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Coral Park Earthmoving and Landscape Supplies
28 Coral Park Road,
Wolumla, NSW, 2550

Geotechnical Assessment for Development Application (DA2024.109) for Proposed Blasting and Extension of Existing Quarry

Crozier Geotechnical Consultants were engaged by the client Coral Park Earthmoving following a request for further assessment/details by Transport for NSW (TfNSW) as part of their review of a Development Application (DA) submission (DA2024.109) for expansion of an existing quarry.

It is understood that the existing quarry has operated for at least 60 years through removal of gravel material near surface to supply building and construction contracts. However, the readily accessible gravel component has now been exhausted and extension of the quarry which will require blasting is now proposed.

1. INTRODUCTION:

The undersigned completed an inspection of the quarry and adjacent areas on the 03 February 2025 as part of the assessment and preparation of this report. Further discussions with TfNSW were then undertaken prior to preparation of this report to clarify approval requirements.

As part of the assessment we have reviewed the following documents:

- Letter from Transport for NSW, Reference: STH24/00477/001, Dated: 05 July 2024
- Letter from Transport for NSW, Reference: STH24/00477/003, Dated: 14 October 2024
- Proposed Quarry Expansion plans by BSE Consulting Engineers, Project No.: KEE01 – 05, Drawing No. / Revision / Date; C04 / 03 / 08 March 2025; C05 / 04 / 08 March 2025; C06 / 04 / 08 March 2025; C07 / 04 / 08 March 2025; C07-A / 03 / 08 March 2025, C07-B / 01 / 16 March 2025.
- Blasting Impact Assessment by GHD, Project No.: 12582654, Dated: 22 May 2024.
- Environmental Impact Statement by Metro Planning, Reference: Blasting of Existing Quarry, Dated: May 2024

It is understood that TfNSW harbour concerns which were spelled out in their initial response as:

- **Paragraph: 2 c: Vibration:** TfNSW requires the applicant to outline how vibration monitoring of the two reinforced concrete culverts at the Princes Highway will be undertaken to ensure they are protected.

- **Paragraph: 3. Geotechnical Stability:** TfNSW requires the applicant to provide an assessment/details on how blasting and associated quarry operations over the period for which approval is sought, as the extraction area moves closer to the Princes Highway road reserve, will ensure that the geotechnical stability of the Princes Highway road reserve will not be impacted (i.e. destabilised) by the quarry operation>.

The two culverts in question (No. 612242 and 612243) are defined within TfNSW documents and are shown below in Figure: 1.

Figure: 1 – Google Earth view showing TfNSW culverts below Princes Highway in proximity to quarry and road cutting (red) and embankment position (green) along road reserve.

2. Site Observations:

The quarry is located on the high west side of Coral Park Road within gently to moderately sloping topography adjacent a ridge crest, which strikes roughly east-west through the centre of the quarry location with ground surface levels dipping to the north-east and south-east into natural drainage gullies.

The Princes Highway passes around the western side of the site and is formed through two ridge lines with a west plunging drainage pathway between. The road pavement is gently south dipping to near level and is formed through two cuttings and over a filled embankment of up to 5.0m height between, see Figure:1.

2.1 Culverts:

The southern culvert is located at the approximate location shown on Figure: 1. Its eastern side is formed in the base of a gully, with the culvert passing through the base of the embankment formed across the gully as part of the construction of the Princes Highway, which is raised up to approximately 5.0m above adjacent natural slopes.

The culverts eastern side could not be inspected due to extensive weed vegetation (see Photographs: 1 and 2) however its western side was visible. This culvert's numbering was also visible, and it comprises a concrete wing wall with approximately 400m diameter concrete pipe that extends through the filled road embankment see Photographs: 3 and 4. It is assumed that the eastern side of the culvert is of similar construction.

The northern culvert is approximately 50m north and involves a similar 400mm diameter concrete pipe that extends west below the Princes Highway. It extends from a concrete box on its eastern side (Photograph: 5 and 6) that is formed into the road drainage channel within the base of a cutting with the western side appearing to comprise a concrete wingwall formed in the base of a 3.0m high filled embankment, however inspection was limited by slope and vegetation (Photograph: 7 and 8).

