RILEY CONSULTANTS LTD
New Zealand
Email: riley@riley.co.nz
Email: rileychch@riley.co.nz
Web: www.riley.co.nz

AUCKLAND
4 Fred Thomas Drive, Takapuna, Auckland 0622
PO Box 100253, North Shore, Auckland 0745
Tel: +64 9 489 7872 Fax: +64 9 489 7873

CHRISTCHURCH
22 Moorhouse Avenue, Addington, Christchurch 8011
PO Box 4355, Christchurch 8140
Tel: +64 3 379 4402 Fax: +64 3 379 4403

Stevenson Aggregates Ltd
sean.mitchell@stevenson.co.nz

17 September 2021

Our Ref: 15211-Q

Attention: Mr Sean Mitchell

Dear Mr Mitchell

PRELIMINARY ROCK RESOURCE ASSESSMENT PROPOSED CLEVEDON QUARRY EXPANSION 646 McNICOL ROAD, CLEVEDON

1.0 Executive Summary

An assessment has been undertaken of potential rock resource in the northern portion of 646 McNicol Road, immediately south of the existing Clevedon Quarry. This assessment has been prepared in support of a proposed expansion of approximately 30 hectares to the south of the current Clevedon Quarry to secure resource for future development of Auckland.

This assessment has included review of aerial imagery, published geological maps, terrain models, review of previous geological inspections and conduct mapping on the property. No subsurface investigation has been undertaken on the property at this time.

The following comments are made:

- Inspected rock exposed in streams was often moderately to slightly weathered and strong to very strong.
- The greywackes observed in the exposures are similar to that currently excavated from Clevedon Quarry, with a mix of argillite, siltstone and sandstone, likely of similar mineralogical composition to Clevedon Quarry.
- Testing of material recovered from the existing face of the Clevedon Quarry and subsurface investigations indicates that the material will be suitable aggregate resource.
- We conservatively estimate the rock resource (brown and blue) at 70 million tonnes for the proposed extension into 646 McNicol Road.
- No obvious large-scale instability features were evident within the proposed quarry expansion area in either the aerial images or from the on-site mapping. This is not to exclude their possible presence, but they have not been noted within the evidence collected.
- The north-east to east north-east rock fabric may present stability challenges with respect to rock drop out as the quarry face advances southward as related defects will be sub-parallel to the face.
- Similar to Clevedon Quarry, it is expected there will be a shallow perched groundwater table, which responds to rainfall, and a deeper regional groundwater table possibly below RL 30.0m.

An active fault (Wairoa North Fault) is present through the western portion of the proposed quarry extension. There is no evidence of movement across the fault in the past 10,000 years, although it likely would have experienced displacement within the past 400,000 years. I consider that blasting and quarry activities, which are appropriately controlled will have less than minor effects on stability of the surrounding hillside and any structures. None of these activities will have any effect on fault activity.

2.0 Introduction

As requested, the following report summarises investigation findings to-date with respect to 646 McNicol Road and possible rock resource. This property is in ownership of Stevenson Aggregates Ltd. This assessment in support of a proposed expansion of the current Clevedon Quarry to the south to secure resource for future development of Auckland.

Riley Consultants Ltd (RILEY) has previously been involved with Clevedon Quarry, initially in 2015 as part of a due diligence land purchase study and, more recently, in resource evaluation and preparation of geological/geotechnical documentation in support of a proposed quarry expansion to the east along with stability assessment.

