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Karst Management Plan for Stage 1

E & JW Glendinning Ltd.

November 2024

LINHAY-ATK-S1-G-001

LINHAY HILL QUARRY, ASHBURTON - PLANNED EXTENSION

Notice

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1. Introduction

1.1. This is the first revision of the Karst Management Plan 2021 (KMP) that was prepared in 2021 following the Grant of Conditional Planning Permission in March 2021 for planning permissions reference 0322/16 & DCC/3994/2017 for the extension to Linhay Hill Quarry, Ashburton, Devon. The planning condition requiring preparation of the KMP is Condition 20. This version is prepared for Stage 1 of the quarry extension to discharge the requirement of part b of Condition 21, which states:

21. Following approval of the Karst Management Plan in Condition 20,

a) monitoring shall be undertaken, and mitigation implemented, in accordance with the approved Karst Management Plan or such revised plan as may be approved in writing by the Mineral Planning Authority from time to time under part b) of this condition; and

b) the extraction of limestone in Stage 1 of the extension area, and in each subsequent Stage of the extension up to and including Stage 6 and a post-restoration period to be agreed, shall not be commenced until a revised Karst Management Plan (including updated monitoring and mitigation measures) for that stage has been submitted to and approved in writing by the Mineral Planning Authority.

1.2. The KMP 2021 covered the following topics, and this version provides updates or revised proposals in the same order.

- Baseline Building Surveys.
- Karst Liaison Network.
- Land stability trigger events and mitigation responses.
- Ground surface monitoring.
- Arrangements for reporting of data and findings.
- Process of dispute resolution.

1.3. This KMP for Stage 1 should be read in conjunction with the report ‘Proposed Extension to Linhay Hill Quarry Land Stability Risk Assessment (LSRA) 2020’, August 2020 prepared by Atkins Ltd.

2. Baseline Building Surveys

2.1. During Stage 0 the owners and occupiers of Lower Waye, Alston Farmhouse, Alston Cottage, and properties within the hamlet of Caton were approached for consent to undertake a baseline building survey. Permission was obtained in respect of all but three of these properties. The Baseline Building Surveys were undertaken by PCA Consulting Engineers during 2022-2023. Copies of the Baseline Survey Reports were provided to the DNPA in March 2024.

2.2. The Baseline Survey Reports will be used as a record of the structural condition of those properties before the extension commences in the event that changes in condition are detected in future.

2.3. No further baseline surveys are proposed during Stage 1.

3. Karst Liaison Network

3.1. The Karst Liaison Network (KLN) is a requirement of Condition 20b and the proposals for the KLN were set out in the KMP 2021. The KLN is open to landowners, tenants, and occupiers of surrounding agricultural and developed land situated on the Chercombe Bridge Limestone Formation outcrop within 1 km from the red line of the quarry extension planning permission and provides a mechanism for land stability matters to be reported to the Mineral Planning Authority and E & JW Glendinning and recorded appropriately.

3.2. The network is based on a dedicated 'Karst Log' page on E&JW Glendinning's website (ejwglendinning.co.uk) which was set up in the summer of 2022. It includes background details about karst geology and features and a facility to log observed changes to the ground or buildings together with photographs if available. The facility is tested periodically to confirm that it is working.

3.3. In August 2022 Ashburton Town Council, Devon County Council, the DNPA and the British Geological Survey were informed of the establishment of the KLN and provided with the link to the relevant page of the website. Members of the Local Liaison Group were informed about the KLN at the meeting in September 2022.

3.4. To date (September 2024) no new karst features have been reported through the web page. However Glendinning was contacted direct by the South Dartmoor Community College in autumn 2023 about the formation of possible new sinkholes on the college campus which have been investigated by the school and found to have been caused by faulty surface water drainage. The drainage and sinkholes have now been repaired and the details added to the Map of Sinkholes and the Table of Sinkholes in Appendix A. The map in the karst section of the Glendinning website will also be kept updated.

3.5. Further details are provided in the KMP Monitoring Report 1 (2022 to Sept 2024).

3.6. No changes to the arrangements for the Karst Liaison Network are proposed in this KMP for Stage 1, so the existing KLN arrangements will continue for Stage 1 of the quarry extension.

4. Land Stability Trigger Events and Mitigation Responses

4.1. Proposals for the setting of land stability trigger events and mitigation responses are a requirement of Condition 20c. and details were set out in Chapter 5 of the KMP 2021.

4.2. No changes to those details are proposed for this KMP for Stage 1, so the land stability trigger event and mitigation response details remain for Stage 1 as stated in Chapter 5 of the KMP 2021, and the relevant text is replicated herein Appendix C.

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5. Ground Surface Monitoring

5.1. Ground surface monitoring is proposed in the LSRA 2020 and is a requirement of planning condition 20d. Proposals for ground surface monitoring during Stage 0 by scheduled and ad hoc walkover surveys were set out in Chapter 6 of the KMP 2021. Minor changes are proposed in Stage 1 to the frequency of the scheduled surveys to two a year, once in March to April and once in September to November.

5.2. The additional walkover survey outlined in the KMP 2021 for between April and September of the areas around receptors denoted as 'medium' risk in Table 6-5 of the LSRA 2020, namely the new Alston Farm access from chainage 350, Alston Cottage and the diverted Alston stream, is no longer considered necessary. That is because E & JW Glendinning Ltd. carries out frequent liaison with its tenants at Alston Farm and Alston Cottage and there is also now a reporting mechanism via the KLN. Furthermore the diversion of the Alston stream is not planned until required for formation of the Stage 2b overburden bund which may not be until circa 2030.

5.3. Also to avoid replicating walkovers within a few days of each other it is not considered necessary to carry out a scheduled walkover if an 'ad hoc' visit in response to high rainfall is carried out during the period of and before a scheduled walkover.

5.4. The proposed revised ground surface monitoring is detailed as follows:

Objectives

5.5. Monitoring before, during and after the deepening and extension of the quarry provides a means of enhancing the land stability and hydrogeological conceptual models and for the early identification of changes to or impacts on drainage, watercourses, and potential sinkhole development.

5.6. The LSRA 2020 contains the baseline knowledge of sinkholes which was established by Atkins by walkover surveys in December 2016, August 2017, October 2019 and March 2020, in combination with examination of historical aerial photographs held by Historic England and the Dartmoor National Park Authority, and regular monitoring visits.

5.7. The previous walkover surveys entailed the inspection of Linhay Hill Quarry, geomorphological walkover of accessible land, and the observation of surrounding land. Their objective was to identify and assess possible karst features, including those interpreted by Atkins from remote sensing (satellite imagery and historical aerial photographs).

