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17 March 2008
Ref:18724ZR2let

Alexandria Landfill Pty Ltd
PO BOX 1040
MASCOT NSW 1460

ATTENTION: Mr Christopher Biggs

Dear Sir

GEOTECHNICAL QUARRY SLOPE STABILITY ASSESSMENT
EXISTING QUARRY, ARCHBOLD ROAD, EASTERN CREEK

1. INTRODUCTION

Acting on your commission (Purchase Order No. 004553, dated 31 January 2008) the undersigned visited the above site on 20 and 26 February 2008. The purpose of the site visits was to assess the nature, geometry and stability of the existing quarry slopes.

Based on the provided undated Development Application documentation for the proposed Light Horse Business Centre (Ref. 0627) prepared by Stanic Harding and discussions with representatives of Alexandria Landfill Pty Ltd (ALPL), we understand the proposed development to comprise:

- Outside the existing quarry footprint, construction of a re-cycling centre, workshop, administration building (including the existing weighbridge) and a sales and distribution centre over the western and north-western portion of the site. New access roads and vehicle parking areas will also be provided.

- Backfilling of the existing quarry with landfill materials; some localised excavation of existing quarry faces will be undertaken to source rock for aggregate as backfilling proceeds. We understand that the existing quarry haul road from the

Hanson site to the south-east will be used for site access. Entry to the quarry will be via a new haul road running parallel to the crest of the western side of the quarry then extending down from above the central portion of the northern crest of the quarry down to the existing quarry haul road over the north-eastern corner of the quarry. From this point, the existing haul road will be used to access the base of the quarry.

We note that we have prepared a previous report for the site (Ref. 18724ZRrpt1) dated 18 May 2007. In addition, we have been provided with the following previous geotechnical reports on the existing landslip prepared by Pells Sullivan Meynink Pty Ltd (PSM) for Hanson Construction Materials Pty Ltd (HCMPL):

- Report Ref. PSM497.L20 and PSM497.L21, dated 11 December 2006 which outlined short term and long term risks, respectively within the quarry.

- Draft Report Ref. PSM497.L23, dated 14 December 2007 which provided further advice regarding stabilisation of the landslip within the northern quarry face.

The above geotechnical reports should be referred to for more information and have been used for reference purposes in preparing this letter.

The purpose of this letter is to summarise the results of our assessment of the existing quarry slopes and to provide general advice on the nature and extent of stabilisation measures. For selected areas of the site, more specific advice is also provided.

2. ASSESSMENT PROCEDURE

An Associate carried out a geotechnical mapping survey of the site. The approximate locations of various geotechnical features are presented on the attached plates 1 to 15. The attached Figures 1 to 4 present cross sectional sketches summarising details of specific areas of the quarry slopes and, where applicable, providing details of recommended stabilisation measures. The features identified during the assessment were compared to those of other similar lots in neighbouring locations to provide a comparative basis for assessing the risk of instability affecting the proposed development. The attached Appendix A defines the terminology adopted for the risk assessment together with a flow chart illustrating the risk management process based on the guidelines given in Reference 1.

The features on Figures 1 to 4 have been measured by hand held inclinometer and tape measure techniques and hence are only approximate. Should any of these features be critical to the proposed development, we recommend they be located more accurately using instrument survey techniques.

A summary of our observations is presented in Section 3 below. Our specific recommendations regarding the likely range of stabilisation measures are discussed in Section 5 following our risk assessment.

3. OBSERVATIONS

We have identified a number of broad categories of slope within the quarry which are generally characterised by distinct types of slope instability and are summarised in the following table.

SUMMARY TABLE OF QUARRY SLOPE TYPES AND TYPICAL INSTABILITY ISSUES

SLOPE TYPE	TYPICAL IDENTIFIED FORMS OF SLOPE INSTABILITY	COMMENTS
SHALE/SOIL	Weathering and erosion of slope face leading to formation of 'talus' slopes at the base of the face.	Benches and catch bunds satisfactorily collecting debris
SHALE/SOIL WITH LANDSLIP FEATURES	Near surface rotational failures within steep soil (including fill) and weathered shale slopes.	Smaller features contained on berm below. Larger features within the upper quarry slope have breached the catch bund.
SHALE WITH SANDSTONE 'CAP' (See Figure 1)	Preferential weathering and erosion of shale below sandstone cap leading to undercutting of sandstone and collapse of blocks of sandstone.	Blocks and material captured by catch bund at base of slope.
XW BRECCIA	Weathering and erosion of slope face leading to formation of 'talus' slopes at the base of the face. Occasional near surface slumping also evident.	Material collecting over about a 3m width extending out from the base of the face.
FRACTURED BRECCIA	Weathering and erosion of fractured faces leading to localised collapse of near surface of face.	Material collecting over about a 2m width extending out from the base of the face. Blocks less than 1m maximum dimension.
INTACT BRECCIA (See Figure 3)	Spalling of isolated blocks of rock (defect controlled). Localised sliding failure of distinct wedges formed by unfavourable orientated defects.	Site experiments indicate blocks come to rest within 2m of the base of the face below. Blocks less than 1m maximum dimension typically observed.
NORTH FACE LANDSLIP (See Figures 2 and 4)	Near surface slumping at the contact between the breccia and shale. Likely to have been controlled by increased rates of weathering concentrated along the contact defect leading to strength reduction together with increased pore water pressures within the slope. Landslip material continues to travel downslope and collect in the berm below (RL85m). Larger blocks within the landslip degrading. Backscar regressing – tension cracks have developed in the haul road since last PSM visit in December 2007.	PSM have been providing advice to Hanson over a number of years since the original slump occurred in 2001. Berm and catch bund below (RL85m) full of debris. Larger blocks (maximum dimension about 1.5m) roll downslope, 'overtop' the catch bund and impact haul road below.

4. RISK ASSESSMENT

The potential instability of the above described types of slope identified within the quarry may be regarded as the potential geotechnical hazards affecting the site. Based on our observations we have carried out a preliminary qualitative assessment of risk to both property and life. The results are summarised in the attached Tables A and B, respectively.

4.1. Risk To Property

The attached Table A summarises our qualitative assessment of each potential geotechnical hazard and of the consequences to property should the hazard occur. Based on these assessments, the qualitative risks to property have been determined. The terminology adopted for this qualitative assessment is in accordance with Table A1 given in Appendix A.

Table A indicates that the assessed risk to property (trucks, plant and buildings) varies between Very High and High, which would be considered 'unacceptable' in accordance with the criteria given in Reference 1. However, Table A also provides a revised risk assessment based on the assumption that risk control measures are put in place and/or trucks or plant are some distance from the potential geotechnical hazard. In these instances, Table A indicates that the assessed risk to property reduces to 'acceptable' levels (i.e. Low) in accordance with the criteria given in Reference 1.

4.2. Risk To Life

We have also used the indicative probabilities associated with the assessed likelihood of instability to calculate the risk to life. The temporal and vulnerability factors that have been adopted are given in the attached Table B together with the resulting risk calculation.

Our assessed risk to life for the person most at risk ranges between about 2.7×10^{-3} and 6.8×10^{-7} for truck drivers, plant operators and persons within the re-cycling depot. These would be considered to be 'unacceptable' and 'acceptable', respectively, in accordance with the criteria given in Reference 1.

With risk control measures put in place, Table B also indicates that risk levels improve to at least 'tolerable' levels, in accordance with the criteria given in Reference 1.

5. STABILISATION MEASURES

A summary of the stabilisation measures for the various types of slope are outlined in the attached Table C. We provide some additional comments regarding each of the recommended stabilisation options.

Catch Bunds

Based on our observations, the existing catch bunds adjacent to the haul road at the base of soil and shale slopes appear to be generally performing satisfactorily. To improve their effectiveness, we recommend that they be cleaned out of debris.

The catch bund lining the crest of the berm at the base of the northern face landslip is full of debris and is currently ineffective. We recommend that the catch bund be cleaned out in a similar manner to that outlined by PSM in their report dated 14 December 2007.

XW (extremely weathered) Breccia faces lining the haul road and any new roads within cut slopes revealing soil and shale should also be provided with similar catch bunds. Similarly, if any such slopes above the quarry (including fill stockpiles) will line proposed or existing access roads (such as the access road that passes close to the southern crest of the quarry) then the bases of such slopes should be provided with catch bunds.

In addition, benches above the haul road within the quarry should be provided with catch bunds to control debris that may otherwise impact the haul road below.

Safety Bunds and Haul Road Drainage

Safety bunds lining the crest of the haul roads should be maintained. In addition, any existing roads above the quarry (such as the access road that passes close to the southern crest of the quarry) should be provided with similar safety bunds. Similar bunds must also be provided along the downslope side of the proposed access road leading down into the quarry from the re-processing centre (north-western corner of the site).

Any safety bunds that have been eroded by concentrated haul road surface run-off should be repaired. The haul road should also be re-graded to direct surface run-off to the bases of the adjacent high side of the haul road face.

Slope Re-grading

Over the western and south-eastern corners of the quarry crest, sandstone capping to shale slopes is likely to collapse over time. The impact on the crest areas of such collapses may be controlled in one of two ways (see Figure 1):

- Lay back the sub-vertical sandstone face to an angle of about 45°. Provide a new safety bund set-back about 1m from the crest of the new slope.

- Provide a new safety bund set-back about 1m from the trace of a zone of influence line projected up from the base of the sandstone face at an angle of about 45°.

Figure 1 also indicates that existing power poles would also need to be re-located. Further, such works would prevent use of the existing road to the east of the weighbridge. However, the existing weighbridge may remain in its current location.

Within the area of existing slump features (e.g. above the haul road over the north-western portion of the site (Plate 3), such areas should be laid back to an angle of about 35°. A new crest safety bund and catch bund at the toe of the slope would also need to be provided.

Landslip Northern Quarry Face

In addition to the previously described clean out of the RL85m berm below the landslip, the crest area of the landslip should also be re-profiled (see Figure 2). The purpose of the re-profiling is to remove material surcharging the upper portion of the landslip and to control potential regression of the backscar.

The re-profiling would impact on the existing fill slope to the north, the shale and soil slopes above and the proposed access road into the quarry leading down from the re-processing centre (north-western corner of the site). New cut batters and benches will need to be provided.

The expected on-going movement of the landslip will need to be monitored. We recommend that two inclinometers are installed in boreholes at the approximate locations indicated on Figure 2 and monitored on, say, a monthly basis and after prolonged or heavy rainfall. The inclinometers should be installed following the above described re-profiling works. The purpose of the inclinometer monitoring is to provide an early warning of landslip movement and to better understand the rate of movement, particularly in response to rainfall events. In addition, on-going optical surveying of various features of the landslip should also be maintained. We understand that such monitoring has previously been carried out by Hanson and a similar regime would seem to be appropriate. However, we note that we have no details of the monitoring regime and recommend that details be provided for review.

