Worcestershire Minerals Local Plan Background Document

Crushed Rock in Worcestershire

Background Document

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1. Executive summary

1.1. Minerals can only be extracted where they are found. Geological features that contain high-quality hard rock deposits are often co-located with designated landscapes[1]. In Worcestershire, most of our hard rock deposits are located within the boundaries of the Cotswolds and Malvern Hills Areas of Outstanding Natural Beauty, with some limited outcrops extending north from the Malvern Hills to the Abberley Hills, and in the Lickey Hills.

1.2. There are not currently any active crushed rock quarries in the county. This means we are failing to meet our apportionment for crushed rock production, and we are not maintaining a 10-year landbank as required by national policy. The latest Local Aggregates Assessment for Worcestershire[2], provides a detailed examination of the implications of these issues.

1.3. Nationally, crushed rock aggregates are essential for the construction industry and for large infrastructure projects, contributing to the country's economic well-being.

1.4. Crushed rock quarries often operate at a large scale, and the magnitude of potential impacts is correspondingly large. However, the potential for achieving multiple benefits through appropriate restoration plans is also substantial.

[1] British Geological Survey (June 2013) *Construction Aggregates Minerals Planning Factsheet.*

[2] Worcestershire County Council (July 2018) Local Aggregates Assessment: Data covering the period up to 31/12/2016 [online] Available on the Worcestershire County Council website at: www.worcestershire.gov.uk/amr [Accessed 12.10.2018].

2. Contents

3. Introduction to crushed rock

Crushed rock in the UK

"Aggregates are the most commonly used construction minerals in the UK. They are widely distributed with a range of potential sources and, while a low cost product, are used in very large quantities. They are essential for constructing and maintaining what is literally the physical framework of the buildings and infrastructure on which our society depends"[3]

3.1. Aggregates can be defined as "hard, granular materials which are suitable for use either on their own or with the addition of cement, lime or a bituminous binder in construction"[4]. Aggregates are essential for the construction industry, and are used in concrete, mortar, roadstone, asphalt, railway ballast, bulk fill, and many other uses.

3.2. Quarrying aggregates is a localised activity: you can only extract minerals from where they occur naturally due to the underlying geology. However, aggregates are widely distributed across the country, and can be won from various sources. Hard rock deposits are extensive, with outcrops located nationwide.

3.3. Primary aggregates are those "produced from naturally occurring mineral deposits, extracted specifically for use as aggregate and used for the first time"[5]. These fall into two categories: aggregate obtained by crushing stone quarried from hard, strong rock formations into appropriate sizes (crushed rock) or by extracting stone from "naturally occurring particulate deposits"[6] (sand and gravel).

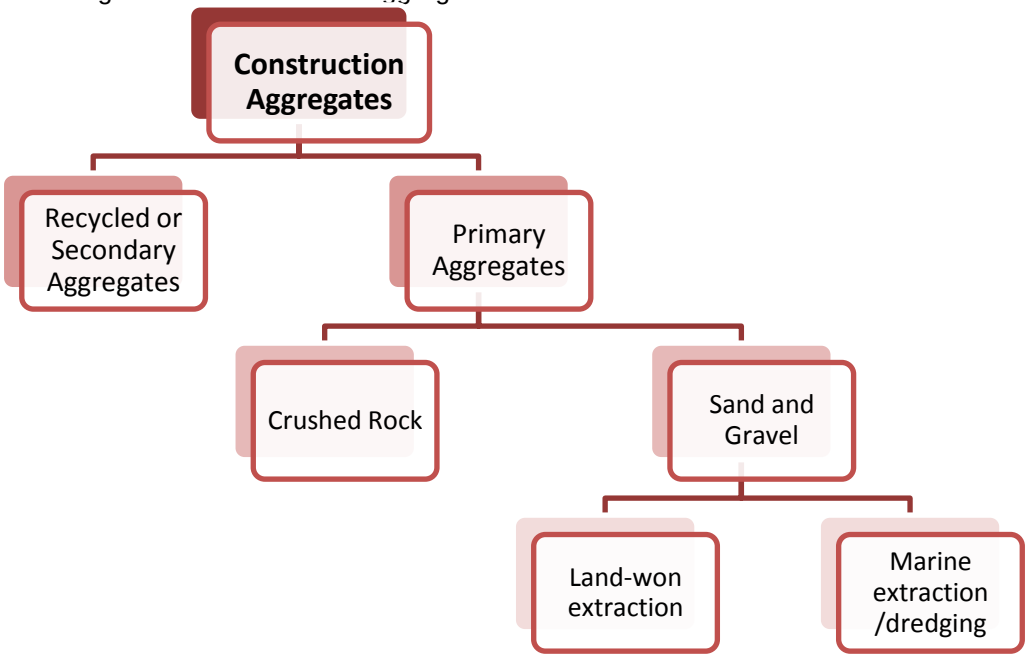
3.4. Though the term 'aggregates' can also include sand and gravel, this background paper primarily focuses on crushed rock. Despite some similarities in end use, sand and gravel and crushed rock workings can operate very differently and have dramatically different landscape impacts. Sand and gravel extraction is dealt with in a separate background paper.

3.5. Secondary and recycled aggregates are also produced in the UK. These include material obtained as a by-product of other extractive industries or industrial processes, and from demolition and other construction works. Secondary and recycled aggregates will also be addressed in a separate background paper. Some information regarding recycled aggregates can be found in the Waste Core Strategy for Worcestershire.

3.6. Aggregates can be sub-divided as follows:

[3] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet.*
[4] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[5] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[6] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.

Figure 1: Categories of Construction Aggregates



3.7. Crushed rock extraction normally takes place in dry workings. This is explained in more detail in the 'Crushed rock extraction' section below.

Economics of crushed rock

3.8. Crushed rock represents approximately 640 of the UK's total primary aggregate sales in 2014[7]. The main sources of crushed rock aggregate are limestone/dolomite, igneous rock, and sandstone. 110,300,000 tonnes of crushed rock were produced in the UK in 2014[8].

3.9. The latest British Geological Society Aggregate Minerals Survey[9] states that sales of crushed rock increased 17% between 2009 and 2014, from 70.7 Mt to 82.5 Mt, respectively.

3.10. The UK is a net exporter of crushed rock. However, there is also a small market for imported crushed rock, mainly for specialised uses that are not able to be supplied domestically.

3.11. There are about 600 crushed rock quarries in the UK. Although these are distributed across the country, there are large regional imbalances in both supply and demand. This means that there is also significant internal movement of aggregates around the country.

3.12. The industry is dominated by several large producers who operate sand and gravel and crushed rock quarries. In 2011, Anglo American and Lafarge announced their intentions to form a joint venture which would combine their operations. The proposal was investigated by the Competition Commission, and in order for the proposal to proceed, both

[7] British Geological Society (2016) *Aggregate Minerals Survey, England and Wales 2014.*
[8] British Geological Survey (2016) *United Kingdom Minerals Yearbook 2015*.
[9] British Geological Society (2016) *Aggregate Minerals Survey, England and Wales 2014.*

companies were required to divest several assets including quarries. These divested assets were purchased by Mittal Investments which formed a new company, now called Hope Cement.

3.13. The Mineral Products Association (MPA) is the main trade association representing the industry. MPA members cover 90% of aggregates production[10]. Independent and privately owned quarries are represented by the British Aggregates Association which accounts for the remaining 10% of national production[11].

3.14. The Landfill Tax was introduced in 1996 as a tax on waste disposal at landfill sites. The purpose was to encourage waste producers to produce less waste, recover more value from waste (for example through recycling or composting), and to use more environmentally friendly methods of waste disposal. The tax, however, led to unanticipated effects on the quarrying industry. Before 1996, quarry operators were able to accept landfill waste to raise the level of quarry voids to assist with restoration. After the introduction of the landfill tax, operators were required to pay for this material, which had impacts on the economic model of their operations.

3.15. Some types of waste is exempt from Landfill Tax, including "material arising from mining and quarrying operations and disposed of at an authorised landfill site". Certain material "which is used for the purposes of filling existing or former quarries may qualify for exemption", subject to meeting specified conditions.[12]

3.16. The Aggregates Levy was introduced in April 2002. The current levy rate is £2.00 per tonne, and it applies to all crushed rock produced in the UK. Aggregate exports are not taxed.

3.17. The Landfill Tax did result in an increase in recycled and secondary aggregates before the introduction of the Aggregates Tax, but the Aggregates Tax has led to other unintended impacts. These include:

- the transport of untaxed aggregates over longer distances,
- difficulties with disposing poor-quality materials (overburden) for primary aggregates companies, and
- build-up of unsalable materials at quarries sterilising permitted reserves[13].

[10] Mineral Products Association, *Explore the MPA* [online] available at https://mineralproducts.org/ [Accessed 12.10.2018].
[11] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[12] HM Revenue & Customs (2018) Excise Notice LFT1: a general guide to Landfill Tax Updated 3 April 2018, sections 8.2 'Mining and quarrying material' and 8.4 'Filling of quarries' [online] Available at https://www.gov.uk/government/publications/excise-notice-lft1-a-general-guide-to-landfill-tax/excise-notice-lft1-a-general-guide-to-landfill-tax#exemptions [Accessed 12.10.2018].
[13] BDS Marketing Research (2009) *The Effects of the Landfill Tax and Aggregates Levy by an Analysis of Aggregates Markets since 1990* [online] Available at https://www.british-aggregates.co.uk/news/doc119_2.pdf [Accessed 12.10.2018].

3.18. There is some debate over the value of the Aggregates Levy, as the government originally justified its introduction as a means of addressing the environmental costs of quarrying. The tax was designed to:

- recognise the significant environmental impact of extracting aggregates, and
- encourage the use of alternative materials.

