The Trustees of the Standen Estate

Land off Littlemoor

Flood Risk Assessment for 49 new residential units

AMEC Environment & Infrastructure UK Limited

April 2012

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Certificate No. FS 13881

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Executive Summary

AMEC Environment & Infrastructure UK Ltd (AMEC) was commissioned in 2012 by Trustees of the Standen Estate to undertake a Flood Risk Assessment (FRA) to accompany an outline planning application for the development of 49 residential homes at the land off Littlemoor, Clitheroe, Lancashire; also known as the 4 Acre Site.

The existing site is greenfield located in Flood Zone 1 and is 1.75 hectares in size, which in accordance with the National Planning Policy Framework necessitates this FRA.

All potential risks of flooding to the site have been assessed and relevant flood management options have been recommended when necessary. This includes a draft surface water management strategy which recommends various SuDS techniques to control discharge rates from the site to a Greenfield runoff rate of 10 l/s/ha as required by the Environment Agency. Ground profiling and minimum finished floor levels are also recommended to ensure control of overland flow in excess of the capacity of the drainage system and to prevent ponding.

A permeability test and assessment of groundwater level has been recommended prior to the installation of any SuDS features to determine the whether or not infiltration options can be employed at the site.

Contents

1. Introduction

1.1 Context

AMEC Environment & Infrastructure UK Ltd (AMEC) was commissioned in February 2012 by Trustees of the Standen Estate to undertake a Flood Risk Assessment (FRA) to accompany an outline planning application for the development of 49 residential homes at the land parcel off Littlemoor, Clitheroe, Lancashire (referred to as the site). The site is currently greenfield and is 1.75 hectares in area. The Environment Agency Flood Risk map currently classifies the site as Flood Zone 1, defined as having a less than 0.1 % annual exceedance probability (AEP) of fluvial or tidal flooding.

This FRA has been prepared in accordance with the National Planning Policy Framework (NPPF)[1] which replaces Planning Policy Statement 25 (Development and Flood Risk) (PPS25) while retaining the key elements of that policy statement The NPPF states (paragraph 103) that a site-specific FRA is required for development proposals of 1 hectare or greater in Flood Zone 1, all proposals for new development located in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency) and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

The core content of an FRA, as detailed in NPPF, is to demonstrate how flood risk from all sources of flooding to the development itself and potential increased flood risk to others will be managed over the lifetime of the development, taking climate change into account.

1.2 Structure of this report

The report is structured as follows:-

- Section 2: Site Description: - development proposals and planning context.
- Section 3: Flood Risk Appraisal: - this provides an initial assessment and a summary of the various sources of flood risk to the site.
- Section 4: Surface Water Management Strategy: - this section details the surface water drainage strategy and provides details of any mitigation required to limit surface water runoff.
- Section 5: Flood Risk Management and Mitigation: - this section applies the Exception Test and details the measures to be taken to mitigate flood risk.
- Section 6: Summary, Conclusions and Recommendations; this Section summarises the report findings and presents the conclusions and recommendations.

The figures are embedded within the main text of this document while other supporting documents are presented at the end of the report in the form of appendices. There are five appendices, as follows:

- Appendix A contains the topographic survey;
- Appendix B provides the illustrative site layout plan;
- Appendix C provides evidence of the consultation process (including United Utilities, Lancashire Country Council and Environment Agency);
- Appendix D contains a photograph of the site; and
- Appendix E contains the service plan.

1.3 Sources of Data

- National Planning Policy Framework (2012)[1].
- Technical Guidance to the National Planning Policy Framework (2012)[2].
- British Geological Survey (BGS) DiGMapGB-625 data 1:625,000[3]
- Institute of Hydrology, Flood Studies Report, (1975)[4].
- Institute of Hydrology, Report No. 124, Flood Estimation for Small Catchments, (1994)[5].
- Environment Agency website. What's in your backyard (2012)[6].
- Defra/Environment Agency Flood and Coastal Defence R&D Programme: Preliminary rainfall runoff management for developments, Technical Report W5-074A/TR/1 Revision B, (2004)[7].
- Defra/Environment Agency. FD2320. Flood Risk Assessment Guidance for New Development Phase 2. R&D Technical Report FD2320/TR2. 2005' and 'Environment Agency. Supplementary note on flood hazard ratings and thresholds for development planning and control purpose – clarification of the Table 13.1 of FD2320/TR2 and of FD2321/TR1. (2008).[8]
- CIRIA, C697, The SUDS Manual, (2007)[9].
- Ribble Valley Borough Council. Strategic Flood Risk Assessment – Level 1, (2010)[10].
- Landmark Information Group. Envirocheck Report. Flood Screening Report Datasheet, (2012)[11].

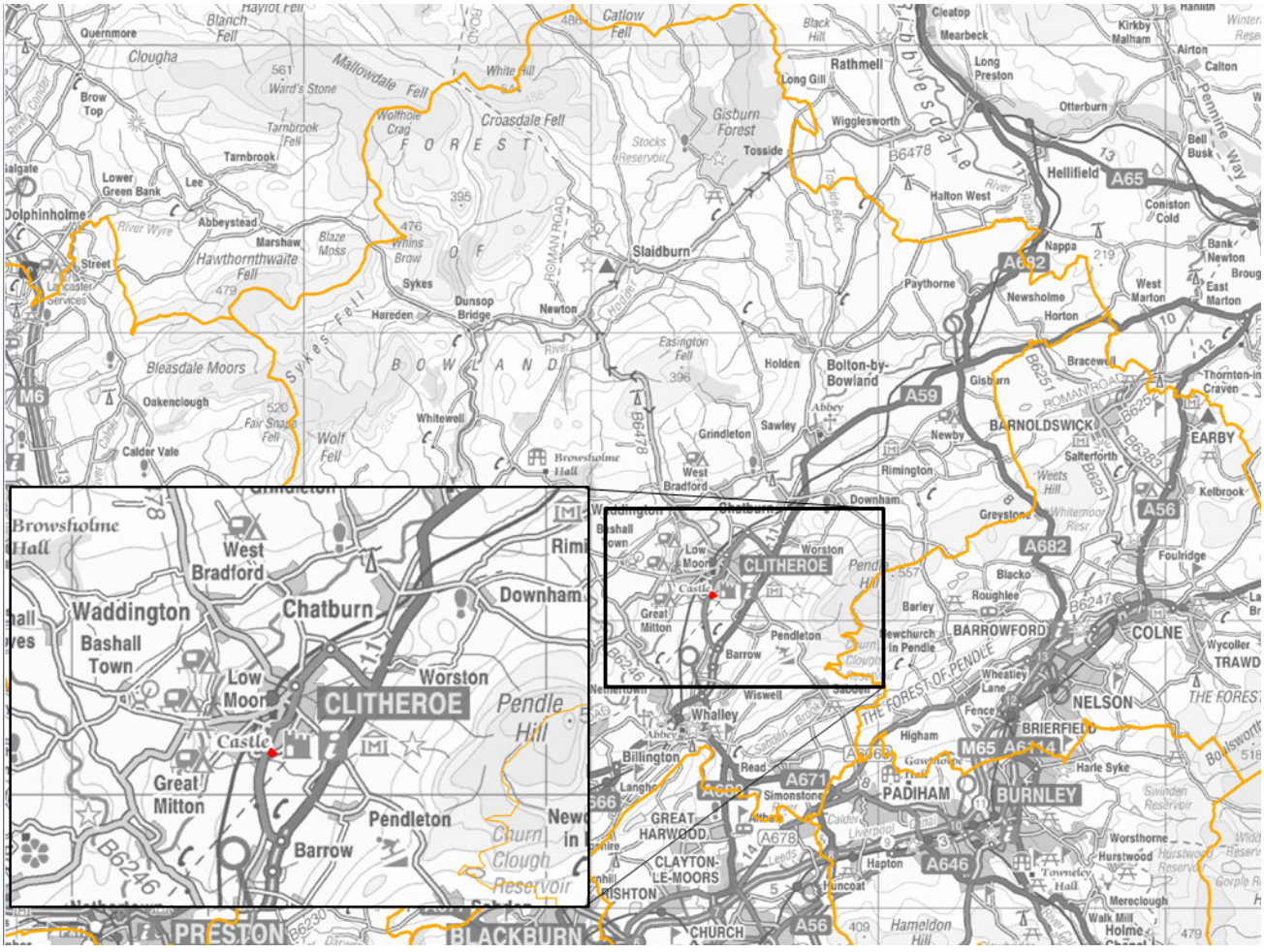
2. Site Description, Development Proposal and Planning Context

