coffey geotechnics
SPECIALISTS MANAGING THE EARTH

15 May 2008

SEQ Water
Information Centre Brisbane Valley Highway
PO Box 367
FERNVALE QLD 4306

Attention: Barton Maher

Dear Barton

RE: Site Assessment Report

Outlet Works Cutting Stability, Lake Wivenhoe

1 INTRODUCTION

This letter reports on a site assessment of an existing rock cutting located adjacent to the outlet works at Lake Wivenhoe. The purpose of the work was to assess the condition of the cutting and to recommend remedial options for the wall if considered necessary.

It is understood that ravelling of the existing cutting face and potential instability of isolated sandstone blocks presents a safety hazard for personnel working near the toe of the cutting and also a damage risk to nearby infrastructure, including an electrical substation and two small buildings.

It is understood that the cutting has been exposed for about 30 years.

2 SITE DESRIPTION

The cutting is located east of the main outlet works for Lake Wivenhoe and near the downstream toe of the dam and consists of five essentially vertical faces. The site locality and the general site layout are shown in attached Figures 1 and 2 respectively. General photographs of the site are included in Figure 3 attached.

The cutting consists of two main faces oriented approximately east – west (main north face) and north – south (main east face), about 19.2 m and 17.3 m in length respectively with maximum height of about 11 m. Three smaller faces located at the western end are oriented approximately northwest – southeast, west - east and north - south, and are about 6.7 m, 5 m and 16.2 m in length respectively with a maximum height of about 9.5 m. To the east of the vertical cutting is a rock slope battered at about 1:2 (V:H) which was not included in the assessment.

Existing structures in the vicinity of the cutting include:

- Dam embankment located adjacent to the western end of the cutting, with rock beaching and wire mesh cover,
- Small brick work shop building and separate lavatory at the western end of the cutting,
- 4 m high concrete retaining wall located to the west of the cutting behind the buildings and at the bottom of the dam embankment,
- An electrical substation located adjacent to the main east face which is surrounded by a chain wire fence,
- A steel service pipe runs along the main northern face about 1 m off the ground and 3 steel service pipes run up the main eastern face.

3 GEOLOGY

As reported previously by Coffey, the geology at the site consists of a surface layer of residual soil underlain by weathered, undifferentiated sandstone and siltstone beds of the Lower Jurassic Marburg Subgroup and the Upper Triassic Woogaroo Subgroup. The sandstone is typically thickly bedded and occasional thinner layers of siltstone. Strata is near horizontal, or dip to the south and south east at around 2° and 5°. Bedding planes can be slightly folded and local dip directions and angles vary. This description is consistent with the site observations.

4 SITE OBSERVATIONS

The site was visited by a Coffey Geotechnical Engineer on 12 December 2007 for an initial assessment and later on 17 January 2008 for a more detailed assessment. For the latter visit, the Engineer was assisted by a Coffey Technician.

During the assessment observations of the cutting including geometry, geology, rock mass defects. face condition, and the proximity of surrounding structures were noted. Measurements of dip and dip direction were taken of the defects. An extension ladder was used to measure defects and bedding planes at height. Photographs were also taken which are presented in Figures 2 to 8 attached.

The cutting has been excavated mainly in moderately and slightly weathered sandstone with the higher degrees of weathering located near the crest. Behind the crest the surface is grassed and there is a thin cover of residual soil, estimated at less than 0.5 m thick, overlying the sandstone. The exposed sandstone in the cutting has developed an uneven relief due to weathering/erosion and ravelling of cobble size fragments has begun to occur. Some fragments about 0.25 m across were noted at the toe of the cutting. The sandstone beds typically dip at about 2° to 5° but are locally steeper (up to 10°) in some areas.

Two bands of highly weathered to extremely siltstone present in the northern and eastern faces lie concordant with the sandstone beds varying between about 0.3 m and 0.8 m thick. The weathered siltstone bands have eroded more rapidly than the sandstone and have begun to undercut the overlying face by typically 0.2 m to 0.3 m but on the main eastern face the undercutting extends up to about 0.5 m deep.

