The Solar Building COMPANY LIMITED®

Building a Solar Future

Moneystone Quarry Solar Farm

Appendix H

Flood Risk Assessment

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Project Quality Assurance Information Sheet

Proposed Solar Farm, Moneystone Quarry, Staffordshire
Flood Risk Assessment

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Prepared for Solar Building Company

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FLOOD RISK ASSESSMENT

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EXECUTIVE SUMMARY

Stratus Environmental Limited was commissioned to prepare a Flood Risk Assessment to support a planning application, to develop a Solar Farm at Moneystone quarry, located between the villages of Whiston and Oakamoor in Staffordshire. The assessment considers the potential flood risk from a variety of sources, including those from fluvial, tidal, groundwater, pluvial, canals, reservoirs and other water bodies.

Environment Agency flood maps show the site to be located within a Flood Zone 1. Based on National Planning Policy Framework guidance vulnerability criteria the development proposals are listed as 'Essential Infrastructure', which is considered as a suitable development within areas identified as Flood Zone 1. No Essential test is therefore required.

A scheme of restoration approved by Staffordshire County Council seeks to restore the wider quarry through the creation of several habitats. The proposed restored surfaces are considered to represent greenfield runoff conditions.

Some areas of the application site are considered to have a high susceptibility from groundwater flooding which is likely to present a risk to infrastructure located at ground level only.

Only limited areas of the proposed development zones are currently at risk from pluvial flooding, although it is considered that initial restoration of the quarry site will reform the surfaces to prevent such localised ponding.

There are no sewers, canals or reservoirs in close proximity of the site.

Whilst the development of a solar farm will result in a large area of the site being covered with raised impermeable surfaces the permeability of the soil surface will largely be unaltered. Consequently, it is considered that rain water will effectively run off the solar panels on to the restored soil surfaces.

The development will result in a small proportion of the site surface becoming impermeable as a result of the construction of inverter and transformer station and substations. Of the 14.3ha of site area less than 0.5% will made impermeable. These areas are therefore unlikely to have any significant effect on Greenfield runoff rates for the site.

The restoration of the quarry and development of the solar farm will result in the removal of a large area of impermeable surfaces. In turn, the development will not significantly change the permeability of the restoration soils. It can therefore be considered that restoration and subsequent re-development of the quarry will result is an overall reduction in site runoff in relation of current conditions.

To mitigate from the risk of groundwater flooding and surface flows all connection cabinets will be located on areas with the least susceptible areas of the site, where possible. Other precautionary measures to mitigate the residual risk of surface flows and groundwater flooding include raising all cabinets 300mm above the surrounding land and ensuring that doors and entrances do not face upslope.

1.0 INTRODUCTION

1.1 Scope

1.1.1 Stratus Environmental Ltd (Stratus) was commissioned by The Solar Building Company Limited (SBC) to undertake a Flood Risk Assessment (FRA) to accompany a planning application for the development of a solar farm at Moneystone Quarry, Staffordshire.

