IN THE MATTER OF AN APPLICATION TO

AN BORD PLEANÁLA

FOR APPROVAL OF (I) THE N6 GALWAY CITY RING ROAD PURSUANT TO SECTION 51 OF THE ROADS ACT 1993 (AS AMENDED); (II) THE N6 GALWAY CITY RING ROAD MOTORWAY SCHEME 2018; and (III) THE N6 GALWAY CITY RING ROAD PROTECTED ROAD SCHEME 2018

ABP Ref. ABP-302848-18 and ABP-302885-18

ORAL HEARING

STATEMENT of Evidence

Responses to Soils and Geology

Objections/Submissions

by

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and assisted by

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Arup

19 February 2020

1 Qualifications and Experience

1.1 Lead Witness

1.1 My name is Juli Crowley and I am a Senior Geotechnical Engineer with Arup working in the Ground Engineering team. I have over 14 years of engineering experience. I hold a Bachelor in Engineering in Structural Engineering from Cork Institute of Technology (BEng, 2005), a Masters in Geotechnical Engineering from Newcastle University (MSc Eng, 2012) and I am a Chartered Engineer with Engineers Ireland (CEng, 2011).

1.2 I have extensive geotechnical feasibility, design and construction experience. I have worked on a broad range of projects including projects within the infrastructure sector such as the M20 Cork to Limerick Motorway and the Mallow Flood Protection Scheme. I have project experience at concept stage, pre-planning stage, pre-tender stage, detailed design stage and post construction stage.

1.2 Support Witness

1.2.1 Marie Fleming is an Associate of Arup working in the Ground Engineering team in Arup. Marie has a Bachelor of Science (Earth Sciences) honours degree from University College Cork and a Master's Degree in Engineering Geology from Imperial College London. Marie has over 18 years professional experience on large infrastructure projects and is a Professional Geologist (PGeo) with the Institute of Geologists of Ireland (IGI), a Chartered European Geologist (EurGeol) with the European Federation of Geologists and a Fellow of the Geological Society of London (GSL).

1.2.2 Marie is Past President of the IGI, Chair of the Registration Authority of the EFG and member of the External Relations Committee of the GSL. She is and has been the industry advisor on a number of Engineering Geology research projects and is a visiting lecturer in Engineering Geology in UCD, UCC and NUIG.

2 Role in Proposed Road Development

2.1 I have been working as the lead geotechnical engineer on the N6 Galway City Ring Road (GCRR) since 2015. I have managed a team of geologists and geotechnical engineers to complete the assessment of soils and geology for the proposed road development. I was responsible for the geotechnical element of the design for the proposed road development including (but not limited to) the following structures Lackagh Tunnel, Menlough Viaduct, Galway Racecourse and River Corrib Bridge.

2.2 Marie has been working on the project since 2014, providing ongoing engineering geology experience of the proposed road development. Marie also acted as senior peer reviewer on the Chapter 9, Soils and Geology of the EIAR.

2.3 Our team scoped, supervised and managed the ground investigations undertaken to inform the assessment and design of the proposed road development.

2.4 In addition to our assessment of the soil and geology environment as presented in Chapter 9 of the EIAR, we coordinated, designed (where appropriate) and delivered the Lackagh Tunnel Geotechnical and Hydrogeology Appraisal report, Material Deposition Areas Baseline report and Lackagh Quarry Material Deposition Area Requirements report.

3 Key issues in relation to Soils and Geology

3.1 Chapter 9 of the EIAR is to be taken as read in its entirety and is not replicated here. To assist the Board in its consideration of this application for Approval and for the convenience of all participants at this hearing, and to set the context for responding to the objections and submissions, the key items pertaining to the soils and geology assessment of the proposed road development detailed in Chapter 9 of the EIAR are summarised briefly below.

3.2 The receiving soils and geology environment within the study area is set out in detail at Section 9.3 of Chapter 9 of the EIAR. In this section a regional overview is provided in terms of the geomorphology, topography, soils and solid geology of the local area followed by sub sections identifying the feature importance ranking of the agricultural soils, superficial deposits, bedrock geology, soft and unstable ground, contaminated land, karst solution features, mineral and aggregate resources and geological heritage sites within the study area.

3.3 To validate and support the receiving environment study, five ground investigation contracts were commissioned during constraints, route options and design stages of the proposed road development. These ground investigations (factual reports of which are contained in Appendix A.9.1 of the EIAR) informed the design of the proposed road development and the soils and geology assessment presented in Chapter 9 of the EIAR along with relevant historic ground investigation data, desk study data and walkover surveys.

3.4 From this information a plan and profile conceptual site model based on the ground investigation data was developed for the proposed road development, refer to Figures 9.8.001 to Figure 9.8.012 of the EIAR. These figures present the ground investigation data which outline the underlying ground conditions, the existing topography and proposed ground levels and in turn the expected depths of cut and fill across the proposed road development.

3.5 The general geomorphology of the western area consists of gently undulating to hummocky topography in areas overlying granite (Ch. 0+000 to Ch. 8+500). Generally, this area consists of soils which include a mix of peaty podzols, blanket peat, lithosols/regosols and surface water gleys, overlying subsoils which include pockets of peat and alluvial deposits associated with current and historic water courses and predominantly granular glacial till over early-middle Devonian granite intrusions known as the Galway Granite Batholith and other igneous intrusive rocks.

3.6 On crossing the River Corrib, the topography to the eastern area is less undulating than in the western area. The soils in the east consist predominantly of grey brown podzolics, lithosols peat and renzinas/lithosols, overlying subsoils which include alluvial deposits associated with current and historic water courses and predominantly cohesive glacial till derived from the underlying bedrock. The underlying bedrock in this area from approx. Ch. 8+500 (west of the River Corrib) to Ch. 17+500 is karstified Carboniferous Visean Limestone.

3.7 As described in Section 9.5 of Chapter 9 of the EIAR, there are potential impacts on the soils and geology environment as a result of the proposed road development. These potential impacts are determined based on the construction and operational activities. These include the following potential impacts which are raised in the submissions/objections:

- Potential impact from the excavation of rock during construction to properties due to blasting activities
- Potential impact to Limestone pavement during tunnelling during construction
- Potential impact to soils and geology during construction caused by contamination
- The overall potential impact to soils

3.8 An appraisal of these potential impacts to geological features during the construction and operational phases was undertaken as presented in Section 9.5.3 and 9.5.4 of Chapter 9 of the EIAR.