There is a vertical joint set striking approximately north – south. Two of these joints daylight near the north eastern corner of the cutting and also on the battered cutting, located behind the main east face. The joints appear to have irregular spacing, but are spaced no less than about half a metre. There appears to be no obvious ground water seepage through these joints or in other areas on the face.

The defect properties are summarised in Table 1.

Table 1: Summary of Defect Characteristics

Type	Orientation	Length	Spacing	Roughness/ Condition	Comments
Joint set	Sub vertical, striking north south	Continuous along height of cutting	Irregular, but no less than 0.5 m.	Planar, rough, stained, dry	Daylights in north face and also adjacent batter slope to east behind main east face
Bedding Parting	Dip - 2° to 5°, Dip Dirn 215° to 240°	Continuous	0.5 m to 1 m	Planar, rough, stained, dry	Confined to upper 1 to 2 m of cutting in bedrock

There are a number of irregular fractures through the rock mass, prevalent on corners of the cutting which form small irregular shaped blocks, typically ranging in height from 0.5 m to 1 m.

One wedge shaped block was observed at the top of the western end of the cutting, formed by a combination of bedding partings in the overlying thinly bedded sandstone and irregular fractures down the face. The block is estimated at 1.3 m deep and 0.9 m high. The block appears to have the potential to be dislodged. The block is shown in Photo 6 in Figure 3.

5 DISCUSSION

5.1 Stability Issues

Based on the site assessment a number of stability issues have been identified that are considered to present a safety risk to personal working near the bottom of the cutting and a damage risk to the nearby buildings and the electrical sub station.

It is considered the failures are largely surficial in nature and have been caused by degradation of the exposed rock at the surface by erosion and weathering that has occurred since the rock was exposed. The main issues are considered to be:

- Ravelling of the sandstone face resulting in large cobble and small boulder size fragments being released from the wall. Present across all faces. Considered to be a minor risk to safety and damage of buildings.
- Minor blocks / slabs of sandstone 0.5 m to 1.5 m height. Located on the western end / main north face. Considered to be a minor risk to safety and damage of buildings.
- Erosion of the siltstone beds causing undercutting and instability of overlying sandstone beds. Potentially for further erosion to occur causing slabs of overlying sandstone beds to fall. Present on the main northern and eastern faces. Presently considered to be a minor risk to safety and damage of buildings.
- Single wedge of sandstone location at top of north – south face at top of cutting. Have unfavourable oriented release planes, consisting of bedding partings and irregular fractures.

The block has the potential to become dislodged through further erosion and water ingress which could cause significant injury / damage to workers and buildings below.

Vertical joints orientated parallel to the main east face have the potential to induce toppling failure, however this type of failure is considered a remote possibility, considering the performance of the cutting over its inferred 30 year life.

5.2 Remedial Treatments

The following remedial treatments for the wall are recommended:

- Remove ravelling potential and potential for small sandstone blocks to be released from face by scaling / smoothing of the cutting face and removing potentially unstable blocks. Unstable block recommended for removal are indicated on Figure 4 attached.

  This would best be carried out with an excavator using only the back of the bucket, being careful not to create new areas of instability. The excavator will need sufficient reach to access the main eastern face adjacent to the electrical sub station. The sub station would need to be isolated during these works.

- Provide erosion protection and prevent further undercutting of the siltstone beds by applying shotcrete supported with dowell bars.

  The shotcrete should have a minimum thickness of 150 mm. Dowell bars should have a 25 mm minimum diameter and be grouted back into the rock face. Weep holes in the shotcrete should be provided at no less that 1.5 m centres.

- Stabilise the single sandstone wedge at the western end of the cutting by installing a minimum of two dowell bars. The installation location of the bars is indicated on the attached photo in Figure 7 and 8.

  The dowell bars should be minimum 32 mm diameter and be fully grouted back into the rock face. The bars should be installed at a minimum angle of 5° below the horizontal and extend a minimum length of 1 m beyond the unstable wedge, into competent rock. A design bond stress of 350 kPa in low strength sandstone was adopted for design purposes.

