Hafren Water

Planning Application for the Restoration of Cambrian Quarry by the Importation and Recycling of Inert Materials

Flood Consequence Assessment

Final
February 2013

Report prepared for:

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1 INTRODUCTION

1.1 Background

Cambrian Quarry is a limestone quarry located south of Gwernymynydd, Flintshire, about 2.8 km southwest of Mold town centre. The quarry is centred on National Grid Reference (NGR) SJ 215 622. ASH Resource Management (Cambrian Quarry) Ltd (ASH) lease Cambrian Quarry from the landowners who are Valeway Ltd and Jennings Building and Civil Engineering Ltd.

ASH is seeking Planning Permission for a waste recovery operation to restore the quarry void to the profile of the surrounding landscape. Under guidance set out by the Welsh Assembly Government in Technical Advice Note 15 (TAN15) the site requires a Flood Consequence Assessment (FCA) to ensure that there is no flood risk to or from the site for the lifetime of the development. Hafren Water has been commissioned by Sloane Mead, who is preparing the Planning Application on behalf of ASH, to undertake the FCA.

Flood risk to and from the Application Site has been assessed, quantified and the required surface water storage volumes given for both the development and restoration phases. Potential mitigation measures have been outlined and surface water management has been addressed.

A site visit was undertaken on 15th March 2012 to gather site-specific information.

A Hydrogeological Impact Assessment has been undertaken and is presented within a separate report.

1.2 Site location

The quarry is located immediately south of the village of Gwernymynydd, which is about 2.8 km southwest of Mold town centre (***Drawing CQ/FCA/01***). The proposed restoration area is the quarry void which is centred on NGR SJ 215 622. Access to the site is off Glyndwr Road, which is a secondary road off the A494. The quarry void and land immediately north of the void that is required for access is termed the ‘Application Site’ within this report.

1.3 Site description

The Application Site comprises an elongated quarry void with associated former stone processing areas to the north. The quarry void is elongated along its north-south axis being approximately 350 m long and 110 m wide. The Application Site is approximately 5.3 hectares (Ha), of which the quarry void is 2.8 Ha.

The former quarry void and areas to the north are derelict and overgrown. The quarry void is 266 metres Above Ordnance Datum (mAOD) (c34 m below surrounding land) at its deepest.

The Application Site is located on a gently-contoured ridge bounded to the north by woodland and to the east, south and west by fields used for grazing. The nearest housing is scattered along Glyndwr Road, c100 m east of the quarry. Land surrounding the site slopes to the north and east, away from the site. Woodland north of the quarry void includes overgrown areas formerly used as part of quarry and mine operations.

Surrounding areas east of the site were mined historically for both Silica Sandstone and metalliferous ores. There are known worked underground areas adjacent to the northeastern part of the site and shafts marked on recent mapping. The surrounding region had a considerable metal mining industry and therefore contains numerous shafts, adits and underground workings together with surface remnants of former mining activity.

1.4 Hydrology

1.4.1 Watercourses

The quarry is situated within the surface water catchment of the River Alyn, which is located approximately 3.5 km east of the site at its closest point and follows a northerly, then easterly course to and through Mold. The River Alyn is a tributary of the River Dee. The closest watercourse to the site is about 800 m northwest of the site and immediately west of the village of Gwernymynydd. Drainage in the area around the site is generally in an easterly or northeasterly direction toward this watercourse, which is a tributary of the River Alyn.

1.4.2 Waterbodies

Scattered small pools are identified east of the site on the 1:25,000 scale map and shown on ***Drawing CQ/FCA/01***. The only major waterbodies in the vicinity of the site are located at Aberduna Quarry and Burley Hill Quarry, located some 1 km west and 2 km southwest of the site respectively. The quarries are located in the Cefn Mawr Limestone Formation and waterbodies are likely to represent an interception of the watertable.

1.4.3 Springs and wells

The nearest well is about 200 m east of the site. Other wells are generally scarce and are further east and south of the site. The Local Authority (Flintshire County Council) is aware of 6 unlicensed abstractions (private water supplies) within a 3 km radius of the site, however none are the closest wells marked on the map. Neither of the 2 closest wells is adjacent to buildings and it is therefore assumed that they are not used for potable supply.

1.4.4 Rainfall data

The nearest rainfall monitoring station is at Loggerheads, which is 1.5 km west of the site. The long-term average (LTA) monthly rainfall data was obtained from the Environment Agency or the period 1987-2012. The data is presented in Table CQ/FCA/T1 below.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
83	71	59	61	56	59	69	90	70	90	100	98

Table CQ/FCA/T1: Long-term average monthly rainfall (mm)

The equivalent LTA annual rainfall is 906 mm/year

1.5 Climate change

Within the UK projections of future climate change indicate that there will be more frequent, short duration, high intensity rainfall events and periods of long duration rainfall. TAN15 recommends that the effects of climate change are incorporated into Flood Consequence Assessments. Precautionary sensitivity ranges for peak rainfall used in this report are considered appropriate for the lifetime of the development. Peak rainfall intensity increase of 5% is used to represent the period 1990-2025, this is considered representative of the infilling phase which would extend to approximately 2023. An increase of 30% is used in surface water calculations to represent the period 2085-2115; this is deemed to be appropriate for perpetual lifetime of the restored site.