2.1 Site Description

2.1.1 The Site

The dimensions of the site are approximately 132m by 140m occupying a 1.75 hectare parcel of greenfield land. The site is centred at National Grid Reference (NGR) 374221 440895 just off Littlemoor in Clitheroe, Lancashire (see Figure 2.1). Clitheroe is a small historic market town with a population of approximately 15,038 (as taken from Ribble Valley Borough Council, 2011[12]) and is located at the heart of the largely rural District of the Ribble Valley in the North West of England (see Figure 2.1).

Figure 2.1 Site location plan.



Orange line represents the District boundary, while the red point shows the location of the site.

The site is surrounded by residential properties to the south, southeast and the north, with Primrose Garage to the west and recreational playing fields to the northeast. Littlemoor road runs along the eastern perimeter of the site. As the site is currently a greenfield site it does not have a vulnerability classification in NPPF.

2.1.2 Topography

The site and the area immediately surrounding it are relatively flat with a gentle fall from east to west. A topographic survey carried out in July 2011 (see Appendix A) shows that the site has a gentle slope of approximately 0.032m/m from northeast to southwest, with the ground elevations ranging between 76.89mAOD to 82.91mAOD. .

Clitheroe is located in the Ribble Valley which is an undulating, broad bottomed, fertile valley between the moorland hills of Pendle Hill to the east, Waddington Fell and the Bowland Hills to the north-west and Longridge Fell to the southwest.

The catchment's headwater valleys are steep sided with numerous minor tributaries, giving way to less steep valley sides with wider floodplains in their middle courses, such as on the Ribble around Clitheroe.

2.1.3 Hydrology, Drainage, Hydrogeology and Soils

Hydrology and Drainage

Pendleton Brook is the nearest watercourse to the site, flowing in an east-southeast to west-northwest direction. At its closest point to the site (130m) the ground elevation is approximately 73mAOD (as shown on Ordnance Survey mapping). Another watercourse, Mearley Brook, flows in a north to south direction via a series of weirs and a reservoir. The reservoir is located 225m west southwest of the site (at an elevation of approximately 70mAOD). Ordnance Survey mapping shows a second smaller reservoir to the southwest of the site, however during a site visit it was noted that this reservoir no longer exists and has been in-filled. The area of land formerly occupied by the reservoir is currently under development for new housing.

The Flood Estimation Handbook (FEH) CD ROM locates the site within the Pendleton Brook catchment; at this point Pendleton Brook has a catchment area of 6.4km^2. The FEH CD ROM gives a standard average annual rainfall (SAAR) for the site of 1274mm. The 1 in 100 year 6 hour design rainfall event (generally used to assess surface water storage requirements when designing drainage systems) for the area, is given by the FEH CD-ROM as 75.6mm. A further requirement of NPPF is to increase design rainfall depths by 30 % in order to account for the potential effects of climate change. The 1 in 100 year 6 hour duration rainfall event, with added allowance for climate change, is 98.3mm.

The service plan drafted by AMEC (see Appendix E),shows there is a private 300mm surface water drain crossing the site as well as one private and one public combined sewer also crossing the site. It is not known where the

private sewers outfall. A public foul sewer connects with the public combined sewer within the site boundary. In addition to these sewers there is a public water supply pipe crossing the site (see Appendix E).

Geology, Hydrogeology and Soils

British Geological Survey (BGS) DiGMap[3] data shows the bedrock at the site to be Bowland High Group and Craven Group, made up of Mudstone, Siltstone and Sandstone. The BGS website[13] shows the Clitheroe Limestone Formation and Hodder Mudstone formation to be the dominant bedrock formation while the superficial geology is made up of Till and Diamicton. There is an extensive limestone quarry at Clitheroe from which limestone is extracted for cement production. Pendle Hill, Waddington Fell, the Bowland Hills and Longridge Fell are all predominantly formed of Millstone Grit.

At the site location the bedrock is designated as a Secondary A aquifer. The Environment Agency website[14] defines this as *"A permeable layer 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."* This area is also defined as having soils with a high leaching potential, which means any liquid discharges have the potential to move rapidly to underlying strata or shallow groundwater.

The FEH CD-ROM gives an SPRHOST value of 42.1 for the site. This indicates a moderate to low soil permeability hence high greenfield run-off rate provided by the Environment Agency. The Flood Studies Report Winter Rainfall Acceptance Potential (WRAP) Map also indicates that the site is located with a zone of low permeability, on the basis of soil characteristics. This is consistent with the FEH CD-ROM. The FEH CD-ROM gives a BFIHOST value of 0.349 which confirms the low permeability of the catchment. This value indicates that the catchment groundwater sources comprise approximately 35 % of the annual discharge (for the catchment to the site).

The Environment Agency has stated in recent correspondence (see Appendix C) that the existing greenfield runoff rate adopted for the calculations should be 10 l/s/ha.

2.2 Development Proposal

The proposal is to build 49 new homes. Table 2.1 shows the schedule of accommodation. The vulnerability classification of dwelling houses is 'More Vulnerable' (see Table 2 in NPPF Technical Guidance[2], also shown in Table 2.2).

Table 2.1 Schedule of accommodation.

Property type	Number of units
2 bed bungalow	8
2-3 bed terraced / semi-detached	13
3 bed semi-detached (2.5 storey)	14
3-4 bed semi-detached	11
4 bed detached	3
Total	**49**

Table 2.2 Extract from Technical Guidance to the NPPF Table 2 'more vulnerable' classification

More vulnerable
Hospitals.
Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
Buildings used for dwelling houses, student halls or residence, drinking establishments, nightclubs and hotels.
Non-residential uses for health services, nurseries and educational establishments.
Landfill and sites used for waste management facilities for hazardous waste[6].
Sites used for holiday and short-let caravans and camping, *subject to a specific warning and evacuation plan*[7].

[6] For definition, see Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10 at www.communities.gov.uk/publications/planningandbuilding/planningsustainable.

[7] For any proposal involving a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site, the Sequential and Exception Tests should be applied.

The footprint of the buildings will be approximately 3,511m^2 and Appendix B shows the illustrative layout for the outline application. There are no basements proposed as part of this development. The existing and proposed land covers and associated surface area values of are summarised in Table 2.3.

Table 2.3 Proposed surface cover distribution at the site

Surface Cover Unit	Existing (m^2)	Proposed (m^2)
Roofs	0	3,511
Roads and pavements	0	3,915
Parking (permeable paving)	0	0
Greenfield/garden/planted/grassed	17,750	10,324
Total	17,750	17,750
Total impermeable	0	7,426

As shown in Table 2.3, the impermeable surface cover at the site, as determined from the Illustrative layout in Appendix B, would increase by approximately 7,426m^2, an increase of approximately 42%. As a result peak rates and volumes of storm run-off will increase and require management to achieve the greenfield rate of 10 l/s/ha specified by the Environment Agency (see section 5 for the Drainage Strategy).

