

3655

MEMORANDUM

To Darcy Maddern, Andy Campbell
From Sandy Ormiston, Louise Vick, Ormiston Associates Limited.
Date 28th July, 2016
Subject Kiwi Point Quarry Queries Response For Wellington City Council.

1. Introduction

We have been provided with a review prepared by Opus International Consultants Ltd and titled '*Kiwi Point Quarry – Review of Geotechnical Information*' dated 11th July 2016 of supporting information provided to Wellington City Council by Holcim for development of the Kiwi Point Quarry southern ridge area.

2. Review of Comments

These comments refer to section 3.3 of the Opus letter.

2.1 Northern Pit

The reviewer incorrectly assumes that rule of thumb slope angles have been recommended by Geoscience. It is clearly stated in section 5.2 of the Geoscience report that a kinematic analysis of discontinuities has been completed and the findings of the analysis are detailed in that report.

It is also completely incorrect to state that the northern face has only been examined against circular failure. We refer the reviewers to the Geoscience report section 5.2 for the detailed assessment which comprised,

- Kinematic analysis.
- Planar failure.
- Wedge failure.
- Toppling failure.

We have referred the implications from a 1:500 year earthquake back to Geoscience for comment and will provide their response when available.

We append an updated rock fall assessment prepared for Kiwi Point Quarry in July 2015 which provides recommendations for rock fall containment at the toe of the northern face.

The highly weathered material at the crest of the northern batter includes remnant rock. However the principle issues in this area include'

- The limited area at the crest available to allow flattening of the batter to improve overall stability.
- The existing very steep northern batter slope.
- The existing rock mass kinematic conditions.

Holcim have inherited the current northern batter slope configuration and are working towards achieving multiple goals to improve the batter slope stability. Wellington City Council were originally advised that the end result from quarrying the northern area would provide a platform suitable for development. To achieve a useable platform there are limitations on the final batter slope angle and this results in slope angles that may be steeper than are desirable. The alternative is to buttress the toe and build fill up the existing batter to improve long term stability but this may result in little if any suitable building platforms for future uses.

In view of the conflicting finished pit and batter slope requirements a compromise including some reduction in slope angle from the existing and forming toe rock traps was developed and is proposed.

Geological Mapping and Investigation of Defects

We refer to sections 5.2 and 6.0 of the 2015 Geoscience report for the kinematic analyses requested.

Planar failure referred to by Opus within the western wall is detailed in Section 6 of the geoscience report and recommendations for slope design based on the discontinuities and kinematic analysis are provided.

2.2 Southern Ridge (Area H and Open space B)

2.2.1 Geological Interpretation

The reviewers recommend adding more detailed geology onto the Southern ridge geological cross section including faults, argillite layers, rock quality of the overburden.

Comment

Cross sections provided in the Ormiston Reports for the Business Area and Open Space B show a simplified geological structure showing the weathered zones and quarry batter slope options.

Cross section SR2 – SR2' dated 20 November 2015 showing batter slope stages subdivides the greywacke weathering profile into Brown, Competent Brown, Blue-Brown and Blue and based on the quarry operator rock classification for quarrying purposes.

A fault zone was identified and within Boreholes BH408 and BH409 and inferred to be dipping steeply into the proposed batter slope. Attached Drawing 3655-SR25 shows the boreholes and the inferred fault zone to assist the reviewers. The cross section remains simplified and is based on the borehole intersections.

Boreholes identified argillite beds but we have not plotted these as bedding intersections are not orientated and therefore cannot be plotted with accuracy and are likely to be highly misleading.

The resource is very similar to the northern pit resource which also comprises interbedded sandstone and argillite (mudstone) although it is likely there will be some variation in the percentage of argillite compared with the northern resource.

We agree that the presence of a fault zone would impact on the batter slope design. In view of the difficulty accessing rock exposure and measuring defects for kinematic analysis and the potential impact from the inferred fault we have proposed a staged development beginning with the Geoscience lower recommended slope batter angle (45°) which also allows the batter to be

increased to 55° also within the batter slope range recommended by Geoscience. The proposal allows highwall batter slope design modifications within the fault zone if required and as it is exposed. At this stage there is insufficient detailed information for specific design. Subsurface information is extremely difficult to collect due to machine access issues in the extremely steep elevated terrain and the level of vegetation clearance that would be required.

3. Responses to Recommendations

The review includes a list of recommendations which are addressed below.

