Flood Risk Assessment and Drainage Strategy
Land at Cliffe Lane, Markfield, Junction 22 – M1

22/10/2024
Version 2.0
RAB: 3206_FRD

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Quality Control

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Approved	G. M. Wilson

Revision History

Version	Date	Amendments	Issued to
1.0	27/10/2023	First Issue	Jon Imber – JMI Planning
2.0	22/10/2024	Minor amendments	Jon Imber – JMI Planning

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1.0 Introduction

RAB Consultants has prepared this Flood Risk Assessment (FRA) in support of the proposed development at Land at Cliffe Lane, Markfield LE67 9TE.

The development site is located in Flood Zone 1 according to the Environment Agency's Flood Map for Planning (Rivers and Sea). A Flood Risk Assessment for this site is required under the Planning Practice Guidance for the National Planning Policy Framework (NPPF) as it is a major development. The site-specific FRA is required to ensure that the development is safe from flooding and will not increase the risk of flooding elsewhere.

2.0 Site details

2.1 Site location

TABLE 1: SITE LOCATION

Site address:	Land at Cliffe Lane, Markfield LE67 9TE
Site area:	Approximately 6.2 ha
Existing land use:	Pastureland
OS NGR:	SK 47508 11136
Local Planning Authority:	Hinckley and Bosworth Borough Council

2.2 Site description

The proposed site is a piece of pastureland situated directly north of Old Cliffe Hill Quarry near Junction 22 of the M1.

Vehicular access to the site can be made via Little Shaw Lane (A511) to the north, with pedestrian access from Cliffe Lane to the east via a public footpath.

The site forms an 'L' shape around an existing service station on the Junction 22 – M1 roundabout. The general surrounding area is predominantly pasture and agricultural land as well as supporting various quarries.

Freely available LiDAR (1m-DTM-2022) and the topographic survey shows the site is relatively steep, falling from 200mAOD at the west corner, down to 190mAOD at the east corner, with a general gradient of 1:30.

A topographic survey of the site is included within Appendix A.

2.3 Development proposal

Outline planning is sought for the construction of 5 commercial / industrial units on the site, consisting of 3 large units (in excess of 2500m^2) and 2 smaller units, as well as associated parking and access road.

A new vehicular access is proposed from Cliffe Lane at the east of the site. A proposed layout plan is included in Appendix B

3.0 Flood Risk

3.1 Sequential test

According to the Environment Agency's Flood Map for Planning the site lies in Flood Zone 1, which is described in the NPPF as land having a less than 1 in 1,000 annual probability of river or sea flooding (less than 0.1% AEP).

The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. NPPF Planning Practice Guidance (PPG) Annex 3 confirms the 'Flood risk vulnerability classification' of a site, depending upon the proposed usage. This classification is subsequently applied to Table 2 'Flood risk vulnerability and flood zone incompatibility' to determine whether:

- The proposed development is suitable for the flood zone in which it is located; and
- Whether an Exception Test is required for the proposed development.

The proposed development is classed as a 'less vulnerable' development in accordance with NPPF PPG. The development is therefore appropriate for the Flood Zone. Both a Sequential Test and Exception Test are not required given the site is within Flood Zone 1.

3.2 Flood History

The Environment Agency's Recorded Flood Outlines GIS layer shows no record of flooding at the proposed site.

Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (2017) makes no reference to any previous flood events around the site.

Internet searches reveal no evidence the site has previously flooded.

3.3 Fluvial (Rivers)

The site lies in Flood Zone 1 on the Environment Agency's Flood Map for Planning, indicating a risk less than 0.1% AEP.

The proposed development is more than 2000m away from the nearest fluvial risk extent, associated with the River Sense, north of the site.

3.3.1 Climate Change Impact on Fluvial Risk

The Environment Agency guidance document 'Flood risk assessments: climate change allowances' was released in February 2016 and last updated in May 2022. It includes statistical increases on peak fluvial flows by Management Catchment and allowance categories based on epochs and development vulnerability classification. Referring to the NPPF PPG, the development is classified as 'more vulnerable' and could have an expected lifetime of up to 100 years. In this case as the site is located in Flood Zone 1 the peak river flow allowances are not applicable.