3.19. The Mineral Products Association disagrees with the appropriateness of this justification on the basis that the Levy is environmentally inefficient and operates effectively as a tax on production.[14] However, until 2011, part of the Aggregates Levy was used for the Aggregates Levy Sustainability Fund, which provided funding for local environmental and community projects that mitigated the effects of quarrying, including restoration and conservation schemes, and was positively viewed by many conservation agencies.

3.20. Secondary and recycled aggregates are also economically important as they make a contribution towards total reserves of aggregates and help reduce reliance on primary extraction. The Mineral Products Association estimates that recycled and secondary materials currently account for just under 30% of the aggregates market. The UK leads Europe in recycled materials production.

Crushed rock extraction

3.21. Minerals are only able to be worked where they are found, and those locations are predetermined by the underlying geology. This means that quarry locations are fixed, and reserves of all mineral types are limited.

3.22. Taking the view that any mineral working must be restored, mineral extraction is considered a temporary land use. Hard rock quarries may operate over very long time frames and restoration plans will need to reflect this. Because of the high initial investment and start-up costs of a hard rock quarry, they are generally expected to have a longer life than sand and gravel quarries even though annual production may be similar[15].

3.23. "Working hard rock quarries is generally a more complicated and intensive process than quarrying sand and gravel"[16], and they generally take one of two forms:

- Hill-side quarries (where excavated material is normally hauled *down* to the processing plant)
- Open-pit quarries (where the quarry workings are below the level of the processing plant, and excavated material is hauled *up)*

[14] Mineral Products Association website, General Issues: the Aggregates Tax [online] Available at https://mineralproducts.org/iss_key01.htm#tax [Accessed 12.10.2018].
[15] GWP Consultants (2008) *Quarry Design Handbook: Appendix 4-3, Principles of design for hard rock quarries* [online] Available at http://gwp.uk.com/publications-and-research [Accessed 12.10.2018].
[16] GWP Consultants (2008) *Quarry Design Handbook: Appendix 4-3, Principles of design for hard rock quarries* [online] Available at http://gwp.uk.com/publications-and-research [Accessed 12.10.2018].

The design of a particular quarry depends on the topography and geology of the site, land ownership, and environmental and amenity considerations.[17]

3.24. Other key considerations for the design of a hard rock quarry are:

- Site and plant access,
- Location of plant and/or facilities,
- Water management,
- General site screening and security, and
- Soil, overburden and waste stockpiling.

3.25. Crushed rock is normally extracted from a dry working. Some quarries may extend below the water table, and therefore need to be pumped to allow them to be worked 'dry'. After extraction is complete, these sites may be allowed to flood as part of a restoration plan.

3.26. There are five principal stages in the extraction of hard rock:

- Removal of soil and other overburden
- Primary (and secondary, if required) crushing/fragmentation
- Excavation and loading
- Hauling to the processing plant
- Grading or screening

3.27. Overburden includes all material that must be removed in order to expose the rock that will be excavated for sale. It can include soil, subsoil, other undesirable rock formations, and/or weathered materials. The thickness of the overburden can vary tremendously, and so the cost of removing it can also vary. Overburden can play an important role in site restoration. Careful handling of soils and subsoils at the early stages can impact restoration quality, as soils handled incorrectly may lose fertility.

3.28. The BGS states that "Blasting is normally required to extract the required rock and this is carried out in one or more benches. After blasting, and any secondary breaking of larger blocks by drop-ball or hydraulic breaker, a mechanical excavator loads the rock into dump trucks for transfer to either a fixed primary crusher or a mobile crusher on the quarry floor".[18]

3.29. Laser profiling of the quarry can be used to ensure that the correct amount of explosive is used. This involves creating a 3D model of the quarry face which allows the blasting engineers to calculate the precise volume of rock to be blasted. Timing the blasts – creating a 'blast sequence' – can ensure that the pressure waves from subsequent blasts interfere with each other (effectively cancelling each other out) to reduce vibration.

3.30. Softer rock formations may undergo 'mechanical breaking' – that is, the initial phase of fragmentation may be done with a mechanical ripper or

[17] GWP Consultants (2008) *Quarry Design Handbook: Appendix 4-3, Principles of design for hard rock quarries* [online] Available at http://gwp.uk.com/publications-and-research [Accessed 12.10.2018].
[18] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.

hydraulic pecker. These methods are more selective and may have fewer impacts than blasting, but are uneconomical for very large volume quarries.

3.31. Secondary fragmentation – breaking the rock down into a size that the primary crusher can handle – may be done using more blasting, a drop ball, or various mechanical or hydraulic means. A good primary blasting sequence will greatly simplify the later stages of crushing.

3.32. After fragmentation, the rock will be transported to the primary crusher. Hauling is normally done using large lorries, and careful attention must be paid to the design of access roads in the quarry, including the gradients and surfaces of the access ramps. Some operations employ a mobile crusher which can be positioned near the working face where it can be fed directly, and others use fixed conveyors which have the advantage of being able to operate at much higher gradients and may be more cost-effective.

3.33. Once the material has been crushed and screened to the appropriate size, it is loaded into lorries for delivery to clients.

3.34. Depending on geological conditions, it is sometimes possible to mine crushed rock. This involves removing the material from the deposit without damaging its outward appearance, and can also address some access issues.

3.35. A report assessing the feasibility of the underground mining of aggregates in London and the South East investigated whether it is possible to reduce the reliance on aggregates imported over long distances by producing aggregates locally from underground facilities. The report concludes that the capital costs for underground mining are higher than for surface working by a factor of 1.3 to 1.6, which may be a disincentive for operators.[19] In areas outside the South East where the aggregates industry may already serve a more local market and where land-use pressures may be lower, the prospect of underground mining seems unlikely on a cost basis alone.

4. Crushed rock resources in Worcestershire

Geological context

4.1. Whether an aggregate is fit for a certain purpose "depends principally on its physical and mechanical properties…for general purpose applications an aggregate of high strength and durability with low porosity is required"[20]. However, some uses require additional mineralogical or chemical specifications. These can include particle shape and grading, resistance to chemical and physical weathering, volume stability, frost resistance and other properties.

[19] B Teresa J. Brown, TJ, Coggan, JS, Evans, DJ, et al (May 2010) *Underground Mining of Aggregates, Main Report*, available at http://nora.nerc.ac.uk/11016/1/MA-1-S-7-01_REPORT_WITH_APPENDICES.pdf [accessed 16.10.2018]
[20] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet.*

4.2. Once they are crushed, a variety of rock types are appropriate for use as aggregates. Most hard rocks are potentially suitable for coarse aggregate. In the UK, the main sources of crushed rock are limestones, igneous rocks, and sandstones. A rock's suitability for different uses depends on its physical characteristics including:

- Crushing strength
- Porosity
- Resistance to impact, abrasion and polishing[21].

4.3. Hard rock suitable for aggregate use is widely distributed across the UK, although some specialised applications require rocks with properties that are only available in a limited number of locations.

Limestone

4.4. Limestone is a sedimentary rock. This category also includes dolomites, which are closely related to limestones. Limestones and dolomites are hard and durable rock types which are widely available and therefore frequently extracted for use as aggregate. Limestone is also used to make cement, and both limestone and dolomite have industrial applications which rely on specific chemical properties of the rocks. Limestones and dolomites provide 49% of all crushed rock aggregate produced in the UK[22].

4.5. The two primary areas for limestone quarrying in the UK are Derbyshire and the Mendip Hills; both areas contain Carboniferous age deposits. The Jurassic limestone deposits of the Cotswolds (inferior Oolite group) extend into Worcestershire in the areas around Broadway and Bredon Hill. Limestone has been the only source of crushed rock aggregate in Herefordshire and Worcestershire for many years. In the past, Aymestrey Limestone was extracted commercially in Worcestershire, notably at Shavers End and Woodbury quarries.

Igneous rocks

4.6. Igneous (and metamorphic) rocks tend to produce very strong aggregates with high skid resistance. These are well-suited to road surfacing uses and as railway ballast. Igneous and metamorphic rocks represent 42% of the crushed rock production in the UK. Extraction of this type of rock is mainly concentrated in Northern Ireland and Scotland, though there are some important smaller outcrops across England and Wales[23]. These outcrops are mainly worked where they are easily able to serve areas of high demand.

4.7. A small number of large rail-linked quarries located in Leicestershire account for 28% of the total igneous rock production in Great Britain, demonstrating that sometimes "deposits are of economic importance out of proportion to their relatively small size".[24]

[21] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[22] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[23] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[24] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.

4.8. Worcestershire's deposits of igneous and metamorphic rock are concentrated in the Malvern Hills in a linear formation known as the "Malvern Complex" which runs roughly north to south along the border between Worcestershire and Herefordshire. This formation contains the oldest rocks in Worcestershire, and some of the oldest exposed rocks in England. As these hard igneous rocks have resisted erosion better than the surrounding countryside, the effect is of a "striking line of hills of which the Malvern Hills are the most impressive".[25] The Suckley and Abberley Hills to the north are visually similar but not part of the same geological formation.

4.9. The Malvern Complex contains potentially good sources of high-quality aggregate material, and was worked historically for road and building stone. However, the Malvern Hills Acts were passed specifically to protect the hills from damage by quarrying, and quarrying in the area ceased in the 1980s. More information on this is available in the 'Malvern Hills Acts background paper.

