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INTRODUCTION

This chapter sets out a consideration of how the proposed development may affect the wellbeing of the local community. Traditionally, consideration of how a proposal may affect a local community has been addressed within the individual environmental topics, such as noise, air quality and vibration. The assessments look at pathways and the level of potential emissions, having regard to published standards and limits: such limits are typically based around wellbeing considerations, for example noise and air quality.

Legislation and Guidance

- 13.1 The EIA Regulations introduced the requirement to consider health in connection with considerations of population¹ along with the likely significant effects of the development on the environment resulting from *inter alia* the risks to human health². This does not mean that it is mandatory to undertake a Health Impact Assessment for a proposal and the level of consideration needs to be proportionate to the scale of the development. This is especially relevant given the extant planning permission for slate extraction and ancillary operations at Penrhyn Quarry.
- 13.2 Planning policy is clear in that the role of planning should not duplicate other regulatory functions. In this respect Paragraph 1.20 of PPW states that *“The planning system should not be used to secure objectives which are more appropriately achieved under other legislation. The aim should be to maintain the principle of non-duplication, wherever possible, even where powers and duties resulting from other legislation may also be the concern of local authorities.”*

Scope

- 13.3 The MPA’s scoping opinion stated that:

“the EIA must show that the levels of noise, blasting and air overpressure are within acceptable limits.

It is considered therefore that Air Quality and Noise cannot be scoped out of the EIA and the applicant should ensure that a thorough assessment of waste tipping and ancillary development on air quality, noise is included in the ES. Having considered the comments of Gwynedd Public Protection it is agreed that the impact on community health should be assessed and it will be necessary therefore to include a Welfare Assessment as part of the Environmental Impact Assessment”.

¹ Regulation 4(2)(a)

² Schedule 4, paragraph 5(d)

- 13.4 This chapter therefore sets out the baseline conditions for the local area in terms of population, deprivation and health based on publicly available information. It then considers the main areas where the wellbeing of the local community may be affected by the proposed development. In this respect, it is important to note that the assessment considers the proposed extension and changes to the mineral waste tips; it does not consider the operation of the quarry (with ancillary processing and distribution) as these are approved developments and would not be altered by the current proposals. As such, this assessment does not address the effects of the processing or distribution of slate products.
- 13.5 It is clear from national policy contained in PPW that there is a balance to be struck between safeguarding the environment and wellbeing of local communities against the economic benefits of the development. The latest edition of PPW is heavily centred around wellbeing and indeed recognises that economic benefits of a development can feed into the wellbeing of a community (refer to Chapter 5 above).
- 13.6 The essential role of MPAs in relation to mineral working is to ensure that a proper balance is struck between the fundamental requirement to release new reserves and the protection of existing amenity and the environment. The requirement is thus not to eliminate impacts (which in practical terms would not be feasible with any mineral extraction development by virtue of the nature of the activity), but rather to ensure development proceeds without giving rise to “*unacceptable adverse impacts*” and in so doing, will protect human health.
- 13.7 The starting position is that the ES concludes that the development could proceed in accordance with the limits which have been set, which are founded upon the acceptable limits set out in Welsh Government and other relevant guidance. Adherence to these limits is based upon the series of environmental control and commitments embedded in the ES as mitigation measures.

BASELINE CONDITIONS

Existing Planning Permission

- 13.8 The planning history for the quarry has been summarised in Chapter 2 above.
- 13.9 Of note is that the planning permissions were reviewed under the Environment Act 1995 in 2016, with a new set of planning conditions issued (ref. C16/1164/16/MW). As part of this process, an EIA was undertaken, including assessments of air quality, landscape and visual, noise, traffic, vibration and water; all matters which could have a bearing on wellbeing. The approach to the technical assessments was to assess whether the development of the quarry could proceed in accordance with government advice and standards, notably contained in the PPW and the other relevant guidance (such as MTAN1). The Environment Act Review is not the same as a planning application in that it considers the environmental controls of the development (and not whether quarrying should be undertaken).
- 13.10 In considering the previous planning applications (with the most recent being in c. 2011, ref. C12/0874/16/MW), consideration has also been given to the potential environmental effects and

whether the effects were of such a magnitude that significant adverse effects on the community would arise (and thus planning permission should not be granted).