2.3 Planning Context

2.3.1 Ribble Valley Strategic Flood Risk Assessment[10] and Local Plan[15]

The Local Plan[15] was adopted in 1998 and replaced the Clitheroe Local Plan Review (adopted 1992) and the Southern Fringe and Longridge Local Plan.

The Ribble Valley Borough Council Level 1 Strategic Flood Risk Assessment (SFRA)[10] was adopted in 2010. The SFRA describes how over 70% of the District lies in the Forest of Bowland Area of Outstanding Natural Beauty and comprises a largely rural district with a number of large and small settlements. Clitheroe is the largest of three main settlements in the District. The SFRA places the site in Flood Zone 1.

The Local Plan encourages new development to include adaptation to climate change. Measures include increasing urban densities to limit land take and minimizing the threats from flood risk. Also it emphasises the protection of the most versatile agricultural land and the use of Sustainable Drainage (SuDS) techniques.

2.3.2 Ribble Valley Catchment Flood Management Plan

The Ribble Valley Catchment Flood Management Plan (CFMP)[16] stated that Clitheroe (sub-area 4) is at risk of flooding from culverted (Mearley Brook) and open watercourses in the town. The development site discussed in this FRA is not at flood risk from neither culverted nor open watercourses.

2.4 Sequential Test and Exception Test

2.4.1 Sequential Test

NPPF and the Technical guidance describe the principles of the Sequential Test, which aims to steer new development to areas with the lowest probability of flooding. The Sequential Test is a decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk. As the development site is located within Flood Zone 1, the Sequential Test has been passed and has not been considered further in this FRA.

2.4.2 Exception test

Table 3 in the Technical guidance for NPPF identifies that for a 'more vulnerable' development within Zone 1, the Exception Test does not need to be applied and that the development is appropriate, therefore the Exception Test has not been considered further in this FRA.

3. Flood Risk Appraisal

3.1 Summary of Potential Sources

Table 3.1 Summary of Potential Flood Risk Sources

Source of Flooding	Risk Posed	Notes
Fluvial	Insignificant Risk	The site is located in Flood Zone 1. The nearest watercourse is approximately 133m south of the site, however the site is approximately 3 to 4m above the level of the watercourse at this point.
Tidal	No Risk	There is no risk of tidal flooding to the site.
Groundwater	Medium to high	The BGS groundwater flooding susceptibility maps (taken from the Envirocheck report[11]) show the site to have a moderate to moderately high susceptibility to groundwater flooding.
Surface runoff/ run on and surface water drainage	Medium	The Risk Management Solution flood data (taken from the Envirocheck report[11]) shows approximately one sixth (17%) of the site to be at risk from pluvial and minor river flooding under the 1 in 75 year return period. The 1 in 1,000 year map shows a pluvial and minor river flood risk covering almost the entire site. The proposed area of impermeable surfaces increases to 42% of the site (0% pre-development).
Sewer	Low	United Utilities has recorded a sewer flooding incident 300m north of the site. There are no other records of sewer flooding near the site.
Artificial	No risk	There are no artificial waterbodies that pose a risk of flooding to the site

3.2 Historic Flooding

The Envirocheck report[11] shows that the Environment Agency has no record of flooding (record from 1703 to 2008) at the site or in any area with a 1000m radius. Lancashire County Council and United Utilities were contacted to request any information on historic flooding in the area. Lancashire County Council stated that they had no record of any major flooding incidents however on Standen Road there is the occasional blocked gully that can cause localised flooding; no detail was provided on the exact location of this gully. However Standen Road is over 800m northeast of the site and flooding at this location would not impact the proposed development site. During consultation a few local residents referred to past localised flooding on the site and into the area in front of Little Moor View next to the play area and Park Street. United Utilities checked their records (no detail of the record period was provided) and found a DG5 sewer flooding issue within the immediate vicinity on Turner Street. There is no detail as to the date and severity of the issue or whether the cause had been addressed. Turner Street is approximately 300m north of the site and therefore this should not directly impact the development site.

The Envirocheck report[11] presents flood insurance risk data which provides an insight into historical flooding incidents via the record of insurance claims at that postcode. The report shows that there have been no recorded claims suggesting that there have been no major flood events (the record was last updated in November 2011, however the start date of the record is not provided).

The SFRA[10] presents a record of the major historical river flood events in the Ribble catchment since 1600 with flooding recorded in Clitheroe in 1866, 1923 and 1936.

production of the SFRA[10] consultation with the Environment Agency yielded no evidence of groundwater flooding in the area.

3.3 Fluvial Flooding

The Environment Agency has provided river modelling flood level data for Pendleton Brook, which is the closest watercourse to the site, just over 130m south of the site. The maximum modelled water level (at the closest node to the site (PTON01_0420), approximately 155m from the site) is 73.52mAOD for a 0.1% AEP flood event. The lowest elevation at the site is 76.89mAOD (approximately 3.4m above this flood level) so flooding from this watercourse does not pose a risk to the development. Model results for the 1% plus climate change event were not available to us, however the 0.1% event has been looked at.

3.4 Groundwater Flooding

The SFRA[10] determined that using the best available information groundwater flooding was not considered to be a significant risk at the time of writing (2010). However the Envirocheck report[11] presents BGS groundwater flooding susceptibility maps and shows the site to have a moderately high susceptibility over the large majority of the area. The area is known to be underlain by Limestone which is fairly permeable; however the WRAP map and FEH CD ROM suggest that the soils have a low permeability which would act as a barrier to rising groundwater.

The development proposals for the dwelling houses do not include underground basements at present and therefore there should be no danger of groundwater ingress into the properties. If the plans should change to include basements it is recommended that a geotechnical engineer investigates the soil type, permeability and groundwater level in more detail to determine the risk and whether it is necessary for the development to include precautions for ensuring the development is resilient to groundwater ingress.

In addition the following precautions should be taken against groundwater flooding, and be incorporated within the surface water management strategy:-

- Finished Floor Levels should be maintained a minimum of 150mm above surrounding ground
- Low points within the site where rising groundwater might pond should be avoided by careful profiling of the ground to allow overland drainage away from the buildings

3.5 Surface Water Flooding

The Risk Management Solution flood data (taken from the Envirocheck report[11]) shows approximately one sixth (17%) of the site to be at risk from pluvial and minor river flooding under the 1 in 75 year return period, while the 1 in 1,000 year return period map shows a pluvial and minor river flood risk covering almost the entire site. This

rating is potentially due to the low permeability of the soil and high annual rainfall (SAAR of 1274mm) meaning that the surface water cannot drain away at a sufficient rate potentially resulting in ponding. This is correlates with observations from the local residents which indicate that ponding has occurred on site in the past.

The increase in impermeable surfaces will also increase the surface water flood risk, therefore a draft surface water management strategy is presented in Section 4, this outlines a recommended strategy which will restrict runoff from the site to greenfield rates (10 l/s/ha as provided by the Environment Agency) and should reduce the risk of surface water flooding.

In addition the following precautions should be taken against surface water flooding on site, and be incorporated within the surface water management strategy:-

- Finished Floor Levels should be maintained a minimum of 150mm above surrounding ground
- Low points within the site where water might pond should be avoided by careful profiling of the ground to allow overland drainage away from the buildings

3.6 Sewer Flooding

There is currently a minor risk of sewer flooding to the site due to the several sewers and pipes which cross the site. United Utilities have been contacted to request that as part of the development the public sewer should be diverted around the site to reduce the risk of sewer flooding and enable the construction of the development. United Utilities have confirmed that they would no objection to diverting the existing sewer as long as a Section 185 Diversion agreement is entered into before starting. United Utilities have also confirmed that they would accept foul discharge from 50 residential units into the existing 300mm combined sewer; however they would not accept any surface water. This should be dealt with separately within the surface water drainage strategy. United Utilities states that the points of connection and discharge rates cannot be reserved for a particular development and they reserve the right to revise any points of connection and discharge rates between the date of enquiry and the date that the connection is required.

