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Structural Inspection & Report

BRON Y GRAIG, CEFN MAWR – ROCK SLOPE ASSESSMENT AND STABILISATION

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Bron-y-Graig, Cefn Mawr –
Rock Slope Assessment and Stabilisation

1. Introduction and Development Proposals.

1.1 Proposals and a Planning Application have been submitted to Wrexham County Borough Council to redevelop part of a former quarry between Tan-Y-Graig and Bron-Y Graig in Cefn Mawr, near Wrexham. The proposed development comprises high quality detached properties, with associated access roads and driveways.

1.2 The development area comprises a generally flat area of land which was once the quarry floor, surrounded by the former quarry rock faces. The rock faces show evidence of instability and Wrexham County Borough Council requested that a stability assessment be carried out to ensure the safety of the proposed development.

1.3 This report presents the findings of the site inspection and stability assessment, and provides recommendations on proposed appropriate rock face stabilization measures.

2. Geology and Rock Face Conditions.

Geology and Ground Strata.

2.1 The published geological map Sheet 121, Wrexham, indicates the site to be directly underlain by Cefn Rock of the Carboniferous Bettisfield Formation which also contains Productive Coal Measures and sandstone bands. No superficial or drift deposits are indicated however the surrounding area has a mantle of Glacial Till. Information on the geological map indicates that the Cefn Rock strata dip at 16 to 20 degree towards the southeast.

2.2 Old Ordnance Survey maps indicate that the land to the north of Bron-y-Graig was formerly a quarry. It is probable that sandstone were recovered from the quarry, the worked faces of which marks the north, north east, north west and south east boundaries to the development area.

2.3 The findings of the site inspection confirmed the rock strata to comprise a strong medium and thickly bedded light brown fine to medium grained Sandstone generally fresh or slightly weathered with medium to wide smooth or stepped discontinuities typically at 90 degrees to bedding planes. The patterns of bedding and discontinuities results in the rock mass having a slab or block appearance with block size dependant upon the bedding and discontinuity spacing.

2.4 Measurements taken on site show the bedding planes to dip at typically 15 to 22 degrees towards the south east. Therefore bedding planes dip out of the rock face on the north and northwest side of the site and into the rock face on the east and south east side. Rock faces are typically near vertical and where benched still rain very steep. Three sets of discontinuities were noted; two dipping towards the northwest at angles of 50 degrees and 80 degrees and one towards the east at 80 degrees. These patterns cause blocks and wedges of sandstone bedrock to be created.

2.5 Overlying the bedrock at the crest of the quarry face is a thin mantle of boulder clay, typically 1.0m thick, but thinning to 200mm at the edge of the rock face. The boulder clay comprises a loose light brown silty clayey medium to coarse Gravel with cobbles.

2.6 At the ground surface immediately behind the crest of the northwest rock face holes and depressions within the drift deposits were noted. These are due to tension cracks from the opening of discontinuities within the rock mass near the rock face and indicate the general instability of the rock face. Numerous trees and shrubs have taken root on the rock face within the discontinuities.

Groundwater

2.7 No groundwater or seepages were noted issuing from the rock face.

3. Causes and Modes of Failure

3.1 The principal types of movement and mode of failure noted within the rock faces include:

- Translational sliding of blocks
- Toppling failure
- Minor rock and debris fall

3.2 The causes of both translational sliding and toppling failure of blocks of rock is the orientation of the bedding planes and discontinuities, which particularly on the north and northwest rock faces, slope out of the rock face. The effect of weathering, erosion, vibration and root action have caused discontinuities to open and blocks of sandstone to slide or topple. Although such failures have been relatively small to date, the movements occur rapidly. With increased vibration and the continuing action of weathering and opening of discontinuities there is increased likelihood of larger failures. Some of the discontinuities exposed at the rock face have opened significantly and there is evidence of freshly exposed failure surfaces.

3.3 Rock fall and debris fall which includes the movement of dislodged and loosened material occurs because of the adverse jointing and bedding slopes and the overall overstep rock faces. The action of rain, frost and vibration will continue to cause minor rock falls on all rock faces.

4. Stabilisation Proposals

4.1 The stability and overall safety of the rock face at Bron-y-Graig can be achieved by undertaking a series of measures, but predominantly involve reducing the slope angle, scaling and the removal of loose or unsafe blocks, and the creation of features that 'catch' future rock falls.