6 CONCLUSIONS

Coffey has undertaken a site assessment, identified stability issues of the existing cutting and provided recommendations for the remedial treatment of the cutting at the outlet works area at Lake Wivenhoe. The stability problems are largely regarded surficial in nature. No global instability has been recognised.

The remedial works are intended to maintain the integrity of the cutting, reduce the safety risk to site workers and damage risk to infrastructure in a cost effective manner.

The treatments do not preclude the cutting from requiring further treatment in the future. The majority of the face still remains exposed to erosion and weathering and may therefore require minor maintence or further assessment from time to time.

Until the remedial works are carried out, personnel working at the bottom of the cutting should wear safety helmets to provide some protection against falling material from the face.

We trust this meets you requirements, however should you require further information please contact Nick Alexander or the undersigned.

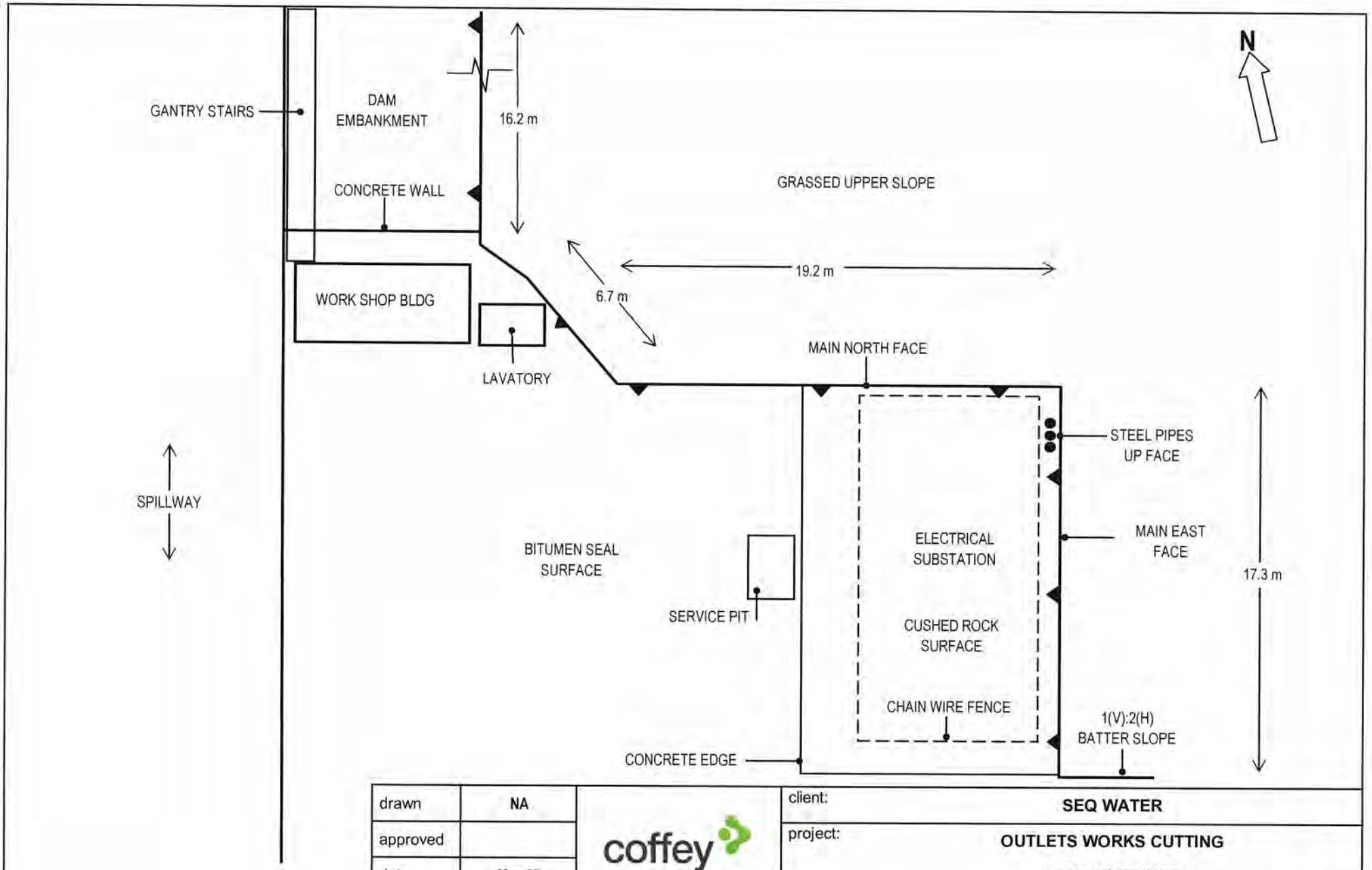
For and on behalf of Coffey Geotechnics Pty Ltd

