AECOM Imagine it. Delivered.

AECOM Services Pty Ltd
Level 10, Tower Two
727 Collins Street
Melbourne VIC 3008
Australia
www.aecom.com

+61 3 9653 1234 tel
+61 3 9654 7117 fax
ABN 46 000 691 690

17 February 2020

Matthew Dodd
Quarry Manager
Holcim (Australia) Pty Ltd
Mt. Shamrock Road

Pakenham, Victoria 3810

Dear Matthew

**Mt. Shamrock Quarry - Toomuc Valley Slope Inspection, January 2019**

## 1.0 Introduction and Background

AECOM Services Pty Ltd (AECOM) was requested by Holcim (Australia) Pty Ltd (Holcim) to undertake a visual inspection of the slopes adjacent to the Mt Shamrock Quarry in Pakenham as per the requirements of Mt Shamrock Quarry – Environmental Management Plan (EMP) (Section B, subsection 2.5, Version 3, August 2015).

The EMP requires visual inspection of vegetation planting in previously identified landslip areas, inspection of spring and drainage conditions and monitoring of slope conditions related to movements and instability in the Toomuc Valley.

Luke Clarkson (AECOM – Senior Geotechnical Engineer) completed the inspection on Tuesday 21st of January 2020 in the company of David Steele (Holcim), which comprised a walkover survey of the relevant areas as identified in the EMP, which have been inspected on previous occasions by AECOM (Legacy URS). For the avoidance of uncertainty, this letter report refers to and presents the findings from the annual 2019 inspection.

## 2.0 Geological Setting

The 1:25,000 scale Pakenham geological map (Geological Survey of Victoria, 1985) indicates that the near surface geology at, and surrounding, the Mount Shamrock Quarry consists of the following units in stratigraphic order from youngest to oldest. Indicative geological overlay is presented in Figure 1 (Attachment 1):

- **Qa1 - Quaternary Alluvium**: Quaternary aged (<0.01 Ma) alluvial sediments consisting of silty sands and clays, deposited along the floor of the Toomuc Valley.
- **Tvo - Older Volcanics:** Miocene aged (23 – 5 Ma) Older Volcanics of the Thorpedale Volcanic Group, consisting of a single flow of massive, blue/dark grey olivine rich basalts. It is this unit which is currently quarried at Mt Shamrock. It is noted to have a maximum thickness of ~70 m. The Older Volcanic basalt flow is suggested to have extruded into an ancient river valley which resulted in its current vertical and lateral profile. The ancient valley walls have been weathered and eroded to leave the more resistant basalt as a north-south trending ridgeline.
- **Tew - Werribee Formation**, fluvial clays and sand deposits, with trace organic material. Where present this unit underlies the Older Volcanics and will be variable in composition and thickness, but typically thin.
- **Dgl – Lysterfield Granodiorite:** Devonian aged Granodiorite. Regionally extensive intrusive unit locally overlain by Werribee Fm sediments (paleo soil) and the basalts of the Older Volcanics(Tvo)
- **S – Anderson Creek Siltstone:** The basement rock in the region is Silurian aged siltstone and sandstone.

## 3.0 History of Landslips in the Toomuc Valley

Old landslips observed on the eastern flanks of the Toomuc Valley in the vicinity of the Mt Shamrock Quarry are likely to be natural occurrences with some possibly pre-dating late 1700's. The Geological Survey of Victoria, 1;25,000 scale 1977-1979 Berwick Generalised Slope Map and accompanying engineering geology report which covers the general area identifies that slopes with gradients greater than 14 degrees formed from tertiary clays or granodioritic materials (Paleo soils) were identified as

exhibiting major old landslides. The report notes the slides as being stable at the time, but suggests they could be remobilised and should be treated as hazardous features.

Remobilisation triggers could be one or a combination of the following:

- Land clearance
- Increased water infiltration and/or groundwater rise due to rainfall or man-made causes
- Slope landform reshaping

The debris from earth slide / slip failures is generally considered to be slow moving, and once it reaches an area of shallower profile, it will typically stop.

## 4.0 Aerial Photography Identified Historical Landslips

- In preparation for the 2019 site inspection a review of *Google Earth* aerial imagery, as well as a Photogrammetric 3D Mapping flyover provided by Holcim and undertaken on 04/11/2019 was undertaken;
- It is noted that, with time, the land areas which comprise the historical landslips have been modified for different reasons; erosion of the slip, land use (predominantly as grazing land), and revegetation (land disturbance facilitating regrowth and/or increased moisture content);
- Notably, many of the slip areas have considerably more vegetation than that observed historically;
- Most of the masses identified in the EMP can be seen on the 2001 Google Earth imagery. 2001 is noted as the earliest dated imagery available on Google Earth;
- With the benefit of reduced vegetation cover in 2001 it is possible to see that a number of the EMP masses are in fact either:
    - Smaller recent remobilisation of much larger historical landslides that encompass a number of the EMP masses (ie Mass 1, 2, 3, 9 and 17); or
    - Smaller recent remobilisation of a larger historical landslide (ie Mass10, Mass12, Mass13).

