1 : introduction gillabbey quarry is located in

1 : Introduction Gillabbey Quarry is located in Cork City Centre adjacent toUniversity College Cork. It is a disused quarry that has been closed for ~100years. All that is visible today is the exposed outcrop along the South ofGillabbey Park. The exposure is ~120m long and ~4. 5m high. The top of theoutcrop isn't visible due to the presence of vegetation.

This quarry issurrounded by residential housing. The eastern end of the outcrop area isfenced off as it is an active construction site. New community buildings arebeing built in this part of the quarry. The instability of the outcropcan have a negative effect on the local infrastructure and may impact the constructionof the communal building.

Slope failure in this area could cause damage to theoverlying Connaught Avenue road and facilities, could cause damage to adjacenthouses on O'Donovan Rossa Road or could cause damage to the building site. The aim of this survey is to determine the stability ofthe outcrop and to recommend options for the maintenance of the rock slope ifnecessary. 2 : Rock Description All exposed outcrops at thislocation are Waulsortian Limestone. The fresh colour is light grey – grey.

Itis a fine to medium grained micritic limestone that has been slightly tomoderately weathered. There are cavities present in the sequence. This rock isstrong, 50 – 100 MPa. The beds are highly jointed.

There is clay present withinthe larger joints and behind the outcrop. This clay is very stiff and containsrounded gravel indicating that it was transported far. 3 : Karst The Waulsortian Limestone is aclean unbedded limestone. This pure limestone is Carboniferous in age.

Most karstic landforms in Irelandare Juvenile Karst KI or Youthful Karst KII. This means that there are fewcomplex underground structures in Ireland's karstic landforms. Juvenile orYouthful karst would be easier to build on than more complex or extreme karst. Figure 1 : Map of the Hydrogeology oflowland karst in Ireland by D. P. Drew.

Image taken from John Lawlor'sPreliminary Desk Study. Figure 2 : Chart outlying the EngineeringClassification of Karst Ground Conditions by A. C. Waltham and P. G.

Fookes. Image taken from John Lawlor's Preliminary Desk Study. 4 : Scanlines & Stereonets Three scanline locations wereselected. Location 1 coordinates; 566535, 571491. Location 2; 566572, 571376. Location 3; 566509, 571495.

At location 1, a horizontal and vertical scanlinewas produced. At locations 2 and 3 a horizontal scanline was produced. For eachlocation the dip and dip direction of the joints was recorded. The type ofjoint was noted, along with other features. The dip and dip direction data foreach scanline was plotted on a stereonet. Please find further scanline data in the appendix. Figure 3 : Image taken of the outcrop at Location1 where the scanline data was collected.

Figure 4 : Stereonet image of theScanline data from Location 1, Horizontal. Figure 5 : Stereonet image of the Scanline data fromLocation 1, Vertical. Figure 6 : Image taken of the outcrop at Location 2where the scanline data was collected. Figure 7 : Stereonet image of the Scanline data fromLocation 2, Horizontal. Figure 8 : Image taken of the outcrop at

Location 3where the scanline data was collected. Figure 9 : Stereonet image of the Scanline data fromLocation 3, Horizontal. 5 : GIS Below is a digitized map ofGillabbey Quarry and the surrounding area.

The outcrop is shown as light grey, the fenced off construction site is shown on the right of the map as the pinkarea and the three scanline locations are shown on the map also. N Figure 10 : Digitized GIS Map of GillabbeyQuarry showing the Scanline Site Locations, the outcrop, the construction siteand surrounding residential area. 6 : Slope Stability In the fenced off constructionarea the outcrop and overburden are unstable. The rock is heavily fractured andweathered which has lead to crumbling in places as well as small block failures. The overlying topsoil is also loose as the vegetation has been ripped away. This slope has recently been worked.