Garth Powell

Senior Principal

Attachments: Figure 1: Plan of Site Locality
Figure 2: Plan of site Layout
Figure 3 + 4: Photograph 1 to 8
Figures 5 to 8: Remedial Works

drawn	NA	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	SEQ WATER
approved			project:	OUTLETS WORKS CUTTING LAKE WIVENHOE
date	May-08		title:	SITE LOCALITY PLAN
scale	NTS		project no: GEONEWS20208AA	figure no: FIGURE 1
original size	A4			



drawn	NA
approved	
date	May-08
scale	1:200 (approx)
original size	A4

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client:	SEQ WATER
project:	OUTLETS WORKS CUTTING LAKE WIVENHOE
title:	PLAN OF SITE LAYOUT
project no: GEONEWS20208AA	figure no: FIGURE 2

F:\GEOT\GEOTNEWS\GEOTNEWS20200's\GEOTNEWS20208AA - Wivenhoe Outlet Works Rockwall\[Photos.xls]Figure 7

Photo 1: View of cutting looking towards north. Electrical substation located to right and workshop buildings located to left.

drawn	NA
approved	
date	May-08
scale	-
original size	A4

coffey geotechnics
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client:	SEQ WATER		
project:	OUTLETS WORKS CUTTING LAKE WIVENHOE		
title:	PHOTO 1 - OVERALL SITE		
project no:	GEONEWS20208AA	figure no:	FIGURE 3

F:\GEOT\GEOTNEWS\GEOTNEWS20200's\GEOTNEWS20208AA - Wivenhoe Outlet Works Rockwall\[Photos.xls]Figure 2

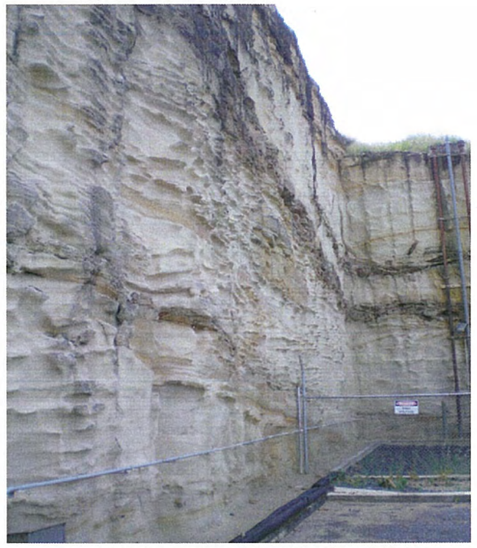

Photo 2: View of main north face towards east. Uneven surface relief visible; surface ravelling occurring.

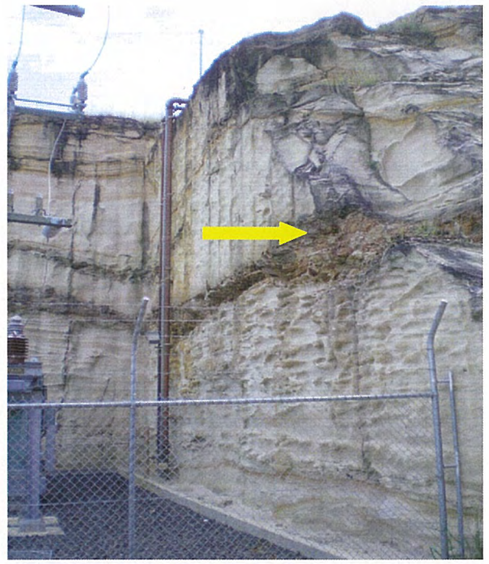

Photo 3: View of main east face towards north. Undercutting of siltstone beds arrowed.