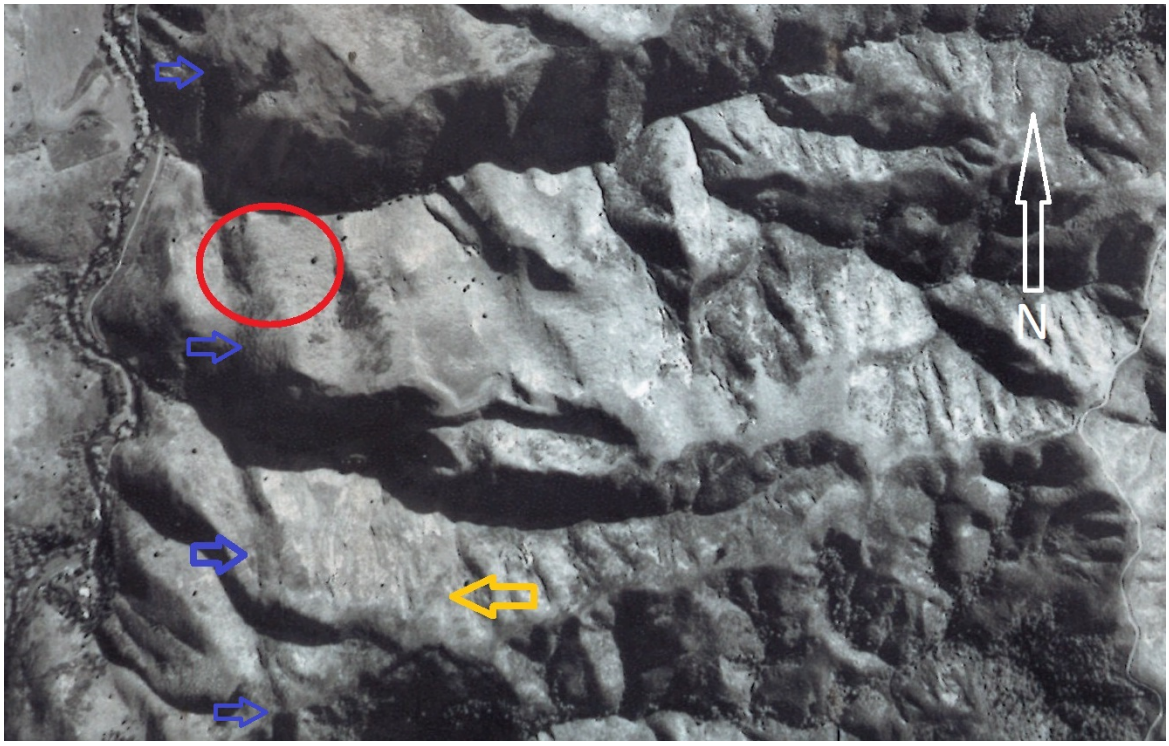
3.0 Site Description

The property is immediately south of the current Clevedon Quarry and the proposed expansion comprises in the order of 30 hectares. The land is largely in forestry mixed with portions of regenerating bush. For potential resource extraction, Stevenson Aggregates Ltd is interested in the northern portion of the land as indicated on the attached RILEY Dwg: 15211-14.

The proposed expansion area is generally steep, consistent with the surrounding terrain as part of the Hunua Ranges. Inspection of aerial images suggests the land in 646 McNicol Road immediately south of the current quarry may be steeper than slopes adjacent to the existing quarry excavation. Walkover inspection was consistent with this observation, possibly indicating rock type materials near surface producing steeper slopes.

Aerial images from 1944 show the northern portion of the property, where the quarry expansion is being considered, to be largely in pasture with some isolated patches of bush in steep gully heads to the east (see Figure 1 below).

Figure 1: Aerial Image from 1944



Notes:
Red circle = current Clevedon Quarry
Blue arrows = Wairoa North Fault trace
Yellow arrow = northern slope in pasture affected by significant shallow instability

4.0 Preliminary Site Investigations

To-date, the following work has been undertaken as part of the preliminary assessment:

- Inspection of stereo aerial pair photographs from 1944 (for the northern portion of the land adjacent to the existing Clevedon Quarry).
- Review of the terrain model from Auckland Council GIS.
- Review of previous geological mapping along the southern stream as part of previous resource evaluation for the current quarry.
- Undertaken general mapping across the property near the existing quarry (in the area of possible near future expansion).
- Inspection of published regional Auckland geological maps.

No subsurface investigations have been undertaken as part of this review. It is anticipated further on-site geological mapping will be needed in specific areas to complement the existing data along with subsurface information to gain a more complete assessment of the potential resource. However, the work undertaken to-date is considered sufficient to determine the presence of rock resource.