Consultation with the owners of the private sewers will need to be undertaken to determine whether an agreement can be meet for the diversion of these pipes. Therefore a low residual risk of sewer flooding remains. This should be incorporated within the surface water management strategy.

4. Surface Water Management Strategy

This section summarises the existing surface water drainage at the site and details the proposed surface water management strategy for the new development, which has been designed to manage runoff rates from the site to 10 l/s/ha.

4.1 Approach

The proposal is for the development of a greenfield site and therefore, attenuation of surface water run-off to greenfield rates is required. The Environment Agency requires a rate of 10 l/s/ha to be used as the limit for surface water discharge. Sustainable Drainage Systems (SuDS) will be utilised to meet this requirement.

4.2 Existing Drainage Arrangements

As the site is currently a greenfield site there are no existing surface water arrangements and the water is allowed to soak away or otherwise drain naturally. Section 2.1.3 identified that the soils are fairly impermeable in nature and result in a relatively high runoff rate. .

4.3 Attenuation Calculations

4.3.1 Run-off coefficient

For the run-off coefficient, C, a value for the whole site was obtained by weighting the proportion of the site covered by each ground type. Typical values for run-off coefficients are provided in Corbitt[17] and Singh[18] and have been reproduced in Table 4.1. At any particular site the run-off coefficient is dependent upon slope, as well as ground type, with the higher end of the scale generally applicable to steeply sloping catchments. The site is predominantly flat but a mid range value was used for soft landscaping and garden areas (e.g. lawns), as the under-lying soils have a lower permeability (see Section 2.1.3). The average values of the range were used for impermeable surfaces such as roofs.

Table 4.1 Run-off coefficients used for the site to determine the volume required for attention

Ground cover	Runoff coefficient C	Values used for the site
Lawns	0.05 - 0.35	0.2
Forest	0.05 - 0.25	
Cultivated land	0.08-0.41	
Meadow	0.1 - 0.5	
Parks, cemeteries	0.1 - 0.25	
Unimproved areas	0.1 - 0.3	
Pasture	0.12 - 0.62	
Residential areas	0.3 - 0.75	0.3*
Business areas	0.5 - 0.95	
Industrial areas	0.5 - 0.9	
Asphalt streets	0.7 - 0.95	
Brick streets	0.7 - 0.85	
Roofs	0.75 - 0.95	0.85
Concrete streets	0.7 - 0.95	0.85

* (used to represent permeable paving for the redeveloped site SuDS option)

4.3.2 Attenuation Volumes Required

The volume of storage required at the site has been calculated by determining the volume of surface water produced by the developed site for the 1% AEP critical storm duration event plus allowance for climate change and the volume that can be discharged from the site over the same duration, assuming that the discharge rate is controlled to 10 l/s/ha.

Storage requirements were determined for storms of varying duration to determine the critical storm duration and thus the storage requirement of the drainage system for the proposed development. The run-off and storage calculations are to be found in Appendix F.

The results of the runoff and storage calculations for the critical storm duration event are summarised in Table 5 2. It can be seen that a volume of 477m^3 is required to attenuate the 1% AEP (1 in 100 year) plus climate change rainfall event to the greenfield discharge rate.

Table 4.2 Surface water storage requirement at the proposal site

AEP (%)	Critical Storm Duration (hrs)	Rainfall Depth (mm)	Run-off Volume (Permeable) (m^3)	Run-off Volume (Impermeable) (m^3)	Total Run-off Volume (m^3)	Discharge from storage device (m^3)	Approximate storage required (m^3)
1	2.5	58.05	119.9	366.4	486.3	159.8	326.5
1 + 30% (climate change)	3	79.8	164.7	503.5	668.2	191.7	476.5

4.4 Selecting the Appropriate SuDS Strategy

4.4.1 Requirements of the Drainage System

The drainage system is required to limit the peak discharge rate from the site to 10 l/s/ha (0.0178m^3/s) and provide storage for 477 m^3 during the 1% AEP (1 in 100 year) rainfall event, including a 30% allowance for climate change. A piped drainage system should also be capable of coping with the 1:30 year event (3.33% AEP event) without any flooding on-site, in accordance with the guidance provided in Sewers for Adoption[19].

In addition the drainage system should be based on a SuDs approach, looking to maximise drainage at source. This is achieved by applying a hierarchical approach, prioritising sustainable drainage solutions wherever these are feasible.

4.4.2 The SuDS Hierarchy

The SuDS Hierarchy is illustrated in Figure 4.1, which rates each type of technique in terms of its overall sustainability. It can be seen that the most sustainable solutions are provided by 'Living Roofs', also known as green roofs, basins and ponds, and filter strips and swales.

Figure 4.1 SuDS Hierarchy

Most Sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✔	✔	✔
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices - soakaways - infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✔	✔	
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms cells	✔		

Source: SuDS A Practical Guide, Environment Agency Development Control Thames Region, 2006[20]. This is provides an indication to the preferred SuDS hierarchy.

All the SuDS techniques presented in Figure 4.1, with the exception of greenroofs, are located at ground level and therefore must take due account of groundwater and geological conditions. As identified in Section 2.1.3, the site is underlain by limestone, which is in turn underlain by the Mudstone, Siltstone and Sandstone. This has been classified by the Environment Agency as a Secondary A Aquifer. Therefore, SuDS techniques which use infiltration techniques may be suitable at the site. However the low permeability of the soils needs to be considered and investigated prior to any infiltration techniques are installed. The suitability of such techniques needs to be confirmed by site-specific investigation to confirm the groundwater conditions and the permeability of the underlying ground prior to installation of the SuDS features. There are no existing British Geological Survey (BGS) borehole records at the site or in the immediate vicinity. Due to the flat topography of the site it is possible that groundwater is close to the surface, however the site is fair enough away from any watercourse and raised above the floodplain level to be able to assume that the groundwater level is sufficiently deep to utilise infiltration techniques under normal climatic conditions, however this should be confirmed by a site-specific investigation prior to installation.

The potential for ground contamination also needs to be considered. The site is not located in a groundwater Source Protection Zone (SPZ), an area in which contamination of groundwater or the mobilisation of contaminants

is particularly sensitive. However, as a general rule infiltration SuDS should not be located in contaminated ground, therefore this should be investigated prior to the installation of infiltration techniques.

Urban type solutions, such as filter drains (also known as French drains) and permeable paving would also be appropriate. Filter drains comprise trenches filled with a permeable material into which run-off is collected from the edge of paved areas, then stored and conveyed. They are usually used next to roads and in parking areas. Permeable paving allows water to infiltrate into a sub-base. Water can be allowed to infiltrate into the underlying ground or the structure can be lined to prevent infiltration and promote storage and conveyance to another SuDS device or an outfall.

4.5 The Proposed SuDS Solution

It is recommended that parking areas and the minor access road (see Appendix B and Figure 4.2) are constructed out of permeable paving. This would reduce the required storage volume by almost 50m^3 to 427.3m^3 for the 1% AEP plus climate change event.

The proposed site layout plan indicates that there may be sufficient space for basins, ponds, filter strips or swales at the site. Detention basins are designed to remain dry for all but the most extreme rainfall events (for flood events of less than the 0.2% AEP) and are appropriate for other uses, such as amenity use. To comply the with current layout any basin would have to be located in the northeast of the site where there is available space. The area available at this location is 525m^2; therefore there should be sufficient space for an attenuation basin. but this area is situated at the highest point on site, hence drainage to this location would only be possible if the site were to be re-levelled.