We note that a tension crack has developed in the haul road since December 2007. As outlined to a Hanson representative during our initial site visit (20 February 2008), the tension crack should be backfilled without delay to prevent ingress of water into the landslip. Such water ingress may lead to further landslip movements. We understand that PSM advised Hanson during December 2007 to re-grade the haul road and provide a seal of cement stabilised road base. We understand that these works were completed. A similar temporary treatment is considered reasonable at this stage.

Scaling Off

The fractured breccia faces and intact breccia faces adjacent to the haul road should have all potentially loose blocks and fragments scaled off prior to commencement of backfilling operations. Such works would also need to be continued on a regular basis. The frequency may be determined following geotechnical inspection. At this stage we would expect scaling off to be completed on, say, a 6 monthly basis; increased intervals may be appropriate following on-going geotechnical monitoring.

6. FURTHER GEOTECHNICAL INPUT

We note that further geotechnical assessment of the lower portion of the quarry will be required following pumping out of the water currently in the quarry. In addition, further details relating to the above advice are likely to be required with regard to proposed locations of buildings, structures and other infrastructure.

7. GENERAL COMMENTS

It is possible that the subsurface soil, rock or groundwater conditions encountered during construction may be found to be different (or may be interpreted to be different) from those inferred from our surface observations in preparing this report. Also, we have not had the opportunity to observe surface run-off patterns during heavy rainfall and cannot comment directly on this aspect. If conditions appear to be at variance or cause concern for any reason, then we recommend that you immediately contact this office.

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Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

Yours faithfully
For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD

Paul Roberts
Associate

Reference 1: Australian Geomechanics Society (2007c) *'Practice Note Guidelines for Landslide Risk Management'*, Australian Geomechanics, Vol 42, No 1, March 2007, pp63-114.

Attachments

TABLE A: SUMMARY OF RISK ASSESSMENT TO PROPERTY

TABLE B: SUMMARY OF RISK ASSESSMENT TO LIFE

Figures 1 to 4: Cross Sectional Sketches.

Plates 1 to 13: Photographic Plates

APPENDIX A: LANDSLIDE RISK MANAGEMENT TERMINOLOGY

REPORT EXPLANATION NOTES

TABLE A
SUMMARY OF RISK ASSESSMENT TO PROPERTY UNDER EXISTING CONDITIONS OF QUARRY FACES AND SLOPES

POTENTIAL GEOTECHNICAL HAZARD			Instability of Shale/Soil Slope	Instability of sandstone faces above shale	Instability of XW Breccia Slopes	Instability of Fractured Breccia Slopes	Instability of Intact Breccia Slopes	Instability of existing landslip – Northern quarry face
Assessed Likelihood			Almost Certain	Almost Certain	Almost Certain	Almost Certain	Possible	Almost Certain
Assessed Consequences	Truck on haul road	truck above/below hazard when occurs	Major	Minor	Minor	Minor	Major	Major
		truck some distance from hazard, time to stop/avoid hazard	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
	Plant around perimeter of quarry crest	plant within zone of influence of hazard	Major	Major	N/A	N/A	N/A	N/A
		plant outside zone of influence of hazard	Insignificant	Insignificant	N/A	N/A	N/A	N/A
	Proposed Re-cycling depot	proposed depot within zone of influence of hazard	Major	Major	N/A	N/A	N/A	N/A
		proposed depot outside zone of influence of hazard	Insignificant	Insignificant	N/A	N/A	N/A	N/A
	Landfill compaction plant/dozers	plant below hazard when occurs	Major	Minor	Minor	Minor	Major	Major
		plant some distance from hazard, time to stop/avoid hazard	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Risk	Truck on haul road	truck above/below hazard when occurs	Very High	High	High	High	Very High	Very High
		truck some distance from hazard, time to stop/avoid hazard	Low	Low	Low	Low	Low	Low
	Plant around perimeter of quarry crest	plant within zone of influence of hazard	Very High	Very High	N/A	N/A	N/A	N/A
		plant outside zone of influence of hazard	Low	Low	N/A	N/A	N/A	N/A
	Proposed Re-cycling depot	proposed depot within zone of influence of hazard	Very High	Very High	N/A	N/A	N/A	N/A
		proposed depot outside zone of influence of hazard	Low	Low	N/A	N/A	N/A	N/A
	Landfill compaction plant/dozers	plant below hazard when occurs	Very High	High	High	High	Very High	Very High
		plant some distance from hazard, time to stop/avoid hazard	Low	Low	Low	Low	Low	Low

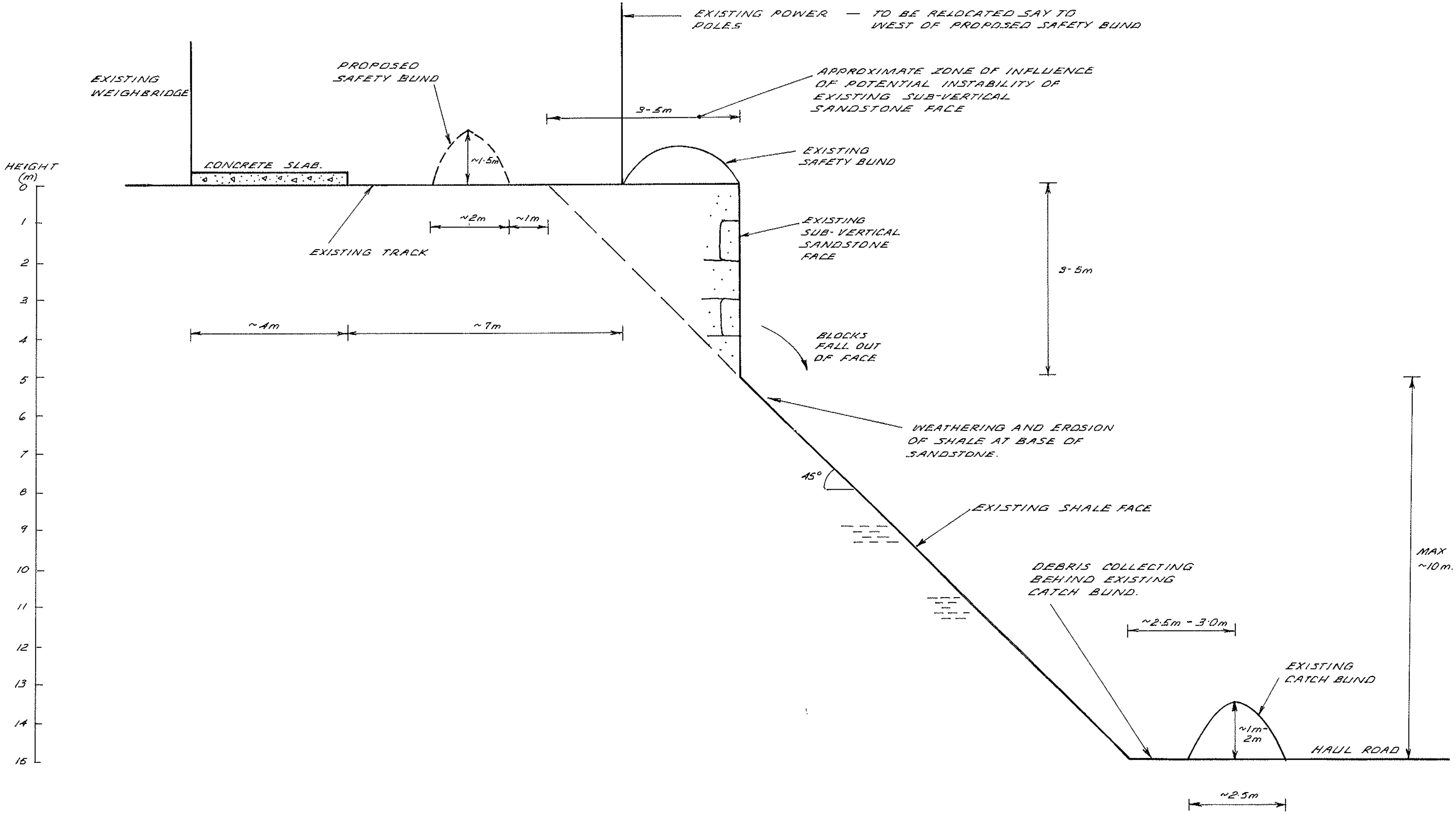
TABLE B
SUMMARY OF RISK ASSESSMENT TO LIFE

Potential Landslide Hazard	Instability of Shale/Soil Slope		Instability of sandstone faces above shale		Instability of XW Breccia Slopes		Instability of Fractured Breccia Slopes		Instability of Intact Breccia Slopes		Instability of existing landslip – Northern quarry face	
Assessed Likelihood of hazard occurring and affecting haul road, landfill or re-cycling depot	Under Existing Conditions Almost Certain	With risk control measures in place Possible	Under Existing Conditions Almost Certain	With risk control measures in place Unlikely	Under Existing Conditions Almost Certain	With risk control measures in place Possible	Under Existing Conditions Almost Certain	With risk control measures in place Possible	Under Existing Conditions Possible	With risk control measures in place Unlikely	Under Existing Conditions Almost Certain	With risk control measures in place Possible
Indicative Annual Probability	10^{-1}	10^{-3}	10^{-1}	10^{-4}	10^{-1}	10^{-3}	10^{-1}	10^{-3}	10^{-3}	10^{-4}	10^{-1}	10^{-3}
Persons at Risk	Truck drivers Plant operators Person in Re-cycling depot		Truck drivers Plant operators Person in Re-cycling depot		Truck drivers Plant operators		Truck drivers Plant operators		Truck drivers Plant operators		Truck drivers Plant operators	
Number of Persons Considered	1		1		1		1		1		1	
Duration of Use of Area Affected (Temporal Probability)	8hr/day & assume operators adjacent to particular hazard for say 50% of the time i.e. 0.17 (Truck drivers & Plant operators) 8hr/day i.e. 0.33 (Person in Re-cycling depot)				8hr/day & assume operators adjacent to particular hazard for say 50% of the time i.e. 0.17							
Probability of Not Evacuating Area Affected	0.8 (Truck drivers & Plant operators) 0.4 (Person in Re-cycling depot)		0.2 (Truck drivers & Plant operators) 0.1 (Person in Re-cycling depot)		0.4		0.4		0.2		0.2 (assumes slow failure)	
Spatial Probability	10m wide slump over say 50m length of slope i.e. 0.2		5m length of sandstone face over say 50m length of slope i.e. 0.1		5m length of XW slope over say 25m length of slope i.e. 0.2		5m length of fractured face over say 25m length of slope i.e. 0.2		1m length of rock face slope over say 10m length of slope i.e. 0.1		1.0	
Vulnerability to Life if Failure Occurs Whilst Person Present	1.0 (Operator buried in vehicle). 0.2 (person in re-cycling depot)		0.2 (Operator in vehicle). 0.1 (person in re-cycling depot)		0.3		0.3		0.2		0.2 (assumes slow failure)	
Risk for Person Most at Risk	**2.7×10^{-3}** (Truck drivers & Plant operators) 5.3×10^{-4} (Person in Re-cycling depot)	2.7×10^{-5} (Truck drivers & Plant operators) 5.3×10^{-6} (Person in Re-cycling depot)	6.8×10^{-5} (Truck drivers & Plant operators) 3.3×10^{-4} (Person in Re-cycling depot)	6.8×10^{-8} (Truck drivers & Plant operators) 3.3×10^{-7} (Person in Re-cycling depot)	4.1×10^{-4}	4.1×10^{-6}	4.1×10^{-4}	4.1×10^{-6}	6.8×10^{-7}	6.8×10^{-8}	**6.8×10^{-4}**	6.8×10^{-6}