The outline of large old landslides, originally identified from 2001 *Google Earth* aerial imagery and updated to overlie geological setting maps and recent flyover mapping has been included on Figure 1 and Figure 2 of Attachment 1, respectively.

## 5.0 Summary of discussion with Holcim

The key observations made by Holcim representatives (Matthew Dodd and David Steele) since the 2018 inspection include:

- There has been no observed change to any masses, nor any new failures observed;
- Several remedial treatments were undertaken leading up to the 2018 inspection, which are considered to be performing well;
- No additional remedial treatments of slopes or landslip areas have taken place since the 2018 inspection;
- No work has been undertaken on or near the farm dams observed onsite;
- Holcim reported that frequent inspections of the slopes are taking place by site personnel, particularly after heavy rainfall events;
- Water levels and water storage volumes within the quarry pit(s) has remained relatively stable over the last 12 months;
- There are a number of long-term springs which have been identified across the study area. Generally, they are positioned in a relatively small elevation band, approximately a third of the way below the slope crest. Discharge from a number of these springs is being captured and used for stock water and as such it is important to maintain the dams. Anecdotally, discharge from the springs is relatively constant.

AECOM Note: Review of the regional geology and contour information (Figure 1) notes that the identified springs appear to be positioned around elevation 135 m to 165 m AHD which corresponds approximately to the basalt / granodiorite geological boundary; and

- All masses identified by the EMP (and reproduced in the in the 2018 annual inspection) are understood to be stable.

## 6.0 Site Observations

The weather at the time of the inspection was overcast with the slopes being moist from rainfall the previous day. It was reported by the Bureau of Meteorology that approximately 44mm of rainfall was recorded at Scoresby Research Institute nearby Pakenham Quarry in the day prior to the inspection. The conditions onsite were still moist, hence some previous water observations (such as localised damp spots) were unable to be discriminated and separately documented in this inspection.

The slopes were observed to have relatively more vegetation than previous inspections (somewhat overgrown) which masked and hence challenged observation of some slope areas. Thistles were present on the site and can be observed in photographs in Attachment 2. Where the thistles are observed as brown and dead, it was advised by Holcim that this was because they had been sprayed and hence is not relied on as an indication of environmental conditions.

The primary objective of the landslip inspections was to determine whether there has been any significant change in the stability of the Toomuc Valley slopes adjacent to the quarry in the period since the previous inspection in January 2018. Any additional geotechnical observations are also to be documented.

In the 2013 inspection report, minor evidence of ground movement was observed in three areas identified as Mass04, Mass09 and Mass19 (Figure 2). The subsequent inspections over 2014, 2016, 2017 and 2018 inspections observed that evidence of the original movement is still visible, however there were no indications that the areas had deteriorated further since the 2013 inspection.

Some minor animal burrowing was observed to have occurred in landslip scarps during the inspection period. These burrows introduce the risk of undercutting the slope and progressing crest retreat. At the time of inspection, the animal burrowing was observed to be at maximum 500mm deep into the slope (laterally) and was not expected to be of sufficient size to collapse the overlying material. However, to mitigate any potential future degradation of the slope, these areas are proposed to be filled and revegetated, where possible.

Vegetation beneath tree cover around the slope areas, in particular in the grazing fields downslope of the masses was observed to be dead. This is potentially due to the combination of oversaturation of the ground from recent rainfall, the frequent cattle traffic in using these areas for shade, and consequentially vegetation removal and an increase in the potential for surface erosion.

Table 1 summarises the visual observations made.

