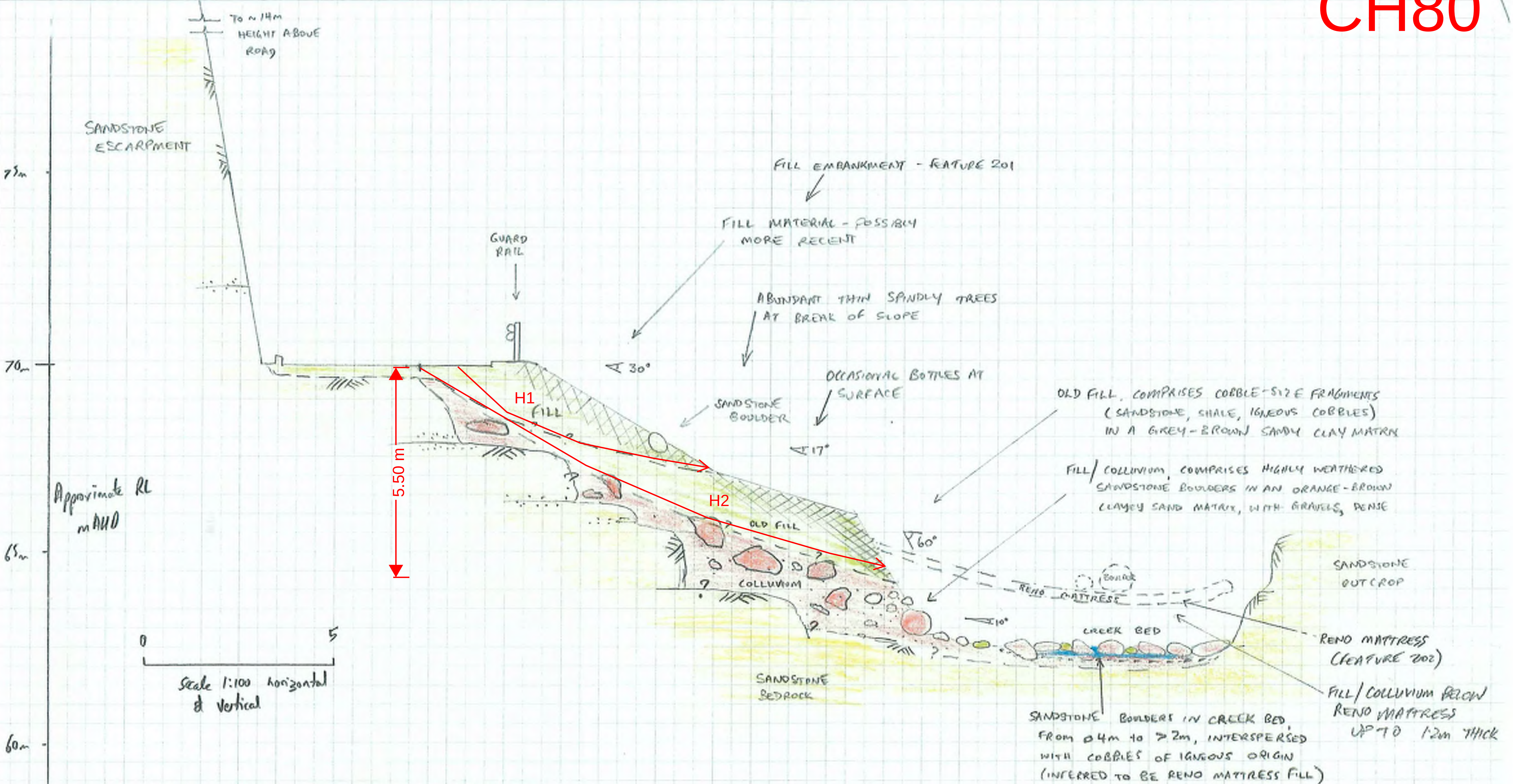
Scale at A1
1:500

Drawing No.
304001630-01-C1005

Revision
A

ORIGINAL SHEET - ISO A1

CH80



NOTES:
- RENO MATTRESS IS EXTENSIVELY DAMAGED AND TORN, SOME VOIDS (INDICATIVE EXTENT SHOWN)
- LARGE SANDSTONE BOULDERS ARE LYING IN THE CENTRE OF THE CREEK BED, ON THE RENO MATTRESS. POSSIBLE SOURCES ARE ROCKFALL OR WASHED DOWN THE CREEK, POST-CONSTRUCTION.

	H1	H2
P(d)	0.01	0.001
p(t)	1	1
L	L3	L4

H1: small rotational through fill profile, severe weather event to trigger a 100mm step in pavement on downslope lane, approx volume 40-50m3.
H2: large translational between fill and colluvium, unusually sever weather event to trigger a shallow void in downslope lane, approx volume ~200m3

No.	Revisions	Approved	Date
			/ /
			/ /
			/ /
			/ /
			/ /
			/ /

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GHD Pty Ltd ABN 39 008 488 373

GHD CLIENTS | PEOPLE | PERFORMANCE

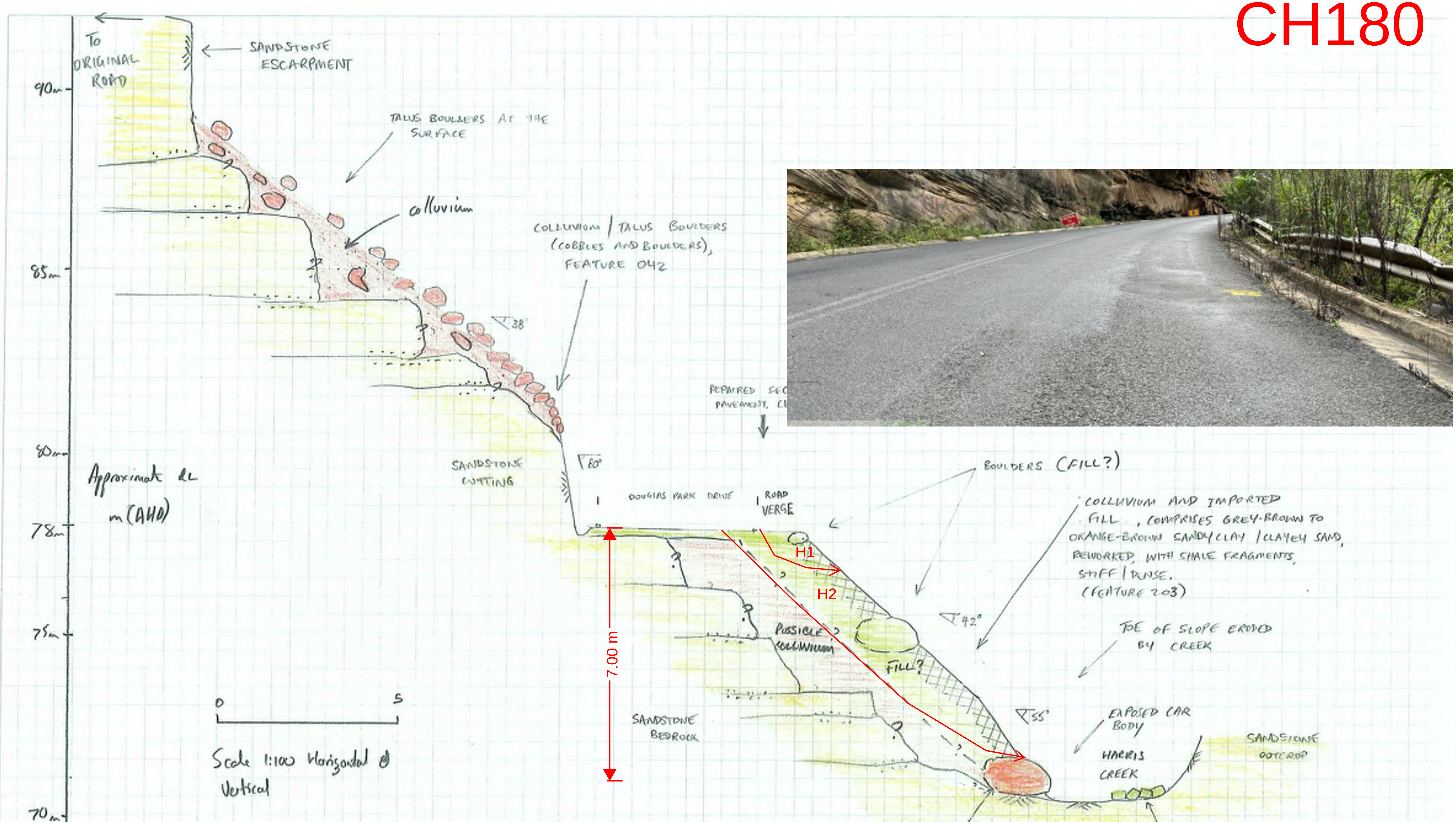
Drawn	HS / DPJ	07/09/2010
Designed		/ /
Draft check		/ /
Design check		/ /
Approved		/ /

Client and project: BHP BILLITON - ILLAWARRA COAL, APPIN AREA 9, HARRIS CREEK CLIFFLINE LANDSLIDE RISK ASSESSMENT

Title: KEY SECTION B-B' CHAINAGE 080

A3 Drawing no. SK-1971501-B Scale 1:100 Rev A

CH180



	H1	H2
P(d)	0.01	0.001
p(t)	1	1
L	L3	L4

H1: small rotational through fill profile, severe weather event to trigger a 100mm step in pavement on downslope lane, approx volume 40-50m3. Small signs of pavement stress suggest a very slow creep mechanism is at play

H2: large translational between fill and colluvium, unusually sever weather event to trigger a shallow void in downslope lane, approx volume ~100-150m3

No.	Revisions	Approved	Date
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			/ /
			/ /
			/ /
			/ /
			/ /

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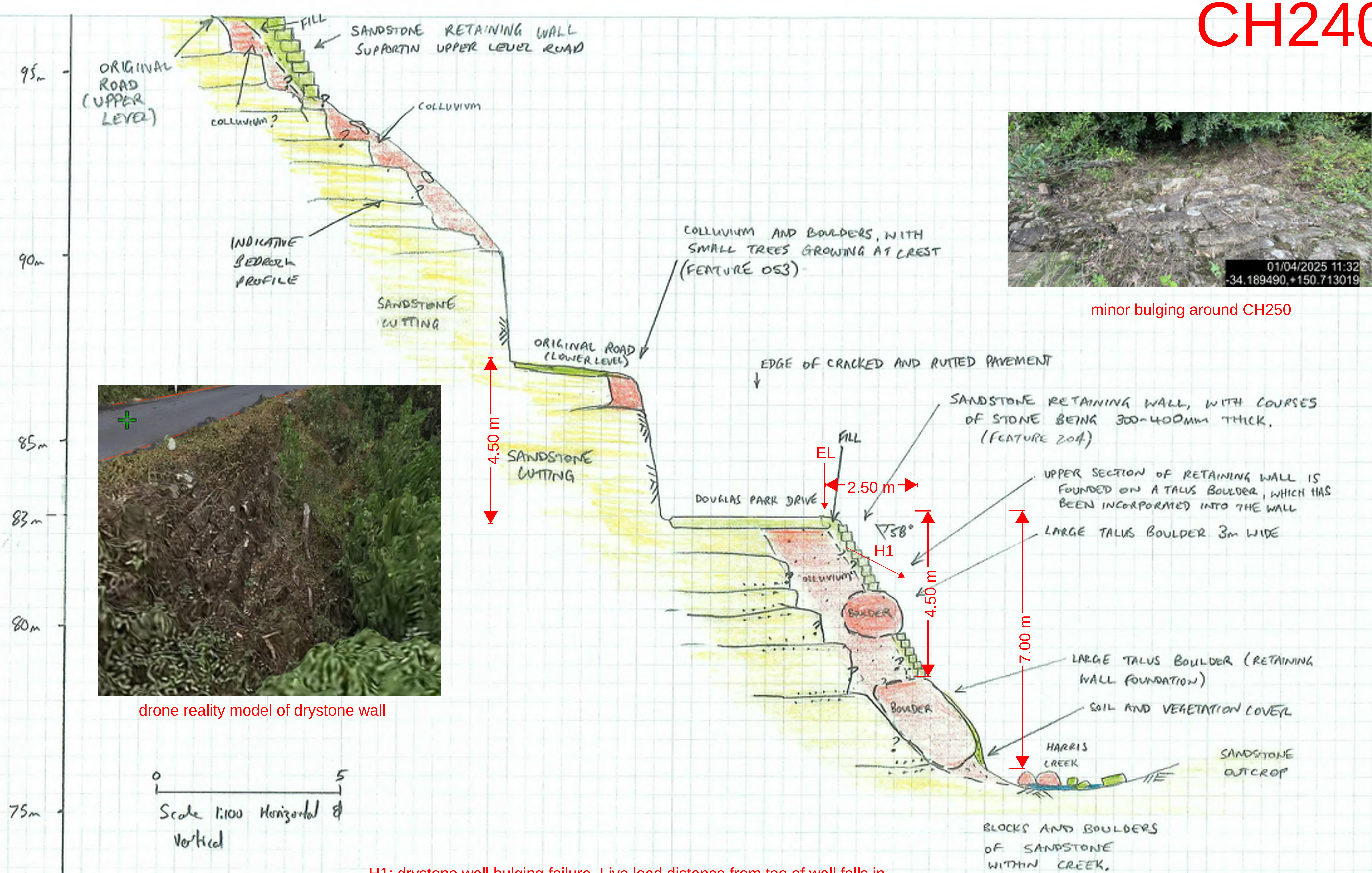
Drawn	HS / DPJ	7 / 09 / 10
Designed		/ /
Draft check		/ /
Design check		/ /
Approved		/ /

Client and project: BHP BILLITON - ILLAWARRA COAL, APPIN AREA 9, HARRIS CREEK CLIFFLINE, LANDSLIDE RISK ASSESSMENT

Title: KEY SECTION D-D' CHAINAGE 180

A3 Drawing no. SK-1971501-D Scale 1:100 Rev A

CH240



minor bulging around CH250

drone reality model of drystone wall

H1: drystone wall bulging failure. Live load distance from toe of wall falls in "H/2-H" range with minor signs of distress has a L4 likelihood of creating a small, up to 0.5m void

No.	Revisions	Approved	Date
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			/ /