In addition to an attenuation basin the road network could be edged with filter strips which could either allow infiltration or act as a carrier to the attenuation basin.

An alternative option to a large attenuation basin serving the entire site would be to provide individual soakaways at each property and a smaller attenuation basin serving the access road network only. These could be located in the back gardens of each property and would be fitted with a throttle to attenuate the runoff to 10 l/s/ha. See Figure 4.2 for the proposed layout.

Figure 4.2 Proposed SuDS Options Layout

4.5.1 Outfall options

There are several options to consider for the outfall from a possible attenuation basin:

- The first option would be to come to an agreement with the owner of the private surface water pipes that currently cross the site and if feasible discharge into the network. An investigation into the discharge location and current state of the network would have to be undertaken to ensure that the additional discharge (of 10 l/s/ha) could be accommodated and that it did not result in any increase in flood risk elsewhere.

- The second option would be to pipe the discharge from the basin over 250m to Pendleton Brook where it could then be discharged. However this would require the permission from various landowners to install the pipes through their land.

- A third option would be to pipe the discharge to a drainage ditch which runs through the adjacent larger site to the east and discharges to Pendleton Brook. Once the larger site is developed the surface water system constructed for that site could incorporate the discharge from the smaller site.

4.5.2 Finished floor levels and ground profiling

The finished floor levels and surrounding ground within the development should be profiled in such a way to allow safe conveyance of overland flows in excess of the capacity of the drainage system and to avoid flooding the proposed properties or causing increased flood risk outside the site boundary. These flows may arise from rising groundwater or from extreme storm events or blockages of the new drainage system.

In particular

- Finished Floor Levels should be maintained a minimum of 150mm above surrounding ground

- Low points within the site where water might pond should be avoided by careful profiling of the ground to allow overland drainage away from the buildings and safe discharge to SuDs storage features without causing increased flood risk elsewhere. This may require some raised shallow bunds to convey water to the storage feature and prevent the water leaving the site in an uncontrolled manner.

5. Conclusion and Recommendations

5.1 Conclusions

The following conclusions can be drawn:-

- The Sequential Test has been passed and the Exception test does not need to be applied to this FRA.
- All potential risks of flooding to the site have been assessed and relevant management options have been presented where necessary.

5.2 Recommendations

The following recommendations are made:-

- Should the proposals ever change to included basements it is recommended that a site-specific investigation is undertaken at that stage to assess the risk of groundwater ingress and if deemed necessary the development should be made resilient to groundwater.
- A site-specific investigation should be undertaken prior to installation of the SuDS features to determine the infiltration rate and whether infiltration SuDS options are appropriate for this site. This investigation to support detailed drainage proposals would be undertaken as a pre-commencement planning condition attached to the outline consent.
- The proposed development will result in an approximate increase in impermeable surfaces of 7,426m^2, which will increase surface runoff. To comply with the discharge rate and NFFP, 476.5m^3 of storage would have to be provided to attenuate the runoff for 1% AEP plus climate change event if no other SuDS were proposed. It is therefore recommended that permeable paving is utilised where ever possible and that filter strips are included along the access road verges. All remaining surface water runoff would then be diverted to an attenuation basin which would control the discharge rate to10 l/s/ha.
- The preferred surface water outfall option would be via the existing privately owned surface water pipes. An agreement with the owner should be sought together with an investigation as to whether it is feasible to discharge into this network. The investigation would need to determine the discharge location and current state and capacity of the network to ensure that the additional discharge (of 10 l/s/ha) did not result in any increase in flood risk elsewhere.
- Finished Floor Levels should be maintained a minimum of 150mm above surrounding ground
- Low points within the site where water might pond should be avoided by careful profiling of the ground to allow overland drainage away from the buildings and safe discharge to SuDs storage features without causing increased flood risk elsewhere. This may require some raised shallow bunds to convey water to the storage feature and prevent the water leaving the site in an uncontrolled manner.

6. References

[1] Communities and Local Government. National Planning Policy Framework. London: HMSO. 2012

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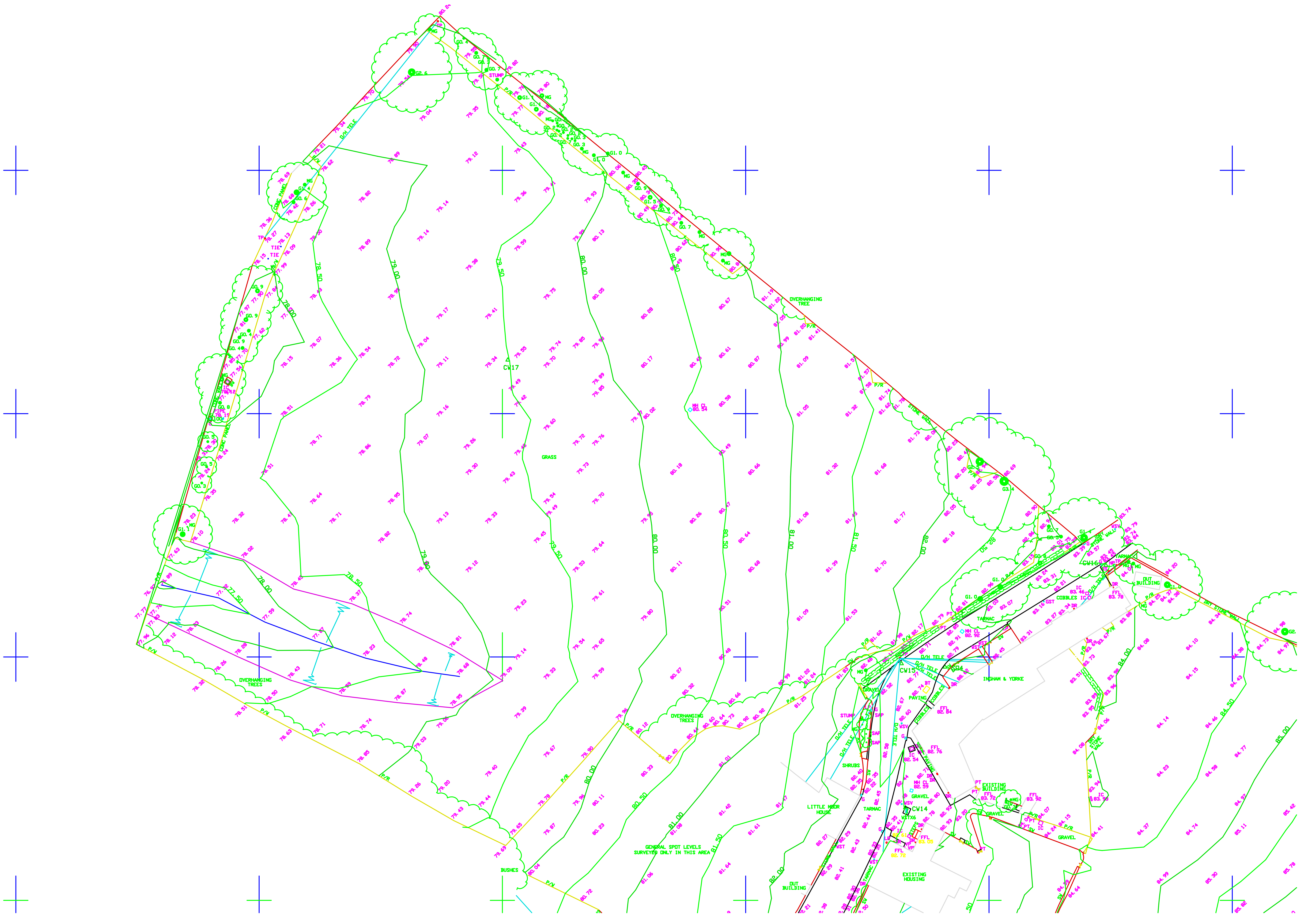
Appendix A
Topographic Survey



OVERHANGING TREE
OVERHANGING TREES
GRASS
STUMP
CV17
CV16
CV15
CV14
INGHAM & YORKE
COBBLES
TARMAC
GRAVEL
PAVING
SHRUBS
LITTLE MOOR HOUSE
EXISTING BUILDING
EXISTING HOUSING
OUT BUILDING
GENERAL SPOT LEVELS SURVEYED ONLY IN THIS AREA
BUSHES

Appendix B
Illustrative proposed site layout

April 2012
Doc. Reg No.