Slope Re-profiling and Benching

4.2 Re-profiling will initially involve the removal of rock 'blocks' or masses that are susceptible to toppling or wedge type failure. Controlled removal can be achieved with an excavator from the toe of the rock face or by working from benches. There will be no need for blasting or pre-splitting. Removal of unstable rock should continue up and back into the rock face until all large perched unstable bocks have been removed and a safe slope angle is achieved. It is likely to involve benching along appropriate bedding planes to create an overall stepped final profile to the rock face. For the north and northwest rock faces, where large wedges of unstable rock are present at a high level, and the bedding planes slope out of the rock face, the proposed final rock face profile following the removal of unstable blocks is indicated on Photographs in Appendix 1. For the southeast rock face, the proposed final rock face profile is indicated on Photographs in Appendix 2.

Scaling

4.3 Following the overall re-profiling of the rock face and removal of large unstable blocks scaling should be undertaken which involves the removal of loose smaller blocks of rock and debris. This should be undertaken over the whole rock face with particular attention to the crown or top of the rock face.

Rock Fall Prevention and Catchers

4.4 The benching of the rock face may in some locations provide suitable platforms to act as 'rock fall' collectors, however the dip of the bedding planes and likely small width of the benches will limit the volume of material that can be collected. If the freshly exposed rock is very fractured then hanging nets suspended from above should be placed over the rock face to retain rock blocks which become loose. At the toe of the slope a rock trap ditch should be created to catch falling blocks.

4.5 At the crest of the rock face the boulder clay will have to be re-profiled as a result of the excavation works at the rock face. The disturbance to the soils should be minimized as the clayey gravel will be easily eroded by rainwater. The final slope profile within the soils should be no grater than 1:1. If erosion is likely then hydro seeding may be required to provide a raid cover of vegetation.

4.6 It is not anticipated that rock bolts or dowels will be required to anchor loose blocks however the final rock face profile should be inspected when the excavation and re-profiling works have been completed.

5 Monitoring and Maintenance

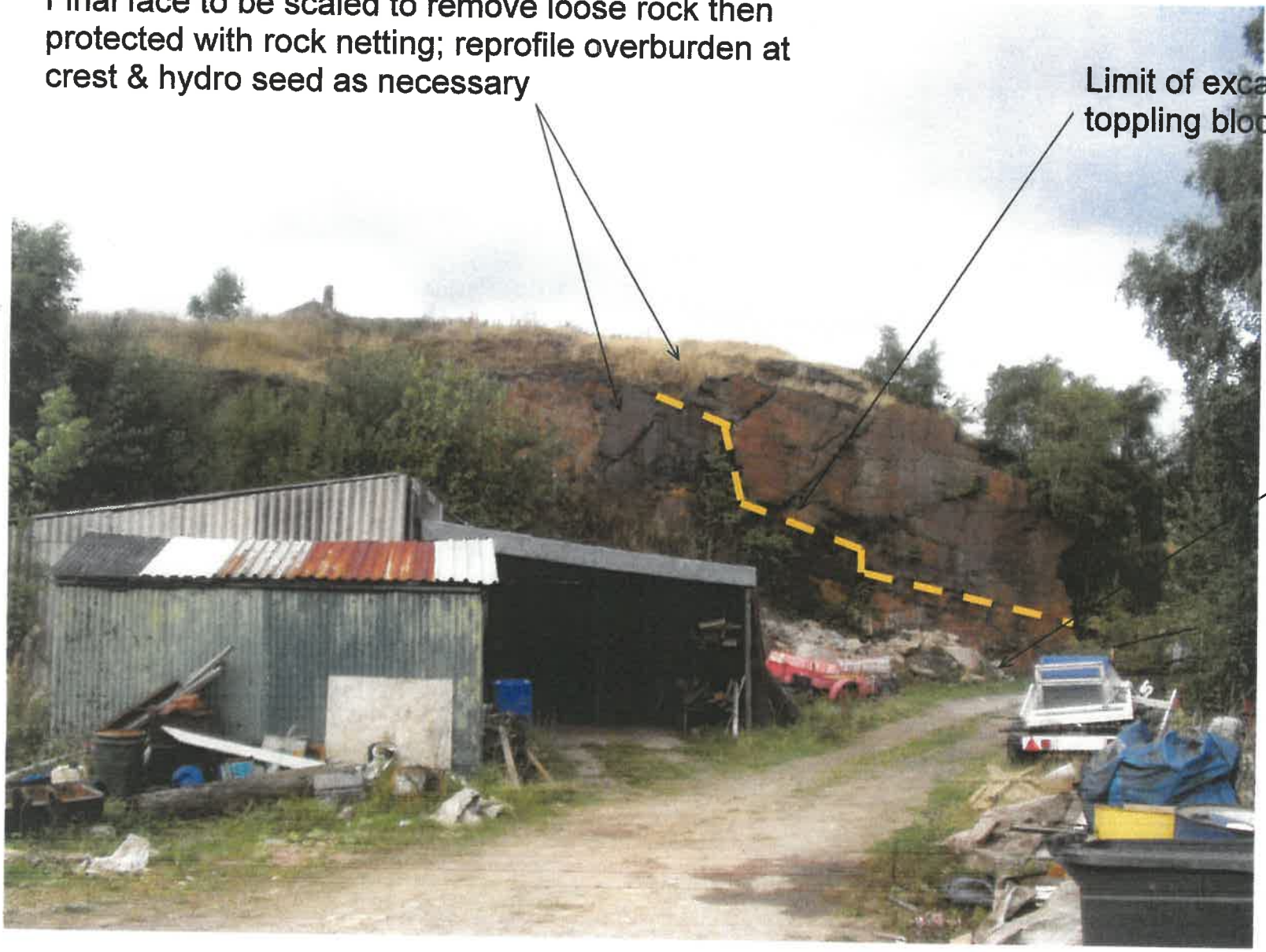
5.1 The rock faces should be inspected annually to monitor conditions and schedule any maintenance works. Maintenance could include the removal of loose rock, repair to netting and the removal of rock caught within the toe ditch or on benches.