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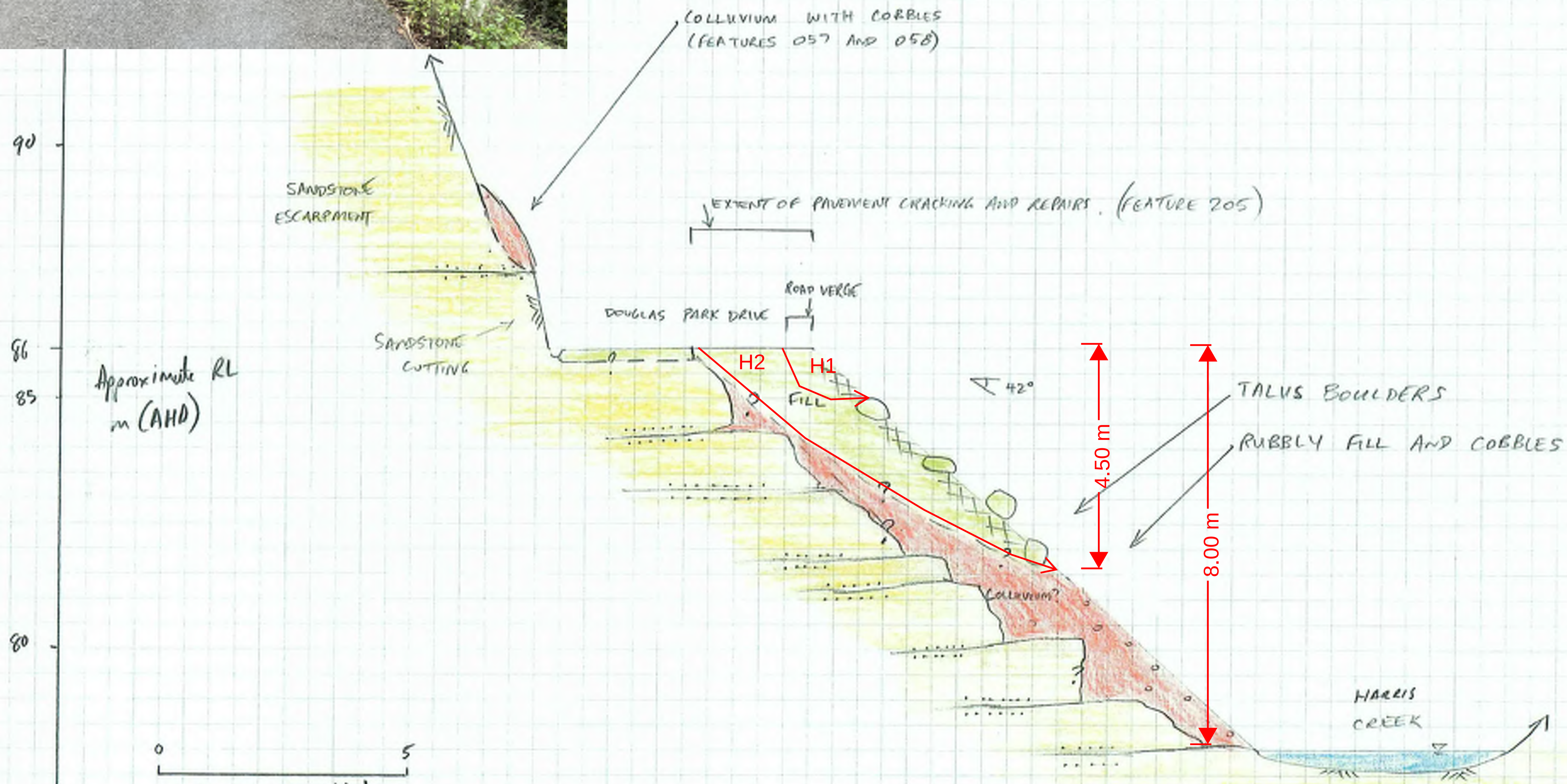
Designed	/ /
Draft check	/ /
Design check	/ /
Approved	/ /

Client and project: BHP BILLITON - ILLAWARRA COAL APPIN AREA 9, HARRIS CREEK CLIFFLINE, LANDSLIDE RISK ASSESSMENT

Title: KEY SECTION E-E' CHAINAGE 240

A3 | Drawing no. SK-197/501-E | Scale 1:100 | Rev A

CH290



Scale 1:100 Horizontal & Vertical

	H1	H2
P(d)	0.01	0.001
p(t)	1	1
L	L3	L4

H1: small rotational through fill profile, severe weather event to trigger a 100mm step in pavement on downslope lane, approx volume ~10m3. Signs of pavement stress (slight slumping on downslope edge of pavement), suggest a very slow creep mechanism is at play

H2: large translational between fill and colluvium, unusually sever weather event to trigger a shallow void in downslope lane, approx volume ~100-150m3

No.	Revisions	Approved	Date
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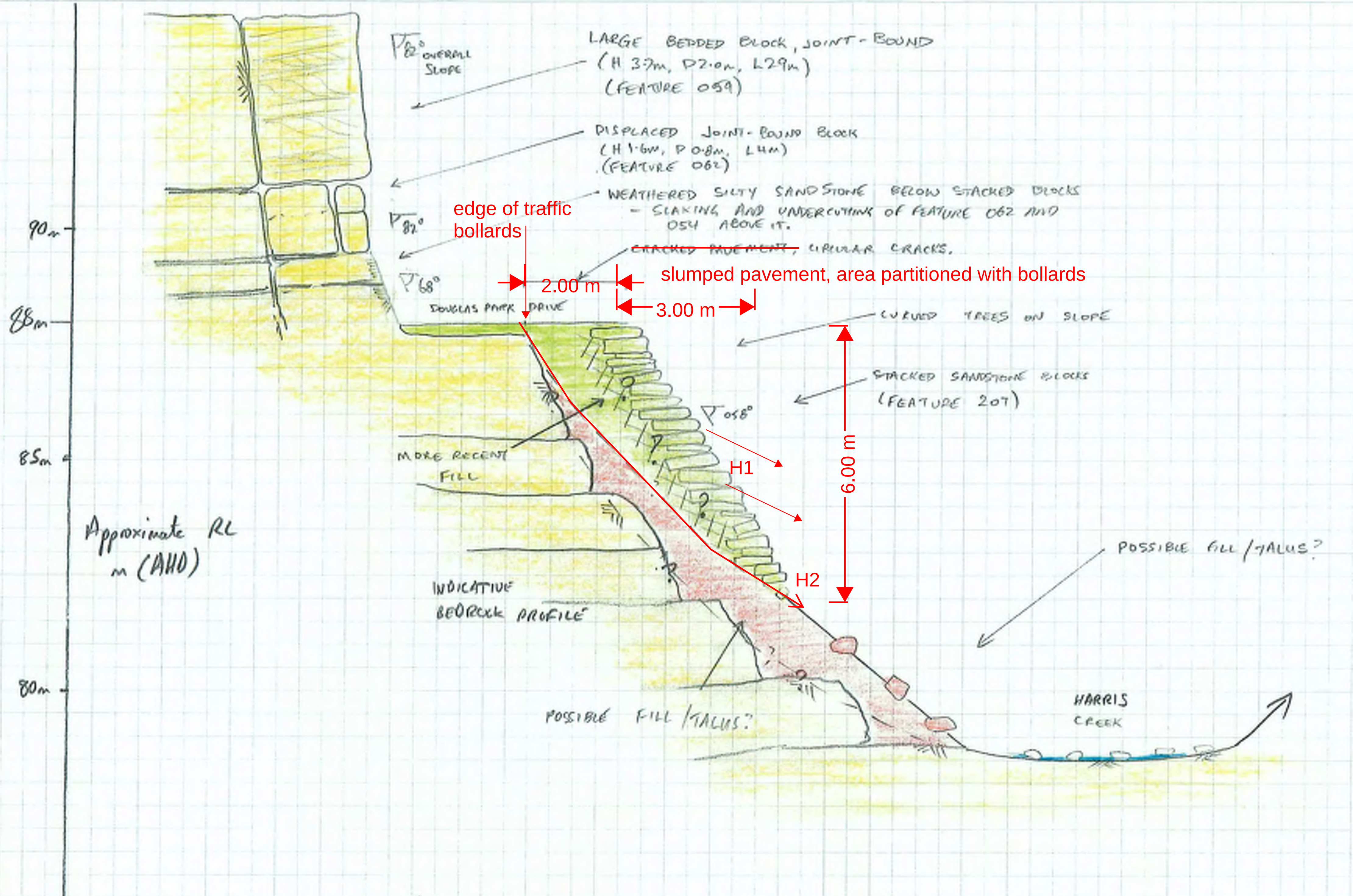
Drawn DPJ/HS	7/ 9/10	Client and project BHP BILLITON - ILLAWARRA COAL, APPIN AREA 9, HARRIS CREEK CLIFFLINE, LANDSLIDE RISK ASSESSMENT
Designed	/ /	
Draft check	/ /	Title KEY SECTION F-F' CHAINAGE 290
Design check	/ /	
Approved	/ /	A3 Drawing no. SK-197150/-F · Scale 1:100 · Rev A

CH325



Scale 1:100 Horizontal & Vertical

H1: drystone wall bulging failure. Live load distance from toe of wall falls in "H/2" range while currently active has a L1 likely-hood of creating a small, up to 0.5m void. Temporary traffic bollards keeping live loads a further ~2m from crest has reduced likelihood down to a L2.
H2: large translational between fill and colluvium, unusually sever weather event to trigger a shallow void in downslope lane, approx volume ~100 m3. P(d) = 0.001, Pt(t) = 1.0, L = L4

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Designed		/ /
Draft check		/ /
Design check		/ /
Approved		/ /

Client and project: BHP BILLITON - ILLAWARRA COAL APPIN AREA 9, HARRIS CREEK CLIFFLINE LANDSLIDE RISK ASSESSMENT

Title: KEY SECTION G-G' CHAINAGE 325 SHEET 2 OF 2

A3 | Drawing no. SK197/501-G2 | Scale 1:100 | Rev A

CH330

coffey

Computations

project no: GEOTWOLL03882 AB | sheet | of

client: Wollondilly Shire Council

office: CHATSWOOD

principal:

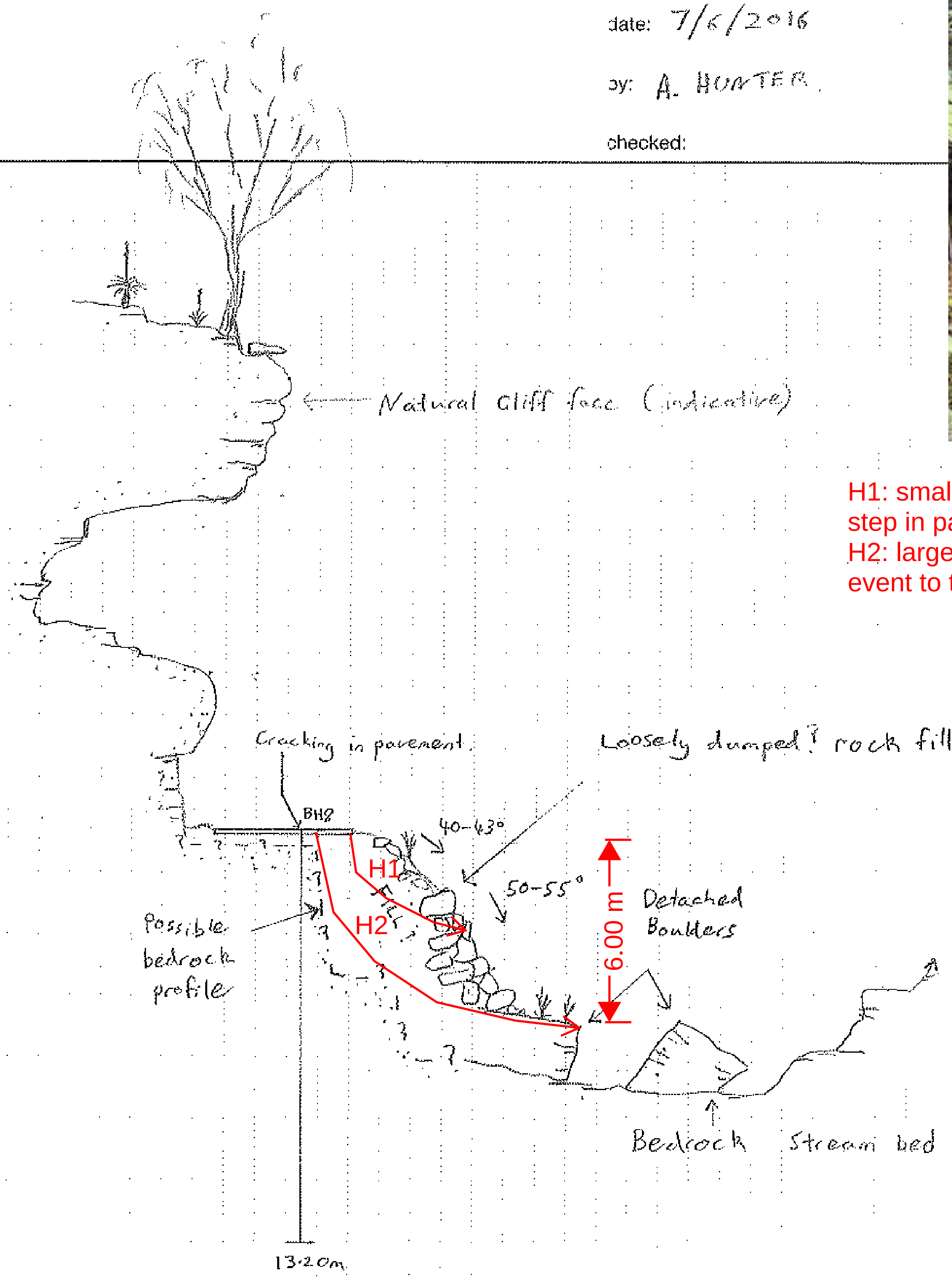
date: 7/6/2016

project: Douglas Park Drive

by: A. HUNTER

location: Douglas Park

checked:



H1: small rotational through fill profile, severe weather event to trigger a 100mm step in pavement on downslope lane, approx volume ~30m3.