**Table 1 Summary of Observations (21 January 2020)**

| Landslide Reference ID | 2019 Visual Observation |
|---|---|
| Mass01 | • Established vegetation consisting of dense grass, and small trees and shrubs.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Minor erosion observed on south west side of downslope mass. |
| Mass02 | General Slope Stability of Mass02 Area<br>• Overall the area is well vegetated with dense grass cover and small to medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed (exception being existing dam, as discussed below).<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 5 years.<br>• Two concrete tanks (20 $m^3$) were observed on the downslope, with evident deterioration and removal of grass surrounding this area.<br>Existing Dam (located midway up Mass02) refer Figures 1 and 2.<br>• Current water level was not visible due to overgrown vegetation.<br>• Evidence that overtopping has occurred (northern end) resulting in washout and scour of the downstream embankment face. It is partially vegetated now. The affected area is (~5 m in width, 1.5 m in height). Apparently the initial event occurred about 4 years ago however there is evidence of minor ongoing deterioration.<br>• The area is fully vegetated and fenced with tightly spaced tree planting completed in the review period.<br>• The dam embankment crest has also been damaged by softening, due to water infiltration, and animal trafficking.<br>• There is a small intake structure (steel tank) with two small diameter poly pipes to collect dammed water and transfer to lower third of slope. Evidence suggests that these have insufficient capacity to capture water in periods of high water flow into the dam, leading to a high likelihood of further overtopping.<br>• The gloryhole spillway has been lowered by approximately 200mm (as informed by John Everitt) and a contingency overflow pipe has been added (Attachment 2) which works to prevent embankment overtopping.<br>A full dam embankment failure may occur at the next overtopping, as the wall has experienced appreciable damage from previous events. The consequences of such a failure would be minor as the asset is isolated from infrastructure such as dwellings, public roads etc. However a full failure would result in rapid discharge of a reasonably significant volume of water and mud which likely would severely damage vegetation and could trigger other remobilisation landslips further down slope. Another consequence would be loss of stock drinking water.<br>**Remedial Solution Treatments**<br>The following remedial options have been implemented during the previous review period:<br>1. Construct a barricade to prevent animal access to the dam crest (fenced).<br>2. Full supply level lowered by 0.2m and complemented by a contingency overflow pipe to maintain the full supply level.<br>3. It is not anticipated that a hydrological assessment was undertaken in order to determine required pipe size / or chute size.<br>4. Reinstate the scoured dam crest with locally won clays (keyed in, placed and compacted in accordance with good dam construction practice.<br>5. Complete a detailed inspection of the downstream embankment erosion to determine extent. Assuming that it is surficial only, place rock spalls (150-75mm) on face to protect from ongoing erosion.<br>*Note: works should be carried out under the direction of an appropriately experienced and qualified dams or geotechnical engineer.<br>6. Maintain regular documented inspections of the dam and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction. |
| Mass03 | • Overall the area is well vegetated with dense grass cover and small to medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years. |

| Landslide Reference ID | 2019 Visual Observation |
|---|---|
| Mass04 | General Slope Stability of Mass04 Area<br>• Overall the area is well vegetated with dense grass cover and small to medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 5 years.<br>Localised Small Circular Failure of Old Backscarp (refer Attachment 2)<br>• During review period a small, shallow circular failure of an old backscarp from the larger historical landslide has occurred. The slope behind the failure is relatively flat, appeared dry and is vegetated with grass and bushes. There is no evidence of tension cracks behind the failure.<br>• The failure measures about 5 m in width and ~1.5 m in height. The slope below slump is damp, likely associated with a spring. Surface water was not able to be observed based on moist conditions from recent rainfall.<br>• The circular failure is small in volume and, given that the location is isolated from any downhill infrastructure, is not considered to be a significant geological risk.<br>**Remedial Solution Treatments**<br>The following remedial options have been implemented during the previous review period:<br>1. Construct a barricade to prevent animal access to the area to allow vegetation to establish, it is currently fenced on all sides at approximately a 50m radius.<br>2. Revegetate behind the failure / old backscarp with deep root (but small canopy) shrubs / bushes and grasses<br>3. Revegetate in the saturated area below the failure with wet tolerant species, ie swampy gums, river gum, boobiellas<br>4. Revegetate the slump surface with grasses.<br>5. Maintain regular documented inspections and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction.<br>It is deemed important to continue to monitor the vegetation of this scarp to ensure that washouts do not inhibit the progress.<br>Some vegetation regrowth (likely to be as a result of previous remedial treatments and revegetation) was observed at the toe of the scarp area. |
| Mass05 | • Overall the area is well vegetated with dense grass cover throughout.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years.<br>• Minor historical circular failures were observed in four locations: these failures were observed to be associated with exposed (bare) scarps and a change in the natural topography locally downslope with remnant mobilised material. A natural drain has formed through this material to avoid the local high. It is recommended that the bare scarp areas are grassed to mitigate potential of further erosion.<br>• The mobilised material is well vegetated. Observation of the exposed scarp suggests that the material is weakly structured, near-surface soil possibly associated with the Werribee Formation (Attachment 1 for geological map and Attachment 2 for photo of scarp). |
| Mass05 Dam | • Upstream drainage channel/ catchment from Mass05 is unobstructed. Embankments are vegetated. Eastern side is bare, with an observed retreating crest. There is waste (rubbish) blocking the upstream channel to the east. This is recommended to be monitored but is not anticipated the comprise significant risk at this stage.<br>• A downstream spillway has formed naturally.<br>• Water was observed 500mm below the crest of the dam, with the crest material softened by cattle traffic. There is a low risk for this structure in terms of both likelihood and consequence |
| Mass06 | • Overall the area is well vegetated with dense grass cover throughout.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years. |
| Mass06 Dam | • This dam contains a comparatively large volume of water to other dams (surface area 45 $m^2$, total depth unknown). The water level was observed at 500mm below the crest.<br>• A natural overflow to east has been identified, which directs water to a dam on an adjacent property downstream.<br>• The dam crests are retreating, predominantly due to fauna traffic, with characteristically erosive material. A visual assessment indicates a low risk of failure.<br>• Risk to cattle adjacent to dam, where in some places a 1.5-2m vertical difference was observed due to the retreating crest. |
| Mass07 | • Tree planting has been undertaken upslope.<br>• There is a minor scarp adjacent to the worn cattle track on the eastern side, suggested erosive driver being the cattle traffic but reiterating the poor structure of the soils.<br>• Historical scarp has been vegetated with no exposed ground or evidence of movement. Overall the area is well vegetated with dense grass cover throughout.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years |
| Mass08 | • Overall the area is well vegetated with dense grass cover throughout.<br>• There are some historical scarps up to 1m height. These demonstrate weak soil structure, with anticipated minor failures in rain events.<br>• The local area immediately below scarp is poorly to moderately vegetated. Bare ground was observed for approximately 500mm laterally at the toe of the scarp.<br>• A minor, unrelated scarp was observed upstream.<br>**Proposed Remedial Solution Treatments**<br>1. Revegetate the scarp surface with grasses; and<br>2. Maintain regular documented inspections and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction. |