1.6 Site elevations

The site is located on a broad ridge and elevations in its vicinity generally decrease northwards towards Gwernymynydd. The rim of the quarry void is some 314 mAOD in the south and some 302 mAOD in the north. The floor of the quarry is generally 30 m below the rim of the void. In the north of the void there is a lip some 26 m high which marks the northern limit of the void and the divide between the former extraction area and plant area. To the north of the lip ground falls away gently to the edge of the Application Area. The fall continues along the access road which falls some 50 m over a distance of some 500 m.

As the site is located on top of a broad ridge there is very little potential for surface water from beyond the Application Site to affect the site.

1.7 Ground conditions

The quarry worked limestone of the Minera Formation, which comprises interbedded dark argillaceous (silty) limestones, pale massive limestones and calcareous sandstones. The Minera Formation is of Upper Carboniferous age and is overlain by coarse to fine-grained Quartzitic sandstones. At the site, the Minera Formation dips eastwards at about 20^{o}. The BGS geology map does not record significant drift deposits at the site.

Besides quarrying of limestone, silica sandstone was also mined and there is a resultant network of tunnels in a room and pillar arrangement from the northeast side of the quarry. Mining of silica sandstone was undertaken by Lever Brothers from 1905 and the material was used for making scouring powder.

The Upper Carboniferous bedrock contains numerous northwest-southeast trending mineral veins which were mined locally and regionally in the 19^{th} century. The extent of mineral mining around the site is not exactly known, however there are numerous surface remnants of mining on all sides of the quarry. The quarry void also cut at least two metal mine adits which are in the southern quarry face. Review of historical maps from the early 19^{th} century shows the quarry as much smaller and shafts present in areas which are now quarry void. From research undertaken, it is assumed that all surrounding traces of shafts and surface workings are associated with 19^{th} century metal working.

1.8 Proposed development

The proposed development is shown on plans presented at the start of the Environmental Statement.

The quarry is inactive and the Application proposes that no further extraction of mineral will take place. The Planning Application would permit an operation to restore the site with imported inert fill. It is planned that the void will be filled and the surface restored over a period of up to 10 years.

A new access to the site will be constructed from Glyndwr Road, at a point approximately 40 metres from the A494 road. A new internal access road will be constructed to run parallel to Glyndwr Road until it meets with the existing internal site access road.

Restoration of the site will be to a surface elevation similar to that of surrounding land but with a shallow valley feature. The restored area will be returned to nature conservation and agricultural use.

1.9 Current drainage

There is currently no formal drainage installed at the site. Surface water drains to low points in the quarry void and flows northwards from areas around the access road. Infiltration occurs readily due to the permeable ground conditions and therefore run-off volumes are limited.

The final length of the current internal Quarry access road slopes steeply towards the existing entrance point onto Glyndwr Road. During recent heavy rain surface water has been observed to run down this last section of access road and onto Glyndwr Road. The landowner has recently installed a cut off drain to prevent this from happening in the future.

2 FLOOD RISK TO THE SITE

The risk of flooding at the site has been assessed by examining the likelihood of flooding, the hazard caused if the site were to flood and its vulnerability. This has been undertaken for a variety of mechanisms using both quantitative and qualitative methods. Details of how these assessments were made are included in ***Appendix CQ/FCA/A2***.

The site is classed as 'less vulnerable' in TAN15.

2.1 Fluvial flooding

The site is situated entirely within Flood Zone A on the Welsh Assembly Government's Development Advice Map (DAM), which is defined as having a 1 in 1,000-year or less (<0.1%) annual probability of fluvial flooding (***Drawing CQ/FCA/03***). There are no permanent watercourses present in, or around, the Application Site. The closest area of Flood Zone B or C identified on the Environment Agency Indicative Flood Map is located some 1.5 km west of the Application Area at Loggerheads. This is associated with the River Alyn, which is located at an elevation some 50 m below the lowest point of the Application Site.

The overall risk of fluvial flooding is considered to be 'negligible' and mitigation measures are not considered necessary.

2.2 Groundwater flooding

Cambrian Quarry is located within the Minera Formation, which is of Lower Carboniferous (Dinantian) age (***Drawing CQ/FCA/02***). The Minera Formation comprises interbedded dark argillaceous limestones and calcareous sandstones. The Minera Formation dips steeply (around 20^{o}) in an approximate easterly direction. The quarry has worked this formation for aggregate.

The Minera Formation is classified as a Secondary 'A' aquifer; a formation which contains permeable layers which can potentially provide local water supplies.

The Minera Formation is underlain by the Cefn Mawr Limestone Formation comprising thinly interbedded argillaceous limestones and mudstones with thick shelly limestone. This formation is classified as a Principal Aquifer; having high intergranular and/or fracture permeability meaning that they usually provide a high level of water storage. Groundwater movement in the Cefn Mawr Limestone is mostly in fractures.

No groundwater level, groundwater quality or permeability information has been located for either of these formations. Both formations have been extensively mined, with shafts and adits dug in the 19^{th} century following lead and zinc veins.

