pitt&sherry

Cornwall Coal

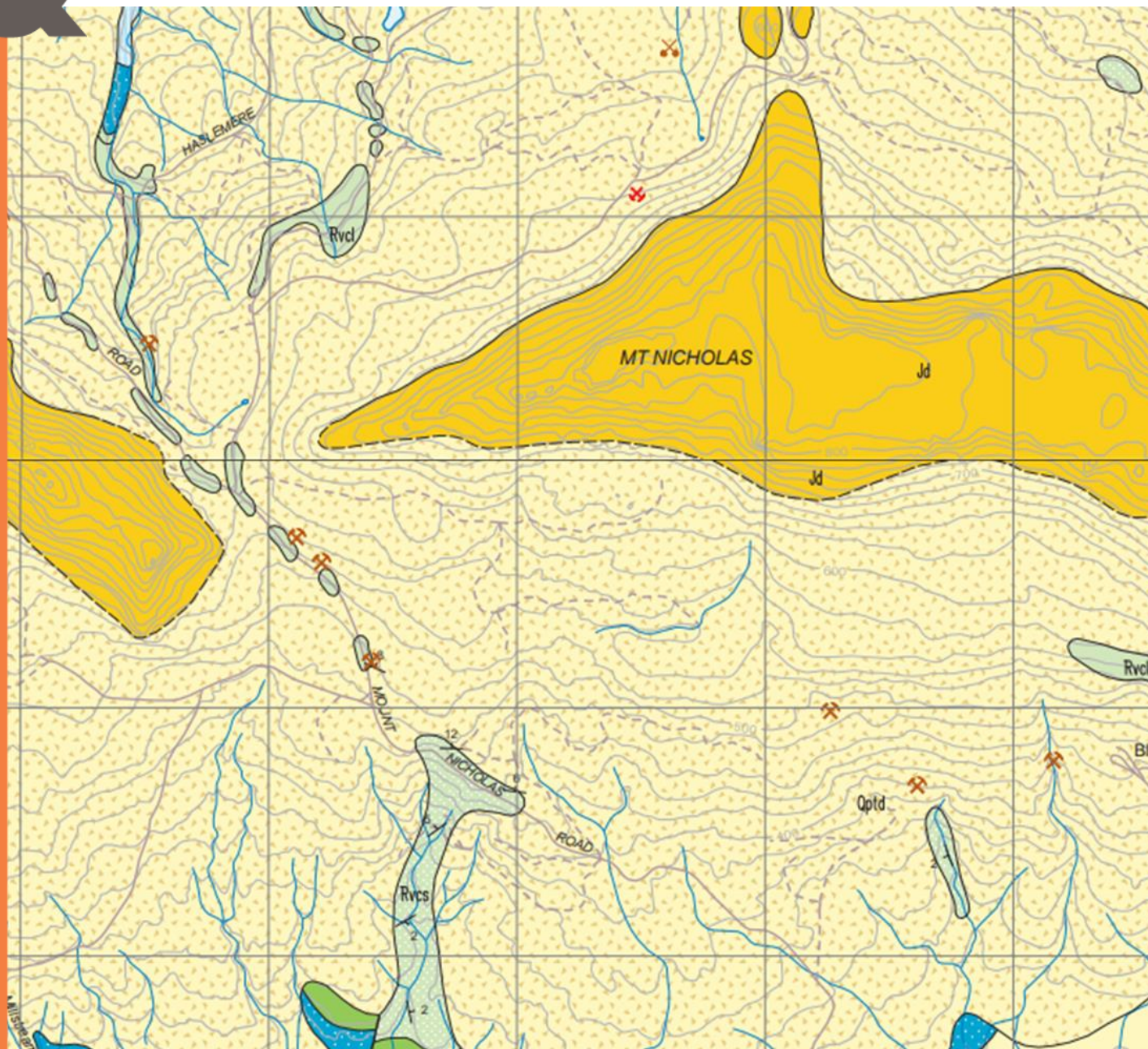
Blackwood 6 Landslide Risk Assessment

Prepared for
Cornwall Coal

Client representative
Keith Falconer

Date
3 May 2021

Rev00



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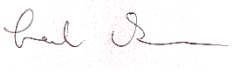
Prepared by — Peter Hills		**Date** — 3 May 2021
Reviewed by — Leah Brown		**Date** — 3 May 2021
Authorised by — David Atchison		**Date** — 3 May 2021

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
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1. Introduction

Cornwall Coal is seeking to establish an underground mining operation on the Nicholas Range in the vicinity of Millstream Creek below the Mount Nicholas Road. The mine, to be known as Blackwood 6 will have three portals and surface infrastructure established at the base of a steep slope. As is the case elsewhere on the Nicholas Range, colluvium derived from the weathering of dolerite blankets much of the surface over Permo-Triassic sediments. Landslide has been an ongoing hazard for coal mining on the south side of the Nicholas Range since the mid 1800's with the most recent significant events occurring as recently at 2010 in the vicinity of the current Blackwood 4 operation.

Due to concerns raised by Mineral Resources Tasmania following the presentation of various proposals to obtain permitting for the Blackwood 6 development, pitt&sherry has been retained to review the information presented and provide an assessment of the landslide risk. pitt&sherry has extensive recent experience with the landslide risk on the Nicholas Range, particularly in relation to the Blackwood 4 operation and remediation and mitigation works undertaken at that site. pitt&sherry has previously investigated Blackwood 6 site and is familiar with the terrain.

