Proposed Transport Distribution Point, Tile Kiln Green, Stansted

Flood Risk Assessment

on behalf of

FKY Ltd

January 2022

INTERMODAL TRANSPORTATION
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1 INTRODUCTION

1.1 Intermodal Transportation Ltd (ITL) has been commissioned by FKY Ltd to prepare a Flood Risk Assessment (FRA) report in support of a planning application for a sui-generis 'just in time' transport distribution / transfer point on land to the west of Tilekiln Green near Stansted Airport. The site development area is approximately 5.1 hectares in total.

1.2 The site falls within the jurisdiction of Uttlesford District Council (TDC) as the Local Planning Authority (LPA). The planning application is in outline with all matters reserved except access.

1.3 An earlier application (reference: UTT/21/0332/FUL) for a similar proposal was refused planning permission by Uttlesford District Council (UDC). However, the reasons for refusal for that application did not include drainage related reasons. Furthermore, ITL would confirm that the Lead Local Flood Authority (LLFA), Essex County Council (ECC) did not object to the earlier proposal.

1.4 The vast majority of the development site is located in a Flood Zone 1 area in terms of potential flood risk, which is the lowest classification. Therefore, the site is not predicted to be subject to fluvial (river based) or coastal flooding for a 1 in 1000 year or more frequent storm event. However, a very small part of the south west corner is identified as being in Flood Zone 3, at a higher risk due to its proximity to the Main River, Great Hallingbury Brook, running along the west of the site. Consequentially, no development is proposed in this area. This FRA considers the risks to flooding on the site and downstream as well as including a drainage strategy which outlines the design philosophy for the management of surface water and disposal of foul effluent that would arise from the site, if the proposed development is permitted by the LPA.

1.5 Under the Flood and Water Management Act 2010, the Lead Local Flood Authority (LLFA) is Essex County Council (ECC). Where possible, Sustainable Drainage Systems (SuDS) mechanisms are the preferred methods to minimise the run off to existing public sewers or watercourses and would be used for this development. The Environment Agency (EA) has not been approached as the proposed development at the site would be entirely located within a low flood risk area (Flood Zone 1) and, it is expected that the EA would not have a particular concern in regards to this application.

1.6 In producing the FRA for the earlier application, representatives of ITL visited the site. A walk over survey was undertaken, by ITL staff, on 14th May 2019 to gain a better understanding of how the site naturally drains at present. A topographical survey was undertaken by Laser Surveys Ltd in January 2016. ITL obtained sewer records from Thames Water to ascertain the existing sewer infrastructure in the vicinity of the site and to establish whether there are options to drain to any existing public sewer systems.

1.7 The proposed development would be situated on a field, and for the purposes of this assessment the site is to be regarded as entirely 'greenfield'. Vehicular access would be taken from Tilekiln Green to the east.

1.8 Revised National Planning Policy Framework (NPPF) was published in July 2021, updating the earlier NPPF of June 2019. This framework document supersedes many planning policy guidance documents including PPS25, which covered land drainage matters. The NPPF sets out the Government's planning policies and, like its predecessor documents, provides guidance for local planning authorities when considering suitable sites for appropriate development in preparing development plans. The NPPF places a greater presumption in favour of sustainable development.

1.9 The technical guidance to NPPF, Flood Risk Section, classifies commercial property as 'Less Vulnerable' in terms of Flood Risk Vulnerability Classification (Table 2). NPPF also defines that developments classified as 'Less Vulnerable' are appropriate in Flood Zone 1 (Table 3 Flood Risk Vulnerability and Flood Zone Compatibility).

1.10 The flood risk assessment for planning applications guidance section of the Gov.uk website advises that developments in excess of one hectare require a site-specific FRA. Therefore, as the total site area is approximately 5.1 hectares, an FRA report is required. This FRA and integral drainage strategy report therefore addresses issues relating to flooding as well as the surface water and foul drainage management arising from the proposed development of the site.

Plate 1.1 Existing, looking north from eastern side of site

2 SITE LOCATION AND EXISTING CONDITIONS

Site Location

2.1 The site is located about 1km (0.62 miles) to the east of the town of Bishop's Stortford. The centre of the site is approximately 1km southwest (as the crows flies) of London Stansted Airport.

2.2 The site is located directly south of the B1256 (former A120) just east of M11 Junction 8. The site is bounded to the north by the B1256 and M11 Junction 8 and to the east by Tilekiln Green. To the south the site is bounded by a ditch and disused railway line, which is also part of the Flitch Way pedestrian / cyclist route. The site's western boundary is formed by the Great Hallingbury Brook at the southern end and a green area to the north with agricultural fields and the M11 beyond.

2.3 The nearest watercourse to the proposed development on the site is a ditch running along the southern boundary, separating the site from the disused railway line and residential dwellings to the west of Tilekiln Green. The Strategic Flood Risk Assessment for Uttlesford District identifies this ditch as an Ordinary Watercourse and the topographical survey shows that this ditch discharges into Great Hallingbury Brook, which runs southwards to the west of the site. Great Hallingbury Brook joins the River Stort to the south of Bishops Stortford, which in turn joins the River Lea near Hoddesdon about 17.5km south west of the site. The River Lea joins the River Thames in east London. Great Hallingbury Brook, the Rivers Stort, Lea and Thames are classified as Main River by the EA.

2.4 Bishop's Stortford is a small to medium sized town in East Hertfordshire District, located about 2km from the south-west edge of the Stansted Airport. The site location in the local and wider context is shown on Drawing **IT1896/FRA/001** included with this report.

Plate 2.1 Existing, looking west from eastern side of site

Existing Conditions

2.5 The development areas of the site, within the larger site boundary, amounts to approximately 3.1 hectares on what is currently rough grassland, shrub and woodland. The site sits within a single field. Watercourses bound the site on the southern and southern part of the western side and public roads the northern and eastern side. A private vehicular access to a foul water pumping station abuts the south eastern corner of the site. Plate 2.1 shows a general view of the current conditions on site.

2.6 The site walkover survey on 14th May 2019 confirmed the information shown on the topographical survey, in that the existing field generally falls from northeast to southwest. Inspection of the topographical survey indicates that the lowest point of the field within the site is in the south western corner at approximately 73.5m AOD (Above Ordinance Datum). The highest point is towards the north eastern corner of the site, adjacent to Tilekiln Green at 85.0m AOD. The site has a typical gradient of between 1 in 20 and 1 in 30 from northwest to southeast. A copy of the topographical survey is provided in **Appendix A**.

Plate 2.2 Existing ditch in south western corner of site looking west

2.7 The topographical survey identifies that there is a ditch along the southern boundary of the site. Most of the ditch appears to be about 700-800mm in depth, increasing to about 1.5m below the adjacent ground at its eastern end. The survey also identified that the base of Great Hallingbury Brook to the west was between 1.0m and 1.9m below the adjacent ground and that the middle section was heavily vegetated, something the site visit verified.

Plate 2.3 Existing, Great Hallingfordbury Brook looking north from western edge of site

2.8 Infiltration testing was undertaken by Stansted Environment Services in May 2019. Testing found that the site was underlain by impermeable London Clay, therefore that infiltration measures would be unsuitable for disposal of surface water at both higher and deeper levels. A summary of the testing results is provided in **Appendix B**.

2.9 The Thames Water Services Ltd (TWS) sewer records obtained indicate the presence of a public foul water sewer in Tilekiln Green to the east of the site. The records identify that this sewer runs from south to north near the eastern side of the site and discharges to a pumping station located adjacent to the site boundary. The records state that Man Hole (MH) number 831A, located east of the pumping station in Tilekiln Green, has a cover level of 77.325m and an invert level of 74.200m AOD. No public surface water sewers are shown on the TWS records. An extract from the TWS sewer records is provided in **Appendix C**.

Plate 2.4 Foul water pumping station adjacent to eastern side of site, looking south east

3 POLICY AND GUIDANCE

National Planning Policy Framework (July 2021)

3.1 The latest revision to the National Planning Policy Framework (NPPF) was published in July 2021. The framework sets out the Government's planning policies for England and how the framework objectives are expected to be applied. The NPPF provides guidance for local planning authorities when preparing development plans and clarifies that there should be a presumption in favour of sustainable development. The NPPF does not propose anything dramatically new in terms of its responsibilities from the preceding PPS 25 guidance where the key principles to be applied by Authorities should:

- include Strategic Flood Risk Assessments as part of the LDF process and include policies to manage flood risk from all sources with wide consultation with all relevant bodies. LPA's should apply a sequential approach to the location of development.
- take climatic change into account and avoid increased vulnerability to ensure that risks can be managed where necessary;
- inappropriate development should be avoided in areas at risk of flooding by directing development away from areas at highest risk; where development is necessary it should be made safe without increasing flood risk elsewhere;

3.2 The NPPF requires site-specific FRAs, application of the Sequential Test where this has not been undertaken and, for sites that are vulnerable, possible application of the Exception Test.

Planning Policy Statement 25 'Development and Flood Risk' (March 2010)

3.3 The last issue of PPS 25 (March 2010) has now been superseded by the NPPF. However, many of the requirements of PPS 25 have been carried forward within the Technical Guidance to the NPPF, but with an emphasis for LPA's to ensure, as far as they are able, that appropriate SuDS mechanisms are required as part of development and, in many cases, for the LPA's to maintain adoptable SuDs systems.

3.4 The Development and Flood Risk Practice Guide (December 2009) provided advice on the practical implementation of PPS 25, and provides additional guidance on what is required at regional and local level. The document is still very relevant given that the NPPF is a more holistic document. The guidance is more helpful in considering regional spatial strategies, sustainability appraisals and local development documents and the roles and responsibilities for those managing individual planning applications. It also gives additional guidance on the importance of regional and strategic FRAs; the application of the sequential approach and Sequential and Exception Tests; surface water management and implementing sustainable drainage and measures to reduce flood risk.

3.5 Whilst the Environment Agency has the lead role in providing advice on flood issues, at a strategic level and in relation to planning applications, the LPA's have a duty to ensure that 'precautionary principles' in relation to flood risk and the location of vulnerable development are adopted, first using a risk based site search sequential review to avoid any risk of fluvial or sea flooding where possible and managing residual (perhaps pluvial) risks elsewhere.

Flood and Water Management Act, 2010

3.6 The FWMA now places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues. The Act, and supporting Regulations, together bestows more responsibility onto LPA's by requiring Authorities to:

- Develop Local Flood Risk Management Strategies (LFRMS);
- Implementing requirements of Flood and Water Management legislation;
- Preparation of preliminary flood risk assessments and flood risk management plans;
- Development and implementation of drainage and flooding management strategies; and
- Taking responsibility for approving, adopting, managing and maintaining Sustainable Drainage System (SuDS) where they serve more than one property.

3.7 The FWMA makes provision for a national standard to be prepared on SuDS, and developers will be required to obtain local authority approval for SuDS in accordance with the standards; this may be covered by appropriate conditions which would need to be discharged. Supporting this, the Act requires local authorities to adopt and maintain SuDS, removing any on-going responsibility for developers to maintain SuDS.

3.8 ITL are aware that some Local Authorities have not yet taken on the responsibility to maintain SuDS systems due to differences in opinion between the LLFA and the Highway Authority in terms of maintenance liabilities.

Sewers for Adoption / Design and Construction Guide for Developers (April 2020)

3.9 Detailed design of proposed adoptable sewers should be in accordance with the above documents and the LLFA's design requirement (where feasible and viable) which are the definitive guides for those planning and designing sewers (both surface water and foul water) for subsequent adoption by the relevant water authority. This guidance provides best practice on planning, design, construction and operation of sewers, and their maintenance. The standards do not apply to private systems although the principles of the design requirements would generally be respected to ensure efficient performance of the systems from source to the identified discharge point from the site.

SuDS Design Guide, Report C753, CIRIA 2015

3.10 This detailed document provides guidance on the planning, design, construction and maintenance of Sustainable Drainage Systems (SuDS). The guide considers the benefits of managing water quality as well as quantity, amenity and biodiversity in new and existing developments. It presents a wide collection of good practice guidance from the UK and abroad to illustrate options and ideas.

Essex County Council Sustainable Drainage Design Guide (February 2020)

3.11 Essex County Council have published a document to set out the approach they would like to see in relation to surface water drainage design based on sustainable urban drainage principles. This document refers heavily on national and other guidance, including that noted above.

Uttlesford District Council Strategic Flood Risk Assessment, JBA Consulting (May 2016)

3.12 Uttlesford District Council commissioned JBA Consulting to produce a strategic assessment of historic and possible future flood risks across the district. This document aims to guide development to suitably consider flood risk by sharing the information gathered about the district.