5.8. The objective of the walkover surveys proposed herein is to continue to update the Map of Sinkholes and accompanying Table (Appendix A of this KMP for Stage 1) and to update the map of hydrogeological features (Appendix B of this KMP for Stage 1) and record the survey findings and land stability mitigation response.

Data collection

Geographical limits of surveys

5.9. For continuity with the KMP 2021, the limits of the surveys will continue to be defined by the predicted maximum unmitigated extent of groundwater drawdown, which is presented as Figure 5-3 in Section 5 of the HIA 2020 and included as Appendix D of this KMP for Stage 1.

Frequency

5.10. Scheduled walkover surveys of the full area within the predicted maximum unmitigated extent of groundwater drawdown will be undertaken twice yearly: once in March to April and once in September to November.

5.11. Additional ad hoc walkover surveys will be carried out after high rainfall events because they have the potential to trigger sudden sinkhole appearance. For consistency with the KMP 2021 high rainfall events are defined herein as the total rainfall within a 24 hour period that exceeds 51mm.

5.12. That rainfall was for a return period of 1 in 2 years derived using the Flood Estimation Handbook 2013 (FEH13) rainfall model for the Balland Stream and Kester Brook catchments. However, for information, the latest rainfall model is now from 2022 (FEH22) which predicts the 1 in 2 year 24 hour rainfall within those catchments to be 54.3 - 55.1mm.

5.13. E & JW Glendinning will monitor the Environment Agency's rainfall data recorded at the Bickington tipping gauge rainfall station by including the rainfall data for the Bickington station within the E & JW Glendinning website. If the 1 in 2 years 24 hour (taken from 0800h to 2000h) rainfall value (51 mm) is exceeded, E & JW Glendinning will alert its advisors / specialists, who will undertake a survey of the areas around those receptors which are denoted as 'medium' risk in Table 6-5 of LSRA 2020 within four weeks of the high rainfall event. That table is included as Appendix E of this KMP for Stage 1. Note there are no receptors denoted as 'high' risk.

Method

5.14. The majority of land within the geographic limits of the surveys is rural with agricultural use where the land cover varies considerably spatially, seasonally and from year to year, ranging from natural vegetation seasonal changes or pasture grazed low to very long grass for hay or silage, to ploughed or tilled fields of soil with crops planted varying from pumpkins to maize with the latter providing dense cover to over 1.5m high. Nevertheless it is an apparent change in the eyeline view of the colour, shade, shape or height of ground cover over the land being surveyed which has been found to be the main indicator observation meriting further investigation during a survey.

5.15. The walkover surveys will comprise observation from walkover or viewpoints on public rights of way with the aim of identifying changes to the terrain or drainage which may indicate a potential sinkhole and record the dimensions, classification, and coordinates of new sinkholes if observed. Distinct changes observed to existing sinkholes or drainage will also be recorded.

Reporting

5.16. The reporting of the collected data is described in Section 6 of this KMP for Stage 1.

6. Reporting of data and findings

6.1. The KMP 2021 proposed that an annual report would be produced to include:

- The results of the walkover surveys (both scheduled and ad hoc in response to high rainfall events).
- Details of sinkholes and other observations reported through the KLN.
- Updated versions of the Map of Sinkholes and accompanying Table.
- Details of hydrogeological and hydrological data collected in accordance with the requirements of Conditions 15 to 17, where relevant to land stability.
- Details of mitigation measures undertaken in response to the development of a sinkhole; and
- review of the data and, if appropriate, the presentation of recommendations for modification of the monitoring scheme (described in Section 6 [of the KMP 2021]).

6.2. The KMP 2021 covers the Stage 0 duration of the extension to Linhay Hill Quarry which is anticipated to be circa 3.5 years to spring 2025, whereas Stage 1 of the extension is planned to be circa eleven years.

6.3. Therefore it is proposed that during Stage 1a reporting on the matters in the preceding list be compiled to cover circa every two years. That frequency should ensure the reporting process is not too frequent or onerous given that data from the KLN or surveys or other site visits will be available during planning monitoring visits or on request.

7. Process of dispute resolution

7.1. The proposals for a process of dispute resolution were set out in Chapter 8 of the KMP 2021.

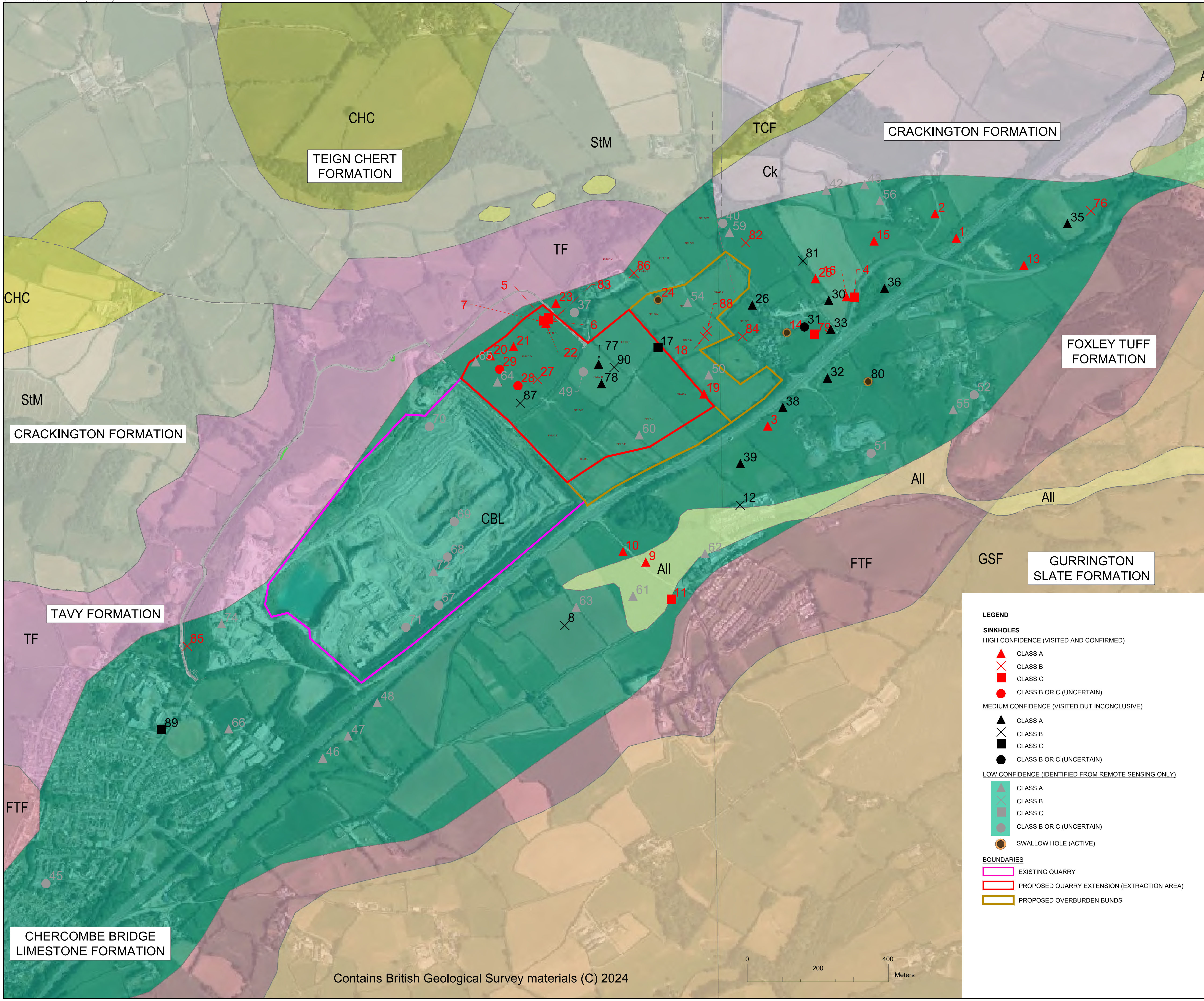
7.2. No changes to the process are proposed in this KMP for Stage 1, so the process remains as stated in the KMP 2021 and replicated below:

1. Disputes between the parties (i.e. the Mineral Planning Authority, a member of the KLN, and E & JW Glendinning Ltd) relating to a matter regarding ground stability that cannot be resolved by negotiation may be referred by any of the parties for the determination of an Arbitrator who shall be appointed by agreement between the parties.
2. The Arbitrator shall be a Chartered Geologist with at least ten years' relevant experience.
3. If the parties cannot agree on the appointment of an Arbitrator, then E & JW Glendinning Ltd will ask the President of the Geological Society of London or his/ her nominated deputy (or its equivalent if that society no longer exists) to appoint an Arbitrator.
4. The Arbitrator shall have full discretion to award costs between the parties, including his/ her own costs, as he/she shall consider fair and reasonable in all the circumstances.

APPENDICES

Appendix A. Map and Table of Sinkholes

A.1. Map of Sinkholes



KEY

All	Alluvium
Ck	Crackington Formation
TCF	Teign Chert Formation
CHC	Codden Hill Chert, previously known as Mount Ararat Chert
GSF	Gurrington Slate Formation
TF	Tavy Formation, previously known as Kate Brook Slate Formation
CBL	Chercombe Bridge Limestone
FTF	Foxley Tuff Formation
StM	St. Mellion Formation
RM	Rora Mudstone Formation
	Faults

LEGEND

SINKHOLES

HIGH CONFIDENCE (VISITED AND CONFIRMED)
- CLASS A
- CLASS B
- CLASS C
- CLASS B OR C (UNCERTAIN)

MEDIUM CONFIDENCE (VISITED BUT INCONCLUSIVE)
- CLASS A
- CLASS B
- CLASS C
- CLASS B OR C (UNCERTAIN)

LOW CONFIDENCE (IDENTIFIED FROM REMOTE SENSING ONLY)
- CLASS A
- CLASS B
- CLASS C
- CLASS B OR C (UNCERTAIN)

SWALLOW HOLE (ACTIVE)

BOUNDARIES
- EXISTING QUARRY
- PROPOSED QUARRY EXTENSION (EXTRACTION AREA)
- PROPOSED OVERBURDEN BUNDS

Rev.	Date	Description	By	Chk'd	App'd
P02	25/10/24	Update for Oct KMP monitoring, feature 90	TSM		

Drawing Status: FOR INFORMATION
Suitability: S1

AtkinsRéalis
The Octagon
2nd floor, Pynes Hill Court
Rydon Lane
Exeter
EX2 5AZ
Tel: +44 (0)1392 352900
Fax: +44 (0)1392 352999
www.atkinsrealis.com
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Client: Glendinning

Project Title: LINHAY HILL QUARRY PROPOSED EXTENSION

Drawing Title: LOCATION OF SINKHOLES MAPPED BY ATKINS

Scale	Designed	Drawn	Checked	Authorised
1:10000	JH	JDP	TSM	ATF
Original Size: A3	Date: 02/09/2024	Date: Aug 2024	Date: 06/09/2024	Date: 09/09/2024

Drawing Number: LHQALS-ATK-S1-DR-C-010
Revision: P02

Internal Project Number: 5196443

A.2. Table of Sinkholes

Linhay Hill Quarry, Ashburton - Planned Extension
Karst Management Plan - Table of sinkholes / land stability trigger events recorded post KMP June 2021

Feature ID	Date observed / recorded	Land stability trigger event mapped / reported and location	Potentially karst related Yes / No	Building affected Yes / No	Building inspection Yes / No + findings	Sinkhole feature Class	Confidence in presence of sinkhole	Receptor / Land use	Receptor Sensitivity	Feature repaired ?			Included in sinkhole map ?
										Yes / No	Non engineered infill + details	Engineering repair + details	
80	01/02/2016	Suspected swallow hole where Caton stream normally infiltrates to ground	Yes	No	No	Class C	Medium	Small woodland copse	Low	No	N/A	N/A	Yes
83	03/06/2021	Alston Farm, circa ch 450 of new access	Yes	No	No	Class B	High	New access to Alston Farm	Medium	Yes	N/A	Yes, partial excavation (soil too deep to bedrock), backfill with boulders then gravel with geogrid.	Yes
84	07/05/2021	Steep sided hole in ground observed under dense bramble and nettle vegetation inside west boundary of field in east of Alston Farm.	Yes	No	No	Class B	High	Farm field used for hay, not grazing, but just inside west boundary where circa 3-4m wide area of dense bramble and nettles around the the inside of the field boundary.	Low	No	N/A	N/A	Yes
85	06/01/2022	East of public footpath three depressions encountered during vegetation clearance for public footpath diversion, east of Waye Lane chainage 120.	Yes	No	No	Class C	High	Woodland at toe of bund along quarry's west boundary	Low	Yes	Infill with gravel and installation of new drainage for Waye Lane will capture the previous flow of surface water from west of the public footpath.	N/A	Yes
86	10/03/2022	Alston Farm, field T, near Alston stream & 11kV diversion	Yes	No	No	Class B	High	Farm field for pasture	Low	Yes	Excavation then backfill with limestone boulders then soil arisings.	N/A	Yes
87	23/06/2022	Alston Farm, field A.	Yes	No	No	Class B	Medium	Farm field for pasture	Low	Yes	Backfill with soil by farmer.	N/A	Yes
88	24/01/2023	Alston Farm, field N.	Yes	No	No	Class B	High	Farm field for pasture	Low	Yes	Excavation then backfill with limestone boulders then soil arisings (feature 18 also topped with soil at this time).	N/A	Yes
89	01/12/2023	South Dartmoor Communirty College, south access.	Yes	No	No	Class C	Medium	Access to non residential college	Medium	Yes	N/A	Yes - College employed civil engineering contractor to repair the area and drainage	Yes