- 13.11 In view of this, there is considerable knowledge about the development and the potential effects on the local community.

The Local Area

Setting

- 13.12 Penrhyn Quarry (and the proposed extension) is located within a mainly rural area where low intensity agriculture land use predominates.
- 13.13 The proposed extension lies within the Eryri/Snowdonia SAC³ and SSSI⁴ and is considered under the provisions of the Conservation (Natural Habitats etc.) Regulations 1994. The SAC features potentially affected are blanket bog, dry heath and wet heath.
- 13.14 The closest communities to the Quarry are Bethesda, Braichmelyn, Bryn Eglwys, Gefnan Hirdir, Mynydd Llandegai Penybryn and Tan-y-Bwlch, at approximately, 0.5km north west, 0.4km north, 0.9km west, 0.9km north and 0.9km west respectively. Individual properties are located at closer distances to the quarry boundary, for example Ogwen Holiday Park, Tai Pont Twr, Grisiau-Cochion and 3 Tai Duon are all within 100m of the site boundary. The closest properties to the proposed tipping area are around 350m to the west.
- 13.15 The geography of Wales has been a key influence on the development of the country's transport system, with the main settlements lying on the coasts of North and South Wales while Mid-Wales is lightly populated.

Area and Population

- 13.16 Penrhyn Quarry is located within the Gwynedd Council area which has a population of some 121,874 (2011 Census) and extends in area to 2,450 square kilometres. Compared to 2001, the population has increased in Gwynedd by 5,031 people (4.3% increase). The population in the whole of Wales was reported as 3.06 million people in 2011, increasing by 5.5% since the 2001 census.
- 13.17 For administrative purposes is divided into three sub areas namely:
- Arfon (in which the quarry lies);
 - Dwyfor; and
 - Meirionnydd

³ Special Area of Conservation

⁴ Site of Special Scientific Interest

- 13.18 The Arfon Sub Area is further divided into 22 Wards with Penrhyn Quarry lying within the Tregarth and Mynydd Llandegai Ward (TMLW).
- 13.19 The population density of Gwynedd is approximately 0.5 persons per hectare, rising to 0.8 persons per hectare in TMLW, which has a population of some 2,218 persons (2011 census). Nationally in Wales, the population density is 1.5 persons per hectare.

Employment

- 13.20 In 2011 there were 53,961 people aged between 16 and 74 employed within the boundaries of Gwynedd, which represents 60.7% of the population within that age group, and the same level as the national figure. Locally, 69.1% of the population aged 16 to 74 are in employment, which is above both the county and national levels.
- 13.21 The largest sectors of employment are classed as 'Health and Social Work' (14.7%); 'Wholesale and Retail' (14.5%); and 'Education' (12.6%). The figure for Wholesale and Retail is slightly below the national figure of 15.6%, but both Health/Social Work and Education are above the national figures. For TMLW, the same sectors represent the greatest employment areas, with 17.5% employed in Health/Social Work; 19.2% in Education and 13.9% in Wholesale and Retail. In comparison, '*Mining, Quarrying, Energy and Water*' sector accounts for 2.6% of employment in Gwynedd, being slightly lower than the level in TMLW, but above the national level of 1.9%.
- 13.22 In terms of social class, 26.7% of the population in Gwynedd is classed as 'Managerial or Professional'; this is slightly below the national level (27.4%). However, for TMLW, the figure rises to 39.3%. Skilled labour in Gwynedd is 30.4%, being above the national level of 29.4%, with 28.9% in TMLW (being below the national figure). Part or unskilled labour accounts for 25.9% in Gwynedd and 21% in TMLW, both below the national figure of 28.9%.
- 13.23 The number of working age unemployed people in Gwynedd in 2011 was 3,176 (5.5%) compared to 54 (4.6%) in TMLW and 6.5% in Wales.