4 THE PROPOSED DEVELOPMENT

4.1 The development proposal consists of a planning application to create an open logistics facility with associated new access, parking areas and ancillary office and amenity facilities. In essence, most of the site would be turned over to hard standing areas to park vehicles to enable transhipment. A small welfare unit / office is proposed which is understood to consist of a temporary building placed on the hardstanding. Vehicular and pedestrian access to the application site would be achieved via a new priority junction with Tilekiln Green.

4.2 A certain amount of ground remodelling is proposed to create flatter vehicle parking areas with steeper banks around their edges to effectively terrace the site. Outside of the main development area in the centre of the larger site it is understood a large number of trees are to be retained and ground levels kept as they are now. Drawing IT1896/FRA/002 B indicates the proposed development and shows the areas of existing landscape to be retained.

4.3 The development area within the site is about 3.1ha. The impermeable areas have been measured to be 2.07ha, which represents just over two thirds of the development area, with other areas generally being given over to earthworks required to achieve level hard standings. This 2.07ha area has been used to calculate the greenfield runoff rates in the Micro Drainage computer program. The results have been summarised in **Table 4.1** below. See **Appendix D** for the Micro Drainage printout of the greenfield runoff calculations.

Table 4.1 Greenfield Runoff Calculations

Event	Flow (l/s) for 2.07ha
Q_1 (1 in 1 year)	2.7
Q_{30} (1 in 1 year)	7.2
Q_{100} (1 in 1 year)	10.1

4.4 The CIRIA guidance suggests that an allowance is made for increases to the buildings within a development to account for future increases in impermeable area for building extensions for example. However, with no permanent building proposed, and the impermeable hard standing areas accounting for the useable surface within the development area, no additional allowance for urban creep has been assigned.

5 DRAINAGE STRATEGY

Surface Water Drainage

5.1 The hierarchy of disposal methods identifies that discharge to the ground is the first choice, followed by discharge to a watercourse and then to a sewer as the third choice. The soakage testing has identified that the underlaying ground is basically impermeable, therefore it would be expected that there would be very limited scope for infiltration methods for the disposal of surface water.

5.2 The drainage strategy presented here focuses on the collection of surface water from the impermeable areas of the site, before attenuating them prior to discharge to the ditch located at the southern edge of the site. With the existing ground sloping towards this watercourse, it is suggested that this would mimic the existing greenfield conditions in an extreme storm event if the ground were inundated. As a result, the drainage strategy focuses on the collection of water in channels, gullies and/or linear drainage systems, positively directing it to an attenuation device at the lower, south western corner of the site, after which a new conduit would direct the water at a controlled rate to the existing ordinary watercourse.

5.3 With much of the development site given over to impermeable hard standings, and green areas steeply sloping to provide banks between the flatter paved areas, there are limited opportunities for surface level Sustainable Drainage Systems (SuDS). Therefore, underground cellular storage is proposed to be provided underneath the lower paved parking area. A supplementary smaller underground storage area is also proposed near the head of the principal run modelled to hold some water closer to source, in order to allow a reduction in the size of drainage pipes required to deal with intense short duration storms.

5.4 The potential to utilise permeable paving was also explored, however with poor infiltration rates and a notable gradient across the site, it would not offer infiltration to ground or significant storage opportunities. Permeable paving has therefore not been included within the drainage strategy.

5.5 The 1 in 1 year greenfield runoff rate for the impermeable area of 2.07ha was calculated in Micro Drainage as 2.7l/s. To store the surface water generated up to and including a 1 in 100 year storm with a 40% allowance for climate change for this 2.07ha area, limiting discharge to the 1 in 1 year greenfield runoff rate, Micro Drainage calculated that approximately 1,720m^3 of storage would be required in an attenuation device, in addition to that stored in the system itself. A cellular crate system is specified to attenuate this volume of runoff because it offers 95% voids and is therefore more efficient that other types of underground storage devices.

5.6 A vortex type flow control device such as a 'Hydro Brake' is proposed between the attenuation device and the outfall into the watercourse to limit the discharge rate in accordance with the calculated greenfield runoff rate. A Hydro Brake device was selected as they are less prone to blockages than orifice type devices at low flows, such as the 2.7 l/s specified in this case.

5.7 The Micro Drainage calculations have identified that the 2,880 minute duration winter storm is the critical storm event, with approximately 1,722m^3 stored in the main cellular structure for the 1 in 100 + 40% storm. Micro Drainage calculations for the 2,160 minute and 4,320 minute events have also been supplied to demonstrate that the storage volume requirement associated with the 2,160 minute storm is the largest, and therefore that this is the critical event. Micro Drainage calculations also indicate that the maximum storage in the cellular structure would be 320m^3 and 1300m^3 in the 1 in 1 and 1 in 30 year storms respectively. The 960 and 2880 minute winter storms were the critical events respectively.

5.8 Given that the outflow from the system is relatively low, and therefore that the attenuation device would not be able to 'half empty' within 24 hours of the peak of the critical storm, a short exercise was undertaken to calculate if the system would be able to accommodate a 1 in 10 year storm after the main critical event. Reviewing the results for the critical 1 in 100 year + 40% 2,880 minute winter storm after 24 hours of the peak, the volume retained would be approximately 170m^3 less than the peak. The structure has been sized to have a total storage of 2,216m^3, of which approximately 664m^3 would be available 24 hours after the peak of the critical storm. The Micro Drainage calculations estimated that the 1 in 10 year storm would need about 650m^3 storage in a 1,440 minute storm. As this 650m^3 figure is less than that available in the structure, the system should be able to accommodate a 1 in 10 year storm following the critical 1 in 100 year +40% storm after 24 hours.

5.9 As the storage is proposed to be situated underground there would not be health and safety risks with people using the site. Suitable training would be required for any persons needing to maintain the structure, which should generally be carried out from the surface wherever possible and only entering manholes as the last resort.

5.10 It is considered that the above strategy would provide betterment over the existing situation for all storms above a 1 in 1 year event. Surface water would be stored in the attenuation device as opposed to discharging directly into the watercourse.

5.11 In exceedance events, above the 1 in 100 year + climate change storm, surface water would be directed along the internal paved areas towards the existing watercourse, mimicking the existing greenfield arrangements. Suitable detailing around the proposed temporary buildings would ensure that surface water would be directed around the buildings rather than towards thresholds for example.

5.12 **Appendix E** contains Micro Drainage calculations and Drawing **IT1896/FRA/002 B** illustrates the drainage strategy. The calculations included in Appendix E are based on the previous planning application's impermeable area of 2.09ha and the reduction in impermeable area to 2.07ha means that the calculations are slightly conservative. However, at this stage the drainage concept would not be affected by changing the area in the calculations.

Construction

5.13 It is anticipated that the storage structures and drainage system would be built as one of the first activities on site and therefore they would be available for attenuating the surface water generated during construction. As construction activities may generate higher levels of silt than ongoing operation, it is recommended that an inspection regime with increased frequency would be required and that all systems are thoroughly checked and cleaned as necessary at the end of the construction phase.

Maintenance

5.14 It is envisaged that the surface water system would be maintained by an on-site management company, paid for by the occupier.

Table 5.1 Maintenance Schedule

Item	Plan of Action	Frequency
Vortex Flow Control Devices	Check for blockages	After initial establishment period, at least every 6 months and after any particularly severe storms
Catchpits and gully sumps	Remove silt from sumps	At least every six months
Below ground surface water systems	To be monitored and cleaned up when any debris/ silt reduces the cross-sectional area by 25% or more. Inspection to include both manhole inspections and silt trap/ gullies outlets.	Bi-annual Inspection

5.15 Suitable routes for maintenance workers and vehicles should be provided to the various features from the internal hard standing areas.

Water Quality

5.16 The measures described above may have a degree of cleansing effect on the water passing through them, with sumps in gullies and catchpits removing silt and other suspended solids for example. It is recommended that catchpits are installed on pipes leading to the attenuation devices to enable silt to settle out in these, where access is easier than in the cellular storage structure itself. Catchpit manholes would also enable access for CCTV inspection and jetting of the cellular structure too.

5.17 Consulting the CIRIA SuDS Manual 2015 **Table 26.2** gives pollution hazard indices for different land use classifications. An extract of the table is reproduced in **Table 5.2** below:

Table 5.2 Extract of CIRIA SuDS Manual 2015 Table 26.2 on Predicted Pollution Levels

Land Use	Pollution hazard level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Sites with heavy pollution such as lorry parks	High	0.8	0.8	0.9

5.18 Given that the system would only provide a limited degree of water cleansing it is proposed that a proprietary system is installed prior to discharge to the watercourse to attend to any pollution arising from the development. SDS's Aqua-Filter has been tested against the pollution types in Table 5.2 above and the literature advises that it is able to cleanse water to these levels. **Appendix F** contains details of the Aqua-Filter device. Alternative devices are available and could be used, if they meet the cleansing levels set out in the Table 5.2.

5.19 The preliminary drainage design that has been undertaken for the proposed development and is illustrated on Drawing **IT1896/FRA/002 B**. The Micro Drainage results for the design illustrate that for storms up to the 1 in 100 year event (including 40% climate change) the surface water from the developed area of the site should be managed on the site to ensure no surface flooding occurs or creates safety hazards.

Foul Drainage

5.20 TWU records indicate that there is a foul water pumping station adjacent to the eastern corner of the site. The local foul water network gravitates north along Tilekiln Green to the pumping station and is then pumped along a rising main south under Tilekiln Green. The records indicate that the invert of the sewer in Tilekiln Green to the east of the pumping station is 74.2m AOD. Given that this is less than the proposed site levels, it should be possible to provide a gravity connection from the temporary building proposed on the site, containing toilets and any other welfare facilities, to the sewer under Tilekiln Green. Sewer connections should not be flatter than 1:80 to accord with Building Regulations if one or more WC is connected, or no flatter than 1:40 if no WC is connected.

Approvals

5.21 TWU agreement would be required for any connections to their existing FW sewers Under Section 106 of the Water Industry Act 1991. If any sewers are to be offered up for adoption these would be made under a Section 104 agreement of the same Act. Both the S106 and S104 applications should be made direct to TWU and would attract fees. Suitable time should be allowed in advance of construction to allow the applications to be determined.

5.22 Any connections to the existing Highway drainage systems in Tilekiln Green for draining the new access bellmouth / realigned carriageway would need the Highway Authority's approval. It is likely that they would not have records of the existing systems, therefore surveys of their location and condition may be requested.

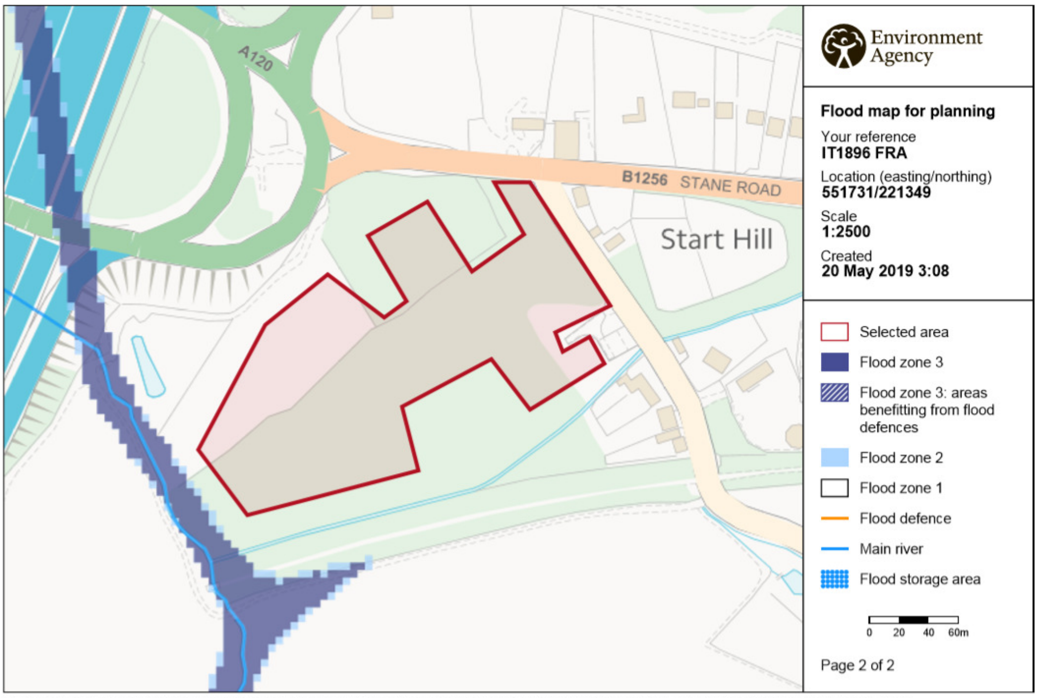
5.23 The LLFA are likely to ask the LPA to impose a condition relating to the management of the surface water on site. Any connection to an Ordinary Watercourse or works within 8m of such, would need Flood Drainage Consent (previously known as Land Drainage Consent).