Mesh wire has been installed with rockbolts and a rock trap fence has also been put in place. As the vegetation andloose material was removed, many of the discontinuities have been daylightedhere. The outcrop at locations 1, 2 and3 isn’t as well exposed. At all 3 locations, the rock is covered withvegetation, many of the joints aren’t exposed. The vegetation may have causedjoints to form in places.

7 : Discontinuities and Block Failure All discontinuities recorded atlocations 1, 2 and 3 are joints. As there are 3 types of joints present at eachlocation, wedge and/or toppling failures may occur though the base of eachdiscontinuity is well supported. No veins or bedding were noted.

For moreinformation on the joints recorded, please see appendix. There is no evidence of large wedgeor block failure having occurred to date though

the fallen rock could have beencleared during construction. Failures occur as a result of many processesincluding; construction, vegetation wedging in joints, weathering, blocking ofdrainage pathways, etc. Future failures are possible at this site.

For a wedgefailure to occur, there must be at least two discontinuities separating theblock from the rock mass. The intersection of the discontinuities must bedaylighted. For toppling failures to occur it is required that the centre of gravity beclose to the rotational point of the block. 8: Water & Dissolution Of Clay Figure 11 : Image of a large discontinuity, major joint which has been infilled with clay. There is water present comingfrom some of the joints, particularly at location 3. There are also areas ofclay infill along the outcrops. Both of these features can contribute to slopefailure.

9 : Maintenance Of Site Figure 12 : Image of the rock face insidethe construction site. The rock here is unstable and supports have been put inplace. There are a 3mitigation strategies in place along the outcrop within the construction site.

No strategies have been put in place at locations 1, 2 and 3. At theconstruction site the loose material has been ripped away, mesh wire has beeninstalled with rock bolts and a rock trap fence has also been put in place. The supports inplace at this location are more than adequate and do not require updating noris maintenance of the supports necessary as they were newly installed and arein good repair. The structures in place here might be a bit over the top but asthis is a private, excluded area, aesthetics

are not a priority. Protection oflocal residences and the construction site is the priority.

Table 1 : Table outlining the appropriate stabilisation methods fordifferent failure types. Sourced from Marie Fleming’s lectures slides. A more suitable option may havebeen using rock dowels and bolts asthese are more subtle. The dowels would be able to hold the smaller wedges inplace but the bolts would be necessary for larger wedges and blocks. Figure 13 : Left; Rock Dowel. Right; Rock Bolt. Sourced from Marie Fleming’s lectures slides.

Dentition is a discrete method of securing loose/crumbling material andcan prevent further weathering of the cliff faces. Vegetation can be reintroducedfor further stability of topsoil. It is not necessary to install stabilising features are locations 1, 2or 3 unless the building site is extended down to these areas. Figure 14: Graph showing excavatability of Rock, by Pettifer, G. S.

andFookes, P. G. Image taken from John Lawlor’s Preliminary Desk Study. Appendix – Scanline Data SheetsLocation 1 : Horizontal Distance (m) Rock Type DIP DIP Direction Type Trace Length Above Trace Length Below Large Scale Planarity (> 1m) Small Scale Planarity (<1m) Top Termination Infill Aperture 0. 10 Waulsortian Limestone 87° 292 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Firm Clay Open (0. 5 - 2. 5 mm) 0. 15 Waulsortian Limestone 82° 008 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Soft Clay Open (0. 5 - 2. 5 mm) 0. 15 - 0. 37 Waulsortian Limestone 78° 270 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clean 0. 37 Waulsortian Limestone 88° 178 Joint 2 Very Low (<1m) Low (1