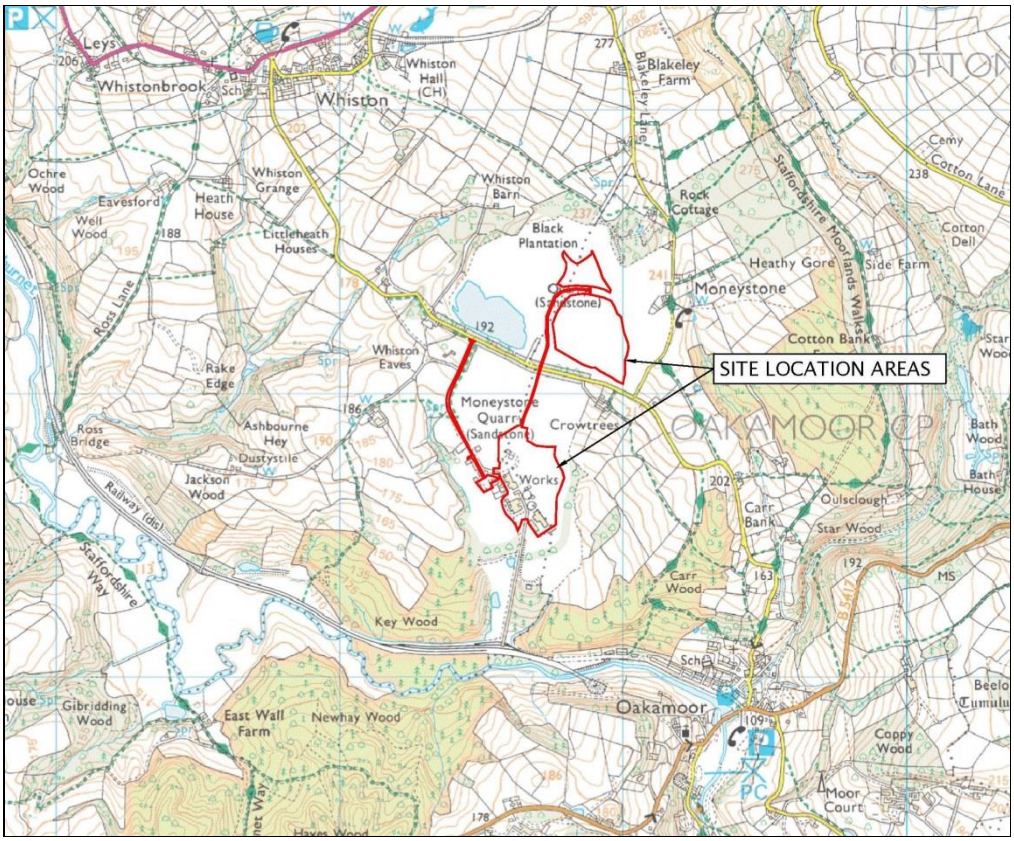
1.1.2 The requirements of this study is to consider the potential risk of flooding in terms of its effects on flood flows and run-off as a result of the proposed development of the site over its expected lifetime and any possible impacts on flood risk elsewhere. For the purposes of this assessment it is considered that the restored quarry, as per the scheme currently under consideration, greenfield conditions will be the most representative of the site.

1.1.3 In accordance with current best practice and legislative and planning policy requirements, this assessment has been carried out in compliance with National Planning Policy Framework and it supporting Technical Guidance[1].

1.1.4 The site is located mid-way between the villages of Whiston and Oakamoor to the northwest and southeast of the site respectively. The National Grid Reference (NGR) for the site is SK 04681 46095. A site location plan is shown in **Figure 1**.

[1] *National Planning Policy Framework Technical Guidance, March 2012.*

Figure 1: Site Location



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1.2 Planning Policy

National Planning Policy Framework (2012)

1.2.1 The National Planning Policy Framework (2012) states that *"when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the Exception Test..."*

1.2.2 "Flood risk" means risk from all sources of flooding – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

1.2.3 The NPPF technical Guidance defines "Areas at risk of flooding" as land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency. Tables 1 and 2 summarise the appropriate land uses and FRA requirements for the aforementioned flood zones ('Sequential Test').

Table 1: Flood Zones

Flood Zone Definition	Appropriate land uses and FRA requirements
Zone 1 (Low Probability) – Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).	**Appropriate uses** All uses of land are appropriate in this zone. **FRA requirements** For development proposals on sites comprising one hectare or above, the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, should be incorporated in a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 2 (Medium Probability) – Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.	**Appropriate uses** The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table 2 are appropriate in this zone. Highly vulnerable uses in Table 2 are only appropriate in this zone if the Exception Test is passed. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Flood Zone Definition	Appropriate land uses and FRA requirements
Zone 3 (High Probability) – Land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	**Appropriate uses** The water-compatible and less vulnerable uses of land in Table 2 are appropriate in this zone. The highly vulnerable uses in Table 2 should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table 2 should only be permitted in this zone if the Exception Test is passed. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to: • reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; • relocate existing development to land with a lower probability of flooding; create space for flooding to occur by allocating and safeguarding open space for flood storage.
Zone 3b (Functional Floodplain) – Land where water has to flow or be stored in times of flood. (Land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the local planning authority and the Environment Agency, including water conveyance routes).	**Appropriate uses** Only the water-compatible uses and the essential infrastructure listed in Table 5-3 that has to be there should be permitted. It should be designed and constructed to:- • remain operational and safe for users in times of flood; • result in no net loss of floodplain storage; • not impede water flows; • not increase flood risk elsewhere. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** In this zone, developers and local authorities should seek opportunities to: • reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; • relocate existing development to land with a lower probability of flooding.