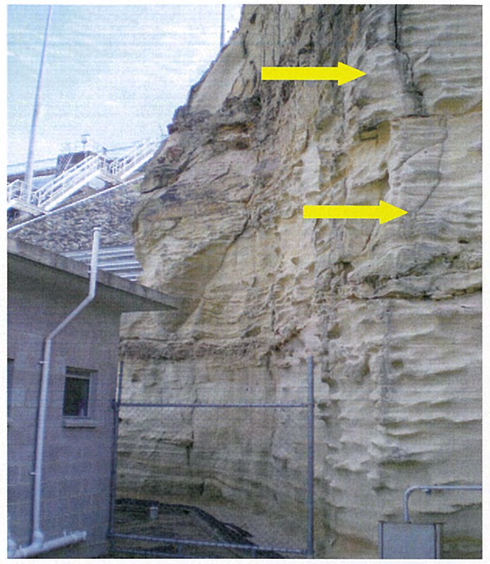

Photo 4: View of small faces towards western end of cutting. Irregular, potentially unstable blocks / blocks arrowed.

Photo 5: View of up main northern face. Unstable cobble sized fragements visible.

Photo 6: View of top of western end of cutting. Potentially unstable wedge arrowed.

Photo 7: View of batter slope located, to east of vertical cutting.

Photo 8: Cobble sized (150 mm) rock that has apparently fallen from the face.

revisior	description	drawn	approved	date

drawn	NA
approved	-
date	1/05/2008
scale	-
original size	A3

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client:	SEQ WATER		
project:	OUTLET WORKS CUTTING LAKE WIVENHOE		
title:	PHOTOS 2 to 8 - GENERAL		
project no:	GEOTNEWS20208AA	figure no:	FIGURE 4