- 3m) N/A 1 Another Joint Clay Smearing 0. 37 - 0. 70 Waulsortian Limestone 78° 122 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 1 Another Joint Clay Smearing 0. 70 Waulsortian Limestone 89° 028 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clay Smearing 0. 70 - 0. 95 Waulsortian Limestone 78° 024 Joint 2 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clay Smearing 0. 95 Waulsortian Limestone 88° 018 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Firm Clay Open (0. 5 - 2. 5 mm) 0. 95 - 1. 30 Waulsortian Limestone 89° 088 Joint 2 Very Low (<1m) Low (1 - 3m) N/A 1 Another Joint Clay Smearing 1. 30 Waulsortian Limestone 81° 124 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clay Smearing 1. 50 Waulsortian Limestone 85° 100 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 1 Another Joint Soft Clay Wide (10 - 100mm) Location 1 : Vertical Distance (m) Rock Type DIP DIP Direction Type Trace Length Above Trace Length Below Large Scale Planarity (> 1m) Small Scale Planarity (<1m) Top Termination Infill Aperture 0. 24 Waulsortian Limestone 70° 036 Joint 2 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clay Smearing 0. 27 Waulsortian Limestone 23° 179 Joint 3 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clean 0. 32 Waulsortian Limestone 85° 100 Joint 1 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clay Smearing 1. 0 - 2. 0 Waulsortian Limestone 66° 104 Joint 2 Very Low (<1m) Low (1 - 3m) N/A 4 Another Joint Clean Location 2 : Horizontal Distance (m) Rock Type DIP DIP Direction Type Trace Length Above Trace Length Below Large Scale Planarity (> 1m) Small Scale Planarity (<1m) Top Termination Infill Aperture 0. 25 Waulsortian Limestone 70° 281 Joint 1 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Firm Clay Wide (10 - 100mm) 0. 55 - 0. 97 Waulsortian Limestone 38° 189 Joint 3 Very Low (<1m) Low (1 - 3m) 4 5

Another Joint Clean 0. 97 Waulsortian Limestone 60° 020 Joint 2 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Clean 1 Waulsortian Limestone 86° 003 Joint 1 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Clean 1 - 1. 35 Waulsortian Limestone 52° 102 Joint 2 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Clean 1. 35 Waulsortian Limestone 59° 272 Joint 1 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Clean 1. 70 Waulsortian Limestone 62° 273 Joint 1 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Clean Open (0. 5 - 2. 5 mm) 1. 90 Waulsortian Limestone 63° 289 Joint 1 Very Low (<1m) Low (1 - 3m) 4 5 Another Joint Clean Waulsortian Limestone Waulsortian Limestone Waulsortian Limestone

Location 3 : Horizontal Distance (m) Rock Type DIP DIP Direction Type Trace Length Above Trace Length Below Large Scale Planarity (> 1m) Small Scale Planarity (<1m) Top Termination Infill Aperture 0. 00 Waulsortian Limestone 80° 280 Joint 1 N/A Very Low (<1m) 4 4 N/A Clean 0. 10 Waulsortian Limestone 74 161 Joint 2 N/A Very Low (<1m) 4 4 N/A Clean 0. 25 Waulsortian Limestone 61° 268 Joint 1 N/A Very Low (<1m) 4 4 N/A Firm Clay Wide (10 - 100mm) 0. 20 - 0. 35 Waulsortian Limestone 62° 082 Joint 2 N/A Very Low (<1m) 4 4 N/A Clean 0. 35 Waulsortian Limestone 80° 174 Joint 1 N/A Very Low (<1m) 4 4 N/A Clean 0. 50 Waulsortian Limestone 40° 178 Joint 3 N/A Very Low (<1m) 4 4 N/A Clean 1. 20 Waulsortian Limestone 82° 014 Joint 1 N/A Very Low (<1m) 4 4 N/A Clean 1. 30 Waulsortian Limestone 63 103 Joint 1 N/A Very Low (<1m) 4 4 N/A Clean 1. 30 - 1. 70 Waulsortian Limestone 90° 100 Joint 2 N/A Very Low (<1m) 4 4 N/A Clean 1. 70 Waulsortian Limestone 54° 008 Joint 1 N/A Very Low (<1m) 4 4 N/A Firm Clay Wide (10 - 100mm) Waulsortian Limestone