Illustrative Layout

Schedule of Accommodation:

2 bed bungalow	4
2 bed bungalow (larger)	4
2 - 3 bed terraced / semi	13
3 bed semi (2.5 storey)	14
3-4 bed detached (semi)	11
4 bed detached	3
Total	49

Density = 28/hectare. (11/acre)

Appendix C
Evidence of consultation process

April 2012
Doc. Reg No.

Environment Agency

April 2012
Doc Reg No

Dawson, Emily

From: Worswick, Colin
Sent: 03 April 2012 10:33
To: NW North Preston, Information Requests
Subject: PRE3187_DFR 31936 - Land at Higher Standon, Clitheroe - FRA

Colin Worswick

Development and Flood Risk Engineer
North Area, North West Region
01772 714259
07741 019565

From: Worswick, Colin
Sent: 22 March 2012 10:02
To: 'stewart.griffiths@amec.com'
Subject: RE: 31936 - Land at Higher Standon, Clitheroe - FRA

Stewart,

I can confirm that both sites lie within Flood Zone 1. We are not aware of any flooding incidents, however you are advised to contact Ribble Valley Borough Council who may have more detailed local records. Surface water run-off must be restricted to existing greenfield rates which is 10l/s/hectare. You will require Flood Defence Consent to culvert or divert any watercourses.

Regards

Colin Worswick

Development and Flood Risk Engineer
North Area, North West Region
01772 714259
07741 019565

From: stewart.griffiths@amec.com [mailto:stewart.griffiths@amec.com]
Sent: 20 March 2012 14:28
To: Worswick, Colin
Subject: 31936 - Land at Higher Standon, Clitheroe - FRA

FAO: Colin Worswick

I understand that you cover the Clitheroe Area.

We are undertaking a Flood Risk Assessment for a couple of development sites in Clitheroe - see attached layout plan(s).

a) **Site 1 - 4 Acre Site**(Post Code BB7 1HF)

The site is located between Little Moor and Little Moor View as indicated by the attached plan.

b) **Site 2 - Main Development Site**(covering an area of approx 70 ha)

Located to the east of Little Moor Road, as indicated on the Drawing.

Could you advise me whether there are any flooding restrictions on this site, for our inclusion in our Flood Risk Assessment Report?
We understand that the site is located in a Flood Zone 1 Area, but could you confirm this.

Any queries then contact me on the number below.

Regards

Stewart Griffiths
Senior Civil Engineer
AMEC
Amec Environment & Infrastructure UK Limited
Windsor House, Gadbrook Road, Northwich CW9 7TN, UK
Tel +99 (0)1606 354800
Direct +44 (0)1606 354812 mobile +44(0)7896 213922
stewart.griffiths@amec.com
amec.com/ukenvironment

----- Forwarded by Stewart Griffiths/NOR/ENTEC/NWG on 20/03/2012 14:03 -----

From: "Welsby, Cliff" <cliff.welsby@environment-agency.gov.uk>
To: "stewart.griffiths@amec.com" <stewart.griffiths@amec.com>
Date: 15/03/2012 12:15
Subject: RE: 31936 - Land at Higher Standon, Clitheroe - FRA

Stewart.

Colin Worswick is the engineer for Clitheroe area.

Tel. 07741 019565

Cliff.

From: stewart.griffiths@amec.com [mailto:stewart.griffiths@amec.com]
Sent: 14 March 2012 10:08
To: Welsby, Cliff
Cc: Carter, Philip A; andrew.worsdale@amec.com
Subject: 31936 - Land at Higher Standon, Clitheroe - FRA

Hi Cliff,

We have a couple of Greenfield sites in Clitheroe where we have been asked to undertake an Outline FRA.

Who is the EA contact for this area?

Regards

Stewart Griffiths
Senior Civil Engineer
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Amec Environment & Infrastructure UK Limited
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Direct +44 (0)1606 354812 mobile +44(0)7896 213922
stewart.griffiths@amec.com
amec.com/ukenvironment

From:	"Welsby, Cliff" <cliff.welsby@environment-agency.gov.uk>
To:	"stewart.griffiths@amec.com" <stewart.griffiths@amec.com>
Cc:	"Carter, Philip A" <PCARTER@environment-agency.gov.uk>
Date:	07/03/2012 10:28
Subject:	RE: 31936 - Site at Lightfoot Lane, Fulwood, Preston - FRA

Stewart.

As detailed by Philip on site attenuation will be required for surface water at existing "green field" rates usually considered to be 10l/sec/hec.
Any works to the culverted watercourse may require Agency formal consent.
Please contact me again should you need to apply for any consents.

Regards

Cliff.

From: stewart.griffiths@amec.com [mailto:stewart.griffiths@amec.com]
Sent: 07 March 2012 09:59

To: Welsby, Cliff
Cc: andrew.worsdale@amec.com; sammy.spaine@amec.com
Subject: 31936 - Site at Lightfoot Lane, Fulwood, Preston - FRA

Cliff,

Further to Phil Carter's e:mail below, are you aware of any site specific issues for the site at Lightfoot Lane (location plan attached) which will need to be included in the FRA?

Many Thanks

Stewart Griffiths
Senior Civil Engineer
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stewart.griffiths@amec.com
amec.com/ukenvironment

----- Forwarded by Stewart Griffiths/NOR/ENTEC/NWG on 07/03/2012 09:53 -----

From:	"Carter, Philip A" <PCARTER@environment-agency.gov.uk>
To:	"stewart.griffiths@amec.com" <stewart.griffiths@amec.com>
Cc:	"Welsby, Cliff" <cliff.welsby@environment-agency.gov.uk>
Date:	07/03/2012 09:47
Subject:	RE: 31936 - Site at Lightfoot Lane, Fulwood, Preston - FRA

Stewart

The engineer who covers the area is Cliff Welsby - you can contact him directly on 01772 714016 but I've also copied him into this e-mail.

I can confirm that the area is Flood Zone 1 and any development must ensure that surface water run-off from the site is restricted to existing rates (to be identified in the FRA). From the OS map of the area, there is an ordinary watercourse flowing through the site in a northerly direction, under the motorway, in culvert. The risk of flooding due to blockage or under capacity of the watercourses and culverts on site will need to be considered in the FRA, as will the potential for removal of any culverts that could reduce flood risk.

I would recommend contacting Cliff to see if he has any other site specific issues that would need to be considered in the FRA. Kind regards

Philip

Philip Carter
Planning Liaison Officer
Environment Agency
PO Box 519
South Preston
PR5 8GD
01772 714219

philip.carter@environment-agency.gov.uk

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Best for Waste & Resource Management 2011, edie Awards for Environmental Excellence
Best Consultancy 2011, Airport Operators' Association Awards

Lancashire County Council

April 2012
Doc Reg No

Flooding data Request - Standen Road, Clitheroe

Finch, Peter to: richard.breakspear 14/02/2012 14:42

Richard,

Thank you for your Email dated 13th.February 2012.

There are no major recorded flooding incidents on Standen Road, except for the occasional blocked gully that can cause a localised flooding problem.