Sandstone

4.10. Sandstones make up the remaining 9% of crushed rock production in the UK. Sandstones of various geological ages are found across Britain, and their properties vary dramatically, with many are not appropriate for aggregate use at all. Historically sandstone was been primarily valued as a source of building stone, but this has declined substantially and "today only about 8% of total production is for this purpose".[26]

4.11. A type of sandstone known as 'greywacke' (a hard coarse-grained sandstone with angular minerals grains within a clayey matrix) has high polishing and abrasion resistance and is particularly valuable for road surfacing as it provides excellent skid resistance. These types of rocks are obtained from several localised areas including South Wales and the Forest of Dean.

4.12. Worcestershire contains a number of sandstone deposits, primarily in the north-east of the county. The two major groups are the Wildmoor Sandstone Formation and the Kidderminster Formation. Some of these are quarried as solid sand (and are discussed in the Sand and Gravel background paper). Other sandstone deposits in Worcestershire have historically been used as building stone[27], but these have not been quarried for aggregate use since before the beginning of modern planning records.

4.13. The Lickey Hills in the north-east of the county include a wide range of geological types but are predominantly hard quartzite. The hills have not been quarried commercially since the early twentieth century.

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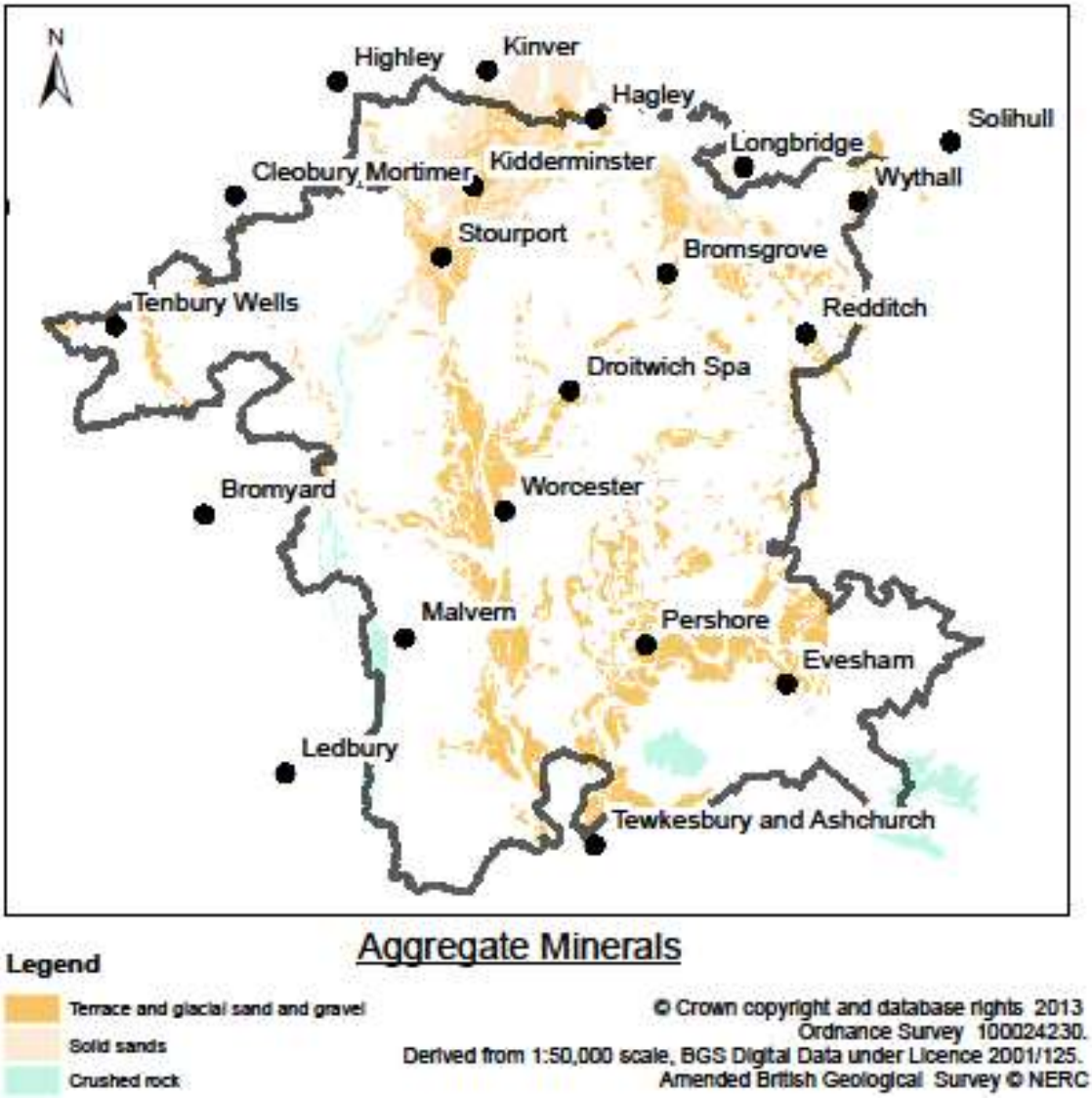
[25] Earth Heritage Trust (undated) *Malverns Complex* [online] Available at http://www.earthheritagetrust.org/pub/learning-discovery/aggregates/lithology-profiles/malverns-complex/ [Accessed 16.10.2018].
[26] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[27] BGS, DETR (1999) *Mineral Resource Information for Development Plans, Herefordshire and Worcestershire: Resource Constraints* [online] Available at http://www.bgs.ac.uk/mineralsuk/planning/resource.html [Accessed 16.10.2018].

4.14. The map on the next page shows the geological distribution of crushed rock, terrace and glacial sand and gravel, and solid sand deposits in Worcestershire. Neighbouring counties also produce crushed rock (primarily Shropshire and Staffordshire, both of which have substantial reserves).[28]

[28] Regional Aggregates Working Party (2013) *Draft Report 2011* [unpublished].

Figure 2: Geological distribution of sand, gravel and crushed rock in Worcestershire.



History of crushed rock extraction in Worcestershire

4.15. Crushed rock quarries are often co-located with designated landscapes, sites of special scientific interest, or other locally important landscapes[29]. This is the case in Worcestershire, where most crushed rock extraction took place in the Malvern Hills and Cotswolds AONBs.

4.16. There is evidence that hard rock quarrying in Worcestershire began during Roman times, and some old quarry faces contain historical evidence of ancient workings. These historical traces can become important in their own right as a record of industrial heritage, and may merit protection.

4.17. As noted above, quarrying in the Malvern Hills has a long and contentious history, and the Malvern Hills Acts were established with the express goal of controlling the impacts of quarrying on the Hills.

4.18. Until 1907, small-scale quarrying for local building stone was fairly common in the Hills, and there were a number of small operators supplying aggregates to the local area. From 1907, commercial quarrying began to be concentrated in fewer hands, and by the early 1920s the number of quarries had dramatically reduced, but the size of the remaining operations was having serious negative effects on the amenity of the Malvern Hills.

4.19. The Malvern Hills Act of 1924 gave the Malvern Conservators the ability to compulsorily purchase land and mineral rights on the hills for a period of five years. The objective was to lessen the impact of deleterious quarry activity, but ultimately the last quarry in the Hills did not close until 1977.

4.20. Localised hard rock quarrying also took place in some other parts of the county, including the Lickey Hills, and Fish Hill near Broadway. In the Lickey Hills, extensive quarrying took place for road aggregate, but these quarries ceased working in the early 20th century.[30] Aymestrey limestone was produced from a succession of quarries in the Abberley and Suckley Hills, notably at Penny Hill, Abberley Hill and Woodbury Hill, the last of which closed in the 1990s.

4.21. The Fish Hill quarry in the Cotswolds AONB produced aggregate and building stone until recently but extraction ceased in 2010.

Local economic context

4.22. Sales data is commonly used when considering the supply of aggregates. This can be problematic, as sales will vary depending on both supply and demand factors in the market. Despite this, however, it is considered to remain the best indicator of the state of the market.

4.23. Sales data for crushed rock production is not available for Worcestershire due to the long-standing confidentially agreements between the industry

[29] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[30] Earth Heritage Trust (2013) *Lickey Hills Quarries* [Online] Available at http://ehtchampions.org.uk/ch/?page_id=76 [Accessed 16.10.2018].

and government to protect operators' commercial interests. This means that sales data will not be released or published where there are fewer than three operational sites in an area. The last time there were three operating quarries producing crushed rock in Worcestershire was 2003, and since then crushed rock sales data for Worcestershire have been combined with those for Herefordshire. Of the two counties, Herefordshire has always been the larger producer of crushed rock.

4.24. As Worcestershire does not currently produce any crushed rock, the county is a net importer, with 2014 figures showing 540,000 tonnes of material[31] imported in that year. Whilst this tonnage may be an over- or under-estimate, it is clear that 100% of Worcestershire's demand have been met by imports since production ended at the county's last remaining hard rock quarry. Further information on imports and exports between Worcestershire and neighbouring authorities is available in the 'Duty to Co-operate' background document.

[31] British Geological Survey/Department of Communities and Local Government (2016) *Collation of the results of the 2014 Aggregate Minerals survey for England and Wales*. NB: Discussion with the survey authors revealed that the information does not represent a complete dataset from all mineral operators. It is therefore considered that significant caution must be applied in relying on this data.

5. Policy context for crushed rock extraction

National Planning Policy Framework

5.1. The National Planning Policy Framework (NPPF) sets out policies on the development of mineral resources. It states that "great weight should be given to the benefits of mineral extraction, including to the economy"[32]. Authorities must ensure that there are no unacceptable adverse effects on natural or historic environments, or on human health.