3.9 Measures for the mitigation of soils and geology impacts are set out in Section 9.6 of Chapter 9 of the EIAR. This includes specific measures to be employed during the construction phase (Section 9.6.2) and the operation phase (Section 9.6.3).

3.10 The proposed mitigation measures comprise a comprehensive suite of appropriate activities and measures that are designed to avoid, remediate and/or mitigate the identified soils and geology impacts of the proposed road development.

3.11 The proposed modification to the Parkmore Link Road will have no effect on the soils and geology assessment results contained in the EIAR and RFI response document.

3.12 The current National University of Ireland (NUIG) planning permission application (Ref 19/373) to construct additional playing pitches and the two proposed strategic housing development applications (Ob_229 and Ob_469 and S_003) do not change the conclusions of the cumulative impact assessment on Soils and Geology contained in the EIAR.

4 Responses to Submissions/Objections

4.1 Overview

4.1.1 31 of the 296 submissions and objections made to An Bórd Pleanála (ABP) in respect of the N6 Galway City Ring Road (GCRR) Environmental Impact Assessment Report (EIAR), Natura Impact Statement (NIS), Motorway Scheme (MS) and Protected Road Scheme (PRS) raise issues that relate to soils and geology. A further 5 of the 17 submissions/objections received in relation to the Request for Further Information Response raise issues that relate to soils and geology. The items raised are categorised under two headings: (1) Potential Impacts to the Soils and Geology Environment and (2) Design related submissions. These headings are further subdivided as follows:

1) Potential Impacts to the Soils and Geology Environment:

- Blasting – Potential impact from the excavation of rock during construction to properties due to blasting activities
- Limestone Pavement - Potential impact to Limestone pavement during construction from tunnelling
- Overall Impacts on Soils
- Potential Contamination to lands/soils during construction

2) Design related submissions:

- Observations and request from Geological Survey Ireland
- Request for survey and earthworks information
- Query in relation to Embankment design
- Query in relation to Slope Stability of Cuts
- Query in relation to Earthworks Design
- Query in relation to the disciplines and qualifications of the specialists inputting to the MDA plan in Lackagh Quarry
- MDA Clarification

4.2 Blasting

Issues

4.2.1 23 of the submissions and objections raise queries in relation to the potential impact to properties from blasting activities and/or the excavation of rock as follows.

4.2.2 Ob_111 "*If the project is given the go ahead there may be devastating consequences to our client's residence given its proximity and we believe that drilling and explosives may be required to construct the adjoining road and this may cause cracks in foundations not just in our clients property but the adjoining ones too*".

4.2.3 Ob_136 *"My third major concern is the impact of the construction phase of this motorway on the structural integrity of my residence where I reside. Will this motorway be conducting controlled demolition blasting in the area or surrounding area near my home and if so, will that lead to damage to my property from the vibrations of the blasting if stone needs to be removed the likes of granite stone etc. If cracks start to appear on my property due to the actions of the construction phase, how does that action help me. All it does is weaken my property structure."*

4.2.4 Ob_155 *"Drilling and road building on local granite rock could cause damage to houses not just in the immediate area but further afield."*

4.2.5 Ob_159 "*My wife and I have a young toddler and another baby expected in 2019 I'm extremely concerned that we have to move out of our house during the period when blasting will be taking place*".

4.2.6 Ob_201 "*Blasting/Rock breaking: They are fearful of blasting and rock breaking so near to their property. Their house is built on sheer granite which will be connected to the same granite that will be blasted or cut within 100 meters from their house (refer to drawing 7.201). At a meeting on the 5th December 2016 it was noted by Cliodhna Ni Mhurchu (Arup) that 'Pre and post construction structural surveys would be carried out on all homes in the vicinity of blasting. Existing cracks would be photographed, measured and monitored during construction. Vibration limits would also be set and monitored during construction'. by the council at no expense to client*".

4.2.7 Ob_298 *"No noise barriers are evident to the rear of our clients property to mitigate noise levels from blasting on the N59 Link Road South. This is of great concern to our client."*

4.2.8 Ob_512 *"If the project is given the go-ahead there may be devastating consequences to our clients residence given its proximity and we believe that drilling and explosives maybe required to remove adjoining road, and this may cause cracks in foundations not just in our clients property but adjoin ones too."*

4.2.9 Ob_584 "*Blasting/Rock breaking: How will we be impacted by the blasting? How do we sort out any damage done during blasting/rock breaking*" "Page 782 *Earthworks Haulage During earthworks construction, heavily loaded large earthmoving vehicles will travel through the site, causing ground vibrations, unwanted compaction and disturbance of natural ground of unfinished road surfaces.*

4.2.10 Ob_584 *"Effect on Surrounding Ground Soil and rock excavation has the potential to induce movement and settlement of surrounding ground. The breaking or blasting of the bedrock could result in ground vibrations and destabilisation of existing slopes, existing rock slopes, with affects felt in the immediate vicinity of the works."*

4.2.11 Ob_584 "*Given the above, I am very concerned that my property will suffer structural damage from rock excavation associated with the construction of the Lackagh Quarry tunnel. Previous blasting in Lackagh Quarry has caused severe damage to neighbouring properties in the past*".

4.2.12 Ob_654 *"We are very concerned about noise levels and vibration of our house if this"* i.e. road development *"goes ahead during construction. For years we have been greatly affected by vibration as a result of blasting rock in Roadstone and that's further away from us so we can just imagine what its going to be like then as its directly behind our house."*

4.2.13 Ob_677 *"The figure"* Figure 7.202 – Potential Blasting Locations during Construction *"indicates proposed blasting location between chainage 14+200 and 14+600. We object to the design decision that will cater for blasting within 200m of our property. There has been no assessment carried out on how such blasting will impact on structural integrity of our property."*

4.2.14 Ob_678 *"The figure"* presumably Figure 7.202 – Potential Blasting Locations during Construction *"indicates proposed blasting location between chainage 14+200 and 14+600. We object to the design decision that will cater for blasting within 200m of my property. There has been no assessment carried out on how such blasting will impact on structural integrity of our property."*