Health

- 13.24 Based on the 2011 census data, in terms of health, 81.1% of the population in Gwynedd are classed as having very good/good health; this compares to 77.8% of the population in Wales and 83.9% of the population in TMLW. At the other end of the spectrum, 5.3% of the population of Gwynedd are classed as having very bad/bad health which is below the national level of 7.6%; the figure for TMLW is below the county figure, with 3.9% of the population having very bad/bad health.
- 13.25 Data on health is also provided on the InfoBaseCymru web site, which provides various data sets for each Lower Super Output Areas (LSOA)⁵. Penrhyn Quarry is located in the Tregarth and Mynydd Llandygai LSOA (W01000115). From this it can be deduced that:

⁵ Lower Layer Super Output Area (LSOA) is a geographic area. Lower Layer Super Output Areas are a geographic hierarchy designed to improve the reporting of small area statistics in England and Wales.

- the rate of cancer incidence per 100,000 population (between 2007 and 2016) was 541.8, which is in the lowest bracket. The neighbouring areas to the east of the quarry of Ogwen 2 (W01000097) and Gerlan (W02000071) are higher at 690.4 and 675.6 respectively, whilst Arllechwedd (W01000050) is in the third bracket at 603.5. To the west Deiniolen (W01000063) and Penisarwaun (W01000099) are in the fourth and third brackets (with 647.4 and 613.6 respectively).
- the rate of premature death (deaths of those under the age of 75) per 100,000 population (between 2009 and 2018) was 273.3, which is in the lowest bracket, being the same as Arllechwedd (which was 254.6). Again the rate of deaths in Gerlan was higher (at 456.3), but Ogwen 2 is slightly better than Gerlan. To the west, Deiniolen and Penisarwaun are the same as Ogwen2 (being 365.4 and 366.9 respectively).
- The rate of limiting long-term illness per 100,000 population (2011) was 17.9, again being in the lowest bracket. Most of the neighbouring areas are in the next bracket above, with the exception of Ogwen 2 and Deiniolen (both being in the third bracket).

13.26 Data for heart and respiratory diseases is not broken down into the LSOA level, but is provided at the county level. In both cases, Gwynedd has the one of the lowest rates within the whole of Wales.

13.27 Finally, in terms of the Welsh Index of Multiple Deprivation (2019) Tregarth and Mynydd Llandygai LSOA is ranked 1187 out of 1909 LSOA's in Wales which places it among the 50% least deprived areas. In the context of Gwynedd, it is ranked 53 out of 73 LSOA's. The WIMD is also broken down into a number of subsets, from which the following is noted:

- Employment: Ranked 1267 out of 1909 LSOAs in Wales, which places it among the 50% least deprived.
- Health: Ranked 1546 out of 1909 LSOAs in Wales, which places it among the 50% least deprived.
- Physical Environment⁶: Ranked 1329 out of 1909 LSOAs in Wales, which places it among the 50% least deprived.

13.28 Overall therefore, it can be seen that the area within which Penrhyn Quarry is located does not suffer from significant deprivation or have any underlying poor health issues.

PUBLIC HEALTH AND WELLBEING ISSUES

13.29 Based on experience there are three key themes of principal relevance to this wellbeing assessment, namely:

- (i) dust and air quality;

⁶ The purpose of this domain is to measure factors in the local area that may impact on the wellbeing or quality of life of those living in an area. The indicators are: Air Concentrations; Air Emissions; Proximity to Waste Disposal and Industrial Sites; Flood Risk

(ii) noise; and

(iii) blast induced vibration.

- 13.30 The responses set out below address these topics in turn, and summarise the key concerns, the approach taken as part of the ES and the mitigation measures proposed in the ES.
- 13.31 It is noted from Planning Policy Wales⁷ that a proposed development should be designed wherever possible to prevent adverse effects to amenity, health and the environment but as a minimum to limit or constrain any effects that do occur (paragraph 6.7.14).