5.2. The NPPF also requires that minerals planning authorities should "provide for restoration and aftercare at the earliest opportunity, to be carried out to high environmental standards".[33]

5.3. In addition, the NPPF requires local planning policies to "provide for the extraction of mineral resources of local and national importance".[34] Minerals of local and national importance are defined as "minerals that are necessary to meet society's needs, including aggregates".[35] The NPPF also stipulates that minerals planning authorities should "adopt appropriate policies so that known locations of specific minerals resources of local and national importance are not sterilised by non-mineral development where this should be avoided".[36]

Planning Practice Guidance

5.4. The web-based Planning Practice Guidance (PPG) contains further detail on the policies contained in the NPPF in an extensive Minerals section which includes a "planning for aggregate minerals" chapter. The Managed Aggregates Supply System, Local Aggregates Assessments, Aggregate Working Parties, and landbank requirements are all covered, alongside other issues which apply to all mineral sites.

5.5. The Planning Practice Guidance specifically states that local planning authorities should address any potential impacts that minerals extraction may have on nationally protected landscapes, including Areas of Outstanding Natural Beauty (AONBs). There are parts of two AONBs within Worcestershire, and the management plans for these areas contain guidance on issues related to the supply of aggregates. Both of these areas (the Malvern Hills and the Cotswolds) have been worked for crushed rock in the past, and contain potentially high-quality crushed rock resources.

[32] Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205.
[33] Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 205.
[34] Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 204.
[35] Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, Annex 2: Glossary.
[36] Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 204.

5.6. Issues which must be addressed at any mineral site include amenity, dust, noise, stability and restoration and aftercare.

5.7. For amenity, the key issues are proximity to occupied properties and the impacts on the local community.

5.8. For both dust and noise emissions, the Guidance requires assessments to be carried out. The assessments should identify all potential sources of nuisance, and for each source, consider the procedures and mitigation measures that may be necessary. For noise, this assessment should be in accordance with the Noise Policy Statement for England. In the case of dust, health impacts must be considered, and in both cases the impacts on site neighbours and sensitive facilities must be taken into account[37]. More detail is provided in the 'Emissions' section below.

5.9. Slope stability issues should also be appraised to identify potential hazards.

5.10. Finally, restoration of mineral sites is a priority in the NPPF, and its importance is reflected in the detailed information contained in the PPG. Restoration and aftercare should incorporate, at a minimum, an overall restoration strategy; information about soil resources and hydrology and how soils and overburden materials will be handled during excavation; an assessment of the agricultural land classification (where the land is agricultural); and a landscape strategy. Applicants must also provide an outline strategy of their commitments for the five-year aftercare period[38]. Key issues for restoration are covered in the 'Potential for restoration' section of this document.

Local planning policies

5.11. The adopted Minerals Local Plan from 1997 forms part of the existing Development Plan. Only policies 1,2,5,6 and 7 have been "saved" by the Secretary of State. The saved policies set criteria for assessing applications for the extraction of hard rock and minerals other than aggregates and for the restriction of quarrying in the Abberley Hills.

5.12. The adopted plan identified a "Crushed Rock Preferred Extension Area" at Fish Hill Quarry. This extension was granted and the reserves there have been exhausted. Fish Hill quarry is currently being restored.

District, city and borough council plans

5.13. Policies contained in district, borough and city plans do not typically mention crushed rock extraction specifically. However, local plans set out the amount of development for each area. As most aggregates are used

[37] Ministry of Housing, Communities and Local Government (2014) *Planning Practice Guidance* [online] Available at https://www.gov.uk/guidance/minerals#Assessing-environmental-impacts-from-minerals-extraction [Accessed 17.10.2018].
[38] Ministry of Housing, Communities and Local Government (2014) *Planning Practice Guidance* [online] Available at https://www.gov.uk/guidance/minerals#Assessing-environmental-impacts-from-minerals-extraction [Accessed 17.10.2018].

within 30 miles of their point of extraction[39], district, city and borough council development projections are directly related to the need for crushed rock extraction, as well as to policies on local materials.

5.14. Other policies in these plans address protecting green open space, green infrastructure and amenity, all of which may be affected by applications for crushed rock extraction. Restoration plans for crushed rock sites may also contribute to achieving these types of objectives.

Borough of Redditch Local Plan No. 4

5.15. Policy 15 'Climate change' of the Borough of Redditch Local Plan No.4 includes a requirement for all proposals to "demonstrate that the use of sustainable, locally sourced and recycled materials has been considered".

Wyre Forest Core Strategy

5.16. The Wyre Forest Core Strategy contains development objectives to "safeguard and enhance natural resources" (DO7) and to "safeguard and enhance the District's unique landscape character, Green Belt, natural environment and green infrastructure" (D05).

Bromsgrove District Plan

5.17. The Bromsgrove District Plan strategic objective SO8 aims to "protect and enhance the unique character, quality and appearance of the historic and natural environment, biodiversity and Green Infrastructure throughout the District". SO9 aims to "Safeguard and enhance the District's natural resources such as soil, water and air quality; minimise waste and increase recycling including re-use of land, buildings and building materials".

South Worcestershire Development Plan

5.18. The South Worcestershire Development Plan contains a reference to the adopted Minerals Local Plan (1997). SWDP 32: Minerals seeks to protect minerals from being sterilised and encourages the recycling and reuse of construction waste on-site and encourages the use substitute or secondary and recycled minerals within development.

5.19. The SWDP contains further direction on safeguarding and best practice, including several local examples, and sections on secondary and recycled aggregates and the legacy of mineral extraction.

Other local policies

5.20. There are also a number of local planning policies and guidelines in place in Worcestershire that make reference to local materials. There are parts of two Areas of Outstanding Natural Beauty (AONB) within the county, and the management plans for these areas contain guidance on issues related to

[39] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.

the supply and use of crushed rock aggregate. The Cotswolds Conservation Board has also produced a position statement on Minerals and Waste Planning.

Cotswolds Area of Outstanding Natural Beauty Management Plan[40]

5.21. The Cotswold Area of Outstanding Natural Beauty (AONB) extends into Worcestershire in the area of Bredon Hill and Broadway. This area contains the recently closed Fish Hill quarry which produced Cotswold stone.

5.22. Policy CE3 of the Cotswold AONB Management Plan states that "Provision should be made for the quarrying of limestone, at an appropriate scale, in order to provide building materials that help maintain and enhance the local distinctiveness of the AONB. Any such mineral sites should be required to demonstrate that they do not have any significant adverse effects on the special qualities of the AONB or integrity of existing wildlife sites".

Image 1: The recently closed Fish Hill Quarry *(Photo: Worcestershire County Council).*

Cotswolds Area of Outstanding Natural Beauty Minerals and Waste Planning position paper[41]

5.23. Although this position statement pre-dates the latest AONB Management Plan, it nevertheless sets out a positon on minerals. It states that "The Board will be expecting a Minerals and Waste Planning Authority to demonstrate very clearly that any extensions to existing or new quarries for crushed limestone in the AONB are only to be permitted if in the national

[40] Cotswolds AONB Conservation Board (2018) Cotswolds AONB Management Plan 2018-2023

[41] Cotswolds AONB Conservation Board (2013) Positon Statement on Minerals and Waste Planning.

interest. The Board will wish to see the use of secondary aggregates promoted in Minerals Core Strategies/Local Plans".

Malvern Hills Area of Outstanding Natural Beauty Management Plan[42]

5.24. The Malvern Hills AONB Management Plan includes policy BDP8 to "Support the recycling, re-use and limited extraction of small quantities of locally distinctive building materials, such as Malvern stone, where this is needed to help retain local distinctiveness in the built environment". However, the focus is predominantly on building stone, rather than aggregates.

Image 2: The Malvern Hills *(Photo: Worcestershire County Council).*

Malvern Hills Conservators Management Plan

5.25. The Malvern Hills Conservators[43] were established under the Malvern Hills Act 1884 to manage and protect the hills. One of their key aims is to prevent unlawful digging and quarrying on the hills.

5.26. The Malvern Hills Conservators Management Plan (2016-2021) identifies disused quarries as being important features of geological interest. It states that "geological exposures play a significant and charismatic role in the heritage of this area. While all rock outcrops contribute, the designated 25 Local Geological Sites showcase Malvern geology to a high standard. Here, the accessibility to the exposure and visibility of the rock face/landform are excellent allowing their interpretation and use by people and habitation by appropriate species including lichens and the grayling butterfly".

Herefordshire and Worcestershire Earth Heritage Trust

Geodiversity Action Plan

5.27. The Earth Heritage Trust is a charity active in Worcestershire and Herefordshire. Their mandate is to record, protect and promote geology and landscape and to raise general awareness of earth heritage by offering educational programmes to the public.

[42] Malvern Hills Area of Outstanding Natural Beauty (2014) Malvern Hills AONB Management Plan 2014-2019

[43] The Malvern Hills Conservators have used the working name of the *Malvern Hills Trust* since 2017.

5.28. The Trust has produced a Geodiversity Action Plan (GAP) for Worcestershire, which identifies a number of objectives and actions to "provide long term and sustainable support for the conservation of geodiversity within Worcestershire". Objective 7 of the GAP is to "improve and sustain the links between geodiversity, biodiversity, archaeology and landscape".[44]

A Thousand Years of Building in Stone[45]

5.29. The Earth Heritage Trust's 'A Thousand Years of Building with Stone' project traced the history of stone buildings and re-discovered former quarries across Worcestershire and Herefordshire. One of the key project outcomes is a database that records "over 4500 stone buildings and quarries across Herefordshire and Worcestershire, connecting buildings with their quarry sources".

