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Development at How Bank Farm Egremont

Flood Risk Assessment

Client:

Gleeson Developments Ltd

Rural Enterprise Centre
Redhills
Penrith
Cumbria
CA11 0DT

Prepared by:

joc consultants ltd

Park Farm House
Leathley Lane
Leathley
Otley
LS21 2JU

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ABBREVIATIONS

AEP:	Annual exceedance probability
AOD:	Above Ordnance Datum
CCA:	Climate change allowance
FRA:	Flood risk assessment
LiDAR:	Light detection and ranging
LLFA:	Lead Local Flood Authority
MBC:	Metropolitan Borough Council
OWC:	Ordinary watercourse
PPG:	Planning Practice Guidance
ReFH2:	ReFH2: Revitalised flood hydrology model, version 2
SFRA:	Strategic Flood Risk Assessment
SuDS:	Sustainable drainage systems

1.0 INTRODUCTION

1.1. JOC Consultants Ltd is instructed by Gleeson Developments Ltd (the Client), to prepare a flood risk assessment (FRA) for a proposed residential development on land at How Bank Farm, and at the site of the former Orgill Primary School, Egremont, Cumbria. The development is the subject of a planning application to Copeland District Council under reference 4/20/2432/0F1. This report deals only with the How Bank Farm site and the Orgill School site is the subject of a separate FRA report.

1.2. The Environment Agency was consulted by the planning authority on the application and responded by letter dated 10th December 2020. This revision of the FRA report addresses the matters raised by the Environment Agency and the report reflects the most recent guidance on flood risk and climate change.

1.3. References in this report to "the site" are references to the How Bank Farm site to which the planning application applies. Specific references to sources of information used in the report are shown in square brackets and are listed in section 11. Figure 1 is presented immediately following page 20 and the appendices follow thereafter.

1.4. This report is prepared specifically for Gleeson Developments Ltd for the purpose of the aforementioned planning application and the report may not be used for any purpose other than for the purpose for which it was commissioned, and it may not be assigned to any third party without our written permission.

1.5. In the preparation of this FRA report, JOC Consultants Ltd has relied on published information and on information provided by the Environment Agency and the Client and accepts no liability for its accuracy or adequacy or for the consequences of any changes to or re-assessment of this data in the future.

2.0 OBJECTIVES

2.1. The objectives of a site specific flood risk assessment, as stated in the current version of the Planning Practice Guidance for Flood Risk and Coastal Change [1], are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;

- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable.

3.0 PLANNING POLICY ON FLOOD RISK

3.1 National Policy

3.1.1. National Planning Policy in relation to flood risk is set out in the National Planning Policy Framework (NPPF) [1].

3.2 Local Policy

3.2.1. Proposed local policy on development and flood risk is set out in Policy ENV 1 and Policy DM24 of the Copeland Local Plan, adopted on 5th December 2013 [2]. The local planning policies on development and flood risk reflect the requirements of the NPPF and are informed by the Copeland Strategic Flood Risk Assessment (SFRA) published in October 2021 [3].

3.3 Planning Practice Guidance

3.3.1. In addition to national and local policy, the Planning Practice Guidance for Flood Risk and Coastal Change [4] provides advice to planning authorities to assist them when considering planning applications in areas at risk of flooding. The Environment Agency Standing Advice [5] also provides guidance to assist local planning authorities when considering planning applications in areas at risk of flooding.

3.3.2. This report has been prepared with reference to the Planning Practice Guidance and the Standing Advice.

4.0 LOCATION AND DESCRIPTION OF THE SITE

4.1. The site, which is currently in agricultural pasture, is situated adjacent to the west of Egremont, as shown in Figure 1 and extends to approximately 4.21ha. The NGR coordinates at the approximate centre of the site are 300090E, 510980N.

4.2. The topographical survey plan reproduced in Appendix A shows the site to fall generally towards the south, with secondary gradients falling to the west and east. Ground levels fall

from 91.4m AOD at the northernmost corner to 67.1m AOD at the south east corner, close to Baybarrow Road. The average gradient of the site is approximately 1 in 16. The lowest part of the site however is at the north-east corner, close to Chaucer Avenue, where ground levels fall to 61.28m AOD.

4.3. The nearest watercourse is Whangs Beck, an OWC which flows south-east, adjacent to the south west boundary of the site. Skirting Beck, which is designated as a "Main River", is approximately 350m to the east of the site and flows south into a culvert which outfalls into the River Ehen.

4.4. The BGS Geology of Britain shows the site to overly the St Bees Sandstone bedrock which is overlain by superficial glacio-fluvial deposits of Devensian – Sand and Gravel and Till, Devensian – Diamicton. The results of the ground investigation show a clear division between these deposits, with low permeability cohesive soils (Till) in the NW part of the site and granular soils (Devensian sand and gravel) in the SE part of the site.

5.0 THE PROPOSED DEVELOPMENT

5.1. A development of 90 dwellings is proposed at the How Bank Farm site, as shown on the site planning layout drawing provided in Appendix B. Access is from Baybarrow Road and an emergency access link to Chaucer Avenue is also proposed.

5.2. A sustainable drainage scheme is proposed for the development, details of which are provided the Drainage Strategy report submitted with the planning application documents.

5.3. The development is classified as **More Vulnerable** in accordance with Table 2 of the Planning Practice Guidance, paragraph 066.

6.0 FLOOD RISK

6.1 Assessment methodology

6.1.1. The development and proposed or recommended mitigation measures are assessed against the Design Flood, as defined in PPG paragraph 002 [4], taking into account existing flood defences.

6.1.2. Events which exceed the Design Flood and breach events are assessed as residual risks.

6.1.3. Flood risk at the site has been assessed using data received from the Environment Agency and the local planning authority.

6.2 Information Reviewed

6.2.1. In the preparation of this FRA report, the following information been reviewed:

6.2.2. Information received from the Environment Agency:

- Product 4 information received on 28th May 2019;
- Modelled flood levels in email dated 22nd October 2019;
- Skirting and Whangs Beck FRMS 2016/17 Modelling Report Final, June 2017 – received on 22nd October 2019;

6.2.3. Information received from Copeland District Council:

- Skirting Beck and Whangs Beck Flood Risk Assessment Report January 2019, VBA Joint Venture Limited – received 22nd October 2019.

6.2.4. Information received on 16th April 2019 from Gleeson Developments Ltd:

- Copy of the Copeland DC Report to the Planning Panel dated 24th April 2019 for application reference 4/19/2044/0F1;
- Topographical survey;
- Site layout sketch plan;
- Whangs Beck Storage Area General Arrangement and Cross Section drawing no: MNW000818-VBA-XX-4T3-DR-PL-0001, revision C01 dated 31/1/19;
- Whangs Beck: Tree Retention, Removals and Protection Plan drawing no: MNW000818-VBA-XX-4T3-DR-L-0001, revision C01 dated 31/1/19;
- Whangs Beck: Landscape Master Plan drawing no: MNW000818-VBA-LL-4T3-DR-L-0001, revision C01 dated 31/1/19;
- Copy of pre-development enquiry to United Utilities.

6.2.5. Information received on 22nd October 2019 from Gleeson Developments Ltd:

- Copy of Sirius Geotechnical Letter report on infiltration tests dated 22nd October 2019.

6.2.6. Information received on 25th August 2020 from Gleeson Developments Ltd:

- a set of the Environment Agency drawings for the Whangs Beck flood alleviation scheme.

6.2.7. Information received on 5th September 2022 from Gleeson Developments Ltd:

- Updated site layout plan.

6.3 History of Flooding

6.3.1. Egremont has a well documented history of flooding, caused by a combination of insufficient capacity in the sewerage network and culverted watercourses which is exacerbated by the back-up effect of the River Ehen when it is in spate. There is however, no available evidence of historic flooding at the site which, given its location and elevated position is not surprising.

6.4 Flood zones

6.4.1. The Flood Map for Planning in Appendix C shows the site to be in Flood Zone 1. No part of the site is in the Functional Floodplain, zone 3b.

6.5 Skirting Beck and Whangs Beck Flood Alleviation Scheme

6.5.1. In assessing the risk of flooding to the development the effect of the Skirting Beck and Whangs Beck Flood Alleviation Scheme, proposed by the Environment Agency has been considered. The scheme has been developed in response to the high risk of flooding in the town of Egremont and is described in the FRA report [6] submitted with the planning application to Copeland District Council under reference 4/19/2044/0F1.

6.5.2. In summary, the scheme comprises the creation of four main flood storage areas at:

- How Bank on Skirting Beck, to the north of How Bank Farm, providing 10,000m^3 of storage retained by an earth embankment with a crest level in the range 67.65m to 68.50m AOD;
- Whangs Beck Upper on Whangs Beck, to the west of the site, providing 6,000m^3 of storage retained by an earth embankment with a crest level of 78.80m AOD and a spillway crest level of 78.0m AOD;

- Whangs Beck Lower on Whangs Beck, to the south of the site, providing 4,500m^3 of storage retained by an earth embankment with a crest level of 70.62m AOD and a spillway crest level of 69.80m AOD;
- West Lakes Academy to the east of the site, providing 6,000m^3 of storage retained by earth embankments and retaining walls up to 1.5m high.

6.5.3. In addition to the storage areas, the scheme also includes for improvements to existing culverts; the creation of sustainable drainage features to manage overland flows; the raising of kerbs and the creation of low walls to manage overland flows in the highway, and flood resilience measures to selected properties that are exposed to residual risks.

6.5.4. The scheme is now substantially complete and we understand from the Environment Agency that the flood storage embankments have been inspected by a reservoirs panel engineer[1].

6.6 Fluvial flood risk

6.6.1. Although the site is in Flood Zone 1, which represents an annual probability of fluvial flooding less than 0.1%, the Skirting Beck and Whangs Beck Flood Alleviation Scheme flood storage areas will result in raised water levels behind the impounding embankment structures which could potentially have an effect of the site. Modelled flood levels at the storage areas have been provided by the Environment Agency and are provided in Appendix D.

6.6.2. The spillway level at the How Bank Storage area is 67.65m AOD but, as shown in the data in Appendix D, the 1% AEP flood level including an allowance for climate change is 67.48m AOD, which indicates no overtopping of the spillway in this event. The site will not therefore be at risk from this storage area under normal operating conditions.

6.6.3. The Whangs Beck Upper flood storage area is adjacent to the south-west boundary of the site. The modelled 1% AEP flood level at the Upper storage area including an allowance for climate change is 78.12m AOD, which exceeds the spillway level of 78.00m AOD, so the spillway will be overtopped in this event. The site layout plan in this area however, shows houses that are either at a higher level than the 79.0m contour, or downstream of the impounding embankment where the flood level will be lower.

[1] Telephone call: JOC/Graham Stanger 08/09/22

6.6.4. The Whangs Beck Lower flood storage area is adjacent to the southern boundary. The modelled 1% AEP flood level at the Lower storage area including an allowance for climate change is 69.90m AOD, which exceeds the spillway level of 69.80m AOD. The houses in the vicinity of this storage area are all on ground that is higher than the 71.5m contour, except plots 80 to 90 which are on ground between 67.5m and 71.0m AOD. The Capita/Aecom modelling report refers to proposals by Cumbria County Council to create cascading swales in the verge of Baybarrow Road to convey exceedance flows and to alter the road profile in order to direct surface water towards the swales. Provided the swales have sufficient capacity to convey the exceedance flows there should be no adverse effect of flooding to the development.

6.6.5. Any overtopping of the spillway will, according to the data in Appendix D, result in a velocity of 1.3m/s. This however is the velocity over the 35m wide spillway; if the flow is then contained in a narrower corridor, velocities could be significantly higher with potentially damaging consequences to the site access road from Baybarrow Road, across which the exceedance flow would pass.

6.6.6. The flow rate over a broad crested weir can be estimated as:

$Q = g^{0.5}b(2E/3)^{3/2}$ which resolves to:

$Q = 1.705bE^{3/2}$

where:

Q = flow rate (m^3/s);

b = spillway width (m)

E = specific energy over the crest = $H + v^2/2g$ (m)

H = water depth (m)

v= velocity (m/s).