6 RISK APPRAISAL

Flood Risk

6.1 The proposed development is situated in the lowest flood risk area, Flood Zone 1, with a very low risk of fluvial (river based) flooding. The extent of the flood contour is shown on the Gov.uk Flood Planning Service published web site, an extract of which is provided in **Figure 6.1** below, and shows the potential of fluvial flooding. Whilst the extreme south-western corner of the application site lies within Flood Zone 3 for the Great Hallingbury Brook, development is not proposed in this corner of the site and the relative elevations would ensure that the developed part of the site would not be flooded even for the most extreme event. Therefore, there is little risk to the development, or the future occupants, arising from fluvial flooding for any storm up to and including a 1 in 1000 year storm event.

Figure 6.1 Fluvial Flood Risk Zones from Gov.uk mapping

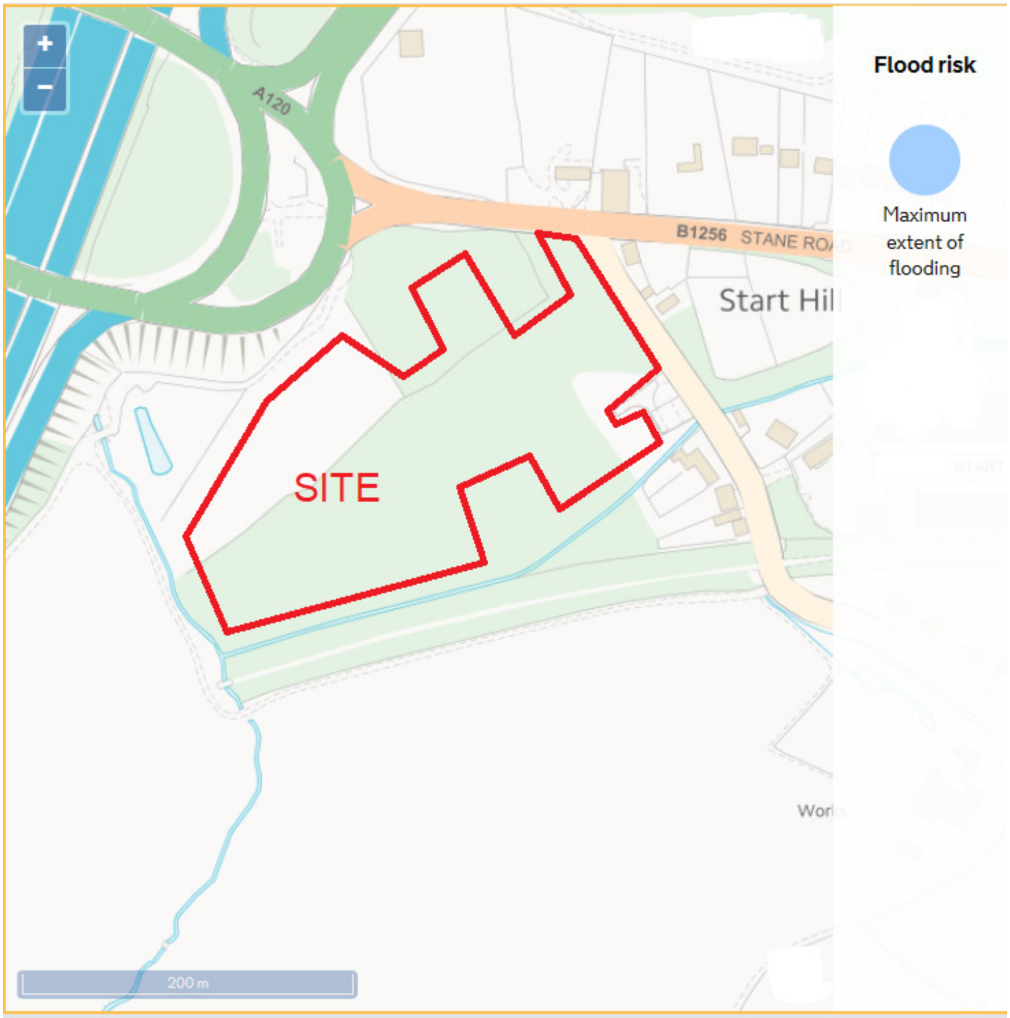


6.2 The Gov.uk maps also give an indication of surface water flood risk. The relevant plan indicates that an area of the south west corner of the site and a much smaller eastern portion of the site is at elevated surface water flood risk, due its lower lying nature adjacent to existing watercourses. **Figure 6.2**, overleaf is an extract from the Gov.uk surface water flood map. The remainder of the site is at very low surface water flood risk. With the proposed terracing within the site, the south western part of the development site would have its levels raised and therefore the surface flood risk would be considered to be suitably ameliorated.

Figure 6.2 Surface Water Flood Risk Zone from Gov.uk mapping

6.3 The Gov.uk maps identify that the site is not at risk of flooding from a reservoir. **Figure 6.3**, overleaf, is an extract from the Gov.uk reservoir water flood map.

Figure 6.3 Reservoir Flood Risk Zone from Gov.uk mapping



6.4 Consulting the Natural England 'Magic' mapping, the site is not in a Groundwater Source Protection Zone.

6.5 The Strategic Flood Risk Assessment (SFRA) for Uttlesford District Council, prepared by JBA Consulting in May 2016, has not identified that site's area itself has experienced historic flooding. The SFRA indicates that the risk of groundwater flooding across the District is low. Furthermore, with impermeable clay underlaying the site, the risk from this source of flooding locally is also assessed to be low. With no surface or foul water sewers under the site, these do not pose a flood risk either. The site is inland and on high ground, therefore there is no risk from sea flooding.

6.6 The NPPF emphasises that development should be located in the least vulnerable places and that Local Plans should look to the Strategic Flood Risk Assessments (SFRA) to inform the process and help with the sequential test. Clearly, the site would be unlikely to suffer from fluvial flooding even for a 1 in 1000 year event. Commercial development is considered to be 'less vulnerable' to flood risk as set out in Table 2 of the NPPF. However, the subsequent section of the NPPF considers that this combination of vulnerability and lowest risk, being in Flood Zone 1, is acceptable as set out in Table 3. Therefore, in planning policy terms, it can be asserted that the site would be compliant with national policy and local policies in terms of its location from a flood risk perspective.

6.7 As the proposed development is not at risk from fluvial or pluvial flooding, the main purpose of this assessment is to consider the management of surface water run-off and to ensure that the impact of the development does not affect downstream interests and / or properties. The drainage strategy set out in the previous chapter and shown on Drawing **IT1896/FRA/002 B** illustrates how, with conservative design, the surface water would be managed on site to prevent flooding within or downstream of the site in storms of up to and including the 1 in 100 year event with a 40% allowance for climate change.

6.8 Based upon the review and conceptual drainage strategy the risk of flooding either on site or downstream of the site would be negligible.

7 CONCLUSIONS

7.1 Intermodal Transportation Ltd (ITL) has been commissioned by FKY Ltd to prepare a Flood Risk Assessment (FRA) report in support of planning application for a sui-generis 'just in time' transport distribution / transfer point on land to the west of Tilekiln Green near Stansted Airport. The total site area is approximately 5.1 hectares, and is currently entirely undeveloped 'greenfield'.

7.2 This report considers the flood risk issues arising from the proposals for the development on land to the west of Tilekiln Green. In this report the requirements of the guidance embodied within the NPPF Framework have been considered.

7.3 An earlier application (reference: UTT/21/0332/FUL) for a similar proposal was refused planning permission by Uttlesford District Council (UDC). However, the reasons for refusal for that application did not include drainage related reasons. Furthermore, ITL would confirm that the Lead Local Flood Authority (LLFA), Essex County Council (ECC) did not object to the earlier proposal.

7.4 The proposals indicate that 2.07ha would be converted to impermeable surfaces. Soakage testing has indicated that the ground would be unsuitable for soakaways or permeable paving that infiltrates to ground due to the very low infiltration rates present in the clay subsoil. On this basis a positive discharge to the adjacent watercourse on the southern side of the site is proposed. With the field sloping towards this watercourse, it is suggested that this would mimic the existing greenfield conditions in an extreme storm event if the ground were inundated.

7.5 The drainage strategy focuses on the collection of water, positively directing it to a cellular, underground, attenuation device at the lower, south-western corner of the site, after which a new conduit would direct the water at a controlled rate to the existing ordinary watercourse. A supplementary smaller underground storage area is also proposed near the head of the principal run modelled to hold some water closer to source and was allow a reduction in the size of pipes required to deal with intense short duration storms.

7.6 The main attenuation device has been sized to store 2,216m^3. The principal network has been modelled in Micro Drainage to test that it can limit discharge off site to no more than the 1 in 1 year greenfield runoff rate of 2.7l/s in the critical 1 in 100 year + 40% climate change storm, without causing flooding on or off the site. In this case the critical storm is the 2,880 minute winter event. The system has also been tested to check that it can also accommodate a 1 in 10 year storm 24 hours after the peak of the critical storm. The calculations estimate that there would be a small amount of spare capacity in the attenuation device, therefore the system is suitably sized to deal with water generated on site, without being overdesigned.

7.7 As the collection and storage methods would not contribute much towards water quality improvements, a propriety treatment unit is proposed close to the outfall to deal with any on site pollution.

7.8 It is considered that the above strategy would provide betterment over the existing situation for all storms above a 1 in 1 year event. Surface water would be stored in the attenuation device as opposed to discharging directly into the watercourse.

7.9 Thames Water Utilities Ltd (TWU) records indicate that there is a possible point of connection onto the existing public Foul Water (FW) sewer network in Tilekiln Green to the east of the site. Given the ground and sewer levels, a gravity connection should be possible from the proposed temporary buildings provided minimum gradients in accordance with the appropriate Building Regulation are respected.

7.10 TWU consent would be required for any connections to their existing FW sewers Under Section 106 of the Water Industry Act 1991. If any sewers are to be offered up for adoption these would be made under a Section 104 agreement of the same Act. Both the S106 and S104 applications should be made direct to TWU and would attract fees. Suitable time should be allowed in advance of construction to allow the applications to be determined.

7.11 Any connections to the existing Highway drainage systems in Tilekiln Green for draining the new access bellmouth / realigned carriageway would need the Highway Authority's approval. It is likely that they would not have records of the existing systems, therefore surveys of their location and condition may be requested.

7.12 The LLFA are likely to ask the LPA to impose a condition relating to the management of the surface water on site. Any connection to an Ordinary Watercourse or works within 8m of such, would need Flood Drainage Consent (previously known as Land Drainage Consent).

7.13 The development part of the site is in the lowest flood risk area, Flood Zone 1, with a very low risk of fluvial (river based) flooding. The Gov.uk mapping identifies that most of the site has very low surface water flood risk. However, lower lying south western area close to the ditch, and eastern corner of the site have a slightly elevated risk. These areas are proposed to be lifted to suit the new layout, which would reduce this risk.

Therefore, there is little risk to the development, or the future occupants, arising from fluvial or surface water flooding for any storm up to and including a 1 in 1000 year storm event.

7.14 The Gov.uk maps identify that the site is not at risk of flooding from a reservoir. The SFRA indicates that the risk of groundwater flooding across the District is low, and underlaid by impermeable clay the local risk from this source is considered low also. The site is situated inland and on high ground, therefore the risk of flooding from the sea is very low. With no sewers under the site, these do not pose a flood risk either. The SFRA has not identified any historic flooding in the vicinity of the site.

7.15 It is therefore concluded that the site would be at very low risk of future flooding and in planning policy terms it can be asserted that the site would be compliant with national policy and local policies in terms of its location from a flood risk perspective.

7.16 A considerable amount of drainage assessment has been carried out to demonstrate that the site is suitable for commercial development in drainage terms, based upon reasonable assumptions. It is expected that further detailed modelling work would be required at the post-planning consent stage, but it can be confidently stated that a drainage scheme could be developed that would not create any surface flooding for the worst case 1 in 100 year + 40% climate change probability event and is sustainable, as far as practical, for this site.

7.17 Hence, it can be concluded that there would be no flood risk affecting property or the welfare of workers and visitors arising from the development of the site and that surface water discharge from the development can be adequately managed to ensure no additional risk of flooding both on site and off site, even under extreme conditions.