| Landslide Reference ID | 2019 Visual Observation |
|---|---|
| Mass09 | • Overall the area is well vegetated with dense grass cover and small to medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed. Minor scarp erosion was observed but it is not anticipated to pose significant geotechnical risk.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years. |
| Mass10 | • Overall the area is well vegetated with dense grass cover and medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years.<br>• Minor grass cover has been removed with bare earth exposed – surficial erosion only.<br>• Minor downstream surficial erosion.<br>• A drain was observed under road to the south of the mass. No blockage observed at entry/ exit. |
| Mass11 | • Overall the area is well vegetated with dense grass cover and shrub and tree planting program, on a tight grid, has been established (refer Attachment 2). During the inspection period, the vegetation guards have been removed. Some vegetation as part of the program has also died off, which was reported by Holcim to be because of drought conditions.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• The small area in the top north corner of the Mass previously observed to be bare of grass cover was observed to have some vegetation growth albeit still comprising relatively less vegetation than surrounding areas. This area is coincident with a historical slump, as evidenced by a heaved mass in front of the area. At the area of the scarp of this slump, the slope remains bare and animal burrowing was observed to be undercutting the slope.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years.<br>**Proposed Remedial Solution Treatments**<br>1. Fill/ remediate burrowing so that the undercutting risk is mitigated;<br>2. Construct a barricade to prevent animal access to the area to allow vegetation to establish;<br>3. Revegetate the scarp surface with grasses; and<br>4. Maintain regular documented inspections and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction. |
| Mass12 | • Overall the area is well vegetated with dense grass cover and medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years. |
| Mass13 | • Overall the area is well vegetated with dense grass cover and medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years.<br>• Pipe under road. No blockage observed at entry. The exit of the pipe was observed to have some silt and sediment build-up (anticipated to be as a result of recent rainfall), which is damming the pipe exit.<br>• Minor scarp erosion approximately halfway between the access road and the dam was observed to have enlarged slightly during the inspection period. It is noted that there is negligible immediate risk, however there may be value in revegetating this area to mitigate further erosion.<br>• **Proposed Remedial Solution Treatments**<br>1. Revegetate the scarp surface with grasses; and<br>2. Maintain regular documented inspections and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction. |