Table 2: Flood risk vulnerability classification

Vulnerability Class	Types of Development
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; • Wind turbines.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flood events; • Emergency dispersal points; • Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use; • Installations requiring hazardous substances consent.
More Vulnerable	• Hospitals, • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling house, student halls of residence, drinking establishments, nightclubs, hotels • Sites used for holiday or short-let caravans and camping. • Non-residential uses for health services, nurseries and education. Landfill and waste management facilities for hazardous waste.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities), minerals working and processing (except for sand and gravel). • Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	• Flood control infrastructure, water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. Sand and gravel workings. • Docks, marinas and wharves, navigation facilities. • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. • Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.

1.2.4 The flood risk vulnerability classification can be summarised in the **Table 3**.

Table 3: Flood Risk Vulnerability and Flood Zone 'Compatibility' ***(Table 3 of NPPFTG)***

Flood risk vulnerability classification		**Essential infrastructure**	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less vulnerable**
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

1.2.5 The 'Exception Test' requires a development to demonstrate the following criteria:-

a) the development provides wider sustainability benefits to the community that outweigh flood risk,
b) the development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and
c) a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Staffordshire Moorlands Strategic Flood Risk Assessment (January 2008)

1.2.6 The Level 1 Strategic Flood Risk Assessment (SFRA) is an essential part of the 'evidence gathering' stage in relation to the preparation of the Local Development Framework (LDF) and it Local Development Documents (LDDs). The SFRA provides baseline information for use in the preparation of LDDs and the Sustainability Appraisal (SA) of LDDs for the scoping and evaluation stages.

1.2.7 SFRA's can also provide a much broader and inclusive vehicle for integrated strategic and local Flood Risk Management (FRM) assessment and delivery, by providing the linkage between Catchment Flood Management Plans (CFMP's), Regional Flood Risk Appraisals (RFRA's) and Surface Water Management Plans (SWMP's).

1.2.8 The Level 1 SFRA for Staffordshire Moorlands was published in 2008. It was developed in line with Planning Policy Statement 25 Development and Flood Risk (PPS25) and its Practice Guide, although it should be noted that these policy documents have since been replaced by the National Planning Policy Framework and associated Technical Guidance.

1.2.9 In accordance with national policies, the SFRA stipulates the incorporation of Sustainable Urban Drainage Systems (SUDs) into any development to manage surface runoff. In accordance with Environment Agency requirements any development should achieve 'Greenfield' discharge rates with a minimum reduction of 20% to account for the future effects that climate change will have on runoff volumes.

2.0 SITE AND DEVELOPMENT DESCRIPTION

2.1 Landuse and Site Setting

2.1.1 The development site measures circa 14.3ha within the larger former Moneystone quarry complex (that measure approximately 168ha) as shown on Drawing No. SBC1049/17/02. The quarry complex is intersected laterally at its approximate centre by the unclassified Eaves Road.

2.1.2 The former quarry complex is located within the tributary valley network that feeds the Churnet Valley. Surrounded immediately by woodland plantations the wider setting can be described as a predominantly rural setting with a number of sparse farmsteads and other dwellings.

2.1.3 A large lagoon currently occupies a large section of the northern quarry whilst smaller lagoons are present in the southern quarry. There are several surface water features located to the west and east of the quarry complex including small field drainage ponds, issues, sinks, spreads and associate land drains which drain southwards to the River Churnet. Springs are present to the north and west of the site. The spring to the north of the quarry is elevated at c. 235mAOD whist spring to the west whilst those of the west are elevated at c. 168mAOD and c. 152mAOD.

2.2 Topography

2.2.1 Ground levels within the vicinity of the Moneystone Quarry complex are at their highest elevation of c. 290mAOD at a point 600m north. The land falls steeply south to the base of the Churnet valley, elevated at c. 110mAOD to the south of the quarry complex.