6.6.7. With a spillway crest of 69.80m AOD; a water level of 69.9m AOD and a velocity of 1.3m/s (both as stated in Appendix D), the 1% AEP flow rate including CCA passing over the spillway is estimated to be $4.79m^3/s$. The velocity will be higher in the conveyance swale downstream of the storage embankment and it is essential therefore, that the access road to the site is designed with sufficient surface resistance to overland flows at high velocity.

6.7 Surface water flood risk

6.7.1. Surface water flood risk must be considered in terms of risk to the site and the effect of the development on the risk of surface water flooding. The effect of the development is discussed in section 8.2 below.

6.7.2. The Updated Surface Water Flood Map shows the site is at a 'Very Low' risk of surface water flooding, (see Appendix E). No overland flow paths are indicated within the site.

6.8 Risk of sewer flooding

6.8.1. Sewer flooding can occur when the capacity of a sewerage system is exceeded, or when the outflow from the sewer is restricted to the extent that the water level in the system rises and emerges from gullies or manholes at low points. There is no existing risk of sewer flooding to the site as there are no sewers in the immediate vicinity, and given the topography of the site, the risk of this type of flooding following development is assessed to be low.

6.9 Risk of groundwater flooding

6.9.1. Groundwater flooding of land occurs when the water table rises above the ground surface or enters basements and is typically associated with permeable rock such as chalk. These conditions are not present at the site and no basements are proposed in the development. The risk of this type of flooding is negligible, given the geology and topography of the site.

6.10 Risk of flooding from reservoirs and canals

6.10.1. The reservoirs flood map shows the site is not in an area at risk of flooding from the uncontrolled release of water from reservoirs (see Appendix F). A catastrophic failure of the Whangs Beck Lower impounding embankment however, could result in the sudden release of up to 4,500m^3 of water. The likelihood of such an event is very low, provided the embankment and spillway are adequately maintained by the Environment Agency but, should such a release of water occur, the area most affected would be downstream of the site. There could be shallow overland flow at high velocity close to the eastern boundary however, between Chaucer Avenue and Baybarrow Road. The storage capacity of the lower storage area is 4,500m^3, which is below the threshold of 10,000m^3 at which the requirements of the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010 apply but, as noted above, the flood storage embankments have been inspected by a reservoirs panel engineer. As the Environment Agency is responsible for the maintenance of the embankment, it is reasonable to expect that periodic inspections by a reservoirs panel engineer will be carried

out in the future. The risk of a catastrophic failure of the embankments is therefore assessed to be low.

6.10.2. The site is not at risk of flooding from canals.

7.0 EFFECTS OF CLIMATE CHANGE

7.1 Effect on rivers

7.1.1. The effects of climate change must be assessed over the lifetime of the development. The Planning Practice Guidance states that residential development should be considered for a minimum period of 100 years. For the purposes of this assessment, climate change effects are therefore considered up to the year 2122.

7.1.2. Current guidance on the application of climate change allowances was issued in February 2016 and updated on 27th May 2022 [7]. The guidance recommends that flood risk assessments should apply the central (50th percentile) allowance to peak river flow rates when considering the risks to more vulnerable developments in Flood Zones 2 or 3. The allowances need only be applied to a development in flood zone 1 when there is the possibility that the development could be in flood zone 2 or 3 in the future. Given the elevation of the development, it is likely to remain in flood zone 1, but the lower reach of Whangs Beck is currently in flood zone 3 and will remain in this zone in the future.

7.1.3. The site is in the South West Lakes Management Catchment and the peak river flow central allowance in the 2080s epoch is 29%.

7.1.4. The Capita/Aecom Modelling Report states that a 20% CCA has been applied, based on the Central allowance, adjusted from the 2012 estimates in an earlier report by Atkins. If flow rates in Whangs Beck increase by a further 9% compared with the modelled predictions, the frequency of overtopping the spillway will increase but the houses are unlikely to be affected, owing to their elevation above the watercourse. As noted above, the lowest house is at an elevation of 67.5m AOD, bur the swale conveying exceedance flows descends from the toe of the embankment which is at an elevation of approximately 65.50m AOD.

7.2 Effect on peak rainfall intensity

7.2.1. For developments having a lifetime beyond 2100, the Upper End CCA is to be used which, in the South West Lakes Management Catchment, is 45% for the 3.3% AEP event and 50% for the 1% AEP rainfall event.

7.2.2. The drainage system was designed before the current climate change guidance was published, so it is recommended that the design calculations are checked the assess the effect of the increased allowances for climate change.

7.2.3. Estimates of peak rainfall rates and runoff have been prepared using FEH 2013 point data for the site and the ReFH2 model. The results for return periods between 1 year (100% AEP) and 1000 years (0.1% AEP) are provided in Appendix G. The effects of the CCA allowances on the site in its existing and post-development conditions are shown in Tables 7.3 and 7.4 below.

Table 7.3: Effect of climate change – existing condition

	Peak runoff rate increase	Runoff volume increase
3.3% AEP_45% CCA	61.5%	64.0%
1% AEP_50% CCA	74.6%	76.3%

Table 7.4: Effect of climate change – post-development condition

	Peak runoff rate increase	Runoff volume increase
3.3% AEP_45% CCA	45.9%	46.5%
1% AEP_50% CCA	51.5%	52.3%

8.0 EFFECT OF THE DEVELOPMENT ON FLOOD RISK

8.1 Fluvial flood risk

8.1.1. The proposed development will have no effect on fluvial flood risk.

8.2 Surface water flood risk

8.2.1. It is estimated for the purposes of this FRA that the development will create an impervious area over approximately 50% of the site. This is a conservative estimate as the impervious area in Gleeson developments is usually between 40% and 50% of the gross site area. The ReFH2 model results in Appendix G show that this could increase the 1% AEP peak runoff rate and runoff volume by approximately 518% and 470% respectively. These increases can be mitigated by the proposals for surface water management in section 9.2 below.

9.0 FLOOD RISK MANAGEMENT

9.1 Fluvial flood risk

9.1.1. With the exception of those parts of the development on land between 67.5m and 71.0m AOD at Whangs Beck Lower storage area, (plots 80 to 90), no flood risk management measures are necessary in respect of fluvial flooding.

9.1.2. Plots 80 to 90 are potentially at risk of flooding from overland flow when the Lower storage area spillway is overtopped. It is understood from the Environment Agency and Cumbria County Council however that overland flow downstream of the spillway will be conveyed swales adjacent to Baybarrow Road. This exceedance flow will be prevented from entering the low lying part of the site where plots 80 to 90 are located by the access road into the site from Baybarrow Road. We have not had sight of any details of the proposed swales and it has not therefore been possible to assess the risk of flooding from the swales when the spillway is overtopped. It is a matter for the Environment Agency to ensure that this risk is adequately assessed.

9.1.3. The design of the access road and footpaths from Baybarrow Road should allow for a crossing of high velocity overland flows from the spillway, unless the Environment Agency provide for exceedance flows to pass safely under the access way in a culvert; otherwise there is a risk that the roadway of footpath could be washed away in a major flood.

9.2 Surface water flood risk

9.2.1. The effect of the proposed development on surface water run-off volumes can be mitigated by the implementation of sustainable drainage principles. The Building Regulations require surface water to be discharged according to the following preference hierarchy:

1. to ground by infiltration;
2. to a watercourse;
3. to a sewer, if options (1) and (2) are not reasonably practicable.

9.2.2. Infiltration tests were carried out in September 2019 by Sirius Geotechnical and its report is provided in Appendix H. Conditions in the southern part of the site appear favourable for infiltration drainage but it is likely that a supplementary controlled surface water discharge to Whangs Beck may be required.

9.2.3. The drainage strategy for the development divides the site into four sub-catchments, as shown in the plan in Appendix I. Each sub-catchment drains to its own attenuation storage facility

which discharges to a watercourse. Ground conditions for infiltration are suitable only in sub-catchments 3 and 4 and this is reflected in the estimates of storage capacity provided in Appendix J.

9.2.4. Details of the sub-catchments and discharges therefrom are provided in Table 9.1 below.

9.2.5. The attenuation storage facilities are:

- Sub-catchment 1: below-ground storage tank;
- Sub-catchment 2: five cascading storage basins;
- Sub-catchment 3: three cascading storage basins; and
- Sub-catchment 4: one storage basin.

Table 9.1: Drainage of sub-catchment areas

Sub-catchment	Area (ha)	Suitable for infiltration?	Preliminary storage estimate (m^3)	Proposed controlled discharge rate (l/s)	Receiving watercourse
1	0.611	No	230	5.0	Whangs Beck
2	0.743	No	280	5.0	Whangs Beck
3	1.260	Yes	171	5.0	Whangs Beck
4	1.650	Yes	225	5.0	Skirting Beck

9.2.6. The preliminary estimates of storage in Table 9.1 are subject to review in the detailed design of the drainage system.

9.2.7. It is recommended that a detailed drainage design is prepared for the development in accordance with the technical standards for sustainable drainage [8] and the Building Regulations 2015. The design should be submitted to Copeland District Council for approval prior to construction.

9.3 Residual risks

9.3.1. Residual risks are those which persist after any flood risk management measures designed to protect against the design flood event. These risks include:

- flood events that are greater than the design event;
- catastrophic failure of the impounding embankments; and
- an increase in the design event resulting from updated flood forecasting.

9.3.2. The site is in Flood Zone 1 and is not therefore generally at risk from a 0.1% AEP flood event. There is no reference in the FRA report for the Skirting Beck and Whangs Beck Flood Alleviation Scheme, or in any of the other documents received in connection with that scheme, to the 0.1% AEP flood level at the Whangs Beck storage areas. As the Lower storage area embankment provides containment only for flood events having an AEP greater than 2% (occurring on average more frequently than once in 50 years), it is evident that in all events greater than this, the spillway will be overtopped. In a 0.1% event, there could be downstream flooding, originating from the How Bank and Whangs Beck storage areas, some of which could potentially affect the lower parts of the site. It is therefore recommended that finished floor levels at plots 80 to 90 are at least 450mm above the external ground level in order to mitigate this risk. It is also recommended that flood resilient construction methods and materials are applied up to 900mm above the finished floor level. These measures should be reviewed and, if necessary, adjusted when the results of the Environment Agency verification modelling are known.

9.3.3. In the unlikely event of a catastrophic failure of the impounding embankments, as discussed in 6.10.1 above, there would be a sudden release of stored water. The effects of this do not appear to have been considered in the FRA report for the flood alleviation scheme. The recommended raised floor levels to Plots 80 to 90 will provide some protection against such an event, but internal flooding of these houses cannot be ruled out should such an event occur. As noted in paragraph 6.10.1, a catastrophic failure of the impounding embankments is considered to be very unlikely.

9.3.4. It is recommended that the above recommendations for flood risk management are reviewed when further details of the proposals for managing exceedance flows and the effects of increased climate change allowances are received from the Environment Agency.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

10.1.1. The development is classified as More Vulnerable and is in Flood Zone 1.

10.1.2. Although Egremont has a history of severe flooding, caused by rapid response runoff from the upper catchment; inadequate capacity in the sewerage and culvert network; and high water levels in the River Ehen preventing drainage, there is no evidence of flooding at the site, which is in an elevated position upstream of Egremont.

10.1.3. The risks of surface water flooding and sewer flooding to the development are very low and the site is not currently within an area at risk from the uncontrolled release of water from reservoirs. The Skirting Beck and Whangs Beck Flood Alleviation Scheme will however create areas of impounded water above the downstream ground level and a catastrophic failure of the embankments could potentially affect the eastern part of the site between Chaucer Avenue and Baybarrow Road. The likelihood of such an event is assessed to be very low, provided the embankments are adequately designed and maintained.

10.1.4. The site is not at risk of flooding from any canal.

10.1.5. The use of a 20% CCA in the Skirting Beck and Whangs Beck Flood Alleviation Scheme is not in accordance with current guidance and could result in future flood levels being under-estimated. The lowest part of the site, at the north-east corner near Chaucer Avenue, is potentially at risk from flood events which exceed the spillway levels of the flood storage embankments at How Bank and Whangs Beck. The risk can be mitigated by the flood risk management recommendations in paragraph 9.3.2 above.

10.1.6. The effect of climate change on peak rainfall intensity is estimated to increase peak runoff rates and volumes in the 1% AEP by approximately 52%.