| Landslide Reference ID | 2019 Visual Observation |
|---|---|
| Mass13 Dam | Existing Dam<br>• Current water level observed to be 400mm below dam embankment crest.<br>• Dam embankment appears to be in good condition and where water level has exceeded embankment crest it appears to discharge naturally at the northern end of the embankment. The point of discharge has been softened by animal traffic with minor desiccation cracking at crest.<br>• Continued uncontrolled discharged of water from an over full dam could result in erosion and scour of the dam wall and whilst the consequences of dam failure would be moderate as the asset is isolated from infrastructure such as dwellings, public roads etc. A more detailed assessment should be considered as there is property potentially in line with the dam albeit some distance away. A visual assessment of the dam surface area and anticipated (albeit unknown) depth indicates that should water runout, this would saturate the ground however is not anticipated to detrimentally influence the downstream property. A full failure would result in rapid discharge of a not insignificant volume of water and mud which likely would severely damage vegetation and could trigger other remobilisation landslips further down slope. Another consequence would be loss of stock drinking water.<br>• The natural slope at the back of the dam which has experienced a shallow surficial slump has the potential to continue moving and may result in causing an overtopping of the dam if this is to occur. The same mechanism was observed to be beginning to form on the northern side of the dam.<br>• The upstream embankment is steepening/ eroding. Many areas appear to fail locally and deposit material into the dam. The pressure of water does not visually appear great enough to destabilise downstream embankment. The primary risk would be degradation of embankment stability as a result of cattle/ ongoing erosion.<br>• To maintain the integrity of the dam and prevent damage to the dam wall due to uncontrolled discharged and possible overtopping possible remedial solutions are suggested below.<br>**Remedial Solution Treatments**<br>The following remedial options have been suggested on the basis that, at this point, only small earthmoving plant is considered feasible to mobilise to the area<br>1. Construct a barricade to prevent animal access to the dam crest and northern area which appears to have been disturbed by stock.<br>2. Lower the full supply level to be at least 0.5m below the dam crest and maintain as the full supply level, by construction of a rock lined emergency spillway chute with floor level at design full supply level. The most suitable location is likely towards the north where water appears to be naturally discharging. An engineered solution would ensure that the chute is aligned away from the dam wall (in natural material) so that if discharging water cannot work back and erode / scour the dam embankment). The chute would require rock lining and the outlet would have to be designed so water is dispersed in a manner that does not cause slope instability at or below the point of discharge. A small (say 8t) backhoe would be suitable for this task.<br>A hydrological assessment should be undertaken in order to determine required pipe size / or chute size.<br>3. Remove / trim the failure cutting slope back to undisturbed ground and vegetate with deep-rooted grasses so the excavated surface is stabilised.<br>4. Install a cut-off swale behind the cut batter on the upslope side of the dam to intercept any slope wash and direct it either around the dam or into the dam in a controlled manner.<br>*Note: works should be carried out under the direction of an appropriately experienced and qualified dams or geotechnical engineer.<br>• Maintain regular documented inspections of the dam and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction. |
| Mass14 | • Overall the area is well vegetated with dense grass cover and medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years. |
| Mass15 | • Overall the area is well vegetated with dense grass cover and medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years.<br>• Minor side-road scarps were observed, anticipated due to cattle traffic.<br>• Holcim representatives previously and anecdotally shared that there is a spring present under the large tree at the elevated east of this mass. |
| Mass16 | • Access gained to site but noted that it is important to contact landowner prior to entering.<br>• Heavy vegetation in the northern area, predominantly trees and shrubs. There is minor side slope erosion visible but anticipated to be related to traffic (both vehicles and cattle).<br>• A minor farm dam was observed approximately halfway up the mass. The vegetation on the dam bank has decreased, anticipated to be as a result of fauna traffic. The water level was observed 1.5m from crest of the dam with minor cattle tracks observed on the crest. |
| Mass17 | • Area is well vegetated with dense grass cover.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years. |
| Mass18<br>Mass19<br>Mass20 | • Overall the area is well vegetated with dense grass cover and medium shrubs and trees throughout.<br>• Whilst the slope surface is hummocky, this appears to be associated with historical major landslips and no evidence of recent or ongoing instability was observed.<br>• Holcim representative indicated that there is no known slope movement in this area over the review period and in general the area is considered to have remained stable over the last 7 years.<br>• Mass 19 was observed to have localised surface erosion, evidenced by exposed (bare) earth < 0.5m$^2$. |

| Landslide Reference ID | 2019 Visual Observation |
|---|---|
| Other Areas Visited | |
| Back scarp of Large Historical Landslide comprising Masses 1, 2, 3, 9 and 17 | • The crest of the backscarp was observed to be relatively fresh (recently eroded), and suggests retreating of the crest is occurring. At time of inspection, this retreat was anticipated to be <100mm laterally.<br>• The downslope area of the backscarp is well vegetated with grasses and trees.<br>• Slope erosion was observed on adjacent slopes, in particular around larger gum trees but is anticipated to be historical and of no significant geotechnical risk.<br>**Proposed Remedial Solution Treatments**<br>1. Construct a barricade to prevent animal access to the area to allow vegetation to establish;<br>2. Revegetate behind the failure / old backscarp with deep root (but small canopy) shrubs / bushes and grasses; and<br>3. Maintain regular documented inspections and if conditions deteriorate notify suitably qualified geotechnical engineer for further direction. |

## 7.0 Conclusions and Recommendations

The project area contains numerous historic landslips that possibly predate the construction of the quarry and occur naturally due to the prevailing conditions relating to the geological setting, slope profile and orientation, and meteorological events.

Typically the landslips observed in the project area present themselves as small remobilisations of old larger landslides. The remobilisation landslips tend to be minor earthflow / earth slide events and debris flows which typically can be triggered by periods of increased rainfall.

No formal risk assessment has been undertaken to date to assess the likelihood and consequence of potential failure or travel distances of deposited material. While it is noted that, no properties are currently present in the direct line of travel, there is the possibility of property and asset damage should significant movements occur. Whilst the location and size of the masses identified in the EMP by themselves are unlikely to pose a threat to infrastructure downslope ongoing vigilance, monitoring and revegetation should be undertaken to guard against possible reactivation of larger historic landslides. Areas suggested for further revegetation are described in Table 1.

The observations made during the 2019 landslip inspection suggest no new areas of instability were identified on the slopes surrounding the quarry.

Based on the observations, the following specific recommendations are suggested:

1. Introduce additional vegetation at the crest of a scarp at “Back scarp of large historical landslide” (refer Attachment 1), as it appeared to be freshly eroded and retreating;
2. Fill animal burrowing holes and revegetate scarps at Mass11;
3. Revegetation of scarp surfaces with grasses proposed at Mass08 and Mass13; and
4. Remedial treatments previous proposed for Mass13 Dam remain, as this has not yet been undertaken. These are aimed at establishing a permanent freeboard and reinstating the dam embankment. Whilst the dams are typically located remotely to existing downslope infrastructure, should failure occur, the potential for downslope damage exists. In the case of the dam at Mass13, more detailed assessment of runout paths should be undertaken to assess the risk, if any, to infrastructure.