It is expected that groundwater flow will generally follow the dip of the strata, with movement being primarily through fractures. The natural drainage will be significantly altered by flow into and from former mineshafts and tunnels. The true groundwater flow pattern and resultant groundwater levels are not known and are likely to be complex. It is expected that water from the Minera Formation is able to drain readily into the underlying Cefn Mawr Limestones.

As it is considered that groundwater in the Minera Formation and Cefn Mawr Limestone is primarily present in fractures, it is likely that water levels will respond rapidly to rainfall. It is expected that the Minera Formation will continue to be drained by former mine workings and that the quarry void will not contain significant groundwater in the short or long-term following infilling.

Therefore the overall risk of groundwater flooding is considered to be 'low'.

2.3 Surface water flooding

The site currently receives limited amounts of run-off from the surrounding area as it is situated near the top of a broad ridge. The quarry void is free-draining and is not at risk from surface water run-off. The area to the north of the void is located on a slope and surface water readily drains northwards reducing the potential for surface water accumulating and flooding occurring.

The overall risk of surface water flooding is considered to be 'low'. During the restoration of the site surface water management is anticipated to reduce the risk further.

Flood risk from the site to the surrounding area is considered in Section 3.

2.4 Flooding from sewer and water mains

Owing to its rural location it is considered that flooding from sewers and water mains poses no risk to the Application Site.

3 FLOOD RISK FROM THE SITE TO THE SURROUNDING AREA

3.1 Background

The proposed development would change the surface water run-off rates by changing the permeability and gradient of the land. Therefore potential exists to increase surface water run-off to the surrounding area, thereby potentially increasing flood risk. The effects of predicted climate change over the lifetime of the development also need to be considered.

A 5% increase in peak rainfall intensity as a result of climate change has been used to represent the restoration phase and is based upon recommendations in TAN15 outlined in Section 1.6. An increase in peak rainfall intensity of 30% has been used to represent the restored site. Details of how these assessments are made are included in ***Appendix CQ/FCA/A3*** and outlined below.

Surface water run-off rates have not been calculated for the current quarry void as this is self-contained and free-draining.

3.2 Post-completion run-off rates

Surface water run-off rates have been calculated for the completed restoration of the site to ensure that there is no increased flood risk to the surrounding area.

Land use upon completion is proposed to be nature conservation and agricultural grassland to replicate that of the surrounding area. There is anticipated to be increased run-off rates when compared to the current situation due to the decreased permeability and change in landform of the restored quarry void.

Run-off rates from the development have been calculated to determine the volume of storage required to attenuate flows, including the increase attributed to climate change during on-going agricultural use post-completion. This has been undertaken to ensure there is no increase in flood risk downstream of the site from increased run-off rates. Further details on these calculations can be found in ***Appendix CQ/FCA/A2***.

The peak run-off rates for the post-completion site have been estimated for a range of storm durations using the Rational Method. The Rational Method to give peak flows (Q_p) is of the form:

$$Q_p = 2.78\, CiA$$

Where: C = run-off co-efficient (dimensionless)
i = rainfall intensity (mm/hr)
A = catchment area (Ha)

The co-efficient of run-off, C, varies for different surfaces. The value of C used for the restored quarry void has been taken as 0.7 based on a partially impermeable cap. The volume of storage required for the 1 in 100-year event for the 28-hour storm (to provide the maximum attenuation volume when discharge is limited 6 l/s) in the quarry void is some 1,625 m^3.

3.3 Surface water management

3.3.1 Overview

Due to the changes in landform and permeability of the restored site surface water run-off should be managed to ensure there is no increase in downstream flood risk. The details outlined below are based on surface water calculations undertaken within Section 3.2.

3.3.2 Restored quarry void

The final landform would include a shallow elongated valley feature with base elevations falling generally northwards. At the northern end of the restored quarry void the valley feature would be constrained by existing topography. It is proposed to create an ephemeral wetland in the north of the restored quarry void to intercept surface water run-off. An additional ephemeral wetland will be provided in the north east of the restored quarry void to capture surface water draining to this area.

Drainage from the ephemeral wetland areas would be via gravel filled concrete ring soakaways which would provide a direct drainage route to the permeable limestone beneath the imported inert fill. The diameter of the main ring soakaway would be 2 m with an anticipated discharge rate of 6 l/s, while that in the north east corner of the restored quarry void would be 1 m diameter with an anticipated discharge rate of 2 l/s. Soakaway tests will be undertaken prior to development to ensure that drainage is sufficient. If required, the limestone could be drilled to increase permeability and achieve the required discharge rate.

The main ephemeral wetland will have a capacity of some 1,615 m^3 with an additional 300 mm freeboard, the ring soakaway would provide an additional volume of some 19 m^3. The ephemeral wetland in the north east corner of the quarry void has a capacity of 59 m^3 with an additional 300 mm freeboard, the ring soakaway would provide some 0.7 m^3 of additional attenuation volume.

As surface water would be attenuated and allowed to infiltrate to ground there is considered to be no increase in downstream flood risk.

3.3.3 Office and weighbridge area

Surface water run-off from the office and weighbridge area to the north of the quarry void will be reduced as the site is vegetated post-restoration. There are proposed to be no substantial changes to the plant area during the restoration of the site. Therefore this area is not anticipated to increase flood risk to its surroundings and further consideration is not considered necessary. Furthermore this area is generally flat and surface water will predominantly infiltrate to ground.