The guidance also relates to peak rainfall intensity allowance, which is relevant for surface water flooding. For development with a lifetime beyond 2100, the 'upper end' allowance for the 2070s epoch (2061 to 2125) should be used which is a 40% addition to rainfall intensity in the Soar Management Catchment.

3.4 Flood defence breach or overtopping

3.4.1 Breach Risk

The site does not benefit from flood defences, so there is no breach risk for the site.

3.4.2 Overtopping Risk

The site does not benefit from flood defences, so there is no overtopping risk for the site.

3.5 Coastal/Tidal

The site is not affected by coastal or tidal flood risk as it is located at a considerable distance from the sea.

3.6 Pluvial (Surface water)

Referring to the Environment Agency's surface water flood map (Figure 1), the majority of the site is identified as being at 'very low' risk. However, the map does show the north section of the site at risk of flooding from an overland flow route.

Two sub-catchments are shown to converge at the north corner of the site before flowing across the northern field of the site, through the car park of the adjacent service station and then continue south, either side of the M1.

The surface water flood map indicates that the expected depth in the low-risk scenario in the site is up to 300mm. The topographic survey of the site shows the existing ground in the northern field has a gentle valley shape which would tend to concentrate flows to its centre.

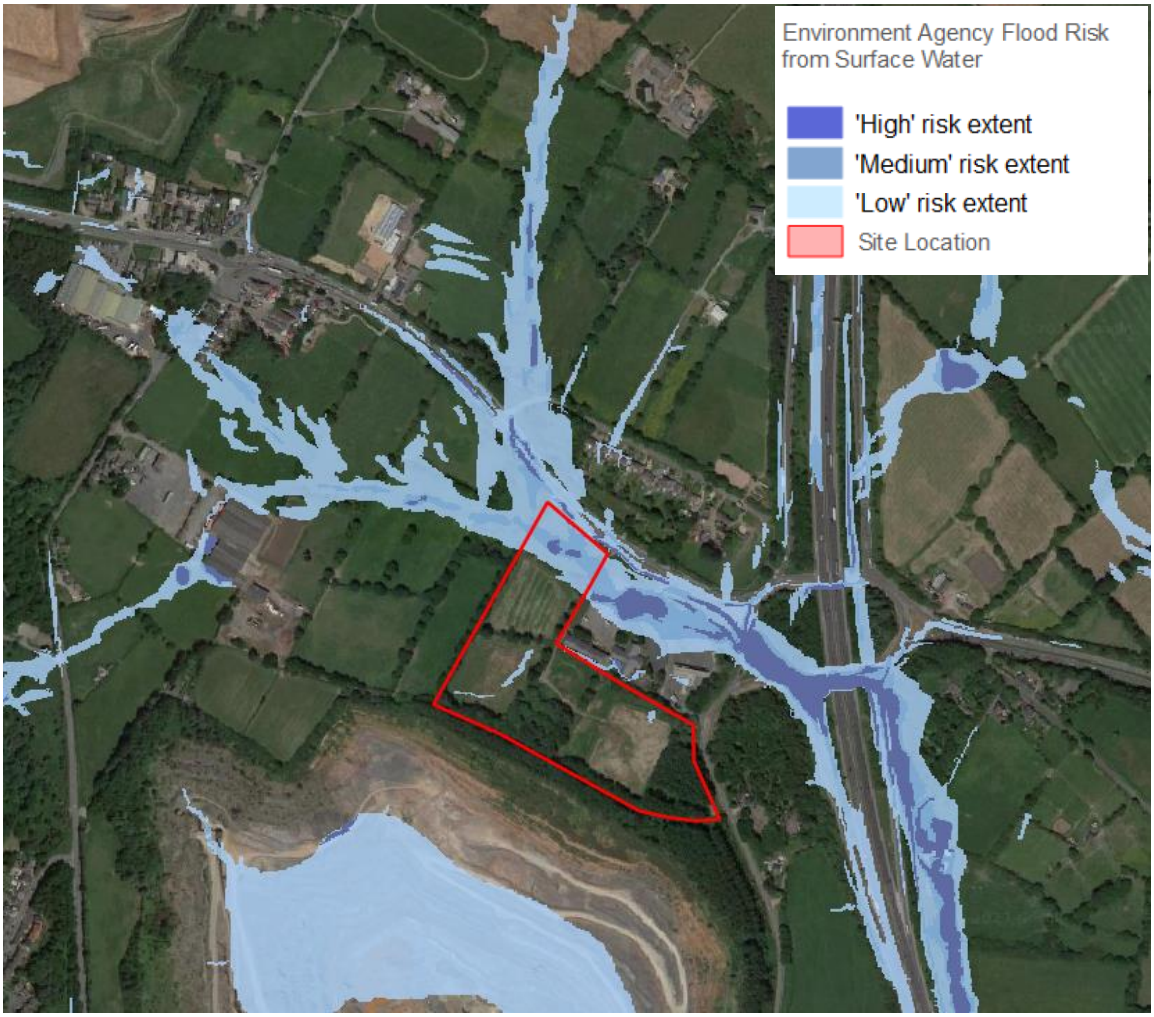

FIGURE 1: ENVIRONMENT AGENCY SURFACE WATER FLOOD MAP OVER GOOGLE SATELLITE MAP

The Ordnance Survey map (Figure 2) shows a network of drainage ditches associated with the natural surface water flow path that serves land in the area, one of which passes through the north part of the site.

Prior to the Cliffe Hill quarrying and long before the construction of the M1, historic OS Maps show a more natural river route in the late 1800s, following the natural contours of the land.