Linhay Hill Quarry, Ashburton - Planned Extension
Karst Management Plan - Table of sinkholes / land stability trigger events recorded post KMP June 2021

24	20/02/2023	Alston Farm, field M.	Yes	No	No	Class C	High	Farm field for pasture	Low	Yes	Yes - excavation then backfill with limestone boulders, aggregate with geogrid then soil arisings	N/A	Yes
90	23/10/2024	Alston Farm, field H	Yes	No	No	Class B	Medium	Farm field for pasture	Low	Yes	Backfill with soil by E&JW Glendinning.	N/A	Yes

Appendix B. Hydrological Features in the Vicinity of Linhay Hill Quarry

Millimetres 0 10 100

LEGEND

- Swallow hole (active)
- Swallow hole (infilled)
- Spring
- Mine adit
- Permanent watercourse
- Intermittent watercourse
- Existing underground pipe or culvert
- Pond (dashed extent indicates flood level)
- Chercombe Bridge Limestone Formation outcrop

New paved areas of Caton Farm access, Alston Farm access and Waye Lane are shown and the associated drainage, with new underground pipes shown as continuous line, and ditches light blue

Rev.	Date	Description	By	Chk'd	App'd
P1	7/11/24	Update for Karst Management Plan Monitoring Report 1	TSM	PC	KR

Drawing Status: FOR INFORMATION

Suitability: S1

AtkinsRéalis
The Octagon
2nd floor, Pynes Hill Court
Rydon Lane
Exeter
EX2 5AZ
Tel: +44 (0)1392 352900
Fax: +44 (0)1392 352999
www.atkinsrealis.com

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Client: Glendinning

Project Title: LINHAY HILL QUARRY PROPOSED EXTENSION

Drawing Title: HYDROLOGICAL FEATURES IN THE VICINITY OF LINHAY HILL QUARRY

Scale	Designed	Drawn	Checked	Authorised
1:10000	TSM	TSM	ATF	ATF
Original Size	Date	Date	Date	Date
A3	29.02.16	29.02.16	01.03.16	01.03.16

Drawing Number: LHQALS-ATK-GEN-C-PL-0003

Revision: P01

Internal Project Number: 5196443

USER: MORG1734 Date: 07/11/24 13:49:07 Filename: P:\GBEXD\Property Design\DE2 519000s\5196443 Linhay Quarry Stage 1400 LHQ CAD\401 WIP\GLINHAY-ATK-GEN-C-PL-0002&3-Water Features.dwg

Appendix C. Proposed Land Stability Trigger Events and Mitigation Responses

Note this appendix is the same as Chapter 5 of the KMP 2021 which is replicated from that document.

5. Proposals for setting land stability trigger events and mitigation responses

5.1. Introduction

Proposals for the setting of land stability trigger events and mitigation responses are required in Condition 20c: "*proposals for setting land stability trigger events and mitigation responses, including sinkhole repair where necessary*."

5.2. Land stability trigger events

For the purposes of the Karst Management Plan, a land stability trigger event is defined as:

- the development of a new sinkhole; and/or
- the significant enlargement of an existing sinkhole; and/or
- evidence of incipient sinkhole(s), such as the new tilting of fence posts and trees, new depressions and cracks in the ground, new cracks in walls or around doors or window frames in buildings, and new areas of ponding of rainfall and surface runoff. We note that structural damage of the type listed herein may arise from causes other than karst-related land stability.

5.3. Response to a land stability trigger event

The most appropriate response to a land stability trigger event will depend on the physical size of the event and the sensitivity of the receptor effected by the event. The sensitivities of receptors are presented in Table 6-1 of LSRA 2020 and are repeated in Table 5-1 below.

Table 5-1 Receptor Sensitivity

Receptor / Land Use	Relative Importance / Sensitivity
Existing quarry rock extraction area	Minimal
Land and buildings used for agriculture or forestry, natural and semi-natural land, minerals processing.	Low
Non-residential commercial buildings and local infrastructure e.g. services and minor roads, B roads or lesser classification.	Medium
Dwellings, A roads / Highways England network, and essential utility infrastructure.	High

Specific receptors situated on the CBLF within 1 km of the application red line are categorised in Table 6-5 of LSRA 2020.

Land stability trigger events that are reported through the KLN (described in Section 4 above) will be reviewed by E & JW Glendinning's engineering geologist/ geomorphologist. If the reviewing engineering geologist/ geomorphologist assesses that the event reported is not karst-related, then no further action is required.

If the reviewing engineering geologist/ geomorphologist assesses that the event reported is karst-related, then he/she will inspect the event (sinkhole etc.).

Once a sinkhole or other feature has been inspected, an appropriate repair strategy should be agreed between the landowner, tenant and occupier (as appropriate) and E & JW Glendinning. All sinkholes will be documented and added to Atkins' map and table of sinkholes.

A small sinkhole that effects a low sensitivity receptor such as agricultural land may be to infilled (following the guidance presented in Section 5.4 below).

Potential effects on buildings (which are medium to high sensitivity receptors) are likely to require inspection by a building surveyor to determine the need for more detailed monitoring or appropriate repair of the structure.

The Building Research Establishment's Digest 251 'Assessment of damage in low-rise buildings with particular reference to progressive foundation movement' [4] outlines three broad categories of damage:

- ‘aesthetic’, which affects only the appearance of a building.
- ‘serviceability’, which includes cracking and distortions that impair weathertightness or other functions of a building.
- ‘stability’, where there is an unacceptable risk that some part of a building will collapse unless preventative action is taken.

Vulnerability to damage will depend on a building’s construction, the ground movement, and resulting strain or distortion. Precise damage prediction is therefore not possible because of uncertainty about actual behaviour of the ground and building.

Although the response to a land stability trigger event will be determined on a case by case basis, the flowchart in Figure 5-1 below indicates the general response to a land stability trigger event.