LEGEND

- Bedding Parting
- Joint
- Concrete Application

drawn	NA
approved	
date	May-08
scale	1:100 (approx)
original size	A4

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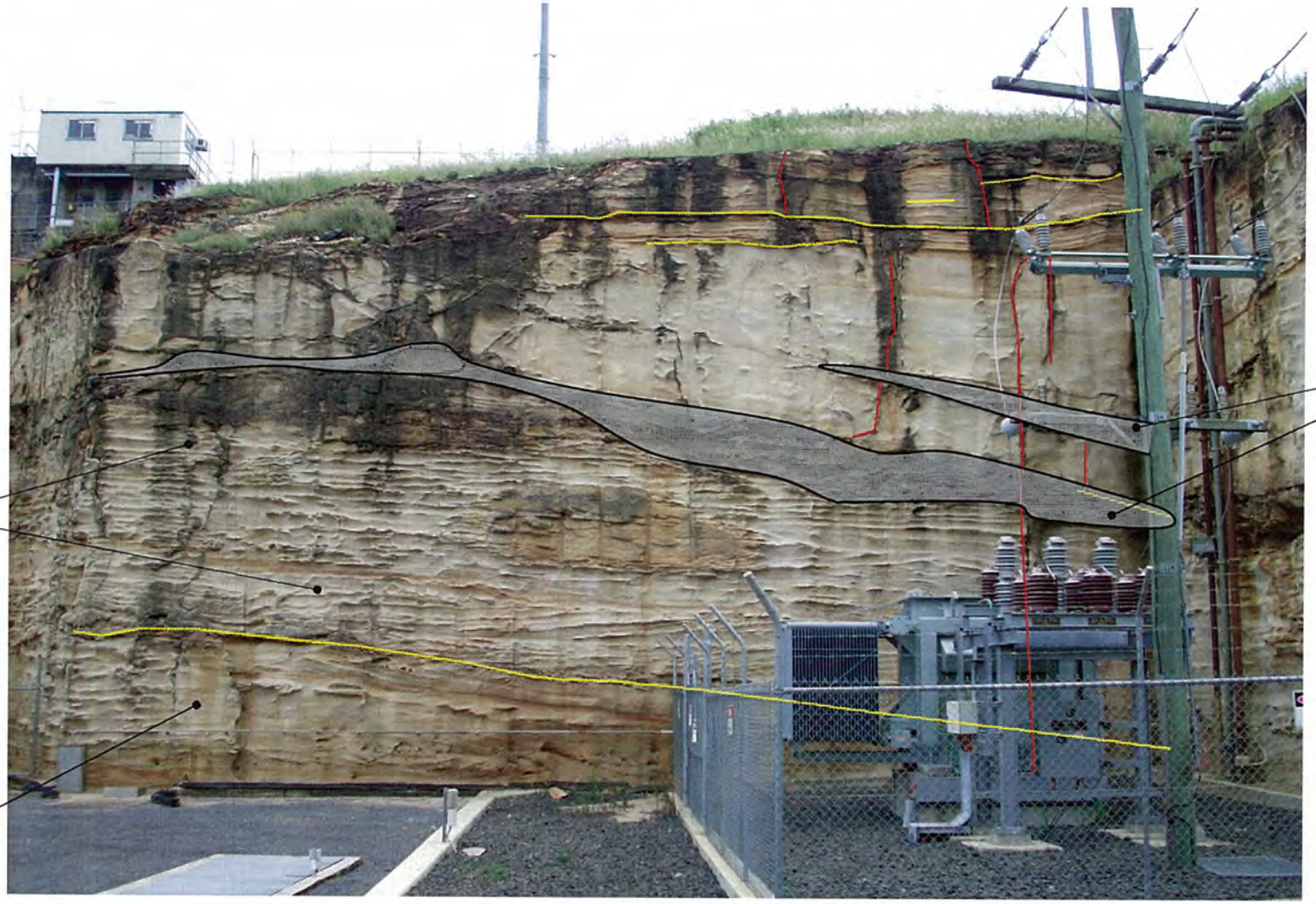
client:	SEQ WATER
project:	OUTLETS WORKS CUTTING LAKE WIVENHOE
title:	REMEDIAL WORKS - MAIN EAST FACE
project no:	GEONEWS20208AA
figure no:	FIGURE 5

F:\GEOT\GEOTNEWS\GEOTNEWS20200's\GEOTNEWS20208AA - Wivenhoe Outlet Works Rockwall\[Photos.xls]Figure 4



LEGEND

Bedding Parting

Joint

Concrete Application

drawn	NA
approved	
date	May-08
scale	1:100 (approx)
original size	A4

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SPECIALISTS MANAGING THE EARTH

client: SEQ WATER

project: OUTLETS WORKS CUTTING
LAKE WIVENHOE

title: REMEDIAL WORKS - MAIN NORTH FACE

project no: GEONEWS20208AA

figure no: FIGURE 6

F:\GEOT\GEOTNEWS\GEOTNEWS20200's\GEOTNEWS20208AA - Wivenhoe Outlet Works Rockwall\[Photos.xls]Figure 4