Abberley and Malvern Hills Geopark

5.30. The Abberley and Malvern Hills Geopark encompasses parts of Gloucestershire, Herefordshire, Shropshire and Worcestershire. It is driven by a collection of local organisations and exists to allow "people from all walks of life the opportunity to experience geology and to appreciate the importance of their geological heritage".[46]

Image 3: The Abberley Hills from Teme Valley Road *(Photo: Worcestershire County Council).*

Regulatory framework

European Union Directives

5.31. EU Directives are transposed into national legislation through a number of regulations. These cover several areas which affect aggregates extraction including waste, recycling, water, habitats, and sustainability.

5.32. The Waste Framework Directive established the waste hierarchy as the governing paradigm for waste management in the UK. Encouraging

[44] Earth Heritage Trust (2009) Geodiversity Action Plan Worcestershire [online] available at http://www.earthheritagetrust.org/pub/category/local-gaps/ [Accessed 17.10.2018].
[45] Earth Heritage Trust, A Thousand Years of Building in Stone [online] available at http://www.buildingstones.org.uk/.
[46] Information available at http://geopark.org.uk/pub/.

recycling is enshrined in national policy, and recycled aggregates account for approximately 29% of the total national supply[47].

5.33. Strategic Environmental Assessment is required by an EU Directive, and is often integrated within Sustainability Appraisal, in the UK. Its goal is to increase the consideration of environmental issues during the development of strategic documents. This is a high-level process that is intended to guide decision-making.

5.34. The European Environmental Impact Directive has been enshrined in national legislation through the Town and Country Planning (Environmental Impact Assessment) Regulations 2017. Environmental Impact Assessments occur at the project level, and the objective is "to provide a high level of protection of the environment and to help integrate environmental considerations into the preparation of proposals for development to reduce their impact on the environment".[48]

5.35. The Habitats Directive protects plants, animals and 'habitat types' which may include designated landscapes, and is the primary piece of European nature conservation policy.

5.36. Air quality, safety and pollution are all also subject to EU directives that are expressed in statutory requirements and national policy.

Environment Agency

5.37. The Environment Agency handles the permitting system for many EU directives in the UK. These are collectively known as "Environmental Permitting Regulations" (EPR) and are determined by National legislation and policy. They primarily cover environmental protection and waste management.

5.38. The Mining Waste Directive is part of the Waste Framework Directive mentioned above, and requires sites which manage waste generated by extraction to obtain a permit. Rock, overburden, or other soils may be considered extractive waste under these regulations.

5.39. The Water Framework Directive protects surface and ground water. Water use is also regulated under the EPR by Water Abstraction Licences. A licence is required if an operation intends to "impound water or take more than 20 cubic meters (4000 gallons) of water per day" from a water source[49]. This may occur at crushed rock sites where the site extends below the water table and pumping is necessary.

Managed Aggregate Supply System (MASS)

[47] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet*.
[48] 2017 No. 671, Explanatory Memorandum to the Town and Country Planning (Environmental Impact Assessment) Regulations 2017.
[49] Guidance: Apply for a water abstraction or impoundment licence [online] Available at https://www.gov.uk/guidance/water-management-apply-for-a-water-abstraction-or-impoundment-licence [Accessed 18.10.2018].

5.40. The Managed Aggregate Supply System works through networks of national, sub-national and local partners in order to ensure a steady and adequate supply of aggregates. This is necessary because of the geographical variation in the occurrence of suitable aggregate resources and the areas which have the highest demand for these products.

5.41. The MASS effectively redistributes aggregates, by requiring minerals planning authorities "which have adequate resources of aggregates to make an appropriate contribution to national as well as local supply […] it also ensures that areas with smaller amounts of aggregate make some contribution towards meeting local and national need". Government guidance on the provision of aggregates in England is set out in the National and Regional Guidelines for Aggregates Provision in England, 2005 to 2020 and in the NPPF.

5.42. At the local level, the MASS requires mineral planning authorities to produce a Local Aggregates Assessment (LAA) on an annual basis. The LAA assesses the supply of and the demand for aggregates within that authority's area. Sub-nationally, Aggregate Working Parties made up of mineral planning authorities and other bodies (by invitation) produce comprehensive data on aggregates covering specific broader areas. They scrutinise and provide advice on the Local Aggregate Assessment of each mineral planning authority in their area, and provide advice to the National Aggregate Co-ordinating Group. The role of the National Aggregate Co-ordinating Group is to monitor the overall provision of aggregates in England.

5.43. The volume and adequacy of aggregate supply in Worcestershire and effectiveness of local policy are also monitored annually in the Council's Authority Monitoring Report (AMR) published on the Council's website.

6. Planning issues arising from crushed rock quarrying

6.1. The emerging Minerals Local Plan is required to provide a policy framework to ensure that the environmental, amenity and other impacts of any crushed rock extraction in the county are acceptable. Potential impacts and other planning issues are detailed below.

6.2. Actual impacts will vary depending on the location of the site. Even a small site located within a designated area may have the potential to be "more damaging to important habitats and species than a large aggregates quarry located in a less sensitive, undesignated area"[50].

6.3. As the scale of production at a quarry largely determines the amount of road traffic as well as the amount of noise, dust, and vibration caused,

[50] Thompson, A. et al. (2004) *Planning for the Supply of Natural Building and Roofing Stone in England and Wales (The Symonds Report)* Office of the Deputy Prime Minister, London p.94

these issues must be handled on a case-by-case basis with each individual application.

Traffic and transport

6.4. Crushed rock extraction will almost inevitably cause some traffic impacts. As quarries are typically relatively small employers[51], the major transport impacts will come from the transportation of crushed rock off site to customers. Developing quarries near major centres of demand can help to reduce transport costs, but this might not always be possible due to geological constraints.

6.5. Aggregates are usually transported by road and are frequently used in fairly close proximity to the quarry. Nationally, the average delivery distance for aggregates is about 30 miles[52].

6.6. Aggregates are a 'low value, high weight/volume' product. This means that the cost of transport is an important consideration for the commercial viability of a deposit, as it can have a large effect on the final delivered cost of the material.

6.7. Traffic issues will be most acute near the quarry site, as "more distant transport movements are generally dissipated within the whole transport system"[53], and most aggregates are used near their source. It may be possible to mitigate traffic issues, and any applications would need to assess the potential transport implications.

6.8. The noise from traffic can be effectively reduced through natural screening using trees and hedgerows or temporary earth bunds or acoustic fencing. To keep local traffic to a minimum, the use of other means of transport including rail, private roads, or waterways should be considered.

6.9. According to the British Geological Survey, "in 2010, approximately 10% of primary aggregates were moved by non-road means for part of their delivery journey, although local deliveries from rail depots or wharves are also carried out by road".[54] There is currently one (sand and gravel) operation in the county transporting aggregates by water from the point of extraction to a processing site located upstream. Water transport may be viable for deposits located near water courses, but because Worcestershire's hard rock deposits are mainly located on high ground, water transport may prove unrealistic. It may also be possible to consider rail transport where facilities are suitably located. There are currently two rail haulage depots in Herefordshire but none in Worcestershire. Transport issues are discussed further in separate background documents.

[51] The largest number directly employed at a quarry in Herefordshire and Worcestershire (in the 1990s) was 40, at Leinthall Earls, Wigmore, Herefordshire.
[52] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet.*
[53] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet.*
[54] British Geological Survey (2013) *Construction Aggregates Minerals Planning Factsheet.*

Emissions

6.10. The Planning Practice Guidance states that "significant environmental impacts are best addressed through consideration of an Environmental Statement which will have to accompany nearly all planning applications for new mineral working".[55] Operators will also have consulted statutory regulators as part of the Environmental Impact Assessment process.

Dust

6.11. Dust is the most important air quality issue that arises from crushed rock extraction, and is an almost "inevitable consequence of all mineral extraction due to the processes of breaking and handling rock and soils".[56] Dust can also be generated during the transportation of material within and off the site, during soil stripping operations, and from exposed strata. The NPPF requires that unavoidable dust emissions be controlled, mitigated or removed at source, and the Planning Practice Guidance provides detailed guidance on dust.

6.12. Modelling the possible effects of dust is a complex task because of the large number of factors that affect dust levels, and so predicting the level of dust emissions from a new quarry is very difficult.

6.13. The amount of dust emitted from a quarry is affected by:

- weather (temperature, wind speed and direction, precipitation, humidity),
- quarry design (deep or shallow workings),
- working methods (drilling, blasting),
- type of working (hard crushed rock, sand and gravel),
- size of the working,
- type of soils or overburden,
- the extent of exposed soil and other strata,
- local topography, hydrogeology and vegetation cover, and
- the dust control measures employed by the site operator[57].

6.14. Concerns about dust generally fall into two categories: nuisance effects and health effects. There is also the possibility of negative impacts on the wider environment, including heritage, ecology, agriculture and designated nature conservation sites.

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[55] Ministry of Housing, Communities and Local Government (2014) Planning Practice Guidance: How and when are the details of any significant environmental impacts best addressed? Paragraph: 011 Reference ID: 27-011-20140306, Revision date: 06 03 2014 [online]. Available at https://www.gov.uk/guidance/minerals#The-Managed-Aggregate-Supply-System [Accessed 18.10.2018].

[56] Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [online] [Accessed on 5.12.2013 from http://sustainableaggregates.com/sourcesofaggregates/landbased/dust/dust_introduction.htm, but no longer available.

[57] Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [online] [Accessed on 5.12.2013 from http://sustainableaggregates.com/sourcesofaggregates/landbased/dust/dust_introduction.htm, but no longer available.