2. Broad Geology

The simple geology of the Nicholas Range as it appears now, for the purpose of this report the ridge extending from Mount Durham in the west, over Mount Nicholas and on to South sister in the east is a sequence of Permo-Triassic sediments (including coal measures) beneath a ridge line of Jurassic dolerite. It forms a semi-isolated fault bounded island of post-Devonian rocks above a statewide unconformity between those rocks and all older Tasmanian rocks of whatever origin and can be mapped from Cape Portland to Southeast Cape and Bicheno to Zeehan. The dolerite was originally emplaced into the Permo-Triassic sediments as a sill and the sediments above have long since eroded away. So too, much of the dolerite once it was exposed.

However, fresh dolerite is a very hard, strong rock and it is not prone to simply disintegrating as the Permo-Triassic sediments do. Rather, groundwater penetrates the joints and faults in the fabric of the rock, many of which date back to the dolerite cooling from its magmatic state, and the rock breaks down along these discontinuities, ultimately to clay, while, for a considerable period, the rock between the joints remains fresh and sound. Over time, the clay is washed out leaving isolated columns of fresh rock which continue to slowly weather from the outside. The clay migrates down the slope and from time to time blocks of largely fresh dolerite, which have become unstable, topple in the clay where they continue to break down by slowly exfoliating to create more and more clay with smaller and smaller dolerite boulders. This is the colluvium.

The colluvium serves to protect the underlying Permo-Triassic sediments by blanketing the slope. It tends to be thickest just below the base of the dolerite where it is accumulating, and it eventually makes its way down slope using landslide as a primary mechanism. South facing slopes are particularly prone to landslide and the Nicholas Range particularly so due to the high intense rainfall environment.

3. Blackwood 6 Area Geology

The Nicholas Range is transected by series of broadly north-south striking faults which have tended to partition and limit the east-west extent of the individual coal mines (i.e. Mt Nicholas to Blackwood to Cornwall) into a series of zones. The Blackwood 6 Zone is approximately 2 km west to east and is bounded to the west by a fault which passes through the saddle between Mount Durham and Mount Nicholas and to the east by a fault which delimits the western boundary of the Mt Nicholas Mine, passes approximately 600 m east of the Mount Nicholas peak and continues up the west side of Huntsman's Cap. The Huntsman Open Pit is also within this zone. This zone was the primary area of interest for Shell during their 1982 exploration (Patterson and Ward, 1982).

Between the bounding structures the base of the dolerite overlying Permo-Triassic sediments dips generally to the north

at approximately 5°. The most likely base for the dolerite on the south side of the Nicholas Range is close to 525 mRL. It is highly likely that the interface between the base of the dolerite and the top of the sediments is a local aquitard resulting from baking of the sedimentary interface in a process of thermal metamorphism at the time of emplacement of the dolerite sill. The majority of the trapped ground water will flow to the north towards Huntsman. A profile of the Nicholas Range through the easting of the Blackwood 6 portal area at 590600 mE shows that whereas the northern slope from the base of exposed dolerite is a relatively gentle 10 % before it drops off towards the Avenue River immediately north of the Huntsman Open Pit, increasing to 12 % in exposed fresh dolerite at the summit. On the south side however, the exposed dolerite presents a 35 % slope above a wedge of colluvium resting at 15 %. The slope increases to 20 % below the top of the Permo-Triassic sediments and again to 30 % below Mount Nicholas Road before flattening to 10 % down slope from the Blackwood 6 portal area to the Break O'Day River flood plain (Figure 1).

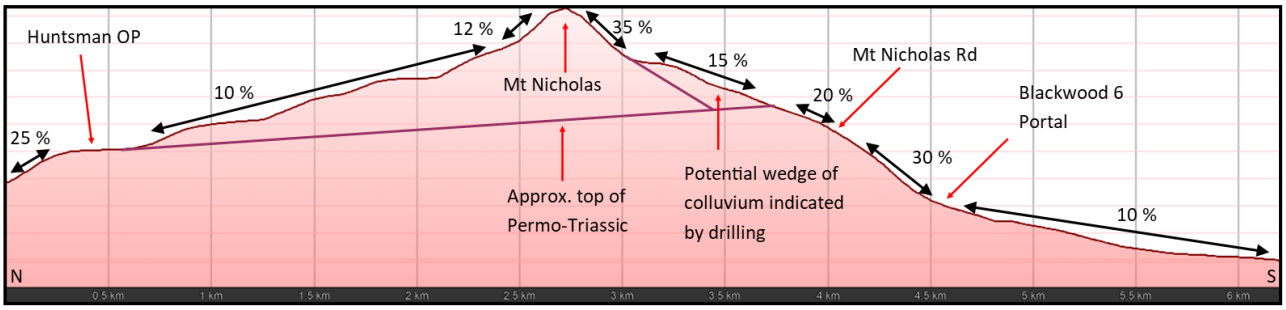

Figure 1: N-S profile of the Nicholas Range through the Blackwood 6 portal area at 590600 mE

An investigation of available data in the vicinity of the proposed Blackwood 6 Portals suggests that the landslide risk is relatively low. Data from diamond drilling and modelling by The Shell Company of Australia Limited (Shell) in 1982 and subsequent work by Palaris in 2010 has been reviewed in making this determination. The drilling is plotted over the regional 1:25,000 geological mapping in Figure 2 for reference.