10.1.7. The creation of impervious area within the development could increase surface water runoff rates and volumes by factors of approximately 5.6 and 5.1 respectively. These increases will be mitigated by the application of sustainable drainage principles in the drainage design for the development, including the provision of attenuation storage.

10.1.8. Ground conditions are not suitable for infiltration drainage in the northern part of the site, but are likely to be suitable in the southern part. Disposal of surface water from the development

by infiltration, supplemented by controlled discharges to Whangs Beck and Skirting Beck is therefore proposed.

10.1.9. The development will not increase off-site flood risks provided the recommendations for surface water management are implemented.

10.2 Recommendations

10.2.1. The recommended flood risk management precautions in section 9 of this report should be implemented in the design and construction of the development.

10.2.2. It is recommended that a detailed drainage design, based on the drainage strategy, is prepared and submitted to Copeland District Council and United Utilities for approval, prior to construction.

11.0 REFERENCES

1. National Planning Policy Framework. Department for Communities and Local Government. February 2019.

2. Copeland District Council Local Plan 2013 – 2018, adopted 5th December 2013.

3. Copeland District Council Level 1 SFRA, 2021.

4. Planning Practice Guidance: Flood Risk and Coastal Change. Updated 25th August 2022. Department for Communities and Local Government.

5. Environment Agency Standing Advice to local planning authorities, April 2015, updated 8th February 2022.

6. Skirting Beck and Whangs Beck Flood Risk Assessment version S2, VBA Joint Venture Limited, 31st January 2019.

7. Flood risk assessments: climate change allowances. Environment Agency, 19th February 2016, updated 27th May 2022.

8. Sustainable Drainage Systems. Non-statutory technical standards for sustainable drainage systems. DEFRA March 2015.

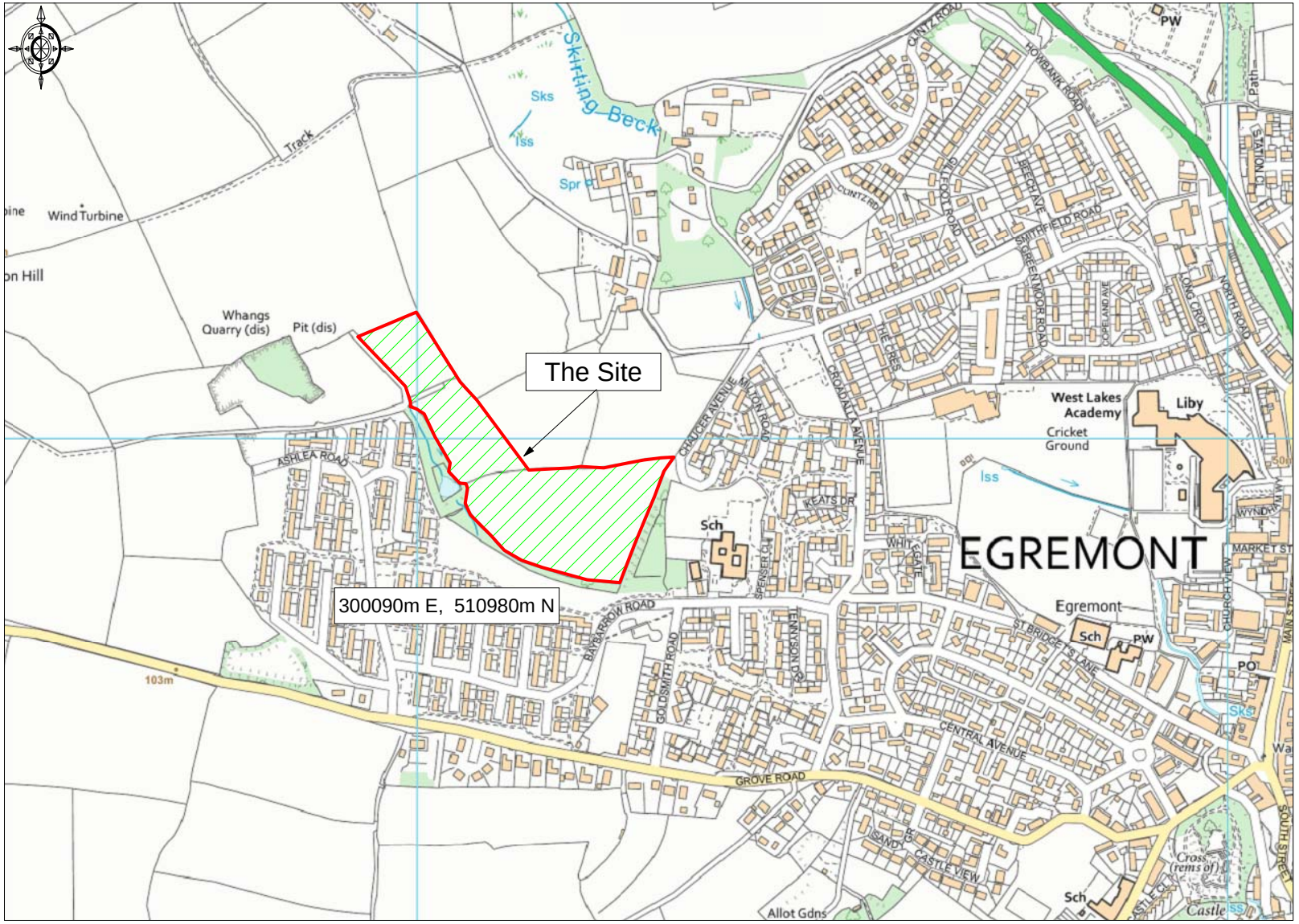
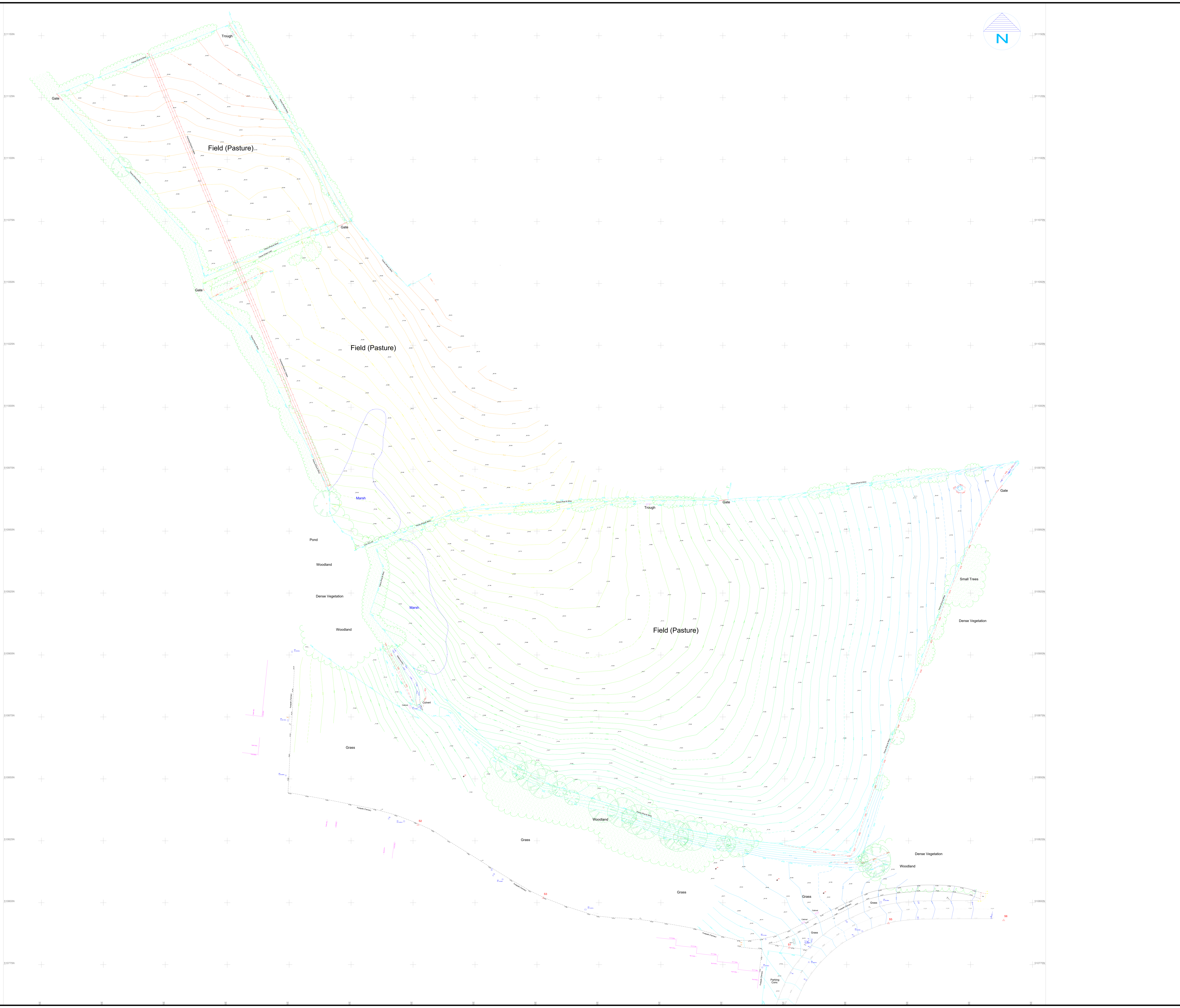
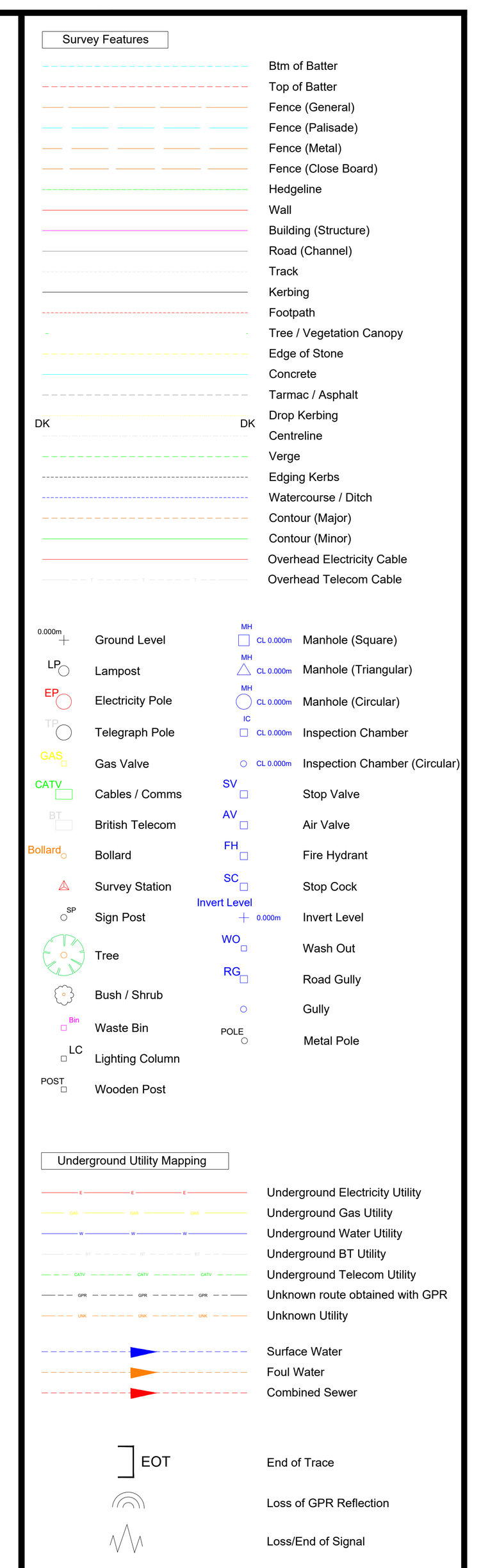


Figure 1: Location Plan

APPENDIX A

Topographical survey plan





Notes :-

DO NOT SCALE FROM DRAWING
DIMENSIONS TO BE TAKEN ON SITE

Site Grid

Ordnance Survey Grid & Datum
(Trimble GPS System OSTN15 Transformation)
RTK Network

SURVEY STATIONS				
Name	Easting	Northing	Height	Remark
S1	300226.838	510781.821	66.832	
S2	300077.015	510831.396	75.917	
S3	300127.564	510801.912	74.376	
S4	300226.320	510749.899	68.737	
S5	300266.854	510791.710	63.460	
S6	300313.333	510792.930	60.344	

REV	AMENDMENT	DRAWN	DATE

How Bank
Farm
Egremont
JOB TITLE

Gleeson Homes
CLIENT

Topographical
Survey
DRAWING TITLE

1:500 @ A0 SCALE	J D Gibson DRAWN
08/04/2019 DATE	J D Gibson APPROVED

Gibson Surveying and Mapping Ltd
21 West View,
Crook,
County Durham.
DL159EY.
Mob. 07896698645
Tel. 01388 764106
email : info@gsmsurvey.co.uk
www.gsmsurvey.co.uk

PROJECT No.	DRG No.	REV
	GH/NBF/TS01	

APPENDIX B

Planning Layout drawing

Drawing No: MGL/PL/111 Revision E dated 4th September 2022 by
Twenty 10 Design and Planning

FORMER ORGILL INFANTS SCHOOL, EGREMONT

HOW BANK FARM, EGREMONT

APPENDIX C

Fluvial Flood Map for Planning

Flood map for planning

Your reference	Location (easting/northing)	Created
19/013	**300090/510980**	**7 Sep 2022 11:52**

Your selected location is in flood zone 1, an area with a low probability of flooding.