Southern Culvert (No. 612243)

Photograph: 1 – culverts eastern end, formed into drainage gully but completely obscured.

Photograph: 2 – close in view of eastern side of culvert.

Photograph: 3 – culverts western end, formed at base of embankment.

Photograph: 4 – showing exposed culvert on western side.

Northern culvert (No. 612242)

Photograph: 5 – culverts eastern end, formed at base of cutting with pipe extending across road.

Photograph: 6 – culverts eastern end, formed at base of cutting with pipe extending across road

Photograph: 7 – culverts western side position, crest of road embankment.

Photograph: 8 – culverts western side, as visible from crest of 3.0m high embankment, viewed west.

2.2 Quarry:

The quarry is formed with steep (=26 to 32°) excavated batters around its upslope western edges, which extend through surficial soils and extremely weathered granite material to very low strength granite bedrock (Photographs 9 and 10). These batters are understood to have been formed at least 5 years prior to the inspection and show limited erosion and no signs of slope instability (circular failures, tension cracking etc).

Similar batter slopes are formed around the eastern side of the quarry, adjacent to Coral Park Road and also show no signs of instability.

Photograph: 9 – existing batter slopes through residual soils and weathered bedrock around central to southern portion of western quarry side.

Photograph: 10 – existing batter slopes through residual soils and weathered bedrock around northern portion of western quarry side.

The eastern side of the quarry is formed close to Coral Park Road levels at the south-east corner with a gentle rise in the quarry floor towards the north, resulting in an increased variation to the road. This portion of the quarry is formed below a vertical excavated/quarried face of up to approximately 8.0m in height that strikes north-south across the quarry and exposes the granite bedrock (Photograph: 11).

Photograph: 11 – quarry floor across eastern side, formed close to RL 152 with quarried vertical face to west and Coral Park Road to east.

The quarried rock face exposes generally fresh to moderately weathered bedrock with extensive discontinuous fracturing and several orientations of relatively continuous planar defects. As a result of these defects the quarry face is in parts formed overhanging, as seen in Photograph: 15.

Only limited mapping of defects was undertaken during the inspection however it identified within the rock mass exposed on the eastern side of the quarry that a set of planar joint defects dip steeply (30°) east-south-

east with high continuity (Photograph: 14 and 15) whilst an apparent different set of planar very steeply (40 – 45°) north-east dipping joint defects of lower continuity were exposed in the north-east corner of the quarry near surface (Photograph 15).

A series of sub-vertical, planar joint defects with high continuity were also identified, striking south-east with both variable dips (80 – 89°) to the south-east and north-west.

The quarried face is understood to have been blasted prior to mechanical excavation and is understood to have been in existence for at least 3 years however it shows no signs of movement/instability with no indications of tension cracking within the crest of the quarried face, though inspection was limited.

Photograph: 12 – existing quarry, as viewed west at approximate mid-point.

Photograph: 13 – existing quarried face viewed south-west showing over-hang due to defect orientation.

Photograph: 14 – existing quarried slope, southern end, showing continuous planar joint defects dipping east-south-east.

Photograph: 15 – existing quarried slope, northern end, showing continuous planar joint defects in lower slope and second set in upper slope.

3. Proposed Blasting and Expansion:

The proposed works are understood to be defined by three stages of extraction (Stage 1, Stage 2, Stage 3) which extend incrementally to the north-west, with each stage encompassing a period of approximately 10 years involving blasting and then subsequent removal of material prior to undertaking the following stage.

The stages proposed are outlined within the BSE report and are as per the site plan reproduced below (Figure: 2), with the estimated minimum separation distances of the proposed quarry stages to the Princes Highway road reserve defined on the plan.

The stages will result in the gradual extension of the existing quarry floor level (RL 152) in the south-east corner extending north-west across the quarry area with batter slopes formed around the perimeter.

Figure: 2 – BSE plan of extraction stages showing estimated minimum distances of stage to Princes Highway road reserve.

The sections (Section A – a and B-b) provided in the BSE report identifying the Stages of Extraction and proposed excavated slopes, have been produced with a vertical exaggeration and as such are not indicative of the actual slopes proposed. It is anticipated that a steep (≈45°) overall slope through the hard bedrock will be preferred, formed as a series of subvertical cuts separated by narrow horizontal terraces.