2.2.2 At the northern ridge of the quarry complex ground levels are elevated at between 230-240mAOD. The northern slopes of the north quarry fall consist of initial steep engineered slopes towards the quarry base which falls over c. 375m at a shallower gradient towards Eaves Road which is elevated at c. 195mAOD.

2.2.3 The topography of the southern quarry consists of slightly shallower gradients than that of the northern quarry, falling from c. 195mAOD at Eaves Road to c.150mAOD at the south boundary of the quarry excavation – a distance of c. 600m.

2.3 Geology and Hydrogeology

2.3.1 The quarry complex is located over two distinct rock units. The northern quarry and northern section of the southern quarry is underlain directly by the Namurian Rossendale Formation (Sandstone). The remaining area of the southern quarry is underlain by the Lower Coal Measures of the North Staffordshire Coalfield. Both rock units are classified as Secondary A aquifers, due to the presence of permeable layers capable of supporting water supplies

at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers

2.4 Historical Flooding

2.4.1 There are no recent records of flooding from any sources having impacted upon the site.

2.5 Development Proposals

2.5.1 The proposals consists of the development of an approximately 5MWp solar farm within two deployment zones (Areas D and E) within the Moneystone Quarry complex, as shown in Drawing No. SBC1049/17/06. Area B is not proposed for solar deployment and will be used for a biodiversity enhancement. Earthworks to accommodate the deployment areas have already been undertaken as part of the approved restoration of the quarry.

2.5.2 The earthworks has resulted in a reduction of the impermeable area associated with the existing site (pre-restoration works) and therefore a reduction in any associated flood risk to the site or surrounding land. The restored quarry surfaces are therefore considered to be representative of greenfield runoff conditions. The re-graded surfaces have been compacted to provide a CBR of at least 3%. Existing topsoil will be relayed over Areas B and D, whilst existing topsoil and tailings will be used to cover Area E.

2.5.3 The mounting frames will be matt finished galvanised steel with steel posts of 200mm diameter, driven (screwed or piled) into the ground, without the need for concrete foundations to a depth of approximately 1.50m. Towards the southern extent of area E the panel arrays may be secured by ballast blocks or the ground mount tree system. However, this will be confirmed following further site investigation. Drawing SBC1049/1/03 provides a specification of the panel and frames. The panels will be approximately 20o (+/- 10o) to the horizontal.

2.5.4 The arrays will be connected to inverter and transformer stations which will allow electricity to be transferred around the site at an appropriate voltage. These prefabricated containers will be set on concrete bases. These will subsequently connect to a proposed on site sub-station that will connect to the local distribution network grid via buried cables.

2.5.5 In summary the following infrastructure will be installed:

- PV panels and associated supporting frames and ground mounting;
- 4 inverter and transformer stations (housed in prefabricated containers);
- A sub station housed in a prefabricated container to allow connection to the Local Distribution Network;
- Customer substation;
- Fencing and CCTV;
- Internal service road;

- Temporary set down areas; and
- Site Access

2.5.6 At the development stage it is difficult to confirm which system will be used as this depends on availability of infrastructure at the time of construction and preference of the final contractor. If the string inverter design is pursued than the inverter and transformers stations would not be required and only the individual transformer stations would be needed, as represented by purple blocks on drawing SBC1049/17/06. Should the central inverter design be implemented then the inverter and transformer stations will be retained and the individual transformers removed from the design.

3.0 FLOOD RISK ASSESSMENT

3.1 Preliminary Assessment of Potential Sources of Flood Risk

3.1.1 A summary of the assessment of the potential sources of flooding for the site is shown in table 4. This assessment is supported by an Envirocheck Flood Screening Report provided by Landmark Information Group Service **(Appendix 1)** together with information from Staffordshire Moorlands District Council SFRA.

Table 4: Preliminary assessment of potential flood sources

Flood Source	Risk Potential				Comments
	High	**Medium**	**Low**	**None**	
Main Rivers			✓		Majority of site located with Flood Zone 1
Tidal				✓	Not within zone of tidal influence
Canals				✓	None within vicinity of site
Groundwater	✓				High susceptibility limited to southern quarry area only.
Reservoirs & water bodies			✓		Several ponds proposed with restoration scheme for quarry complex to which surface waters from the development areas will drain.
Sewers				✓	None within vicinity of site
Pluvial runoff			✓		Development areas set on elevated areas of the quarry
Development Drainage			✓		Development only likely to result in a very small increase in runoff rates.