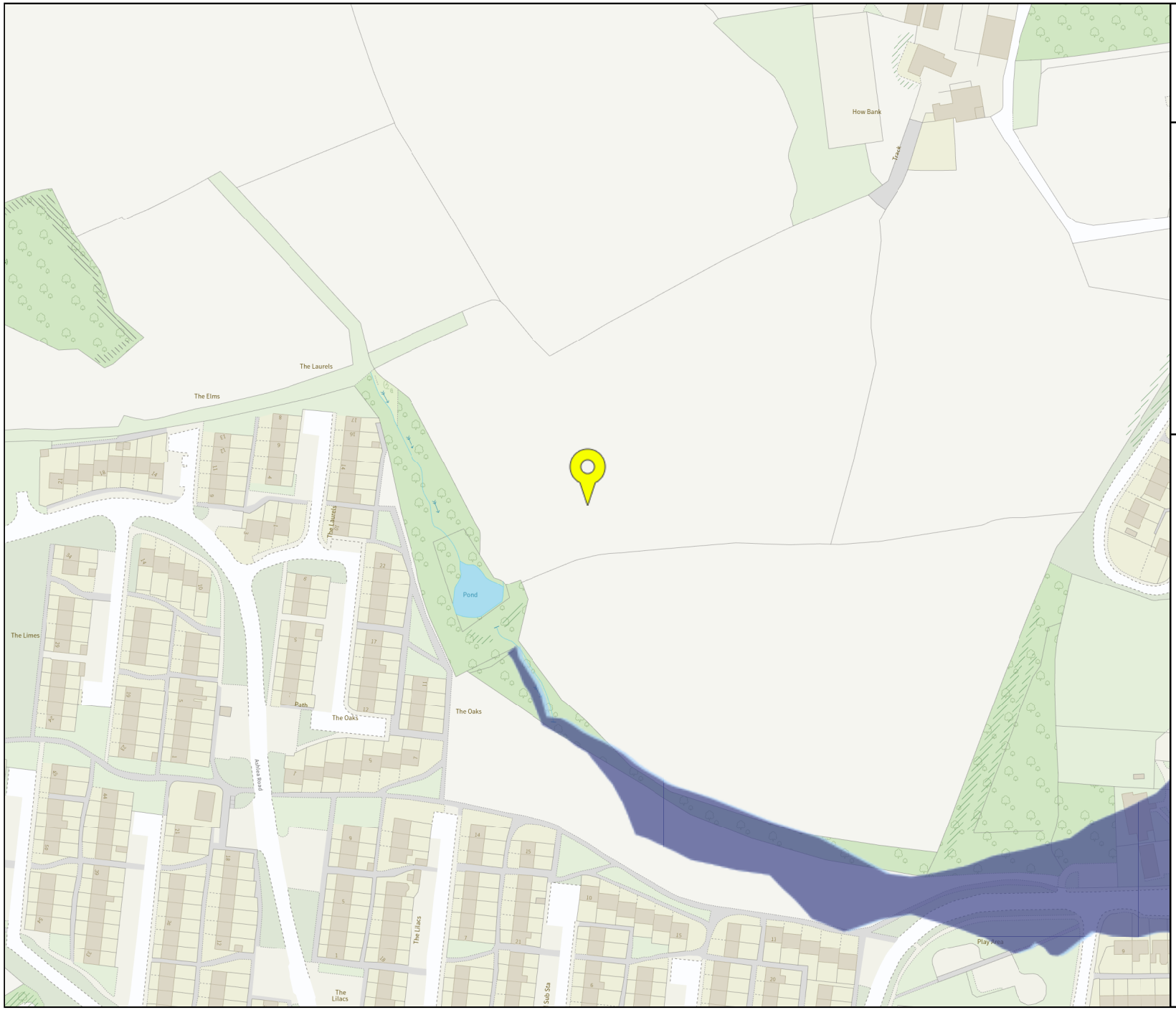
You will need to do a flood risk assessment if your site is **any of the following:**

- bigger that 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
19/013

Location (easting/northing)
300090/510980

Scale
1:2500

Created
7 Sep 2022 11:52

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Water storage area

0 20 40 60m

APPENDIX D

Predicted flood levels provided by the Environment Agency

John O'Connor

From: Stanger, Graham [graham.stanger@environment-agency.gov.uk]
Sent: 22 October 2019 08:22
To: John O'Connor
Cc: Hall, Chris; Scopes, David S; Tom Lawrenson
Subject: FW: Skirting Beck - Information as requested

Hi John,

Please see info below . I am out of the office shortly and will have limited access to my emails, if you need mor model information please contact Chris Hall / David Scopes our design team who will be able to assist with model information.

Regards

Graham Stanger – Project Manager
Programme & Contract Management (PCM)
part of Operations Assets & Programme Management

Environment Agency
Richard Fairclough House, Knutsford Road, Latchford, Warrington WA4 1HT
Mobile: 07771 51 3115

graham.stanger@environment-agency.gov.uk

Please consider the environment before printing this email

From: Hall, Chris [mailto:Chris.Hall2@atkinsglobal.com]
Sent: 21 October 2019 17:05
To: Stanger, Graham <graham.stanger@environment-agency.gov.uk>
Cc: Scopes, David S <David.Scopes@atkinsglobal.com>
Subject: Skirting Beck - Information as requested

Hi Graham,

As requested, the planning application reference is 4/19/2044/0F1

I have included information below, showing overtopping events at the various reservoirs.

	Event	Overtopping Volume (m3)	Peak Overtopping Flow (m3/s)	Peak Level (mAOD)	Notes
How Bank	Q5+CC			65.56	
67.65	Q10+CC			65.62	
	Q20+CC			65.68	
	Q30+CC			65.96	
	Q50+CC			66.65	
	Q75+CC			67.12	No overtopping for during Q100+CC and below
	Q100+CC			67.48	
Whangs Upper	Q5+CC			77.23	
78	Q10+CC			77.97	
	Q20+CC	2621	0.7	78.07	
	Q30+CC	4284	0.92	78.08	
	Q50+CC	6700	1.2	78.09	Overtopping flow into Whangs Lower
	Q75+CC	8400	1.35	78.12	
	Q100+CC	9900	1.44	78.12	
Whangs Lower	Q5+CC	-		65.8	
69.8	Q10+CC	-		66.23	
	Q20+CC	-		68.79	
	Q30+CC	-		69.67	
	Q50+CC	2,300	0.8	69.87	
	Q75+CC	4,300	1.1	69.89	
	Q100+CC	5,900	1.3	69.9	Overtopping flow down Baybarrow road, through school and eventually into WLA
WLA	Q5+CC			48.87	

49.7	Q10+CC			49.1	
	Q20+CC			49.31	
	Q30+CC			49.41	
	Q50+CC	-		49.59	
	Q75+CC	700	0.6	49.72	
	Q100+CC	6,000	1.3	49.73	

Please let me know if you require anything further.

Chris Hall
Graduate Civil Engineer, Infrastructure
UK & Europe
Engineering, Design and Project Management