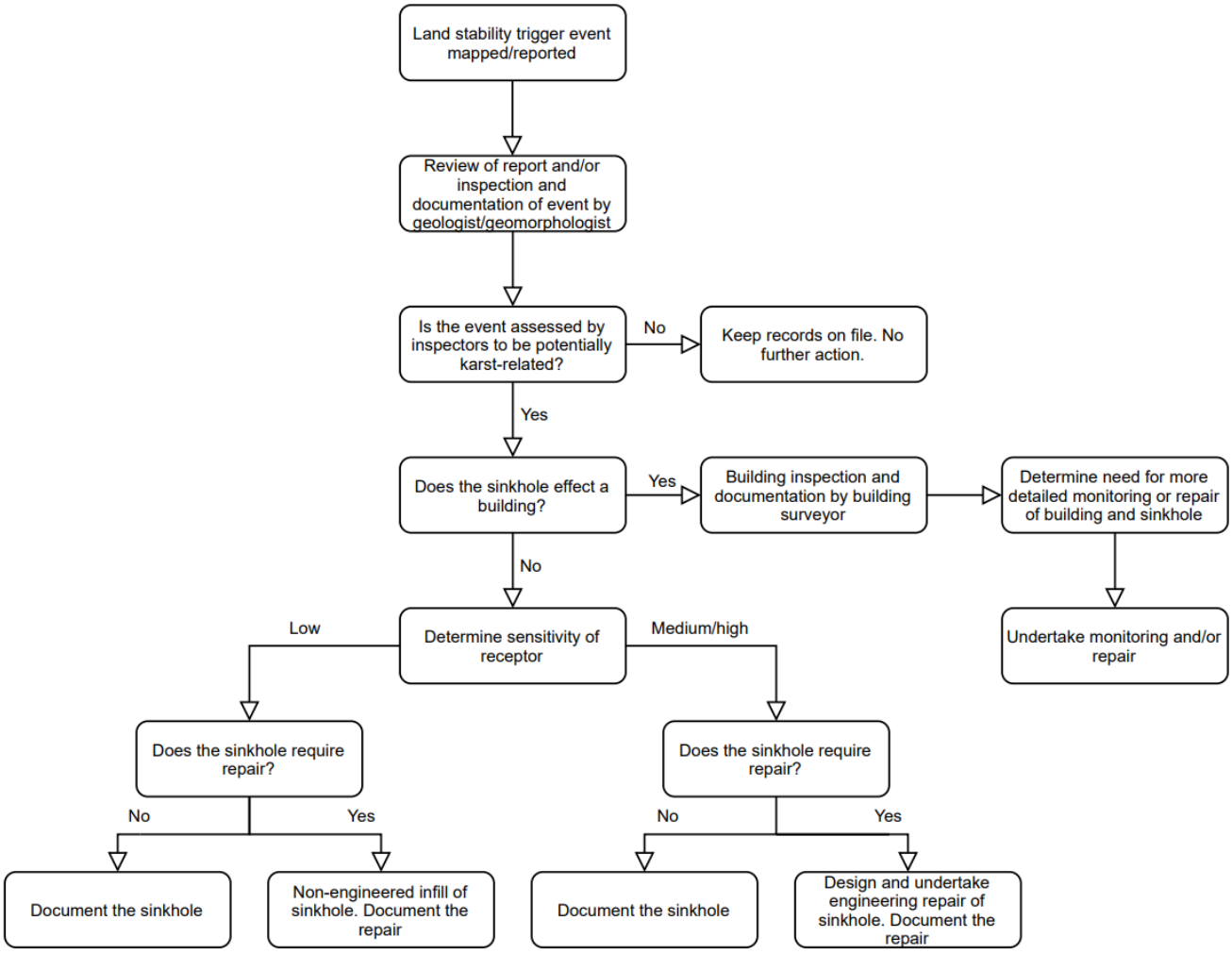


Figure 5-1 - Flowchart of responses to land stability trigger event

5.4. Repair of sinkholes for low sensitivity receptors

Appropriate repair of a sinkhole that is small, stable and effects a low sensitivity receptor (e.g. located in agricultural or open land) is likely to comprise infilling the sinkhole with suitable fill materials, but no further action.

5.5. Repair of sinkholes for medium and high sensitivity receptors

Drainage enhancements and repair of a sinkhole and its effects may be necessary at a receptor of medium or high sensitivity (e.g. a road or building). In cases where a sinkhole effects a medium or high sensitivity receptor,

repair of the sort indicated in Figure 5-2 below may be necessary to reduce the risk of further instability of the sinkhole by preventing soil from entering bedrock fissures, whilst allowing drainage of surface water.

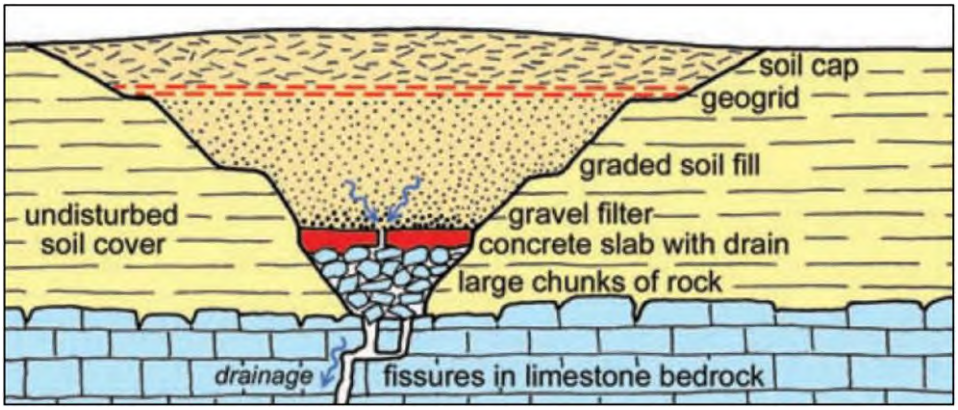
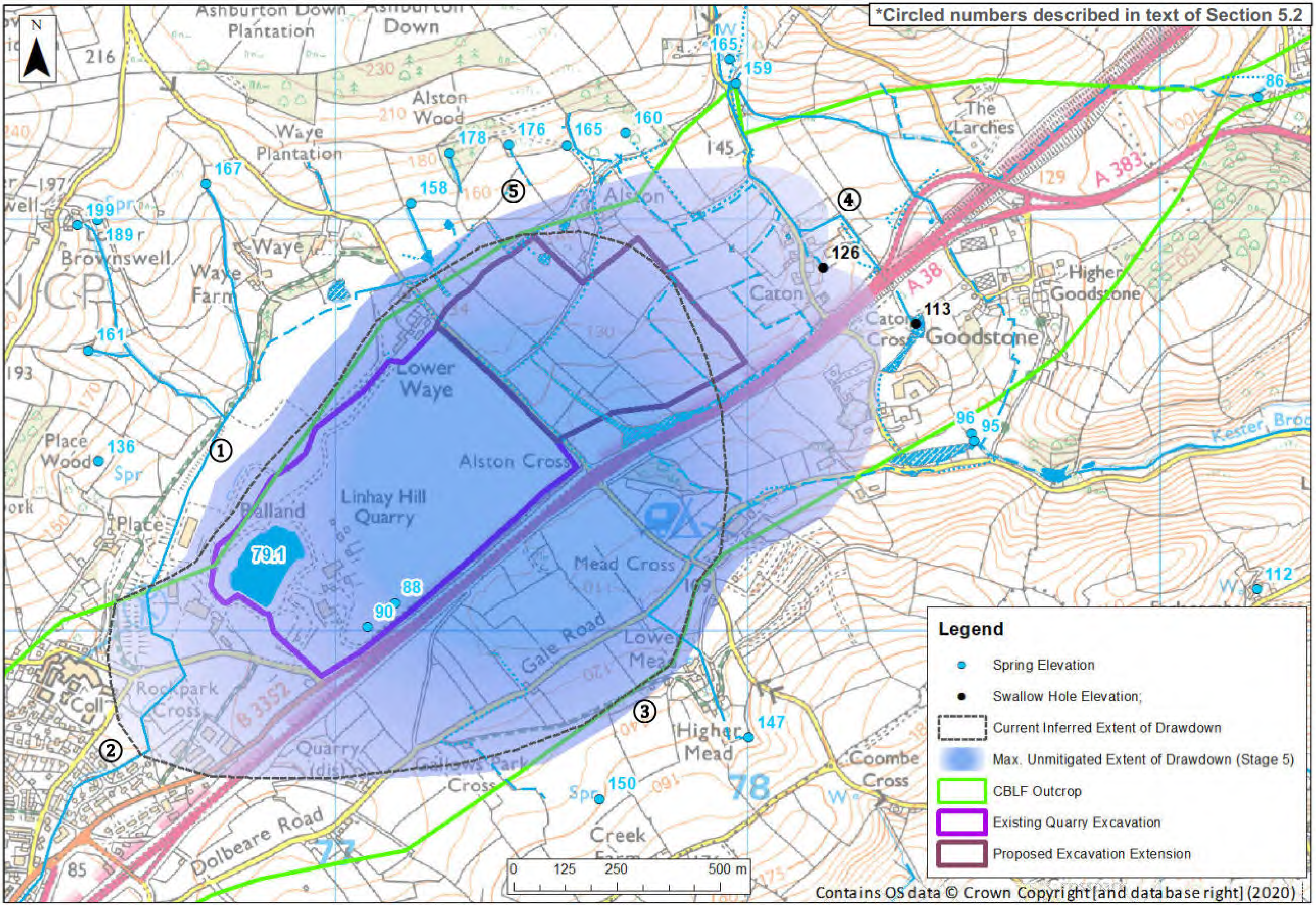