3.3.4 Access road

The proposed access road follows the route of an existing track for the majority of its course. However, the lowest end would be new and parallel to Glyndwr Road to permit safe access via a new entrance near the junction of Glyndwr Road and the A494 Ruthin Road.

Detailed design for the new internal access road will be prepared and submitted to the Planning Authority/Highway Authority for approval prior to the commencement of the development. This will include a surface water drainage scheme for the access road.

4 SUMMARY AND CONCLUSIONS

4.1 Cambrian Quarry is a limestone quarry located south of Gwernymyndd, Flintshire, about 2.8 km southwest of Mold town centre. The quarry is centred on National Grid Reference (NGR) SJ 215 622. ASH Resource Management (Cambrian Quarry) Ltd lease Cambrian Quarry from the landowners who are Valeway Ltd and Jennings Building and Civil Engineering Ltd.

4.2 The site is located entirely within Flood Zone A on the Welsh Assembly Government's Development Advice Map (DAM), which is defined as having a 1 in 1,000-year or less (<0.1%) annual probability of fluvial flooding. There are no permanent watercourses present in, or around, the Application Site. Therefore the overall risk of fluvial flooding is considered to be 'negligible' and mitigation measures are not considered necessary.

4.3 It is expected that the Minera Formation will continue to be drained by former mine workings and that the quarry void will not contain significant groundwater in the short or long-term following infilling. Therefore the overall risk of groundwater flooding is considered to be 'low'.

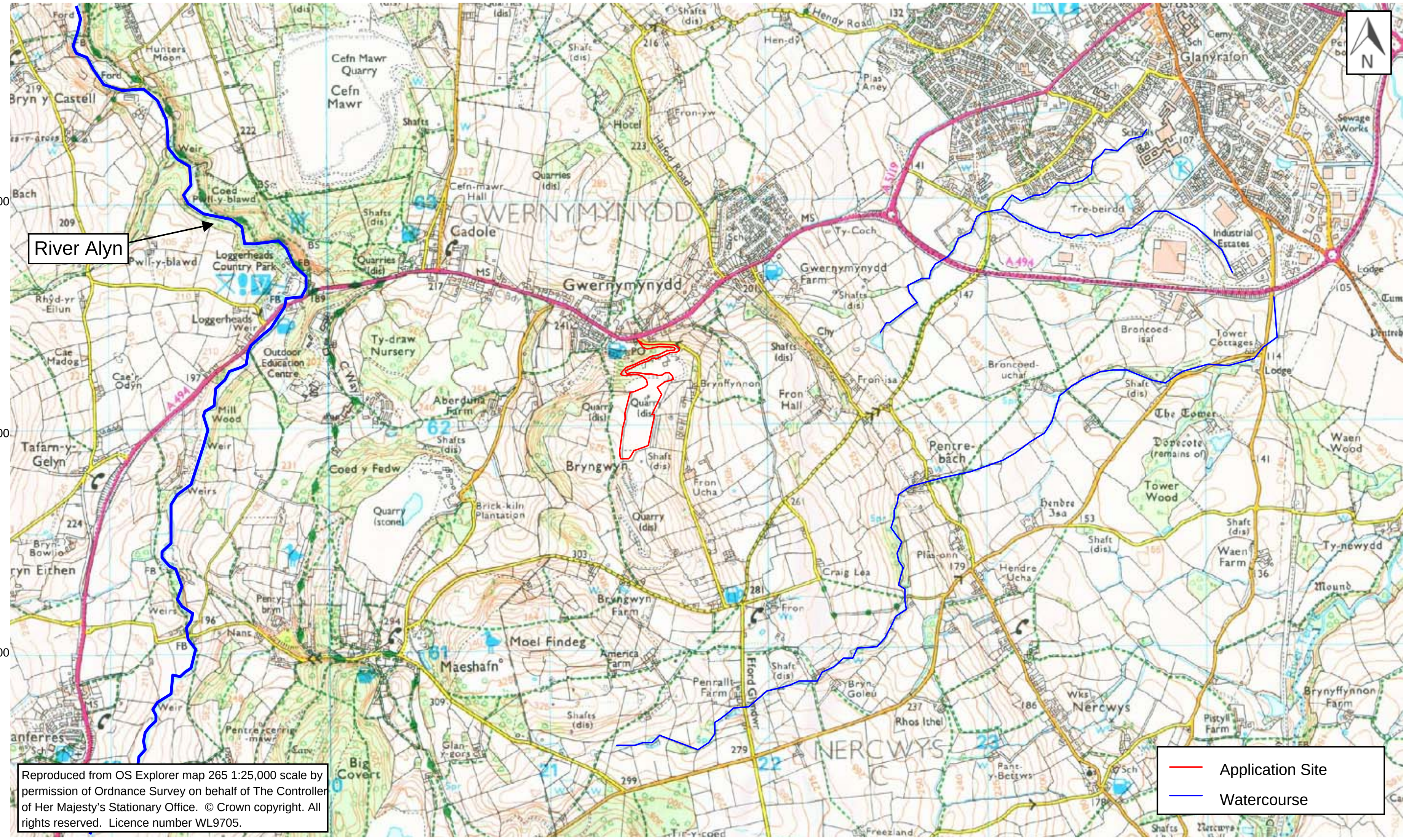
4.4 The site currently receives limited amounts of run-off from the surrounding area as it is situated near the top of a broad ridge. The quarry void is free-draining and is not at risk from surface water run-off. The area to the north of the void is located on a slope and surface water readily drains northwards reducing the potential for surface water accumulating and flooding occurring. The overall risk of surface water flooding is considered to be 'low'. During the restoration of the site surface water management is proposed to reduce the risk further.