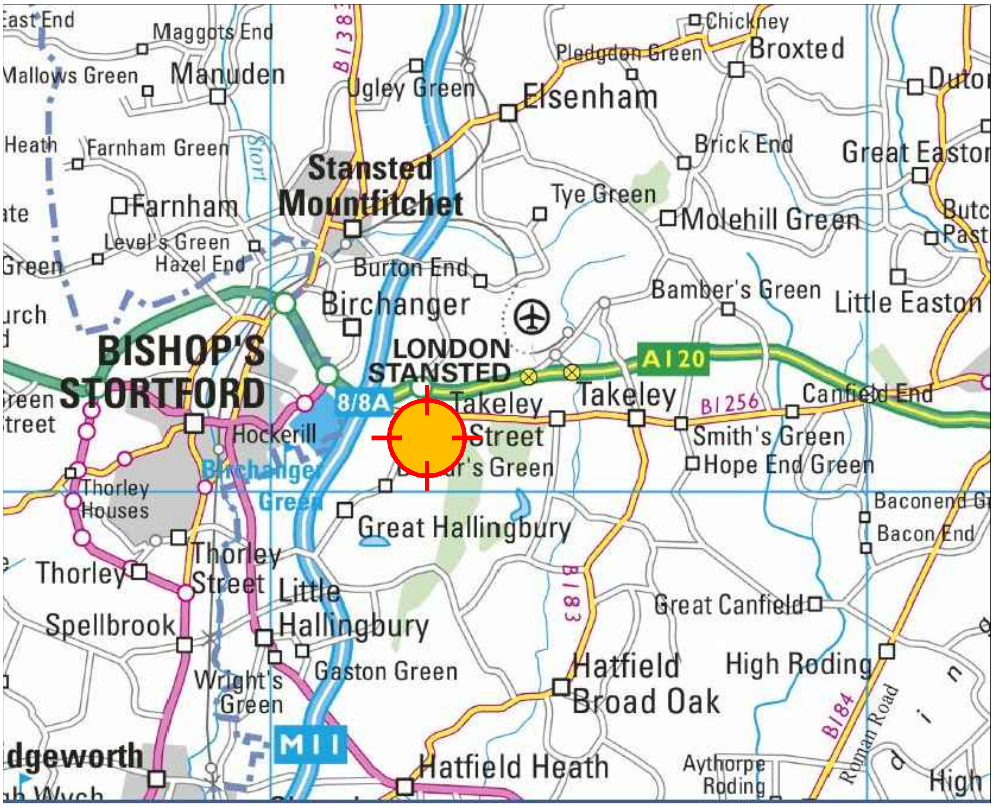
7.18 Sufficient details have been provided to satisfy the requirements of the policy guidance and, with the imposition of a suitable planning condition, the Local Lead Flood Authority and Water Authority's interests can be protected pending final detailed design and subsequent discharge of planning conditions.

7.19 It is therefore concluded that the development site is not at risk to fluvial or pluvial flooding and the development proposal is able to be drained sufficiently to retain the greenfield runoff rate of the existing field. It is therefore considered that from a critical drainage perspective the development proposal should not be denied planning consent.

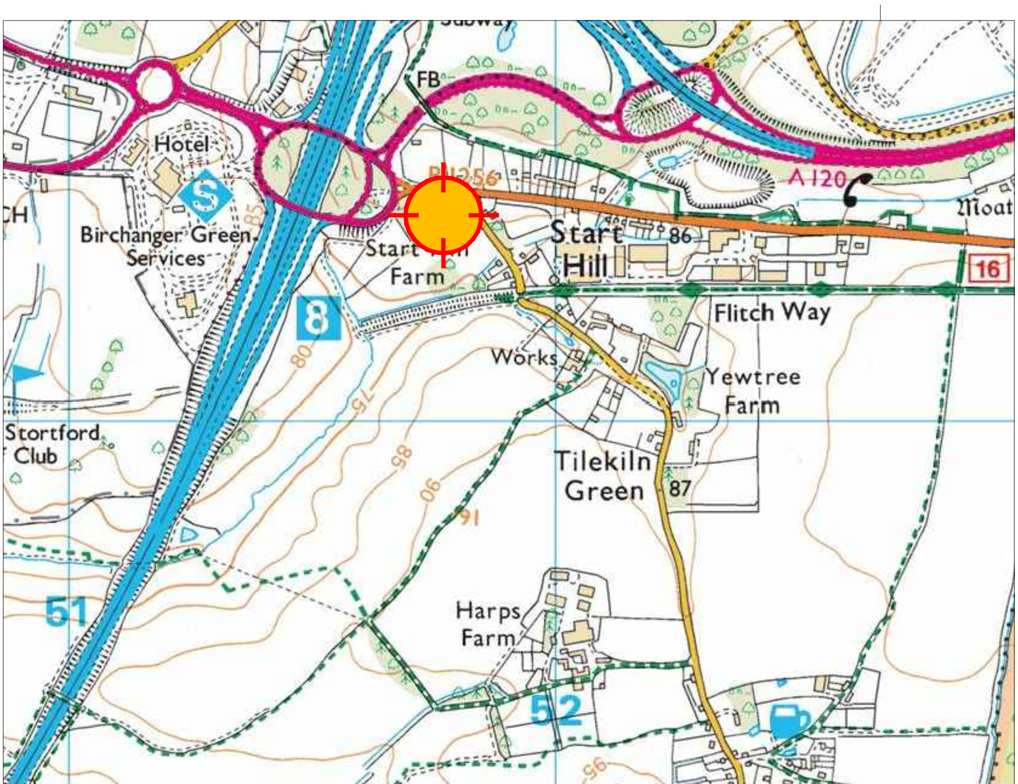
Drawings

N

WIDER CONTEXT



LOCAL CONTEXT



SITE LOCATION

Rev	Description	Date

Client:
FKY LIMITED

A4

IT Project:
PROPOSED TRANSPORT DISTRIBUTION POINT, TILE KILN LANE, STANSTED

Rev:
-

Drawn By:
AS

Approved By:
JB

Notes:
Dimensions should not be scaled from this drawing. The contents of this drawing are confidential, should you receive this drawing in error please return it to Intermodal Transportation at the address printed.

Drawing Title:
SITE LOCATION IN THE WIDER AND LOCAL CONTEXT

Sheet 1 of 1

Drawing No:
IT1896/FRA/001

CAD File:
IT1896_FRA_001.dwg

Date:
MAY 2019

Scale:
NTS

Intermodal
TRANSPORTATION
Hunters Court
Debden Road
Saffron Walden
Essex CB11 4AA

Tel: +44 (0)1799 529529
Fax: +44 (0)1799 5295□0
e: enquiries@inter-modal.co.uk

Drawing Title:
DRAINAGE STRATEGY

Rev	Description	Reviewer	Date
B	Site Layout updated	MDC	25.01.22
A	Site Layout updated	MK	21.01.21

Rev: B

IT Project:
TILE KILN GREEN, STANSTED

Sheet 1 of 1

Client:
FKY LTD

A1

Drawing No: IT1896/FRA/002

CAD File: IT1896_FRA_002_REV B.dwg

Date: JUL 2019

Scale: 1:500

Drawn by: AS

Approved by: PM

Intermodal TRANSPORTATION
Hunters Court
Debden Road
Saffron Walden
Essex CB11 4AA
Tel: +44 (0)1799 529529
e: enquiries@inter-modal.co.uk

Appendix A

TOPOGRAPHICAL SURVEY

LASER SURVEYS

LAND AND BUILDING SURVEYS, UNDERGROUND SERVICES LOCATION, CCTV DRAINAGE SURVEYS.

Established 1975. Member of The Survey Association.

OPEN SPACE, UPPER INTERFIELDS, LEIGH SINTON ROAD, MALVERN, WORCESTERSHIRE, WR14 1UT
TEL 01886 833173 email: worcester@lasersurveys.com

142–144 HILLVIEW AVENUE, HORNCHURCH, ESSEX. RM11 2DL
TEL 01708 438408 FAX 01708 438405. email: london@lasersurveys.com

DATUM NOTES

GRID ORIGIN IS BASED UPON SURVEY STATION 2 FIXED TO THE ORDNANCE SURVEY NATIONAL GRID BY LEICA SMARTNET GPS NETWORK. A SCALE FACTOR OF 1 APPLIES TO THIS DRAWING.

ie. MEASURED DISTANCES ON THE GROUND WITHOUT GPS WILL BE THE SAME AS THOSE MEASURED ON THIS DRAWING

LEVELS ARE RELATED TO :– ORDNANCE SURVEY GPS ACTIVE NETWORK AND TRANSFORMED USING THE OSGM02 & OSTN02 MODEL

SITE BENCH MARK ESTABLISHED IS LOCATED AT :– STATION 2 IN ASPHALT

VALUE GIVEN AS 85.180m

SURVEY CONTROL STATIONS SHOWN △

ABBREVIATIONS (where applicable)

AV	Air Valve	MH	Manhole Cover
BK	Brick	MK	Marker
BL	Bollard	MS	Milestone
BS	Bus Stop	MT	Meter
BT	British Telecom	MY	Mercury
CB	Control Box	OH	Overhead
C/B	Close Boarded	PAV	Paving
CL	Cover Level	PB	Post Box
CLK	Chainlink	PE	Pipe
CO	Column	PM	Parking Meter
Conc	Concrete	P/R	Post and Rail
CP	Catch Pit	PT	Post
CPS	Concrete Paving Slabs	P/W	Post and Wire
CATV	Cable Television	RE	Rodding Eye
DC	Drainage Channel	RET	Retaining
DP	Drain Pipe	RS	Road Sign
EC	Electricity Cover	RSJ	Rolled Steel Joist
ER	Earthing Rod	SC	Stop Cock
FB	Flower Bed	SK	Soakaway
FE	Fence	SP	Signpost
FH	Fire Hydrant	ST	Silt Trap
FL	Floor Level	SV	Stop Valve
FP	Flag Pole	SVC	Security Video Camera
GP	Gate Post	TCB	Telephone Call Box
GV	Gas Valve	TK	Tank
GY,G	Gully	TL	Traffic Light
HT	Height	TP	Telegraph Pole
IC	Inspection Cover	UG	Underground
IL	Invert Level	UTF	Unable To Trace Further
IN	Interceptor	UTL	Unable To Lift
I/R	Iron Railings	VP	Vent Pipe
KO	Kerb Outlet	WL	Water Level
LB	Litter Bin	WM	Water Meter
LP	Lamp Post	WO	Wash Out

CW	Combined Water
FW	Foulwater
SW	Stormwater
D	Depth
UTT	Unable to trace
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UTL	Unable To Lift
d	Diameter

NOTES

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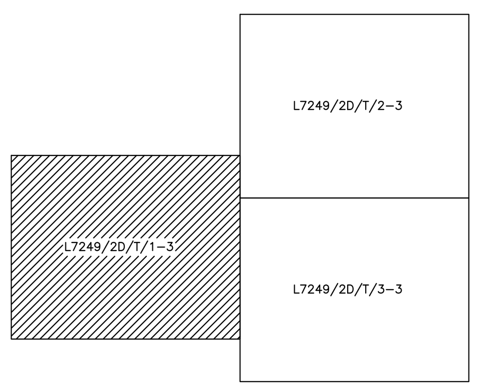
* Areas of woodland contain trees under 0.175m which have not been surveyed.