Regards
Peter Finch
Principal Engineer (Ribble Valley)
Environment Services East
Lancashire County Council
01254 770960

United Utilities

April 2012
Doc Reg No

RE: Sewer flooding data request , site at Standen , Clitheroe, Lancashire

Planning Liaison to: richard.breakspear 20/02/2012 12:23

Hello Richard

Information as requested

DG5 Sewer Flooding

I have checked our records and have found a DG5 flooding issues within the immediate vicinity of the proposed development. The reported issue is on Turner Street, Clitheroe.

Please note that United Utilities Water plc (UUW) can only record and check flooding events which are reported to us and we have to comply with our Regulators instructions on the qualification of flooding events to place on the 'at risk' register.

This assesment does not include any sewer flooding events caused by blockages or collapses which are the result of third party actions, natural events or other actions over which UUW has no control and not a facet of sewer capacity.

If I can be of any further assistance in the meantime then please don't hesitate to get in touch.
Regards
Graham Perry

From: richard.breakspear@amec.com [mailto:richard.breakspear@amec.com]
Sent: 13 February 2012 10:15
To: Planning Liaison
Subject: Sewer flooding data request, site at Standen, Clitheroe, Lancashire

Hi,

I would like to request information on past/existing incidences of sewer flooding in support of a Flood Risk Assessment being prepared for a residential development site at Standen, Clitheroe, Lancashire.

I've checked on your website, under Developer Enquiries (http://www.unitedutilities.com/Wastewaterconnections.aspx) and cannot find a link to the information I require.

The site is immediately west of the A59, (see attached plan). The approximate grid reference for the centre of the area of interest is: SD 74917 40684
Or see:
http://gridreferencefinder.com/?gr=SD7491740684%7CPoint_s_E%7C0&z=15&v=h&t=Point_s_E

Best regards,

Richard

Dr Richard Breakspear

Senior Consultant (Flood Risk, Hydrology and Geomorphology)
AMEC
AMEC Environment & Infrastructure UK Limited
155 Aztec West, Park Avenue, Almondsbury, Bristol, BS32 4UB, UK
Tel +44 (0)1454 822 000
Direct +44 (0)1454 822 008, mobile +44 (0)7966 869343
richard.breakspear@amec.com
amec.com/ukenvironment

Best Environmental Consultancy 2011, edie Awards for Environmental Excellence
Best for Waste & Resource Management 2011, edie Awards for Environmental Excellence
Best Consultancy 2011, Airport Operators' Association Awards

this message by a third party.

United Utilities Group PLC, Haweswater House, Lingley Mere
Business Park, Lingley Green Avenue, Great Sankey,
Warrington, WA5 3LP
Registered in England and Wales. Registered No 6559020

www.unitedutilities.com
www.unitedutilities.com/subsidiaries
==========
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Dawson, Emily

From: Griffiths, Stewart on behalf of Dawson, Emily
Sent: 26 March 2012 10:13
To: Dawson, Emily
Subject: 29421 - Land at Higher Standon, Clitheroe, Lancs

Note the response I received from UU last week, for your information.

Regards

Stewart Griffiths
Senior Civil Engineer
AMEC
Amec Environment & Infrastructure UK Limited Windsor House, Gadbrook Road, Northwich CW9 7TN, UK Tel +99 (0)1606 354800 Direct +44 (0)1606 354812 mobile +44(0)7896 213922 stewart.griffiths@amec.com amec.com/ukenvironment

----- Forwarded by Stewart Griffiths/NOR/ENTEC/NWG on 26/03/2012 10:13

|---------->
| From: |
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>----------|
|"Perry, Graham" <Graham.Perry@uuplc.co.uk> |
>----------|
|---------->
| To: |
|---------->
>----------|
|<stewart.griffiths@amec.com> |
>----------|
|---------->
| Date: |
|---------->
>----------|
|19/03/2012 16:21 |
>----------|
|---------->
| Subject: |
|---------->
>----------|
|RE: 29421 - Land at Higher Standon, Clitheroe, Lancs |
>----------|

Hello Stewart

Further to our discussion, I can confirm that we would accept free foul discharge from 50 domestic units into the 300mm combined sewer crossing the site but we would not accept any surface water. Under the terms of Building regulation H3 & PPS25, you must discharge to either soakaway on site or to the nearby watercourse.

We would have no objection to you diverting the existing 300mm combined sewer that crosses the site providing that you enter into a Section 185 Diversion agreement before starting.

“United Utilities Water plc (UUW) will provide information on connection points and maximum permitted discharge rates to public sewers in response to enquiries by developers and in response to Planning Applications where Planning Authorities have elected to consult UUW on drainage matters.

However, the points of connection and discharge rates cannot be allocated and reserved for a particular development. UUW reserves the right to revise the connection point and discharge rate current at the time that a formal application for connection to public sewer is made, in order to take account of possible changes in discharges to the public sewer between the date of the enquiry and the date of the connection being required”.

Regards

Graham Perry

From: stewart.griffiths@amec.com [mailto:stewart.griffiths@amec.com]
Sent: 13 March 2012 13:17
To: Perry, Graham
Subject: 29421 - Land at Higher Standon, Clitheroe, Lancs

Graham,

FYI

I don't think you received this drawing last time!

Regards

Stewart Griffiths
Senior Civil Engineer
AMEC
Amec Environment & Infrastructure UK Limited Windsor House, Gadbrook Road, Northwich CW9 7TN, UK Tel +99 (0)1606 354800 Direct +44 (0)1606 354812 mobile +44(0)7896 213922 stewart.griffiths@amec.com amec.com/ukenvironment

----- Forwarded by Stewart Griffiths/NOR/ENTEC/NWG on 13/03/2012 13:20

From: Stewart Griffiths/NOR/ENTEC/NWG

To: "Perry, Graham" <Graham.Perry@uuplc.co.uk>

Date: 13/03/2012 13:09

Subject: 29421 - Land at Higher Standon, Clitheroe, Lancs

Hello Graham,

Thanks for the e:mail.

We have an another site in Clitheroe (between Little Moor Road and Little Moor View) for which we are assessing potential connection points for the drainage - see attached location plan.

The site is to accommodate between 40 - 50 properties.

According to United Utilities records, there is a 300mm dia combined sewer crossing the site, which will require an easement or a possible diversion.

Does this sewer have sufficient capacity to accommodate the foul drainage from the site?

Surface water would be discharged by means of a Soakaway and/or watercourse.

[attachment "UU Records For 4 Acre Site.pdf" deleted by Stewart Griffiths/NOR/ENTEC/NWG]

Regards

Stewart Griffiths
Senior Civil Engineer
AMEC
Amec Environment & Infrastructure UK Limited Windsor House, Gadbrook Road, Northwich CW9 7TN, UK Tel +99 (0)1606 354800 Direct +44 (0)1606 354812 mobile +44(0)7896 213922 stewart.griffiths@amec.com amec.com/ukenvironment

From: "Perry, Graham" <Graham.Perry@uuplc.co.uk>

To: <stewart.griffiths@amec.com>

Date: 18/01/2012 10:27

Subject: RE: 29421 - Land at Higher Standon, Clitheroe, Lancs

Appendix D
Photograph

D.1 View looking across the site from the northeast corner to southwest corner, towards the lowest point of elevation.

Appendix E
Service plan

April 2012
Doc. Reg No.