Figure 5-2 - Schematic drawing of sinkhole repair for a medium or high sensitivity receptor (Waltham [5]).

5.6. Repair of buildings

Damage to buildings should be inspected and documented by a building surveyor working in consultation a geologist/ geomorphologist. A structural engineer and geotechnical engineer are likely to be required for the design of the repair of buildings.

Appendix D. Geographical Limits of Surveys (HIA 2020 Figure 5-3)


*Circled numbers described in text of Section 5.2
Legend
Spring Elevation
Swallow Hole Elevation;
Current Inferred Extent of Drawdown
Max. Unmitigated Extent of Drawdown (Stage 5)
CBLF Outcrop
Existing Quarry Excavation
Proposed Excavation Extension
0 125 250 500 m
Contains OS data © Crown Copyright [and database right] (2020)
Linhay Hill Quarry
Lower Waye
Alston Cross
Mead Cross
Goodstone
Caton
A 38
A 383
B 3352
Gale Road
Dolbeare Road
Alston Wood
Waye Plantation
Brownswell
Waye Farm
Place Wood
Rockpark Cross
Higher Mead
Higher Goodstone
The Larches
Coombe Cross
Creek Farm
Gallows Park Cross
Ashburton Down
Plantation
Kester Brook
79.1
88
90
113
126
136
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Appendix E. Assessment of Land Stability Risks (LSRA 2020 Table 6-5)

Table 6-5 Assessment of Land Stability Risks

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Existing quarry rock extraction area	Minimal	A	Karst features are observable and encountered but surface water drainage is direct to the bedrock. Operational health and safety management in place. Within the quarry's current drawdown area.	Very Minor	Localised deepening. Mitigation is by operational health and safety management.	Negligible
Existing quarry processing and maintenance areas	Low	A	Karst features are observable and encountered but surface water drainage is direct to the bedrock or to a positive drainage system. Operational health and safety management in place. Within the quarry's current drawdown area.	Minor	No change. Mitigation is by operational health and safety management.	Negligible
Balland Lane widening	Medium	A	The existing lane does not have positive drainage, though some runoff from the existing lane (upstream of the Balland Stream) will flow to the Balland Stream, whereas in high rainfall events excess runoff contributes to flooding in Balland Lane downstream. Based on the ground elevations and on observations of the Balland Stream immediately downstream of Linhay Hill Quarry through Rockpark Cross playing field, water within the stream is more likely to infiltrate to groundwater rather than receive baseflow from groundwater in the limestone, and groundwater levels are likely to reflect the existing quarry operation. Within the quarry's current drawdown area.	Minor	Increased hard surface area. Mitigation will be by upstream catchment attenuation to ensure no increase in flow in the Balland Stream. The widening will have positive drainage and the works will be carried out to Devon County Council standards.	Negligible

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Waye Lane Public Road and Footpath (western edge to approx. chainage 200)	Medium	A	Natural surface water runoff by overland flow occurs at present. The western end to chainage 200 lies within the quarry's current drawdown area. The rest of the Waye Lane route lies beyond and is not on the limestone.	Minor	Introduction of impermeable road surface. Mitigation will be by upstream catchment attenuation to ensure no increase in flow in the Balland Stream. The new road will have positive drainage and the works will be carried out to Devon County Council adoptable standards.	Negligible
New access route to Alston Farm and Alston Cottage from Chainage 350	Low	C / D	Evidence of nearby sinkholes in the farm fields where existing drainage is mainly infiltration and overland flow. Evidence from geophysical survey and boreholes that there is likely to be several metres of superficial deposits. Groundwater levels are variable within the superficial deposits and limestone. From chainage 350 lies within the quarry's current drawdown area. The rest of the access route lies outside and is not on the limestone.	Minor	Introduction of impermeable surface on a new private access route to only two properties, as such vehicle movements are limited. Road design and construction would take account of the local ground conditions. Mitigation will be by positive drainage to existing drainage routes to reduce the potential for concentrated infiltration forming new subsurface pathways.	Medium