SHEET LAYOUT
NOT TO SCALE



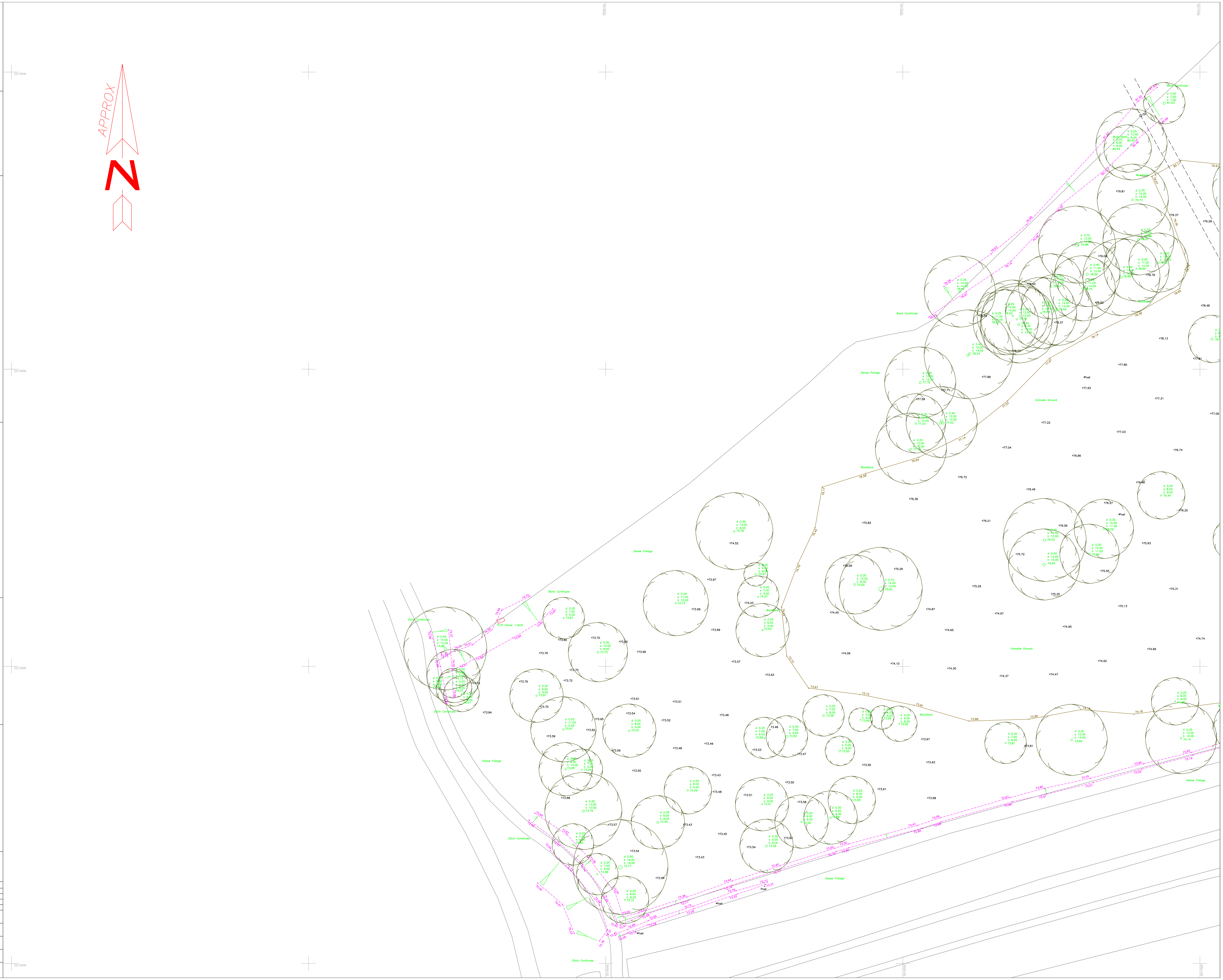
2ND SITE AT START HILL BISHOPS STORTFORD ESSEX, CM22 7TA

2D TOPOGRAPHICAL SURVEY

SURVEYED FOR	MARSHGATE GROUP 22 THE CAUSEWAY BISHOPS STORTFORD HERTFORDSHIRE CM23 2EJ	SURVEYOR	K.RANDALL
		DATE	JANUARY 2016

NO	DATE	REVISION

DRAWING NO	L7249/2D/T/1–3	REV 0
SCALE	1 : 200 @ A0	
SEE ALSO DWG NOS		
SHEET	1 of 3	
REF NO	L 7249	



LASER SURVEYS

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VALUE GIVEN AS 85.180m

SURVEY CONTROL STATIONS SHOWN

ABBREVIATIONS (where applicable)

AV	Air Valve	MH	Manhole Cover
BK	Brick	MK	Marker
BL	Bollard	MS	Milestone
BS	Bus Stop	MT	Meter
BT	British Telecom	MY	Mercury
CB	Control Box	OH	Overhead
C/B	Close Boarded	PAV	Paving
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CPS	Concrete Paving Slabs	P/W	Post and Wire
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DC	Drainage Channel	RET	Retaining
DP	Drain Pipe	RS	Road Sign
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FB	Flower Bed	SK	Soakaway
FE	Fence	SP	Signpost
FH	Fire Hydrant	ST	Silt Trap
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FP	Flag Pole	SVC	Security Video Camera
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GV	Gas Valve	TK	Tank
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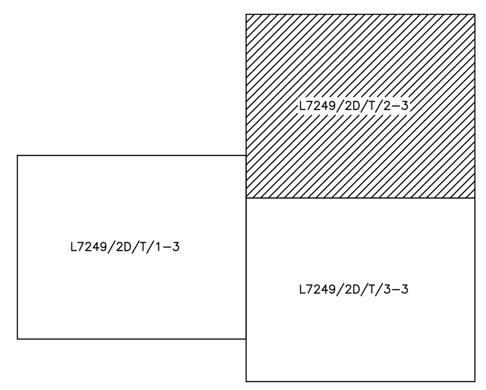
NOT TO SCALE



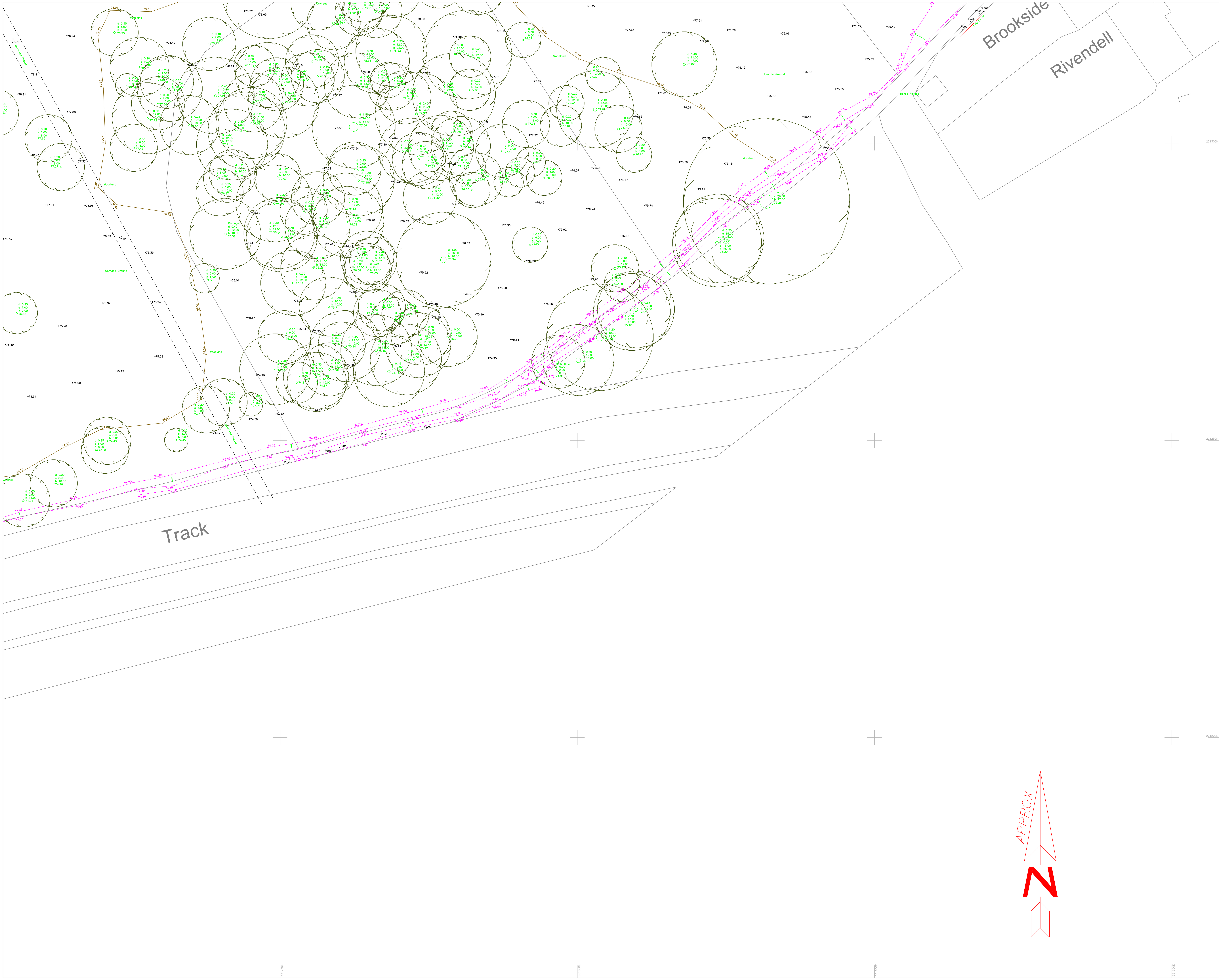
2ND SITE AT START HILL BISHOPS STORTFORD ESSEX, CM22 7TA

2D TOPOGRAPHICAL SURVEY

SURVEYED FOR	MARSHGATE GROUP 22 THE CAUSEWAY BISHOPS STORTFORD HERTFORDSHIRE CM23 2EJ	SURVEYOR	K.RANDALL
		DATE	JANUARY 2016

NO	DATE	REVISION

DRAWING NO	L7249/2D/T/2-3	REV 0
SCALE	1 : 200 @ A0	
SEE ALSO DWG NOS		
SHEET	2 of 3	
REF NO	L 7249	



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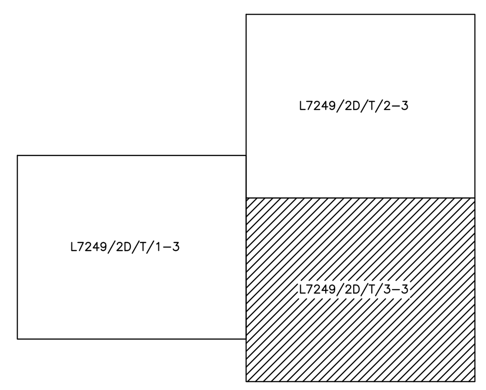


2ND SITE AT START HILL BISHOPS STORTFORD ESSEX, CM22 7TA

2D TOPOGRAPHICAL SURVEY

SURVEYED FOR MARSHGATE GROUP
22 THE CAUSEWAY
BISHOPS STORTFORD
HERTFORDSHIRE
CM23 2EJ

SURVEYOR K.RANDALL
DATE JANUARY 2016

NO	DATE	REVISION

DRAWING NO	L7249/2D/T/3–3	REV 0
SCALE	1 : 200 @ A0	
SEE ALSO DWG NOS		
SHEET	3 of 3	
REF NO	L 7249	

Appendix B

INFILTRATION TESTING RESULTS SUMMARY

STANSTED ENVIRONMENTAL SERVICES

The Stansted Centre
Parsonage Road,
Takeley
Essex CM22 6PU

T. 01279 873380
F. 01279 873381
E. enquiries@stansted-environmental.com
W[redacted]

Our Ref: CON134-BISH-001

13 May 2019

Mr. Justin Bass
Intermodal Transportation
Hunters Court
Debden Road
Saffron Walden
Essex
CB11 4AA

Dear Mr. Bass,

Re: Trial Pit Soakaway Tests – Tile Kiln Green Road, Bishops Stortford, CM22 7TH

Stansted Environmental Services Ltd (SES) was commissioned to undertake trial pit soakaway testing at the above site on 2nd May 2019. Soakaway tests were undertaken in four trial pits (SA1 to SA4) in general accordance with the methodology specified in BRE Special Digest 365.

The trial pits were machine excavated to depths ranging from approximately 0.80m to 2.50m below ground level (bgl). Trial pits encountered topsoil ranging in thickness from approximately 0.15m to 0.68m, overlying the London Clay Formation to the base of each pit.

A trial pit location plan is included as Figure 1.

Calculated permeability characteristics of the soils over the depth of the test zones are presented in the table below:

Table 1: Test Results

Test	Trial pit depth (m)	Trial pit width (m)	Trial pit length (m)	Strata description over test depth	Duration of test (minutes)	Drop in water level (mm)	Permeability (m/s)
SA1	2.50	0.60	2.40	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint.	346	80	N/A
SA2	1.50	0.60	2.40	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint.	340	480	N/A
SA3	2.50	0.60	2.70	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint.	314	90	N/A
SA4	0.80	0.60	2.60	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint.	287	200	N/A

Soakaway test sheets are appended to this report.

Due to the poor infiltration characteristics of the underlying strata, it was not possible to complete the tests within the four trial pits, whereby the water level drops to 25% of its starting depth. Therefore, permeability rates for soils across the depth of the tests could not be calculated.

On this basis, it is considered that pit soakaways would not be suitable for surface water drainage on the site.