Drilling suggests that above the Permo-Triassic sediments, dolerite completely weathered to a wedge colluvium is effectively resting on a platform which reaches a depth in excess of 120 m immediately below the exposed dolerite cliffs as logged in GY132 (collared at and toeing out to 66 m in GY28 and again to 31 m and 43 m in GY40 and GY43 respectively (Figure 1). The wedge of colluvium is considered largely stable and roads constructed across this area 40 years ago still appear to be intact and in alignment on LiDAR imagery (Figure 3) but it is, none-the-less, an area of deep colluvium with the potential for landslide in future. GY151 was drilled at 524.08 mRL, close to the 525 mRL contour that pitt&sherry assesses to be the base of the dolerite sill/top of the Triassic sediments and only encountered 0.2 m of colluvium.

In the meantime, small quantities of colluvium will always be moving down slope blanketing the exposed Permo-Triassic sediments and filling drainage gullies and creeks. Colluvium is mapped on the State 1:25,000 geological map all the way to the base of the range. On the southern, steep slopes of the Nicholas Range the depth of the average depth of colluvium appears to be from virtually nothing, to the order of 2-5 m over the slopes, but may build to significant depths when filling gullies and creeks. In evidence of this, colluvium depths of 28 m and > 75 m were recorded in GY41 and GY38 respectively, both of which are within the confines of an unnamed creek above and below the Mount Nicholas Road. Likewise, GY35 logged > 57 m in another creek further to the east. These buried creek lines pose the greatest risk for landslide on the lower slopes.

By contrast, the slopes at the head of Millstream Creek in the vicinity of the proposed portals it is so steep that the colluvium has been washed away and the State 1:25,000 geological map records Triassic sediments exposed along its length in that area (Figure 2). It is not known how recent that exposure is, but it is perhaps noteworthy that outcropping Triassic sediments follow the path of the Mount Nicholas Road, having been exposed by the road cutting, and a number of culverts beneath the road direct water to Millstream Creek (Figure 4).