Tolerable risk level for loss of life for existing slopes: 10^{-4}
Tolerable risk level for loss of life for existing landslide: 10^{-5}

TABLE C – SUMMARY OF SLOPE STABILISATION AND RISK CONTROL MEASURES

SLOPE TYPE	SLOPE STABILISATION MEASURES			
	ABOVE/ADJACENT TO HAUL ROAD	**Purpose/comments**	**BELOW HAUL ROAD**	**Purpose/comments**
SHALE/SOIL	Clean out debris currently filling toe catch pit. Provide catch bund at crest of bench above haul road. Lay back upper portion of face to 45°. On-going debris clean out from benches above and toe catch pit. Provide safety bund set-back 2m from slope crest.	Reduce current quantity of debris that could fall onto haul road. Improve effectiveness of bench above/catch pit below and so reduce potential quantity of material that can collect on bench and/or fall onto haul road. Frequency of bench/catch pit clean up would be reduced compared to no action taken. Safety zone to control risk.	Provide safety bund set-back about 1m from crest of slope. Regrade haul road so that surface run-off is directed to lined drains located at the toe of the batters adjacent to the high side of the haul road cut face. Drains regularly cleaned out.	Safety zone to control risk (as per current mine health & safety legislation). Reduce potential detrimental erosive effects of run-off discharging over slope and causing instability. Maintain effectiveness of drain – less competent rock wil require more frequent clean out of drains.
SHALE/SOIL WITH LANDSLIP FEATURES	Remove slip debris. Provide new or reinstate existing catch pits at base of slope. Regularly clean out toe catch pit. Lay back slope to overall angle of 35°.	Reduce current quantity of debris that could fall onto haul road. Improve stability of existing slope and reduce potential quantity of material that can collect at toe. Both measures would reduce frequency of bench clean up compared to no action taken.	Provide safety bund set-back about 1m from crest of slope. Regrade haul road so that surface run-off is directed to lined drains located at the toe of the adjacent haul road face. Drains regularly cleaned out.	Safety zone to control risk (as per current mine health & safety legislation). Reduce potential detrimental erosive effects of run-off discharging over slope and causing instability. Maintain effectiveness of drain – less competent rock wil require more frequent clean out of drains.
SHALE WITH SANDSTONE 'CAP' (See Figure 1)	Lay back sandstone to 45° & provide safety bund set-back 1m from new slope crest, or Leave sandstone as is but provide safety bund set-back 1m from 45° line projected up from base of sandstone band. Clean out existing catch pit and re-profile. Regularly clean out catch pit.	Remove existing potential blocks that could fall down slope and provide safety zone should additional collapses occur. Frequency of sandstone blocks collapsing would increase, more debris to clean out of catch pit. Also provides safety zone to control risk. Improve effectiveness of existing catch pit.	Provide safety bund set-back about 1m from crest of slope. Regrade haul road so that surface run-off is directed to lined drains located at the toe of the adjacent haul road face. Drains regularly cleaned out.	Safety zone to control risk (as per current mine health & safety legislation). Reduce potential detrimental erosive effects of run-off discharging over slope and causing instability. Maintain effectiveness of drain – less competent rock will require more frequent clean out of drains.
XW BRECCIA	Clean off debris from haul road. Provide catch bund at crest of bench above haul road. Provide jersey kerb at toe of face, off-set at least 1m from face. Regularly clean out behind jersey kerbs and bench above.	Reduce current quantity of debris that could fall onto haul road. Improve effectiveness of bench above and so reduce potential quantity of material that can collect on bench. Frequency of bench and jersey kerb clean up would be reduced compared to no action taken.	N/A	N/A
FRACTURED BRECCIA	Scale off loose fragments from face and/or bench above and continue on regular basis, or Scale off loose fragments from face and/or bench above and also provide jersey kerb at toe of face, off-set at least 1m from face. Regularly clean out behind jersey kerbs and bench above.	Reduce current quantity of debris that could fall onto haul road. Improve effectiveness of bench above and so reduce potential quantity of material that can collect on bench. Frequency of bench and jersey kerb clean up would be reduced compared to no action taken.	N/A	N/A
INTACT BRECCIA (See Figure 3)	Scale off loose fragments from face and continue on regular basis.	Reduce frequency of blocks that may fall onto haul road compared to if no action taken.	Provide safety bund close to crest of slope. Regrade haul road so that surface run-off is directed to lined drains located at the toe of the batter adjacent to the high side of the haul road cut face. Drains regularly cleaned out.	Safety zone to control risk (as per current mine health & safety legislation). Reduce potential detrimental erosive effects of run-off discharging over slope and causing instability. Maintain effectiveness of drain.
NORTH FACE LANDSLIP (See Figures 2 and 4)	Re-route haul road to north. Excavate out upper portion of slip from haul road (RL136m) down to bench at RL132m. Install at least 2 inclinometers behind believed slip backscar and take readings on regular basis. Possibly supplemented with regular survey monitoring.	Reduce risk by moving haul road away from potentially unstable area. Remove material that otherwise surcharges remainder of slip mass below and also currently provides source for material moving downslope onto (and over) the bench below. On-going monitoring of slip allows early warning of potential movement and better understanding of slip mechanisims so that risk assessment can be refined.	Remove material from RL84m bench and reinstate catch bund at crest of bench.	Improves effectiveness of bench below the slip so that large blocks likely to be caught on bench rather than roll over top surface of current debris filled bench and impact haul road below.



CROSS SECTIONAL SKETCH (LOOKING NORTH)

SUMMARISING RECOMMENDED STABILISATION MEASURES –

EXISTING WEIGHBRIDGE ABOVE CREST OF WESTERN QUARRY FACE

SCALE (M)
0 5

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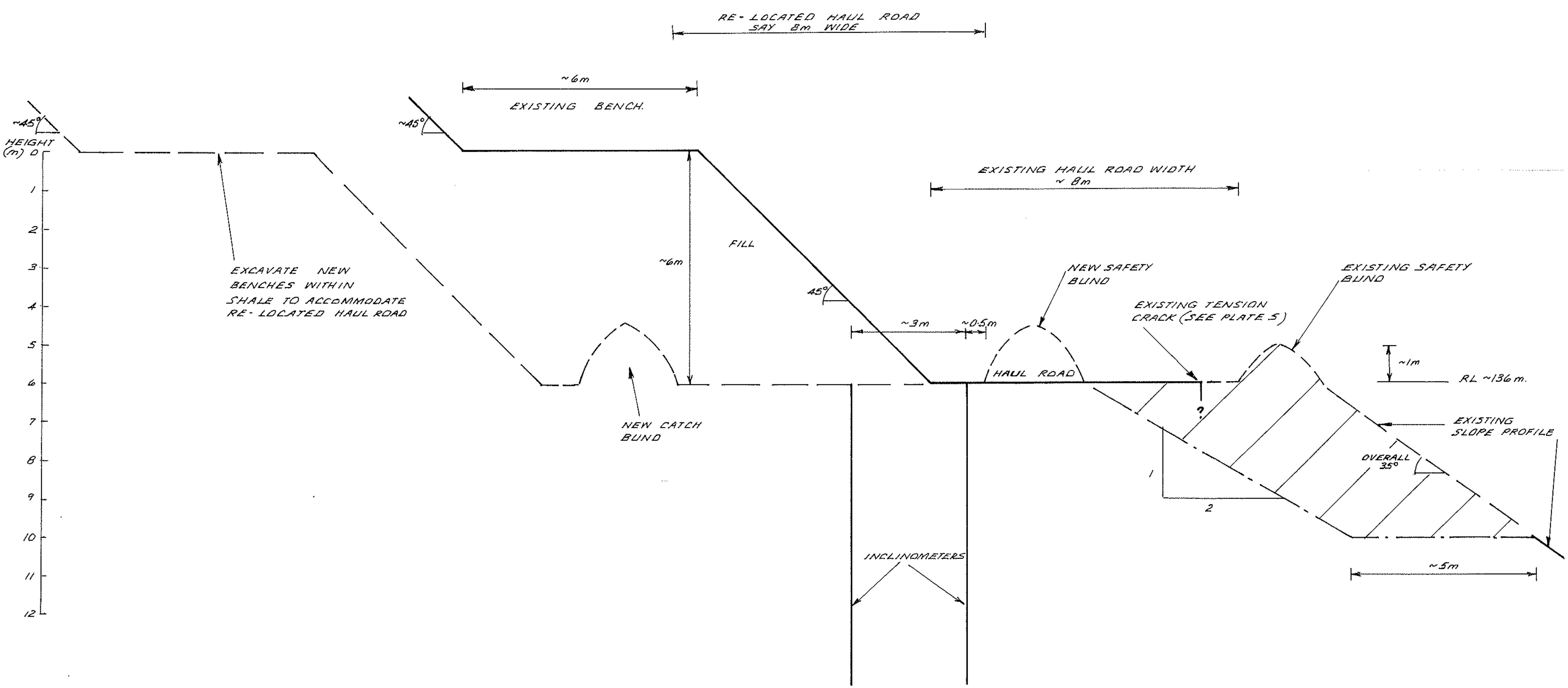
Report No. 18724ZR2 Figure No. 1



CROSS SECTIONAL SKETCH (LOOKING EAST)