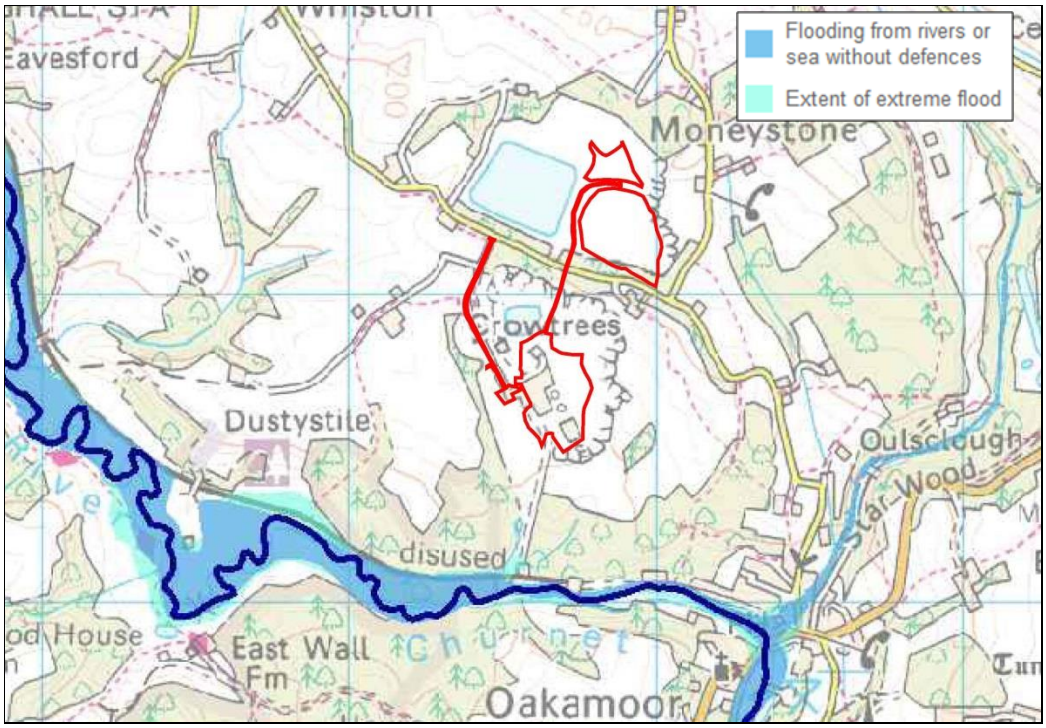
3.2 Risk of Flooding to Proposed Development

3.2.1 This section assesses the associated flood risk posed to the development in order to identify any appropriate mitigation.

Fluvial/Tidal Flooding

3.2.2 The development site is located within a Flood Zone 1. The extents of the modelled floodplains within the vicinity of the site are presented in **Figure 2**.

Figure 2: Extract from EA Flood Data Map



3.2.3 Based on vulnerability criteria outlined in Section 1.2 the development can be classified as 'Essential Infrastructure' which is suitable for development within a Flood Zone 1.

Groundwater Flooding

3.2.4 The site is located with the excavated quarry consisting of permeable bedrock. The presence of springs and wells at higher elevations within close proximity of the site indicates that groundwater levels are higher that ground levels with the quarry. BGS groundwater flood susceptibility data **(Appendix 1)** indicates that the majority of the development zones within the northern quarry area have a negligible susceptibility to groundwater flooding, with some small areas having a low susceptibility. The development zone in the southern quarry is considered to have a high susceptibility to groundwater flooding.

Reservoirs and Waterbodies

3.2.5 The site is not located within an area identified by the EA to be at risk of reservoir flooding.

3.2.6 Several surface water lagoons are located within the lower reaches of the quarry. It is anticipated that these lagoons will form wetland habitats as part of the wider quarry restoration proposals. It is not considered that these wetland habitats will result in flooding of the development areas – the flood risk is therefore considered low.