H2: large translational between fill and colluvium, unusually sever weather event to trigger a shallow void in downslope lane, approx volume ~200m3

CROSS SECTION A-A'

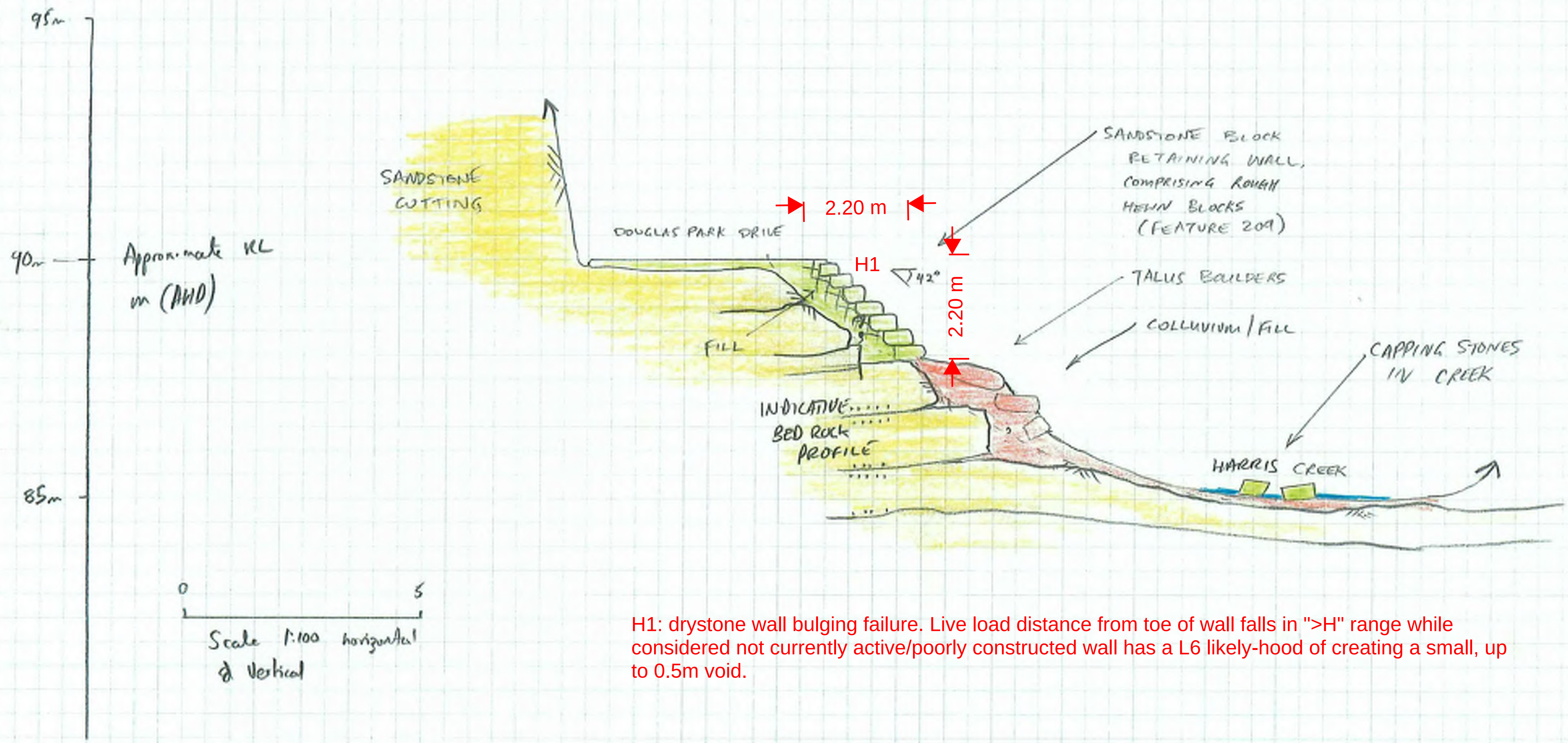
≈ CHAINAGE 330 (FEATURE 207)

SCALE 1:200 APPROX.

5m

SKETCH No. 2

CH370



H1: drystone wall bulging failure. Live load distance from toe of wall falls in ">H" range while considered not currently active/poorly constructed wall has a L6 likely-hood of creating a small, up to 0.5m void.

No.	Revisions	Approved	Date
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GHD CLIENTS|PEOPLE|PERFORMANCE

Drawn	/ /
Designed	/ /
Draft check	/ /
Design check	/ /
Approved	/ /

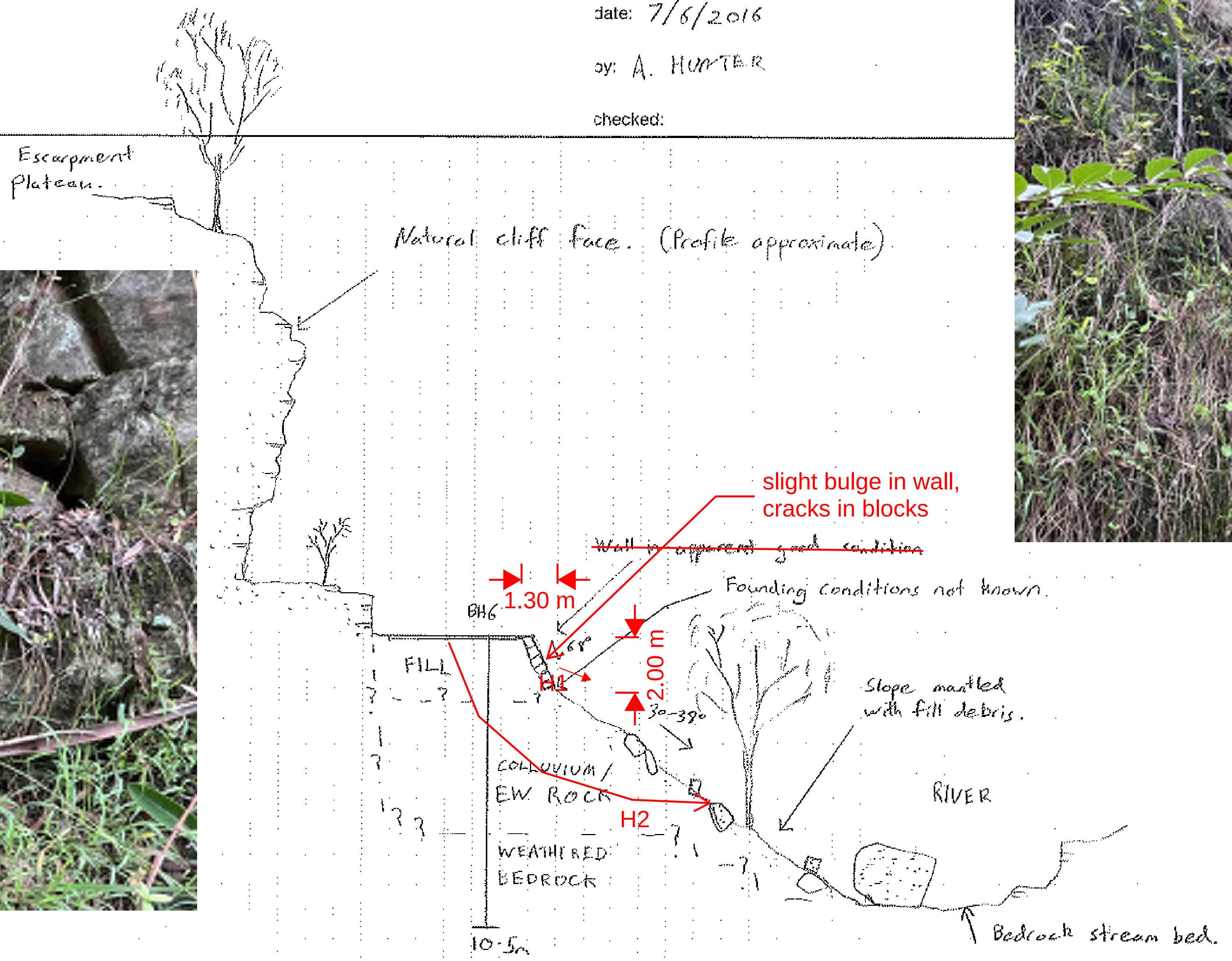
Client and project BHP BILLITON – ILLAWARRA COAL APPIN AREA 9, HARRIS CREEK CLIFFLINE LANDSLIDE RISK ASSESSMENT

Title KEY SECTION H-H' CHAINAGE 370

A3 Drawing no. SK-1971501-H Scale 1:100 Rev A coffey

Computations

client: Wollondilly Shire Council	project no: GEOTWOLL03882AB
principal:	office: CHATSWOOD
project: Douglas Park Drive	date: 7/6/2016
location: Douglas Park	by: A. HUNTER
	checked:



H1: drystone wall bulging failure. Live load distance from toe of wall falls in "H/2-H" range while considered to be under significant distress has a L3 likely-hood of creating a small, up to 0.5m void.
H2: medium rotational failure through fill and colluvium/XW rock causing a 100mm step in road from an unusually sever weather event; P(d) = 0.001, p(t) = 1.0, L=L4
approx volume = ~200m3

CROSS SECTION A-A'

≈ CHAINAGE 400 (FEATURE 211)

SCALE 1:200 APPROX.

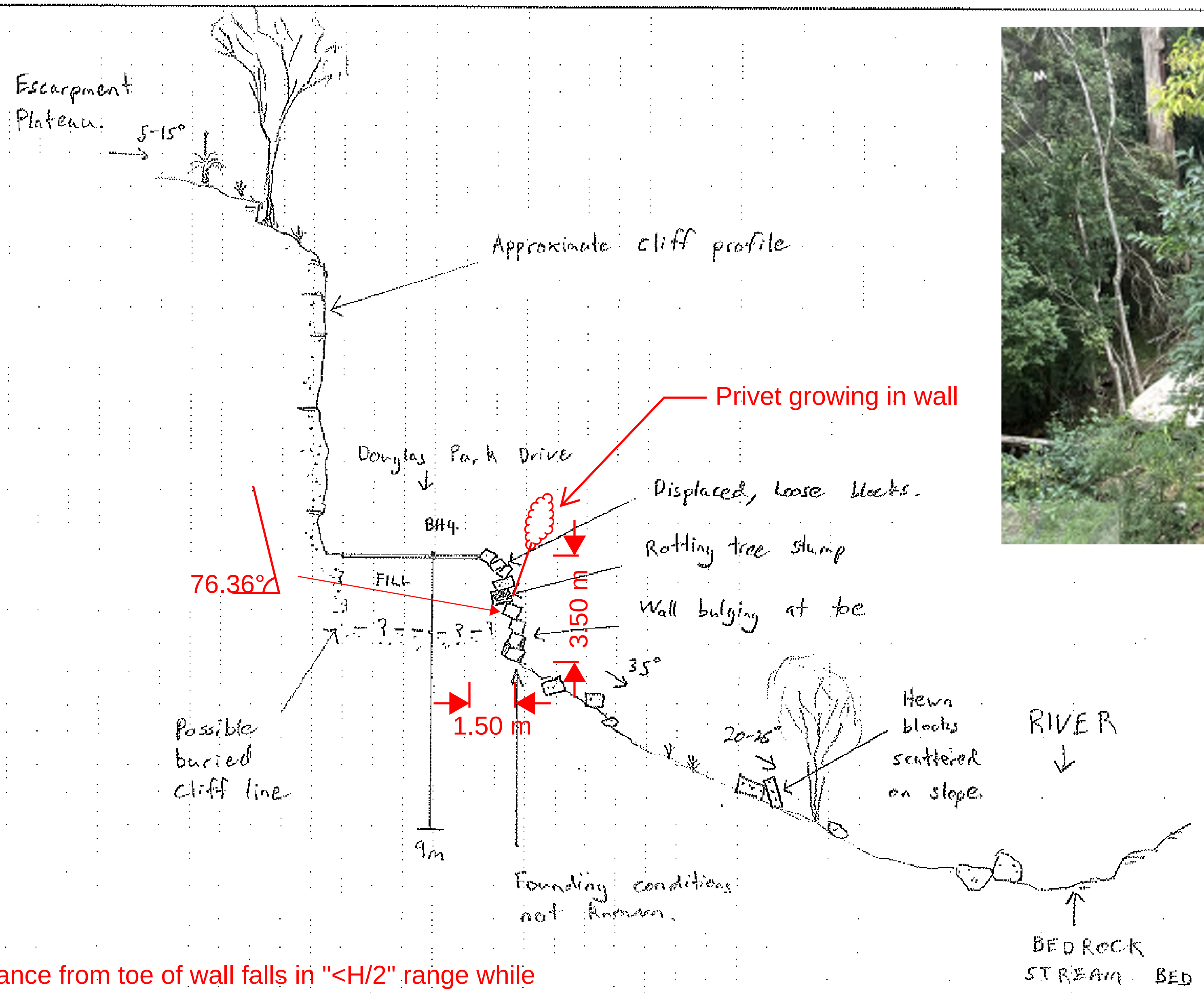
5m

SKETCH No. 8

coffey
Computations

project no: GEOTWOLL03882AB
sheet of

client: Wollondilly Shire Council
office: CHATSWOOD
principal:
date: 7/6/2016
project: Douglas Park Drive
by: A. HUNTER
location: Douglas Park
checked:



H1: drystone wall bulging failure. Live load distance from toe of wall falls in "<H/2" range while considered to be under significant distress and active has a L1 likelihood of creating a small, up to 0.5m void. Bollards installed however move the live load outside to "H/2-H" distance range, lowering the likelihood to a L2

CROSS SECTION A-A'

~~≈ CHAINAGE 443~~ (FEATURE 212)

SCALE 1:200 APPROX.

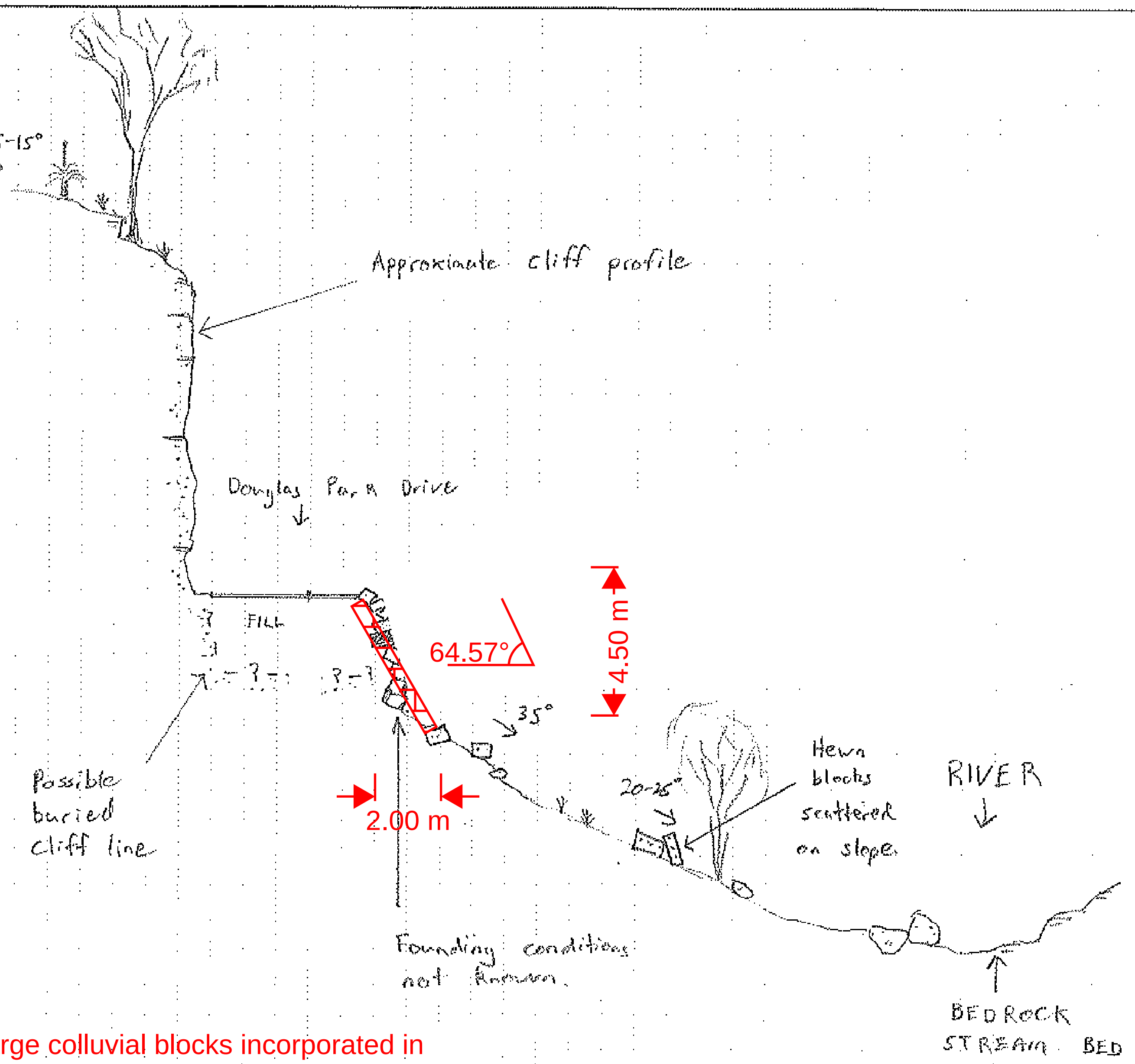
5m

SKETCH No. 4.