4.5 The volume of storage required for the 1 in 100-year event for the 28-hour storm (to provide the maximum attenuation volume when discharge is limited to 6 l/s) in the restored quarry void is some 1,625 m^3.

4.6 It is proposed to create an ephemeral wetland with a freeboard of 300 mm and a storage volume of 1,615 m^3 in the north of the restored quarry void. This is sufficient to store the calculated volumes of surface water run-off during the 1 in 100-year storm event. Discharge would be to a gravel filled concrete ring soakaway allowing surface water to infiltrate to ground below the imported fill and would provide additional attenuation volume of 19 m^3.

4.7 An additional ephemeral wetland would be created in the north east of the restored quarry void and would provide some 59 m^3 of attenuation volume with an additional freeboard of 300 mm. Drainage from this area will also be via a concrete ring soakaway.

DRAWINGS



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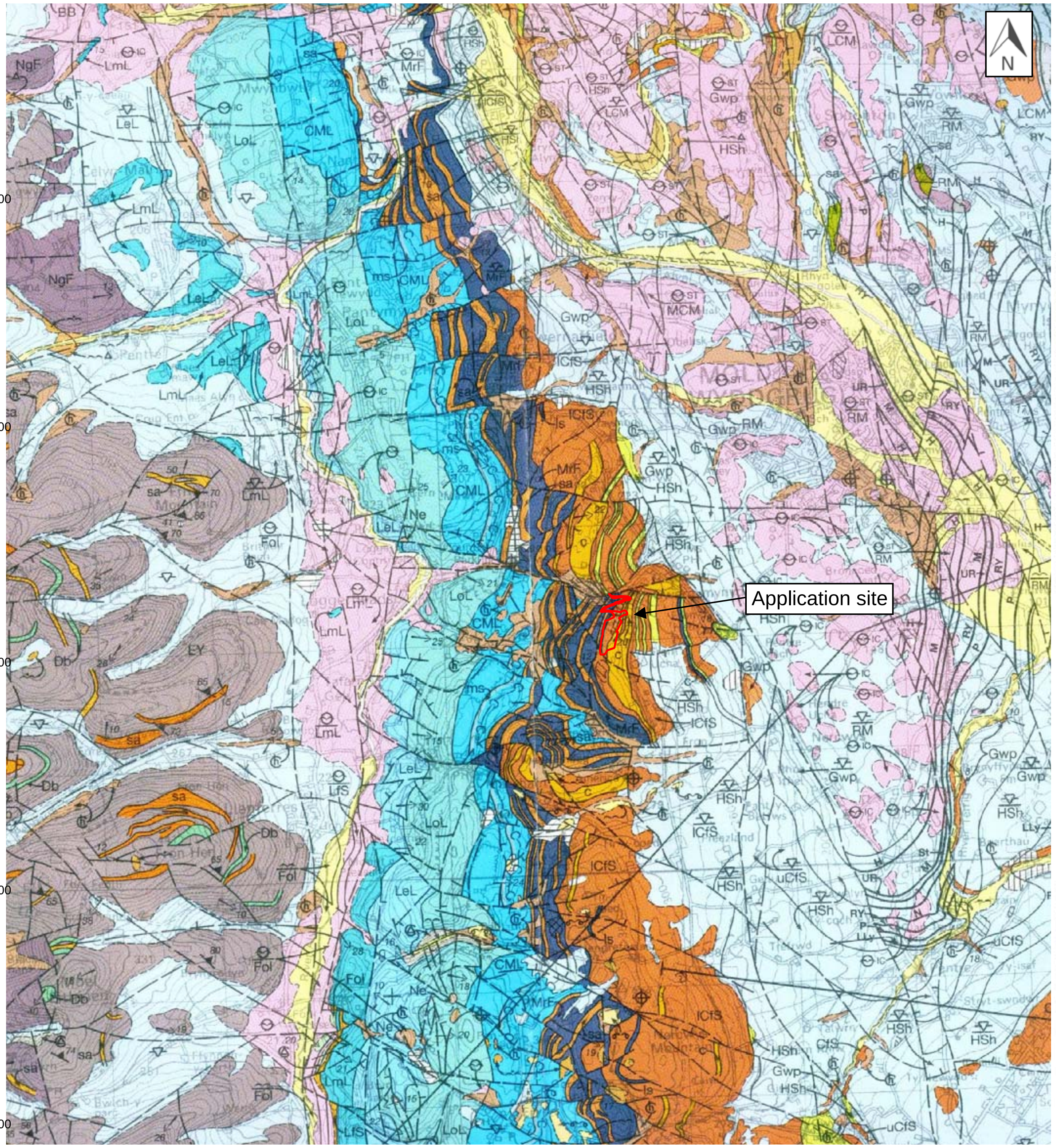
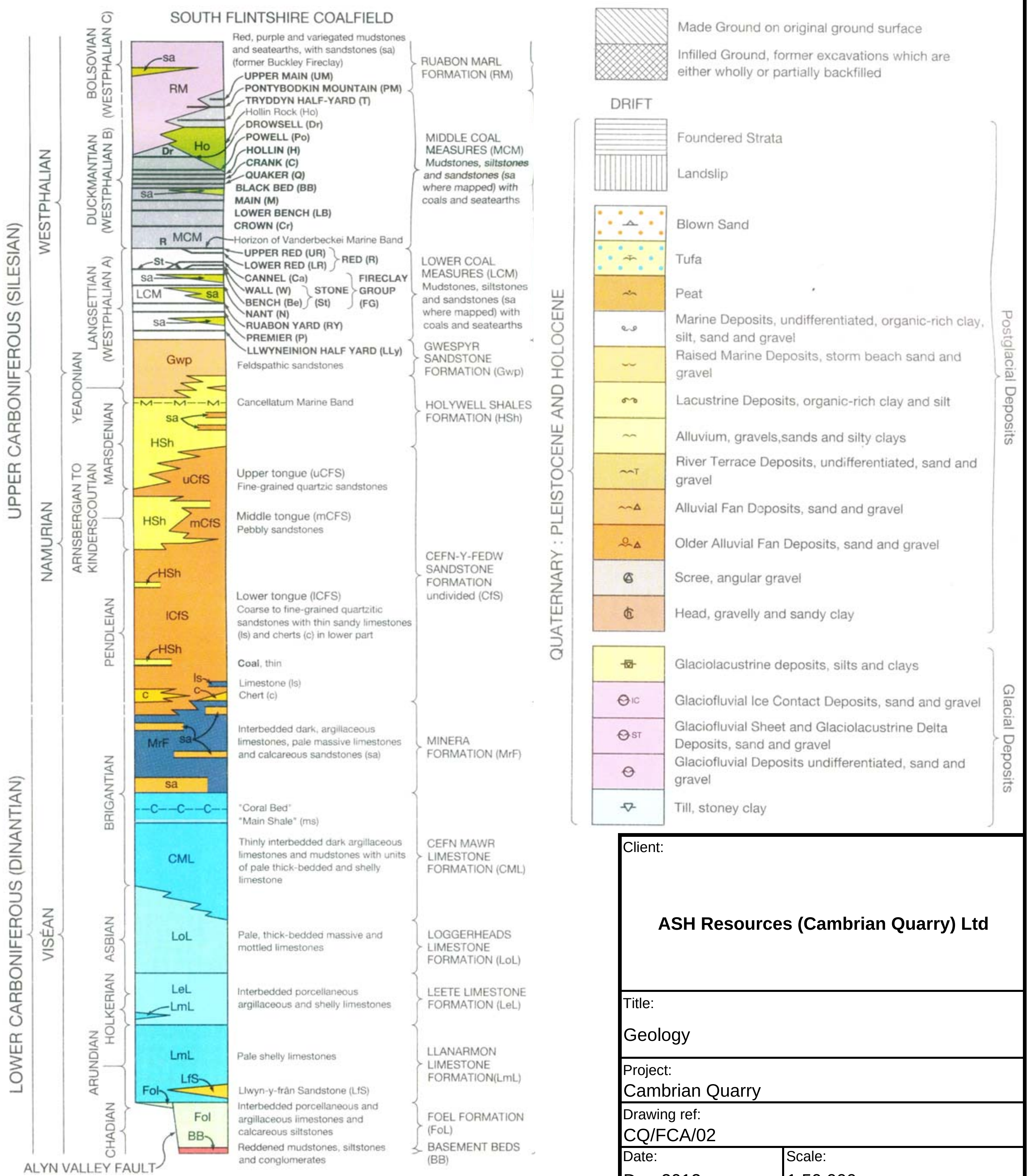
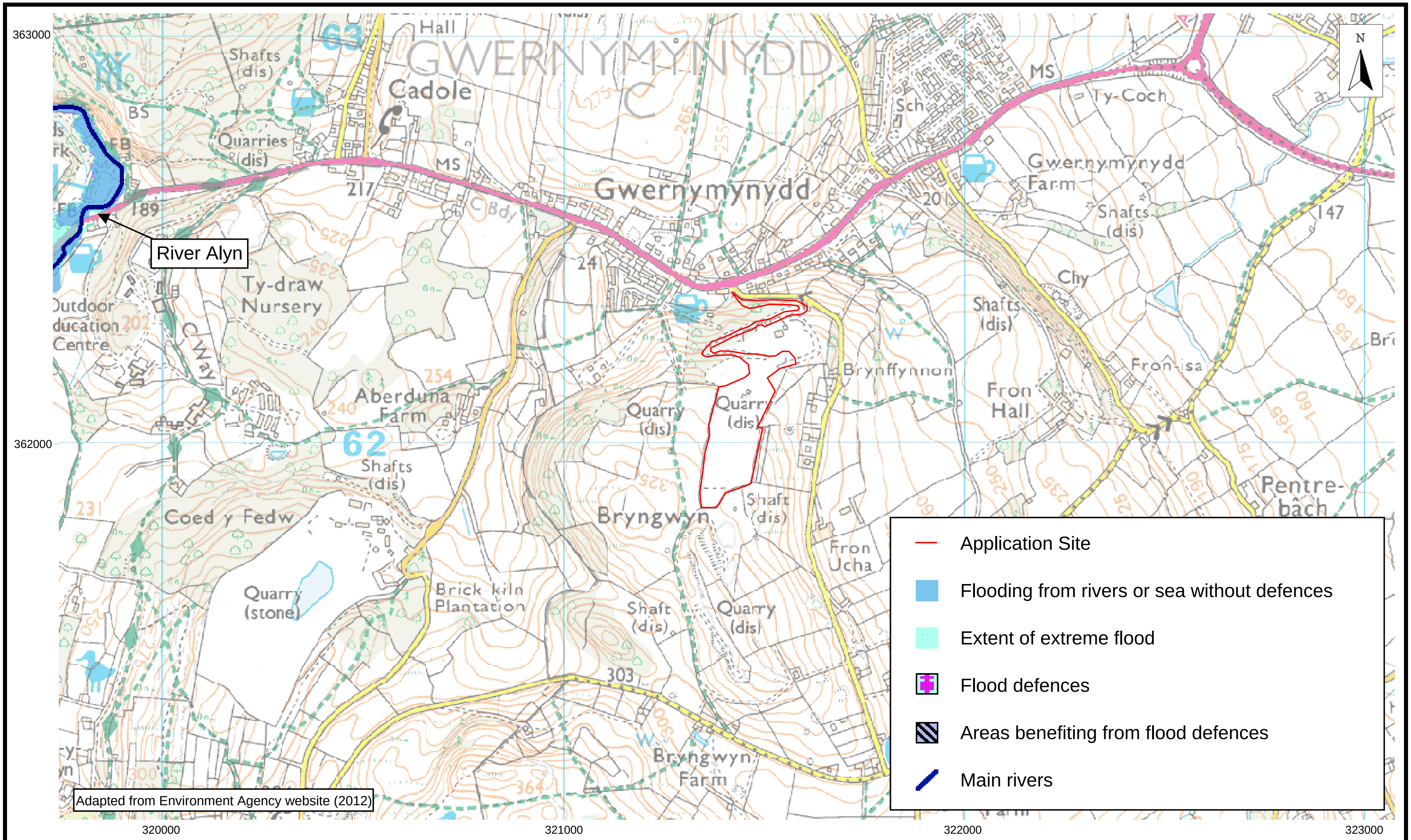
Client:	**ASH Resources (Cambrian Quarry) Ltd**		
Title:	Site location		
Project:	Cambrian Quarry	Date:	Dec-2012
Drawing:	CQ/FCA/01	Scale:	1:25,000 @A4