01925 238905

Chadwick House, Birchwood Park, Warrington, Cheshire WA3 6AE

Company

APPENDIX E

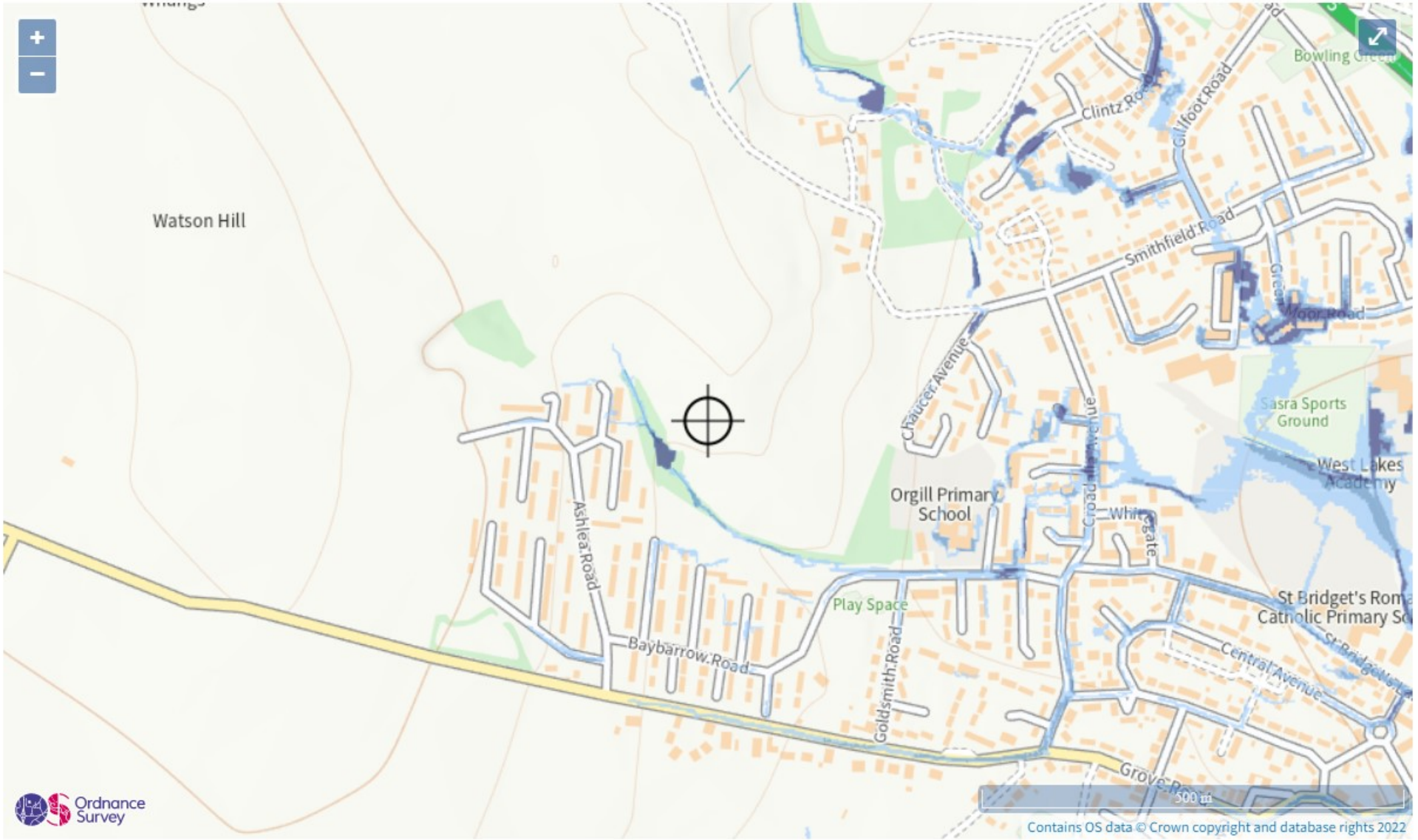
Updated Surface Water Flood Map

Flood risk

Extent of flooding

Location

How Bank Farm, Egremont



Extent of flooding from surface water

High Medium Low Very low Location you selected

APPENDIX F

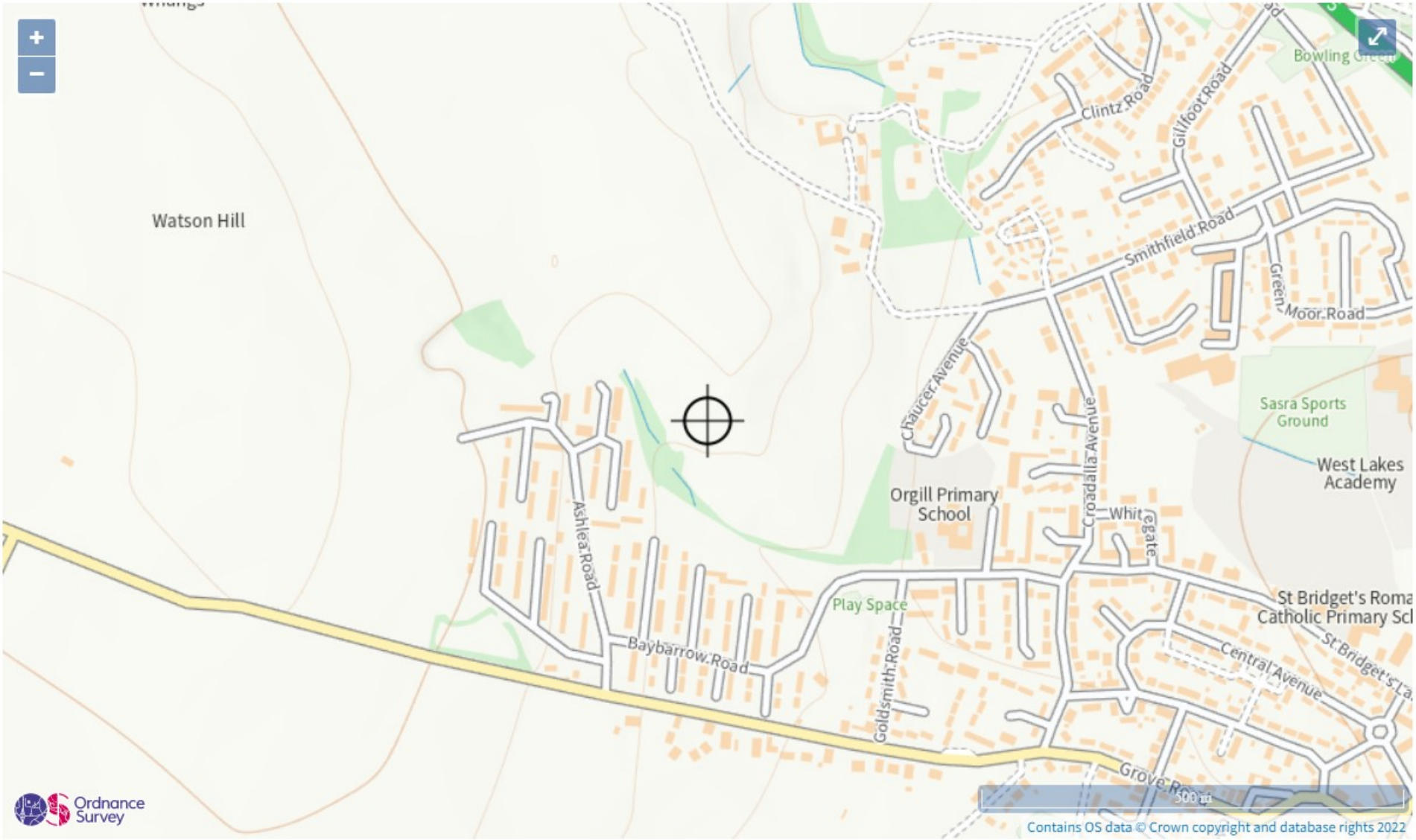
Reservoirs Flood Map

Flood risk

Extent of flooding

Location

How Bank Farm, Egremont



Maximum extent of flooding from reservoirs:

when river levels are normal | when there is also flooding from rivers | Location you selected

APPENDIX G

ReFH 2 estimates of peak surface water runoff rates and volumes

19/013: How Bank Farm, Egremont

REFH2 estimates of surface water runoff rates and volumes

Return period (yrs)	Urbanised peak flow (l/s)	Urbanised direct runoff (m^3)	As-rural peak flow (l/s)	As-rural direct runnof (m3)	Peak flow increase %	Runoff increase %
1	56.74	333.41	7.69	45.47		
2	63.78	375.21	8.68	52.04	634.6%	621.0%
5	87.83	518.29	12.28	75.94	615.0%	582.5%
10	105.16	621.63	15.09	94.55	597.0%	557.4%
30	136.08	806.47	20.51	130.58	563.5%	517.6%
50	153.03	908.05	23.71	151.85	545.4%	498.0%
75	167.99	997.84	26.67	171.50	530.0%	481.8%
100	179.54	1067.22	29.04	187.21	518.3%	470.1%
200	211.44	1259.36	35.99	233.14	487.4%	440.2%
1000	269.42	1371.18	41.99	282.46	541.7%	385.4%
				Average:	559.2%	506.0%
30_45% CCA	198.57	1181.77	33.12	214.17	499.5%	451.8%
100_50% CCA	271.95	1625.39	50.69	330.06	436.5%	392.5%

<u>Effect of CCA on 1% AEP event</u>

	Peak flow rural increase	Runoff volume rural increase	Peak flow post develpment increase	Runoff volume post development increase
30_45% CCA	61.5%	64.0%	45.9%	46.5%
100_50% CCA	74.6%	76.3%	51.5%	52.3%

APPENDIX H

Results Infiltration Tests

Sirius Geotechnical report letter dated 22nd October 2019

Sirius Geotechnical Ltd
Russel House, Mill Road
Langley Moor
Durham
DH7 8HJ

0191 378 9972
www.thesiriusgroup.com

David Wright
Gleeson Regeneration Ltd
Rural Enterprise Centre
Redhills
Penrith
Cumbria
CA11 0DT

Date: 22nd October 2019

Our Ref: C8071/7464/APC/APC

Dear David,

Re: C8071 – How Bank Farm, Egremont, Cumbria – Infiltration Testing

Introduction

Sirius Geotechnical Ltd (Sirius) has previously carried out a geoenvironmental appraisal of land at How Bank Farm, Egremont, on behalf of Gleeson Regeneration Ltd (Gleeson). The findings of that appraisal are presented in a report dated July 2019, and referenced C8071A.

That investigation identified natural soils comprising predominantly of sandy gravelly clay in the north-west, and granular material ranging from sandy silt to sandy gravel with cobbles in the south and east.

Consequently, Sirius was also instructed by Gleeson to undertake undertake soil infiltration rate testing at the site at locations potentially suitable to support soakaway drainage as determined from the findings of the geoenvironmental appraisal. Sirius has therefore subsequently undertaken infiltration tests at 3 No. locations, across the south and east of the site, selected based on strata encountered during the previous investigation. Testing was undertaken in general accordance with guidance given in BRE Digest 365:2016.

This letter presents the results of the soil infiltration rate testing in trial pits ('soakaway tests') carried out by Sirius.

Fieldwork

Fieldwork was initially undertaken on 10 and 11 September 2019. A third day of fieldwork scheduled to take place on 12 September was aborted owing to difficulty in regaining access to the site with the required plant owing to poor weather conditions and wet ground across the sloping area of the site. A further phase of fieldwork was therefore carried out at later date, on 18 and 19 October 2019.

Fieldwork comprised the mechanical excavation of three trial pits (SA01 to SA03) using a wheeled backhoe excavator, the installation of a gravel pack and monitoring pipework to mitigate against instability, and the undertaking of infiltration tests at each location.

The locations of the excavations, are shown on Drawing C8071A/03 Revision A, attached to this letter.

Trial pits were excavated to depths of 1.5m below ground level (bgl). Detailed records of the depths and descriptions of strata encountered within each excavation are attached to this letter as Trial Pit Record SA01 to SA03.

In summary, below topsoil, SA01 encountered topsoil overlying clayey sandy silt; SA02 encountered slightly silty very gravelly fine to coarse sand; and, SA03 encountered silty slightly gravelly fine to medium sand. These soils were encountered to the termination depth of the respective pits.

The strata encountered at the selected infiltration test locations are approximately commensurate with those found during the aforementioned investigation and are considered representative of conditions in those areas of the site selected.

Trial pit excavations were immediately backfilled with 10mm washed gravel to approximately 0.5m bgl. Arisings from the excavation were used to bring the trial pits up to ground level. Two 62mm slotted pipes were installed into each test pit during backfilling, to allow the introduction of water and enable monitoring of water levels within the gravel.

Infiltration Tests

Soakaway tests were undertaken in general accordance with the test method specified in BRE Digest 365:2016.

Water was added to the soakaway test pits using a gravity fed supply from a tractor towed 5,000 litre or similar bowser. The water level and time in minutes from filling the excavation was recorded.

Where possible and appropriate, three soakaway test cycles were performed at each location, on the same or consecutive days. Based generally on guidance given in the BRE Digest, it is possible to provide an indication of likely infiltration rates, using the difference in effective storage volume of water across the duration of the test, together with the internal surface area of the trial pit at 50% of the effective volume change. Soakaway calculations performed using this method are attached.

In the case of SA01 and SA03, due to the low discharge rate from the test pits, only 1 No. test was performed. In those tests, water levels were monitored periodically for 4 hours, with no significant fall in water level within the test pit observed. The pits were monitored again the following day, after a continuous period of testing of circa 21 hours.

The water level in SSA01 was found not to have fallen below the 75% level.

The water level in SS03 had fallen close to the 25% level over the 21 hour period.

Guidance in BRE Digest 365 requires a 'full-depth' test, in which water levels fall to at least 25% of the start level. In the case of the infiltration test performed at location SA03, strictly the water level during the test did not fall to at least 25% of the start level. However, as is shown on the soakaway calculation sheets, water levels fell rapidly to just above the 25% level over the 21 hour test period, and in order to calculate an infiltration rate from this test, discharge to the 25% level has been partly extrapolated.

In each test undertaken within SA02, the water level fell below the 25% full level within around four hours. However, the significant period of time elapsed between tests 01 and A1 should be noted, with only tests A1 to A3 conforming to BRE Digest 365 guidance.

Detailed results of the rates of fall, together with calculations of soil infiltration rates for each test at each location are attached. A summary of the calculated rates is presented below:

Trial Pit/Soakaway Ref.	**Observed Infiltration Rate (m/s^{-1})**	**Soil type**
SA01 Test 01	Rate not calculable	Clayey sandy silt
SA02 Test 01	1.95×10^{-5}	Silty gravelly sand
SA02 Test A1	1.10×10^{-5}	Silty gravelly sand
SA02 Test A2	1.05×10^{-5}	Silty gravelly sand
SA02 Test A3	1.01×10^{-5}	Silty gravelly sand
SA03 Test 01	2.26×10^{-6}*	Silty gravelly sand

* - Result conservatively extrapolated from data acquired as described above.

Conclusions

Infiltration rates in the order of 10^{-5} m/s to 10^{-6} m/s, may be appropriate for the coarser granular superficial soils which are prevalent across the southern and eastern half of the site.

Notwithstanding, horizons of finer material e.g. silt and locally clay, are present within the dominant granular soil, particularly at depths and at lower elevations around the southern and eastern perimeters as presented on exploratory hole records within the aforementioned geoenvironmental appraisal report. No infiltration rate has been determined, owing to anticipated and demonstrably low rates, for such soils, which are unlikely to be capable of supporting soakaway drains.

Care should therefore be taken in the selection of soakaway drains, in order to avoid positioning within the finer silt and clay soils. It is recommended that confirmatory excavation at specific locations where soakaway drains are being considered, to ensure suitable soils are present around the proposed discharge location and depth.

We trust that this is satisfactory for your present needs. However, should you have any queries or require any further information, please do not hesitate to contact the undersigned.