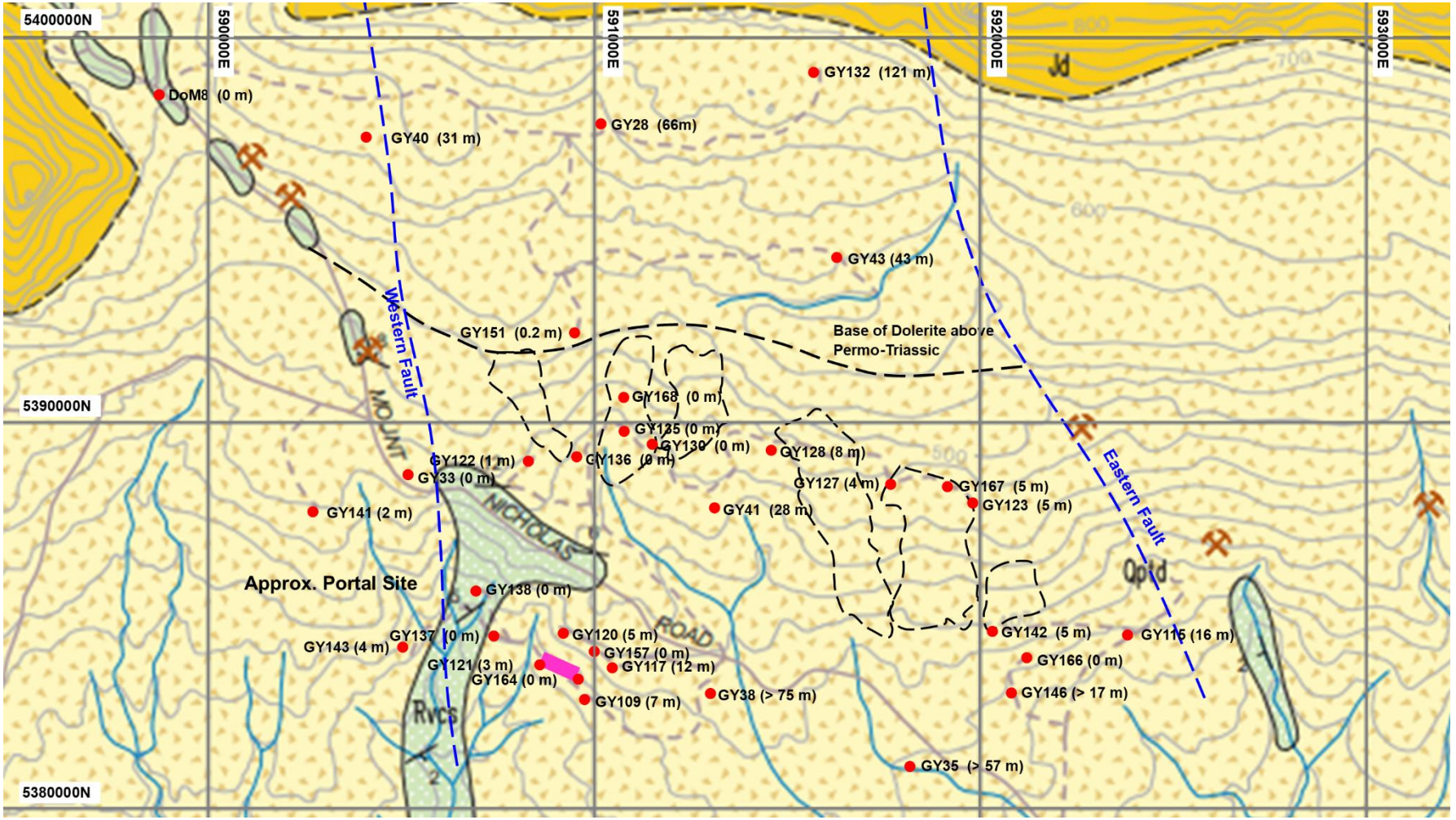

Figure 2: Geological map of the Blackwood 6 area showing 1980's drill holes and the location of past landslides. The magenta shape coincides with the proposed portal cut.

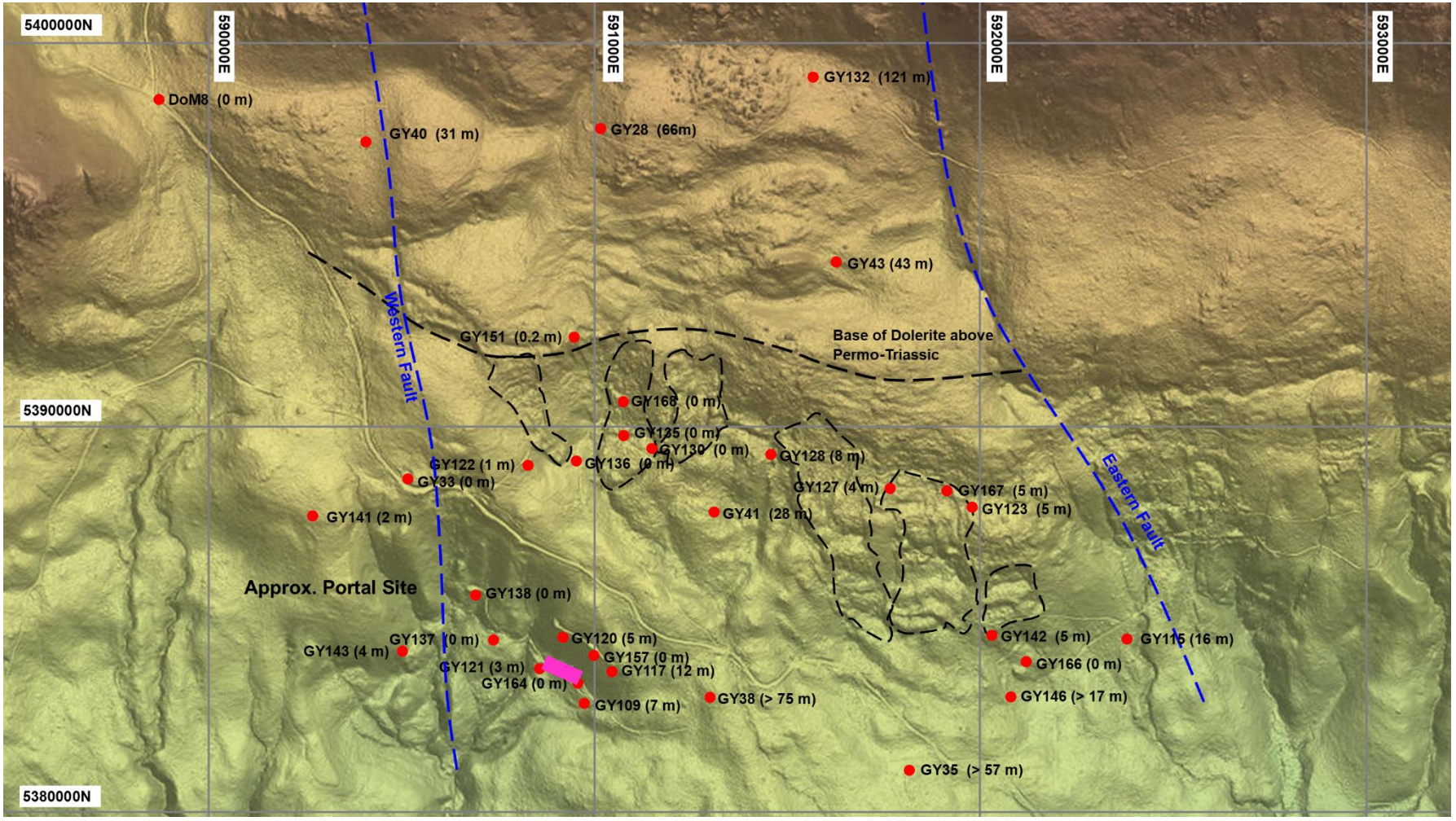

Figure 3: LiDAR image of the Blackwood 6 area showing 1980's drill holes and the location of past landslides. The magenta shape coincides with the proposed portal cut.

Figure 4: Exposed Triassic sediments on Mount Nicholas Road.

Between the creeks, colluvium depths of a couple of metres are typically recorded. Fortunately, the cover of colluvium up slope of the proposed Blackwood 6 Open Cut is either colluvium free or has a very thin cover (Figure 5).