I hope the information presented above meets your requirements.
Yours sincerely

For and on behalf of Stansted Environmental Services Limited

[redacted]

Robert Philip MEng FGS
Geo-Environmental Consultant

Encs: *Soakaway Test Location Plan*
Trial Pit Logs
Soakaway Test Results

Google Imagery *– drawing not to scale*

LEGEND

⊕ Trial Pit

Originator	GB	**LAND ADJACENT TILE KILN GREEN ROAD** **CON0134-BISH-001**
Checked & Approved	WGG	**TRIAL PIT LOCATION PLAN**

SES STANSTED ENVIRONMENTAL SERVICES

16/08/2017

Stansted Environmental Services Limited The Stansted Centre, Parsonage Road Takeley,Essex,CM22 5PU		**Site** Land adj. Tile Kiln Road, Bishops Stortford, Hertfordshire, CM22 7TH	**Trial Pit Number** **SA01**
Machine : JCB 3CX **Method : ** Trial Pit	**Dimensions** 0.60m x 2.40m	**Ground Level (mOD)**	**Client** Intermodal Transportation Ltd	**Job Number** CON134-BISH-001
	Location See site plan	**Dates** 02/05/2019	**Engineer** Stansted Environmental Services Ltd	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30) 0.30	Brown, sandy, organic topsoil.		
					(2.20) 2.50	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint [LONDON CLAY FORMATION].		
						Complete at 2.50m		

Plan

Remarks

Water seepage from 2.00m bgl
Trial pit backfilled with arisings on completion

Scale (approx)	Logged By	Figure No.
1:25	GAB	SA01

Stansted Environmental Services Limited
The Stansted Centre, Parsonage Road
Takeley,Essex,CM22 5PU

Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.60m x 2.40m	**Ground Level (mOD)**	**Site** Land adj. Tile Kiln Road, Bishops Stortford, Hertfordshire, CM22 7TH	**Trial Pit Number** **SA02**
	Location See site plan	**Dates** 02/05/2019	**Client** Intermodal Transportation Ltd	**Job Number** CON134-BISH-001
			Engineer Stansted Environmental Services Ltd	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.15) 0.15	Brown, sandy, organic topsoil.		
					(1.35) 1.50	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint and rare fragments of brick [REWORKED LONDON CLAY FORMATION].		
						Complete at 1.50m		

Plan

Remarks

Concrete obstruction at 1.50m bgl
No groundwater seepage
Trial pit backfilled with arisings on completion

Scale (approx)	Logged By	Figure No.
1:25	GAB	SA02

Stansted Environmental Services Limited The Stansted Centre, Parsonage Road Takeley,Essex,CM22 5PU			Site Land adj. Tile Kiln Road, Bishops Stortford, Hertfordshire, CM22 7TH	Trial Pit Number **SA03**
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.60m x 2.70m	**Ground Level (mOD)**	**Client** Intermodal Transportation Ltd	**Job Number** CON134-BISH-001
	Location See site plan	**Dates** 02/05/2019	**Engineer** Stansted Environmental Services Ltd	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.68)	Brown, sandy, organic topsoil.		
					0.68	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint [LONDON CLAY FORMATION].		
					(1.82)			
					2.50	Complete at 2.50m		

Plan

Remarks

No groundwater seepage
Trial pit backfilled with arisings on completion

Scale (approx)	Logged By	Figure No.
1:25	GAB	SA03

Stansted Environmental Services Limited The Stansted Centre, Parsonage Road Takeley,Essex,CM22 5PU	**Site** Land adj. Tile Kiln Road, Bishops Stortford, Hertfordshire, CM22 7TH	**Trial Pit Number** **SA04**

Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.60m x 2.60m	**Ground Level (mOD)**	**Client** Intermodal Transportation Ltd	**Job Number** CON134-BISH-001
	Location See site plan	**Dates** 02/05/2019	**Engineer** Stansted Environmental Services Ltd	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.33) 0.33	Brown, sandy, organic topsoil.		
					(0.47) 0.80	Orange, brown and grey, mottled CLAY with occasional coarse, subrounded to rounded gravel and cobbles of flint [LONDON CLAY FORMATION].		
						Complete at 2.50m		

Plan

Remarks

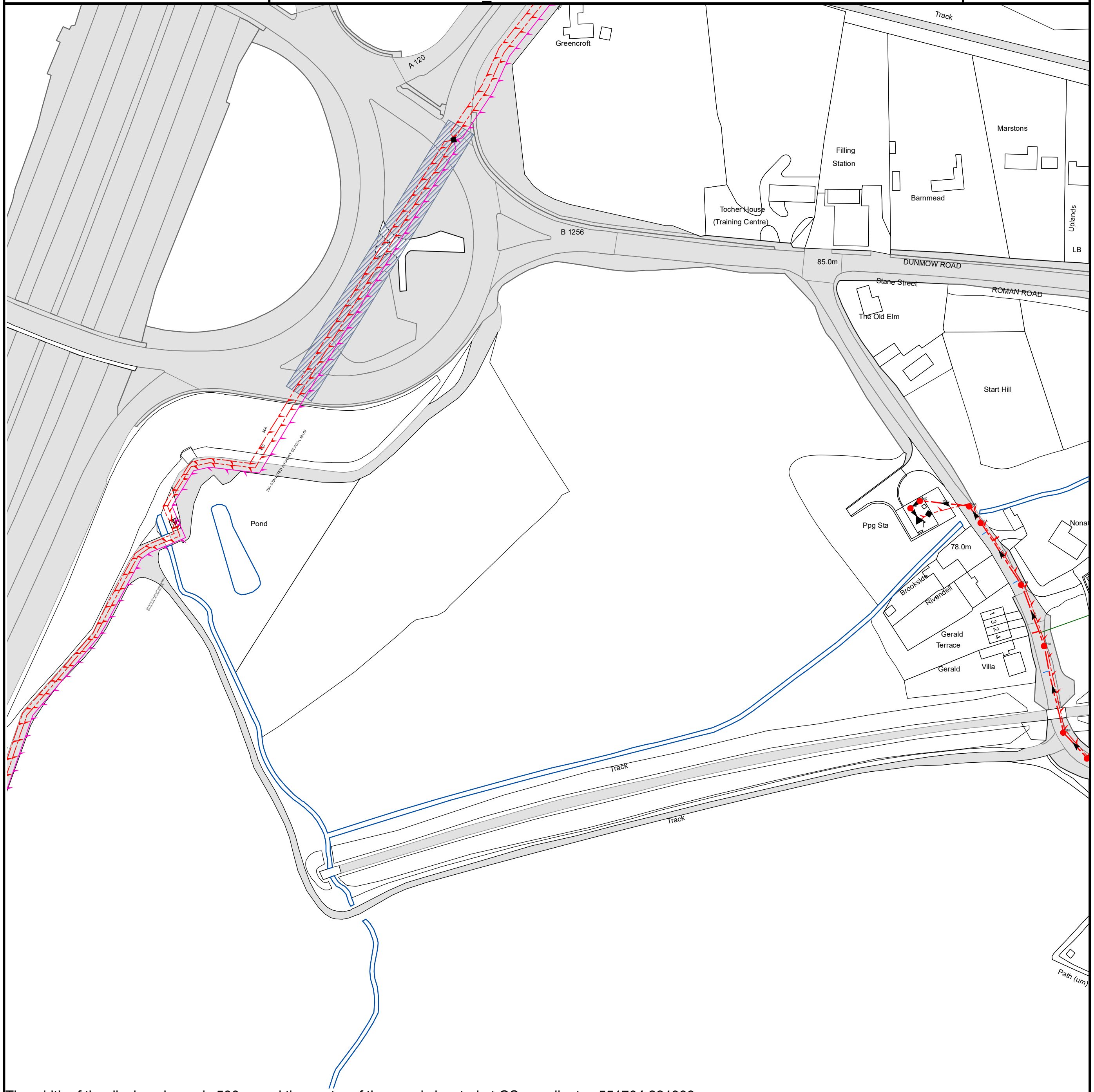
Water seepage from 2.00m bgl
Trial pit backfilled with arisings on completion

Scale (approx)	Logged By	Figure No.
1:25	GAB	SA04

Appendix C

THAMES WATER UTILITIES ASSET INFORMATION

Asset Location Search Sewer Map - ALS/ALS Standard/2019_3975538



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 551704,221339

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
921C	78.899	77.49
921B	78.359	76.966
921A	78.147	76.663
931B	78.184	76.13
931A	77.339	74.405
831B	76.897	73.711
831A	77.325	74.2
831C	77.013	73.823

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

- Trunk Surface Water
- Trunk Foul
- Storm Relief
- Trunk Combined
- Vent Pipe
- Bio-solids (Sludge)
- Proposed Thames Surface Water Sewer
- Proposed Thames Water Foul Sewer
- Gallery
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Sludge Rising Main
- Proposed Thames Water Rising Main
- Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

- Air Valve
- Dam Chase
- Fitting
- Meter
- Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

- Control Valve
- Drop Pipe
- Ancillary
- Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

- Outfall
- Undefined End
- Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

- Public/Private Pumping Station
- Change of characteristic indicator (C.O.C.I.)
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Operational Site
- Chamber
- Tunnel
- Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

- Foul Sewer
- Surface Water Sewer
- Combined Sewer
- Gulley
- Culverted Watercourse
- Proposed
- Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Appendix D

GREENFIELD RUNOFF CALCULATIONS

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	2.090	Urban	0.000
SAAR (mm)	605	Region Number	Region 6

Results	**l/s**
QBAR Rural	3.2
QBAR Urban	3.2
Q1 year	2.7
Q1 year	2.7
Q30 years	7.3
Q100 years	10.2

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	2.090	Urban	0.000
SAAR (mm)	605	Region Number	Region 6

Results	**l/s**
QBAR Rural	3.2
QBAR Urban	3.2
Q1 year	2.7
Q1 year	2.7
Q30 years	7.3
Q100 years	10.2

Appendix E

MICRO DRAINAGE CALCULATIONS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	40
Ratio R	0.434	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.036	4-8	1.025	8-12	0.031

Total Area Contributing (ha) = 2.092

Total Pipe Volume (m³) = 60.071

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.000	58.525	0.244	239.9	0.264	4.00	0.0	0.600	o	300	Pipe/Conduit
1.001	12.621	0.042	300.5	0.290	0.00	0.0	0.600	o	450	Pipe/Conduit
1.002	33.259	0.111	300.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit
1.003	42.977	0.107	401.7	0.251	0.00	0.0	0.600	o	450	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	4.97	76.906	0.264	0.0	0.0	0.0	1.01	71.4	0.0
1.001	0.00	5.15	76.512	0.554	0.0	0.0	0.0	1.17	185.7	0.0
1.002	0.00	5.62	76.470	0.554	0.0	0.0	0.0	1.17	185.8	0.0
1.003	0.00	6.33	76.359	0.805	0.0	0.0	0.0	1.01	160.4	0.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.004	27.331	0.068	401.9	0.233	0.00	0.0	0.600	o	525	Pipe/Conduit
1.005	25.443	0.544	46.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
1.006	74.287	0.186	399.4	0.315	0.00	0.0	0.600	o	600	Pipe/Conduit
1.007	7.348	0.018	408.2	0.739	0.00	0.0	0.600	o	675	Pipe/Conduit
1.008	16.934	0.042	403.2	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit
1.009	38.739	2.169	17.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.004	0.00	6.74	76.177	1.038	0.0	0.0	0.0	1.11	240.5	0.0
1.005	0.00	6.87	76.109	1.038	0.0	0.0	0.0	3.28	710.1	0.0
1.006	0.00	7.89	75.490	1.353	0.0	0.0	0.0	1.21	342.8	0.0
1.007	0.00	7.99	75.229	2.092	0.0	0.0	0.0	1.29	461.9	0.0
1.008	0.00	8.20	75.211	2.092	0.0	0.0	0.0	1.30	464.8	0.0
1.009	0.00	8.47	75.169	2.092	0.0	0.0	0.0	2.39	42.3	0.0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009		73.400	73.000	73.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	40.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	5760
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	24

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.600
Return Period (years)	100	Ratio R	0.434
Region	England and Wales	Profile Type	Winter

Synthetic Rainfall Details

Cv (Summer)	0.750	Storm Duration (mins)	2880
Cv (Winter)	0.840		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.009, Volume (m^3): 8.9

Unit Reference	MD-SHE-0071-2700-1500-2700
Design Head (m)	1.500
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	75.169
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	2.7	Kick-Flo®	0.635	1.8
Flush-Flo™	0.310	2.3	Mean Flow over Head Range	-	2.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.4	3.000	3.7	7.000	5.5
0.200	2.2	1.400	2.6	3.500	4.0	7.500	5.7
0.300	2.3	1.600	2.8	4.000	4.2	8.000	5.9
0.400	2.2	1.800	2.9	4.500	4.5	8.500	6.1
0.500	2.2	2.000	3.1	5.000	4.7	9.000	6.2
0.600	2.0	2.200	3.2	5.500	4.9	9.500	6.4
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.5	6.500	5.3		

Storage Structures for Storm

Cellular Storage Manhole: 1, DS/PN: 1.000

Invert Level (m) 76.906 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	145.0	0.0	0.401	0.0	0.0
0.400	145.0	0.0			