6.15. "Nuisance" dust is dust that collects on windows, cars and surfaces. This is the most frequently mentioned cause of public concern. The rate of deposition can vary enormously depending on weather conditions, and qualitative measurement of the rate and severity of dust accumulation can be difficult due to variation in public perception. There are a number of measurement methods available, but the "wide range of values and subjective descriptions used to define 'acceptable' nuisance dust deposition or spoiling, together with the fact that complaints received are often received well below these levels"[58] indicates that there is no broadly accepted useful standard.

6.16. The health effects of dust are linked to airborne particulate matter. Although any particles smaller than 2mm are sometimes called dust, the industry standard defines dust as particulate matter between 1 and 75µm in diameter. Particles smaller than 10µm are considered "inhalable", while particles smaller than 2.5µm are "respirable" which means they are small enough to be taken down into the lungs. Generally, particles larger than 10µm are associated with nuisance and particles smaller than that cause health concerns[59]. Industry body Sustainable Aggregates states that "it is not thought that there are any substantiated claims that health has been affected around working quarries", but if any evidence to the contrary is brought to our attention, we will revise our guidance as appropriate.

6.17. Good site management can help reduce the impacts of dust at the source. The PPG indicates that mineral operators are expected to prepare a dust assessment study where dust emissions are likely to arise.

6.18. The key stages of a dust assessment as identified by the Guidance are:

- establish baseline conditions of the existing dust climate around the site of the proposed operations;
- identify site activities that could lead to dust emission without mitigation;
- identify site parameters which may increase potential impacts from dust;
- recommend mitigation measures, including modification of site design; and
- make proposals to monitor and report dust emissions to ensure compliance with appropriate environmental standards and to enable an effective response to complaints.

6.19. The severity of dust impacts can also depend on the types and sensitivities of nearby receptors. Special care must be taken to ensure that facilities that are sensitive to dust are not unduly impacted by quarry workings. Dust

[58] Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [online] [Accessed on 5.12.2013 from http://sustainableaggregates.com/sourcesofaggregates/landbased/dust/dust_introduction.htm, but no longer available.

[59] Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [online] [Accessed on 5.12.2013 from http://sustainableaggregates.com/sourcesofaggregates/landbased/dust/dust_introduction.htm, but no longer available.

impacts arising from extraction can be mitigated through the following means[60]:

- Using dust filters on equipment where possible,
- Restricting dust-creating activities to certain times or locations,
- Using water sprays and wheel-washes,
- Protecting materials and active work areas from wind.

Noise

6.20. Noise is an inevitable consequence of mineral workings. It is an important health and safety consideration for employees in the sector, and becomes an issue for the surrounding area when it disrupts or disturbs people outside the site boundary[61].

6.21. Noise can be created during stone extraction, processing, and during the transportation of material around and off the site. Hard rock extraction may include blasting, which in addition to noise, can cause other concerns. This is covered in detail in the Blasting section below.

6.22. The PPG requires a noise emissions assessment to be carried out, and the mineral planning authority to establish appropriate noise limits for any extraction occurring in proximity to noise-sensitive properties[62].

6.23. In addition to setting noise limits, there are a number of other ways to mitigate the noise impacts caused by building stone quarrying:

- Limiting working hours,
- Taking care with reversing alarms,
- Minimising drop heights from lorries or plant,
- Using rubber linings in chutes or transfer points where appropriate, and
- Switching off machinery when not in use.

6.24. Site design is also an important factor for managing noise impacts, and planted screens and bunds may assist with noise management in addition to addressing dust and visual impacts (though in some cases the bunds themselves may cause a nuisance – see below under 'Visual impacts'). The shape of hard rock quarries may be used to assist with noise control.

Blasting

[60] Arup Environmental/Ove Arup & Partners (1995) *The Environmental Effects of Dust from Surface Mineral Workings*. Report on behalf of the Department of the Environment.
[61] Sustainable Aggregates (2011) *Information Gateway: Operational considerations: Dust* [online] [Accessed on 5.12.2013 from http://sustainableaggregates.com/sourcesofaggregates/landbased/dust/dust_introduction.htm, but no longer available.
[62] Ministry of Housing, Communities and Local Government (2014) *Planning Practice Guidance:* How should minerals operators seek to control noise emissions? Paragraph: 019 Reference ID: 27-019-20140306, Revision date: 06 03 2014 [online]. Available at https://www.gov.uk/guidance/minerals#The-Managed-Aggregate-Supply-System [Accessed 18.10.2018].

6.25. With hard rock extraction, stone must first be fractured or fragmented in order to facilitate excavation. To turn solid deposits into crushed stone, blasting is frequently required. The issues caused by blasting are linked to the fact that "not all the energy produced when the explosive is detonated goes into breaking the rock. Some of it is 'lost' in the form of heat, sound, displacement which can cause "flyrock" and ground shaking (vibrations)".[63] Modern technology and techniques can help minimise these impacts, but blasting still requires careful attention.

6.26. The main unwanted effects of blasting include flyrock, vibrations, noise, dust, and fumes. These impacts are managed under the Quarries Regulations 1999 which require a written specification to be prepared by the operator for each blasting operation to ensure that blasting operations take place safely.

6.27. Flyrock is defined as "fragments of rock propelled into the air by explosions".[64] As the primary danger is to people and property in the vicinity of the blast site, this is normally addressed through health and safety regulations.

6.28. Vibrations may be transmitted through the ground (seismic waves) or through the air ("overpressure"). These can cause buildings to shake and cause nuisance to surrounding properties. In extreme cases, vibration can cause damage. Vibrations are often amplified by buildings, and are likely to feel stronger inside a building than they are outside.

6.29. Blasting noise comes from two sources: gases venting from the blast area, and rocks collapsing. Noise may be augmented by the effects of ground vibrations or overpressure (through rattling windows, for example).

6.30. Dust can be associated with blasting. Dust from blasting is normally controlled by existing dust mitigation strategies in place on the site[65]. Please refer to the 'Emissions section for more details on dust.

6.31. Fumes can also occasionally be produced during blasting operations, but this is rare.

6.32. Blasting is a complex part of hard rock quarrying, and operators require a "comprehensive understanding of the blast design parameters and the mechanisms which control the environmental impacts" in order to ensure blasting takes place in absolute safety. Blasting at quarries in England is subject to considerable regulation.

Protected Sites

[63] Sustainable Aggregates (2013) *Blasting: Introduction* [online] Accessed 21.01.2014, but no longer available.
[64] Sustainable Aggregates (2013) *Blasting: Introduction* [online] Accessed 21.01.2014, but no longer available.
[65] Sustainable Aggregates (2013) *Blasting: Introduction* [online] Accessed 21.01.2014, but no longer available.

6.33. Generally, hard rock resources in Worcestershire are coincident with Areas of Outstanding Natural Beauty (AONB) and Sites of Special Scientific Interest (SSSI). These are areas "where geological diversity has contributed to the attractiveness of the landscape and to distinctive styles of traditional architecture,"[66] as well as to biological and geological interest. The hard rock resources are therefore constrained to varying degrees by national designations.

6.34. The NPPF states that mineral planning authorities should, as far as practical, "provide for the maintenance of non-energy minerals from outside […] Areas of Outstanding Natural Beauty".[67] Of the land containing Malverns Complex and Warren House Formation deposits in Worcestershire, 99.4% is within the Malvern Hills Area of Outstanding Natural Beauty[68] and 82.7% is controlled by the Malvern Hills Conservators[69] who own the mineral rights and have a unique responsibility "to save the beauty of the Hills and protect them from the threat of quarrying".[70] Of the land containing limestone deposits in Worcestershire, 68.8% is within 2.5km of the Bredon Hill Special Area of Conservation (SAC)[71] and 94.2% is within the Malvern Hills Area of Outstanding Natural Beauty or the Cotswolds Area of Outstanding Natural Beauty.[72]

6.35. Local sites can also be designated for a variety of purposes, including nature and geological conservation, and the County Council regards these sites as material considerations. Although crushed rock quarries can be restored, it may not be possible to restore them to the same type or standard of landscape that was present prior to working.

6.36. Hard rock quarries often expose geological features of scientific and aesthetic interest which themselves may warrant designation. In Worcestershire, there are a number of examples of disused quarries which are protected as SSSIs because of their geological value.

6.37. In Worcestershire Geological SSSIs that are former quarries include Woodbury Quarry (which exposes a compete succession through the Ludlow Shales[73]) and the quarries of the Malvern Hills. Penny Hill Quarry

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[66] English Heritage (2008) *Mineral Extraction and the Historic Environment* English Heritage Publications, p.13

[67] Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 205(a).

[68] By area (541 hectares of 544 hectares). Worcestershire County Council (August 2018) Location of development: screening and site selection methodology.

[69] By area (450 hectares of 544 hectares). Worcestershire County Council (August 2018) Location of development: screening and site selection methodology.

[70] Malvern Hills Act 1924. Further details regarding the unique legislative context of quarrying in the Malvern Hills is set out in The Malvern Hills Acts background document available at http://www.worcestershire.gov.uk/mineralsbackground.

[71] By area (763 hectares of 1,109 hectares). Worcestershire County Council (August 2018) Location of development: screening and site selection methodology.

[72] By area (1,045 hectares of 1,109 hectares). Worcestershire County Council (August 2018) Location of development: screening and site selection methodology.

[73] Earth Heritage Trust (2014) *Woodbury Quarry* [Online] Available at http://www.earthheritagetrust.org/pub/learning-discovery/aggregates/aggregates-of-worcestershire/site-examples-worcs/woodbury-quarry/ [Accessed 18.10.2018]. [accessed on 22.01.2014]

has been restored by landfill but the site includes grassland which has been designated an SSSI.

6.38. Safeguarding the natural environment as well as sites of historical importance can give rise to occasional conflict; however the Green Infrastructure approach adopted by the council is founded on the idea that it is possible to successfully address both priorities through comprehensive restoration plans.