SUMMARISING RECOMMENDED STABILISATION MEASURES –

UPPER PORTION OF LANDSLIP WITHIN NORTHERN QUARRY FACE

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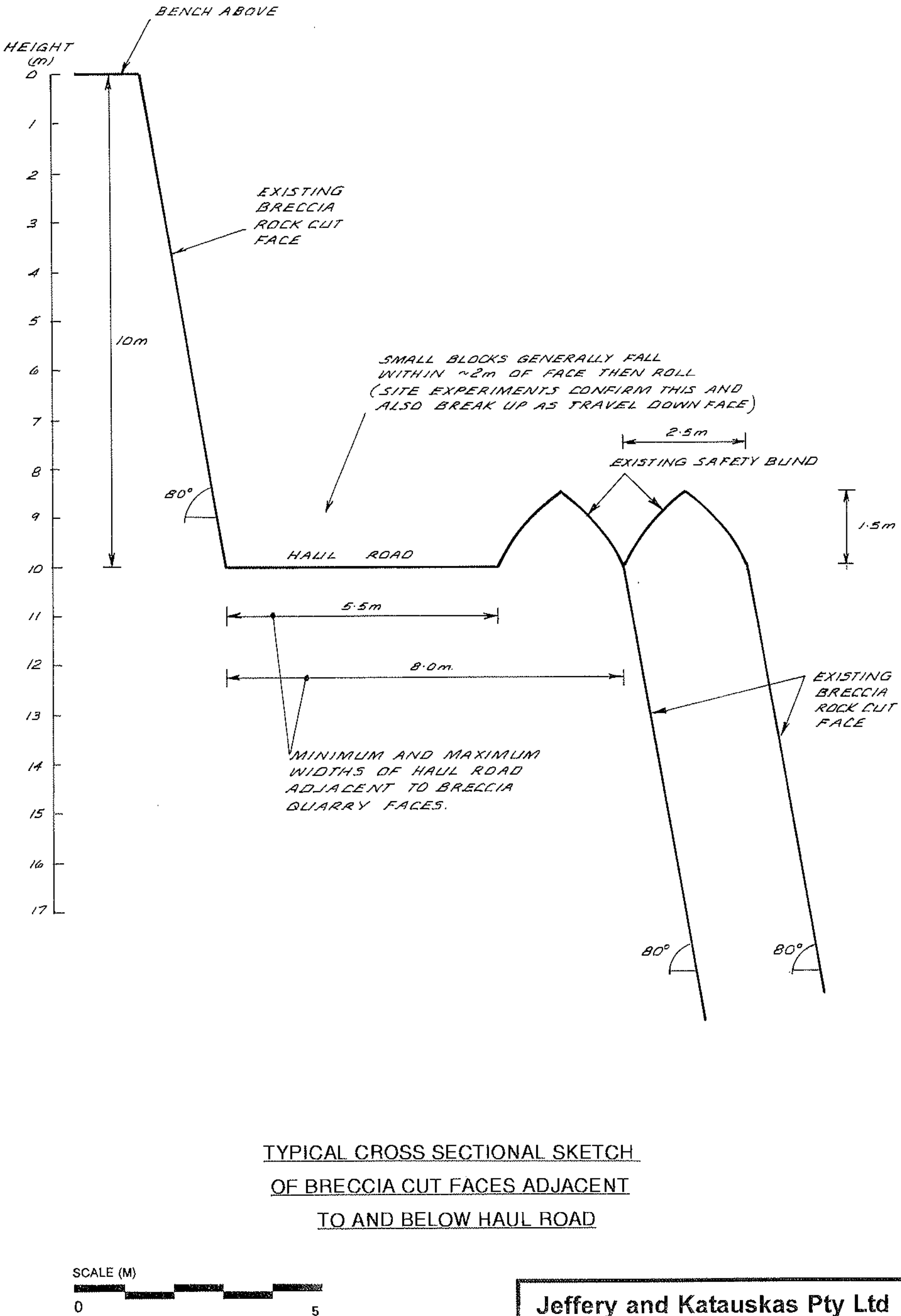
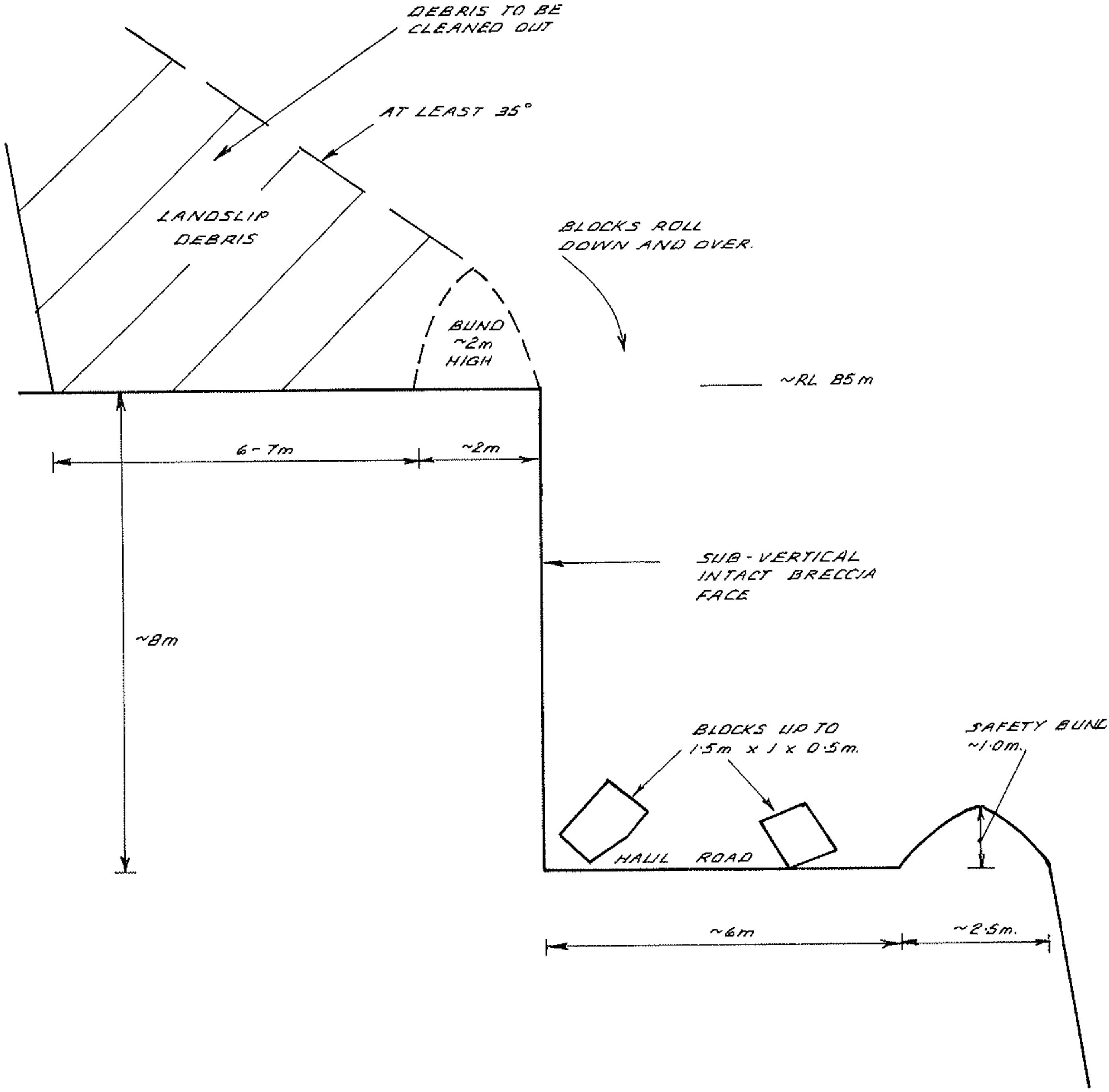
Report No. 18724ZR2 Figure No. 2



TYPICAL CROSS SECTIONAL SKETCH
OF BRECCIA CUT FACES ADJACENT
TO AND BELOW HAUL ROAD

Jeffery and Katauskas Pty Ltd	
Report No. 18724ZR2	Figure No. 3

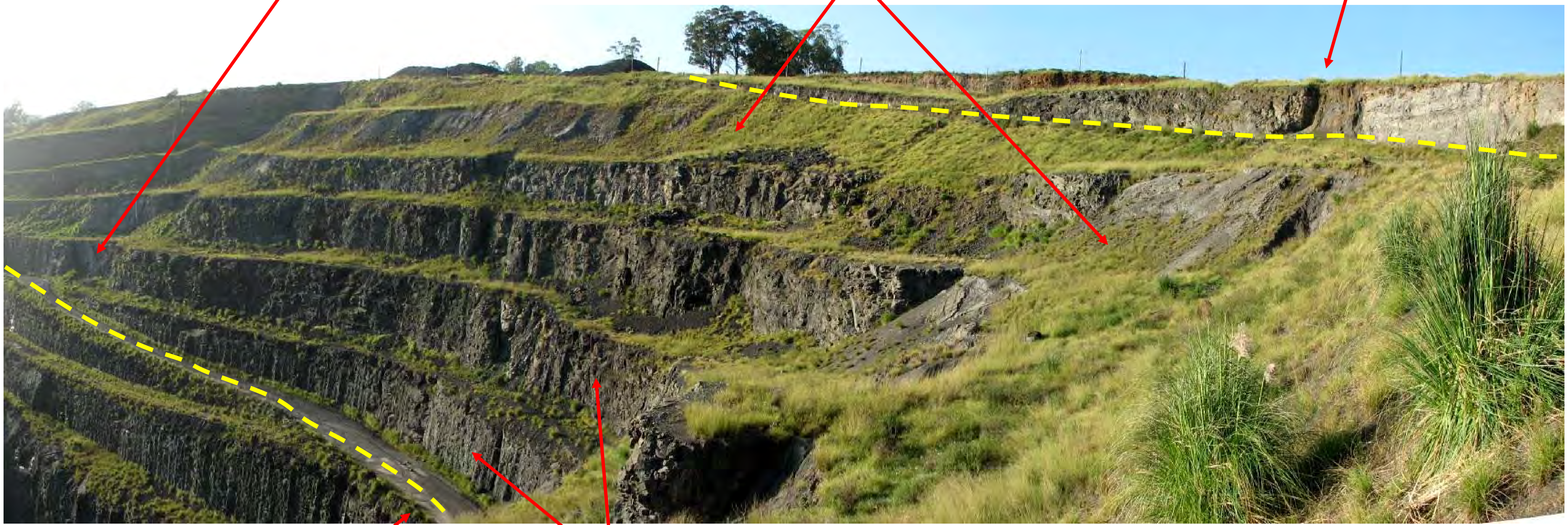


CROSS SECTIONAL SKETCH (LOOKING EAST)