Cellular Storage Manhole: 7, DS/PN: 1.006

Invert Level (m) 75.490 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

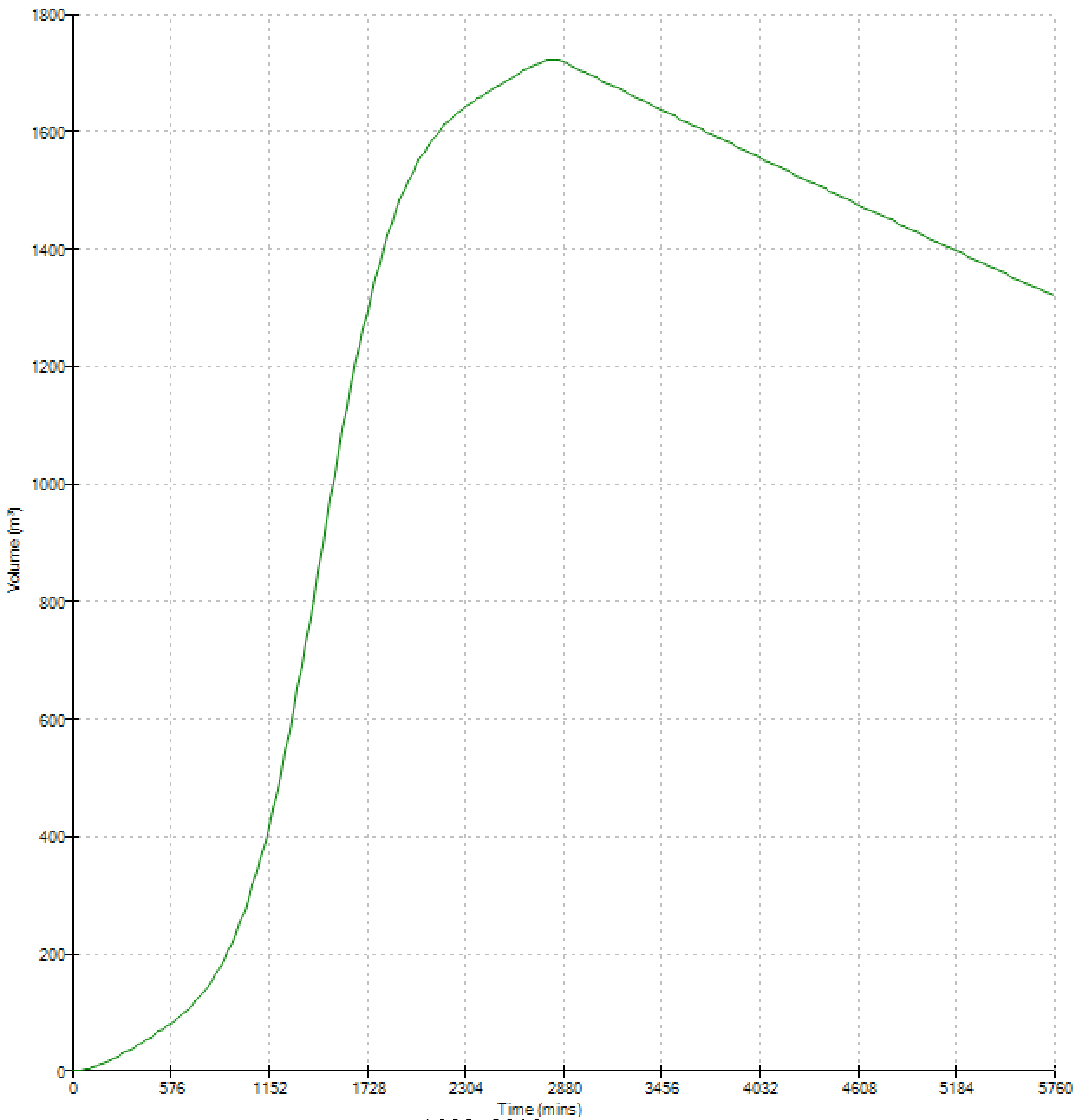
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1944.0	0.0	1.201	0.0	0.0
1.200	1944.0	0.0			

Summary of Results for 2880 minute 100 year Winter (Storm)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

PN	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	78.106	76.953	-0.253	0.000	0.06		6.471	4.0	OK
1.001	2	80.213	76.584	-0.378	0.000	0.06		0.095	8.3	OK
1.002	3	80.384	76.536	-0.384	0.000	0.05		0.170	8.3	OK
1.003	4	80.058	76.446	-0.363	0.000	0.08		0.372	12.1	OK
1.004	5	78.434	76.419	-0.283	0.000	0.08		1.727	15.6	OK
1.005	6	78.166	76.419	-0.215	0.000	0.03		3.197	15.6	OK
1.006	7	77.760	76.419	0.328	0.000	0.01		1721.824	2.5	SURCHARGED
1.007	8	77.403	76.440	0.536	0.000	0.01		22.711	2.7	SURCHARGED
1.008	9	77.368	76.442	0.555	0.000	0.01		4.258	2.5	SURCHARGED
1.009	10	77.099	76.451	1.132	0.000	0.06		7.780	2.5	SURCHARGED

Graphs for Pipe 1.006 US/MH 7 (Storm)
2880 minute 100 year Winter
Status: SURCHARGED



STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	40
Ratio R	0.434	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.036	4-8	1.025	8-12	0.031

Total Area Contributing (ha) = 2.092

Total Pipe Volume (m³) = 60.071

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.000	58.525	0.244	239.9	0.264	4.00	0.0	0.600	o	300	Pipe/Conduit
1.001	12.621	0.042	300.5	0.290	0.00	0.0	0.600	o	450	Pipe/Conduit
1.002	33.259	0.111	300.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit
1.003	42.977	0.107	401.7	0.251	0.00	0.0	0.600	o	450	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	4.97	76.906	0.264	0.0	0.0	0.0	1.01	71.4	0.0
1.001	0.00	5.15	76.512	0.554	0.0	0.0	0.0	1.17	185.7	0.0
1.002	0.00	5.62	76.470	0.554	0.0	0.0	0.0	1.17	185.8	0.0
1.003	0.00	6.33	76.359	0.805	0.0	0.0	0.0	1.01	160.4	0.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.004	27.331	0.068	401.9	0.233	0.00	0.0	0.600	o	525	Pipe/Conduit
1.005	25.443	0.544	46.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
1.006	74.287	0.186	399.4	0.315	0.00	0.0	0.600	o	600	Pipe/Conduit
1.007	7.348	0.018	408.2	0.739	0.00	0.0	0.600	o	675	Pipe/Conduit
1.008	16.934	0.042	403.2	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit
1.009	38.739	2.169	17.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.004	0.00	6.74	76.177	1.038	0.0	0.0	0.0	1.11	240.5	0.0
1.005	0.00	6.87	76.109	1.038	0.0	0.0	0.0	3.28	710.1	0.0
1.006	0.00	7.89	75.490	1.353	0.0	0.0	0.0	1.21	342.8	0.0
1.007	0.00	7.99	75.229	2.092	0.0	0.0	0.0	1.29	461.9	0.0
1.008	0.00	8.20	75.211	2.092	0.0	0.0	0.0	1.30	464.8	0.0
1.009	0.00	8.47	75.169	2.092	0.0	0.0	0.0	2.39	42.3	0.0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009		73.400	73.000	73.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	40.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	4320
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	24

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.600
Return Period (years)	100	Ratio R	0.434
Region	England and Wales	Profile Type	Winter

Synthetic Rainfall Details

Cv (Summer)	0.750	Storm Duration (mins)	2160
Cv (Winter)	0.840		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.009, Volume (m^3): 8.9

Unit Reference	MD-SHE-0071-2700-1500-2700
Design Head (m)	1.500
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	75.169
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	2.7	Kick-Flo®	0.635	1.8
Flush-Flo™	0.310	2.3	Mean Flow over Head Range	-	2.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.4	3.000	3.7	7.000	5.5
0.200	2.2	1.400	2.6	3.500	4.0	7.500	5.7
0.300	2.3	1.600	2.8	4.000	4.2	8.000	5.9
0.400	2.2	1.800	2.9	4.500	4.5	8.500	6.1
0.500	2.2	2.000	3.1	5.000	4.7	9.000	6.2
0.600	2.0	2.200	3.2	5.500	4.9	9.500	6.4
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.5	6.500	5.3		

Storage Structures for Storm

Cellular Storage Manhole: 1, DS/PN: 1.000

Invert Level (m) 76.906 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	145.0	0.0	0.401	0.0	0.0
0.400	145.0	0.0			

Cellular Storage Manhole: 7, DS/PN: 1.006

Invert Level (m) 75.490 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1944.0	0.0	1.201	0.0	0.0
1.200	1944.0	0.0			

Summary of Results for 2160 minute 100 year Winter (Storm)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

PN	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	78.106	76.960	-0.246	0.000	0.07		7.430	5.0	OK
1.001	2	80.213	76.594	-0.368	0.000	0.08		0.111	10.5	OK
1.002	3	80.384	76.546	-0.374	0.000	0.07		0.197	10.5	OK
1.003	4	80.058	76.457	-0.352	0.000	0.11		0.419	15.3	OK
1.004	5	78.434	76.412	-0.290	0.000	0.10		1.600	19.8	OK
1.005	6	78.166	76.411	-0.223	0.000	0.03		3.084	19.8	OK
1.006	7	77.760	76.411	0.321	0.000	0.01		1707.389	2.5	SURCHARGED
1.007	8	77.403	76.428	0.524	0.000	0.01		22.689	2.7	SURCHARGED
1.008	9	77.368	76.428	0.541	0.000	0.01		4.234	2.6	SURCHARGED
1.009	10	77.099	76.438	1.119	0.000	0.06		7.756	2.5	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	40
Ratio R	0.434	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.036	4-8	1.025	8-12	0.031

Total Area Contributing (ha) = 2.092

Total Pipe Volume (m³) = 60.071

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.000	58.525	0.244	239.9	0.264	4.00	0.0	0.600	o	300	Pipe/Conduit
1.001	12.621	0.042	300.5	0.290	0.00	0.0	0.600	o	450	Pipe/Conduit
1.002	33.259	0.111	300.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit
1.003	42.977	0.107	401.7	0.251	0.00	0.0	0.600	o	450	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	4.97	76.906	0.264	0.0	0.0	0.0	1.01	71.4	0.0
1.001	0.00	5.15	76.512	0.554	0.0	0.0	0.0	1.17	185.7	0.0
1.002	0.00	5.62	76.470	0.554	0.0	0.0	0.0	1.17	185.8	0.0
1.003	0.00	6.33	76.359	0.805	0.0	0.0	0.0	1.01	160.4	0.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.004	27.331	0.068	401.9	0.233	0.00	0.0	0.600	o	525	Pipe/Conduit
1.005	25.443	0.544	46.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
1.006	74.287	0.186	399.4	0.315	0.00	0.0	0.600	o	600	Pipe/Conduit
1.007	7.348	0.018	408.2	0.739	0.00	0.0	0.600	o	675	Pipe/Conduit
1.008	16.934	0.042	403.2	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit
1.009	38.739	2.169	17.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.004	0.00	6.74	76.177	1.038	0.0	0.0	0.0	1.11	240.5	0.0
1.005	0.00	6.87	76.109	1.038	0.0	0.0	0.0	3.28	710.1	0.0
1.006	0.00	7.89	75.490	1.353	0.0	0.0	0.0	1.21	342.8	0.0
1.007	0.00	7.99	75.229	2.092	0.0	0.0	0.0	1.29	461.9	0.0
1.008	0.00	8.20	75.211	2.092	0.0	0.0	0.0	1.30	464.8	0.0
1.009	0.00	8.47	75.169	2.092	0.0	0.0	0.0	2.39	42.3	0.0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009		73.400	73.000	73.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	40.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	8640
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	24

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.600
Return Period (years)	100	Ratio R	0.434
Region	England and Wales	Profile Type	Winter

Synthetic Rainfall Details

Cv (Summer) 0.750 Storm Duration (mins) 4320
Cv (Winter) 0.840

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.009, Volume (m³): 8.9

Unit Reference	MD-SHE-0071-2700-1500-2700
Design Head (m)	1.500
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	75.169
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	2.7	Kick-Flo®	0.635	1.8
Flush-Flo™	0.310	2.3	Mean Flow over Head Range	-	2.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.4	3.000	3.7	7.000	5.5
0.200	2.2	1.400	2.6	3.500	4.0	7.500	5.7
0.300	2.3	1.600	2.8	4.000	4.2	8.000	5.9
0.400	2.2	1.800	2.9	4.500	4.5	8.500	6.1
0.500	2.2	2.000	3.1	5.000	4.7	9.000	6.2
0.600	2.0	2.200	3.2	5.500	4.9	9.500	6.4
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.5	6.500	5.3		

Storage Structures for Storm

Cellular Storage Manhole: 1, DS/PN: 1.000

Invert Level (m) 76.906 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	145.0	0.0	0.401	0.0	0.0
0.400	145.0	0.0			

Cellular Storage Manhole: 7, DS/PN: 1.006

Invert Level (m) 75.490 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1944.0	0.0	1.201	0.0	0.0
1.200	1944.0	0.0			