Air Quality

- 13.32 Any health impacts associated with the development of the proposed extension would principally relate to the respirable fraction of particulate matter with diameters below 10µm (microns) (PM₁₀), and a smaller fraction referred to as PM_{2.5}. The effects of particulate matter having a diameter greater than 10µm (often referred to as ‘dust’ or ‘deposited dust’) are mainly associated with nuisance, such as the soiling of surfaces. This can potentially have an effect on well-being through increasing levels of anxiety and annoyance. The distance from the source⁸ to the sensitive receptor is crucial. The vast majority of particles responsible for annoyance (i.e. greater than 10µm) are deposited within 100m of the source, and hence it is in this zone that the risk of problems from dust is greatest. However, as set out in other chapters to the ES, it should be noted that there are no residential receptors within 100m of the site boundary. Particulate matter with a diameter less than 10µm can travel further from the source, and consideration is typically given to receptors within 1km of the source.
- 13.33 Oxides of nitrogen (NO_x, NO₂) principally arise from diesel engines associated with the extraction and transport operations within the quarry. However, as with similar emissions from vehicles using a public highway, such emissions typically reduce to surrounding background levels within 200m of the source; as such the DMRB⁹ considers any receptor within 200m of a road source to be potentially affected by the use of that road. Accordingly, receptors within 200m of a road source require further assessment of potential impacts. For Penrhyn Quarry, the nearest residential receptor is located well over 200m from any haul road and so emissions of NO from quarry related traffic can be screened out of any assessment.
- 13.34 The potential health impacts have been assessed within the ES by comparing the current ambient air quality adjacent to the site, against the standards adopted by Government to protect the health of the public as a whole (the Air Quality Objectives, as most recently defined within the Air Quality Standards Regulations 2010). Planning Policy Wales recognises (at paragraph 6.7.2) that “National air quality objectives are not ‘safe’ levels of air pollution. Rather they represent a pragmatic threshold above which government considers the health risks associated with air pollution are

⁷ Planning Policy Wales, Edition 10. December 2018

⁸ Based upon research document - DETR, The Environmental Effects of Dust from Surface Mineral Workings (Dec 1995)

⁹ DMRB, Volume 11, Section 3, Part 1, HA 207/07 - Air Quality, Highways Agency, 2007.

unacceptable. Air just barely compliant with these objectives is not ‘clean’ and still carries long-term population health risks”.

- 13.35 It is known that the population exhibits a wide range of responses to PM₁₀ concentrations, and that young children, old people and those with pre-existing illnesses are disproportionately susceptible to the effects of PM₁₀ and PM_{2.5} inhalation. This has been taken into account in setting the Air Quality Objectives, and these are taken from the limits for PM₁₀ and PM_{2.5} first set down in the European Council Directive 1999/30/EC of 22 April 1999, and subsequently in Directive 2008/50/EC; the standards in the directives were largely drawn from advice provided by the World Health Organisation, who are solely concerned with human health and wellbeing.
- 13.36 Allied to this, health impacts can be related to ingestion, which are assessed (indirectly) by comparison to Environmental Quality Standards for the protection of agricultural soils, which are given in terms of deposition rates
- 13.37 Chapter 11 of the ES presents the findings of an air quality assessment and potential emissions against the Air Quality objectives in place for the protection of human health.
- 13.38 The aspects of the proposed development of specific relevance to the air quality assessment are as follows:
- continued extraction of slate from the open pit (involving, mineral extraction¹⁰, stockpiling and transportation to works area) and their potential to result in dust emissions;
 - continued tipping operations within the quarry; and
 - phased restoration with soils resulting in potential for dust emissions.
- 13.39 The existing air quality is summarised in Chapter 11 within the ES and shows that PM₁₀ levels are all well below the limits imposed through the 2010 Regulations. In this respect, the Air Quality assessment concludes:

“An assessment of PM10 and PM2.5 was completed following guidance within LAQM.TG(09) considering background particulate matter levels and distance to receptors. Background levels are ‘well below’ the limit. Neither the proposed development of the extension, nor the changes to the tips, are considered to lead to a significant increase in PM10 and PM2.5 emissions which would lead to an exceedance of the Air Quality Objective.

A qualitative assessment of deposited dust was undertaken which identified the potential additional sources of dust onsite. The risk of dust impact at residential receptors was assessed as acceptable or insignificant considering the distance to onsite operations and frequency of exposure. The potential for dust impacts on the surrounding ecological sites is considered to be not significant.