BASE OF LANDSLIP WITHIN NORTHERN QUARRY FACE

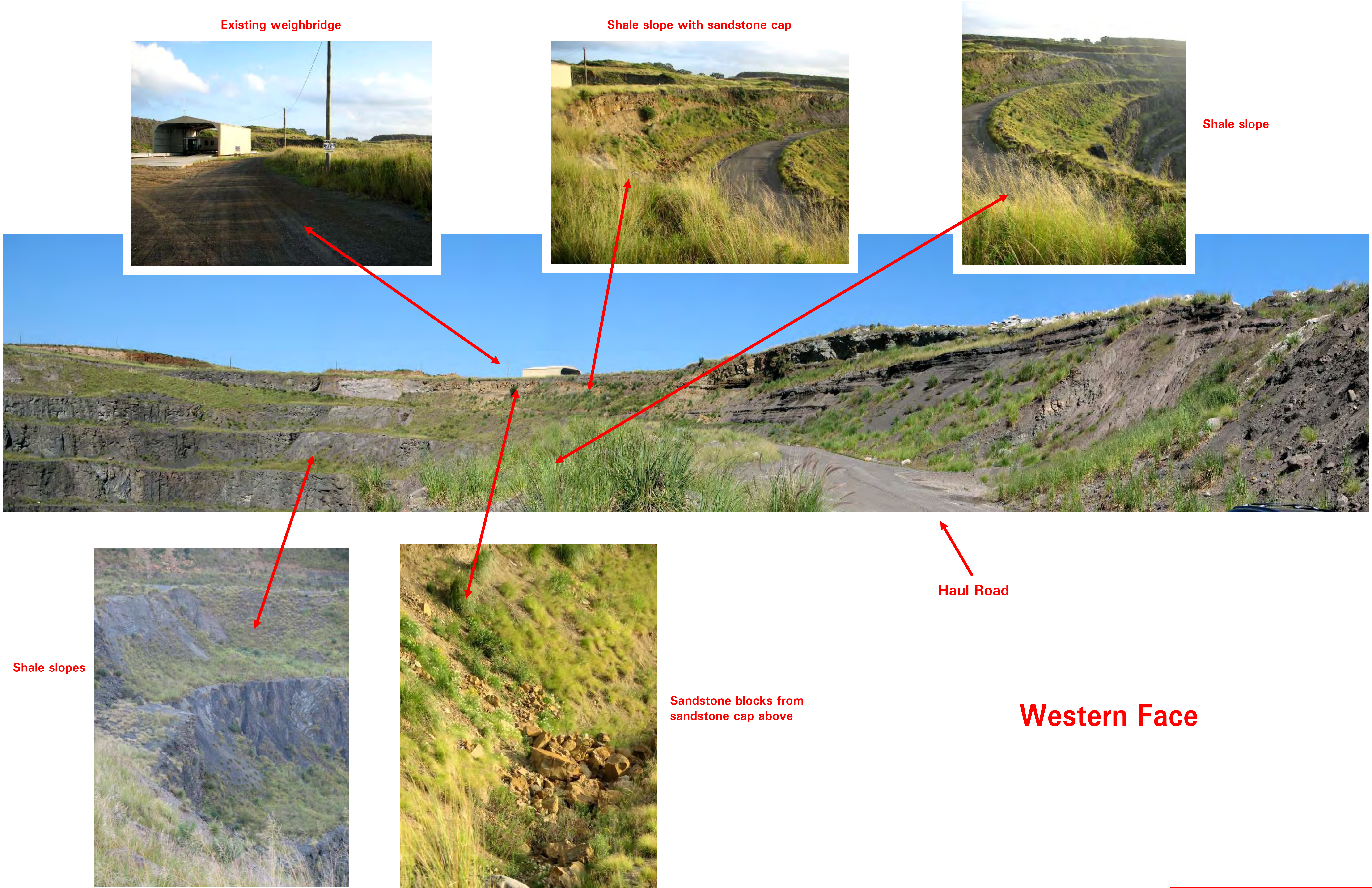
SCALE (M)
0 5

Jeffery and Katauskas Pty Ltd	
Report No. 18724ZR2	Figure No. 4



Southern Face

Ref: 18724ZR2 Plate 2



Western Face

18724ZR2 • PLATE 2

Shale slope with sandstone cap

Landslip

Debris collecting in berm

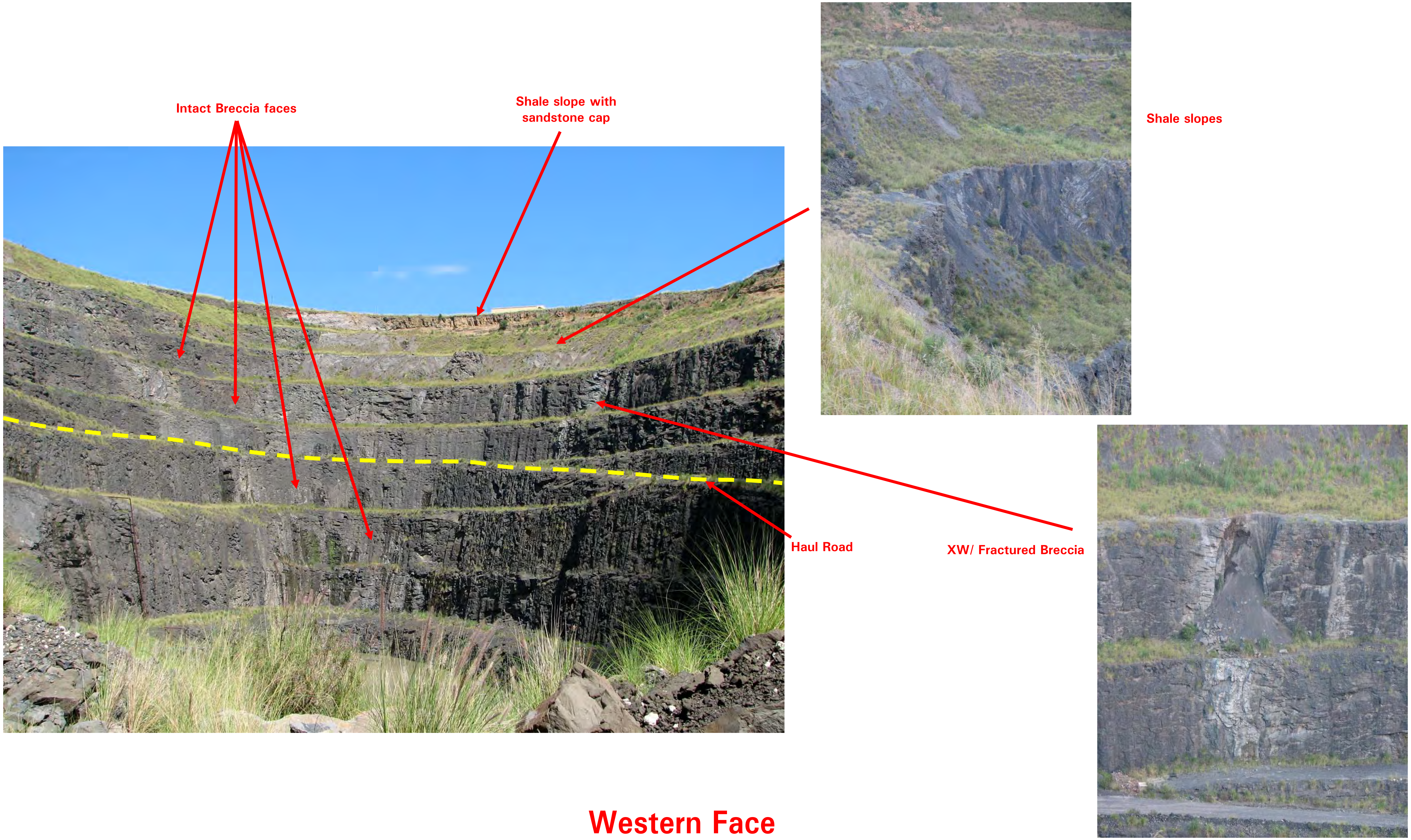
Landslip within shale/soil slope

Toe of landslip

Shale slopes

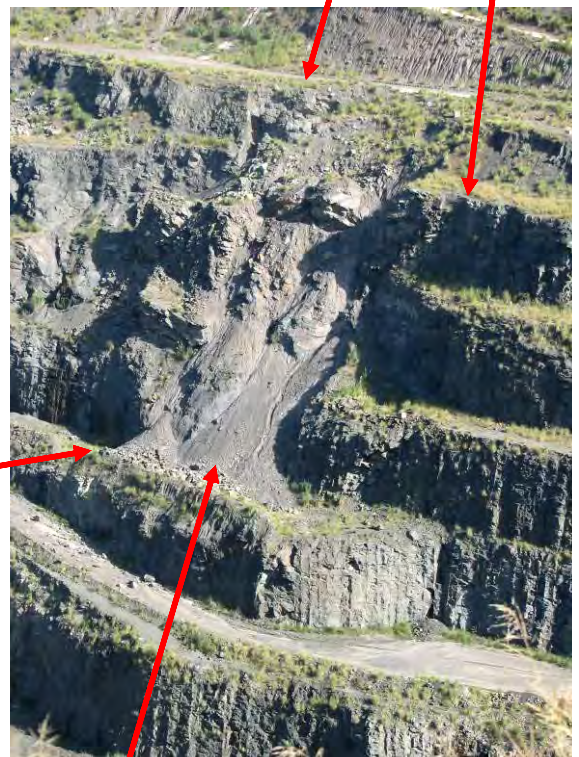
Fill slope

North-Western Corner



Western Face

Tension crack in Haul Road above landslip



Debris collecting on berm (see Figure 4)