P:\Projects\Cambrian Quarry\FCA\Figures\CQ-FCA-01 - Site location and water features





Client: ASH Resources (Cambrian Quarry) Ltd	
Title: Geology	
Project: Cambrian Quarry	
Drawing ref: CQ/FCA/02	
Date: Dec-2012	Scale: 1:50,000
Hafren Water	Barkers Chambers, Barker St, Shrewsbury, UK, SY1 1SB Tel. 01743 355770 www.hafrenwater.com



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Client: **ASH Resources (Cambrian Quarry) Ltd**

Title: Environment Agency indicative flood risk map

Project: Cambrian Quarry

Figure: CQ/FCA/03

Date: Dec-2012

Scale: as shown @ A4

P:\Projects\Cambrian Quarry\FCA\Figures\CQ-FCA-03 - EA flood map

PHOTOSHEET

Photograph 1: Quarry void looking south

Photograph 2: Plant area to the north of the quarry void

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Client: ASH Resources (Cambrian Quarry) Ltd	Title: Photosheet		
	Project: Cambrian Quarry	Date: Dec-2012	

APPENDIX CQ/FCA/A1

Flood Risk Assessment details

Assessment of Flood Consequence

Assessment of flood consequence is undertaken following the requirements outlined in Tan 15. Although each assessment is specific to the site and mechanism of flooding in question a general method is followed when making all assessments. This method is outlined below.

The assessment of flood consequence is undertaken by considering the likelihood of flooding and the risk from flooding as outlined in Table 1

Likelihood of Flooding	*Risk from flooding*			
	Negligible	Low	Medium	High
Low	Very Low	Very Low	Low	Medium
Medium	Very Low	Low	Medium	High
High	Very Low	Medium	High	High

Table 1: Assessment of Flood Consequence

Likelihood of Flooding

Likelihood of flooding is determined taking into consideration the Development Advice maps. For some fluvial sources ie main watercourses the Environment Agency's flood zones are used. For other mechanisms of flooding assessment is made using other sources of data such as historical information, flow data etc. In some situations it may be necessary to undertake monitoring or modelling to determine likelihood of flooding. In others a more qualitative approach can be taken.