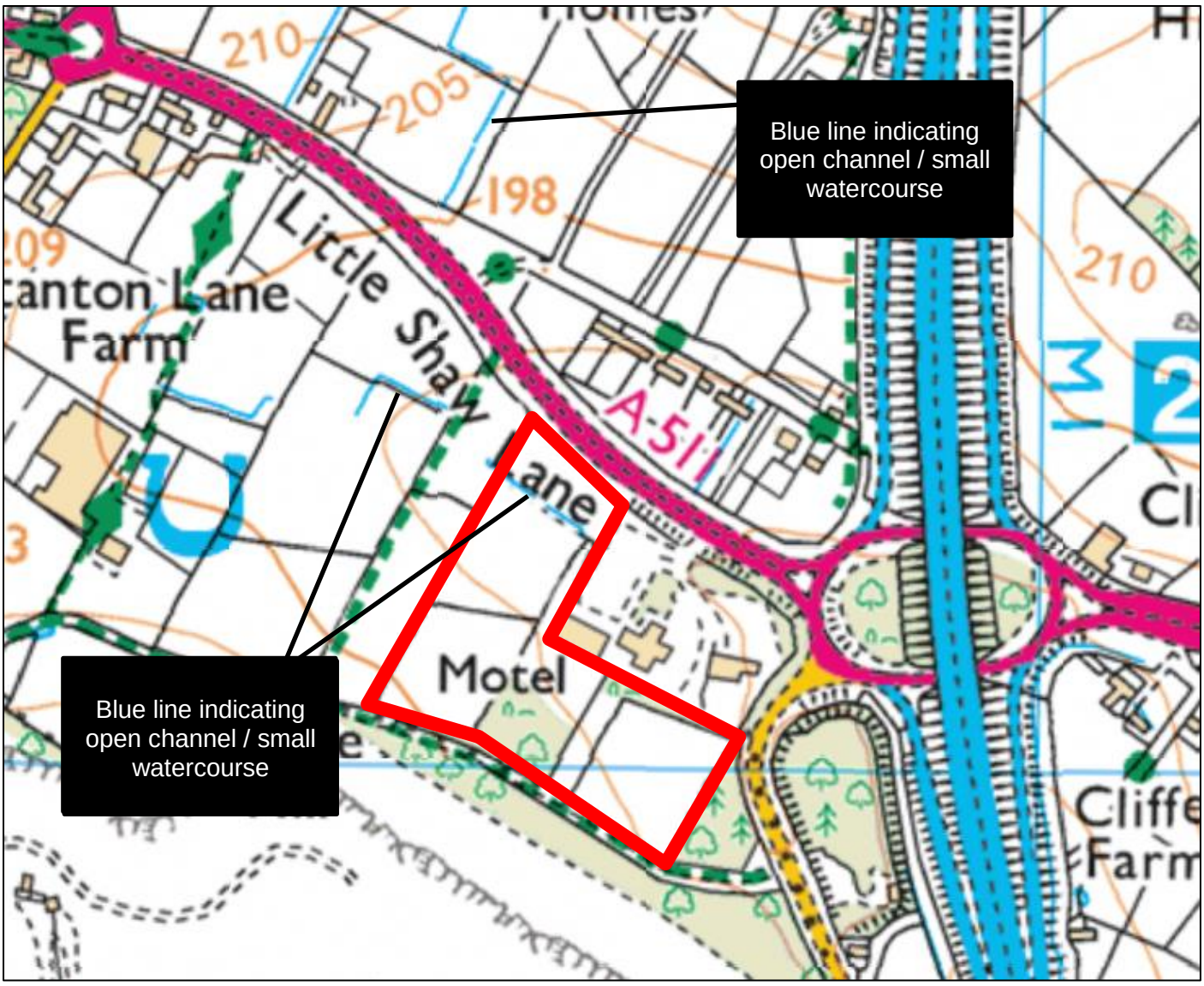

FIGURE 2: BING ORDNANCE SURVEY MAP

Figure 3 below shows the proposed outline masterplan on Google Satellite with the Environment Agency 1% AEP (medium risk) and 0.1% AEP (low risk) surface water risk extents overlain.

There is no development proposed within the 1% AEP surface water flood extent. However, a very small section of the northern most building (Unit D) is located on the edge of the 0.1% AEP surface water flow route extent. Unit D approaches to within 3m of the bank of the drainage ditch that passes through the site.

There are a few isolated very minor areas at low risk of surface water flooding elsewhere in the site such as near the proposed Units A and C. These areas reflect small depressions within the land that will be lost as the site is developed and a dedicated drainage system is implemented.

FIGURE 3: SURFACE WATER RISK (1% AEP AND 0.1% AEP EXTENTS) WITH PROPOSED PLAN

TABLE 2: ENVIRONMENT AGENCY SURFACE WATER RISK CATEGORIES

Surface Water Risk Category	Surface water flooding Annual Exceedance Probability
Very Low	< 0.1% (1 in 1000 years)
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	> 3.3% (1 in 30 years)

3.7 Artificial water bodies

The site is not shown as being at risk from reservoir flooding on the Environment Agency reservoir risk map.

There are no canals within the vicinity of the site that could pose a risk.

3.8 Groundwater

BGS online mapping reports the local bedrock to be mostly Edwalton and Gunthorpe Member, Mudstone, separated by a narrow vein of Cotgrave Sandstone Member – Sandstone, running northwest to southeast. Superficial deposits of Oadby Member – Diamicton are shown for much of the site, with the natural valley associated with the overland flow route shown as Alluvium - Clay, silt, sand and gravel.

Soilscapes describes the soil on the development as: 'Slowly permeable seasonally wet slightly acid clayey soils' with 'impeded drainage'.

The 2017 SFRA makes no reference to groundwater issues in the area.

BGS reports the bedrock at Old Cliffe Hill Quarry and various other quarries in the area as South Charnwood Diorites – Diorite. BGS borehole records located on the M1 to the east suggest a groundwater level several metres below ground.

Based on available data a more detailed analysis of groundwater flooding is not considered appropriate.