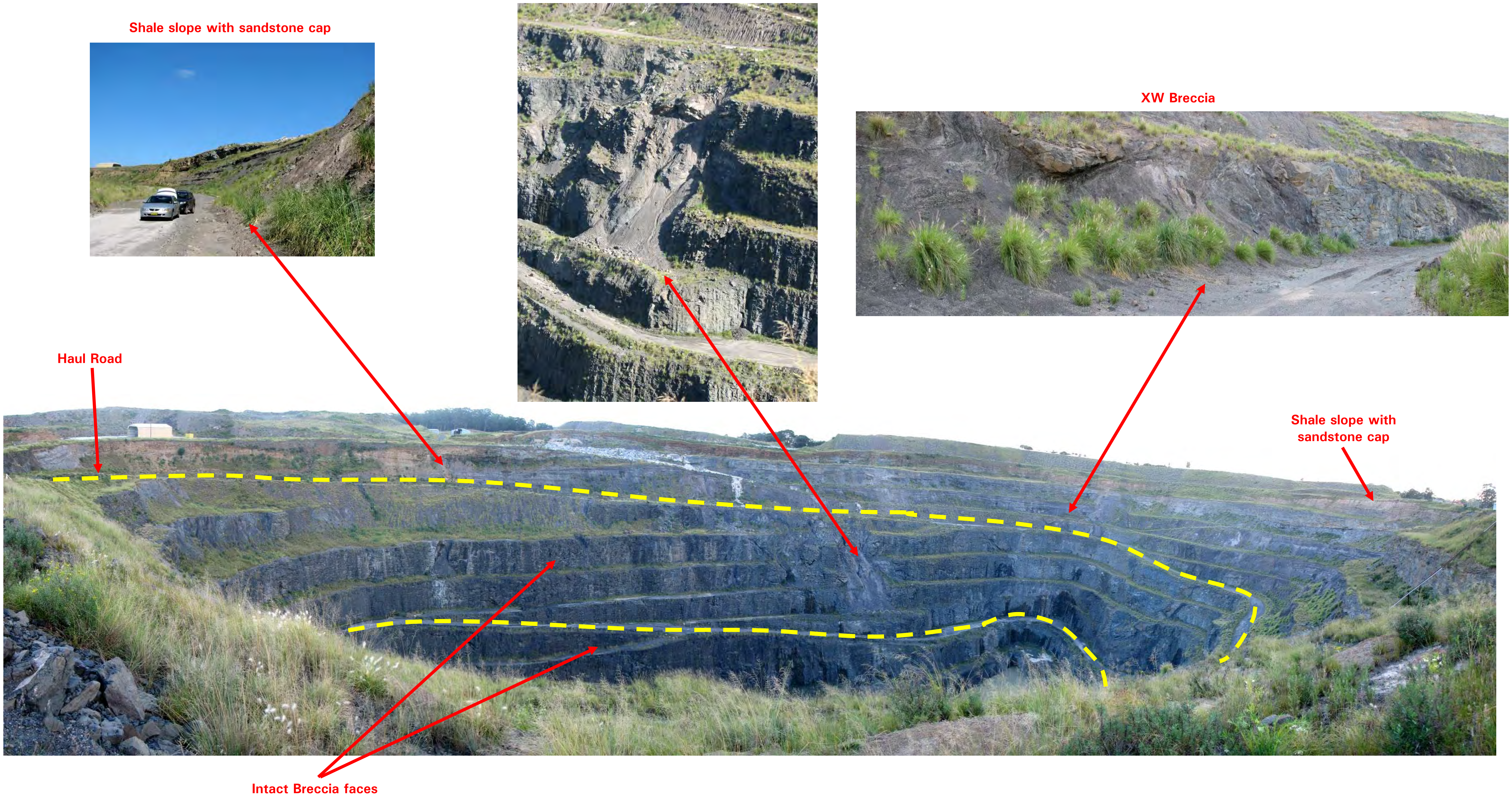
Tension crack in Haul Road above landslip