Pluvial Runoff

3.2.7 Risk Management System Flood data (refer to **Appendix 1**) indicated that the some small areas of development zone D in the northern quarry site may be susceptible to pluvial flooding during a 75, 100 and 1000 year return period. However, in light of the proposed earthworks scheme these areas are likely to be reformed to prevent ponding.

3.2.8 The abovementioned pluvial flood models are based upon the assumption that the underlying soils are saturated.

Sewer Flooding

3.2.9 There are no sewers within the vicinity of the site.

3.3 Effect of the Development on Wider Catchment

3.3.1 The solar modules will be raised significantly above the surface and are designed to allow for between 3m and 6m spaces between the rows. In addition, individual angled solar modules have rain gaps allowing rainwater to disperse more evenly. Taking the above parameters in to account, the panels were not considered to be included when calculating impermeable surfaces and the increased run-off caused by them. The surface of the deployment area is to be maintained as grass to further mitigate any accumulation of water from panels. This water is then assumed to infiltrate or run-off as the field would have pre-development.

3.3.2 The development proposals include the construction of new access tracks. This surface will permit some infiltration, it is reasonable to consider that this surface will have a similar permeability to the existing soils, and therefore will not be included as impermeable surfaces.

3.3.3 The proposed development will create small areas of impermeable surfaces on the site. These impermeable surfaces are created by the following:

- 4 inverter and transformer stations;
- Customer substation; and
- Sub-station

3.3.4 In light of the total area of the site (14.3ha) the development will only increase run off rates from <0.5% of the site. Overall, this is unlikely to significantly alter the Greenfield runoff rate.

4.0 MITIGATION MEASURES

4.1 Site Arrangements

4.1.1 Where possible all inverter and transformer stations will be located on areas of the site that have the lowest susceptibility to flooding. Other precautionary measures to mitigate the residual risk of surface flows and groundwater flooding include cabinets 300mm above the surrounding land and ensuring that doors and entrances do not face upslope.

4.2 Drainage Arrangements

4.2.1 The restoration of the quarry will result in the removal of a large area of impermeable surfaces. In turn, the proposed earthworks to achieve the desired gradients for the solar development will increase the permeability of the development areas. No additional drainage requirements are therefore considered necessary.

5.0 CONCLUSIONS

5.1.1 A flood risk Assessment has been prepared to consider the potential risks to and from the development of a solar farm at the former Moneystone quarry, Staffordshire. The assessment considers the potential flood risk from a variety of sources, including those from fluvial, tidal, groundwater, pluvial, canals, reservoirs and other water bodies.

5.1.2 Environment Agency flood maps to be located within a Flood Zone 1. Based on National Planning Policy Framework guidance vulnerability criteria the development proposals are listed as 'Essential Infrastructure' which is considered as a suitable development within areas identified as Flood Zone 1. No Essential test is therefore required.

5.1.3 Only small areas of the development zones are currently at risk from pluvial flooding, although it is considered that initial restoration of the quarry site will reform the surfaces to prevent such localised ponding.

5.1.4 There are no sewers, canals or reservoirs in close proximity of the site.

5.1.5 Whilst the development of a solar farm will result in a large area of the site being covered with elevated impermeable surfaces the permeability of the soil surface will largely be unaltered. Consequently, it is considered that rain water will effectively run off the solar panel on to the restored soil surfaces.

5.1.6 The development will result in a small proportion of the site surface becoming impermeable as a result of the construction of low and high voltage switchgear cabins. Of the 14.3ha site area <0.5%) will be made impermeable. These areas are therefore unlikely to have any significant effect on Greenfield runoff rates for the site, based on the restored quarry.

5.1.7 The wider restoration of the quarry will result in the removal of a large area of impermeable surfaces. In turn, the proposed solar development will not significantly change the permeability of the restoration soils. It can therefore be considered that restoration and subsequent re-development of the quarry will result is an overall reduction in site runoff in relation of current conditions. No additional drainage requirements are therefore considered necessary.

5.1.8 To mitigate from the risk of groundwater flooding and surface flows all connection cabinets will be located on areas with the least susceptible areas of the site. Other precautionary measures to mitigate the residual risk of surface flows and groundwater flooding include raising all cabinets 300mm above the surrounding land and ensuring that doors and entrances do not face upslope.

Appendix 1

Envirocheck Flood Screening Report