¹⁰ Drilling, blasting and loading of dump trucks

With the implementation of mitigation measures undertaken onsite in accordance with best practice, and as required by the planning conditions and requirements of the Permit, the residual impact is considered to be acceptable or insignificant.

All potential dust impacts from the proposed development are considered to be reversible i.e. the risk of impact will cease on completion of the extraction and restoration activities at the site, with no significant impacts on local air quality on the completion of the development.”

- 13.40 Guidance has been published by the Institute for Air Quality Management¹¹ (IAQM) on dust assessment at mineral sites and includes best practice mitigation. The guidance states that ‘*the scale and nature of dust mitigation measures applied should be commensurate to the risk of dust impact from the site*’. The mitigation measures applied at site have been applied on the basis of best practice and following the findings of the dust risk assessment.
- 13.41 Operational mitigation measures relating to dust emissions have been set out in Chapter 11 above. These dust mitigation measures have been demonstrated as effective by monitoring undertaken by the applicant. Data shows that PM₁₀ concentrations remain well below the Air Quality Objective of 40µg/m³. On this basis it is considered that dust mitigation measures are being effectively applied.

Noise

- 13.42 Planning Policy Wales (at paragraph 6.7.3) indicates that “*Certain sounds, such as those created by trees, birds or water features, can contribute to a sense of tranquillity whilst others can be reassuring as a consequence of their association with the normality of everyday activities. Problematic forms of sound are generally experienced as noise pollution and can affect amenity and be prejudicial to health or a nuisance. ... The planning system must protect amenity and it is not acceptable to rely on statutory nuisance under the Environmental Protection Act 1990 to do so*”.
- 13.43 Minerals Technical Advice Note (Wales) 1: Aggregates (MTAN1) provides the latest advice on planning controls and good practice methods for minerals extraction sites in Wales. It also provides guidance on keeping noise emissions from mineral extraction sites to acceptable levels including advice on noise level limits for various operational stages on mineral developments during specific times of the day.
- 13.44 The guidance suggests that operators should take all reasonable steps, through the use of BATNEEC (best available techniques not entailing excessive cost), to minimise noise emissions and maintain the highest possible environmental standards.
- 13.45 In paragraph 88 of the guidance, MTAN1 states:
- “noise limits should relate to the background noise levels, subject to a maximum daytime noise limit of 55 dB(A) where background noise levels exceed 45 dB(A). 55 dB(A) is the lower limit of the daytime*

¹¹ Institute for Air Quality Management Guidance on the Assessment of Mineral Dust Impacts for Planning www.iaqm.co.uk (May 2016)

noise level where serious annoyance is caused. Where background noise is less than 45 dB(A), noise limits should be defined as background noise levels plus 10 dB(A). Night-time working limits should not exceed 42 dB(A) at noise sensitive properties. Daytime working is defined as 0700-1900 hours and night-time as 1900-0700 hours. Noise limits should be set in terms of $L_{Aeq,T}$ over a 1-hour measuring period. L_{Aeq} is the noise index used to describe the “average” level of noise that varies with time (T) and should be measured “free-field” that is, at least 3.5 metres away from a façade to prevent reflection of noise by any façade that faces the source. During temporary and short-term operations higher levels may reasonable but should not exceed 67dB(A) for periods of up to 8 weeks in a year at specified noise sensitive properties.”

13.46 From this it can be seen that the guidance indicates suitable noise limits at receptors that should not be breached at any point in time (measured over an hour) through the operation of the extended quarry. The guidance does not indicate that operations should only be undertaken for a set number of days in the week. As such if it can be shown that the operation of the quarry (and associated infrastructure) can be achieved within the limits set out in the guidance then the proposal is acceptable for any duration.

13.47 A detailed noise assessment was provided in Chapter 9 of the 2016 ES. That assessment considered the operation of the whole quarry and put forward suitable limits to safeguard amenity, based on published guidance. Overall the assessment concluded:

“Based on the results of the assessment it is considered that the existing planning conditions maintain the necessary guidance to minimise potential impacts and maintain the amenity of local residents and therefore should remain unchanged.