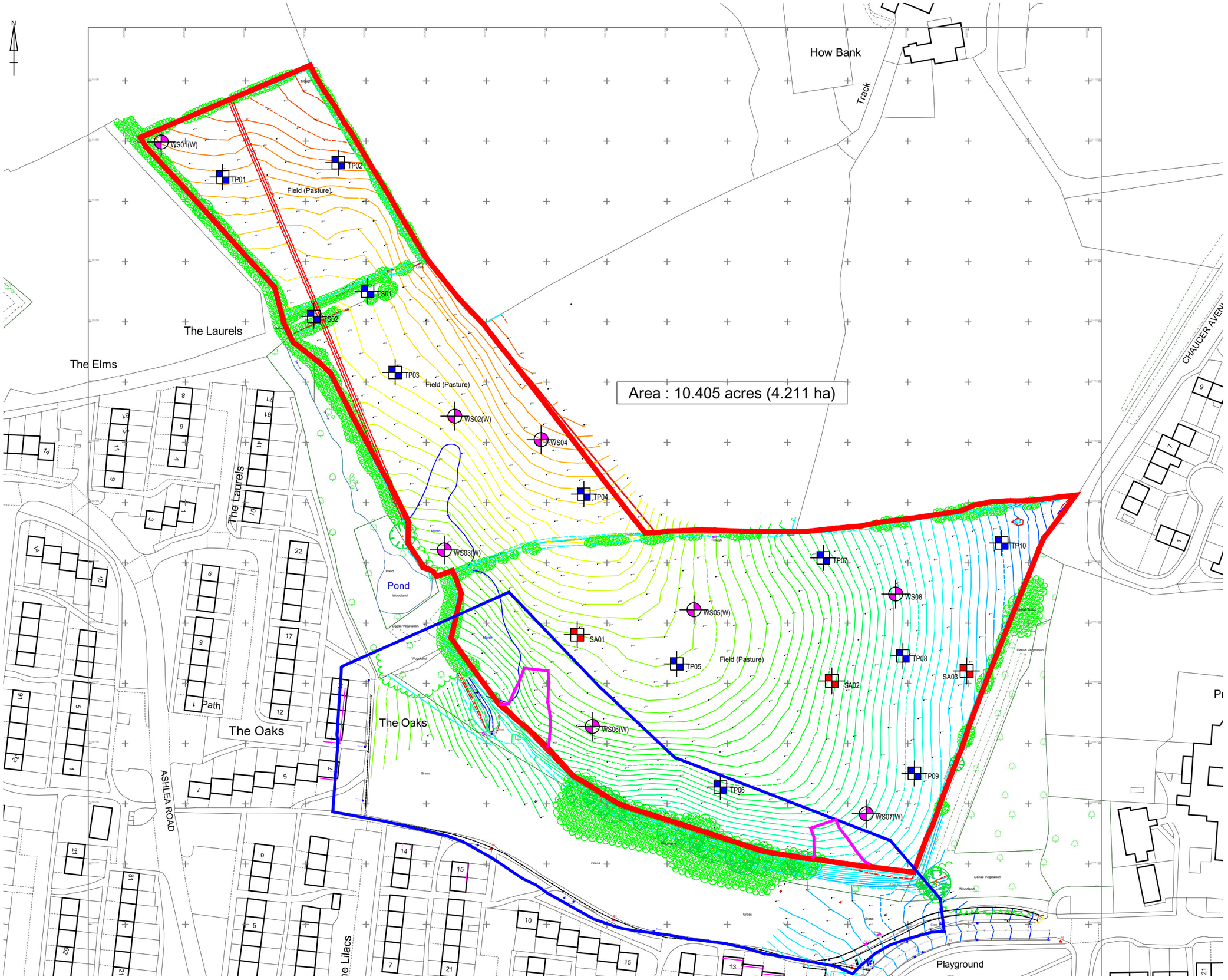
Yours sincerely,

Alastair Cook

Principal Engineer

For and on behalf of
Sirius Geotechnical Ltd

Encs: Drawing C8071A/03A Revision A
Trial Pit Records SA01 to SA03
Infiltration test result sheets



NOTES

- Site Boundary
- Extent of Environment Agency Flood Alleviation Scheme
- Proposed Embankments as Part of EA Works
- Window Sample (W - With Well)
- Trial Pits
- Soakaways Test Pit

REVISION		BY	DATE
0	For Information	MF	31/05/19
A	Proposed SA01-SA03 Added	APC	18/07/19
B	>>	>>	>>
C	>>	>>	>>
D	>>	>>	>>

SIRIUS
GEOTECHNICAL LTD
Russel House,
Mill Lane,
Langley Moor,
Durham DH7 8HJ
www.thesiriusgroup.com
TEL: 0191 378 9972
FAX: 0191 378 1537

CLIENT

Gleeson Regeneration Ltd

SITE

**How Bank Farm,
Egremont,
Cumbria**

DRAWING TITLE

Exploratory Hole Location Plan

DRAWING NO.	REVISION NO.
C8071A/03A	A
DRAWN BY	APPROVED BY
MF	APC
DATE	SCALE	PAPER SIZE
October 2019	1:1500	A3

TRIAL PIT RECORD

TP No. **SA01** Sheet 1 of 1

Site: How Bank Farm, Egremont

Contract No: C8071

Client: Gleeson Regeneration Ltd

Date: 10/09/2019

Method: Pit excavated using a JCB 3CX with a 600mm toothed bucket.

Scale: 1:25

Logged By: DG

Checked By:

SAMPLE DETAILS

STRATA RECORD

Type	Depth From - To(m)	Vane Results (kN/m2) {}{ppm}	Ground -water	Description	Depth (m)	Level (m AOD)	Legend	Backfill
				Red brown silty fine to coarse SAND. Occasional gravel of rounded and sub rounded fine to coarse slate and sandstone. (Topsoil).				
				Red brown slightly clayey very sandy SILT.	0.30	79.90		
				End of trial pit at 1.50m	1.50	78.70		

1
2
3
4
5

Remarks and Groundwater Observations

1. Groundwater not encountered. 2. Pit remained stable. 3. Coordinates and elevation derived from hand held GPS and topographic plans. 4. Pipework installed for water level monitoring during soakaway tests.

GL (m AOD) 80.20

Easting: 300112.00

Northing: 510920.00

Fig No. SA01

TRIAL PIT RECORD

TP No. **SA02** Sheet 1 of 1

Site: How Bank Farm, Egremont

Contract No: C8071

Client: Gleeson Regeneration Ltd

Date: 10/09/2019

Method: Pit excavated using a JCB 3CX with a 600mm toothed bucket.

Scale: 1:25

Logged By: DG

Checked By:

SAMPLE DETAILS

STRATA RECORD

Type	Depth From - To(m)	Vane Results (kN/m2) {}{ppm}	Ground -water	Description	Depth (m)	Level (m AOD)	Legend	Backfill
				Red brown silty fine to coarse SAND. Occasional gravel of rounded and sub rounded fine to coarse slate and sandstone. (Topsoil).				
				Red brown slightly silty very gravelly fine to coarse SAND. Gravel is rounded and sub rounded fine to coarse limestone and occasional sandstone.	0.30	74.45		
				End of trial pit at 1.50m	1.50	73.25		

1
2
3
4
5

Remarks and Groundwater Observations

1. Groundwater not encountered. 2. Pit remained stable. 3. Coordinates and elevation derived from hand held GPS and topographic plans. 4. Pipework installed for water level monitoring during soakaway tests.

GL (m AOD) 74.75

Easting: 300218.00

Northing: 510900.00

Fig No. SA02

TRIAL PIT RECORD

TP No. **SA03** Sheet 1 of 1

Site: How Bank Farm, Egremont

Contract No: C8071

Client: Gleeson Regeneration Ltd

Date: 10/09/2019

Method: Pit excavated using a JCB 3CX with a 600mm toothed bucket.

Scale: 1:25

Logged By: DG

Checked By:

SAMPLE DETAILS

STRATA RECORD

Type	Depth From - To(m)	Vane Results (kN/m2) {}{ppm}	Ground -water	Description	Depth (m)	Level (m AOD)	Legend	Backfill
				Red brown silty fine to coarse SAND. Occasional gravel of rounded and sub rounded fine to coarse slate and sandstone. (Topsoil).				
				Red brown silty slightly gravelly fine to medium SAND. Gravel is rounded and sub rounded fine to coarse limestone and occasional sandstone.	0.30	66.30		
				End of trial pit at 1.50m	1.50	65.10		

1
2
3
4
5

Remarks and Groundwater Observations

1. Groundwater not encountered. 2. Pit remained stable. 3. Coordinates and elevation derived from hand held GPS and topographic plans. 4. Pipework installed for water level monitoring during soakaway tests.

GL (m AOD) 66.60

Easting: 300274.00

Northing: 510905.00

Fig No. SA03

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007			
Client:	Geeson Developmentss Ltd		
Site:	How Bank Farm, Egremont		
Job No:	C8071	Test No:	SA02 Test 01

CALCULATION OF SOIL INFILTRATION RATE

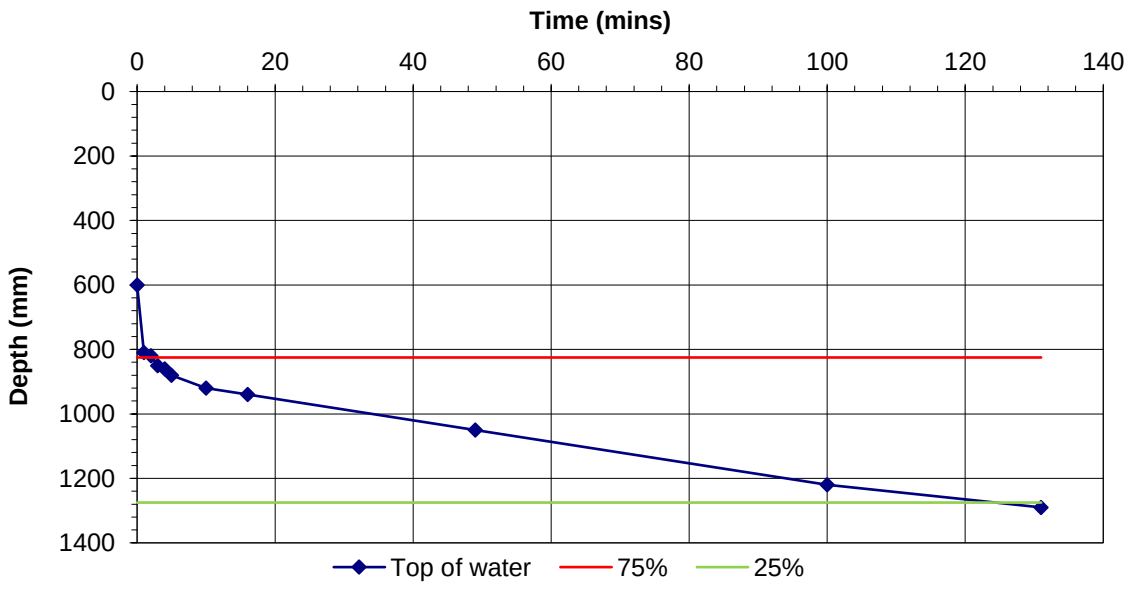
Time (min)	Depth (mm)
0	600
1	810
2	820
3	850
4	860
5	880
10	920
16	940
49	1050
100	1220
131	1290

Size of Soakaway		
	Length (m) =	1.50
	Width (m) =	0.60
	Depth (m) =	1.50

Depth at start of test (mm)=	600mm
Depth of trial pit (mm)=	1500mm
75% effective depth (mm)=	825mm
50% effective depth =	1050mm
25% effective depth =	1275mm
Base area of pit (m^2) =	0.900
Effective area of loss 50% (m^2) =	2.790
Volume outflow 75 - 25% (m^3) =	0.405

From the graph:	
tp 75 (min) =	1
tp 25 (min) =	125

Soil infiltration rate, f, (m/s) =	1.95E-05	Normal test
Input by:	DG	Date: 12/09/2019
Checked by:	APC	Date: 16/09/2019



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007			
Client:	Geeson Developmentss Ltd		
Site:	How Bank Farm, Egremont		
Job No:	C8071	Test No:	SA03 Test 01