Stage 1 is the first stage proposed and is located a minimum of 58m from the Princes Highway road reserve boundary at its upper western crest and will extend through the existing quarry access ramp and rock to an approximate maximum height of 8m below existing quarry surface levels at the southern end.

Stage 2 is located through the central portion of the quarry and will extend to within 48m of the road reserve boundary and be up to 19m depth at its central portion reducing to approximately 12m below current quarry levels at its southern end.

Stage 3 will be the final stage and will involve the greatest perimeter to the Princes Highway road reserve, however it will be continually located at ≥60m from the reserve. This stage will require hard rock excavation of up to 14m depth through its centre, reducing ≤12m near its western edges.

It is understood that each stage will require multiple blasts and subsequent removal/excavation of blasted material and processing prior to subsequent blasting. It is detailed within the EIS that blasting will occur on 1 occasion per month, with a maximum of 12 blasts per year.

The Blasting Impact Assessment by GHD outlines a criterion of PPV 80mm/s for ground vibrations to prevent impact to road infrastructure. This is considered to include the two culverts, however the assessment also indicates that the proposed blast scale will only result in ground vibrations above this level within a distance of 38m of the actual blast perimeter.

4. Monitoring Methodology:

4.1 Ground Vibrations

The separation distances between the quarry blasting perimeter and culverts will vary during the site works.

- Blasting for Stage 1 will be located a minimum of 105m from the southern Culvert (No. 612243) and 102m from the northern culvert (No. 612242).
- Blasting for Stage 2 will be located a minimum of 120m from the southern Culvert (No. 612243) and 60m from the northern culvert (No. 612242).
- Blasting for Stage 3 will be located a minimum of 220m from the southern Culvert (No. 612243) and 60m from the northern culvert (No. 612242).

The separation distances indicate that the ground vibrations at these culvert structures will be well below the PPV 80mm/s criterion defined, which is anticipated from the GHD report to be confined to 38m separation distances from any blast perimeter. However, actual data is not available for this site, therefore it is recommended that vibration monitoring occur at the start of each extraction Stage, during the initial blast, to assess ground vibrations actually received at the culverts. Pending the results of this monitoring, further monitoring of future blasts, may be required to confirm that the vibration criteria is not exceeded by similar scale blasts within that stage. Where large/more powerful (i.e. ≥7.16) blasts are proposed then further monitoring will be required.

As the southern culverts eastern side is currently completely obscured and inaccessible due to vegetation/weed growth this culvert location will require clearing prior to installation of the monitoring equipment.

The northern culvert is located directly adjacent to the road pavement, within a location of high traffic speed. As such, traffic control will need to be implemented to ensure a safe working environment for both set-up and removal of the monitoring equipment in this location.

It is recommended that triaxial geophones be utilised to ensure accurate measurement of ground vibrations during the blast with set-up at least 4 hours prior to ensure collection of background data on ground vibrations and ensure the complete blast sequence is collected.

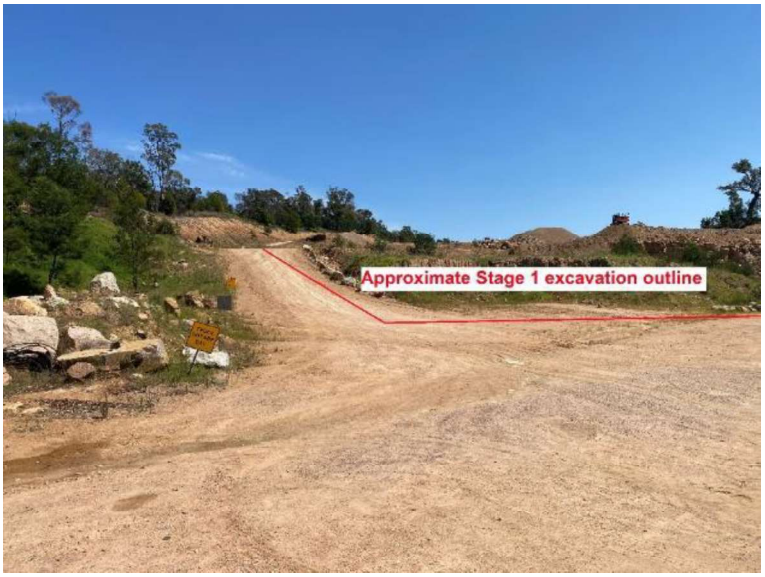
4.2 Slope Instability

The existing batter slopes formed around the western side of the existing quarry are understood to remain and have been in place for at least 4 years. These batters are formed at approximately 30° and extend through the soils, extremely weathered to very low strength granite bedrock to the harder (medium to high strength) granite bedrock surface.