CH460

coffey
Computations

client: Wollondilly Shire Council	project no: GEOTWOLL03882AB
	sheet of
	office: CHATSWOOD
principal:	date: 7/6/2016
project: Douglas Park Drive	by: A. HUNTER
location: Douglas Park	checked:



H1: drystone wall in good condition, with rocky outcrop or large colluvial blocks incorporated in retaining wall construction. Live load distance from toe of wall falls in "<H/2-H" range while considered to be under min distress has a L5 likelihood of creating a small, up to 0.5m void.

CROSS SECTION A-A'

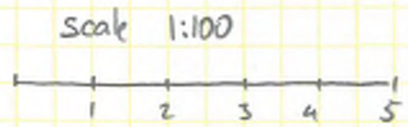
~~≃ CHAINAGE 443~~ ~~(FEATURE 212)~~

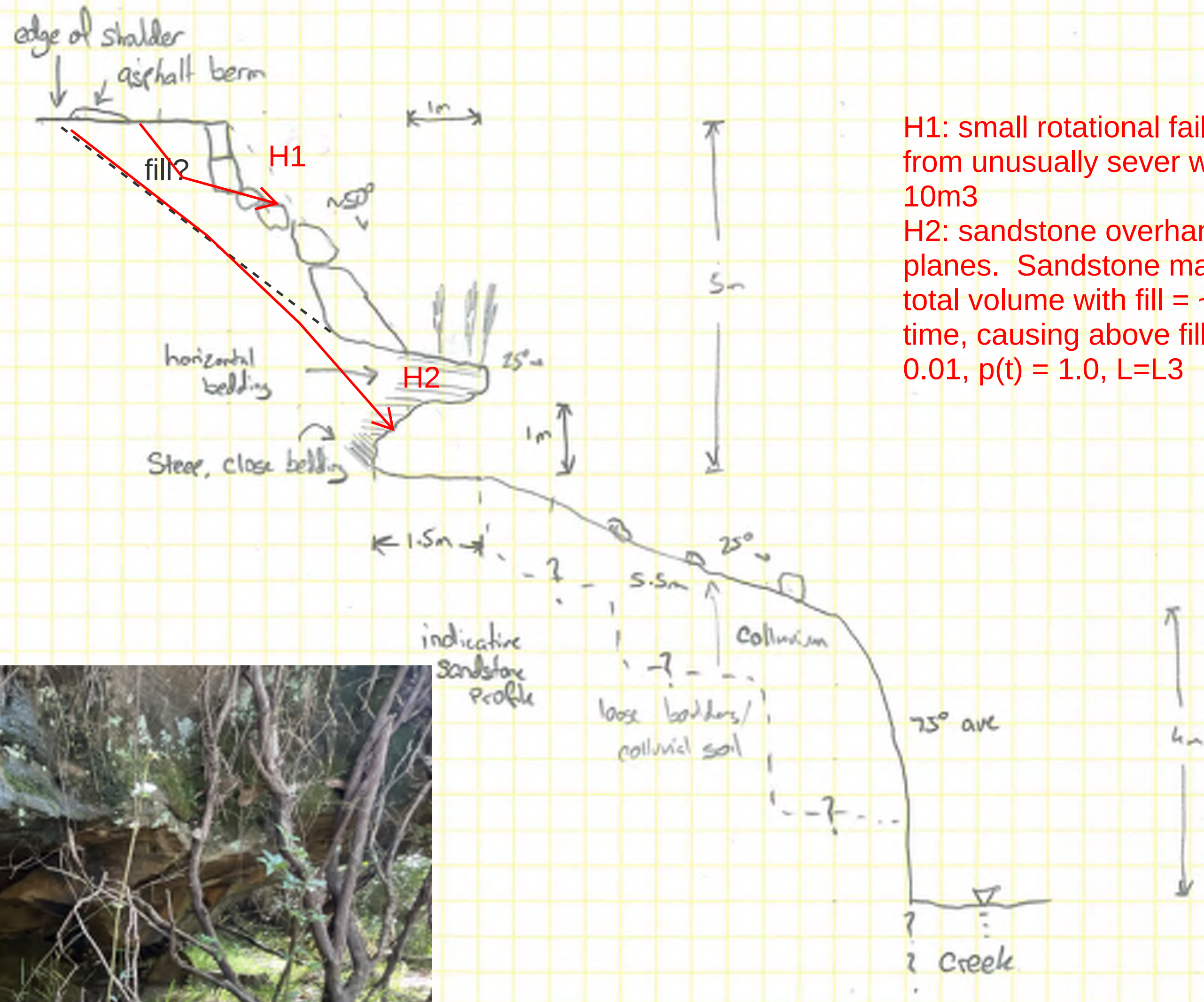
SCALE 1:200 APPROX.

5m

SKETCH No. 4.

CH480





H1: small rotational failure through rock mass at crest in shoulder, triggered from unusually sever weather event. p(d) = 0.001, p(t) = 0.1, L=L5. volume = 10m3
H2: sandstone overhang fail from weathering of sandstone through bedding planes. Sandstone mass overhanging (approx 2x2x5m = 20m3 or 45tonnes, total volume with fill = ~100m3) will eventually fail, maybe in over 100 years time, causing above fill to carriageway to sheer, leaving a 0.5m void p(d) = 0.01, p(t) = 1.0, L=L3

1:100

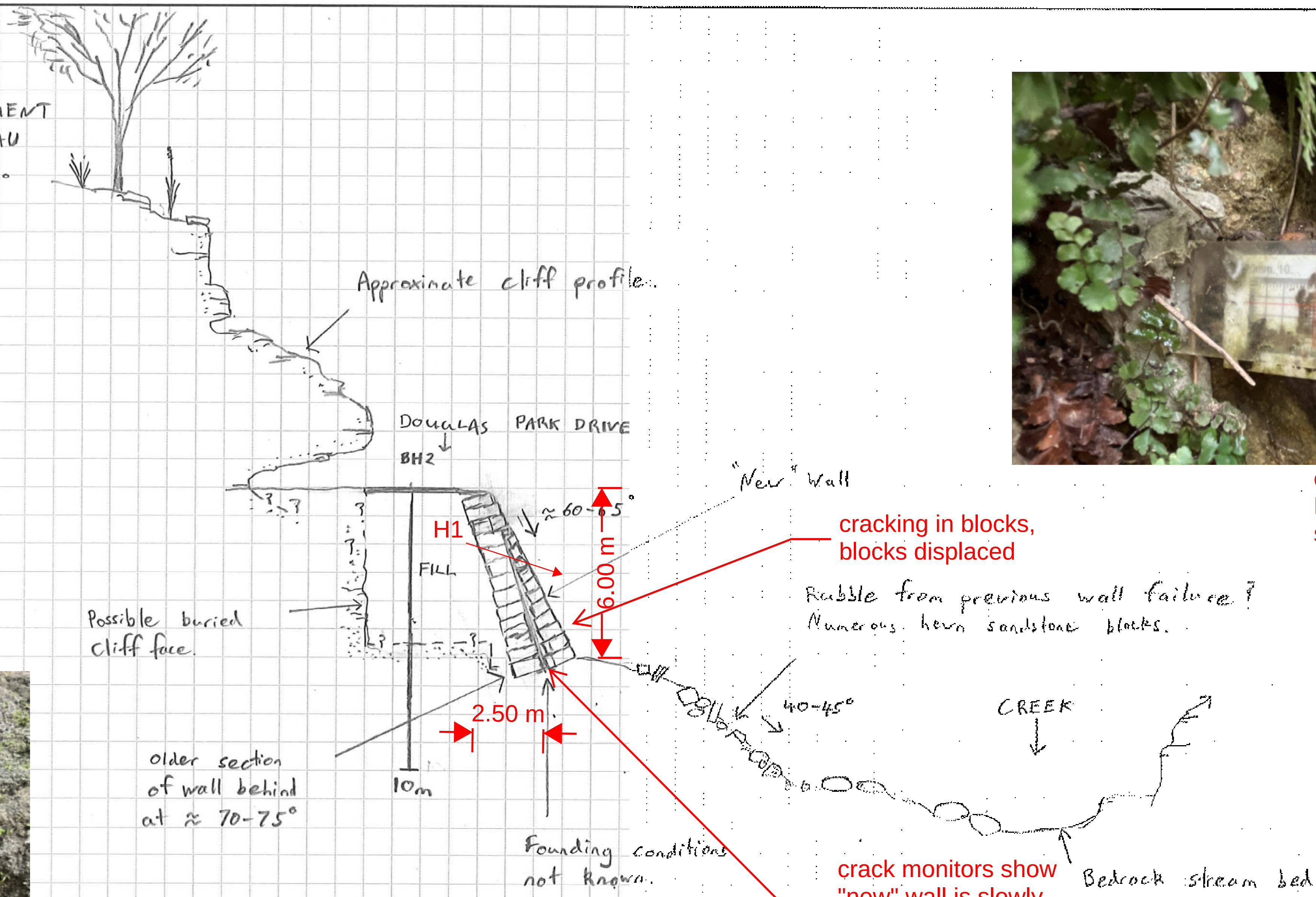
Stantec	Stantec ABN 17 007 820 322	By AC	Date 1/4/2025	Client Wollondilly Shire Council	Sketch No.
	Project No. 304001630 / Scale 1:200	Checked by	Date	Project Name Douglas Park Driveway / Item CH480	

CH500

coffey
Computations

client: Wollondilly Shire Council	project no: GEOTWOLL03882AB
principal:	office: CHATSWOOD
project: Douglas Park Drive	date: 7/6/2016
location: Douglas Park	by: A. HUNTER
	checked:

sheet of



cracking in blocks, blocks displaced

crack monitors show "new" wall is slowly sliding relative to "old" wall

H1: retaining wall bulge failure: blocks cracked, wall bulging and sliding. Live load distance from toe falls in "H/2" range while considered to be under significant distress and is apparently active gives a likelihood of L1

crack monitor between walls. Movement in two axis suggests sliding motion

crack monitor on "new" wall

crack monitor on block on "new" wall

CROSS SECTION A–A'

≈ CHAINAGE 500 (FEATURE 215)

SCALE 1:200 APPROX.

5m

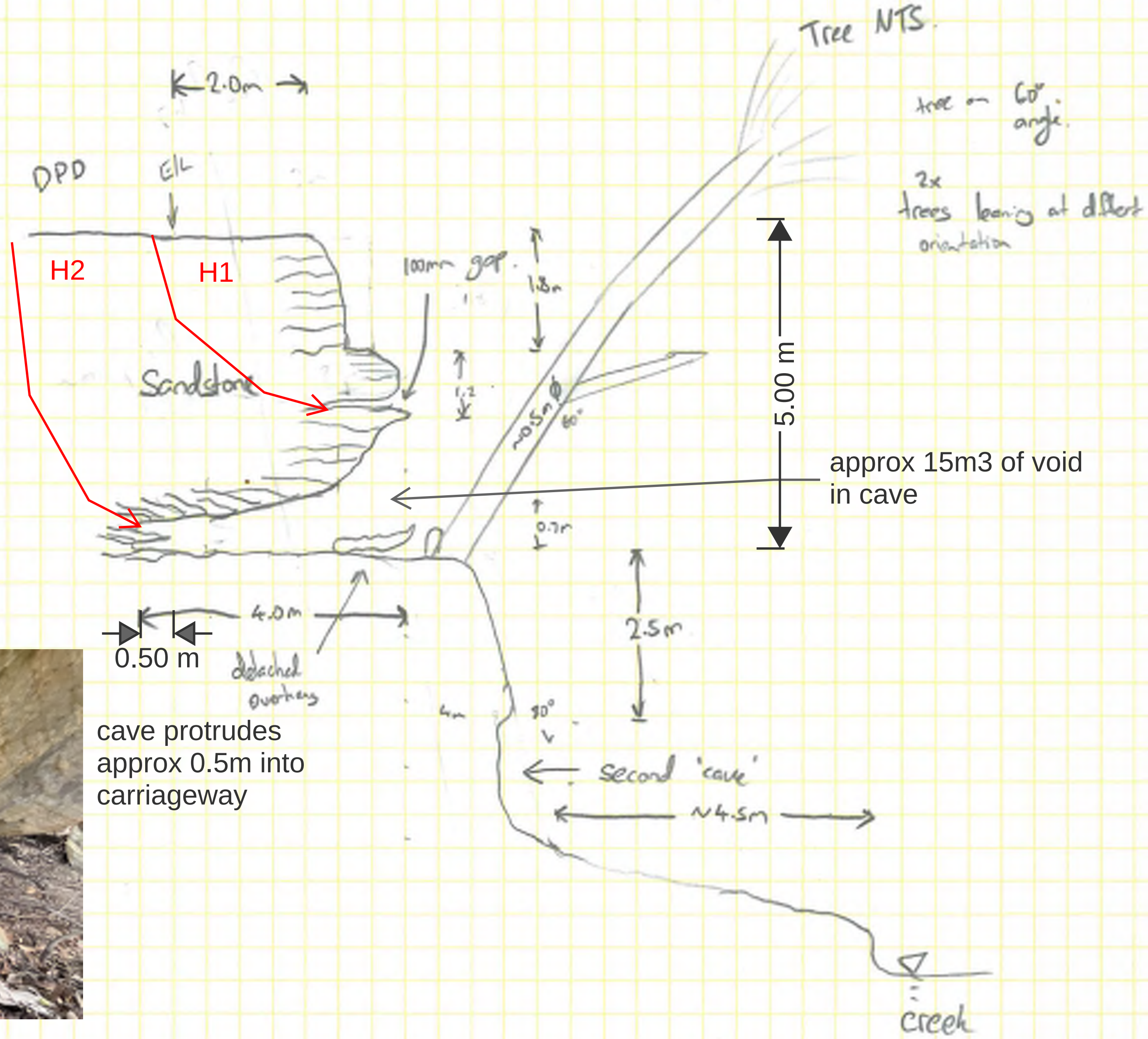
SKETCH No. 6

CH525

SCALE 1:100

5.00 m

~100mm spacing between rock masses



detached overhang

bottom cave

H1: Sandstone block fail through 100mm gap. Evidence of detached overhang failed through bedding plane. Likely to happen as the rock mass weathers through time. Failure will lead to a deep, narrow void. P(d) = 0.001, p(t) =1.0, L=L4

H2: Sandstone block fail from road to cave, likely to happen through an unusually sever event such as a high magnitude earthquake. Failure will lead to a deep, narrow void p(d) =0.0001, p(t) =1.0, L=L5

site 4m wide volume to fill ~ 4m x 4m x 0.7m grout + prop?