5.0 Geology – Rock

Published geological maps (including 1:250,000 Sheet 3 Auckland) indicate the property is underlain by Waipapa Group 'greywackes', which was confirmed by inspection of outcrops on-site. Small quantities of alluvium and colluvium (slip debris) are also found in gently sloping streams and forming a veneer over moderately sloping ground.

The greywackes observed in exposure are similar to that currently excavated from Clevedon Quarry, with a mix of argillite, siltstone and sandstone, likely of similar mineralogical composition to Clevedon Quarry. Exposures inspected in the streams within the property often included a relatively significant amount of fine sandstone, which generally produces a superior aggregate compared with argillite. However, due to the sandstone condition and resistance, it may be preferentially exposed in streams giving a non-representative indication of its relative occurrence.

Photo 1: View of greywacke fine sandstone, rounded by stream water flow

Inspected rock exposed in streams was often moderately to slightly weathered and strong to very strong in accordance with the New Zealand Geotechnical Society Guidelines for description of rock based on exposure inspections. The rock is jointed similar to that seen in the current quarry faces. Bedding is not easily discernible but would appear to be steeply dipping to sub-vertical. Bedding may not have a significant impact on resource extraction. Macro-fabric within the rock appears from limited exposure to have a predominately north-east to east north-east orientation, which is similar to the current quarry.

Photo 2: Moderately strong siltstone with minor sandstone exposed adjacent to McNicol Road

From the aerial photographs, there are no obvious outcrops of rock visible, however, this is no different to the current Clevedon Quarry area, where rock is present beneath a relatively thin veneer of overburden.

The Wairoa North Fault continues south from Clevedon Quarry through the property. This potentially active fault has a surface expression, and thus, can likely be located to a reasonable level of accuracy on-site. Its inferred position from this initial assessment is shown on RILEY Dwg: 15211-14, attached. This fault was drilled through by recent investigations at Clevedon Quarry and found to have enhanced weathering penetration to some 30m below ground level. Trigonometry indicates the fault zone could be up to 10m wide, however, the related Waikopua Fault at Whitford Quarry has a fault zone witnessed to be significantly smaller (1m) with a broken rock zone up to 20m wide. Similar to the Waikopua Fault, the Wairoa North Fault may have splays with associate enhanced weathering adjacent to them.

6.0 Geology – Overburden

In the absence of subsurface investigation, it is difficult to establish overburden depths with accuracy. Limited exposures currently mapped across the site indicate between 1.5m and 2m of residual soil cover transitioning to completely weathered rock on and near ridge crests in the area mapped, similar to subsurface investigation results for the Clevedon Quarry ridge. The depth of overburden likely generally increases to the east, comparable to the ridge on which the Clevedon Quarry is situated. There will likely be areas of deeper weathering associated with substantial defects and enhanced weathering to depth along such defects.

Exposures on the steep ridge flanks indicate 1.5m of residual soil cover over completely weathered rock transitioning to highly and moderately weathered in 10m to 15m vertically near the slope base. The lower and steeper ridge flanks have minimal soil cover (observed to be 1m thick or less) transitioning quickly through completely weathered to moderately weathered.

As encountered at the existing Clevedon Quarry, rock resource is observed west of the Wairoa North Fault, however, it is at greater depth due to increased overburden cover. It is considered this is likely similar for the proposed expansion area, i.e. resource is available, however, likely beneath a thicker overburden and through weathering associated with the Wairoa North Fault if the quarry moves through it from the east. Neither Whitford Quarry nor Brookby Quarry currently extend west of this fault, however, those quarries have non-economic Waitemata Group deposits west of the fault.

The average overburden cover may be greater at 646 McNicol Road than at the current Clevedon Quarry, however, it should be noted the current overburden cover at the active quarry is thin compared with other quarries.

7.0 Stability

Review of aerial images from 1944, when the site was largely in pasture, show extensive areas of shallow instability evident on the northern facing slopes, which may have removed some of the overburden cover (see Figure 1). These features were still visible during the site mapping beneath the pine forest, although the features have 'healed' to varying degrees.

Recent instability was evident following heavy rainfall adjacent to overland flow paths and track cuts. However, this instability was in isolated locations and not extensive, likely due to the current forest and bush cover improving stability compared with the previous pasture.