Figure 5: General area of the proposed portal near the site of GY143.

4. Recent Landslides

The foregoing discussion does not mean that there are no relatively recent landslides in the vicinity of Blackwood 6 and as illustrated in Figure 3 there are at least six obvious examples and a few more subtle which are not highlighted. All occur in just below the base of the dolerite and terminate above Mount Nicholas Road. This cluster of landslides appears to be directed towards the east into the vicinity of the historical Mt Nicholas township rather than towards the Blackwood 6 site, and none of them currently extend within 100 m of the north side Mount Nicholas Road. Established trees on the north side of Mount Nicholas Road are all standing vertically indicating little of no ground movement (Figure 6).

Figure 6: Established trees on the north side of Mount Nicholas Road remain vertical (photo taken close to 591000E from Mount Nicholas Road).

5. Landslide Risk Mitigation

pitt&sherry broadly concurs with the findings of previous assessments that the landslide risk at the proposed Blackwood 6 site as discussed by Murcott (2021) is low, albeit that the local geology, geomorphology and physiography places it in a defined landslide hazard zone under existing statutory guidelines and landslides are common in the area.

None-the-less, there is a risk and it is appropriate to consider the mitigation of those risks in establishing the site. The following plan provided by Cornwall Coal indicates several measures for protection of the portal cut which warrant comment. Specifically:

- All intercept drains must be confirmed to have passed through the colluvium into the Triassic substrate and to maintain a constant negative gradient prior to placement of the lining material
- Colluvium should not remain on the cut slope above the portals if at all possible. Holes such as GY157 and GY164 suggest that this is possible although some is recorded in GY120 (Figure 7). pitt&sherry is not privy to recent site investigations and is unable to comment as to whether any further work is required

- It is likely that anchoring a rebar cage to the face of the cutting and then sealing it with a layer of fibre reinforced shotcrete (fibrecrete) with adequate drainage will provide a better long term solution than the proposed poly liner as suggested in Figure 8. This is particularly important for avoiding some of the negative impacts that occurred at Blackwood 4
- Although past drilling and recent investigations have shown that the depth of colluvium in areas proposed for the establishment of infrastructure is shallow, there remains an issue with deep colluvium in the gullies occupied by the current drainage. This is demonstrated by GY38 and GY35 for both streams that the access road will traverse between the site and Mount Nicholas Road. This will need to be considered during construction and as is the case at Blackwood 4, Trigger, Action, Response Plans (TARP's) should consider the risk that these crossings may present during periods of high rainfall
- The plan shows that the proposed road more or less follows a watercourse. Assuming that this is accurate, sufficient provision will need to be made to ensure that the water doesn't go elsewhere or find itself ponded during heavy rain; particularly so if the area has a colluvium cover; and
- A monitoring array should be established to monitor for any slope movements on that section of the Nicholas range above the Blackwood 6 site. as there is currently no indication of movement, there is no requirement for as elaborate an installation as that at Blackwood 4. However, the installation of permanent prisms at strategic locations should be considered and a plinth installed to ensure that a survey instrument could be located in the same position to undertake the monitoring. It is suggested that they would be monitored twice yearly or following large volume rain events when the short term cumulative rainfall (see Section 6) exceeds 100 mm (whichever is more frequent). Sites will need to be established on the basis of visibility, but ideally these would include half way up the slope towards Mount Nicholas Road, on colluvium above Mount Nicholas Road, on the 20 % slope immediately below the top of the Permo-Triassic and on the 15 % slope above it.