6.39. National and international designations for protected areas afford a high degree of protection from development. While quarries in designated areas may be at less risk of being lost through other development, their importance as sources of nationally important reserves should not be overlooked.

Green Belt

6.40. The north-eastern part of Worcestershire lies within the Green Belt. Kidderminster, Bromsgrove and Redditch are completely surrounded by Green Belt and the area between Worcester and Droitwich is also designated as Green Belt. National policy on mineral working in Green Belt land will apply here.

6.41. The NPPF states that there should be no inappropriate development in the green belt, but that mineral extraction is not inappropriate in the Green Belt provided it preserves its openness and does not conflict with the purposes of including land within it.[74]

6.42. Most of Worcestershire's hard rock deposits do not coincide with Green Belt areas; the areas covered by Green Belt primarily contain large deposits of solid sand. There is one small area of hard rock within the Green Belt (the Lickey Quartzite) which outcrops to the north-east of Bromsgrove, but this deposit has not been worked for crushed stone in recent times. The nature of particular deposits will determine the configuration of any site proposed within the Green Belt.

Visual impacts

6.43. Any large minerals extraction operation will have visual impacts, as will any large buildings or machinery. Smaller quarries will likely have correspondingly smaller visual impacts. Any mineral working must consider the effect it will have on the surrounding area, both during working phases and in the final restoration scheme.

6.44. The hard rock deposits in Worcestershire that are appropriate for crushed rock aggregate are mainly found on high ground in designated areas. This means that they could have visual impacts across a large area.

[74] Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 146

6.45. The visual impacts of hard rock quarrying are generally perceived to be negative, and can arise from a combination of factors, including:

- "elements which contrast in terms of form, height, mass and colour, thereby creating incongruity in the landscape;
- Perceived negative associations with industrial processes […]
- Long term and, therefore, perceived permanent duration".[75]

These effects can be divided into two categories: obstruction and intrusion:

"Visual intrusion occurs when a pre-existing view of the landscape is encroached upon adversely by a new element which is of poorer visual quality. Conversely, visual obstruction results from such a feature blocking and preventing visibility of any pre-existing view".[76]

6.46. Designers must also take into account that the activities at a quarry will change over time with associated effects on visual impact. While some impacts of excavation may be temporary, "the actual excavation and some earth structures constitute permanent landscape change. The long-term physical and visual modification of the landscape must, therefore, be considered".[77] This is typically addressed through restoration plans.

6.47. The mitigation of visual impacts during the working phase can be similar to the mitigation of noise, including planting and bunds. Soil bunds can prove problematic as they may cause additional visual impacts that are inconsistent with the landscape in which they are found, and as they are used so frequently, "an engineered, grassed bund often serves to signal the very presence of the quarry it is intended to hide, obstructing views of the landscape beyond[78]".

6.48. A number of alternative approaches to mitigating visual impact are available including:

- Site selection, orientation and size
- Working methods, phased extraction and progressive restoration
- Screening through advance planting, stone walls and other methods
- Camouflage through colour and natural materials
- Careful design of haulage and transport routes to, from, and within the site
- Good housekeeping including tidiness of the quarry site and weed control[79].

6.49. Where it is impossible to mitigate the visual effects of a quarry (such as through effects on high ground, or plant located on a skyline), the approach should focus on ensuring that the number of viewers and viewpoints affected is minimised and the duration of disruption is also limited. Critical viewpoints to consider may include residential properties, roads, footpaths and public rights of way. Public engagement by the quarry operator is

[75] Nicholson, D. (1995) *The Visual Impact of Quarrying,* Quarry Management, July 1995, p.39
[76] Nicholson, D. (1995) *The Visual Impact of Quarrying,* Quarry Management, July 1995, p.39
[77] Nicholson, D. (1995) *The Visual Impact of Quarrying,* Quarry Management, July 1995, p.40
[78] Nicholson, D. (1995) *The Visual Impact of Quarrying,* Quarry Management, July 1995, p.41
[79] Nicholson, D. (1995) *The Visual Impact of Quarrying,* Quarry Management, July 1995, p.41

regarded as an important factor in managing expectations with respect to visual impacts.

6.50. Visual Impact Assessments are often required for hard rock quarry applications – this is sometimes included in an Environmental Impact Assessment. These typically include background research, mapping work, topographical modelling and field surveys. The Cotswolds and Malvern Hills AONB Management Plans may provide some guidance on visual impact issues that are specific to Worcestershire. The draft policies of the Minerals Local Plan will consider how to address Visual Impact Assessment.

Climate change and resilience

6.51. The Council's 'Minerals and Climate Change' background paper outlines some of the key climate change sustainability issues for the minerals sector and areas in which the minerals industry can contribute to sustainability targets. These include energy efficiency and renewable energy, transportation and other emissions, flood mitigation, habitat creation and biodiversity.

6.52. The capacity for crushed rock quarries to contribute to these targets is heavily influenced by the particular characteristics of these sites. Restored workings are likely to be able to contribute towards biodiversity, flood mitigation, and habitat creation targets.

Potential for restoration

6.53. Quarrying is ultimately a temporary land use, and quarries present excellent opportunities for restoration and for biological, geological and cultural conservation. The NPPF states that minerals planning authorities should "provide for restoration and aftercare at the earliest opportunity, to be carried out to high environmental standards".[80]

6.54. Hard rock quarries present unique challenges for restoration. Because they are often large holes below ground level or excavations into a hillside, restoring the land to the original level or topological profile is usually impossible and restoration may not be practical until the site is worked out. The type and amount of overburden removed from the workings may also affect the restoration potential. Because of the long duration of many hard rock workings, measures put in place to mitigate noise, dust or vibration (such as bunds or screens) may become part of the permanent restoration plans[81].

[80] Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 205.
[81] GWP Consultants (2008) *Quarry Design Handbook: Appendix 4-3, Principles of design for hard rock quarries* [online] Available at http://www.gwp.uk.com/research.html [Accessed 18.10.2018].

6.55. The industry considers 'rolling' or phased reclamation to be best practice. However, this may not be possible in a hard rock quarry due to the geological conditions and the shape of the working area. In these cases, it might be possible to restore the upper benches (those worked first) in order to lessen the visual impact of the quarry from a distance[82].

6.56. Much of the best practice guidance for quarry restoration applies to large-scale sand and gravel sites that are able to progressively return large areas of former workings to productive use and contribute to biodiversity or habitat creation targets. However, hard rock quarries can also present excellent opportunities for nesting sites for certain birds or have great potential for colonisation by specialist plant species.

6.57. Historically, many hard rock sites were simply abandoned. Over time, these have been softened by erosion and natural regeneration, but abandonment no longer accords with national policy and will no longer be acceptable. More recently, many sites have been 'restored' using landfill material, but this is no longer considered the automatic solution. The adopted Waste Core Strategy for Worcestershire actively discourages landfill as a restoration option, and in future we may have to carefully consider options for these sites to ensure restorations result in acceptable landforms that are sympathetic to their surroundings and in keeping with the landscape character of the area.

6.58. There are, nevertheless, many examples of hard rock quarries that have been successfully restored to various productive uses, including new habitats and leisure and amenity uses. Appendix 1: Restoration case studies provides examples of successful restorations.

6.59. There may be valuable geological, historical and archaeological conservation opportunities at quarry sites, and there can be a good chance of maintaining geological exposures in hard rock quarries. Such exposures can be of both scientific/educational and landscape value. It is also possible to recreate "natural" landforms through "restoration blasting", a technique that aims to replicate natural landforms by selective blasting of quarry faces. This has been undertaken successfully in Derbyshire.

6.60. Although less common, it is possible to restore former quarries through built development. A spectacular example is the creation of the Eden Project in Cornwall, but elsewhere other recreation facilities and industrial estate developments have also been successful.

6.61. In Worcestershire old quarries in the Malverns were largely abandoned and have been restored by default through natural revegetation. Because of their scientific value, many have subsequently been cleared to expose geological sections. Some have also been turned into car parks and picnic sites. Fish Hill Quarry at Broadway is being restored to nature conservation and agriculture.

[82] GWP Consultants (2008) *Quarry Design Handbook: Appendix 4-3, Principles of design for hard rock quarries* [online] Available at http://www.gwp.uk.com/research.html [Accessed 18.10.2018].

Historical conservation

6.62. The historical aspects of crushed rock extraction may fit into one of several categories: archaeological remains on the site (including the remains of other historical workings in the same location which require preservation); the impact of the development on the settings of listed buildings, monuments or other sites; and changes to historic landscape character.

6.63. Each of these categories presents unique challenges for site restoration. In the case of archaeological remains, discoveries may ultimately be removed from the site altogether after excavation and therefore not have any implications for the site's restoration plan. However, if remains are deemed nationally significant, best practice might demand that they be preserved in situ. A restoration plan for a site that impacts the setting of a listed building might be dedicated to improving that setting and enhancing the historic landscape character, leaving it in better condition than it was found, or in a state that better reflects the historical context in which the building was originally found.

6.64. Like minerals, archaeological remains can only be extracted from where they occur. As these remains are irreplaceable once they have been removed, it is critical to take proper care with their handling. Archaeological remains on hard rock sites may be found in the topsoil, subsoil, overburden, or within the deposit itself.

6.65. Archaeological remains associated with hard rock areas are typically "stone cairns, standing stones, house platforms, field systems, prehistoric rock art, rock shelters, cave sites and artefact scatters".[83] The potential presence of these types of remains may be determined by pre-application assessments using a number of methods, including desk-based assessment, aerial photography, field walking, test pits and full excavation. Not all of these methods may be required, however.