3.9 Sewers

The 2017 SRFA includes a 'Severn Trent Water internal flooding records' table in which the postcode 'LE67 9' has no recorded incidents.

Given the location of the site (agricultural fields to the west and a deep quarry to the south with ground falling north-east) it is unlikely that a sewer passes through the site. Any emergence of water near the existing service station and A511 would flow south-east in the natural flow path, away from the proposed site.

Based on available data a more detailed analysis of sewer flooding risk is not considered appropriate.

4.0 Mitigation Methods

4.1 Risk to buildings

4.1.1 Finished floor levels

In order to afford a level of protection against flooding it is normally recommended that finished floor levels are set 0.3 - 0.6m above the modelled 1% AEP plus climate change design flood level.

The Environment Agency's surface water flood risk map shows a natural surface water flow path has the potential to pass through the northern section of the site. Risk from this has been managed by adopting a sequential approach to locate the more vulnerable elements outside of this flow route, leaving the north field undeveloped.

Residual risk will be managed by raising all buildings 0.15m above local ground with the exception of Unit D which lies adjacent to the flow path, which will require further raising.

By comparing the 0.1% AEP modelled surface water extent with the topographic survey, the flood level close to Unit D is approximately 192.7mAOD. A finished floor level of 193.3mAOD would provide sufficient residual risk management for this building which is 0.6m above the flood level estimate.

4.1.2 Flood resistance

Flood resistance is a strategy of temporary or permanent measures taken to reduce the amount of flood water that will enter buildings. It is not considered appropriate to adopt a flood resistance strategy for the development given the assessed risk and proposed floor levels.

4.1.3 Flood resilience

Flood resilience measures are intended reduce damage to a building such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment. It is not considered appropriate to adopt a flood resilience strategy for the development given the assessed risk and proposed floor levels.

4.2 Risk to occupiers

4.2.1 Safe access/egress

Proposed access east onto Cliffe Lane is not expected to flood according to the Environment Agency's surface water risk map.

Safe access and egress are therefore considered achievable in all but the most extreme scenarios.

4.2.2 Flood warning and evacuation plan

The Environment Agency do not provide a flood warning or alert for the site. Given the assessed risk, and sequential location of development to the lowest risk areas of the site, a bespoke flood warning plan is not required.

4.3 Risk to others

4.3.1 Floodplain compensation

Environment Agency guidance states there must be no loss of flood storage capacity for flooding up to the 1% AEP plus climate change event.

In this case, the proposed development is not affected by fluvial flooding, however there is a surface water flow path that crosses the north part of the site as discussed in Section 3.6. A very small section of the northern most building (Unit D) is located on the edge of the 'low risk' 0.1% AEP surface water flood extent as shown in Figure 3. Any impact from this interaction within the site or elsewhere is expected to be negligible.

4.3.2 Surface water run-off

The existing site is entirely greenfield condition. It is proposed to create new impermeable features into the site which, if not managed properly, could have the potential to increase surface water runoff and degrade water quality leaving the site; therefore, a drainage strategy will be required in line with the principles of Sustainable Drainage Systems (SuDS).

The SuDS scheme should integrate surface water risk management within the site and provide water quality improvement to people and wildlife.

5.0 Drainage strategy

5.1 SuDS applicable policies

Leicestershire County Council SuDS guidance has been used to assist with this drainage strategy, along with CIRIA's SUDS Manual and LASOO Non-Statutory Technical Standards for Sustainable Drainage, Practice Guidance.

5.2 SuDS feasibility

The SuDS Manual (2015), discusses the SuDS approach to managing surface water runoff which is intended to mimic the natural catchment process as closely as is possible. The approach sets out the design objectives in respect of SuDS:

- Use of surface water runoff as a resource;
- Manage rainwater close to where it falls (at source);
- Manage runoff on the surface (above ground);
- Allow rainwater to soak into the ground (infiltration);
- Promote evapotranspiration;
- Slow and store runoff to mimic natural runoff rates and volumes;
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source; and
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

Depending on the characteristics of the site and local requirements, these may be used in conjunction and to varying degrees. Table 3 presents the functions of the SuDS components (from which a management train can be created) and their feasibility in respect of the site.