Backscar area

Blocks on Haul Road

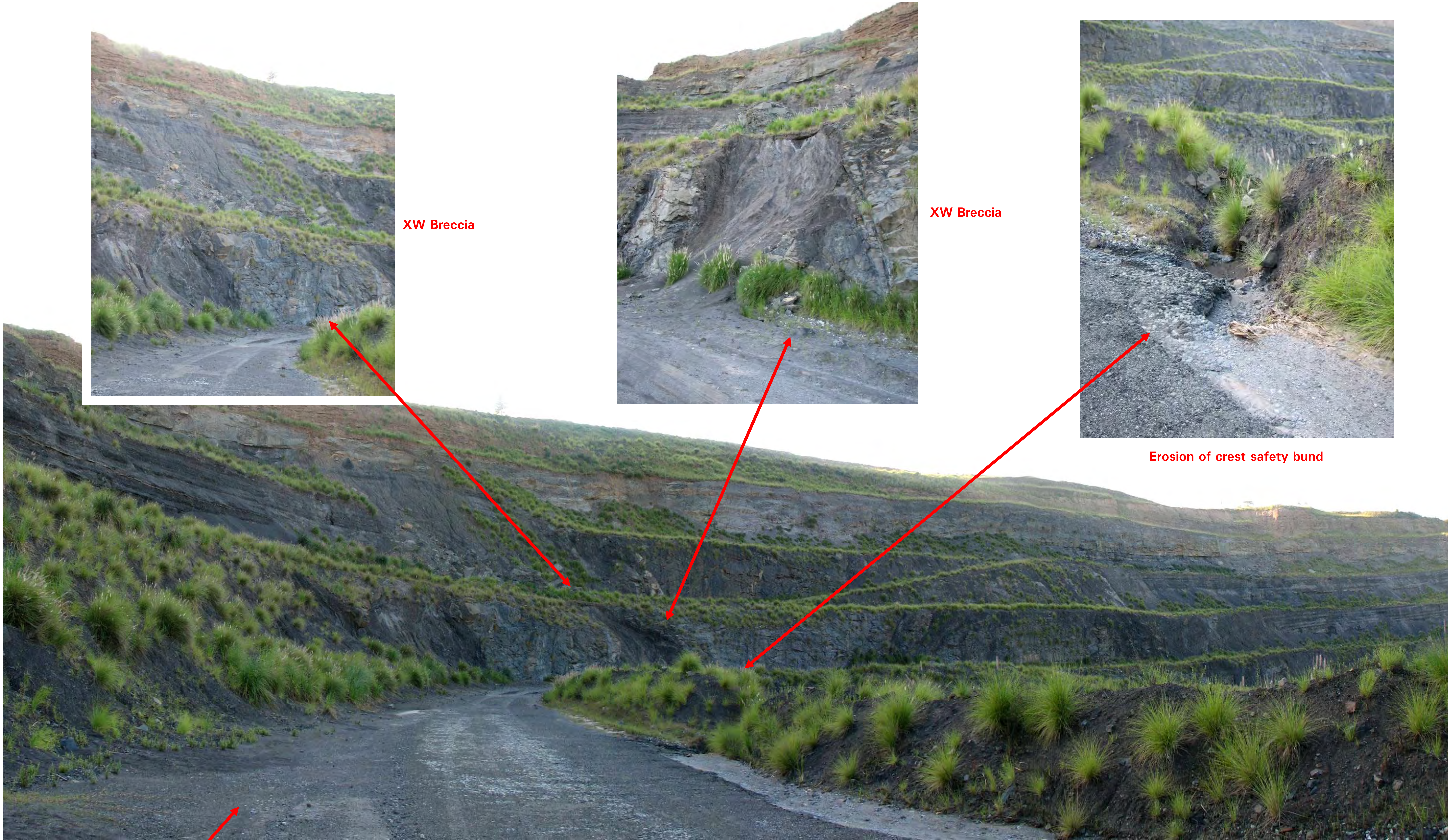
Landslip – Northern Face

Northern & Western Faces



Northern Face

North-Eastern Corner



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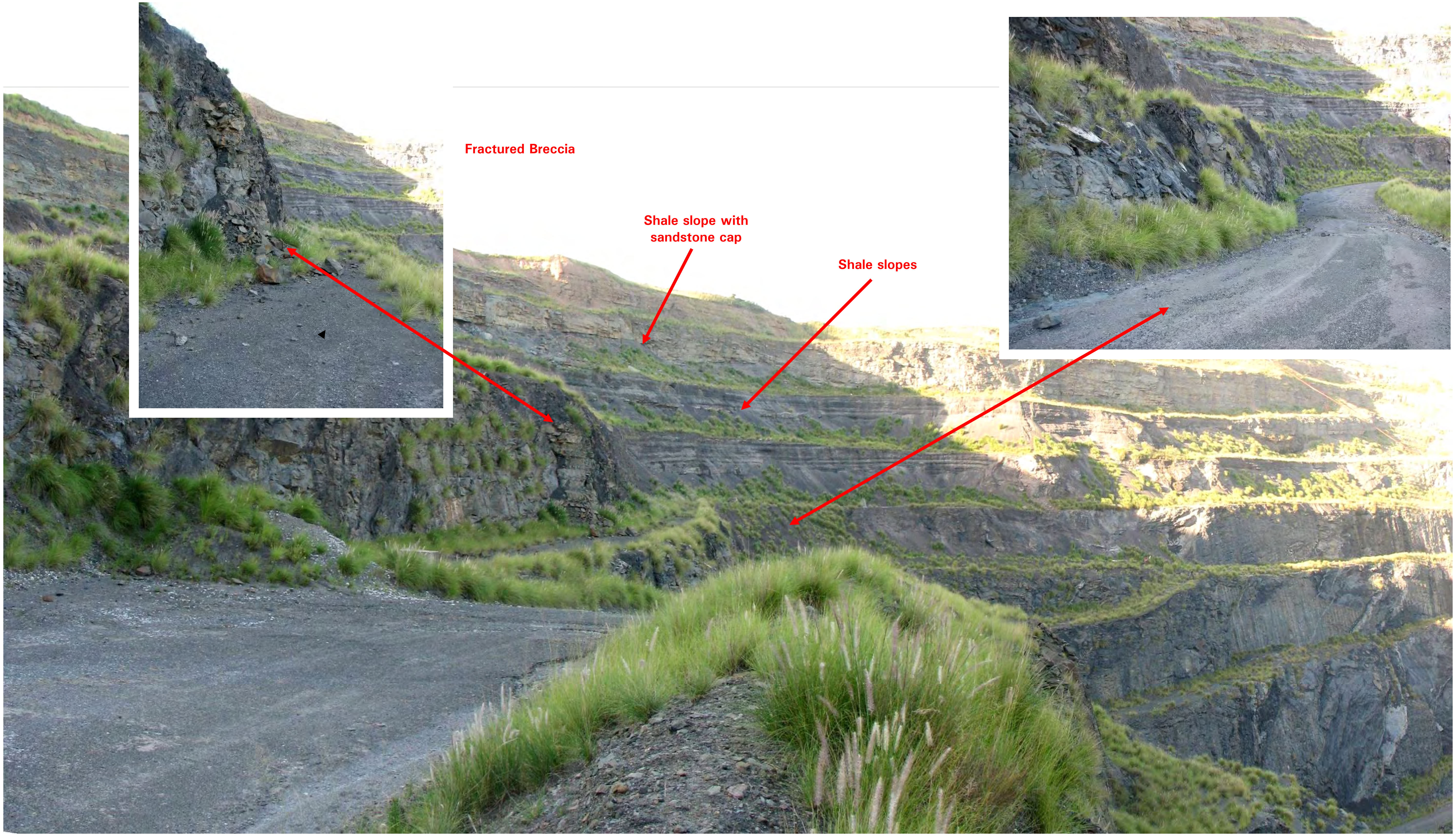
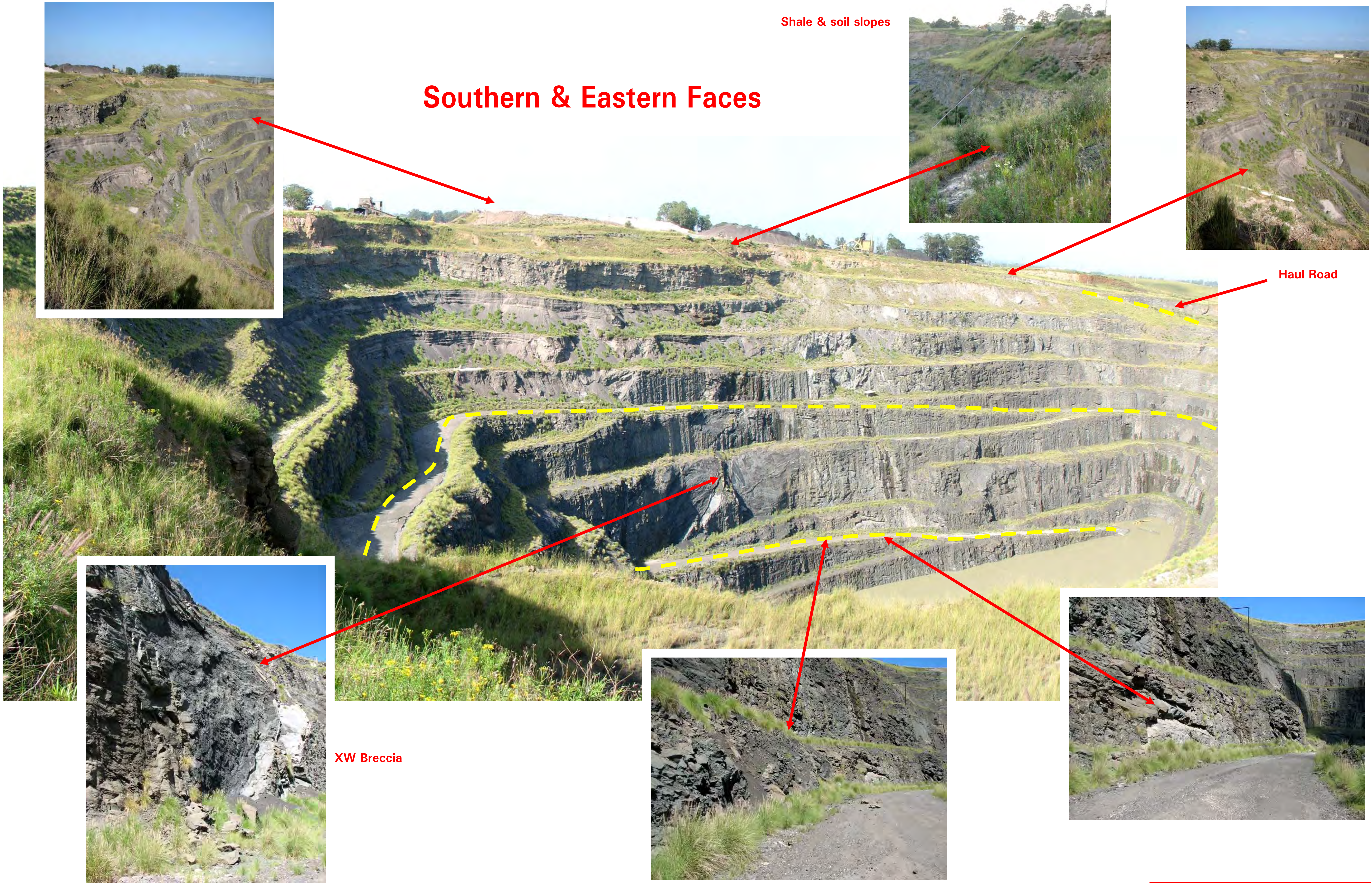
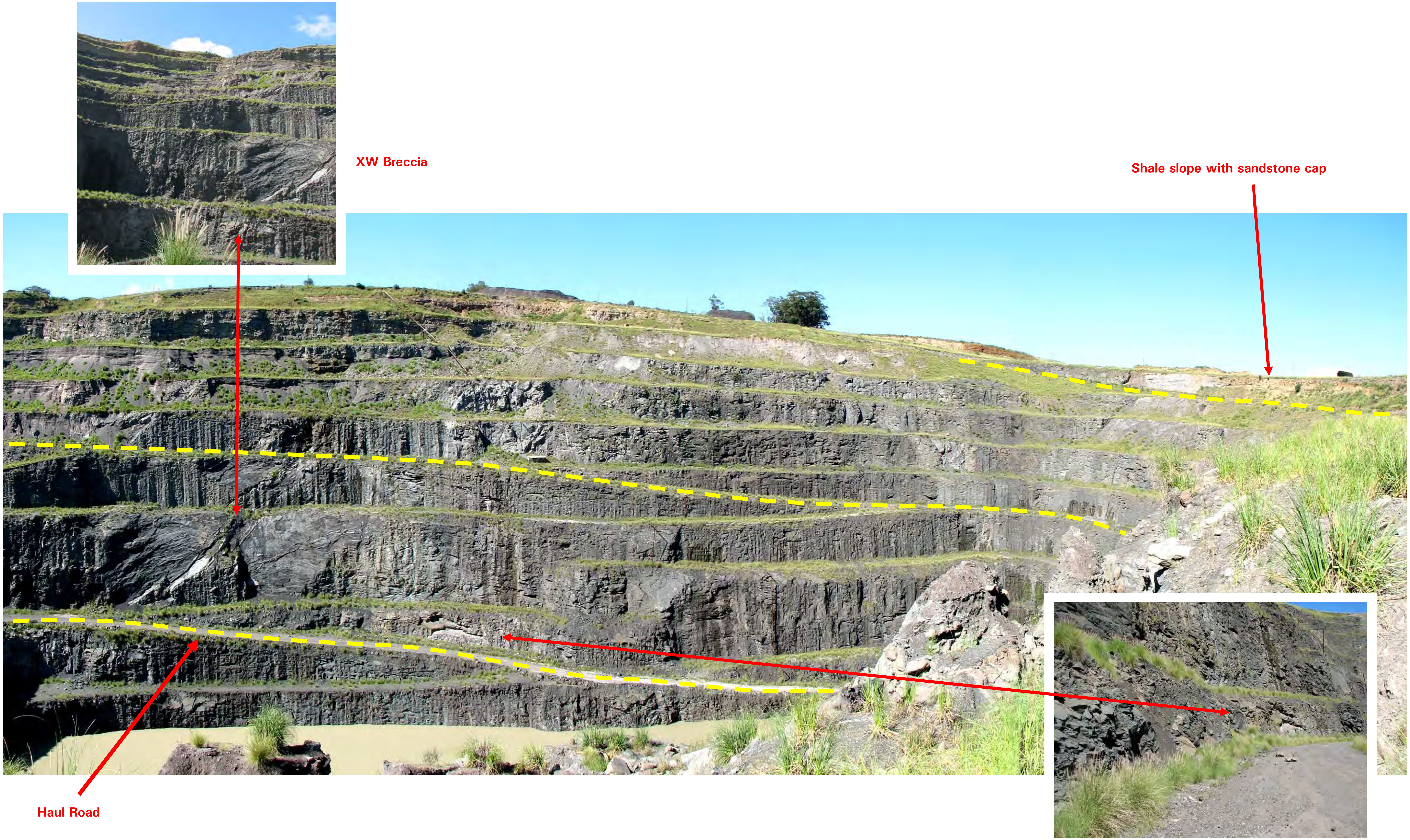


Eastern Face

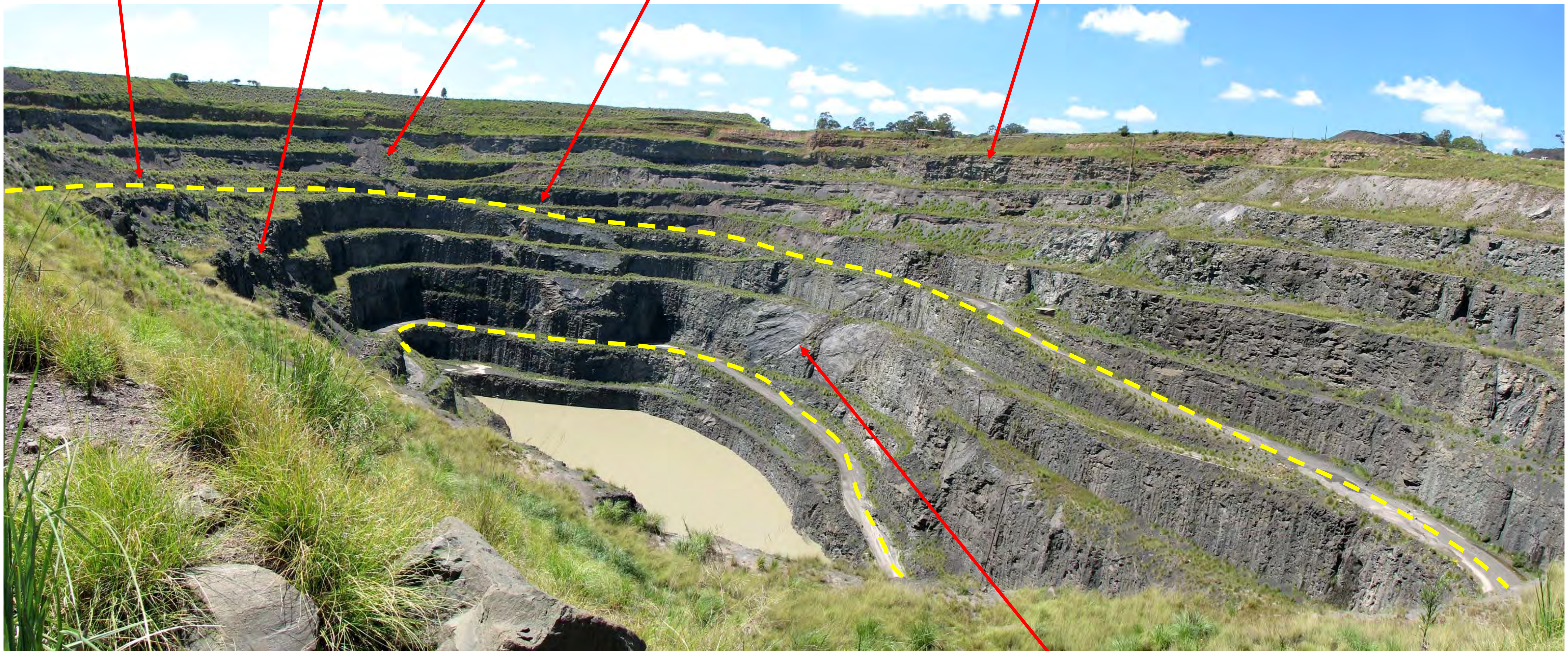
Southern & Eastern Faces



South-Eastern Corner



Southern Face



Eastern & Southern Faces

Northern Face

APPENDIX A

LANDSLIDE RISK MANAGEMENT TERMINOLOGY

APPENDIX A

LANDSLIDE RISK MANAGEMENT

DEFINITION OF TERMS

Risk – A measure of the probability and severity of an adverse effect to health, property or the environment.
Risk is often estimated by the product of probability x consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form.