It is anticipated that slightly steeper over-all slope angles will be preferred through the harder bedrock, down to the base of the proposed quarry works (RL 152). This will be anticipated to be formed as a series of very steep (60°) to sub-vertical cuts separated by narrow sub-horizontal terraces to form a stepped profile over an overall slope of approximately 45°, however this is unconfirmed.

Based on the stability of the existing sub-vertical cut within the eastern side of the quarry, instability as a result of movement along the identified defects appears unlikely to impact/reach the Princes Highway road reserve. However, the persistence of these defects across the western side of the quarry or the existence of new/varied defects is unknown.

The majority of Stage 1 is located well inside the existing quarry confines with the western portion of the quarry hard rock surface of relatively low height (<6.0m) with respect to the proposed base quarry level due to prior excavation of near surface soils and the local topography, see Photograph: 16.



Photograph: 16 – showing southern end of Stage 1, as viewed from south-east corner of quarry at the approximate bas quarry level (RL152).

Stage 1 is located a minimum of 58m from the Princes Highway road reserve with the separation distance increasing as the quarry deepens. Within the reserve adjacent this portion of the quarry, the ground surface elevation reduces to the west due to natural topography with the road pavement formed at approximate RL 165 – 166, at the crest of a filled embankment of up to approximately 3.0m height across its eastern side. As such, ground surface levels within the eastern side of the road reserve are up to a maximum of 13m above the proposed quarry base (RL 152). Therefore, the proposed quarry is located above an influence angle of <13° below the road embankment base.

Based on the quality of the bedrock exposed in the existing quarry and the defects identified, the likelihood for instability as a result of Stage 1 to impact the Princes Highway road reserve is considered to be 'Rare' (AGS 2007).

It is therefore considered that Stage 1 can be completed without further investigation, assessment or monitoring until its completion, at which time geotechnical inspection and mapping of defects within the rock mass must occur.

Stage 2 and Stage 3 will result in steeper influence zones and as such further work is recommended prior to and during the extraction phase.

The completed, entire face of the quarry should be mapped for defects (orientation, continuity) at the completion of each stage by an experienced engineering geologist prior to progress of the subsequent stage (i.e. HOLD POINT).

To provide certainty to the actual deflection/movement occurring within the slopes to the west of the quarry during Stage 2 and Stage 3 it is recommended that a series of boreholes be drilled across the western edge of the site, above the crest of the existing batter slopes, prior to completion of Stage 1.

These bores should be undertaken using NMLC triple tube core under geotechnical supervision and logging to provide a profile of ground conditions and actual defects. These boreholes should extend to a minimum of RL 145. Access to these areas is limited therefore actual positions for the three bores should be defined at the time of investigation based on rig accessibility, approximate positions are detailed below in Figure: 3.

Figure: 3 – Recommended locations for drilling and installation of inclinometer casing for ongoing measurement of bedrock deformation during the proposed quarry works.

Following completion of each borehole, the installation of inclinometer casing to the base of the hole should occur with measurement of casing alignment approximately 1 week after installation to provide a baseline reading.

Subsequent re-measurement of the slope deformation should occur at maximum 3 month intervals to allow assessment of actual deformation with respect to the excavation works undertaken. Readings should be compared to both the previous reading taken and also the baseline reading taken at initial inclinometer installation.

Where noticeable (>3mm) movement is identified, then this down hole inclinometer monitoring should be undertaken both prior to and following each blast, along with mapping of defects within the face of the quarry by an experienced engineering geologist, to assist in identifying potential causes of movement and allow modification of excavation methodology or implementation of remedial measures (i.e. anchoring, berm construction).

We trust the above information meets your requirements. If we can be of further assistance in regards to this matter please don't hesitate to contact the undersigned.

Yours faithfully,

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