TABLE 3: FEASIBILITY OF SUDS TECHNIQUES AT THE DEVELOPMENT SITE

Technique	Description	Feasibility Y / N / M (Maybe)
Good building design and rainwater harvesting	Components that capture rainwater and facilitate its use within the building or local environment.	Y – Collection and re-use of water is viable.
Porous and pervious surface materials	Structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system (green roofs, pervious paving).	Y – Porous surfaces could be used on the proposed roads, car parking areas and building surrounds.
Infiltration Systems	Components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.	M - Ground conditions do not appear suitable for infiltration as the primary discharge method. Infiltration could feature to some extent via the utilisation of on-surface SuDS features subject to the results of ground testing.
Conveyance Systems	Components that convey flows to downstream storage systems (e.g. swales, watercourses).	Y - There is some scope within the proposal for surface conveyance.
Storage Systems	Components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff (e.g. ponds, wetlands, and detention basins).	Y – There is scope within the development to include a detention / retention storage feature.
Treatment Systems	Components that remove or facilitate the degradation of contaminants present in the runoff.	Y – There is scope within the development to introduce a SuDS treatment train.

5.3 Existing drainage

The entire 6.2 ha site is greenfield condition and falls from the southwest corner to the northeast with a general gradient of approximately 1:30.

The existing site includes four 'lateral' agricultural drainage ditches: one on the west boundary; one on the east boundary and 2 near the centre. These discharge into a main drainage ditch which serves land to the west before cutting through the north part of the site and continuing south-east. The main drain runs along the line of the natural surface water flow path discussed earlier in this report (Figure 4). The southeast section of the site is expected to primarily drain into the east boundary drain, with the majority of the site draining to the north main drain, potentially via the central laterals. The main drain continues south-east where it is expected to interact with the M1 drainage system, ultimately flowing east to the River Soar.