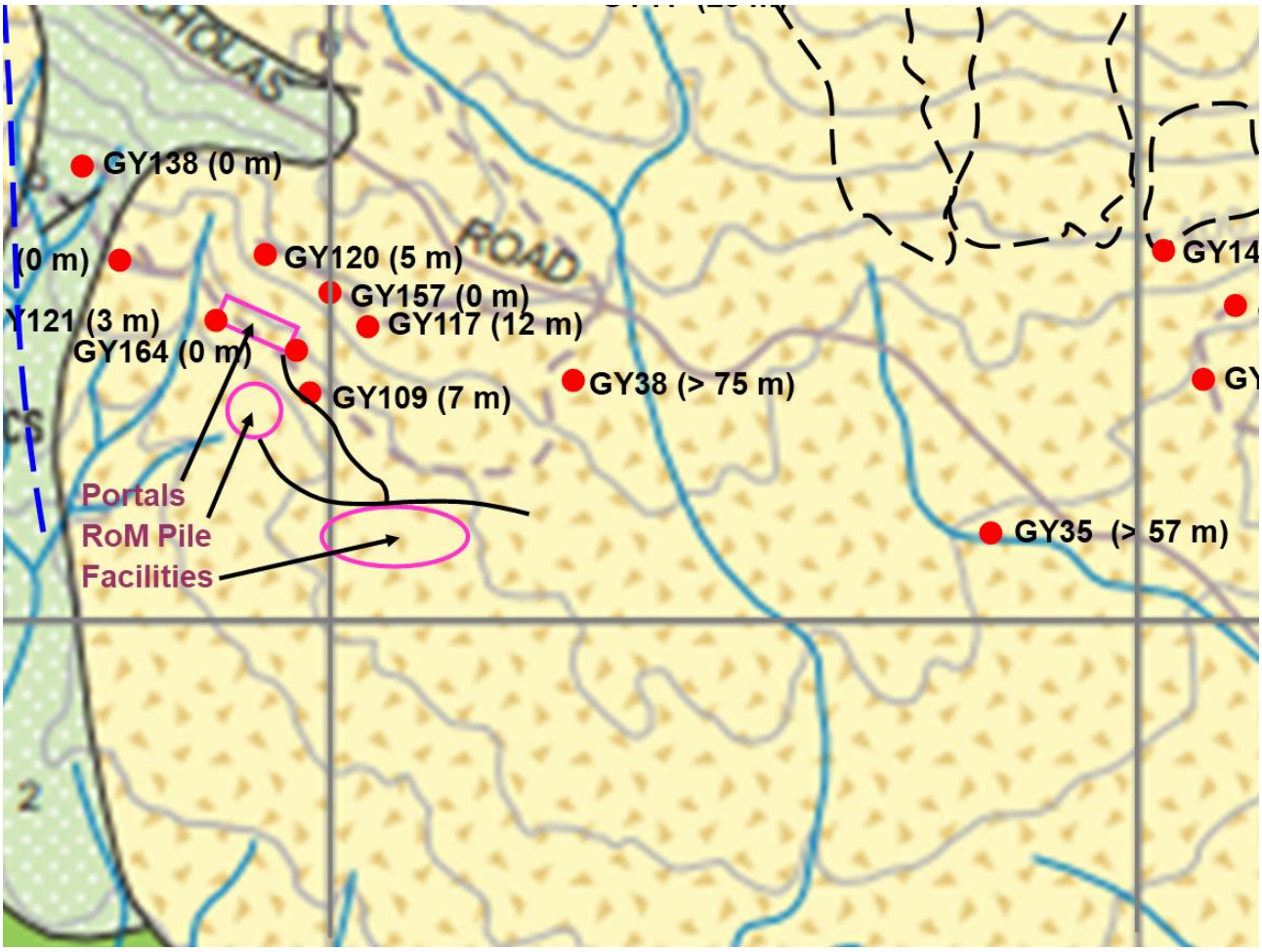

Figure 7: Detail of historical drill holes at the Blackwood 6 site.