Based on the observations, the following general recommendations are suggested:

1. Maintain existing regular visual inspection procedures by site personnel (ie maintain the approximately weekly to fortnightly inspections of each area as part of general operations, with more frequent visits to locations with identified issues). If indications of slope instability are identified, notify a suitably experienced and qualified geotechnical engineer / engineering geologist for further assessment;
2. Continue efforts to revegetate the slopes with deep rooted species;
3. Continue efforts to manage surface water runoff from the natural springs; and
4. Continue to undertake annual inspections during spring and potentially following extended periods of prolonged, intense rainfall should it occur during the review period.

In addition to the landslip monitoring and revegetation recommendations discussed above, the site investigation observed five farms dams exhibiting varying levels of degradation, namely: Small farm dam within Mass02; moderately sized farm dam to southwest of Mass05; larger farm dam on southern side of Mass06; larger farm dam on southern side of Mass13; and small farm dam to south of Mass16.

If there are any questions, comments, or queries on any of the content within this letter report, please do not hesitate to contact the undersigned.

Yours faithfully

Luke Clarkson

Senior Engineer - Ground Engineering and Tunnelling
luke.clarkson@aecom.com

Mobile: +61 499 989 506
Direct Dial: +61 7 3553 3857
Direct Fax: +61 7 3553 2050

Chris Huddy
Team Leader - Ground Engineering & Tunnelling QNT
chris.huddy@aecom.com

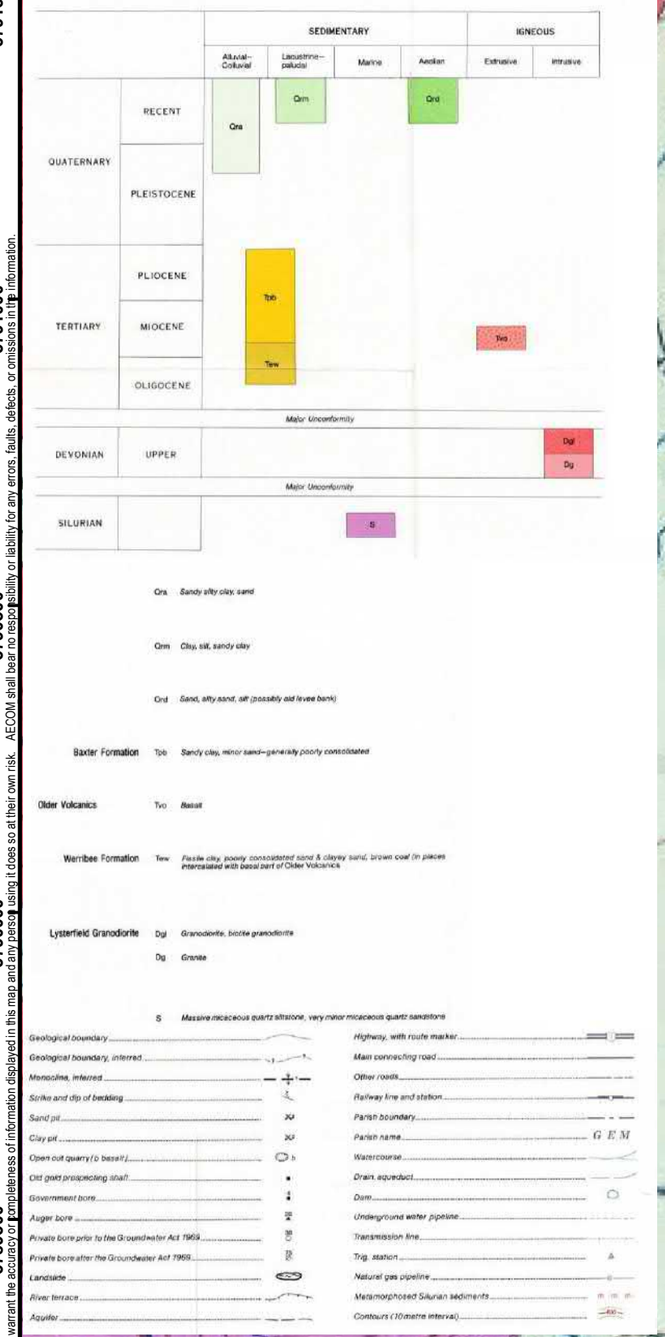
Mobile: +61 427 246 958
Direct Dial: +61 7 3553 3375
Direct Fax: +61 7 3553 2050