It is concluded that noise should not pose a material constraint for the continued operation of the site.”

13.48 The noise assessment undertaken to assess the effects of the current proposals is reported in Chapter 10 of this volume. It adopts a conventional approach to a noise assessment by measuring existing background noise levels; proposing noise limits for operations associated with the development of the quarry; identifying mitigation measures to ensure adherence to the proposed noise limits; and recommending planning conditions setting out the limits to be adhered to for normal and temporary operations to be undertaken as part of the development.

13.49 The study concludes that the development can proceed in accordance with the noise limits which have been put forward by the applicant, which are themselves founded upon the advice in MTAN1 regarding minimising noise to “acceptable levels”.

13.50 In terms of wellbeing, the main consideration relating to noise would be any loss of amenity at a property, which could affect the occupier’s enjoyment of residing at that property. As the operating hours for the quarry do not extend into the night, then loss of sleep is not an issue (save for any members of the local community who may work shifts).

- 13.51 The World Health Organisation provides guidelines relating to health aspects¹². In relation to Cardiovascular and Physiological Effects the same guidance concludes:

The overall conclusion is that cardiovascular effects are associated with long-term exposure to LAeq,24h values in the range of 65–70 dB or more, for both air- and road-traffic noise. However, the associations are weak and the effect is somewhat stronger for ischaemic heart disease than for hypertension. [...] (page 48)

- 13.52 In relation to mental health, the guidance states:

“Exposure to high levels of occupational noise has been associated with development of neurosis and irritability; and exposure to high levels of environmental noise with deteriorated mental health (Stansfeld 1992). However, the findings on environmental noise and mental health effects are inconclusive. [...]”

- 13.53 To safeguard amenity therefore, as noted above it is common practice to impose noise limits at the nearest receptors. As noted from Chapter 10, conditions attached to planning permission (ref. C16/1164/16/MW) impose the following limits through condition 17:

Between the hours of 07.00 and 19.00, the noise level arising from the development shall not exceed the LAeq,1 hr free field levels shown in Table 2 below. Between the hours of 19.00 and 07.00, the noise levels arising from the development shall not exceed 42dB LAeq,1 hr free field at any noise sensitive property.

Tabl 2/Table 2

Lleoliad/Location	Cyfyngiad Swm/Noise Limit
Tal y Waen Grid Ref. 259411 363302	45LAeq,1hr - free field
Bwthyn Gwelain Grid Ref. 259304 365199	45LAeq,1hr - free field
33 Tan y Bwlch Grid Ref. 260300 365199	45LAeq,1hr - free field
14 Gefnan Grid Ref. 260946 365184	45LAeq,1hr - free field
Hirdir Ganol Grid Ref. 251133 365801	45LAeq,1hr - free field

¹² Guidelines for Community Noise, WHO (1999)

<i>Lleoliad/Location</i>	<i>Cyfyngiad Swm/Noise Limit</i>
Bryn Llys Grid Ref. 262024 366115	<i>50LAeq,1hr - free field</i>
Tyn Twr Grid Ref. 262473 365976	<i>55LAeq,1hr - free field</i>

- 13.54 In addition, condition 18 provides that temporary operations (such as site preparation, leat construction, vegetation, soil and overburden removal, bund formation and restoration works) shall not exceed 67 LAeq,1hr. Such Temporary operations are limited to 8 weeks in any 12 month period.
- 13.55 To demonstrate that these limits are being adhered to noise monitoring is carried out on an annual basis at Penrhyn Quarry.
- 13.56 The assessment presented in Chapter 10 of this Volume shows that noise levels would not breach any of the existing limits; however, when considering the cumulative effect with existing operations, noise levels are, at worst, predicted to increase by 1dB for one of the ten receptors considered. It should be understood that the predictions for the quarry operations are based on the worst-case scenario where all plant is working simultaneously at their closest approach to each receptor. It should also be understood that basis of this assessment assumes that all the materials from the southern quarry would transported to the designated new tip area. It is, however, more likely that a large proportion of the materials will be tipped within the existing tip areas in the southern quarry area. Allied to this, the tipping operations at the periphery of the quarry (being closest to the receptor) would be for a small period of the overall development timescale. Therefore, the predicted noise levels are likely to be lower than those shown. With the adoption of best practice it is considered that the existing limit would not be breached and so no change is being proposed.
- 13.57 Overall therefore, through the imposition of suitable noise limits, and the assessment provided in this ES to show that the development would not result in noise levels greater than these limits, it is considered that noise from the proposed development would not have a significant adverse effect on wellbeing of the local community.