CONNECTION FROM OIL INTERCEPTOR TANK

525mmø COMBINED SEWER (OUTFALL POINT TO BE CONFIRMED)

APPROX ROUTE OF PRIVATE 300mmø SWS

300mmø PUBLIC COMBINED SEWER

POSSIBLE ROUTE OF PRIVATE 150/225mmø COMBINED SEWER

150mmø PRIVATE FOUL SEWER (APPROX LOCATION)

GENERAL SPOT LEVELS SURVEYED ONLY IN THIS AREA

OVERHANGING TREES

INGHAM & YORKE

LITTLE MOOR HOUSE

EXISTING HOUSING

PRIVATE PIPE

DESCRIPTION

REV	DATE		DWN	CHK	APP
A	21/03/2012	DRAFT ISSUE	MR	SG	SS

REVISIONS

REV	DATE		DWN	CHK	APP

NOTES:

1. DO NOT SCALE FROM THIS DRAWING
2. ALL DIMENSIONS AND LEVELS IN METRES UNLESS NOTED OTHERWISE
3. TOPOGRAPHICAL SURVEY DATA OBTAINED FROM SURVEY OPERATIONS, DATED JULY 2011.
4. ALL SERVICES SHOWN ARE INDICATIVE ONLY. IT IS THE CONTRACTORS RESPONSIBILITY TO CONFIRM LOCATIONS BEFORE ANY WORK IS UNDERTAKEN.
5. THE SERVICES INFORMATION OBTAINED FROM THE STATUTORY SERVICE PROVIDERS HAS NOT BEEN VALIDATED BY AMEC. FUTURE USERS OF THIS PLAN MUST ENSURE THAT THE ACCURACY OF THE INFORMATION IS CHECKED & PROVEN.

LEGEND:

- 4 ACRES SITE BOUNDARY
- BT — EXISTING UNDERGROUND BT
- OH BT — EXISTING OVERHEAD BT
- CM — EXISTING UNDERGROUND TELECOMS
- EXISTING GAS PIPE
- E — EXISTING UNDERGROUND ELECTRIC
- O/H ELEC — EXISTING OVERHEAD ELECTRIC
- W — EXISTING WATER SUPPLY
- S — EXISTING SURFACE WATER SEWER
- F — EXISTING FOUL WATER SEWER
- C — EXISTING COMBINED WATER SEWER

DRAFT

SCALES: 1:250 @ A0

PROJECT TITLE:
CLITHEROE
4 ACRE SITE

DRAWING TITLE:
APPROXIMATE LOCATION OF EXISTING SERVICES

CLIENT:
TRUSTEES OF STANDEN ESTATES

amec
WINDSOR HOUSE, CADBROOK BUSINESS CENTRE,
CADBROOK ROAD, NORTHWICH, CW9 7TN
TEL: (01606) 354800 FAX: (01606) 354810

DRAWING No.
29421/N/CVD/107/A

Original Drawing Size = A0

Appendix F
Runoff storage calculations

April 2012
Doc. Reg No.

CALCULATION SHEET 001

Details: **1 in 100 Year Storage**

Project: Land off Littlemoor Lane, Clitheroe
Project Ref: 29421-12

Sheet No: 1 of 3
Date: 11/03/2012
Prepared By: ED
Checked By:

Total Area (m^2): 17,750
Impermeable Area (m^2): 7,426
Permeable Area (m^2) 10,324
Runoff Coefficient (C) - Impermeable: 0.85
Runoff Coefficient (C) - Permeable: 0.2

Permissible discharge (m^3/s): 0.0178
Permissible discharge source: Provided by EA
Rainfall Source: FEH (v3) DDF Model
FEH-DDF Grid Reference : SD 74150 40700
Maximum Storage (m^3) 327

Rainfall Duration (hr)	Rainfall Depth (mm)	Runoff Volume (Permeable) (m^3)	Runoff Volume (Impermeable) (m^3)	Total Runoff Volume (m^3)	Pond Discharge (m^3)	Approximate Storage Required (m^3)
0.5	35.020	72.309	221.050	293.359	31.950	261.409
1	43.710	90.252	275.902	366.154	63.900	302.254
1.5	49.610	102.435	313.143	415.578	95.850	319.728
2	54.220	111.953	342.242	454.196	127.800	326.396
2.5	58.050	119.862	366.417	486.279	159.750	326.529
3	61.360	126.696	387.310	514.007	191.700	322.307
4	66.940	138.218	422.532	560.750	255.600	305.150
5	71.590	147.819	451.883	599.702	319.500	280.202
6	75.610	156.120	477.258	633.377	383.400	249.977
7	79.170	163.470	499.729	663.199	447.300	215.899
8	82.380	170.098	519.991	690.089	511.200	178.889
9	85.310	176.148	538.485	714.633	575.100	139.533
10	88.020	181.744	555.591	737.335	639.000	98.335
11	90.530	186.926	571.434	758.361	702.900	55.461
12	92.890	191.799	586.331	778.130	766.800	11.330
13	94.940	196.032	599.271	795.303	830.700	0.000

CALCULATION SHEET 002

Details: **1 in 100 Year +30% Storage**

Project: Land off Littlemoor Lane, Clitheroe
Project Ref: 29421-12

Sheet No: 2 of 3
Date: 11/03/2012
Prepared By: ED
Checked By:

Total Area (m^2): 17,750
Impermeable Area (m^2): 7,426
Permeable Area (m^2) 10,324
Runoff Coefficient (C) - Impermeable: 0.85
Runoff Coefficient (C) - Permeable: 0.2

Permissible discharge (m^3/s): 0.0178
Permissible discharge source: Provided by EA
Rainfall Source: FEH (v3) DDF Model
FEH-DDF Grid Reference : SD 74150 40700
Maximum Storage (m^3) 477

Rainfall Duration (hr)	Rainfall Depth (mm)	Runoff Volume (Permeable) (m^3)	Runoff Volume (Impermeable) (m^3)	Total Runoff Volume (m^3)	Pond Discharge (m^3)	Approximate Storage Required (m^3)
0.5	45.526	94.002	287.365	381.367	31.950	349.417
1	56.823	117.328	358.672	476.001	63.900	412.101
1.5	64.493	133.165	407.086	540.251	95.850	444.401
2	70.486	145.539	444.915	590.454	127.800	462.654
2.5	75.465	155.820	476.343	632.163	159.750	472.413
3	79.768	164.705	503.504	668.209	191.700	476.509
4	87.022	179.683	549.292	728.975	255.600	473.375
5	93.067	192.165	587.448	779.613	319.500	460.113
6	98.293	202.955	620.435	823.391	383.400	439.991
7	102.921	212.511	649.648	862.159	447.300	414.859
8	107.094	221.128	675.988	897.116	511.200	385.916
9	110.903	228.993	700.031	929.023	575.100	353.923
10	114.426	236.267	722.268	958.535	639.000	319.535
11	117.689	243.004	742.865	985.869	702.900	282.969
12	120.757	249.339	762.230	1011.569	766.800	244.769
13	123.422	254.842	779.052	1033.894	830.700	203.194

CALCULATION SHEET 003

Details:	**Catchment Descriptors**	**Sheet No:**	3 of 3
		Date:	11/03/2012
Project:	Land off Littlemoor Lane, Clitheroe	**Prepared By:**	ED
Project Ref:	29421-12	**Checked By:**	

Catchment Descriptors (FEH CD ROM 3)

Location	SD 74150 40700	**SPRHOST**	42.11
AREA	6.4	**URBCONC1990**	-999999
ALTBAR	211	**URBEXT1990**	0.0025
ASPBAR	284	**URBLOC1990**	-999999
ASPVAR	0.69	**C**	-0.0257
BFIHOST	0.349	**D1**	0.40193
DPLBAR	3.26	**D2**	0.37889
DPSBAR	111.5	**D3**	0.40014
FARL	1	**E**	0.30183
LDP	6.64	**F**	2.46808
PROPWET	0.54	**C(1 km)**	-0.025
RMED-1H	10.8	**D1(1 km)**	0.398
RMED-1D	40.9	**D2(1 km)**	0.385
RMED-2D	55.4	**D3(1 km)**	0.43
SAAR	1274	**E(1 km)**	0.299
SAAR4170	1254	**F(1 km)**	2.444