CALCULATION OF SOIL INFILTRATION RATE

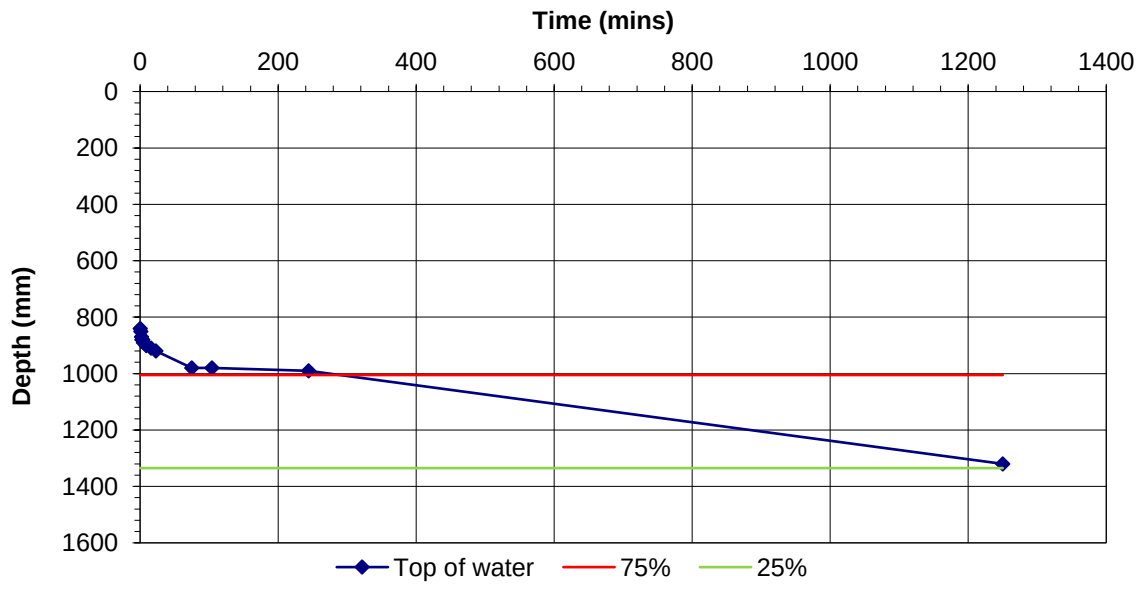
Time (min)	Depth (mm)
0	840
1	850
2	870
3	880
4	880
5	890
9	900
16	910
23	920
75	980
104	980
244	990
1250	1320

Size of Soakaway		
	Length (m) =	1.50
	Width (m) =	0.60
	Depth (m) =	1.50

Depth at start of test (mm)=	840mm
Depth of trial pit (mm)=	1500mm
75% effective depth (mm)=	1005mm
50% effective depth =	1170mm
25% effective depth =	1335mm
Base area of pit (m^2) =	0.900
Effective area of loss 50% (m^2) =	2.286
Volume outflow 75 - 25% (m^3) =	0.297

From the graph:	
tp 75 (min) =	320
tp 25 (min) =	N/A

Soil infiltration rate, f, (m/s) =	N/A	Normal test
Input by:	DG	Date: 12/09/2019
Checked by:	APC	Date: 16/09/2019



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007			
Client:	Geeson Developmentss Ltd		
Site:	How Bank Farm, Egremont		
Job No:	C8071	Test No:	SA01 Test 01

CALCULATION OF SOIL INFILTRATION RATE

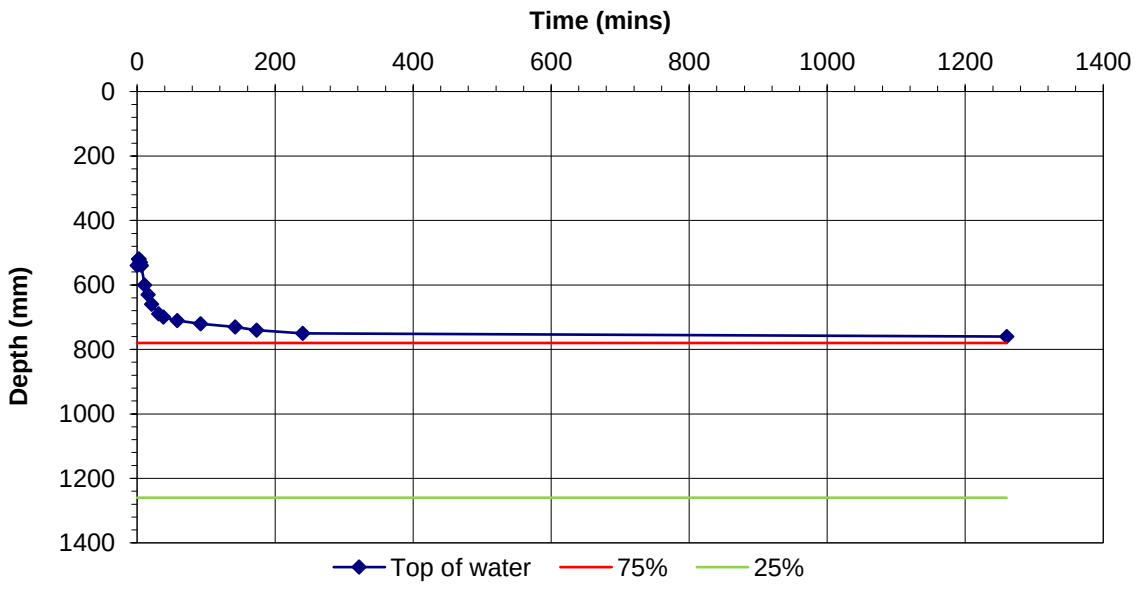
Time (min)	Depth (mm)
0	540
2	520
3	520
4	530
5	530
6	540
11	600
16	630
21	660
31	690
38	700
58	710
92	720
142	730
173	740
240	750
1260	760

Size of Soakaway		
	Length (m) =	1.50
	Width (m) =	0.60
	Depth (m) =	1.50

Depth at start of test (mm)=	540mm
Depth of trial pit (mm)=	1500mm
75% effective depth (mm)=	780mm
50% effective depth =	1020mm
25% effective depth =	1260mm
Base area of pit (m^2) =	0.900
Effective area of loss 50% (m^2) =	2.916
Volume outflow 75 - 25% (m^3) =	0.432

From the graph:	
tp 75 (min) =	
tp 25 (min) =	

Soil infiltration rate, f, (m/s) =	NA	Normal test
Input by:	DG	Date: 12/09/2019
Checked by:	APC	Date: 16/09/2019



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007			
Client:	Gleeson Regeneration		
Site:	How Bank Farm, Egremont		
Job No:	C8071	Test No:	SA02 Test A1

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (mm)
0	700
1	820
2	860
3	870
4	880
5	900
11	910
20	980
106	1150
130	1170
190	1260
250	1350

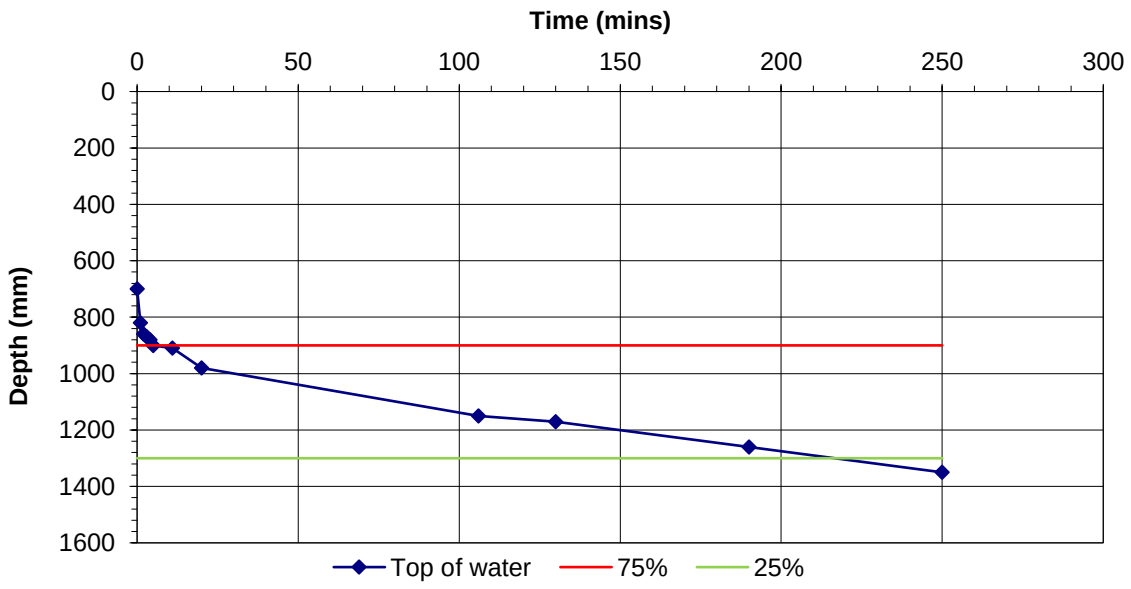
Size of Soakaway		
	Length (m) =	1.50
	Width (m) =	0.60
	Depth (m) =	1.50

Depth at start of test (mm)=	700mm
Depth of trial pit (mm)=	1500mm
75% effective depth (mm)=	900mm
50% effective depth =	1100mm
25% effective depth =	1300mm
Base area of pit (m^2) =	0.900
Effective area of loss 50% (m^2) =	2.580
Volume outflow 75 - 25% (m^3) =	0.360

From the graph:	
tp 75 (min) =	5
tp 25 (min) =	216

Soil infiltration rate, f, (m/s) =	1.10E-05	Normal test

Input by:	DG	Date:	18/10/2019
Checked by:	APC	Date:	23/10/2019



SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007			
Client:	Gleeson Regeneration		
Site:	How Bank Farm, Egremont		
Job No:	C8071	Test No:	SA02 Test A2

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (mm)
0	700
4	850
10	910
21	940
79	1090
120	1160
210	1270
219	1283
230	1300

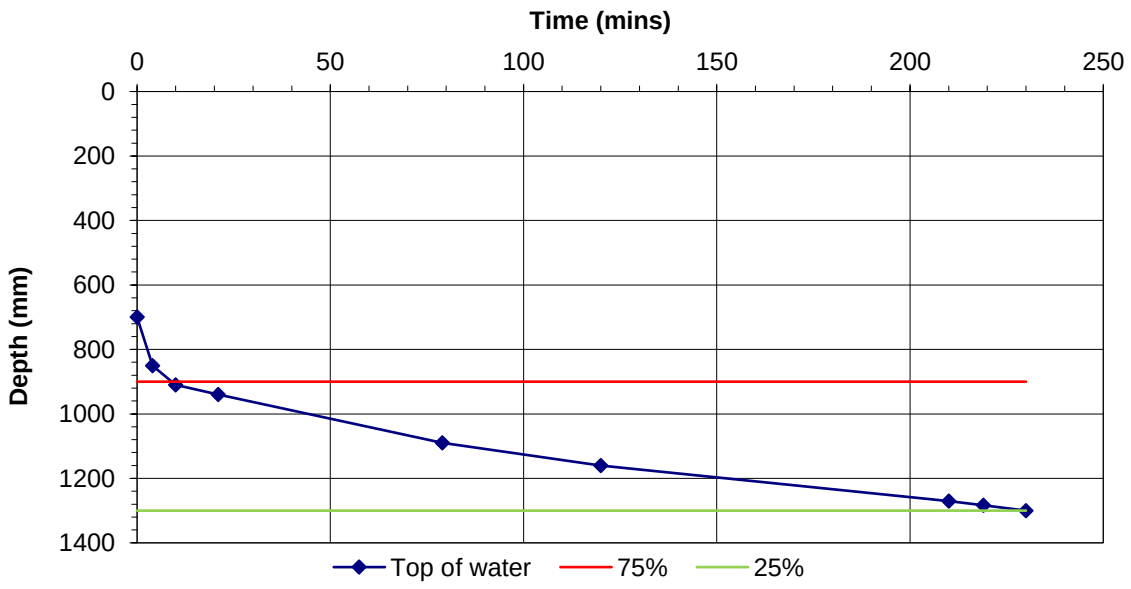
Size of Soakaway		
	Length (m) =	1.50
	Width (m) =	0.60
	Depth (m) =	1.50

Depth at start of test (mm)=	700mm
Depth of trial pit (mm)=	1500mm
75% effective depth (mm)=	900mm
50% effective depth =	1100mm
25% effective depth =	1300mm
Base area of pit (m^2) =	0.900
Effective area of loss 50% (m^2) =	2.580
Volume outflow 75 - 25% (m^3) =	0.360