4.2.15 Ob_691 *Cl.50 "The Galway Race Committee is concerned that the constructability report indicates that rock blasting will be required in the construction of the tunnel. There is no evidence that the Developer has assessed the risk and impact of blasting on the temporary and/or permanent stables, on the tunnel structures itself or on existing Galway Racecourse structures. GRC seeks confirmation that the Developer assessed the risk and impact of blasting on the proposed temporary and permanent stables, on the tunnel structure itself and on the existing Galway Racecourse structures."*

4.2.16 Ob_691 *Cl.58 "The Developer assess at 9.8.7, that blasting will be required for construction of the Galway Racecourse tunnel. The Developer also assesses that blast design may not be viable and that alternative methods may be utilised. GRC seeks confirmation if the Developer has assessed the impact of blasting not being viable and alternative methods of construction being utilised and how it would impact the commitments given GRC to avoid disruption to the operation and functioning of the GRC, and the provision of temporary and permanent stables."*

4.2.17 Ob_696.21 *"From the road development description in the EIAR, M&M Qualtech Ltd. has particular concerns relating to the construction phase of this development which includes rock removal / blasting operations in close proximity to its lands, property and business."*

4.2.18 Ob_705 *"There will be extensive excavations close to this property and the property owners are very worried about how this might impact on their retained buildings/structures."*

4.2.19 Ob_717 *"It is not clear whether the Council has assessed the noise and vibration impact arising for construction activities in proximity to the Connolly Group business operations. The Council has not adequately considered or assessed the potential for the Development construction activities to deter customers."*

4.2.20 S_046 *"Noise and disturbance resulting from construction of the motorway from demolition, drilling, hammering." "Stress from the combination of vibration caused by drilling and demolition."*

4.2.21 S_055 *"With this ring road, we will be living approximately 140 metres from the edge of the Motorway. From this point, they start to construct a tunnel, the environmental impact that this will have on our family while it is under construction will be utterly devastating. This will be due to the massive amounts of drilling, blasting, and rock breaking that is required." "Another worrying part of this is the structural damage that will be done to our home regarding serious cracks etc."*

4.2.22 S_059 *"It is noted that there is a potential blasting location to the north of Árd na Gaoithe. Our clients are concerned about the potential structural impact on houses in Árd na Gaoithe and request that pre and post-construction structural surveys of impacted properties to be undertaken."*

4.2.23 S_062 *"Arup have confirmed there will be blasting. What occurs if there are damages to my property from blasting, I would like an engineer report on my property to confirm its current condition and any damage that occurred during works is this provide, or do I need to get an independent one for this"*.

4.4.24 S_063 *"Blasting damage to house and property." "We want an Engineer to visit our homes which have all been built to very high spec, we feel with blasting there could be structural damage to them and we need this eliminated if possible." "What is in place for notice for this blasting and keeping the noise to a minimum?"*

4.4.25 S_066 *"Blasting damages to house and property" "We want an Engineer to visit our homes which have all been built to very high spec, we feel with blasting there could be structural damage to them and we need this eliminated if possible." "What is in place for notice for this blasting and keeping the noise to a minimum?"*

4.2.26 S_074 *"The Ballinfoile Park residents are concerned re the consequences of the renewed proposed blasting, tunnelling, and the resulting tremors there from, as the infrastructure pictured above is now in a precarious state and the residents are fearful for their family and friends, as sections of the disintegrating chimneys are known to fall into their gardens."*

4.2.27 S_074 *"We would ask that An Bord Pleanála seek to clarify and reveal the source of the licence required for blasting/tunnelling and the use of explosives? As this too will have to be notified to the relevant European authorities, for their consideration, and to clarify if it contravenes existing EU directive regulations re this SAC site."*

4.2.28 S_074 *"There is also the remnants of an intact unidentified stone dwelling {possibly a small chapel} on the Protected Area [SAC], and it is feared that the tunnelling and blasting will knock this and many cairns and the dry stone walls, including the extensive nearby City boundary wall."*

4.2.29 S_074 *"Residents are greatly concerned that the development is to tunnel through a SAC-protected area, with the acknowledgement by the EIAR Hydrology report, that tunnelling and blasting in this and the preceding silted area may cause subsidence and collapse, thus affecting the aquifers, the water supply and the features outlined above?"*

4.2.30 Ob_584.2 *"I am very concerned that damage will occur to my home as I am in very close proximity to the Lackagh Quarry. Should any damage occur to my property from blasting charges who will be held accountable"*.

Response

4.2.31 The potential noise and vibration impacts from blasting will be addressed by Jennifer Harmon in her statement of evidence on noise and vibration. I will cover the geological impacts.

4.2.32 Blasting will only be undertaken in locations that are deemed suitable for blasting. A blast exclusion zone, where blasting is not permitted, will be implemented where a location is not suitable. The blast design uses site specific information to define the extent (radius) of the exclusion zone from the receptor (including dwellings).

4.2.33 Where blasting is not feasible in a particular location, extraction methods such as hydraulic breaking, hydraulic splitting, chemical splitting and electrical disintegration will be implemented (Section 9.6.2.1 of Chapter 9 of the EIAR).

4.2.34 One advantage of blasting is that the time period over which impacts from blasting are experienced are significantly shorter when compared to other extraction methods. Following a blast, the broken rock will be excavated and transported from the area. It should also be noted that the frequency of blasting for the proposed road development is defined in Section 17.2.2.1 of Chapter 17 of the EIAR, and will be no greater than one blast per day in any one location.

4.2.35 To explain this topic, I will firstly present an overview of the potential impacts from blasting along with the appropriate mitigation measures as identified in Chapter 9 of the EIAR. Then I will discuss the proximity of the properties of persons who have made submission/objections to locations where blasting may occur. Finally, I will go through the results from our blasting feasibility assessment and present an outline of the processes and works/activities that will be completed prior to, during and after blasting works.

4.2.36 One method of excavating rock during construction is blasting. This construction activity is discussed in Section 9.4.2.2 of Chapter 9 of the EIAR. The potential impact from blasting during the excavation of rock, which is detailed in Section 9.5.3.4 of the EIAR, includes effects on the surrounding ground including ground vibrations and destabilisation of existing slopes, existing rock slopes, with affects felt in the immediate vicinity of the works.