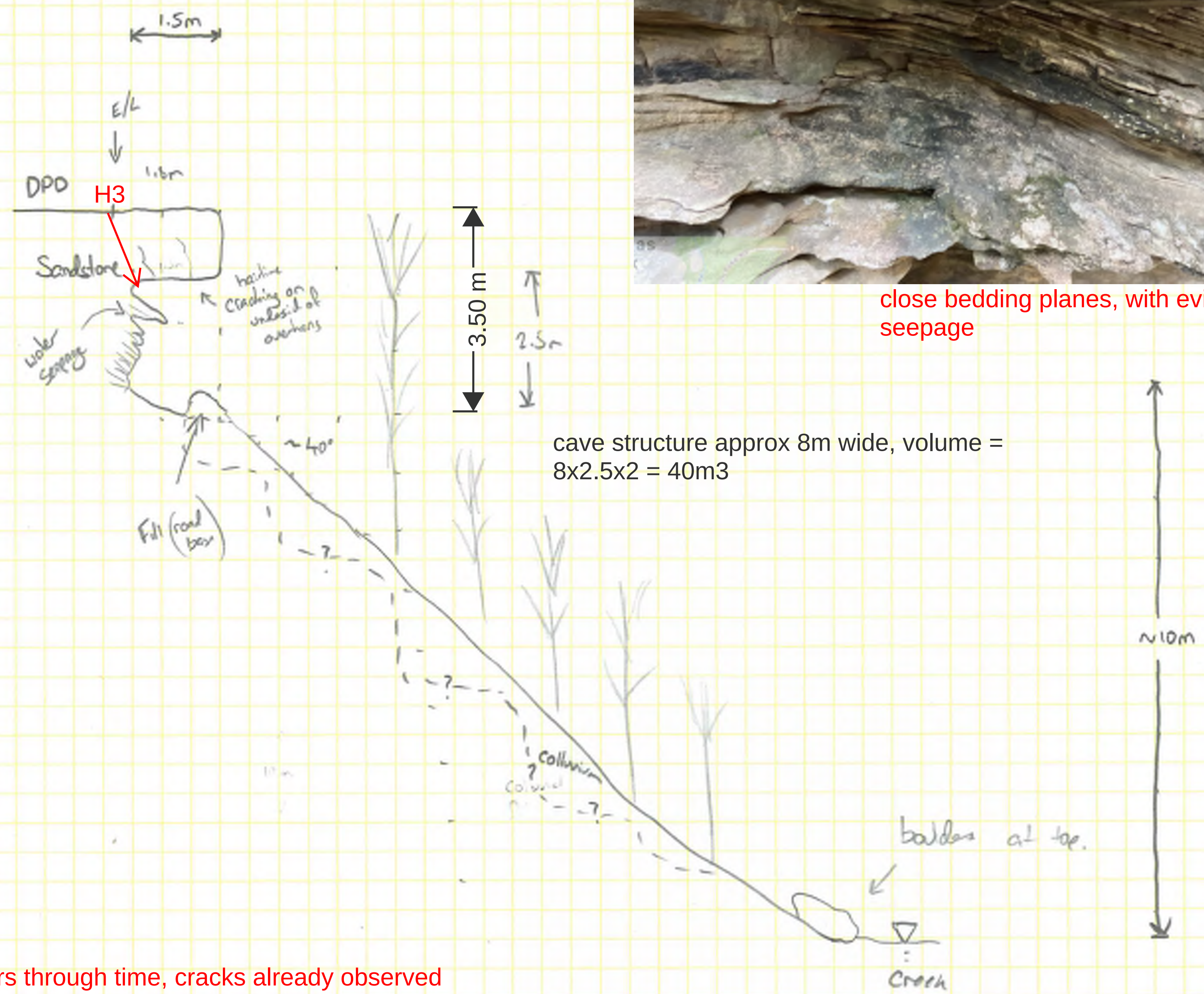
Stantec	Stantec ABN 17 007 820 322	By AC	Date 1/4/2025	Client Wollondilly Shire Council	Sketch No.
	Project No. 304001630 / Scale 1:100	Checked by	Date	Project Name Douglas Park Driveway	
				Item CH525	

CH530

cracking in overhang

crack monitor showing no movement

close bedding planes, with evidence of seepage



cave structure approx 8m wide, volume = 8x2.5x2 = 40m3

H3: Sandstone block fail. Likely to happen as the rock mass weathers through time, cracks already observed on underside of cave. Failure will lead to a deep, narrow void. P(d) = 0.01, p(t) =1.0, L=L3

SCALE 1:100

5.00 m

Stantec	Stantec ABN 17 007 820 322		By AC	Date 1/4/2025	Client Wollondilly Shire Council	Sketch No.
	Project No. 304001630	Scale 1:100	Checked by	Date	Project Name Douglas Park Driveway Item CH530	

DOUGLAS PARK DRIVE STRATEGIC
DESIGN STAGE 1

Slope Identification No.	**DPD ZONE 1 : CH80**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	5.5	Av. Slope Angle (°)	30	Material	soil
	Description:		shallow embankment					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	1	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	small rotational	large translational						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4	S3						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R5	R4						
Likelihood Rating (L1 - L6)	L3	L4						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V4	V3						
Consequence Class for Loss of Life (C1 - C5)	C4	C3						
Consequence Class for property damage etc (C1 - C5)	C4	C3						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL4	ARL4						
Support and Remediation								
Existing support, stabilisation, control or management measures	Nil							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		General mainenance				

Zone 1 CH0-155m: embankment is heavily vegetated with ferns and small trees which will help anchor soil and reduce erosion. Loss of vegetation could lead to an esculated ARL. Culverts should be maintained to prevent overflow and sheeting accross roadway. It should be noted culverts inspeceted appeared to be relatively free of debris

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	6	11						
Height (m)	1.5	2.5						
Width (m)	5	8						
Estimated volume (m^3)	45	220						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	DPD ZONE 2: CH180					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	7	Av. Slope Angle (°)	45	Material	soil
	Description:		steep embankment					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	1	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	small rotational	large translational						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4	S3						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R5	R4						
Likelihood Rating (L1 - L6)	L3	L4						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V4	V3						
Consequence Class for Loss of Life (C1 - C5)	C4	C3						
Consequence Class for property damage etc (C1 - C5)	C4	C3						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL4	ARL4						
Support and Remediation								
Existing support, stabilisation, control or management measures	Nil							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		General mainenance				

Zone 2 CH155-225: embankent appears constructed from fill placed on colluvial material which overlays sandstone, however much steeper and higher fill profile than that in zone 1. The embankment is heavily vegetated with ferns and small trees which will help anchor soil and reduce erosion. Loss of vegetation could lead to an esculated ARL. Some pavement cracking previously noted at CH 215, suggesting some creep mechanicsm present
Culverts should be maintained to prevent overflow and sheeting accross roadway. It should be noted culverts inspected appeared to be relatively free of debris

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	6	10						
Height (m)	1.5	1.5						
Width (m)	5	8						
Estimated volume (m^3)	45	120						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	DPD ZONE 3: CH240					Date		8-Apr-2025
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:		DAVID RONCHI
Slope Data	Slope Class	fill	Max Slope Height (m)	7	Av. Slope Angle (°)	60	Material	soil
	Description:		historic drystone wall					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse							
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4							
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3							
Likelihood Rating (L1 - L6)	L3							
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3							
Vulnerability (V1 - V5)	V3							
Consequence Class for Loss of Life (C1 - C5)	C3							
Consequence Class for property damage etc (C1 - C5)	C3							
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL3							
Support and Remediation								
Existing support, stabilisation, control or management measures	Nil							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier pile				

Zone 3 CH225-270: comprises of dry-stone wall with typical height of 6-7m which incorporates colluvial boulders within the wall construction. Wall also appears to be founded on colluvial boulders. Minor bulging observed at CH250 suggesting minor distress. Ongoing surveillance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2							
Height (m)	4.5							
Width (m)	5							
Estimated volume (m^3)	45							
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	live loading							

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	**DPD ZONE 4: CH290**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	8	Av. Slope Angle (°)	45	Material	soil
	Description:		steep embankment					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	small rotational	large translational						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S5	S4						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R5	R4						
Likelihood Rating (L1 - L6)	L3	L4						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V4	V3						
Consequence Class for Loss of Life (C1 - C5)	C4	C3						
Consequence Class for property damage etc (C1 - C5)	C4	C3						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL4	ARL4						
Support and Remediation								
Existing support, stabilisation, control or management measures								
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil anchors				

Zone 4 CH270-315: start of single lane road. Embankent appears constructed from fill placed on colluvial material which overlays sandstone, however much steeper and higher fill profile than that in zone 1. The embankment is heavily vegetated with ferns and small trees which will help anchor soil and reduce erosion. Loss of vegetation could lead to an esculated ARL. Some pavement cracking previously noted at CH 270-290, suggesting some creep mechanicsm are at play

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2	8.5						
Height (m)	1	2						
Width (m)	5	8						
Estimated volume (m^3)	10	136						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

DOUGLAS PARK DRIVE STRATEGIC
DESIGN STAGE 1

Slope Identification No.	**DPD ZONE 5: CH325**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	7	Av. Slope Angle (°)	45	Material	soil + retaining wall
	Description:		historic drystone wall actively failing					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		N
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse, no TC	Large Translational	Large Translational					
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4	S4	S4					
Scale of Failure Rating - for Block Size (S1 - S5)	-							
Velocity of Failure Rating (R1 - R5)	R3	R4	R4					
Likelihood Rating (L1 - L6)	L1	L4	L4					
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3	T3					
Vulnerability (V1 - V5)	V3	V3	V3					
Consequence Class for Loss of Life (C1 - C5)	C3	C3	C3					
Consequence Class for property damage etc (C1 - C5)	C3	C3	C3					
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL1	ARL4	ARL4					
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier pile				

Zone 5 CH315-330: comprises of undermined stacked sandstone boulders up to 1m diameter with typical height of 6m which is failing, with slumped pavement at crest of embankment and a discrete zone of undermining. This profile is directly adjacent to sandstone outcrop. A traffic control measure has been implemented , with traffic moved approx 2m off the crest of the embankment, reducing the likelyhood from a L1 to a L2 (and consequence ARL1 to ARL2). Ongoing surveillance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2	2	2					
Height (m)	6	8.5	6					
Width (m)	5	5	8					
Estimated volume (m^3)	60	85	96					
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	live loading	live loading	rainfall					

DOUGLAS PARK DRIVE STRATEGIC
DESIGN STAGE 1

Slope Identification No.	**DPD ZONE 6: CH330**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	6	Av. Slope Angle (^{o})	50	Material	soil
	Description:		steep embankment constructed using sandstone blocks					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		N
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	small rotational	large translational						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S5	S4						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R5	R4						
Likelihood Rating (L1 - L6)	L3	L4						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V4	V3						
Consequence Class for Loss of Life (C1 - C5)	C4	C3						
Consequence Class for property damage etc (C1 - C5)	C4	C3						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL4	ARL4						
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier piers				
Zone 6 CH330-340: single lane embankment appears constructed sandstone rockfill approx 6m high. Blocks appear loosly placed and with no apparent control. Bedrock underlies approx 3/4 of the width of the carriageway								
For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	3	10						
Height (m)	2	3						
Width (m)	5	7						
Estimated volume (m^3)	30	210						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	**DPD ZONE 7: CH370**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	2	Av. Slope Angle (°)	45	Material	soil
	Description:		historic drystone wall					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse							
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S5							
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3							
Likelihood Rating (L1 - L6)	L6							
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3							
Vulnerability (V1 - V5)	V3							
Consequence Class for Loss of Life (C1 - C5)	C3							
Consequence Class for property damage etc (C1 - C5)	C3							
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL5							
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier piers				

Zone 7 CH340-370: comprises of dry-stone wall with typical height of approximately 2-2.5m and around 40 degrees, likely founded on bedrock. Approximately 3/4 of the width of the carriageway is also likely founded on sandstone. Ongoing surveillance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2.5							
Height (m)	1							
Width (m)	5							
Estimated volume (m^3)	12.5							
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	live loading							

DOUGLAS PARK DRIVE STRATEGIC
DESIGN STAGE 1

Slope Identification No.	**DPD ZONE 7CH400**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	2	Av. Slope Angle (°)	65	Material	soil + retaining wall
	Description:		historic drystone wall					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse	medim roatation						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S5	S4						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3	R4						
Likelihood Rating (L1 - L6)	L3	L4						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V3	V4						
Consequence Class for Loss of Life (C1 - C5)	C3	C4						
Consequence Class for property damage etc (C1 - C5)	C3	C4						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL3	ARL4						
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail				

Zone 8 CH370-430: comprises of dry-stone wall with typical height of approximately 2-2.5m and around 60-70 degrees. There is a small bulge in the wall around CH420, and some blocks are cracked. Wall founded on fill or colluvium/XW rock as per findings in coffey BH06. Ongoing surveylance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2.5	8.5						
Height (m)	1	2.5						
Width (m)	5	10						
Estimated volume (m^3)	12.5	212.5						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	live loading	rainfall						

DOUGLAS PARK DRIVE STRATEGIC
DESIGN STAGE 1

Slope Identification No.	**DPD CH436**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	4	Av. Slope Angle (°)	75	Material	soil
	Description:		failing historic drystone wall					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse with TC	Retaining wall collapse no TC						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4	S4						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3	R3						
Likelihood Rating (L1 - L6)	L1	L2						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V3	V3						
Consequence Class for Loss of Life (C1 - C5)	C3	C3						
Consequence Class for property damage etc (C1 - C5)	C3	C3						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL1	ARL2						
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier piers, cutting into upslope to move traffic away from crest				