6.66. If the preliminary work for a project has identified archaeological issues, a full archaeological assessment (which would normally form part of the Environmental Impact Assessment) may be required. This may be sufficient, but in some cases, further work might be required or there may be a requirement to preserve any new finds in situ during the work where appropriate. Guidance from English Heritage (now Historic England) states that "The quality of pre-determination information required for proposed mineral developments is a significant consideration for developers and curators because there is usually limited potential for amending permissions to take account of nationally important archaeological remains should these be found post-determination".[84]

[83] Waddington, C. (2008) Mineral Extraction and Archaeology: A Practice Guide [online] Available at https://content.historicengland.org.uk/images-books/publications/mineral-extraction-and-archaeology/mineral-archaeology.pdf/ [Accessed 18.10.2018]
[84] Waddington, C. (2008) Mineral Extraction and Archaeology: A Practice Guide [online] Available at https://content.historicengland.org.uk/images-books/publications/mineral-extraction-and-archaeology/mineral-archaeology.pdf/ [Accessed 18.10.2018]

6.67. Restoration plans for hard rock sites will also need to consider potential impacts on the settings of listed buildings or monuments or other sites, as well as potential changes to the landscape character. In some cases, the restoration of former workings may present opportunities to improve or enhance these settings. There are significant archaeological features in hard rock areas in Worcestershire, notably on the Malvern Hills, which are now formally protected. This has not always been the case, and the industry has evolved since the 1950s when workings at Fish Hill quarry exposed and destroyed Anglo-Saxon graves dug into the rock itself.

Geological conservation

6.68. Because mineral deposits are finite, mineral extraction can permanently destroy geological features that may merit conservation. However, the possibility of maintaining geological exposures in hard rock restorations is very good because of the inherent structural integrity of hard rock exposures.

6.69. Restoration which incorporates an element of geoconservation presents excellent opportunities for active community participation. The Earth Heritage Trust's 'Champions' project resulted in nine former minerals sites in Worcestershire being supported by community 'Champions' who have been trained in geoconservation and who work with land owners to arrange for educational use of the sites.

Safeguarding mineral deposits

6.70. The NPPF requires minerals planning authorities to "adopt appropriate policies so that known locations of specific minerals resources of local and national importance are not sterilised by non-mineral development where this should be avoided".[85] It also requires that appropriate facilities which support minerals production and processing be safeguarded.

6.71. Safeguarding is a key aspect of sustainable development, as it ensures that non-renewable resources are conserved for the use of future generations. The Planning Practice Guidance includes sections on minerals safeguarding. Among other issues, the guidance addresses mineral sterilisation, which occurs when other development or designation causes a mineral deposit to become inaccessible. It also provides detailed information about creating Minerals Safeguarding Areas (MSAs)[86] and Mineral Consultation Areas (MCAs).[87]

6.72. Robust safeguarding policies begin from identifying the best geological and mineral resource information, and deciding which minerals to safeguard and

[85] Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, paragraph 204.
[86] An area designated by a Mineral Planning Authority which covers known deposits of minerals which are desired to be kept safeguarded from unnecessary sterilisation by non-mineral development.
[87] A geographical area, based on a Mineral Safeguarding Area, where the district or borough council should consult the Mineral Planning Authority for any proposals for non-minerals development.

the extent of those safeguards. This can require a high degree of technical knowledge, input from industry, and careful handling of safeguarding in urban areas.

6.73. There are a number of important issues for defining safeguarding areas, including buffer zones, criteria for controlling development within MSAs, and prior extraction policies. There is currently some debate nationally about the viability of prior extraction policies.

7. Conclusions

7.1. Aggregates extraction is essential to the building industry, and as most aggregates are used within 30 miles of their point of extraction, continued local supply of these minerals is critical to the future prosperity of the county.

7.2. Worcestershire contains important hard rock deposits which were worked historically but which are no longer worked. Most of the county's hard rock deposits are constrained by conservation designations, including AONBs and SSSIs. As a result, the county does not currently have a landbank of crushed rock and there are no current applications for crushed rock extraction.

7.3. The adopted Minerals Local Plan (1997) identified a number of preferred areas for minerals development including preferred extension areas for hard rock quarrying. These areas have all been worked, and in order to ensure that production in the county continues, it is important that areas are identified through the emerging Minerals Local Plan.

7.4. Protecting hard rock deposits for the future is also important, and this will be addressed through safeguarding policies to be included in the emerging Minerals Local Plan.

7.5. Crushed rock aggregate sites present excellent opportunities for restoration, and have the capacity to make significant contributions towards habitat, biodiversity, flood mitigation, food production and conservation targets. Visual and amenity issues must be carefully handled in order to mitigate any adverse impacts resulting from the quarry.

Appendix 1: Restoration case studies

CASE STUDY: **CLICKER QUARRY (ADRENALINE QUARRY)**
Location: Cornwall, near Liskeard
Stone Quarried: Blue Elvin (or Elvan, or Alvan)

Clicker Quarry operated from 1932 to 1969 as a quarry for the hard stone known locally as "Blue Elvin" granite. This stone was used primarily as ballast for the Great Western Railway. Recreational use of the quarry began in 1986, and the following 25 years have seen the further development including the UK's longest zip wire. The site is a designated geological SSSI, and the management company for Adrenaline Quarry have a woodland management programme in place to ensure that the wildlife who reclaimed the quarry during the decades it lay silent can continue to call the quarry home. The Cornwall Council's planning department declared the quarry "an intelligent use of space"[88].

CASE STUDY: **STONEY STANTON (STONEY COVE)**
Location: Leicestershire, Stoney Stanton
Stone Quarried: South Leicestershire Diorite (granite)

Quarrying at Stoney Stanton began in the early 19th century. By 1850, the site was established enough to support the construction of a railway line to move material out of the pit to the centre of the village. South Leicestershire Diorite was quarried mainly for use as a road stone. Spring water was a constant problem during the working life of the quarry, and when work ceased in 1958 it was allowed to flood. By the early 1960s, the site was being used as a training site for divers for the North Sea oil platforms. In 1978, a management company was formed to develop the quarry's potential as a scuba facility, and continuous improvements to the facilities there have made Stoney Cove one of the leading inland dive centres in the UK[89].

CASE STUDY: **WHITMAN'S HILL QUARRY**
Location: Storridge near Malvern in Herefordshire
Stone Quarried: Coalbrookdale mudstones and Much Wenlock Limestone

This former hard rock quarry in Herefordshire provided mainly aggregates and foundation stone. It was in operation as early as 1876 and ceased operation in 1988. The quarry was then "restored and made safe"[90], a process which included face clearance, tree planting and the construction of earth bund walls to protect visitors from steep slopes. The site was designated a Regionally Important Geological site in 1999, and in 2005 The Herefordshire and Worcestershire Earth Heritage Trust acquired a ten year lease to manage and run the site as the Whitman's Hill Geodiversity Discovery Venture. The quarry is known for its

[88] Adrenaline Quarry (2013) *Press Kit: All the Facts* Adrenaline Quarry, Cornwall [online] available at http://www.adrenalinquarry.co.uk/media-centre/ [Accessed 18.10.2018].
[89] Stoney Cove (2013) *Stoney Cove History* [online] available at https://www.stoneycove.com/our-heritage.html [Accessed 18.10.2018].
[90] Herefordshire and Worcestershire Earth Heritage Trust (Undated) *The Heritage of Whitman's Hill Quarry* Earth Heritage Trust.

abundance of fossils, and the Earth Heritage Trust offers guided visits to the site for geologists, students and the general public. A fossil collecting area has been created at the quarry in order to make the site as accessible as possible.

Images 4, 5 and 6: Fossil collecting visit to Whitman's Hill Quarry. *Photos © Sarah Button.*

Appendix 2: Glossary

Crushed rock: Crushed rock is produced using heavy machinery which mines a suitable deposit of hard, strong rock and then crushes it into uniform particle sizes. Crushed rock is typically sharp and angular.

Designated areas: A collective term that includes a number of statutory designations including European Designated Sites (Special Areas of Conservation, SACs), National Nature Reserves, Sites of Special Scientific Interest, Scheduled Monuments, Areas of Outstanding Natural Beauty, Conservation Areas, Listed Buildings, Battlefields, Local Geological Sites, Registered Parks and Gardens, and Local Wildlife Sites.

Landbank: This term is used to refer to the stock of mineral reserves with planning permission in a given area.

Limestone: A sedimentary rock mainly made up of calcium carbonate ($CaCO_3$) fragments such as shells and coral fragments. Often contains fossils[91].

Natural Stone: Stone whose shape and size has been determined by natural forces. This term can also be used to distinguish naturally occurring stone from reconstituted stone or other manufactured products.

Quarry: A site where rock or minerals are extracted from the earth.

Restoration: A process whereby a former mineral extraction site is returned to beneficial after-use. Building stone extraction is often a temporary or intermittent land use, and once all of the mineral has been won the site will no longer be useful for mineral extraction and an after-use will have to be established. This is often referred to as "restoration", even though sites are not always returned to their original use or condition. For example, it may be more appropriate for low-grade agricultural land to be 'restored' as a lake or nature reserve rather than returned to agriculture.

Sandstone: A sedimentary rock made up of sand-sized grains that are generally visible to the naked eye[92].

[91] Oliver, P., and Lott, G. (Ed.) (2012) *Strategic Stone Study: A Building Stone Atlas of Worcestershire* English Heritage.
[92] Oliver, P., and Lott, G. (Ed.) (2012) *Strategic Stone Study: A Building Stone Atlas of Worcestershire* English Heritage.