4.2.37 To mitigate the effects from blasting during the excavation of rock the following mitigation measures (detailed in Section 9.6.2.1 of Chapter 9 of the EIAR) will be employed:

- Ground settlement, horizontal movement and vibration monitoring will be implemented during construction activities which will ensure that the construction activities do not exceed the design limitations. The design limitations will ensure no cosmetic damage to adjacent property
- Where blasting has been deemed feasible, monitoring will be implemented. A geotechnical expert will be appointed and will be present to monitor the surrounding ground vibrations near sensitive receptors (including properties) during blasting works to ensure the construction activities will not exceed the blast design limitations. In the unlikely event that the blast vibration limit is exceeded, blasting works will cease on site until the basis for the increased vibration is understood. The blast design will then be recalibrated and blasting works will proceed with continued monitoring. It should also be noted that the noise and vibration limits for rock excavation including blasting are outlined in Section 17.2.2.1 of Chapter 17, Noise and Vibration of the EIAR

4.2.38 Each of the submissions and objections listed above that raised concerns in relation to blasting have been assessed and the results presented in the Table 1 below. This table presents the proximity of the proposed development boundary (fenceline) to the closest structure on the property of the person making the submission/objection and their proximity to the edge of the nearest cutting.

Table 1: Objection / Submission proximity to proposed areas of blasting

Objections / Submissions	Structure Type	Chainage	Approx. Distance to		Blasting (EIAR Fig. 7.201 and 7.202)	Blasting Location	Bedrock Type
			Fenceline	Cutting			
		m	*m*	*m*			
Ob_111	Dwelling	0+300 to 0+400	52	75	Possible	Mainline	Granite
Ob_136	Dwelling	1+200	12	79	Possible	Drainage	Granite
Ob_155	Dwelling	1+600	10	38	Possible	Mainline	Granite
Ob_159	Dwelling	1+500	5	128	Possible	Mainline	Granite
Ob_201	Dwelling	3+300	65	73	Yes	Mainline	Granite
Ob_298	Dwelling	7+350	82	115	Yes	Mainline / Link Road	Granite
Ob_512	Dwelling	8+150	9	28	Yes	Mainline	Granite
Ob_584	Dwelling	10+800	0	375	Possible	Mainline	Limestone
Ob_654	Dwelling	13+540	14	19	Yes	Mainline	Limestone
Ob_677	Dwelling	14+000	18	154	Yes	Mainline / Link Road	Limestone
Ob_678	Dwelling	14+000	18	164	Yes	Mainline / Link Road	Limestone
Ob_691	Business	13+950	0	-	Yes	Mainline / Link Road	Limestone
Ob_696	M&M Qualtech	14+500	26	26	Yes	Mainline	Limestone
Ob_705	Dwelling	13+300 to 13+450	0	5	Yes	Mainline	Limestone
Ob_717	Business	15+150 15+750	120	137	Possible	Mainline	Limestone
S_046	Dwelling	15+500	65	170	Possible	Mainline	Limestone
S_055	Dwelling	15+100	10	137	Possible	Mainline	Limestone
S_059	Numerous Dwellings	6+000	6	30	Possible	Attenuation Pond	Granite
S_062	Dwelling	15+600	65	210	Possible	Mainline	Limestone
S_063	Dwelling	15+600	100	167	Possible	Mainline	Limestone
S_066	Dwelling	15+600	138	147	Possible	Mainline	Limestone
S_074	Numerous Dwellings	9+350 to 12+100	Varies[i1]		Yes	Mainline	Limestone

[1] The exact locations of the properties in this submission/objection were not identified in the submission/objection

4.2.39 The potential blasting locations during construction are presented in Figures 7.201 and 7.202 of the EIAR, are based on the anticipated depth of cut and the corresponding ground conditions acquired as part of the ground investigation. The ground investigation data is presented in Appendix A.9.1 of the EIAR with the locations of the various surveys identified in Figures 9.8.001 – 9.8.012 of the EIAR.

4.2.40 In addition, as part of our analysis, we completed an assessment to determine the feasibility of blasting adjacent to sensitive receptors (including structures and dwellings) along the proposed road development. The assessment was conducted by analysing the estimated blast-induced ground vibrations and the subsequent exclusion zones required based on blasting activities in both the Granite and Limestone bedrock which is the underlying bedrock along the proposed road development. Full details of this assessment are included in Appendix A10.1 of the Design Report in Volume 4 of the RFI Response.

4.2.41 Our analysis concluded that blasting in areas of Granite is feasible where the receptor (structure) is greater than 12.5m from a blast and in areas of Limestone a distance greater than 15m from the edge of the expected blast. A blast exclusion zone will be implemented in areas where the receptor (e.g. structure) is closer than the feasibility findings.

4.2.42 Prior to blasting, a blast assessment will be undertaken to confirm that blasting is viable. This is a desk top assessment (no blasting) and involves defining the area of proposed blasting, identifying the local receptors (e.g. structures, dwellings), defining the bedrock properties and defining the rock excavation sequence. One of the outputs of the feasibility assessment will be determining the noise and vibrations values at the local receptors. Should the output exceed the noise and vibration limitations that are set out in Section 17.2.2.1 of Chapter 17 of the EIAR, blasting will be determined not to be feasible and an alternative method of rock excavation will be implemented.

4.2.43 Where blasting is feasible the blast design assessment will be refined. A conservative monitored trial blast in the same bedrock formation as the proposed blast locations at locations of proposed blasting will be conducted. These trial blasts will calibrate the blast design to site specific designs and will refine and validate the blast design properties. Trial blasts will not exceed the limitations of the local sensitive receptors and, as a result, will not impact structures or Limestone pavement.

4.2.44 Vibration limitations for structures are set out in Section 17.2.2.1 of Chapter 17 of the EIAR. These limitations are the maximum allowable vertical, horizontal and vibration measurements to ensure that no cosmetic damage occurs to structures (higher values of vibration are required to cause structural damage).

4.2.45 As an additional precaution, prior to vibration and movement related construction works commencing (including blasting), pre-condition property surveys will be undertaken in advance as per environmental commitment, C17.19 of the Schedule of Environmental Commitments in Chapter 21 of the EIAR.

4.2.46 During blasting works, movement and vibration monitoring will also be installed and monitored by experts. These monitoring systems will be used to ensure the

construction works do not exceed the design vibration limitations as discussed above. In the unlikely event that the blast vibration limit at the monitoring location (typically at or closer to the blast than the receptor) is exceeded, blasting works will cease at that location until the basis for the increased vibration is understood. The blast design will then be recalibrated and blasting works will proceed with continued monitoring (Section 9.6.2.1 of Chapter 9 of the EIAR).