From the graph:	
tp 75 (min) =	9
tp 25 (min) =	230

Soil infiltration rate, f, (m/s) =	1.05E-05	Normal test

Input by:	DG	Date:	18/10/2019
Checked by:	APC	Date:	23/10/2019



	SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007			
	Client:	**Gleeson Regeneration**		
	Site:	**How Bank Farm, Egremont**		
	Job No:	C8071	**Test No:**	**SA02 Test A3**

CALCULATION OF SOIL INFILTRATION RATE

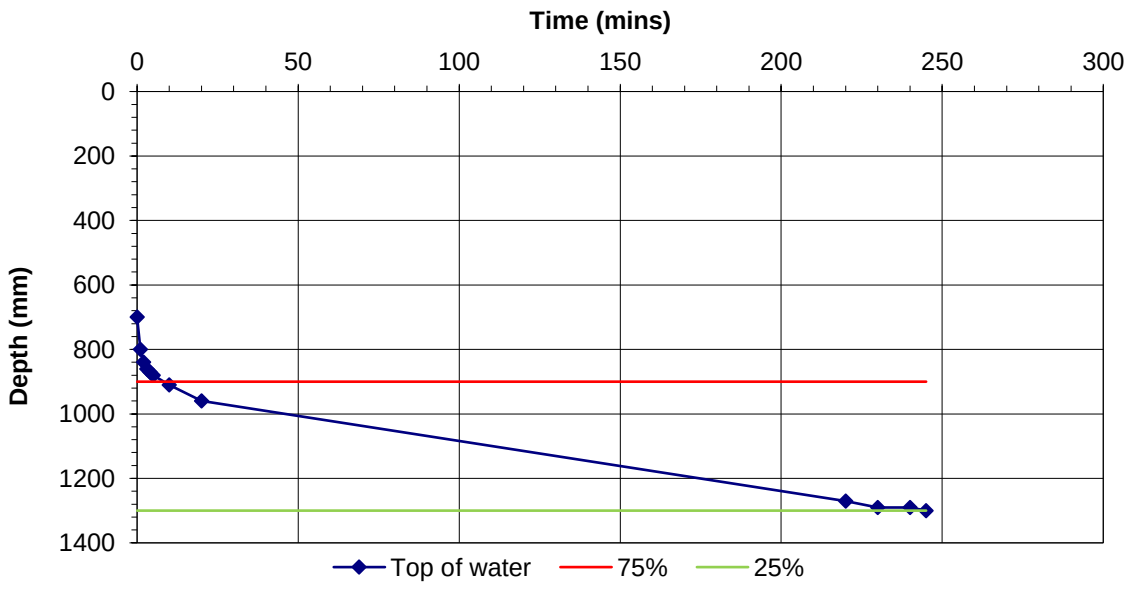
Time (min)	Depth (mm)
0	700
1	800
2	840
3	860
4	870
5	880
10	910
20	960
220	1270
230	1290
240	1290
245	1300

Size of Soakaway	Length (m) =	1.50
	Width (m) =	0.60
	Depth (m) =	1.50

Depth at start of test (mm)=	700mm
Depth of trial pit (mm)=	1500mm
75% effective depth (mm)=	900mm
50% effective depth =	1100mm
25% effective depth =	1300mm
Base area of pit (m^2) =	0.900
Effective area of loss 50% (m^2) =	2.580
Volume outflow 75 - 25% (m^3) =	0.360

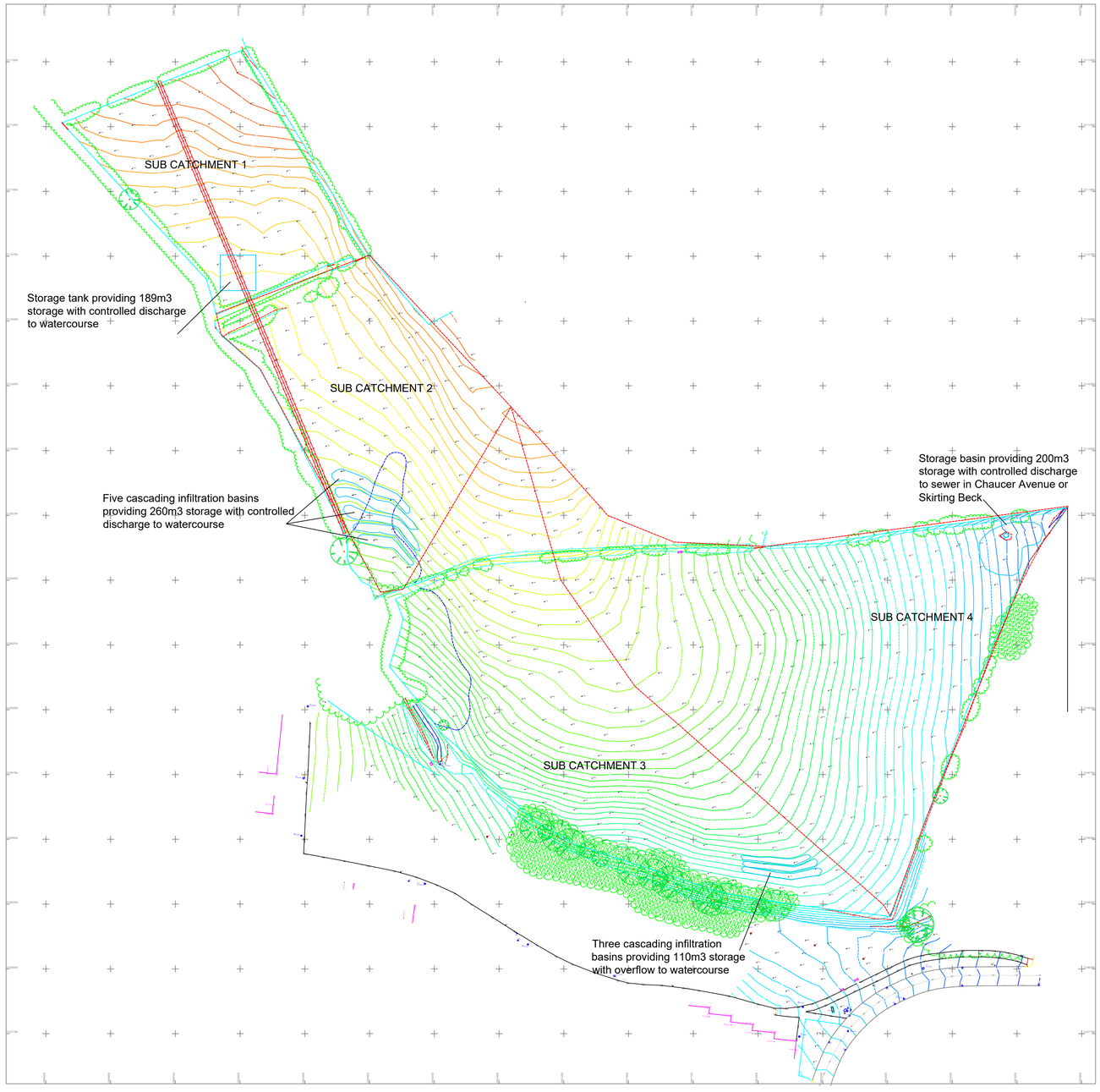
From the graph:	
tp 75 (min) =	9
tp 25 (min) =	239

Soil infiltration rate, f, (m/s) =		**1.01E-05**	**Normal test**
Input by:	**DG**	**Date:**	**19/10/2019**
Checked by:	**APC**	**Date:**	**23/10/2019**



APPENDIX I

Plan of sub-catchments



Notes:

REV:	DESCRIPTION:	BY:	DATE:

STATUS: PRELIMINARY

joc consultants ltd
Park Farm House
Leathley Lane
Leathley
Otley
LS21 2JU

tel/fax: 0113 284 2838

www.jocconsultants.co.uk

CLIENT: GLEESON REGENERATION LTD
5 Europa Court
Sheffield Business Park
Sheffield S9 1EX

ARCHITECT:

SITE: HOW BANK FARM

TITLE: Drainage Strategy Plan

SCALE AT A1:	DATE:	DRAWN:	CHECKED:
1:1000	06-08-2020	JOC	JOC

PROJECT NO:	DRAWING NO:	REVISION:
19-013	19-013-001	-

APPENDIX J

UK SuDS estimates of attenuation storage in sub-catchments

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	John O'Connor
Site name:	How Bank Farm SC1
Site location:	CA22 2HD

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	54.48517° N
Longitude:	3.54319° W
Reference:	10156521
Date:	Sep 23 2022 11:50

Site characteristics

Total site area (ha):	0.611
Significant public open space (ha):	0
Area positively drained (ha):	0.611
Impermeable area (ha):	0.306
Percentage of drained area that is impermeable (%):	50
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.61
Net impermable area for storage volume design (ha):	0.35
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.5
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	70
Rainfall 100 yrs 12 hrs:	--	84
FEH / FSR conversion factor:	1	1
SAAR (mm):	1169	1169
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.38	1.38
Growth curve factor 30 year:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Q_{BAR} for total site area (l/s):	5.37	5.37
Q_{BAR} for net site area (l/s):	5.37	5.37

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	4.7	4.7
1 in 30 years (l/s):	9.1	9.1
1 in 100 year (l/s):	11.2	11.2

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	230	230
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	230	230

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	John O'Connor
Site name:	How Bank Farm SC2
Site location:	CA22 2HD

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	54.48517° N
Longitude:	3.54319° W
Reference:	1741066500
Date:	Sep 23 2022 11:51

Site characteristics

Total site area (ha):	0.743
Significant public open space (ha):	0
Area positively drained (ha):	0.743
Impermeable area (ha):	0.372
Percentage of drained area that is impermeable (%):	50
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.74
Net impermable area for storage volume design (ha):	0.42
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.5
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	70
Rainfall 100 yrs 12 hrs:	--	84
FEH / FSR conversion factor:	1	1
SAAR (mm):	1169	1169
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.38	1.38
Growth curve factor 30 year:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Q_{BAR} for total site area (l/s):	6.54	6.54
Q_{BAR} for net site area (l/s):	6.54	6.54

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	5.7	5.7
1 in 30 years (l/s):	11.1	11.1
1 in 100 year (l/s):	13.6	13.6

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	280	280
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	280	280

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	John O'Connor
Site name:	How Bank Farm SC3
Site location:	CA22 2HD

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	54.48382° N
Longitude:	3.54207° W
Reference:	3765617245
Date:	Sep 26 2022 14:35

Site characteristics

Total site area (ha):	1.26
Significant public open space (ha):	0
Area positively drained (ha):	1.26
Impermeable area (ha):	0.63
Percentage of drained area that is impermeable (%):	50
Impervious area drained via infiltration (ha):	0.63
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.42
Net impermable area for storage volume design (ha):	0.24
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.5
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	60
Rainfall 100 yrs 12 hrs:	--	84
FEH / FSR conversion factor:	1	1
SAAR (mm):	1135	1135
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.38	1.38
Growth curve factor 30 year:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Q_{BAR} for total site area (l/s):	10.71	10.71
Q_{BAR} for net site area (l/s):	3.6	3.6

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	3.1	3.1
1 in 30 years (l/s):	6.1	6.1
1 in 100 year (l/s):	7.5	7.5

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	171	171
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	171	171

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	John O'Connor
Site name:	How Bank Farm SC3
Site location:	CA22 2HD

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	54.48382° N
Longitude:	3.54207° W
Reference:	1255456724
Date:	Sep 26 2022 14:37

Site characteristics

Total site area (ha):	1.65
Significant public open space (ha):	0
Area positively drained (ha):	1.65
Impermeable area (ha):	0.825
Percentage of drained area that is impermeable (%):	50
Impervious area drained via infiltration (ha):	0.825
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.56
Net impermable area for storage volume design (ha):	0.32
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.5
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	60
Rainfall 100 yrs 12 hrs:	--	84
FEH / FSR conversion factor:	1	1
SAAR (mm):	1135	1135
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.38	1.38
Growth curve factor 30 year:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Q_{BAR} for total site area (l/s):	14.02	14.02
Q_{BAR} for net site area (l/s):	4.72	4.72

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	4.1	4.1
1 in 30 years (l/s):	8	8
1 in 100 year (l/s):	9.8	9.8

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	225	225
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	225	225

End of Report