Northern Area.

1. Items 1, 2, 3, 4, 5. The review recommends an assessment of rock defects in the Northern Face for assessment of batter slope stability.

Comment

A detailed rock mass defect assessment and kinematic analysis was completed and reported by Geoscience as detailed in Sections 5.2. and 6.0 of their report dated 24/02/2015.

2. Items 6 & 7.

A report prepared by Ormiston Associates Limited was completed addressing rock fall risks and mitigation measures. The report is titled '*Rocfall Analysis For The Northern Face of Kiwi Point Quarry, Wellington*' ref 3655 and dated July 2015. The report is not listed in the list of documents referenced by Opus and with the supporting documentation reviewed. A copy of the assessment is appended.

Southern Area

3. Item 8 & 9.

Borehole intersection details can be obtained from the borehole logs and the intersection rock quality and weathering relative to the quarry operator requirements are broadly identified on the cross sections provided by colour coding. We have clarified the naming of boundaries at the western end of the cross section and extended the section. The cross section identifies a property boundary approximately 30metres west from the proposed highwall crest. The boundary identified as 'property boundary' is not the boundary with residential properties on Gurkha Crescent but a Lot boundary within the Wellington City

Council property. Drawing No 3655-SR17rev1, cross section SR2 - SR2' has been extended to show the separation distance from Gurkha Crescent. The separation distance between the proposed Stage 5 highwall batter crest and properties on Gurkha Crescent is approximately 100metres.

We note that in Section 3.2 review that the Southern Ridge batter slope design is incorrectly stated by Opus as having benches 5metres wide. Design bench width is 8metres as stated in Para 4.3 (Ormiston reports for Open Space B and Business Centre Ref 3655 Dated February 2016) as being 8 metres wide and also identified on Cross Section 3655-SR25 dated 20 November 2015.

The upper slope top bench area has not yet been accessed for drilling. We anticipate a similar weathering profile intersected in boreholes completed on the Southern Ridge comprising surficial extremely weak, very weak to weak, Completely to Highly Weathered rock (Greywacke) (NZ Geotechnical Society Field Description of soil and Rock' 2005). The preliminary design batter is approximately 7metres in height and battered at 45° with an 8metre wide bench.

A maximum of 2metre depth of completely weathered Greywacke was intersected in Borehole BH406 whilst other boreholes intersected Highly to Moderately weathered greywacke.

4. Southern Area (Area H and Open Space B)

1. A defect analysis of the very limited southern area exposure was completed by Geoscience as reported in section 7 of their report which recommends batter slopes of 45° to 55°. We have allowed for initial development at 45° batters to allow assessment of the southern ridge rock exposure by quarrying for final design. We note that existing batter slopes descending to the motorway are standing at slopes of more than 45° without any protection measures for the motorway.

Access to the ridge for drilling boreholes is extremely difficult and any further drilling will require track construction or helipad construction. Track formation does not provide sufficient exposure of material from which

reliable defect mapping can be undertaken. Additional infill drilling can be undertaken when consent to develop the southern ridge is granted. The proposed staged development comprising progressive exposure of rock will also allow thorough analysis at initial 45° batter slopes and the batter angle retained at 45° or increased to a maximum of 55° as recommended by Geoscience.

2. The inferred fault zone has been added to cross section 3655-SR25. 2 boreholes intersected the fault which appears to be steeply dipping into the slope (to the west).
3. Staged modelling of the proposed pit have been recently completed and attached. These include a geological model and Open Space B and Business Centre options for 45° and 55° batter slopes and potential backfill platforms for later construction. A Rockfall analysis will be required for design of protection measures.
4. Potential failure modes and risks based on the northern pit have been applied for two batter slope scenarios (45° and 55°) and include the western face access road and the inferred fault zone.
Safety measures to protect existing commercial buildings to the south and the motorway comprise;
 - Excavation will be undertaken from the pit side such that all material is excavated into the pit minimising the risk to outside areas..
 - Rock trap fences would be erected along the boundaries above the commercial area and motorway to trap any rocks dislodged by quarrying.
 - Batter slope failures within the working area would be contained within the workings as these would fail into the pit.
5. A range of final rehabilitation plans are attached. We have attempted to provide through access from Tyres Road through to the Atlas concrete plant. This is difficult to achieve due to existing site constraints and the height difference to the finished backfill platform.