Summary of Results for 4320 minute 100 year Winter (Storm)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

PN	**US/MH Name**	**US/CL (m)**	**Water Level (m)**	**Surcharged Depth (m)**	**Flooded Volume (m³)**	**Flow / Cap.**	**Overflow (l/s)**	**Maximum Vol (m³)**	**Pipe Flow (l/s)**	**Status**
1.000	1	78.106	76.945	-0.261	0.000	0.04		5.443	2.8	OK
1.001	2	80.213	76.572	-0.390	0.000	0.04		0.079	6.0	OK
1.002	3	80.384	76.526	-0.394	0.000	0.04		0.140	6.0	OK
1.003	4	80.058	76.430	-0.379	0.000	0.06		0.300	8.7	OK
1.004	5	78.434	76.407	-0.295	0.000	0.06		1.513	11.2	OK
1.005	6	78.166	76.407	-0.227	0.000	0.02		3.019	11.2	OK
1.006	7	77.760	76.407	0.317	0.000	0.01		1700.067	2.5	SURCHARGED
1.007	8	77.403	76.429	0.524	0.000	0.01		22.691	2.7	SURCHARGED
1.008	9	77.368	76.429	0.543	0.000	0.01		4.236	2.5	SURCHARGED
1.009	10	77.099	76.437	1.117	0.000	0.06		7.754	2.5	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	40
Ratio R	0.434	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.036	4-8	1.025	8-12	0.031

Total Area Contributing (ha) = 2.092

Total Pipe Volume (m³) = 60.071

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.000	58.525	0.244	239.9	0.264	4.00	0.0	0.600	o	300	Pipe/Conduit
1.001	12.621	0.042	300.5	0.290	0.00	0.0	0.600	o	450	Pipe/Conduit
1.002	33.259	0.111	300.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit
1.003	42.977	0.107	401.7	0.251	0.00	0.0	0.600	o	450	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	4.97	76.906	0.264	0.0	0.0	0.0	1.01	71.4	0.0
1.001	0.00	5.15	76.512	0.554	0.0	0.0	0.0	1.17	185.7	0.0
1.002	0.00	5.62	76.470	0.554	0.0	0.0	0.0	1.17	185.8	0.0
1.003	0.00	6.33	76.359	0.805	0.0	0.0	0.0	1.01	160.4	0.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
1.004	27.331	0.068	401.9	0.233	0.00	0.0	0.600	o	525	Pipe/Conduit
1.005	25.443	0.544	46.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit
1.006	74.287	0.186	399.4	0.315	0.00	0.0	0.600	o	600	Pipe/Conduit
1.007	7.348	0.018	408.2	0.739	0.00	0.0	0.600	o	675	Pipe/Conduit
1.008	16.934	0.042	403.2	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit
1.009	38.739	2.169	17.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.004	0.00	6.74	76.177	1.038	0.0	0.0	0.0	1.11	240.5	0.0
1.005	0.00	6.87	76.109	1.038	0.0	0.0	0.0	3.28	710.1	0.0
1.006	0.00	7.89	75.490	1.353	0.0	0.0	0.0	1.21	342.8	0.0
1.007	0.00	7.99	75.229	2.092	0.0	0.0	0.0	1.29	461.9	0.0
1.008	0.00	8.20	75.211	2.092	0.0	0.0	0.0	1.30	464.8	0.0
1.009	0.00	8.47	75.169	2.092	0.0	0.0	0.0	2.39	42.3	0.0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009		73.400	73.000	73.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	2880
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	24

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.600
Return Period (years)	10	Ratio R	0.434
Region	England and Wales	Profile Type	Winter

Synthetic Rainfall Details

Cv (Summer) 0.750 Storm Duration (mins) 1440
Cv (Winter) 0.840

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.009, Volume (m^3): 8.9

Unit Reference	MD-SHE-0071-2700-1500-2700
Design Head (m)	1.500
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	75.169
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	2.7	Kick-Flo®	0.635	1.8
Flush-Flo™	0.310	2.3	Mean Flow over Head Range	-	2.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.4	3.000	3.7	7.000	5.5
0.200	2.2	1.400	2.6	3.500	4.0	7.500	5.7
0.300	2.3	1.600	2.8	4.000	4.2	8.000	5.9
0.400	2.2	1.800	2.9	4.500	4.5	8.500	6.1
0.500	2.2	2.000	3.1	5.000	4.7	9.000	6.2
0.600	2.0	2.200	3.2	5.500	4.9	9.500	6.4
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.5	6.500	5.3		

Storage Structures for Storm

Cellular Storage Manhole: 1, DS/PN: 1.000

Invert Level (m) 76.906 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	145.0	0.0	0.401	0.0	0.0
0.400	145.0	0.0			

Cellular Storage Manhole: 7, DS/PN: 1.006

Invert Level (m) 75.490 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	1944.0	0.0	1.201	0.0	0.0
1.200	1944.0	0.0			

Summary of Results for 1440 minute 10 year Winter (Storm)

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

PN	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	78.106	76.947	-0.259	0.000	0.05		5.695	3.1	OK
1.001	2	80.213	76.575	-0.387	0.000	0.05		0.083	6.5	OK
1.002	3	80.384	76.528	-0.392	0.000	0.04		0.147	6.5	OK
1.003	4	80.058	76.434	-0.375	0.000	0.07		0.318	9.5	OK
1.004	5	78.434	76.261	-0.441	0.000	0.06		0.151	12.3	OK
1.005	6	78.166	76.162	-0.472	0.000	0.02		0.223	12.3	OK
1.006	7	77.760	75.841	-0.250	0.000	0.01		648.945	1.9	OK
1.007	8	77.403	75.841	-0.064	0.000	0.01		17.028	2.5	OK
1.008	9	77.368	75.841	-0.046	0.000	0.01		2.929	2.4	OK
1.009	10	77.099	75.840	0.520	0.000	0.06		6.272	2.3	SURCHARGED

Appendix F

SDS AQUA-FILTER DETAILS

STORMWATER TREATMENT

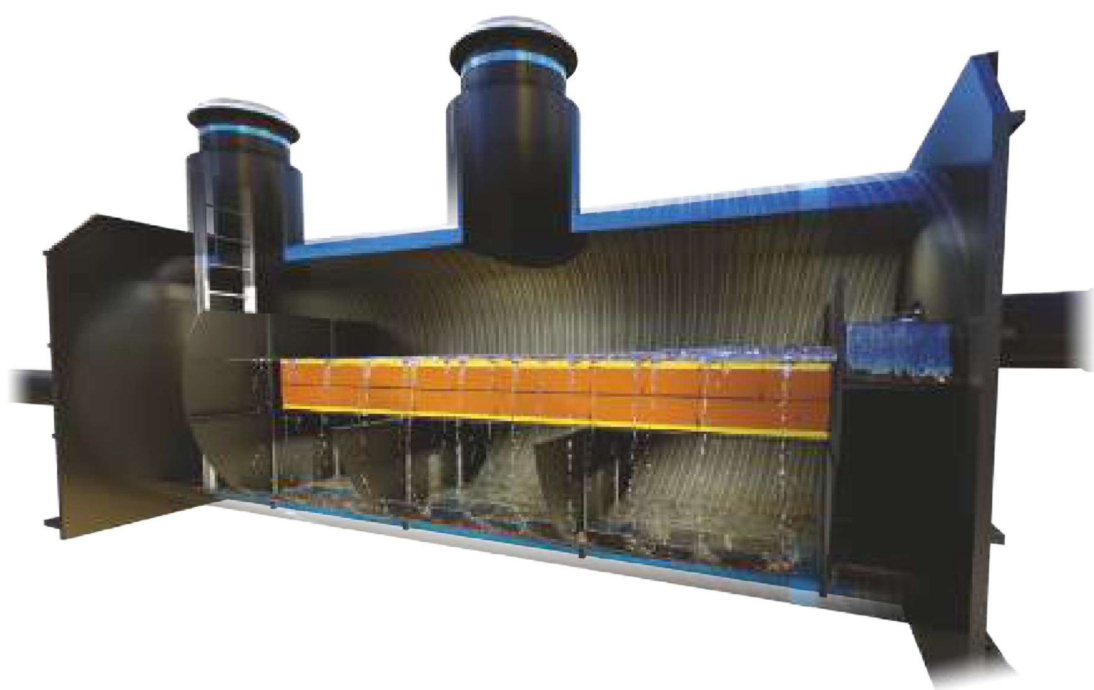
SDS

Water Infrastructure Systems

SDS Aqua-Filter™

Hydrodynamic Vortex Separator & Filtration Unit

SDS Aqua-Filter™ uses hydrodynamic and gravitational forces to remove gross pollutants from surface water runoff. It then filters out fine sediments, nutrients, heavy metals and hydrocarbons through percolation, adsorption, biological breakdown and ionic exchange, prior to final conveyance.



SDS Aqua-Filter™ is designed to work in an offline configuration to mitigate washout of the contained pollutants and should be installed in sequence immediately following an SDS Aqua-Swirl™ unit. It is able to deal with large volume surface water runoff, removing very fine silts and dissolved pollutants that are contained in the initial flush. The treatment flow rate of the SDS Aqua-Filter™ system is engineered to meet or exceed the local water quality treatment criteria and form an intrinsic part of the SuDS solution train.

- *No moving parts*
- *HDPE plastic construction*
- *Twin access manholes*
- *Small footprint design*
- *Filtration media supplied in bags*
- *Available in a range of lengths*
- *Lifting eyelets and handling cables*
- *Bespoke sizing available*

sdslimited.com

SDS Ltd, Clearwater House, Castlemills, Biddisham, Somerset, BS26 2RE

T: +44 (0)1934 751303
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Features	Benefits
Manufactured from HDPE with no moving parts.	Offers a durable, light weight and low cost alternative to concrete. Easy and quick to install resulting in substantial cost savings.
Large volume treatment capacity.	Can be sized for connection to more than one SDS Aqua-Swirl™.
Twin access manholes with built-in ladder.	Provides easy access to recovered sediments and filtration elements.
Small footprint design.	Reduces ground excavation and product installation costs.
Dedicated filtration media supplied in small bags.	Suitable to each type of pollutant including small suspended particles, nutrients, heavy metals, hydrocarbons and poly aromatic hydrocarbons.
Lifting eyelets.	Easy installation without the need for expensive heavy machinery.
Available in a range of lengths.	Can be used in a variety of water quality filtration flows.
Bespoke units can be manufactured.	Satisfies even the most demanding installations.

SPECIFICATIONS

SDS Aqua-Filter™ model	Number of Filter Rows	Filtration Treatment Tank length metres	Filter Media m²	Filtration Rate litres/sec
AF-X.1	1	2.9	0.72	14
AF-X.2	2	3.7	1.44	28
AF-X.3	3	4.4	2.16	43
AF-X.4	4	5.1	2.88	57
AF-X.5	5	5.7	3.60	71
AF-X.6	6	6.4	4.32	85
AF-X.7	7	7.2	5.04	99
AF-X.8	8	7.9	5.76	113
AF-X.9	9	8.6	6.48	127
AF-X.10	10	9.3	7.20	141
AF-X.11	11	10.0	7.92	155
AF-X.12	12	10.9	8.64	169

Note: Values above are approximate and may change without notice.

For assistance in design and specific sizing using historical rainfall data, please contact SDS.

CAD details and specifications are available on request.

A-F DS/0516

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Mitigation Indices:

Device	Total suspended solids mitigation index	Total metals mitigation index	Soluble metals mitigation index[1]	Hydrocarbons[3]
Aquaswirl™ vortex grit separator	0.8	0.5[4]	The Aquaswirl™ is not designed to remove soluble pollutants	0.7[3]
Aquafilter™ stormwater filtration unit	0.8	0.9	0.6	0.9[3]
Aquaswirl™ and Aquafilter™ in sequence	1.2[2]	0.9	0.6	1.1[2,3]

[1] When drainage schemes are designed for road developments in accordance with the Design Manual for Roads and Bridges, the mitigation index for soluble metals is required because particulate metals are considered separately in the total suspended solids assessment

[2] When designing in accordance with the SuDS Manual (Ciria C753), when two devices are used in sequence to target the same pollutant, half of the mitigation index of the second component should be allowed in the calculation.

[3] The test procedures applied to manufactured treatment devices do not include measurement of hydrocarbon removal. Therefore, we have estimated that the Aquaswirl™ removes free-phase hydrocarbons by flotation, and also removes hydrocarbons that are adhered to suspended solids. However, hydrocarbons are known to preferentially adhere to the smaller particles so the Aquafilter™ will remove a higher proportion of those hydrocarbons as it is more effective at removing smaller suspended particles.

[4] Where metals are present in the runoff in particulate form, particularly from vehicle emissions, the Aquaswirl™ will effectively remove those particles in admixture with other suspended solids.