4.2.47 A key contact person will be appointed during the construction phase to facilitate communications between affected property owners informing them of proposed works in their area including blasting.

4.2.48 After blasting works have ceased, a post condition property survey will be undertaken and a comparative assessment with the pre-condition property survey will be completed. In the highly unlikely event that damage from vibration is observed, the damage will be prepared as outlined in the EIAR.

4.2.49 In summary, blasting will only be undertaken in areas that have been identified as suitable following detailed blast assessments and following a pre-condition survey of properties identified. Blasts will be monitored and works will not exceed the design vibration limitations at the identified receptors (including structures, dwellings and Limestone pavement). This ensures that no cosmetic or structural damage will occur.

4.3 Limestone Pavement (Potential impact during construction from tunnelling)

Issues

4.3.1 Two submissions/objections, Ob_510 and Ob_584.2, questioned if tunnelling beneath Limestone pavement in Menlough would damage the Limestone pavement.

4.3.2 Ob_510 "*The original plan for the Galway City Bypass was rejected due to a number of issues which included the possibility of damage to an area of limestone pavement. We are surprised to learn that there are similar areas of limestone paving on the current proposed route and that the plan calls for a tunnel under these areas. We believe that this will still present a threat to the limestone paving*".

4.3.3 Ob_584.2 *"You simply cannot blast and tunnel through rock without disturbing the surface ground overhead"*.

Response

4.3.4 The potential ecological and hydrogeological impacts to the Limestone pavement will be addressed by Aebhin Cawley and Dr. Leslie Brown in their Statement of Evidence. I will cover the geological impacts.

4.3.5 Based on our assessment, the magnitude of risk or threat to Limestone pavement in Menlough by tunnelling beneath it is considered negligible. Our robust

assessment includes a tunnel feasibility assessment, a conservative design approach, a defined construction methodology and mitigation measures.

4.3.6 In order to ensure avoidance of direct impacts to this Limestone pavement, a tunnel feasibility assessment was completed which included a site specific ground investigation (GI) undertaken in 2015 and 2016 to fully understand the Limestone pavement and the adjacent and underlying ground conditions. This assessment included the following:

- Desk study and multi-disciplinary site walkovers
- One horizontal borehole along the proposed tunnel alignment
- Four vertical boreholes west of limestone pavement along the proposed open cut alignment
- Geophysical Survey (surface and downhole)

4.3.7 This in turn facilitated an informed assessment of the potential impacts on the limestone pavement and allowed us to incorporate design measures to avoid adversely impacting the Limestone pavement.

4.3.8 A conservative design approach for this twin bored tunnel was adopted and measures such as defining the tunnel diameter, defining the construction sequence, defining the minimum depth of bedrock between the tunnel crown and separation width between the tunnels were included in the design.

4.3.9 These design measures are summarised below and are included in Section 9.4.1.1 of Chapter 9 of the EIAR and in Appendix A.7.3 of the EIAR:

- Two tunnel bores for the eastbound and westbound carriageways approximately 270m in length. Each bore has an approximately 15m wide span tunnel with a separation pillar between the two bores in order to maintain the twin bore stability. This will minimise the disturbance to the rock mass and, in turn, the threat to the structural integrity of the overlying Limestone pavement. Based on our analysis (using the site specific characteristics) the separation pillar is greater than 7m wide, which is the minimum requirement
- Bedrock cover ranging from approximately 10m to 14.5m between the crown of Lackagh Tunnel and the Limestone pavement surface. This is greater than the minimum requirement of 8m (based on the site-specific characteristics) which allows a stable arch to develop around the tunnel which will prevent settlement or disturbance to the structural integrity of the Limestone pavement at the surface
- The tunnel will include water tight concrete arch lining and a sealed drainage system to prevent any interaction with the surrounding hydrogeological regime

4.3.10 The tunnel construction methodology is set out in Appendix A.7.3 of EIAR which includes the required monitoring to mitigate potential construction impacts. A geotechnical expert will be appointed and will be present to monitor the vibrations

at the surface, including the areas of Limestone pavement, during blasting works for the construction of Lackagh Tunnel and the Western Approach. The blast target vibration limit at the Limestone pavement ground surface is set at 20mm/sec, which is20% lower than the already conservative design vibration limit of 25mm/sec. This provides an added factor of safety to the construction works to ensure that blasting will not impact the structural integrity of the Limestone pavement. In the unlikely event that the blast target vibration limit at the surface is exceeded, blasting works will cease on site until it is understood the basis for the increased vibration. The blast design will then be recalibrated and blasting works will proceed with continued monitoring.

4.3.11 In addition, the geotechnical expert will also monitor the rock mass stability of the supported rock face of the tunnel in Lackagh Quarry. In the unlikely event that instability within the rock mass is observed, additional support measures will be installed to ensure that there is no impact to the surface above. The additional rock support measures comprise ground anchors, rock bolts, rock dowels, rock mesh, shotcrete or a combination of these measures, designed to the relevant design standards and best practice guidance documents. However, based on the conservative design approach it is considered that the risk of instability will be avoided and additional support measures will not be required.

4.3.12 During the operational phase, monitoring of the rock mass stability will continue. The rock and overburden retaining systems in Lackagh Quarry and Western Approach will continue to be monitored as part of the TII (Transport Infrastructure Ireland) maintenance schedule. In the extremely unlikely event that instability within the rock mass is observed, the additional support measures outlined above in Sections 9.4.1.1 and 9.6.2.4 of Chapter 9 of the EIAR for the construction phase will be installed to ensure that there is no impact to the structural integrity of the Limestone pavement.

4.3.13 Based on the conservative design approach, defined construction methodology and construction and operational mitigation measures, it is considered that the magnitude of the risk or threat to the Limestone pavement as a result of tunnelling beneath it at Lackagh Quarry is negligible.

4.4 Overall Impacts on soils

Issues

4.4.1 One submission/objection, Ob_751, raised a concern in relation to potential impacts on soil causing irreparable damage to the local environment.

4.4.2 "*The proposed road development will have significant adverse effects on the environment and the impact will be such on human beings, livestock, flora and fauna, soil, water, climate and the landscape as to cause irreparable damage to the local environment."*

Response

4.4.3 The potential impacts to soils during construction and operation are discussed in Section 9.5 of Chapter 9 of the EIAR.