Risk from Flooding

The assessment of risk from flooding is undertaken by considering the Vulnerability of the site and the hazard of flooding at the site as outlined in Table 2.

Flood hazard	*Vulnerability of development*		
	Emergency Services	Highly Vulnerable	Less Vulnerable
Negligible	Negligible	Negligible	Negligible
Low	Medium	Medium	Low
Medium	High	High	Medium
High	High	High	Medium
Very High	High	High	High

Table 2: Assessment of Risk from Flooding

Flood Hazard

Assessment of flood hazard is undertaken for each possible flooding mechanism and specific to the site in question. An outline of the considerations taken into account when determining the hazard categories used within this report are outlined below:

Very high — High depths of inundation (>600 mm). High velocities of floodwater entering the site (>0.15 m/sec for residential, >0.3 m/sec for commercial). Restricted access/ egress to the site.

High — Depths of inundation up to 600 mm. Floodwater flowing across site at speeds of >0.15 m/s. Access/egress possible but may be through floodwaters.

Medium — Inundation of the site below 600 mm. Slack floodwaters with either very low velocities or on the edge of the floodplain. Easy access and egress.

Low — Some flooding on-site. Not affecting buildings. Negligible flood flows. Dry access/egress routes.

Negligible — No flooding on-site.

Vulnerability of Site

Vulnerability of the site is determined using classifications outlined in Tan15.

APPENDIX CQ/FCA/A2

Surface water run-off calculations

Cambrian Quarry - Surface water runoff - Quarry void - Restored

Parameters

Max height	314	mAOD
Min height	300	mAOD
Flow path	200	m
Slope	0.07	
C	0.6	
Area	2.8	ha
Discharge rate	6.0	l/s
Climate change (% rainfall increase)	30	%

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

	Rainfall *[1]	Rainfall intensity	Flow *[2]	Flow	Volume	Volume minus discharge
Duration	100 yr event	100 yr event	100 yr event	100 yr event		
hours	mm	mm/hr	l/s	l/s/Ha	m^3	m^3
0.25	31.77	127.08	771.57	275.56	694	689
0.5	37.57	75.14	456.21	162.93	821	810
1	44.44	44.44	269.82	96.36	971	950
2	52.55	26.28	159.53	56.97	1,149	1,105
4	62.15	15.54	94.34	33.69	1,358	1,272
6	68.56	11.43	69.38	24.78	1,499	1,369
8	73.5	9.19	55.78	19.92	1,607	1,434
12	81.08	6.76	41.02	14.65	1,772	1,513
16	87.65	5.48	33.26	11.88	1,916	1,570
20	93.11	4.66	28.27	10.09	2,035	1,603
24	97.83	4.08	24.75	8.84	2,138	1,620
28	102	3.64	22.12	7.90	2,229	1,625
32	105.76	3.31	20.07	7.17	2,312	1,620
36	109.19	3.03	18.42	6.58	2,387	1,609
40	112.35	2.81	17.05	6.09	2,456	1,592
44	115.29	2.62	15.91	5.68	2,520	1,570
48	118.04	2.46	14.93	5.33	2,580	1,543

*[1] Obtained from FEH CD-ROM version 3

*[2] Climate change factored into rainfall intensity at this stage

P:\Projects\Cambrian Quarry\FCA\Data\Surface water runoff Cambrian v2/SW runoff quarry floor restored

Cambrian Quarry - Surface water runoff - Bat cave area (NE quarry void) - Restored

Parameters		
Max height	314	mAOD
Min height	300	mAOD
Flow path	200	m
Slope	0.07	
C	0.6	
Area	0.18	ha
Discharge rate	2	l/s
Climate change (% rainfall increase)	30	%

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

	Rainfall *[1]	Rainfall intensity	Flow *[2]	Flow	Volume	Volume minus discharge
Duration	100 yr event	100 yr event	100 yr event	100 yr event		
hours	mm	mm/hr	l/s	l/s/Ha	m^3	m^3
0.25	31.77	127.08	49.60	275.56	45	43
0.5	37.57	75.14	29.33	162.93	53	49
1	44.44	44.44	17.35	96.36	62	55
2	52.55	26.28	10.26	56.97	74	59.4
4	62.15	15.54	6.06	33.69	87	58.5
6	68.56	11.43	4.46	24.78	96	53
8	73.5	9.19	3.59	19.92	103	46
12	81.08	6.76	2.64	14.65	114	28
16	87.65	5.48	2.14	11.88	123	8
20	93.11	4.66	1.82	10.09	131	-13
24	97.83	4.08	1.59	8.84	137	-35
28	102	3.64	1.42	7.90	143	-58
32	105.76	3.31	1.29	7.17	149	-82
36	109.19	3.03	1.18	6.58	153	-106
40	112.35	2.81	1.10	6.09	158	-130
44	115.29	2.62	1.02	5.68	162	-155
48	118.04	2.46	0.96	5.33	166	-180

*[1] Obtained from FEH CD-ROM version 3

*[2] Climate change factored into rainfall intensity at this stage

P:\Projects\Cambrian Quarry\FCA\Data\Surface water runoff Cambrian v2/SW runoff bat area restored