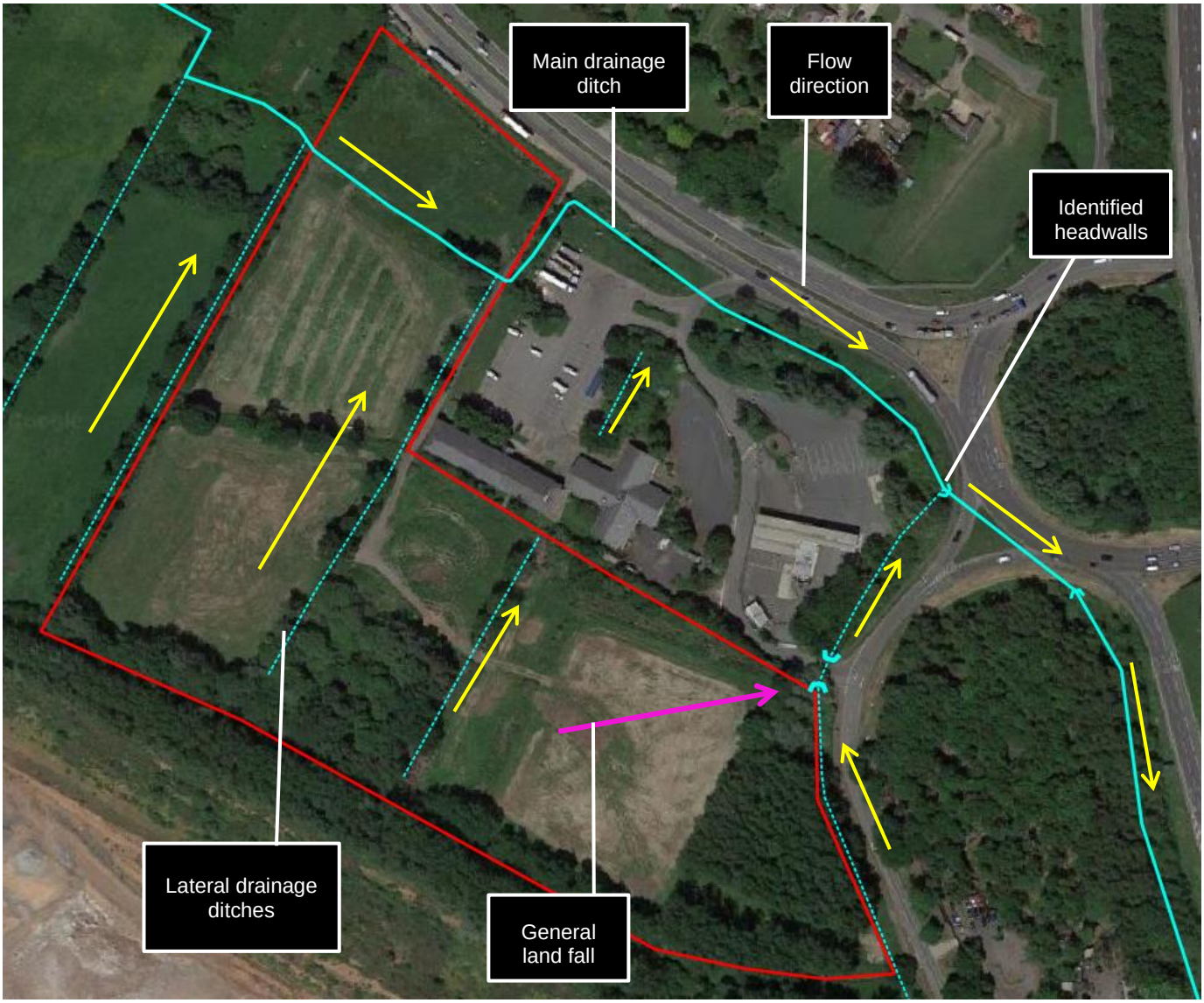

FIGURE 4: GOOGLE SATELLITE – EXISTING DRAINAGE

Greenfield runoff rates for the site have been calculated using the IH124 method (based on the interim Code of Practice of Sustainable Drainage Systems given the small site area).

IH124 parameters:

Area = 6.2ha SOIL = 0.450

SAAR = 700mm Region = 4

TABLE 4: ESTIMATE OF PRE-DEVELOPMENT PEAK RUNOFF RATES

Annual Exceedance Probability (AEP)	Peak Runoff Rate (l/s)
QBAR	27.2 (4.4 l/s/ha)
100% (1 year)	22.6 (3.6 l/s/ha)
3.33% (30 year)	53.4 (8.6 l/s/ha)
1% (100 year)	70.0 (11.3 l/s/ha)

Given the sloped site and concentration of flows into the various ditches and channels, the actual runoff from the site is potentially higher than the values shown in the table above.

5.4 Proposed drainage

It is proposed to construct 5 commercial / industrial units on the site, as well as associated parking and access road.

The recommended hierarchy for discharging surface water (ref. The SuDS Manual, CIRIA C753) is:

1. Infiltration to the maximum extent that is practical.
2. Discharge to surface waters.
3. Discharge to surface water sewer.
4. Discharge to combined sewers.

BGS online mapping reports the local bedrock to be mostly Edwalton and Gunthorpe Member, Mudstone, separated by a narrow vein of Cotgrave Sandstone Member – Sandstone, running northwest – southeast. Superficial deposits of Oadby Member – Diamicton are shown for much of the site, with the overland flow route natural valley shown as Alluvium - Clay, silt, sand and gravel. Soilscapes describes the soil on the development as: ‘Slowly permeable seasonally wet slightly acid clayey soils’ with ‘impeded drainage’. MicroDrainage gives a SOIL value of 0.450 for the site. Given the available data, infiltration as the primary method of discharging surface water runoff is unlikely to be viable. Opportunities are available for the use of infiltration to manage a degree of runoff for day-to-day rain events.

Given the above, the optimal strategy is simply to continue drainage via the existing drainage ditch network.