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Appendix 1 – North and North west Rock Face Photographs

North West Rock Face (top view)

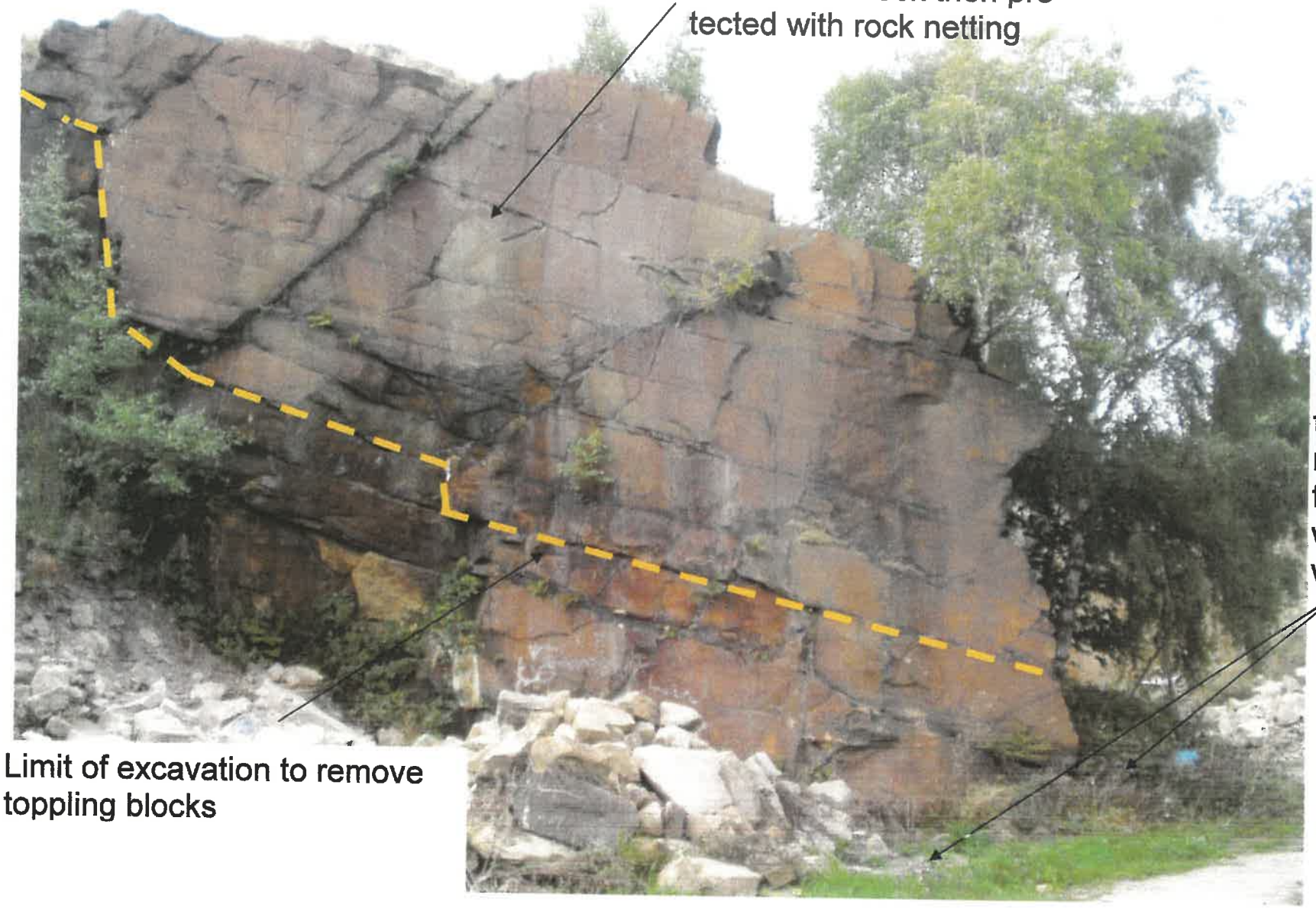
Final face to be scaled to remove loose rock then protected with rock netting; reprofile overburden at crest & hydro seed as necessary