LEGEND

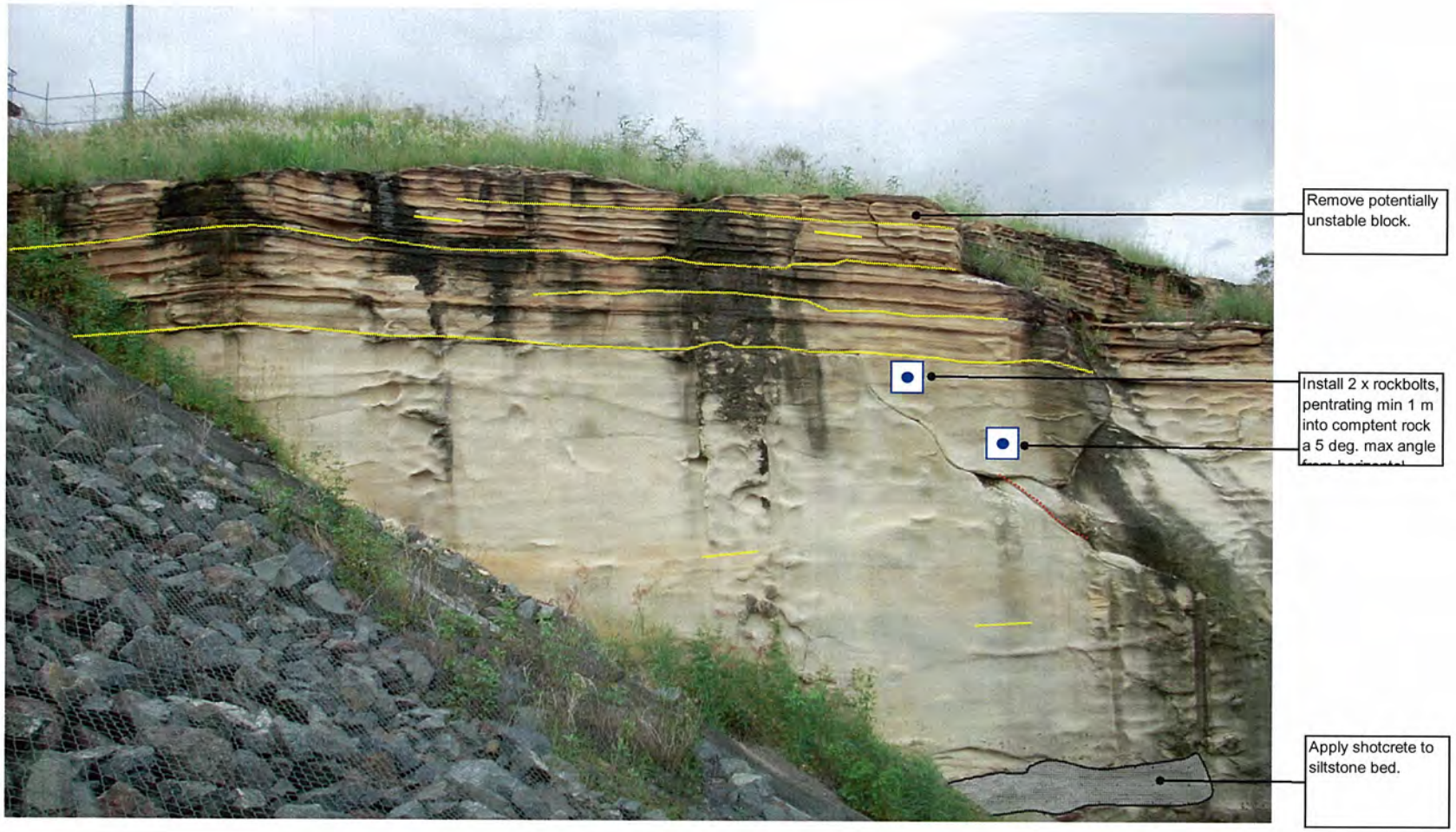
Bedding Parting

Joint

Concrete Application

Indicative rockbolt location

drawn	NA	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	SEQ WATER
approved			project:	OUTLETS WORKS CUTTING LAKE WIVENHOE
date	May-08		title:	REMEDIAL WORKS - WESTERN END
scale	NTS		project no: GEONEWS20208AA	figure no: FIGURE 7
original size	A4			



LEGEND

- Bedding Parting
- Joint
- Concrete Application
- Indicative rockbolt location

drawn	NA
approved	
date	Jan-08
scale	1:50 (approx)
original size	A4

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SPECIALISTS MANAGING THE EARTH

client: SEQ WATER

project: OUTLETS WORKS CUTTING
LAKE WIVENHOE

title: REMEDIAL WORKS - WESTERN END, EASTERN FACE

project no: GEONEWS20208AA

figure no: FIGURE 8

F:\GEOT\GEOTNEWS\GEOTNEWS20200's\GEOTNEWS20208AA - Wivenhoe Outlet Works Rockwall\[Photos.xls]Figure 4