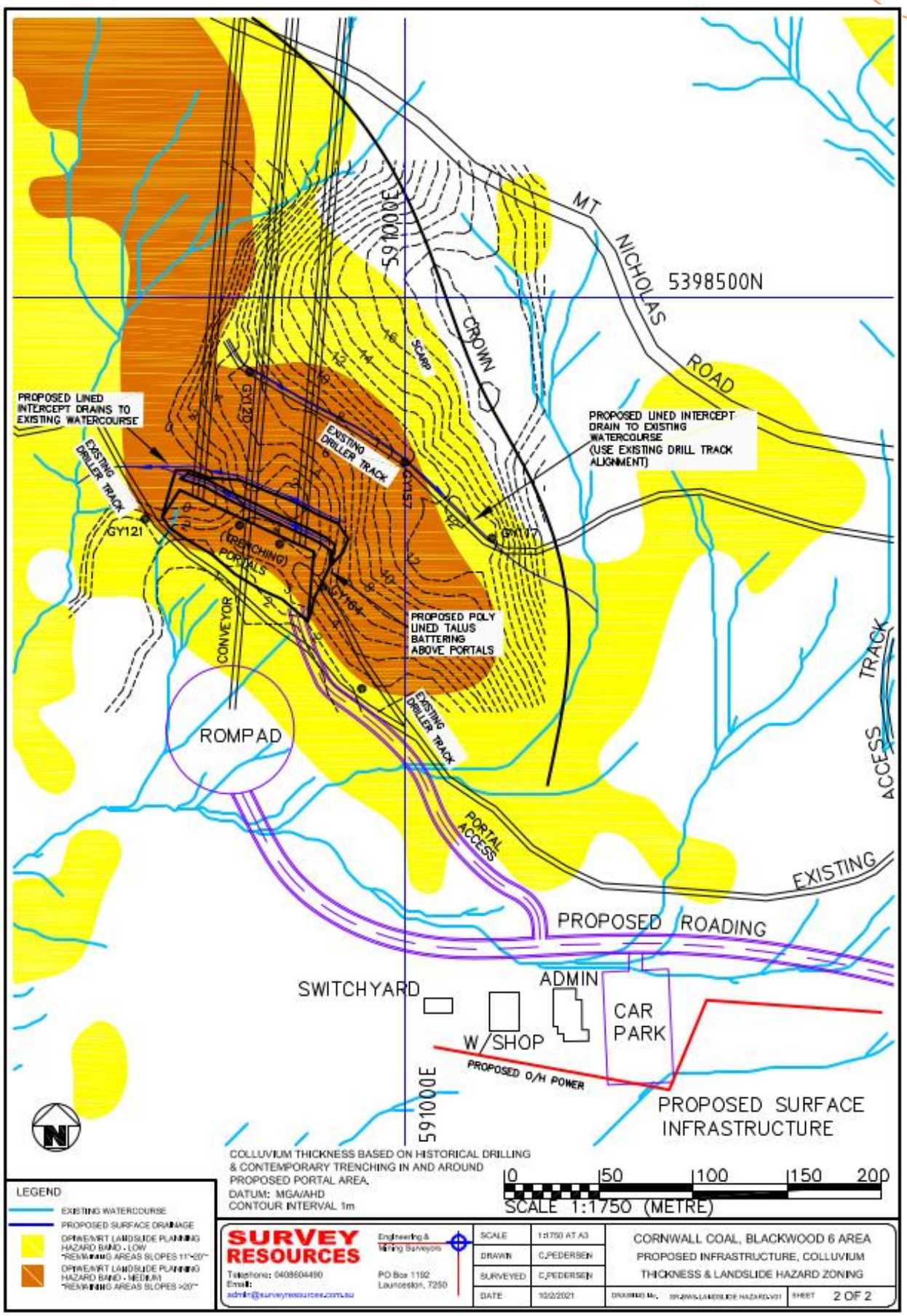

Figure 8. Proposed Blackwood 6 infrastructure development (provided).

6. Short Term Cumulative Rainfall

Previous work by pitt&sherry (2013) demonstrated that significant landslide events on the Nicholas Range occur than the short term cumulative rainfall (24 hours) exceeds 100 mm. This was found to be the case for the Jubilee Slide near German Town in 1950 and four events in the Blackwood 4 – Cornwall are from August 2010 – August 2011 (Figure 9).

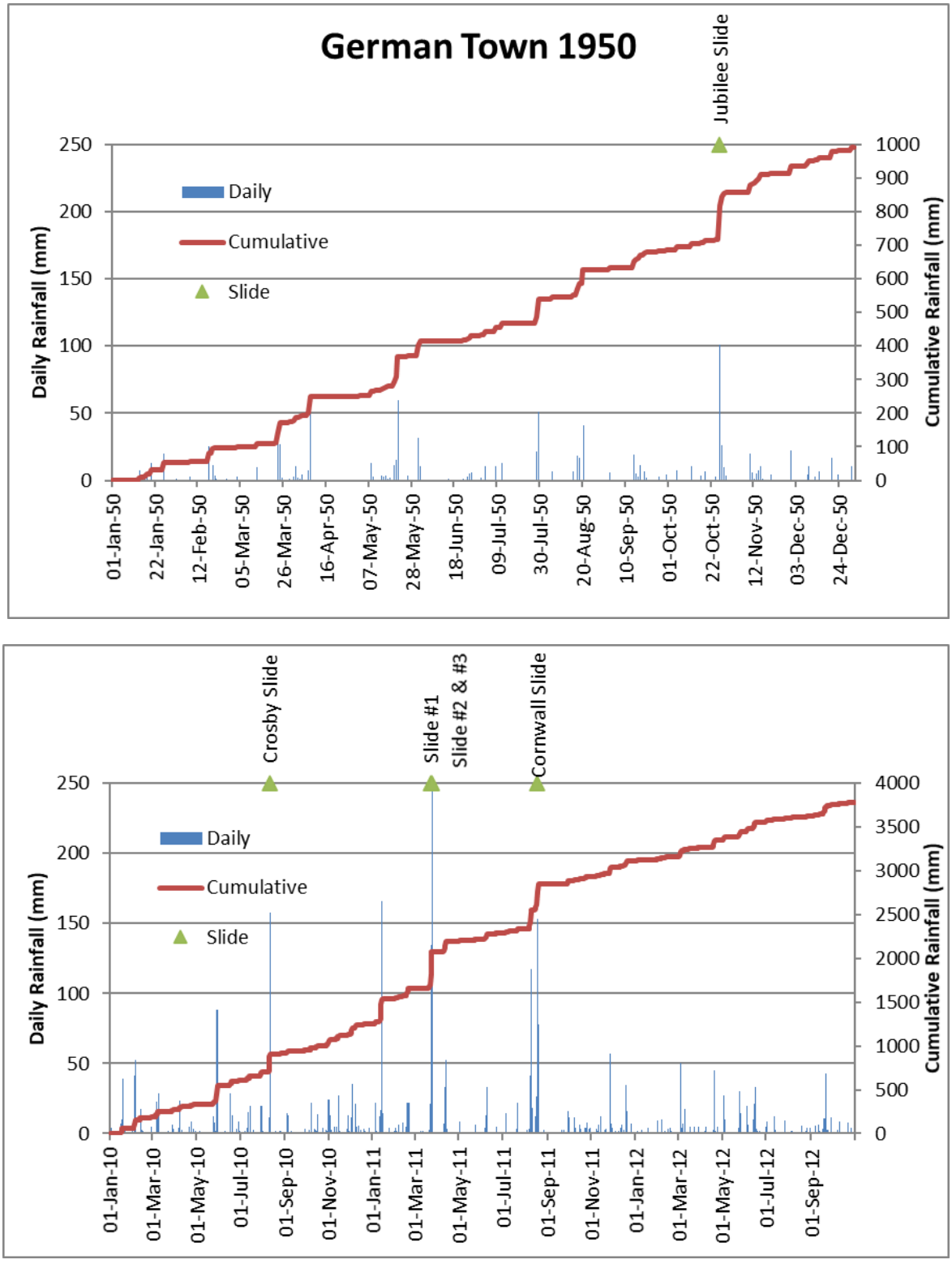

Figure 9: Coincidence of landslides with short term cumulative rainfall in excess of 100 mm.