Hazard – A condition with the potential for causing an undesirable consequence (*the landslide*). The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material, and the likelihood of their occurrence within a given period of time.

Elements at Risk – Meaning the population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.

Probability – The likelihood of a specific outcome, measured by the ratio of specific outcomes to the total number of possible outcomes. Probability is expressed as a number between 0 and 1, with 0 indicating an impossible outcome, and 1 indicating that an outcome is certain.

Frequency – A measure of likelihood expressed as the number of occurrences of an event in a given time. See also Likelihood and Probability.

Likelihood – used as a qualitative description of probability or frequency.

Temporal Probability – The probability that the element at risk is in the area affected by the landsliding, at the time of the landslide.

Vulnerability – The degree of loss to a given element or set of elements within the area affected by the landslide hazard. It is expressed on a scale of 0 (no loss) to 1 (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

Consequence – The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.

Risk Analysis – The use of available information to estimate the risk to individuals or populations, property, or the environment, from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification, and risk estimation.

Risk Estimation – The process used to produce a measure of the level of health, property, or environmental risks being analysed. Risk estimation contains the following steps: frequency analysis, consequence analysis, and their integration.

Risk Evaluation – The stage at which values and judgements enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental, and economic consequences, in order to identify a range of alternatives for managing the risks.

Risk Assessment – The process of risk analysis and risk evaluation.

Risk Control or Risk Treatment – The process of decision making for managing risk, and the implementation, or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.

Risk Management – The complete process of risk assessment and risk control (*or risk treatment*).

Individual Risk – The risk of fatality or injury to any identifiable (named) individual who lives within the zone impacted by the landslide; or who follows a particular pattern of life that might subject him or her to the consequences of the landslide.

Societal Risk – The risk of multiple fatalities or injuries in society as a whole: one where society would have to carry the burden of a landslide causing a number of deaths, injuries, financial, environmental, and other losses.

Acceptable Risk – A risk for which, for the purposes of life or work, we are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable.

Tolerable Risk – A risk that society is willing to live with so as to secure certain net benefits in the confidence that it is being properly controlled, kept under review and further reduced as and when possible.

In some situations risk may be tolerated because the individuals at risk cannot afford to reduce risk even though they recognise it is not properly controlled.

Landslide Intensity – A set of spatially distributed parameters related to the destructive power of a landslide. The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, kinetic energy per unit area.

Note: Reference should also be made to Figure A1 which shows the inter-relationship of many of these terms and the relevant portion of Landslide Risk Management.

Reference should also be made to the paper referenced below for Landslide Terminology and more detailed discussion of the above terminology.

TABLE A1: LANDSLIDE RISK ASSESSMENT
QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

Qualitative Measures of Likelihood

Level	Descriptor	Description	Indicative Annual Probability
A	ALMOST CERTAIN	The event is expected to occur.	$>\approx 10^{-1}$
B	LIKELY	The event will probably occur under adverse conditions.	$\approx 10^{-2}$
C	POSSIBLE	The event could occur under adverse conditions.	$\approx 10^{-3}$
D	UNLIKELY	The event might occur under very adverse circumstances.	$\approx 10^{-4}$
E	RARE	The event is conceivable but only under exceptional circumstances.	$\approx 10^{-5}$
F	NOT CREDIBLE	The event is inconceivable or fanciful.	$< 10^{-6}$

Note: "≈" means that the indicative value may vary by say ±½ order of magnitude, or more.

Qualitative Measures of Consequences to Property

Level	Descriptor	Description
1	CATASTROPHIC	Structure completely destroyed or large scale damage requiring major engineering works for stabilisation.
2	MAJOR	Extensive damage to most of structure, or extending beyond site boundaries requiring significant stabilisation works.
3	MEDIUM	Moderate damage to some of structure, or significant part of site requiring large stabilisation works.
4	MINOR	Limited damage to part of structure, or part of site requiring some reinstatement/stabilisation works.
5	INSIGNIFICANT	Little damage.

Note: The "Description" may be edited to suit a particular case.

Qualitative Risk Analysis Matrix – Level of Risk to Property

LIKELIHOOD	CONSEQUENCES to PROPERTY				
	1: CATASTROPHIC	2: MAJOR	3: MEDIUM	4: MINOR	5: INSIGNIFICANT
A – ALMOST CERTAIN	VH	VH	H	H	M
B – LIKELY	VH	H	H	M	L-M
C – POSSIBLE	H	H	M	L-M	VL-L
D – UNLIKELY	M-H	M	L-M	VL-L	VL
E – RARE	M-L	L-M	VL-L	VL	VL
F – NOT CREDIBLE	VL	VL	VL	VL	VL

Risk Level Implications

Risk Level		Example Implications(1)
VH	VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical.
H	HIGH RISK	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels.
M	MODERATE RISK	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
L	LOW RISK	Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (1) The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.
(2) Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.

These tables are an extract from LANDSLIDE RISK MANAGEMENT CONCEPTS AND GUIDELINES as presented in *Australian Geomechanics*, Vol. 35, No. 1, 2000 which discusses the matter more fully.

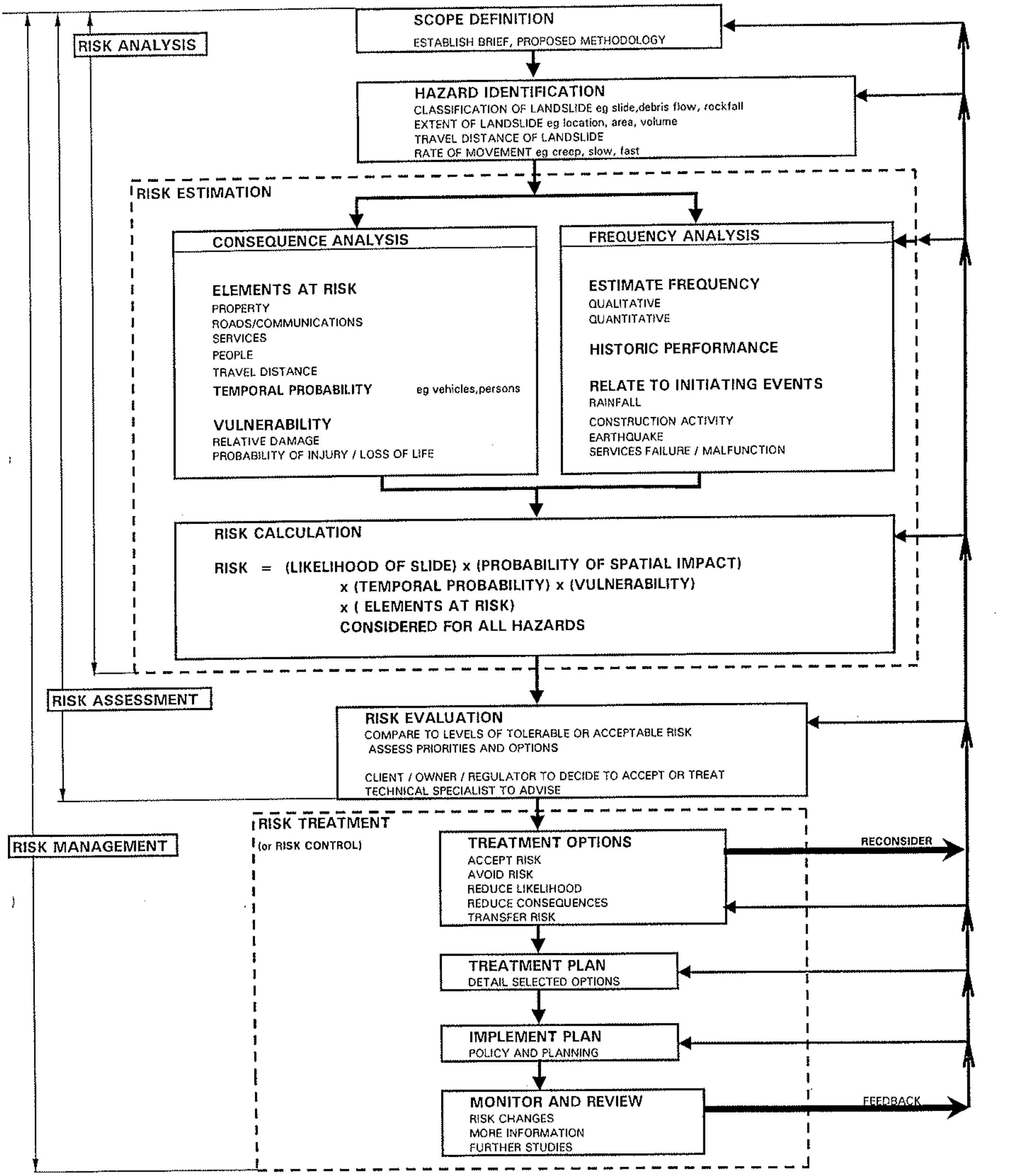


FIGURE A1: FLOWCHART FOR LANDSLIDE RISK MANAGEMENT

This figure is an extract from LANDSLIDE RISK MANAGEMENT CONCEPTS AND GUIDELINES as presented in Australian Geomechanics Vol35, No1, 2000 which discusses the matter more fully.