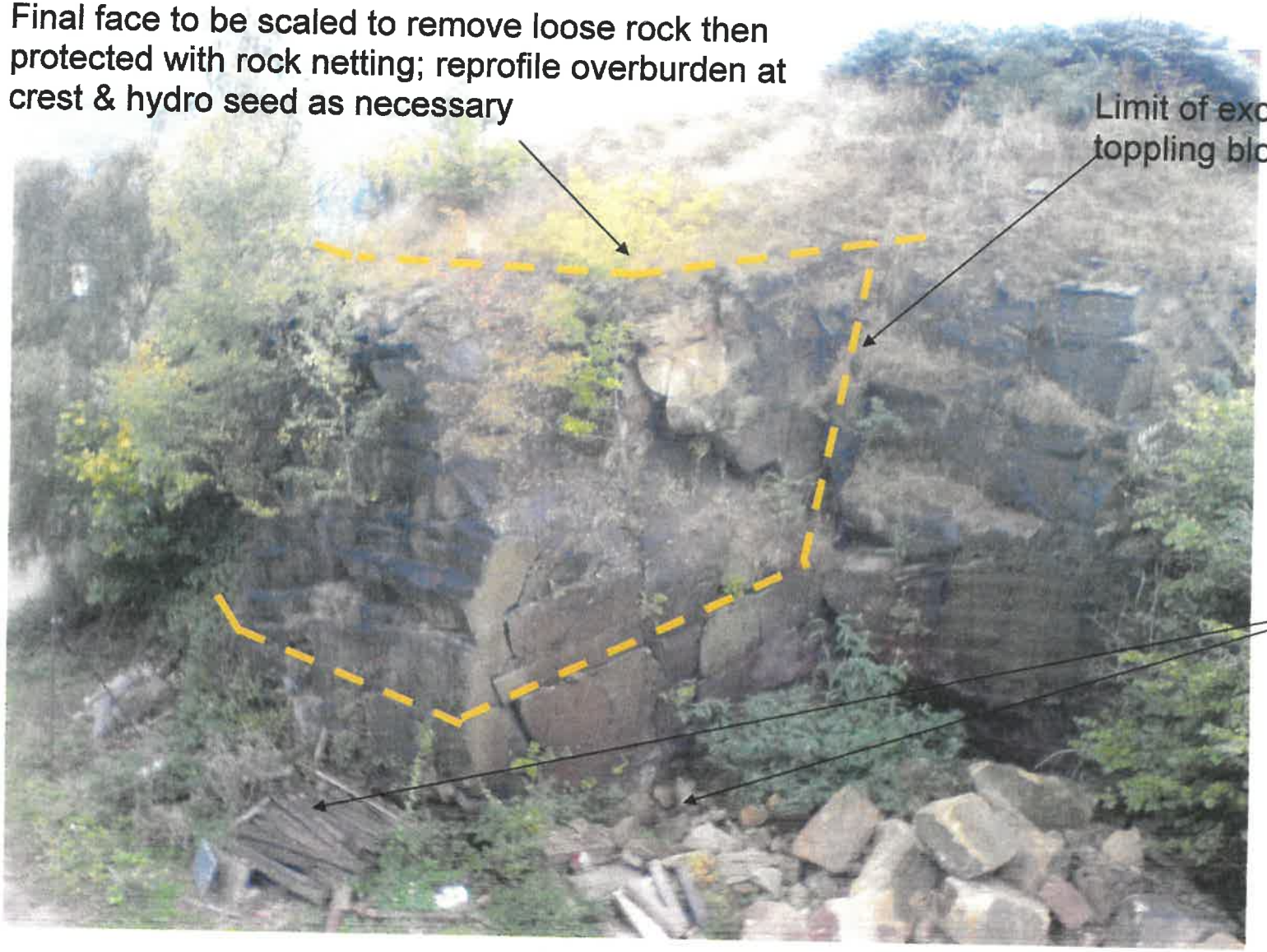
Limit of excavation to remove toppling blocks