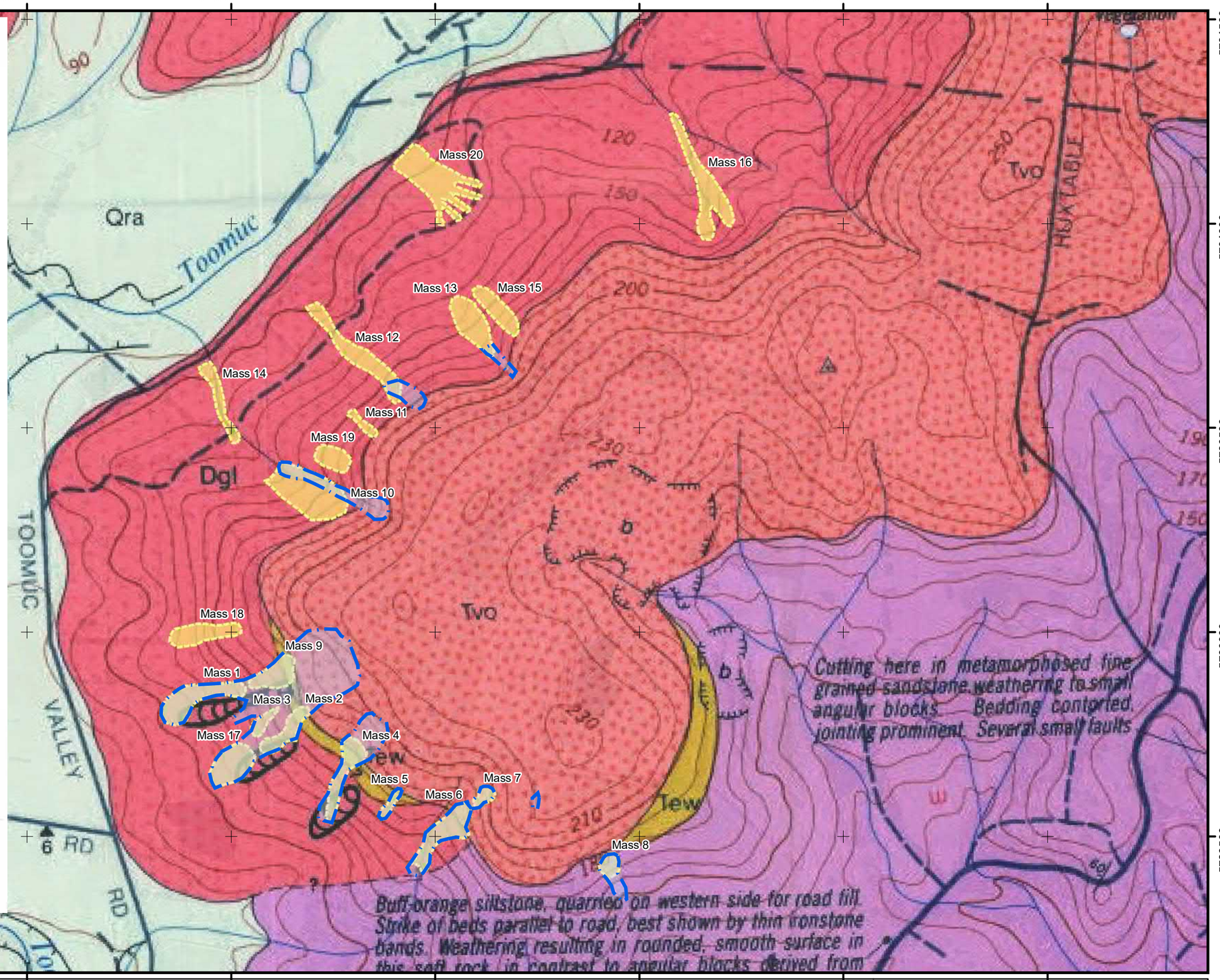
**Attachments**
Attachment 1- Figures
Attachment 2- Site Photos

# Attachment 1 Figures

364000 364500 365000 365500 366000 366500 367000 367500

5791500 5791000 5790500 5790000 5789500






PROJECT ID 60453195 (URS 43283833)
CREATED BY TM
LAST MODIFIED TM 04 FEB 2020

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 55

0 115 230 460
metres

1:10,000 (when printed at A3)

## LEGEND

Indicative Historical Landslips (beyond identified EMP masses)

Landslip Areas (defined by EMP)