4.4.4 During construction, the proposed road development will result in a loss of Agricultural soils where the proposed road development traverses arable or agricultural land. The proposed road development will also result in a loss of Solid Geology and Potential Resources where bedrock excavation is required. These impacts are described in Section 9.5.3 of Chapter 9 of the EIAR.

4.4.5 As outlined in Chapter 9 of the EIAR and summarised in Table 9.19 in that chapter, the loss of Agricultural soils, Solid Geology and Potential Resources result in a number of moderate/slight and moderate residual negative impacts on the soil and geology environment during the construction phase.

4.4.6 To mitigate the potential impacts to soils during construction, all excavated material will be used as construction fill or placed in deposition areas, thus contributing to the construction material requirements for the proposed road development. The re-use of the crushed rock aggregate potential is considered to be a reduction in impact to future quarry reserves.

4.5 Potential Contamination to lands/soils

Issues

4.5.1 One submission/objection, Ob_584.1, raised issues relating to potential contamination of lands.

4.5.2 *"then storing hazardous materials in an area with increased risk of flooding has the potential to contaminate the surrounding lands/soil".*

Response

4.5.3 Potential impact to the soils and geology environment by construction activities causing contamination are discussed in Section 9.5.3.6 of Chapter 9 of the EIAR. It should be noted that there are no known areas of contaminated ground located within the study area. Therefore, the potential impacts that could result in contamination of the underlying soil are from the following activities:

- Exposure of locations of unknown contamination, which could include buried hazardous material, in an unlicensed dumping site for example
- Water Seepage used in washing following concrete activities which could result in contamination of the underlying soil
- Potential for leakage or spillage of construction related materials

4.5.4 As detailed in Chapter 9 of the EIAR, no areas of hazardous contamination were identified during the ground investigations or from our review of historical data. The implementation of the mitigation measures detailed in Section 9.6.2.6 of Chapter 9 of the EIAR including good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the site, and the proper use, storage and disposal of potential substances and their containers that could cause contamination will prevent the generation of contaminated soil.

4.5.5 Procedures are set out in Section 9.6.2.6 for dealing with areas of suspected of contamination. Samples of ground suspected of contamination will be tested during the detailed investigation and, where areas of contamination are encountered, the material will then be disposed of to a suitably licence or permitted site in accordance with the current Irish Waste Management legislation.

4.5.6 All activities involving the use of potential pollutants or hazardous materials, material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants will also be adequately secured against vandalism and will be provided with proper containment according to codes of practice. Provision will be made for the removal of any concrete wash water.

4.5.7 Any spillages will be immediately contained and contaminated soil removed from the site and disposed of to an appropriately permitted or licenced site in accordance with current Irish Waste Management Legislation.

4.5.8 The storage of potentially hazardous material related to construction, or if encountered on site, will be subject to the measures outlined in Section 9.6 of Chapter 9 of the EIAR and as outlined in the Construction Environmental Management Plan (CEMP) in Appendix A.7.5 of the EIAR.

4.5.9 Flood risk is addressed in Tony Cawley’s statement of evidence.

4.6 Observations and requests from Geological Survey Ireland

Issues

4.6.1 Geological Survey Ireland made two submissions/objections as follows.

4.6.2 S_030.1 "***Recommendations*** *Should the development go ahead, all other factors considered, Geological Survey Ireland would much appreciate a copy of reports detailing any site investigations carried out. Should any significant bedrock cuttings be created, we would ask that they will be designed to remain visible as rock exposure rather than covered with soil and vegetated, in accordance with safety guidelines and engineering constraints. In areas where natural exposures are few, or deeply weathered, this measure would permit on-going improvement of geological knowledge of the subsurface and could be included as additional sites of the geoheritage, if appropriate. Alternatively, we ask that a digital photographic record of significant new excavations could be provided. Potential visits from Geological Survey Ireland to personally document exposures could also be arranged".*

4.6.3 S_030.2 "*Geological Survey Ireland (GSI) commends the use of our various data sets in the Route Selection Report but would like to add that Geological Survey Ireland should be referenced as such and any maps and data used should be attributed correctly to us*".

Response

4.6.4 In relation to S_030.1, where the design environmental mitigation measures, safety requirements and engineering constraints permit, significant bedrock cuttings will be designed to remain visible. Where this cannot be done, then digital photographic records of significant new excavations will be recorded and/or visits from Geological Survey Ireland will be facilitated. This will aid in enriching our geological knowledge of the area. Existing site investigation reports for the proposed road development as contained in Appendix A.9.1 of the EIAR have been issued to the GSI.

4.6.5 In relation to S_030.2, the comments from the GSI commending the use of data sets are welcomed. It should be confirmed that the use of GSI mapping and data to inform the constraints and options assessment is acknowledged in Section 7.6.2, Soils and Geology, of the Route Selection Report. Reference is made to GSI throughout this section under the following sub headings Bedrock, Subsoils, Soils Overview of ground conditions in karst limestone areas and Geological Heritage, for each route option.

4.6.6 In addition, the GSI is acknowledged in the references section of Section 7.6.3 Hydrogeology of the report.

4.6.7 The use of available online geological datasets, various literature along with the published geological maps and memoirs, from the Geological Survey of Ireland has been an integral part of establishing the baseline soils and geology for the

proposed road development and have been an invaluable resource from project inception and throughout our appraisal of the soils and geology environment.

4.7 Request for Survey Information

Issues

4.7.1 One submission/objection, Ob_111, requested results of surveys undertaken at their property.

4.7.2 "*We understand that surveys have been undertaken in the area but again through lack of engagement the council limited results have been provided to our clients, this leads to an issue that our clients are not in a position to dispute any finding that may or may not exist*".

Response

4.7.3 Details of the various surveys undertaken in relation to Soils and Geology are described in Section 9.2.4.3 of Chapter 9 of the EIAR with the locations of the various surveys identified in Figures 9.8.001 to 9.8.012 of the EIAR. The factual survey reports are included in Appendix A.9.1 of the EIAR.