Zone 9 CH430-450: comprises of dry-stone wall with typical height of 3-4m which is failing, with bulging in wall observed and a privet growing in the wall which is subject no root-jacking. A traffic control measure has been implemented , with traffic moved approx 1m off the crest of the embankment, reducing the likelyhood from a L1 to a L2 (and consequence ARL1 to ARL2). Ongoing surveylance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	3	10						
Height (m)	2	3						
Width (m)	5	7						
Estimated volume (m^3)	30	210						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	live loading	live loading						

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	**DPD CH460**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	5	Av. Slope Angle (°)	65	Material	soil
	Description:		historic drystone wall					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse							
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4							
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3							
Likelihood Rating (L1 - L6)	L5							
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3							
Vulnerability (V1 - V5)	V3							
Consequence Class for Loss of Life (C1 - C5)	C3							
Consequence Class for property damage etc (C1 - C5)	C3							
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL5							
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier piers, cutting into upslope to move traffic away from crest				

Zone 10 CH450-470: comprises of dry-stone wall with typical height of between 4 and up to 6m high. Wall appears in good condition. Ongoing surveylance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	3	10						
Height (m)	2	3						
Width (m)	5	7						
Estimated volume (m^3)	30	210						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	**DPD CH480**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	5	Av. Slope Angle (°)	50	Material	rock and soil
	Description:		rock fill embankment founded on cave					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	small rotational	overhang failure						
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S5	S4						
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3	R3						
Likelihood Rating (L1 - L6)	L5	L3						
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3						
Vulnerability (V1 - V5)	V3	V2						
Consequence Class for Loss of Life (C1 - C5)	C4	C2						
Consequence Class for property damage etc (C1 - C5)	C4	C3						
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL5	ARL2						
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		props, grout, remove overhang				

Zone 11 CH470-480: comprises of approx 3m of sandstone block fill between carriageway and underlaying cave. Cave petrudes 1.5m, with an overhang of 2x2x5m weighing approx 45 tonnes. Consider proping overhang and filling void with grout. Overhang could also be carefully removed using a saw cut for example to remove unspported mass.
Ongoing surveylance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2	5						
Height (m)	2	2						
Width (m)	2.5	10						
Estimated volume (m^3)	10	100						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

DOUGLAS PARK DRIVE STRATEGIC
DESIGN STAGE 1

Slope Identification No.	**DPD CH500**					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	6	Av. Slope Angle (°)	65	Material	soil + retaining wall
	Description:		historic drystone wall, remediated with a second drystone wall skin					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	Retaining wall collapse							
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S4							
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R3							
Likelihood Rating (L1 - L6)	L1							
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3							
Vulnerability (V1 - V5)	V3							
Consequence Class for Loss of Life (C1 - C5)	C3							
Consequence Class for property damage etc (C1 - C5)	C3							
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL1							
Support and Remediation								
Existing support, stabilisation, control or management measures	historic second skin on drystone wall							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		soil nail, soldier peirs, excavate upslope				

Zone 12 CH480-515: comprises of dry-stone wall with typical height of approximately 5-6m and around 55-65 degrees. CH485-510 a "new" wall skin has been constructed infront of the old wall, likely to stabalise the originial wall. Crack monitors between the walls suggest the new wall is sliding away from the old wall. Frequent cracks in blocks, and crack monitors suggest that slow bulging mechanism at play. Traffic bollards have been placed to keep traffic off the crest, however traffic likely to still be placing unsafe live load on wall . Ongoing surveylance of retaining wall should be undertaken in accordance with TARP.

For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2							
Height (m)	6							
Width (m)	10							
Estimated volume (m^3)	120							
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	live loading							

DOUGLAS PARK DRIVE STRATEGIC DESIGN STAGE 1

Slope Identification No.	DPD CH525-530					Date	8-Apr-2025	
Inspection Date	1-Apr-2025		Completed By:	A. Coghlan		Checked By:	DAVID RONCHI	
Slope Data	Slope Class	fill	Max Slope Height (m)	5	Av. Slope Angle (^{o})	90	Material	rock
	Description:		cave systems downslope of carriagway					
Road Data	AADT		1849	Year of Count	2024	Speed Limit (km/hr)		60
	No of Lanes	Prescribed Direction	1	Counter Direction	0	Site Distance Adequate? (Y/N)		Y
Risk Analysis								
Hazard/Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hazard Type	medium block fail	large block fail	medium block fail					
Failure Dynamics Ratings								
Scale of Failure Rating - for Volume (S1 - S5)	S5	S4	S5					
Scale of Failure Rating - for Block Size (S1 - S5)	-	-						
Velocity of Failure Rating (R1 - R5)	R1	R1	R1					
Likelihood Rating (L1 - L6)	L4	L5	L3					
Consequence Class Ratings								
Temporal Probability (T1 - T5)	T3	T3	T3					
Vulnerability (V1 - V5)	V2	V2	V2					
Consequence Class for Loss of Life (C1 - C5)	C2	C2	C2					
Consequence Class for property damage etc (C1 - C5)	C3	C3	C3					
Risk Analysis Ratings								
Assessed Risk Level (ARL1 - ARL5)	ARL3	ARL4	ARL3					
Support and Remediation								
Existing support, stabilisation, control or management measures	N/A							
Need for further investigation? (Y/N)	N	Possible remedial measures (list)		props, grout				

Zone 11 CH470-480: comprises of approx 3m of sandstone block fill between carriageway and underlaying cave. Cave petrudes 1.5m, with an overhang of 2x2x5m weighing approx 45 tonnes. Consider proping overhangs and filling void with grout.
Ongoing surveylance of retaining wall should be undertaken in accordance with TARP.

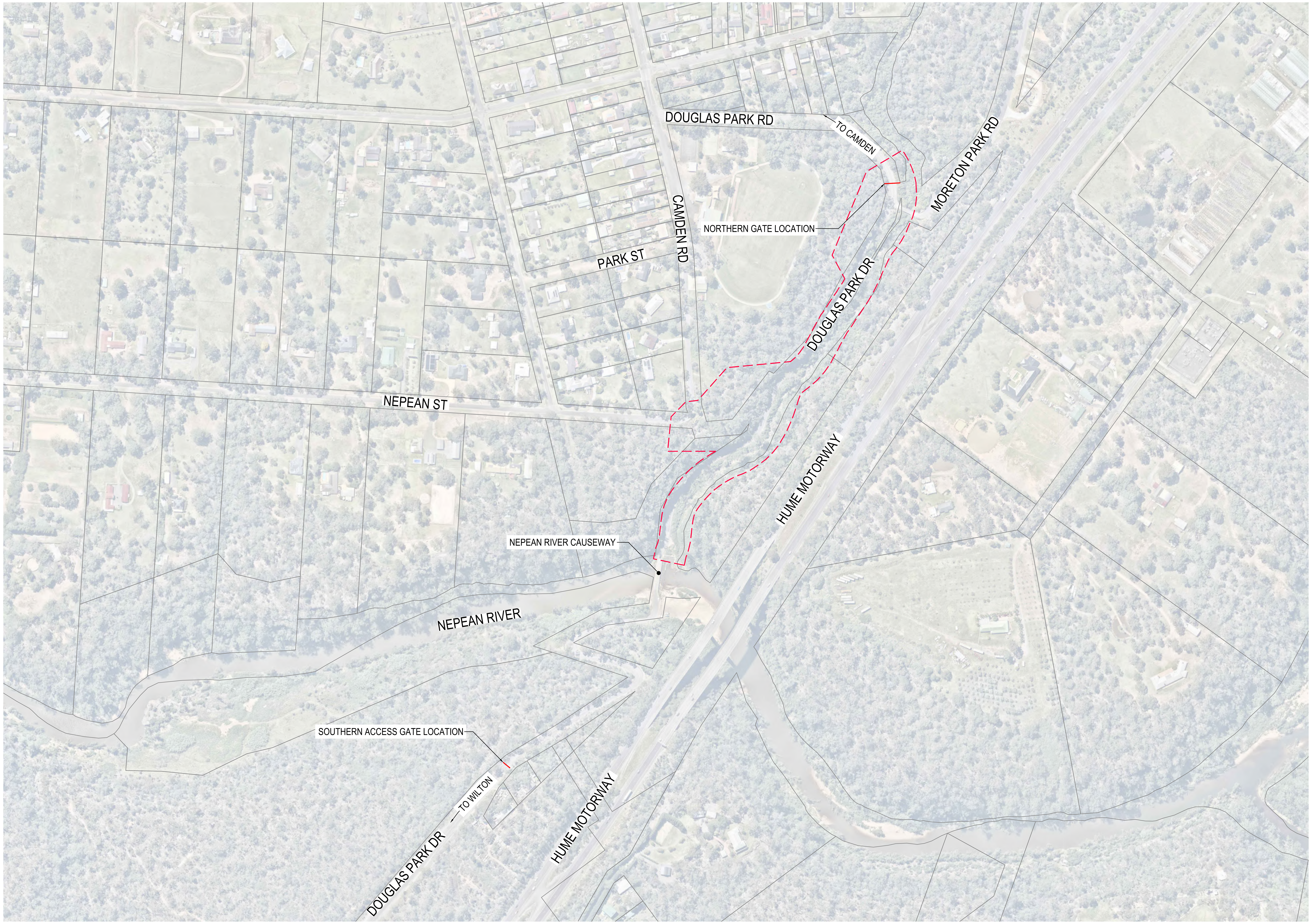
For Each Hazard or Failure Mechanism	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Scale Dimensions for volume								
Length (m)	2	4						
Height (m)	2	4						
Width (m)	4	4						
Estimated volume (m^3)	16	64						
Scale dimensions for block size								
Length (m)								
Height (m)								
Width (m)								
Type of triggering mechanism	rainfall	rainfall						

Appendix B DRAWINGS

DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1
COVER PAGE

DOUGLAS PARK

Project Number: 304001630-01-C1000



NORTH

NOTE

1. IMAGE SOURCED FROM NEAR MAP (MAR, 2025)

LEGEND

- - - PROPOSED WORKS BOUNDARY

OVERALL IMPACT AREA

SCALE 1:1500

0 50 100 150m

SCALE 1:1500 (A1), 1:3000 (A3)

A	ISSUED FOR APPORVAL	EJK	DR	02/04/2025
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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1
DOUGLAS PARK

EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

Title OVERALL IMPACT AREA

Project No. 304001630

Scale at A1 1:1000

Drawing No. 304001630-01-C1001

Revision A

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Plotted: Deitz, Aston Date: 4/04/2025 11:00:31 AM

ORIGINAL SHEET - ISO A1

1 2 3 4 5

C

B

A

0 50 100 150m

SCALE 1:1500 (A1), 1:3000 (A3)

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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

DOUGLAS PARK

EJK		DR	DR	02/04/2025
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Title GENERAL NOTES

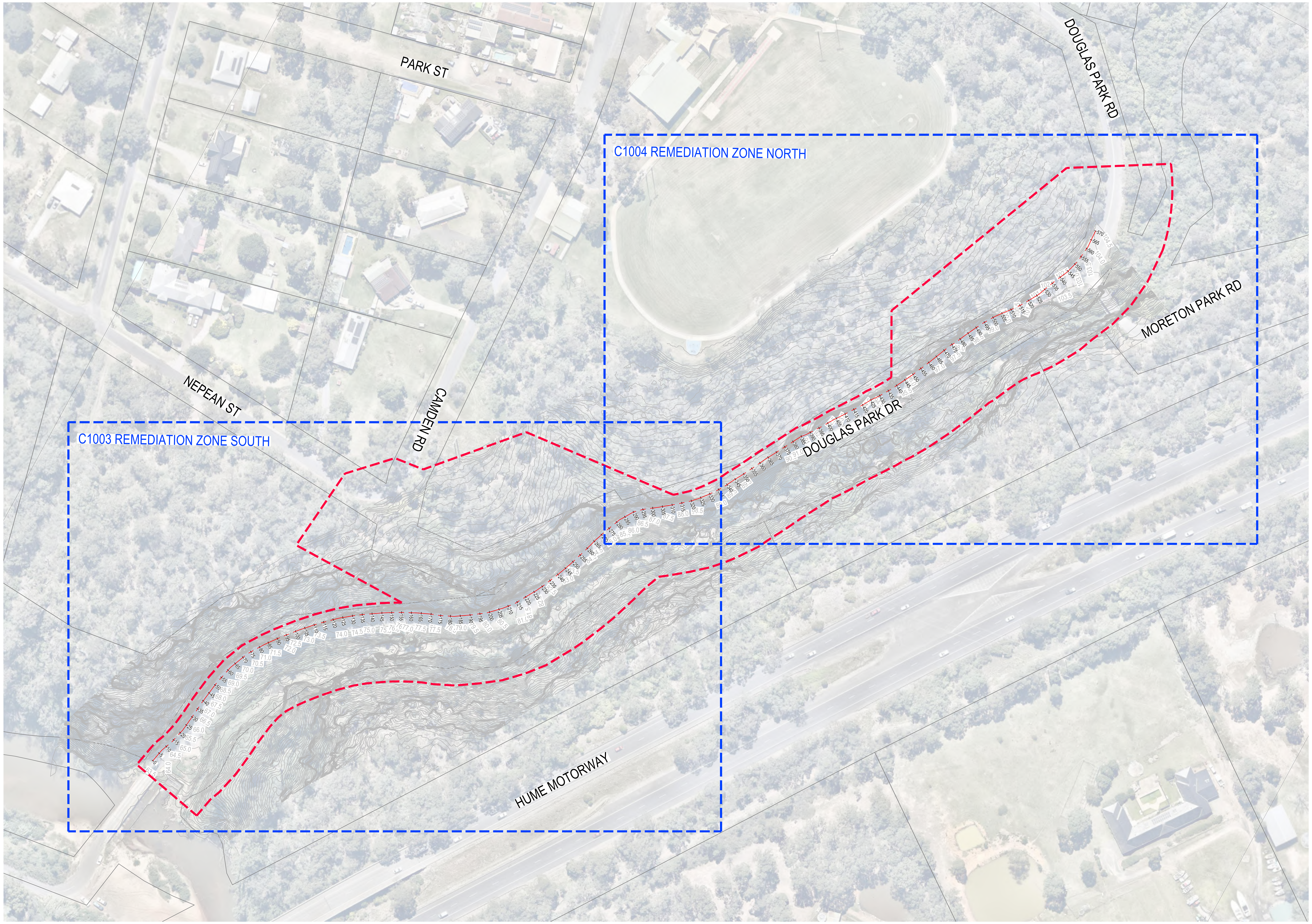
Project No. 304001630

Scale at A1 NTS

Drawing No. 304001630-01-C1002

Revision A

ORIGINAL SHEET - ISO A1



NOTE

1. IMAGE SOURCED FROM NEAR MAP (MAR, 2025)

LEGEND

PROPOSED WORKS BOUNDARY

OVERALL PROJECT AREA

SCALE 1:1000

0 20 40 60 80 100m
SCALE 1:1000 (A1), 1:2000 (A3)