Blast Vibration

- 13.58 The blast vibration study is reported in Chapter 12 of this ES.
- 13.59 The majority of literature on the health impacts on vibration focusses on the impacts of vibration on workers and there is no literature relating specifically to the effects of blast induced vibration on those in proximity to the site¹³.

¹³ A guide to assessing the health and wellbeing impacts of opencast coal mining. Wales HIA Support Unit, March 2011

- 13.60 Key guidance on blast induced vibration can be found in BS 6472:2008 *Guide to evaluation of human exposure to vibration in buildings Part 2: Blast-induced vibration* and BS 7385-2: 1993 *Evaluation and Measurement for Vibration in Buildings: Guide to Damage Levels from Groundborne Vibration*. Details of these two standards is set out in Chapter 12 above. In summary, BS 6472-2:2008 advises on the maximum satisfactory magnitudes of vibration for residential properties. As blasting at the quarry would only be undertaken during the daytime period, the standard indicates that vibration levels should be between 6 and 10mm/s peak particle velocity (PPV). The Standard also sets out how such limits should be reduced if blasting occurs on more than three occasions per day by detailing a formula based on the number of blasts, the duration of the vibration and a constant which is governed by the type of floor and duration. BS 7385-2: 1993 gives guide values to prevent cosmetic damage to property. Between 4 Hz and 15 Hz, a guide value of 15 - 20 mm/s is recommended, whilst above 40 Hz the guide value is 50 mm/s. Notwithstanding this, the standard also comments “*Minor damage is possible at vibration magnitudes which are greater than twice those given in Table [12-2¹⁴], and major damage to a building structure may occur at values greater than four times the tabulated values.*”
- 13.61 The main concern raised in connection with blasting is the potential for damage to private property resulting from blasting, with the fear of vibration causing cracks in walls and affecting foundations. Much of the research into the effects of vibration induced by blasting is related to the potential to cause damage to properties and not the health effects. In terms of well-being (as no direct health effects are likely to arise through vibration from blasting) the key consideration is the fear of damage to property and the anxiety that may cause. In addition, it is noted that the sudden impulsive nature of blasting, particularly the noise generated, can startle local residents, leading to anxiety.

Effects of Ground Vibration

- 13.62 There is considerable practical and theoretical research that has been undertaken in the UK and overseas into the damage potential of blast induced ground vibration. In the UK this includes that published by DETR¹⁵ and guidance published by the Institute of Quarrying¹⁶, as well as the British Standards.
- 13.63 Human responses to blast induced vibration is a relatively complex phenomenon and is dependent upon a range of factors, of which the actual vibration level is one. The susceptibility of individuals to vibration will vary from person to person depending on factors such as age, health, physical attitude and to a large extent, previous exposure. In general terms, a person will become aware of blast-induced vibration at levels of around 1.5mm/s PPV although under some circumstances this can be as low as 0.5mm/s PPV. However, humans are very poor at determining relative magnitudes of vibration; for example, the difference between 4.0mm/s PPV and 6.0mm/s PPV is unlikely to be perceived by a person. When the vibration level is greater than the individuals perception threshold then it is possible for concerns to be raised. In relation to the number of blasting events at any site and the adverse public response, the DETR Report notes that there is no correlation.

¹⁴ Refer to Chapter 12 above.