## GEOLOGICAL SETTING

**Holcim (Australia) Pty. Ltd.**

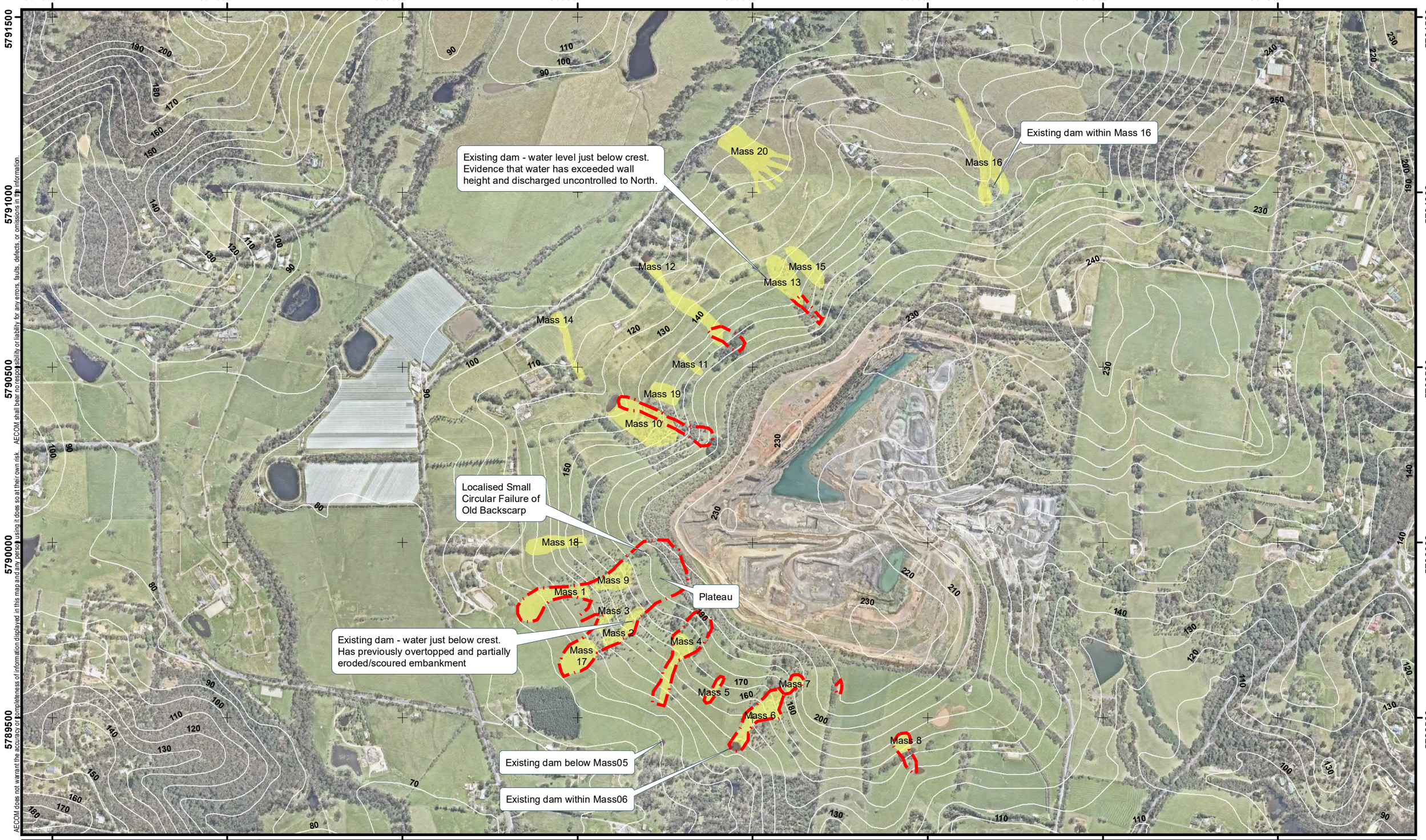
*Mt Shamrock Quarry - Toomuc Valley Slope Inspection - October 2019*

95 Mount Shamrock Road, Pakenham

Figure 1

Map Document: (\\AUMEL1FP001.AU.AECOMNET.COM\Jobs\43283833\5 WIP\2019 Stability Assessment\Map\F1_Geological_Setting_2019.mxd)

A3 size






PROJECT ID 60453195 (URS 43283833)
CREATED BY TM
LAST MODIFIED TM 04 FEB 2020

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 55

0 115 230 460
metres

1:10,000 (when printed at A3)

## LEGEND

Indicative Historical Landslips (beyond identified EMP masses)

**Landslip Areas (defined by EMP)**

# Landslip Location Plan

**Holcim (Australia) Pty. Ltd.**

*Mt Shamrock Quarry - Toomuc Valley Slope Inspection - October 2019*

95 Mount Shamrock Road, Pakenham

**Figure**

**2**

Map Document: (\\AUMEL1FP001.AU.AECOMNET.COM\Jobs\43283833\5 WIP\2019 Stability Assessment\Map\F2_Site_ Plan_2019.mxd)

A3 size

# Attachment 2 Site Photographs

**Mass01**

## Mass02

**Mass03**

## Mass04

## Mass05

## Mass05 Dam

**Mass06**







## Mass06 Dam

## Mass07





**Mass08**

**Mass09**

**Mass10**





**Mass11**







## Mass12

**Mass13**

**Mass13 Dam**

**Mass14**

**Mass15**






SPRING
S1

**Mass16**




Mass17

**Mass18**

**Mass19**

**Mass20**

**Back scarp of Large Historical Landslide comprising Masses 1, 2, 3, 9 and 17**