Ditch required to catch any minor rock fragments which may work loose

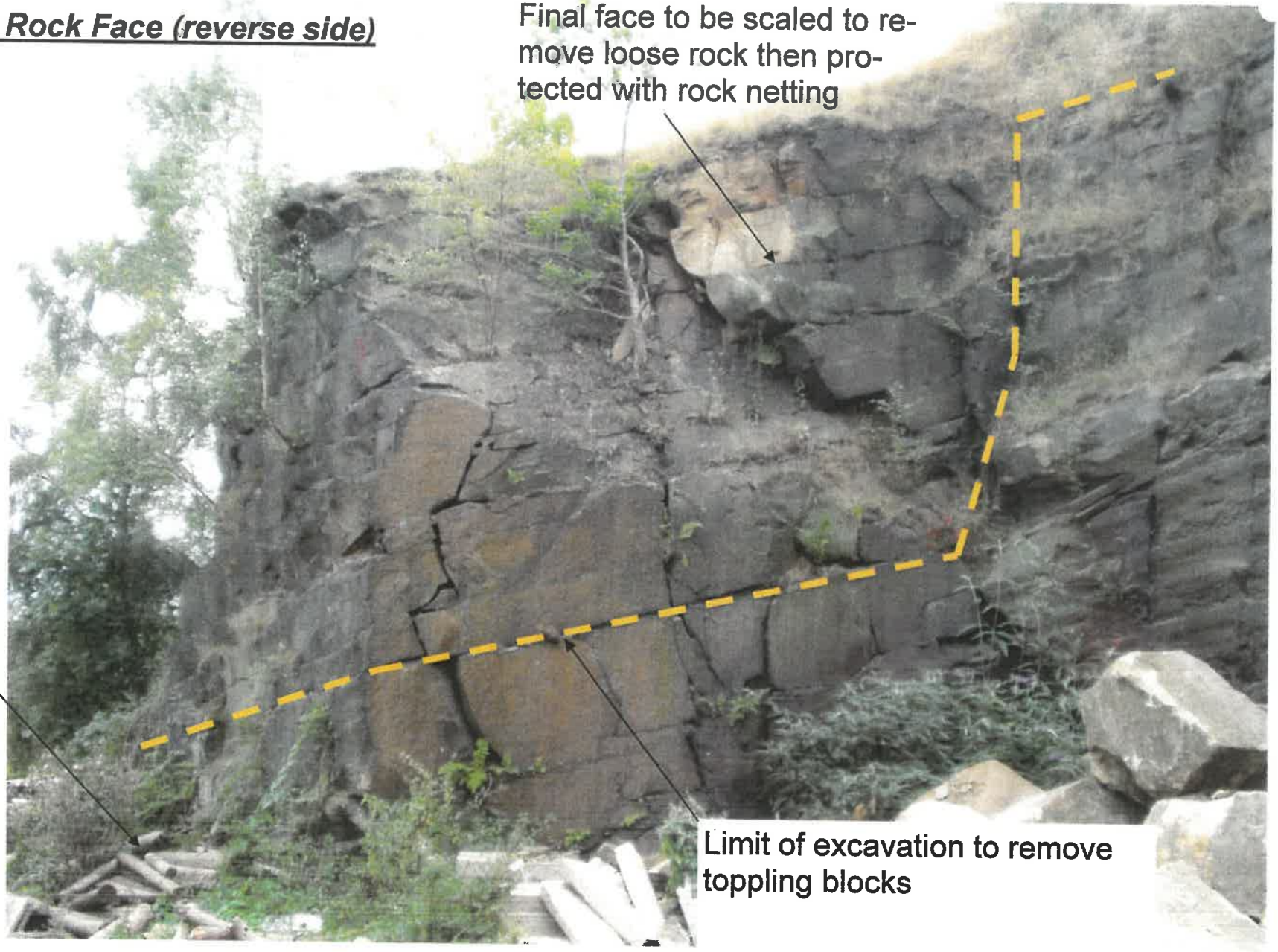
North West Rock Face



North West Rock Face (top view)



North West Rock Face (reverse side)



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Appendix 2 – South and South east Rock Face Photographs

South East Rock Face (front)



South East Rock Face