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Stage 1 – 5 Quarry extension area and operation	Low	C / D	Evidence of a variable thickness of superficial deposits and a likely irregular rockhead profile. Groundwater levels are variable within the superficial deposits and limestone. Sinkholes have been observed near the northern extent of the limestone, with the low permeability Tavy Formation present to the north. Also associated with surface water drainage, including changes to the route of the Alston stream. Existing drainage is by infiltration, overland flow and ditches adjacent to hedge-lines. Apart from a small part of stage 4, this area is within the quarry's current drawdown area. There is potential for enhanced flow rates through conduits or fractures into the quarry.	Very Minor	Staged removal of superficial deposits and subsequent staged extraction of limestone in benches and dewatering as extraction void deepens. The whole of this area lies within the projected maximum extent of the drawdown area associated with the quarry extension proposals. Mitigation will be by controlling the drainage utilising existing surface water drainage routes, and the monitoring proposed in the Karst Management Plan. .	Low

Overburden bund formation	Low	C	Evidence of a variable thickness of moderately permeable superficial deposits with an irregular rockhead profile and observed sinkholes, including a swallow hole along the route of the watercourse (Alston stream) fed mainly by springs in Alston Wood and a Class A sinkhole exists on the western side of the stage 1b bund. Groundwater levels are variable within the superficial deposits and limestone. Beyond the quarry's current drawdown area.	Minor	Increase in ground loading from placement of the overburden soils to form the bunds. Basal and perimeter drainage and diversion of seasonal Alston stream. The anticipated increase in ground loading is not expected to cause land instability from collapse into a potential void in the limestone bedrock. With the exception of the northeasternmost part of the stage 2a bund, the footprint of the bunds is within the projected maximum extent of the drawdown area associated with the quarry extension proposals. Mitigation will mainly be by controlling the drainage such that infiltration beneath the bund(s) footprint will be plane / diffuse, similar to the existing situation. New linear positive drainage routes around the bunds and settlement ponds used during construction will be lined to prevent concentrated infiltration of surface water. Sinkhole repair will be carried out for the Alston stream swallow hole. The final form of the repair will be dependent on the findings of monitoring carried out until the repair is necessary for the formation of overburden bunds in Stage 2b (year 16).	Low

Diverted Alston stream	Low	C / D	A cluster of sinkholes has been recorded in the vicinity of a swallow hole along the present route of the watercourse. It seems likely that these formed as a result of suffosion and collapse at depth, due water entering the ground along the Alston stream via the stream's bed and via the swallow hole. Groundwater levels are variable within the superficial deposits and limestone. Beyond the quarry's current drawdown area.	Minor	Prior to construction of the stage 2b bund, the Alston stream will be diverted around the west of the bunds via pipe and ditch lined with low-permeability material, and to the east via a pipe to an unlined section to be constructed along part of the eastern edge of the stage 1b bund. The rate of flow to the east will be controlled for infiltration along the unlined section to help maintain the groundwater divide in this area. With the exception of the northeasternmost part of the stage 2a bund, the footprint of the bunds is within the projected maximum extent of the drawdown area associated with the quarry extension proposals. Groundwater levels are variable within the superficial deposits and limestone. Mitigation will be primarily by this drainage control and the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan. Regular observation and the stream flow controlled and rate of infiltration managed by design of the soil / filter material within the unlined section. The existing swallow hole and associated sinkholes will be repaired as noted in the row above.	Medium

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Eastern end of Ashburton i.e. Part of Dartmoor Community College and Linhay Business Park and along the B3352 road	Dwellings = high Other receptors = Medium	A	Comprising part of the buildings of the South Dartmoor Community College and its playing fields, together with Linhay Business Park mainly developed since the early 1990s. Some dwellings at the north end of Long Park and opposite the entrance to the Linhay Business Park. Near the northern margin of the limestone and within the quarry's current drawdown area. The area is expected to have positive drainage, though at the college substantial buildings exist some of which use soakaways. Ground investigation in 2014 for new development at the college showed superficial deposits to at least 6.45m below ground level. Surface water conveyed to infiltrate to ground via a large soakaway in west end of the business park and the use of soakaways elsewhere. No known reported subsidence. For the ground elevations and based on observations of the Balland Stream through this area, water in the stream is more likely to infiltrate to groundwater rather than receive baseflow from the limestone; and groundwater levels are likely to reflect the existing quarry operation.	Very Minor	Extended period of dewatering, but the drawdown area is not anticipated to extend further in this direction as a result of the quarry extension proposals. Mitigation will be primarily by controlling the drainage from the Balland Lane Widening and the new Waye Lane Public Road and Footpath and the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan.	None

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Dwellings at Lower Waye	High	B	Located on the northern margin of the limestone. Rockhead is expected to be shallow and historical maps show some of the buildings have been present for more than a hundred years. The dwellings at Lower Waye lie within the quarry's current drawdown area. Groundwater levels are variable within the superficial deposits and limestone, and will reflect the existing quarry operation. Current mitigation is by operational health and safety monitoring e.g. of ground vibration due to blasting.	Serious	Extended quarry extraction area with associated dewatering, but the drawdown area is not anticipated to extend further in this direction as a result of the quarry extension proposals. Mitigation will be by drainage control for the new access to Alston Farm and Alston Cottage and the new Waye Lane Road off Alston Lane, combined with the monitoring feedback and the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan.	Low

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Alston Farmhouse and Alston Cottage	High	B	Located on the northern margin of the limestone with the lower permeability Tavy Formation to the north. Alston Cottage lies within the quarry's current drawdown area. Alston Farmhouse lies outside the quarry's current drawdown area. Surface water is from springs in Alston Wood and farmland to the north. Geophysical survey and boreholes indicate several metres of superficial deposits and there is evidence of sinkholes nearby in the farmland. Groundwater levels are variable within the superficial deposits and limestone. Infiltration drainage is utilised, but historical maps show the buildings have been present for more than a hundred years. Alston Barn has a waterwheel that extends into a pit, which is anecdotally understood to have pipe drainage to the farm fields south or west of the farmhouse There has been no known subsidence at Alston Cottage and Alston Farmhouse. A cluster of sinkholes (Numbers 5, 6 and 7 on Figure 3-3) are present in a field to the west of the farmhouse.	Serious	New access route provided with slight local increase in impermeable surface area, and extended quarry extraction area with associated dewatering. Alston Cottage will be close to the edge of the quarry void in stages 3 and 4 of the quarry extension. Alston Farmhouse is about 100m from the stage 4 quarry edge, and anticipated to lie close to the edge of, but within, the projected maximum extent of the drawdown area associated with the quarry extension proposals. Drawdown at the edges of the drawdown area are anticipated to be significantly less than existing ongoing naturally occurring seasonal fluctuations. Mitigation will be mainly by drainage control for the new access to Alston Farm and Alston Cottage and the new Waye Lane Road off Alston Lane, and the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan.	Alston Cottage = Medium Alston Farmhouse = Low