¹⁵ The Environmental Effects of Production Blasting from Surface Mineral Workings, Vibrock. Published by the Stationery Office 1998 (ISBN 0-11-753412-9)

¹⁶ The Use of Explosives in Quarrying. T E White and P Robinson. The Institute of Quarrying

- 13.64 It is recognised that magnification of vibration can occur within a building from 0.5 to 2, being most likely within low rise residential type structures. The actual amount of magnification depends on many factors, but primarily the frequency content and to a lesser extent, the duration of the incoming vibration and the natural frequencies of the building/parts of the building concerned. At the vibration magnitudes typically associated with surface mineral workings the DETR Report comments that it is often the case that the magnification is less than one (i.e. the level of vibration in a building is less than outside). In terms of damage potential magnification effects are well known and are allowed for in the relevant standards.
- 13.65 Fears that vibration from blasting events are unsafe should be seen in the context of the typical strains a property experiences through daily environmental changes and domestic activities. In this context, as noted in the Institute of Quarrying publication, *“the 1987 USBM Report quotes that daily changes in humidity and temperature can readily induce strain of an order that is equivalent to blast induced vibration of between 30mm/s and 75mm/s”*. Vibration levels between 0.6mm/s PPV and 50.0mm/s PPV are routinely experienced in everyday life within a property and are considered wholly safe. It is apparent though, when similar levels are experienced through blasting operations, it is not unusual for such a level to give rise to subjective concern. Table 13-1 gives examples of vibration levels routinely generated in a property.

Table 13-1
Vibration Levels Generated by Everyday Activities¹⁷

Activity	Vibration level mm/s PPV
Walking, measured on a wooden floor	1.0 – 2.5
Door slam, measured on a wooden floor	2.0 – 5.0
Door slam, measured over the doorway	12.0 – 35.0
Foot stamps, measured on a wooden floor	5.0 – 50.0

Effects of Air Overpressure

- 13.66 Satisfactory air overpressure levels are contained within BS 6472-2: 2008, which states the research by USBM. According to BS 6472-2: 2008, *“air overpressure levels measured at properties near quarries in the United Kingdom are generally around 120 dB(lin), which is 30 dB(lin) below, or only 3% of, the limit for cracking pre-stressed poorly mounted windows”*.
- 13.67 Putting this into context, air overpressure levels of 120 dB(lin) are equivalent to the pressure generated by a constant wind velocity of 5m/s (Beaufort force 3, gentle breeze).
- 13.68 Meteorological conditions, such as wind direction and velocity, cloud cover, humidity and temperature inversions, all influence the intensity of air overpressure levels at any given location. Certain atmospheric conditions can produce a localized enhancement of the air overpressure in one direction.

¹⁷ Taken from the Use of Explosives in Quarrying, Table 8, page 154

- 13.69 Temperature inversions are common in the morning and evening, as the ground surface and air get warmer and cooler and different rates. This is one of the reasons why blasting takes place near the middle of the day. Wind is another significant weather influencer, which can result in a 10-15dB increase in sound level downwind compared with levels in cross- or no-wind conditions.
- 13.70 In view of this, the level of air overpressure experienced, irrespective of how well the blast is designed, is often outside of the operator's control. Whilst it is theoretically possible to predict the level of air overpressure, the metrological data needed would be obtained from weather stations located some distance from the site and several hours before the intended detonation. As such the relevance and accuracy of any predictions is questionable; moreover, the risk of leaving charged holes would outweigh the possibility of elevated air overpressure. In view of this, it is recognised that the best means of limiting air overpressure is at source through appropriate blast design.

CONCLUSIONS

- 13.71 This assessment on wellbeing has looked at the baseline conditions regarding population, employment and health and found that the area within which Penrhyn Quarry is located does not suffer from significant deprivation or have any underlying poor health issues.
- 13.72 The assessment ha also examined three key themes of principal relevance to wellbeing, namely:
- (i) dust and air quality;
 - (ii) noise; and
 - (iii) blast induced vibration.
- 13.73 For each the assessment summarises the key concerns, the approach taken as part of the EIA and the mitigation measures proposed.
- 13.74 Overall, given the controls that are already in place (a imposed through planning conditions for example) and based on the new assessments undertaken (and referred to earlier in this Volume) it is considered that the proposals would not have a significant effect on the wellbeing of the community.