4.7.4 The plan and profile conceptual site model, shown on Figures 9.8.001 to 9.8.012 of the EIAR, is based on the ground investigation data was developed for the proposed road development. The area in question is located between Ch. 0+300 and Ch. 0+350 of the proposed road development. As can be seen from Figure 9.8.01 two trial pits (TP3/02 and TP3/03) were completed locally as part of the EIAR assessment. The ground conditions in this area comprise topsoil, clayey/silty gravel, sandy gravelly clay over granite bedrock (Galway Granite Batholith).

4.7.5 The local topography is this location is generally increase locally from south to north from approximately 22 to 24mOD in the area in question. Figure 9.8.001 indicates the proposed ground level for the proposed road development is approximately 21 to 23mOD. As such the proposed road development in this location will be generally in cut (1 to 2 m).

4.8 Embankment Design

Issue

4.8.1 One submission/objection, Ob 521_O_517.14 02.4, questioned the ability for the embankment to sustain planting.

4.8.2 "*We request additional information be provided in relation to the large bank to ensure that it is properly designed and that the slope etc can accommodate the maturing planting as proposed (reason if this is not the case the site will remain barren)".*

Response

4.8.3 The area of focus is located between Ch. 8+450 and Ch. 8+525 adjacent to the N59 Moycullen Road. In this area, the embankment is approximately 8 meters in height above existing ground level and has a slope footprint of 16 meters which provides a 1 vertical (V) in 2 horizontal (H) slope.

4.8.4 Additional information with respect to design of embankments is presented in Section 5.6.2 of the N6 Galway City Ring Road Design Report, included in Appendix A.10.1 of the RFI Response submitted in August 2109. We have completed a preliminary assessment of embankment stability based on standard practice and guidelines. Based on our stability assessment all embankments are proposed to be constructed with slopes of 1V in 2H as per the slope in question.

4.8.5 As this is an embankment slope with a height greater than 5.0m drainage layers (or comparable stability layers) consisting of granular material (or geotextile) will be incorporated at selected intervals within the embankment to encourage seepage downward and thus increasing slope stability.

4.8.6 The selected planting has considered a sloped surface. Planting will not undermine the overall stability of the embankment. Planting provides additional surface support and will further reduce surface erosion and stability.

4.8.7 In summary embankment design has been undertaken and this design is detailed in Section 5.6.2 of the N6 Galway City Ring Road Design Report, included in Appendix A.10.1 of the RFI Response submitted in August 2109.

4.9 Slope stability of Cuts

Issue

4.9.1 One submission /objection, Ob_691, questioned the slope stability of Cuts.

4.9.2 Ob 691 "*51. The constructability report (2.2 Ground Conditions) states that the acceptable temporary rock slopes will be evaluated based on supplementary ground investigation information prior to construction. Apart altogether from the requirements under EIA for a proper assessment and evaluation of the work prior to development consent, the Galway Race Committee is concerned that the Developer has not indicated why it requires this supplementary ground investigation, who will undertake the investigation, the purpose to which the results of the investigation will be put, whether those results may alter the content and conclusion of the constructability report or whether the Developer has assessed the impact of any such alteration. It is unclear why the rock slopes at Section 2.1 ground conditions appear to be different to the slopes identified in Section 2.2 general description of the proposed structure*".

Response

4.9.3 Supplementary ground investigation information may be required in specific locations at construction stage to confirm or supplement the final design. Any ground investigations will be designed for a specific purpose such as in this case to inform the final slope angle for the rock slopes in this location in both the temporary and permanent cases. The survey will be undertaken by a suitable ground investigation contractor appointed in line with public procurement procedures.

4.9.4 The ground investigation and the baseline data collection is deemed robust and sufficient to complete the soils and geology evaluation as noted in Section 9.2.4 of Chapter 9 of the EIAR and any alterations to the slope design in this application will not be permitted to increase adverse impacts greater than those identified in the EIAR.

4.9.5 Rock slopes have been designed based on our knowledge and understanding of the underlying rock mass from ground investigation and baseline data and in turn the suitable stable slope angles it can be constructed to. As noted in Section 2.2 of Appendix A.7.4 of the EIAR, the permanent slope angles have been designed to cut slope angles of 1V:1.5H and 1V:1H. The slope angles of temporary rock slopes will vary and may be stable at a steeper slope angle due to their temporary nature and in turn a reduced design life requirement. The rock slopes in Section 2.1 are temporary slopes.

4.10 Earthworks Details

Issues

4.10.1 Three submissions/objections raised issues in relation to earthworks: Ob_158, Ob_261 and Ob_484

4.10.2 Ob 158 *These details should have been provided to my client to include: Details regarding the cut and fill required in front of my clients' property.*

4.10.3 Ob 261 *From our review of the drawings, we note that the proposed road design in the vicinity of our client's lands requires a substantial amount of earthworks cutting. The level of the impact is difficult to discern from drawing Figure 5.3.02 (Sheet 3 of 21) and to this end we have requested a more detailed section drawing from the project consultants Arup. We are still awaiting a response to our request.*

4.10.4 Ob 484 *From our review of the drawings, we note that the proposed road design in the vicinity of our client's lands requires a substantial volume of earthworks fill to facilitate the proposed road design. The level of the impact is difficult to discern from drawing Figure 5.3.05 (Sheet 5 of 15 to Sheet 7 of 15) and to this end we have requested a more detailed section drawing from the project consultants Arup. We are still awaiting a response to our request.*

Response

4.10.5 In relation to Ob 158 - Figure 9.8.002 provides an indication of the ground conditions and the cut and fill requirements in the vicinity of their property. This figure is contained within the EIAR and provide ground investigation information along with Plan and Profile information for the proposed road development.

4.10.6 At this location minor earthworks are proposed for the L5387 Troscaigh Link road which runs in front of their property.

4.10.7 In relation to Ob 261 - Figure 9.8.004 provides an indication of the ground conditions and the cut requirements in the vicinity of the lands in question. This figure is contained within the EIAR and provides ground investigation information along with Plan and Profile information for the proposed road development.

4.10.8 The local topography is variable and undulating to a maximum elevation of approximately 66mOD in the area around the lands in question, the drawing indicates the proposed ground level for the proposed road development ranges from 58 to 60mOD in the vicinity of the lands in question. As such the proposed road development in this location will be predominantly in cut, approximately 8m below the maximum elevation.

4.10.9 A meeting was held with the landowner of this property on the 21.01.19 and following the meeting a 3D CAD drawing was issued on the 22.01.19, with further information provided on the 19.02.19.