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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1
DOUGLAS PARK

EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

Title OVERALL PROJECT AREA

Project No. 304001630
Scale at A1 1:1000
Drawing No. 304001630-01-C1003
Revision A

ORIGINAL SHEET - ISO A1

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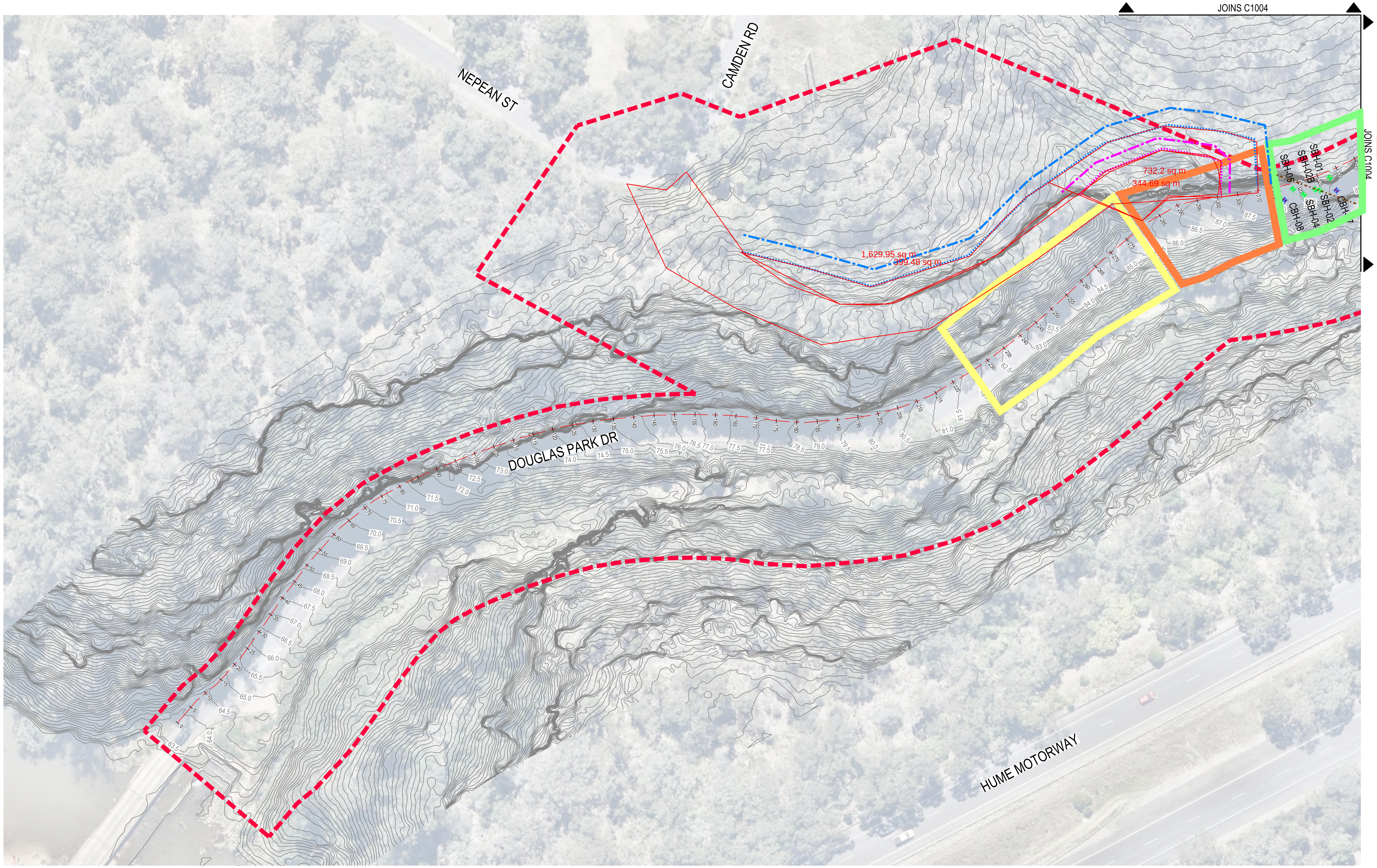

DOMAIN 1 - CH225-280
DOMAIN 2 - CH280-315
DOMAIN 3 - CH315-330
DOMAIN 4 - CH330-370
DOMAIN 5 - CH370-430
DOMAIN 6 - CH430-580

Road realignment (Existing) toe line
Road realignment (Existing) crest line
Road realignment (Widen) toe line
Road realignment (Widen) crest line

NOTE

1. IMAGE SOURCED FROM NEAR MAP (MAR, 2025)

LEGEND

PROPOSED WORKS BOUNDARY
2023 SMEC BOREHOLES
2017 COFFEY BOREHOLES
EXISTING CONTOURS (0.5m)

REMEDIATION AREA - SOUTH

SCALE 1:500

0 10 20 30 40 50m
SCALE 1:500 (A1), 1:1000 (A3)

Rev	Description	By	Appd	Date
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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1
DOUGLAS PARK

Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY
EJK		DR	DR	02/04/2025

Title
REMEDIATION AREA
SOUTH

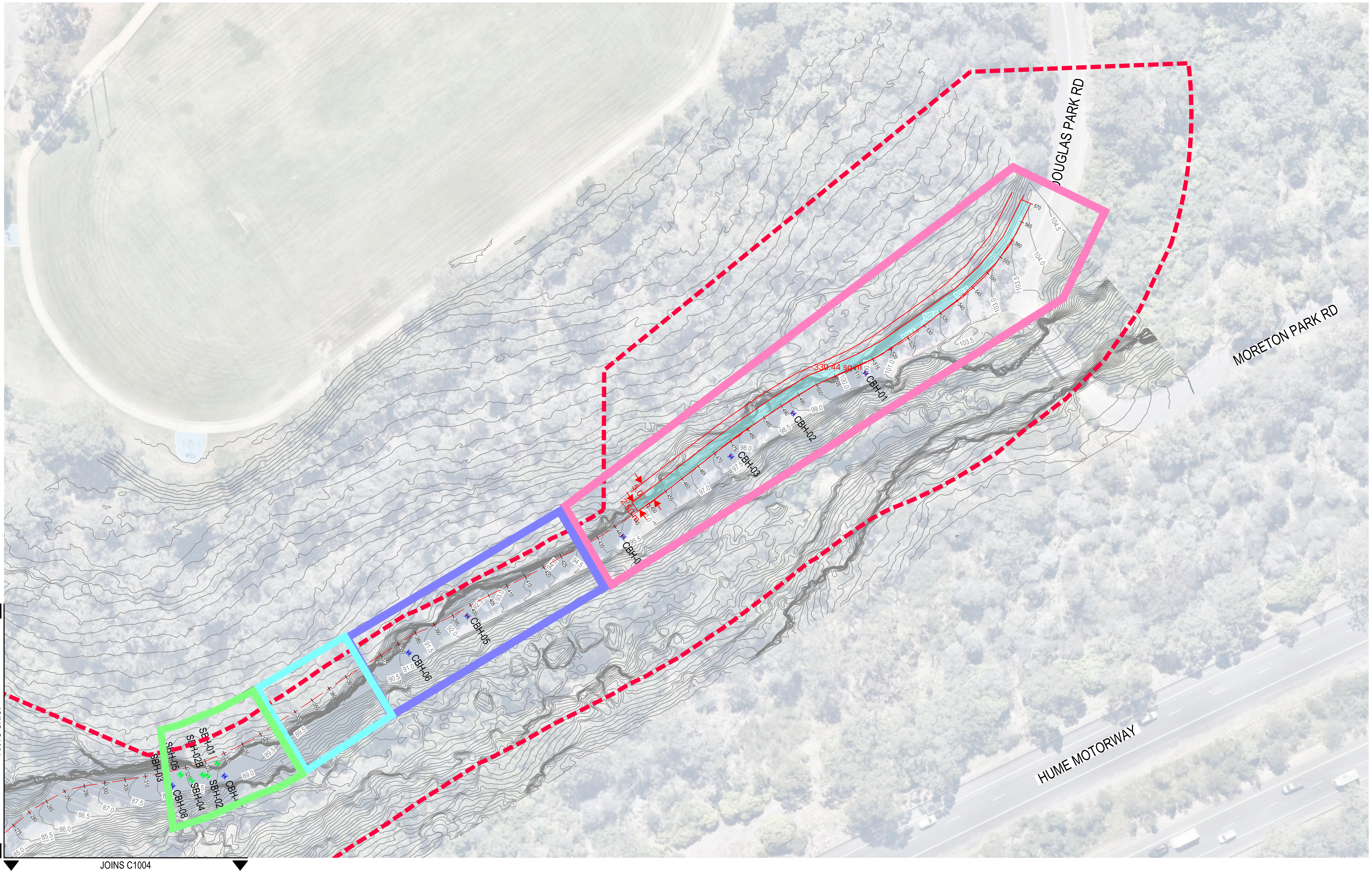
Project No.
304001630

Scale at A1
1:500

Drawing No.
304001630-01-C1004

Revision
A

ORIGINAL SHEET - ISO A1



NORTH

- DOMAIN 1 - CH225-280
- DOMAIN 2 - CH430-580
- DOMAIN 3 - CH430-580
- DOMAIN 4 - CH430-580
- DOMAIN 5 - CH430-580
- DOMAIN 6 - CH430-580

NOTE

1. IMAGE SOURCED FROM NEAR MAP (MAR, 2025)

LEGEND

- PROPOSED WORKS BOUNDARY
- 2023 SMEC BOREHOLES
- 2017 COFFEY BOREHOLES
- EXISTING CONTOURS (0.5m)

REMEDIATION AREA - NORTH

SCALE 1:500

0 10 20 30 40 50m

SCALE 1:500 (A1), 1:1000 (A3)

Rev	Issued/Revision	By	Appd	Date
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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

DOUGLAS PARK

Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY
EJK		DR	DR	02/04/2025

Title
REMEDIATION AREA
NORTH

Project No.
304001630

Scale at A1
1:500

Drawing No.
304001630-01-C1005

Revision
A

ORIGINAL SHEET - ISO A1

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SCALE 1:500 (A1), 1:1000 (A3)

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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

DOUGLAS PARK

EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

Title
CROSS SECTIONS
SHEET 01 OF 03

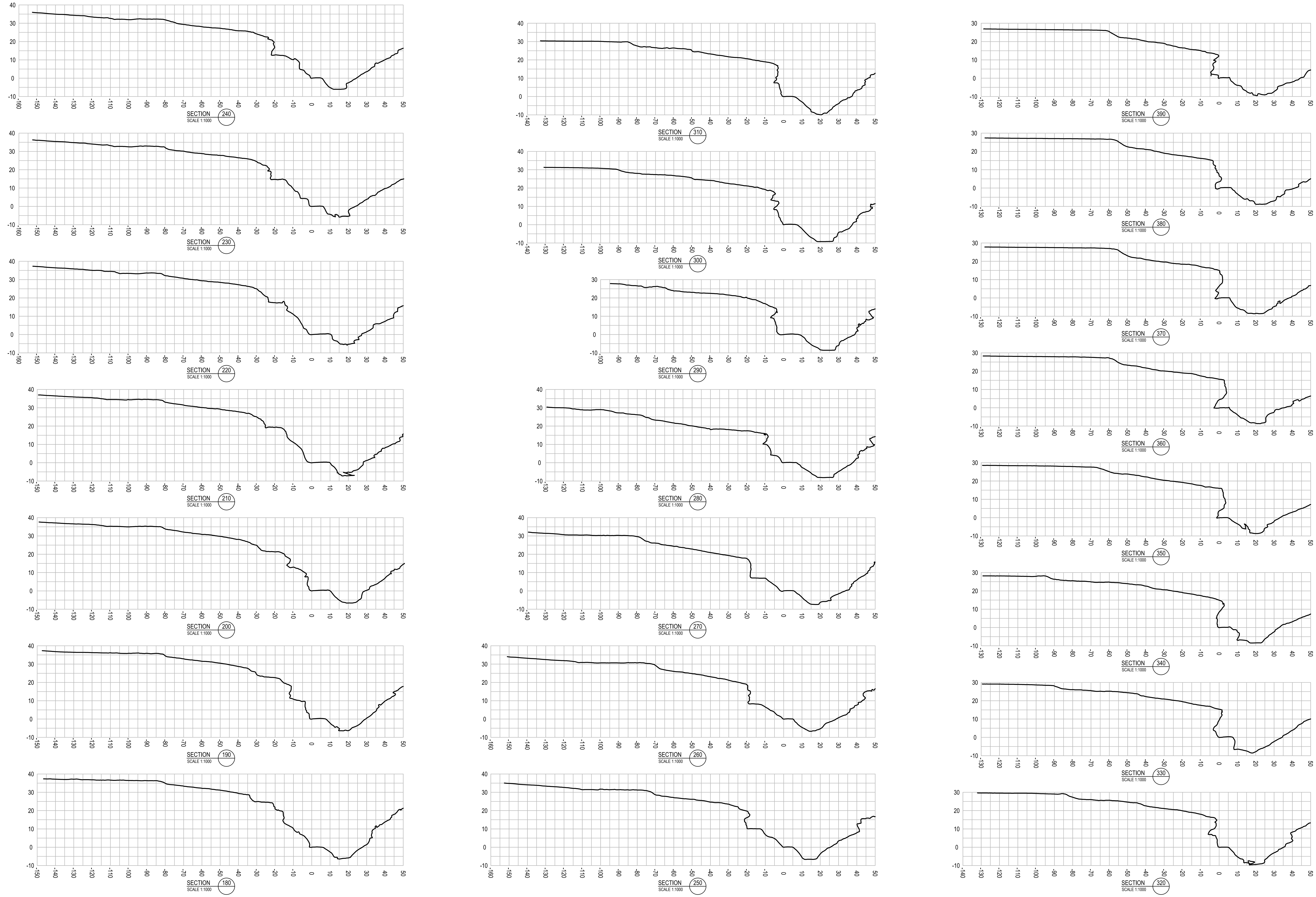
Project No.
304001630

Scale at A1
1:1000

Drawing No.
304001630-01-C1006

Revision
A

ORIGINAL SHEET - ISO A1



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SCALE 1:500 (A1), 1:1000 (A3)

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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

DOUGLAS PARK

EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

Title
CROSS SECTIONS
SHEET 02 OF 03

Project No.
304001630

Scale at A1
1:1000

Drawing No.
304001630-01-C1007

Revision
A

ORIGINAL SHEET - ISO A1

DOMAIN 6 - ROAD CUTTING MAINTAIN WIDTH

0 10 20 30 40 50m
SCALE 1:500 (A1), 1:1000 (A3)