The north-east to east north-east rock fabric may present stability challenges with respect to rock drop out as the quarry face advances southward as related defects will be sub-parallel to the face. This will be difficult to avoid and may require flatter batters on the southern wall as it advances, being particularly important in the higher more weathered portion of the face.

No obvious large-scale instability features were evident within the proposed quarry expansion area in either the aerial images or from the on-site mapping. This is not to exclude their possible presence, but they have not been noted within the evidence collected. The area of the current Clevedon Quarry is similar from a stability perspective, although to the east of the quarry is an area of noted ancient deep-seated instability, which the quarry excavation is yet to encounter.

8.0 Groundwater

Similar to Clevedon Quarry, it is expected there will be a shallow perched groundwater table, which responds to rainfall, and a deeper regional groundwater table possibly below RL 30.0m. The Wairoa North Fault appears to be associated with areas of wetter ground with distinctive vegetation visible in the 1944 aerial images. The fault could be ponding shallow groundwater upslope (east) of the feature.

9.0 Resource Volumes

We conservatively estimate the rock resource (brown and blue) at 70 million to 90 million tonnes for the proposed extension into 646 McNicol Road. This volume is based on assumed:

- Average floor level of RL 40.0m.
- Uniform overburden thickness of 15m.
- Average topographic elevation of RL 185m.
- Overall angle of 45º for completed batters.

As outlined, the above assumptions are generally considered conservative. Minor adjustments to these assumptions (e.g. average topographic height or floor level) yield greater or lesser quantities of rock.

10.0 Limitation

This report has been prepared solely for the benefit of Stevenson Aggregates Ltd as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on a visual appraisal only. The nature and continuity of subsoil conditions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

We trust this letter report satisfies your request. If you have any queries or comments regarding the information provided, please do not hesitate to contact the undersigned.

Yours faithfully
RILEY CONSULTANTS LTD

Prepared by:

Steven Price
Principal, Engineering Geologist, PEngGeol

Reviewed and approved for issue by:

Brett Black
Project Director, CPEng

Enc: RILEY Dwg: 15211-14

MCNICOL ROAD

WAIROA NORTH FAULT

EXISTING CLEVEDON QUARRY

439 OTAU MOUNTAIN ROAD

REPEATER STATION

LIKELY INCREASING OVERBURDEN COVER TO EAST

PROPOSED EXTENT OF QUARRY ZONE EXPANSION

ORUM ROAD

POSSIBLE FAULT SPLAY?

EXISTING DWELLING

WAIROA RIVER

POSSIBLY 2m TO CW MATERIAL

SIGNIFICANT RS + CW COVER IN VALLEY HEADS AND RIDGELINE

646 McNICOL ROAD

50 0 100 200m

SCALE 1:5000

LEGEND

- BOUNDARY
- INFERRED FAULT
- AREA OF LOGGED MW OR SW ROCK (LIKELY PRESENT IN FURTHER STREAM STRETCHES BUT NOT CURRENTLY LOGGED)
- PROPOSED EXTENT OF QUARRY ZONE
- RS — RESIDUAL SOIL
- CW — COMPLETELY WEATHERED ROCK
- MW — MODERATELY WEATHERED ROCK
- SW — SLIGHTLY WEATHERED ROCK
- RECORDED INSPECTION POINT

REV	DESCRIPTION	BY	DATE
1	FIRST ISSUE	ZL	17.09.21

DESIGN SLP | CHECKED SJP
DRAWN JM | CHECKED ZL
DATE DRAWN MAY 2017

APPROVED FOR ISSUE: B. BLACK
DATE: 14/09/21

RILEY CONSULTANTS
P.O.BOX 100 253
N.S.M.C.
AUCKLAND
TEL. 09-4897872
FAX. 09-4897873

TITLE

FULTON HOGAN LTD

646 MCNICOL ROAD, CLEVEDON

PRELIMINARY ROCK RESOURCE ASSESSMENT SITE PLAN

CADFILE 15211-14
SCALES (A3) 1:5000
DRAWING No. 15211-14
REV. 1