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
The western side of Caton Lane south of the entrance to Underway	Medium for lane, High for the gardens of dwellings	B	Lies outside the quarry's current drawdown area. Geophysical surveys indicate a generally shallow depth to limestone bedrock, however boreholes indicate more variability with locally thick superficial deposits. Groundwater levels are variable within the superficial deposits and limestone. There is some evidence of sinkholes to the east, possibly related to the Caton stream swallow hole and/or high surface water runoff. There is no positive drainage of the road. Groundwater in this area is below the elevation of the Caton stream, hence stream water is likely to infiltrate to the superficial deposits and the limestone.	Minor	Extended quarry extraction area with associated dewatering and overburden bunds between the extended extraction area and Caton Lane. The edge of the projected extent of drawdown associated with the quarry extension proposals is anticipated to reach the western side of the southernmost part of Caton Lane when it reaches its maximum. Drawdown at the edges of the drawdown area are anticipated to be significantly less than existing naturally occurring seasonal fluctuations. Mitigation comprises the balancing pond and unlined portion of the diverted Alston stream, drainage control around the overburden bunds, and the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan.	Low

A38	High	B	The highway traverses the central area of the limestone from southwest to northeast, on embankment from Alston to Caton and in cutting elsewhere. A length of some 1.5 km of the A38 lies within the quarry's current drawdown area. Geophysical surveys, boreholes, observations at the quarry, and records of works at Goodstone Cross indicate that rockhead is likely to be irregular with variable thickness superficial deposits, which are locally more than 10 m thick. There is a cluster of sinkholes within the Class A sinkhole adjacent to the slip road at Goodstone Cross associated with A cavity was encountered south west of the quarry during construction of the A38, and reportedly partially infilled with concrete. Basal embankment layers will have utilised an engineered fill, though the contract drawings also show variation in the sub-base thickness. The highway will have intercepted natural drainage, and mainly uses positive drainage, though infiltration occurs along drainage on the north side of its embankment and through the grassed central reservation between Ashburton and Caton. Following its construction, the A38 dual carriageway has coexisted with that existing infiltration drainage and dewatering of the quarry to its current extraction area. There are no known subsidence effects on the A38 reported as being attributed to the quarry operation.	Serious	Extended quarry extraction area with associated dewatering and overburden bunds between the extended extraction area and Caton. A further 350 m of the A38 eastwards will come within the projected maximum extent of the drawdown area associated with the quarry extension proposals. Mitigation will be by drainage control around the quarry and the overburden bunds, and the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan. Quarry slope construction will adhere to the design within the Environmental Statement Appendix Chapter 3 Appendix 3A Site Investigation and Design Report by Sandybed Geological Services. The quarry extension's south east face will be further from the A38 than the south east face in the existing quarry. For south east faces i.e. parallel to A38, that design utilises parameters based on a report on the slope stability of existing and proposed workings prepared by Engineering Geology Ltd. in 1987. Hence, the stability of the quarry slopes is proven by the existing quarry workings, and will be subject to regular inspections as required by the Quarries Regulations 1999.	Low

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Dwellings south of the A38 along Caton Lane and Gale Road east of Mead Cross	High	B	The dwellings are near the southern margin of the limestone, with the lower permeability Foxley Tuff Formation to the south. Outside the quarry's current drawdown area. There is no positive drainage and some evidence of sinkholes nearby. Some of the buildings have been present for more than a hundred years and there is no reported damage to buildings as a result of sinkhole development.	Minor	Extended quarry extraction area with associated dewatering. The edge of the projected extent of the drawdown area associated with the quarry extension proposals is anticipated to reach the dwellings when it reaches its maximum. Drawdown at the edges of the drawdown area are anticipated to be significantly less than existing ongoing naturally occurring seasonal fluctuations. Mitigation will be by the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan. .	Low
Dwellings on Gale Road, Mead Garage and Mead Storage	High, medium for other buildings	B	Located near the southern margin of the limestone, with the lower permeability Foxley Tuff Formation to the south. Mead Garage, Mead Storage and 1 km of Gale Road lie within the quarry's current drawdown area. The Kester Brook flows seasonally in open drainage north of the road i.e. between the properties, and the A38 and the quarry and its proposed extension.	Minor	Extended quarry extraction area with associated dewatering, but the drawdown area is only anticipated to extend a short further in this direction as a result of the quarry extension proposals. No additional properties are likely to be included. Mitigation will be by the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan.	Low

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Dwellings within the hamlet of Caton	High	B	On the central area of the limestone, generally gently sloping land. Geophysical surveys suggest relatively shallow depth to the limestone bedrock, but boreholes indicate variability with locally thick superficial deposits. Groundwater is below the elevation of the Caton stream hence it is likely to infiltrate to the superficial deposits and the limestone. There is some evidence of sinkholes to the east, possibly related to Caton stream sink and/or high surface water runoff. There is no public drainage for foul or surface water in the hamlet of Caton, and foul and surface water enter the ground via septic tanks and soakaways respectively. It is likely that the proportion of rainfall entering the ground has been increased by the use of soakaways, which concentrate infiltration of rainwater into a smaller area and reduce its evaporation and runoff. Some buildings have been present for more than a hundred years and there is no known reported building subsidence. Outside the current extent of the quarry's drawdown area.	Minor	Extended quarry extraction area with associated dewatering and overburden bunds. Caton lies just beyond the eastern edge of the projected maximum mitigated extent of drawdown associated with the quarry extension proposals. Mitigation comprises the balancing pond and unlined portion of the diverted Alston stream, drainage control around the overburden bunds, and the monitoring, periodic reviews and reassessments proposed in the Karst Management Plan, including external structural surveys.	None

Receptor	Receptor importance / sensitivity	Atkins' hazard rating for existing situation	Existing factors likely to affect the local occurrence of sinkholes	Hazard consequence	Quarry extension proposals and mitigation	Risk Level after mitigation
Other areas on the limestone within 1km of the application red line	High for dwellings, medium for other buildings	A-D	In the built up areas of Ashburton and along the B3352, many buildings have existed for more than a hundred years within the area of the limestone; and since the early 1960s there has been extensive development north of the B3352 (i.e. closer to the northern margin of the limestone). The area is expected to have positive drainage, though there may be use of soakaways but no known reported building subsidence. Elsewhere there is a mixture of longstanding and more recent development, and, apart from roads, there is less likely to be positive drainage. Outside the quarry's current drawdown area.	Minor	No anticipated impact, the area lies outside the projected extent of drawdown associated with the quarry extension proposals. Mitigation will be by the monitoring and periodic reviews and reassessments proposed in the Karst Management Plan to address residual uncertainty.	None

AtkinsRéalis UK Limited
The Octagon
2nd floor, Pynes Hill Court
Rydon Lane
Exeter
EX2 5AZ

Tel: +44 (0)1392 352900
Fax: +44 (0)1392 352999

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