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DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1
DOUGLAS PARK

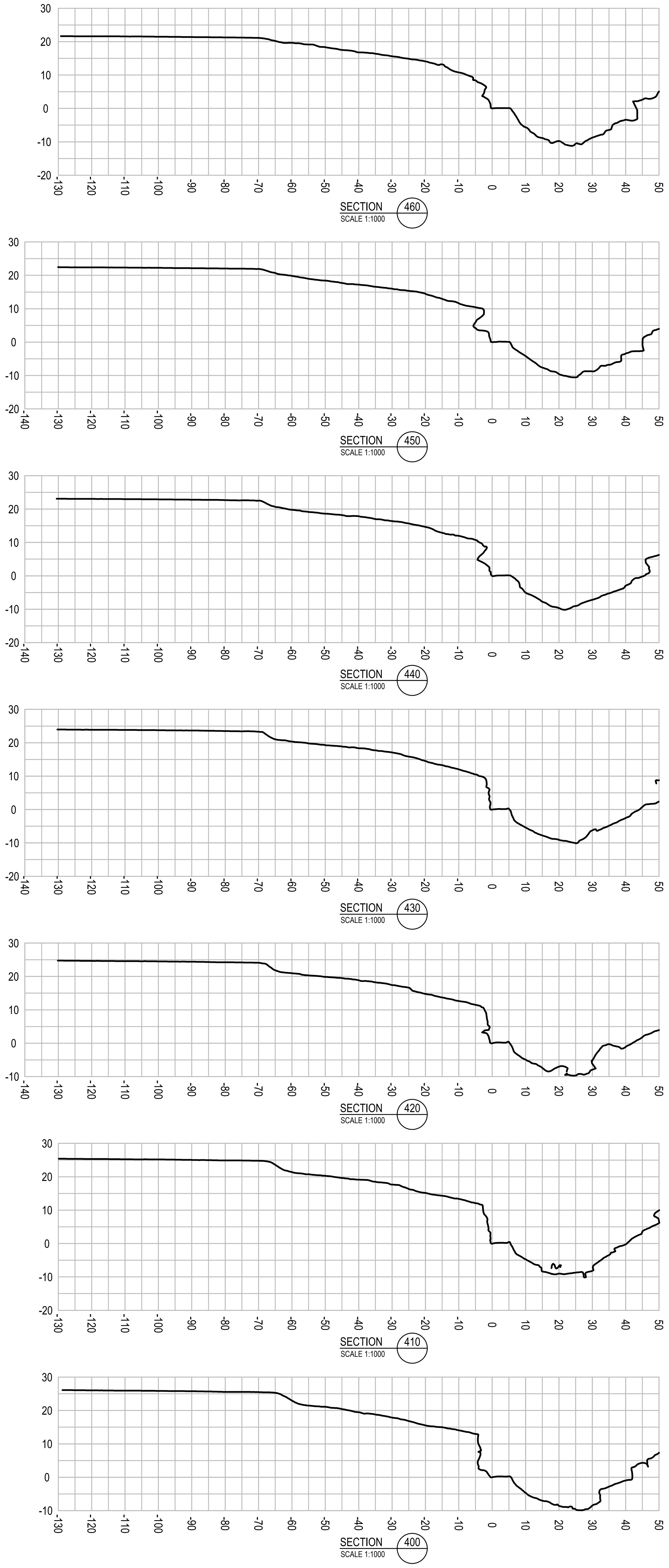
EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

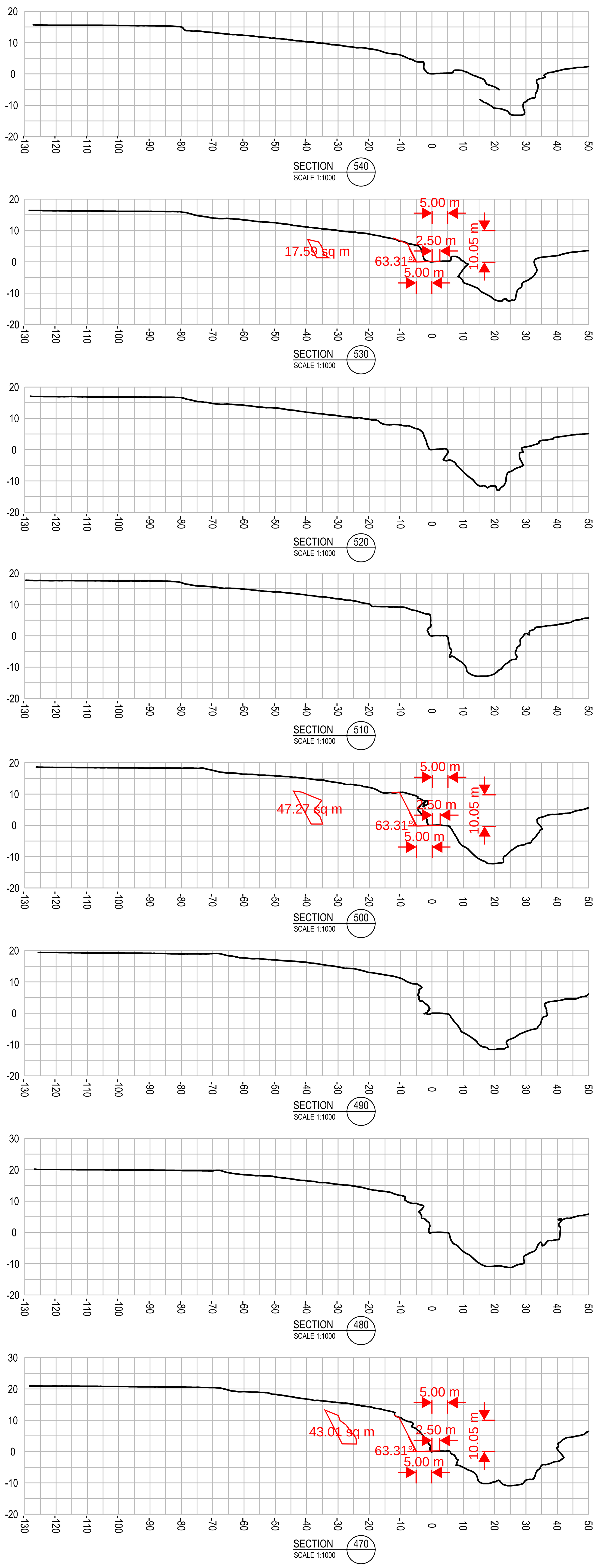
Title CROSS SECTIONS
SHEET 03 OF 03

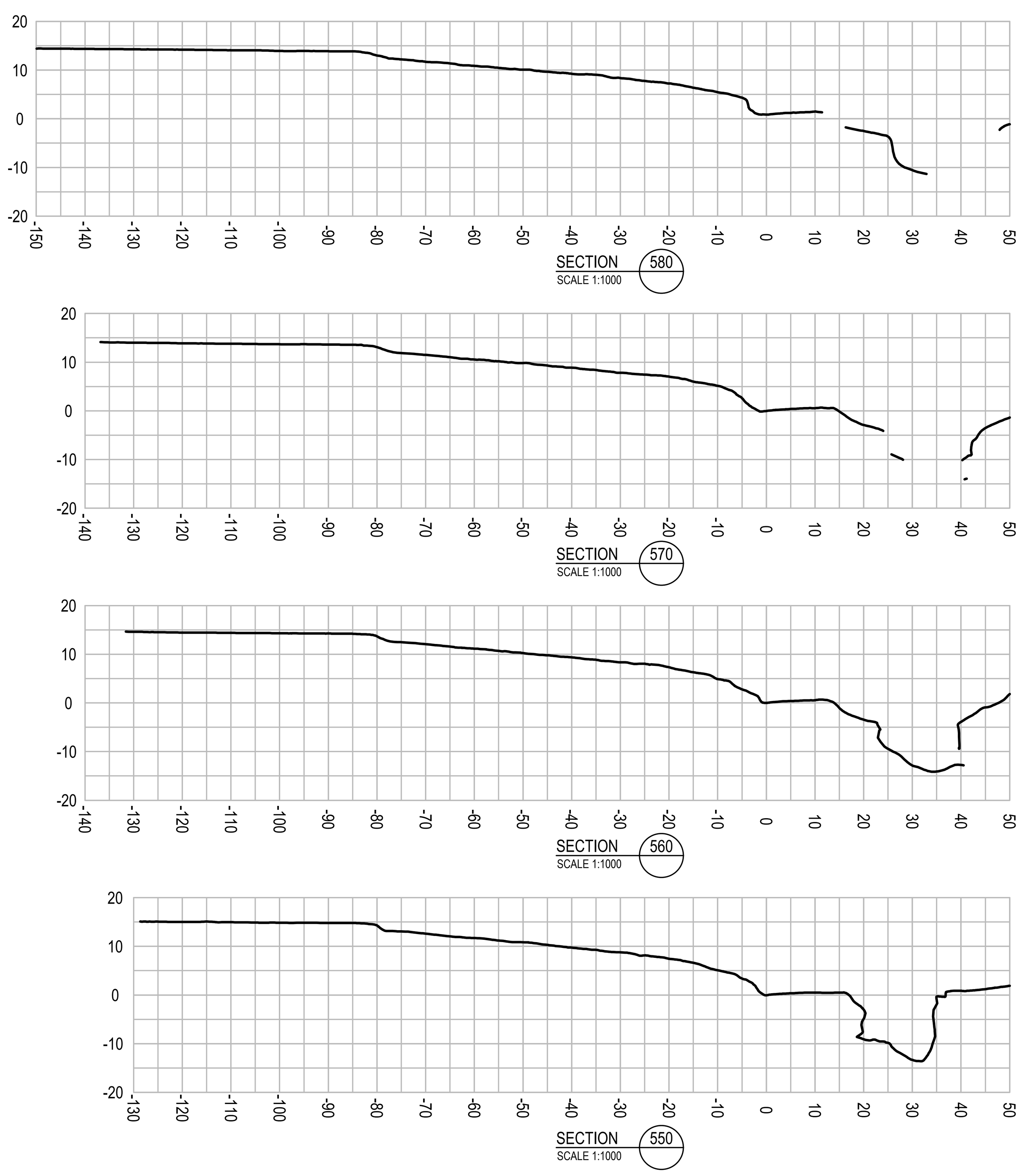
Project No. 304001630
Scale at A1 1:1000
Drawing No. 304001630-01-C1008
Revision A

ORIGINAL SHEET - ISO A1

DOMAIN 6 - ROAD CUTTING WIDEN ALIGNMENT







0 10 20 30 40 50m

SCALE 1:500 (A1), 1:1000 (A3)

A	ISSUED FOR APPORVAL	EJK	DR	02/04/2025
Issued/Revision		By	Appd	DD.MM.YYYY

Issue Status

S0

INITIAL FILE BEING DEVELOPED

This document is suitable only for the purpose noted above. Use of this document for any other purpose is not permitted.

Coordinate System
MGA-2020
Datum
mAHD

Colour Disclaimer

This drawing has been documented in colour. This drawing is required to be printed in colour. Failure to do so may result in loss of information. Black and white printing may be used if specific black and white documents have been obtained from Stantec.

Stantec

Client/Project Logo

Client/Project
XXXX

DOUGLAS PARK, WOLLONDILLY
STRATEGIC DESIGN STAGE 1

DOUGLAS PARK

EJK		DR	DR	02/04/2025
Dwn.	Dsgn.	Chkd.	Appd.	DD.MM.YYYY

Title CROSS SECTIONS
SHEET 03 OF 03

Project No. 304001630

Scale at A1 1:1000

Drawing No. 304001630-01-C1008

Revision A

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Plotted: Deitz, Aston Date: 4/04/2025 11:03:17 AM

ORIGINAL SHEET - ISO A1

Appendix C IMPORTANT INFORMATION

Important Information about this Geotechnical Report

Scope of Work

The purpose of this report and any associated documentation is expressly stated in the document. This document does not form a complete assessment of the site, and no implicit determinations about Stantec's scope can be taken if not specifically referenced. Whilst this report is intended to reduce geotechnical risk, no level of detail or scope of work can entirely eliminate risk.

The nature of geotechnical data typically precludes auxiliary environmental assessment without undertaking specific methods in the investigation. Therefore, unless it is explicitly stated in the scope of work, this report does not provide any contamination or environmental assessment of the site or adjacent sites, nor can it be inferred or implied from any component of the document.

The scope of work, geotechnical information, and assessments made by Stantec may be summarised in the report; however, all aspects of the document, including associated data and limitations should be reviewed in its entirety.

Standard of care

Stantec have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, data that was available or was collected, and previous experience.

Stantec's findings and assessment represent its reasonable judgment, diligence, skill, with sound professional standards, within the time and budget constraints of its commission. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

In preparing this document, or providing any consulting services during the commission, Stantec may have relied on information from third parties including, but not limited to; sub-consultants, published data, and the Client including its employees or representatives. This data may not be verified and Stantec assumes no responsibility for the adequacy, incompleteness, inaccuracies, or reliability of this information.

Stantec does not assume any responsibility for assessments made partly, or entirely based on information provided by third parties.

Variability in conditions and limitations of data

Subsurface conditions are complex and can be highly variable; they cannot be accurately defined by discrete investigations. Geotechnical data is based on investigation locations which are explicitly representative of the specific sample or test points. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and there are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted.

The precision and reliability of interpretive assessment between discrete points is dependent on the uniformity of the subsurface strata, as well as the frequency, detail, and method of sampling or testing.

Subsurface conditions are formed by various natural and anthropogenic processes and therefore are subject to change over time. This is particularly relevant with changes to the site ownership or usage, site boundary or layout, and design or planning modifications. Aspects of the site may also not be able to be determined due to physical or project related constraints and any information provided by Stantecca cannot apply following modification to the site, regulations, standards, or the development itself.

It is important to appreciate that no level of detail in investigation, or diligence in assessment, can eliminate uncertainty related to subsurface conditions and thus, geotechnical risk. Stantec cannot and does not provide unqualified warranties nor does it assume any liability for site conditions not observed or accessible during the investigations.

Verification of opinions and recommendations

Geotechnical information, by nature, represents an opinion and is based extensively on judgement of both data and interpretive assessments or observation. This report and its associated documentation are provided explicitly based on Stantec's opinion of the site at the time of inspection, and cannot be extended beyond this.

Any recommendations or design are provided as preliminary until verified on site during project implementation or construction. Inspection and verification on site shall be conducted by a suitably qualified geotechnical consultant or engineer, and where subsurface conditions or interpretations differ from those provided in this document or otherwise anticipated, Stantec must be notified and be provided with an opportunity to review the recommendations.

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