4.10.10 In relation to Ob 484 - Figure 9.8.012 provides an indication of the ground conditions and the cut requirements in the vicinity of the lands in question. This figure is contained within the EIAR and provides ground investigation information along with Plan and Profile information for the proposed road development.

4.10.11 The local topography is this location is generally decreasing locally from west to east from approximately 58 to 60mOD in the area around the lands in question. Figure 9.8.0012 indicates the proposed ground level for the proposed road development is above existing ground level in the vicinity of the lands in question. As such the proposed road development in this location will be predominantly in fill. The embankment will range from existing ground level to approximately 7.5m above existing ground level.

4.10.12 Information was issued to the property owner as a 3D CAD drawing on the 22.01.19.

4.11 Disciplines and qualifications of specialists inputting to the MDA plan in Lackagh Quarry

Issues

4.11.1 One submissions/objections raised issues in relation to disciplines and qualifications of the specialists who have inputted to the MDA plan in Lackagh Quarry: Ob_584.2.

4.11.2 Ob 158 In relation to the query *on "Pg. 12, 2.8.2.1 Final plan layout of Lackagh Quarry", "Why are the various "specialists" in each of their respective disciplines not referenced/ named anywhere along with their qualifications, in this report? Please provide".*

Response

4.11.3 In relation to Ob 584.2 – The document referred to within the submission, Request for Further Information Volume 1 – Report, outlines the environmental specialists that provided input and completed an environmental assessment of the Material Deposition Areas (MDA). Design input, review and environmental assessment was undertaken by ecological, landscape & visual, geotechnical, hydrogeological and hydrological specialists. These experts are the same as those who were part of the team of the EIAR and presented in Table 1.3 in Chapter 1 of the EIAR. This table presents details of the lead expert in each of these disciples along with their qualifications. The project ecological experts are Aebhin Cawley and Andrew Speer, landscape & visual expert is Thomas Burns, geotechnical expert is Juli Crowley, hydrogeological expert is Dr. Leslie Brown and hydrological expert is Tony Cawley.

4.12 MDA Clarification

Issues

4.12.1 One submission/objection raised issues in relation to the volume of peat being placed in DA28 and queried the use of peat in an MDA where habitat planting is proposed: S_018.2. One submission/objection raised issues in relation to the material being placed in the MDA in the quarry: Ob_583.01.

Response

4.12.2 With reference to Tables 3.2, 3.3 and 6.2 of Appendix A1.11 of the RFI Report. Appendix A1.11 of the RFI Response presents details of Lackagh Quarry post construction which included a review of the Material Deposition Areas (MDAs) in Lackagh Quarry. Details of the Material Deposition Areas as included in the EIAR are compared with the with the modification presented in the RFI Response. It should be noted that a number of factors influence Material Deposition Area make up including the design requirements slope stability, blast damage slope stability, ecological habitat creation and maintenance.

4.12.3 To clarify on the volumes of peat in DA28. It is proposed that 14,000m^3 of peat can be placed in DA28. As per Appendix 1.11 of the RFI Response:

- Table 3.2 presents a breakdown of the material included in the EIAR for Material Deposition Area DA28 – 0m^3 of peat.
- Table 3.3 presents a breakdown of the material included in the proposed modification for of Material Deposition Area DA28 – 14,000m^3 of peat.
- Table 6.2 compares the volumes presented in the EIAR (under the heading EIAR) with the revised capacity of the Material Deposition Area with the proposed modifications (under the heading of "proposed estimated capacity following review") and states that up to 14,000m^3 of peat can be placed in DA28

4.12.4 Where an area of habitat planting has a requirement for a free draining layer beneath the surface and it corresponds with a proposed Material Deposition Area where peat may be placed (including Material Deposition Areas DA24, DA25 and DA28 in Lackagh Quarry), the free draining layer will be placed between the peat placement layer and the habitat to be created layer. The free drainage material will be contained within a filer separator layer (e.g. geotextile), above and below to prevent the migration of fines sediment therefore ensuring the functionality of the layer.

4.12.5 The principles to be employed when handling peat are presented in the Material Deposition Areas – Baseline Report, included in Annex 2 of Appendix A.1.11 of the RFI Response. These include minimising plant movements, using appropriate temporary storage areas close to areas of excavation and minimising delay between final placement and excavation. This report also describes the peat reinstatement options including:

- Peat placement in the upper central portion of the MDA only (U1 material placed in the bund slopes and base)
- Peat blending with a more consolidated peat, granular material or cement
- Drying of peat to reduce the natural moisture content
- Containment, separating the placement area into a series of cells, with the cell structure constructed from impermeable material
- Covering of the peat with subsoils or topsoil to prevent dust generation and to allow for appropriate ecological/landscape finish to surface
- The surface of the MDAs is finished with an ecological/landscape treatment. The treatment should have regard to the local environment and may provide for seeding to meadow grass, for heath development, with or without shrub planting

4.12.6 Earthworks material generated during construction that is surplus to the fill requirement of the proposed road development has been assessed for suitability for beneficial re-use on site in MDAs within the proposed development boundary. The MDA materials are grouped into two categories which are influenced by their

engineering properties, Peat and U1, Non-Hazardous Material. U1 Non-Hazardous Material typically consists of topsoil, made ground comprised of man-made materials, argillaceous rock and calcite, logs, stumps and clay (sub-optimum moisture content). This material is non-hazardous material. Human health has been addressed by my colleague Martin Hogan, in his Statement of Evidence.

5 Conclusion

5.1 The key items raised in the submissions and objections relating to soils and geology are categorised under two headings as follows:

1) Potential Impacts to the Soils and Geology Environment:

2) Design related submissions:

5.2 In conclusion, the above issues have been fully considered along with responding to each of the design related submissions.

5.3 Having considered the submissions and objections, the conclusions of the soils and geology appraisal as presented in Section 9.8 of Chapter 9 of the EIAR have not changed.

5.4 The EIAR presents our assessment of potential impacts to soils and geology which has been undertaken based upon the local soils and geology environment as interpreted from desk studies (information available in the public domain), walkovers and ground investigations completed for the proposed road development.

5.5 Implementing the outlined mitigation measures has minimised the residual impact on the soils and geology environment from the proposed road development.

5.6 All operational activities of the proposed road development are deemed to produce imperceptible impacts to the surrounding geological environment.