The reverse case was not demonstrated. That is, large volume rain events over a number of days did not trigger landslides if the 100 mm per day threshold was not met. It was for that reason that an evacuation trigger was set at 85 mm in 24 hours.

7. Conclusions

This brief report considers the landslide risk for the proposed Blackwood 6 underground coal mine development. The proposed site for the development is south of the Mount Nicholas Road around 591000 mE 5380000 mN in an area previously considered for the development of the Millbrook Open Pit. An investigation focusing on and examination of available geological records and information contained in historical drill hole logs has led to the following conclusions:

- The Nicholas Range has a history of landslide events, predominantly occurring on the steep southern slopes
- These landslide events have impacted coal mining activities since the mid 1800's until as recently as 2011
- The Nicholas Range is comprised of dolerite above Permo-Triassic sediments. Weathering of the dolerite leads to the development of a colluvium cover of variable depth down much of the slope. Landslide is a primary cause of material movement down the slope
- In the vicinity of Blackwood 6 and for much of the slope above it, the colluvium in relatively thin, although deep deposits do occur in gullies. The colluvium is currently stable as evidenced by the verticality of established trees, although some landslides have occurred in the relatively recent past and remain identifiable. The path of those identifiable events is generally away from the location of the proposed development
- pitt&sherry assesses the risk to be relatively low for the Nicholas Range in the vicinity of the proposed Blackwood 6 development but recommends that suitable risk mitigation strategies be undertaken to manage the risk that does exist. Principally, geotechnical design should be incorporated in the construction and development of the site, particularly in the portal cut area. This is necessary to ensure that some of the failures and poor outcomes that occurred at Blackwood 4 are not repeated
- A slope monitoring array (of somewhat less sophistication than that installed at Blackwood 4) is recommended as a tool to manage the landslide risk; and
- Landslides on the Nicholas Range have shown a tendency to coincide with short term cumulative rainfall in excess of 100 mm in 24 hours. This led to the development of evacuation triggers for Blackwood 4 and it is recommended that a similar strategy is adopted, at least until it is demonstrated that they are not required.

8. References

Murcott, R, 2021. Slope Stability in the area of Blackwood 6, Ron Gregory Prospecting.

Patterson, C L and Ward, B, 1982. Mount Nicholas Geological Report. The Shell Company of Australia Limited.

pitt&sherry 2013. Landslide Risk Assessment – Blackwood No. 4 Colliery.

Important information about your ground engineering report

These notes are additional to any limitations noted within the report. They have been provided by pitt&sherry to clarify the limitations of the report, and to clearly identify the individual responsibilities of all parties involved. It is important that all documents from pitt&sherry are read thoroughly and that clarification is sought when necessary.

Specificity

Your report has been developed based on pitt&sherry's understanding of your project requirements and applies only to that project. If there are subsequent changes to the proposed project, pitt&sherry should be consulted to assess how the changes impact on the report's recommendations. If pitt&sherry are not consulted, they do not accept responsibility for issues that may occur due to project changes. No responsibility is accepted for the use of this report, in whole or in part, in other contexts or for any other purpose.

Report integrity

This report is presented as a whole; with conclusions and recommendations reliant upon data presented in other sections. Reading parts of the report in isolation may lead to misinterpretations, and as such the report should not be copied in part or altered in any way.

Where information contained within this report is to be used for tendering purposes it is recommended that the entire report be made available. In situations where this is not appropriate, pitt&sherry can assist in preparing a specially edited document to provide the information within an appropriate context.

Site variability

The results presented in this report represent the conditions at the specific sampling and testing locations. They also represent the conditions at the time that the work was carried out. Variations in conditions may occur between or beyond assessment locations, either due to natural variability or previous excavations.

It is recognised that conditions may change over time. This can be due to natural processes (landslides, water content change) or driven by human activities (cutting or filling in the vicinity).

The advice presented in this report is based on the data gathered during the investigation, and the accuracy may be impacted by undetected variations in ground conditions or later changes to the site. Retaining pitt&sherry throughout development stages can assist in reducing the impact of these issues by identifying variances, conducting additional testing if required, and recommending solutions to problems encountered on site.

Interpretation by others

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a ground engineering report. To help avoid these problems, pitt&sherry can work with other project design professionals to explain the findings in this report, and to review the adequacy of their plans and specifications with respect to these issues. pitt&sherry will not be responsible for interpretations of report findings by others involved in the design and construction process.

Third party and client supplied information

Data supplied by the client or third parties is assumed to be correct, unless otherwise stated. While every care has been taken by pitt&sherry in producing the report, pitt&sherry has not checked or verified the accuracy of such information (unless specifically included in pitt&sherry's scope of services). Accordingly, no responsibility is accepted by pitt&sherry for incomplete or inaccurate data supplied by others.

Safety in design

This report does not contain information sufficient to constitute a safety report. Such a document would require inputs beyond pitt&sherry's current knowledge of the project and is beyond the scope of this investigation. pitt&sherry can assist in the risk assessment process required to produce such a document, if requested.

Geoenvironmental issues

Unless stated otherwise, your report does not make any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site. In the absence of such a statement, pitt&sherry take no responsibility for such issues. Since unanticipated environmental problems have led to numerous project failures it is pitt&sherry's recommendation that you obtain your own geoenvironmental information.

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Blackwood 6 Landslide Risk Assessment

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