A drainage strategy is therefore proposed which comprises:

- Collecting rainfall from impermeable drained areas and conveying via SuDS systems as far as practicable.
- Attenuate and control flow as close as reasonably practicable to greenfield QBAR. In this case, greenfield QBAR for the proposed drained area is 16.7 l/s (3.8 ha masterplan drained area x 4.4 l/s/ha).
- Discharge to the existing eastern boundary lateral drain.

The drainage strategy should aim to create a SuDS treatment train based on a chain of some or all of the following viable components:

- Formal water harvesting or water butts on downpipes for reuse within the site.
- Online rain gardens / bioretention features – to offer green 'source control', to enhance water treatment benefit as well as evapotranspiration and infiltration potential.
- Type A permeable paving – to offer 'source control', to enhance water treatment benefit as well as infiltration potential, prior to water moving to downstream features.
- Swales / filter drains – to provide water treatment benefit as well as evapotranspiration and infiltration potential as part of drainage conveyance.
- Attenuation – SuDS basins or ponds to provide water storage, treatment, evapotranspiration and infiltration potential as well as amenity / biodiversity benefits while managing downstream flow control.

The ability of the site to deliver the above drainage strategy has been demonstrated by working up a conceptual scheme based on the outline masterplan. The details will of course vary depending on the final scheme brought forward.

The proof of viability conceptual scheme comprises:

- Convey surface water from proposed impermeable areas via a network of vegetated swales and underground pipes (specific arrangement to be set at detailed design stage) into a vegetated attenuation basin located towards the east extent of the site.
- A 2200m^2 vegetated attenuation basin with containment level of at least 190.7mAOD, 1.5m available storage depth and 1:3 sloped sides. Overflow spillway to direct exceedance into the adjacent eastern open channel (specific arrangement to be set at detailed design stage).
- Control the flow rate leaving the basin to 16.7 l/s via vortex flow controller set at the invert level of the basin.
- Controlled discharge from the basin into the east boundary lateral drain.

Runoff rates from the conceptual scheme have been calculated using MicroDrainage 2020.1.3[1] Source Control for the full range of storm events, with results summarised in Table 5, with all results included in Appendix C.

TABLE 5: SUMMARY OF MICRODRAINAGE RESULTS

Annual Exceedance Probability (AEP)	Critical Storm	Peak Water depth in basin	Total Final Peak Outflow Rate
1 in 1 (100%)	480-minute winter	0.333m	16.5 l/s
1 in 30 (3.33%)	600-minute winter	0.807m	16.7 l/s
1 in 100 +CC (1% +40% CC)	960-minute winter	1.497m	16.7 l/s

This indicative proof of concept arrangement for the proposed drainage strategy is shown below in Figure 5.

The conceptual scheme is subject to the following contraints:

- Discharge location is the eastern boundary drain – All land up to and including the left bank is under the ownership of the applicant.

  A consent from the Lead Local Flood Authority may be required to construct an outlet structure at this drain.

- The lowest level of the site (eastern corner of the attenuation basin) is 190.4mAOD. Therefore, in order to achieve a 1.5m available storage depth and a gravity fall into the drain, the basin would require slight containment embanking on the eastern corner – up to a level of at least 190.7mAOD.

  This would allow a basin invert level of 189.2mAOD. The bed level of the eastern boundary drain (adjacent the attenuation basin location) is lower, at 189.1mAOD – Therefore, a gravity discharge is viable with an outfall level into the drain set at 189.15mAOD,

The above demonstrates that the site is capable of delivering a SuDS drainage scheme for the proposed quantum of development.

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[1] ***Summary of MicroDrainage Network test parameters:***
2200m² Pond – 1.5m available storage depth – No infiltration
Total drained area = 3.8ha (impermeable area plus account for direct rain in basin + 10% urban creep).
5 min time of concentration
FSR Rainfall – M5-60 = 20.600mm – Ratio R = 0.400
Flow Control = 0.176m diameter Hydrobrake set at invert level of basin – Qmax = 16.7 l/s

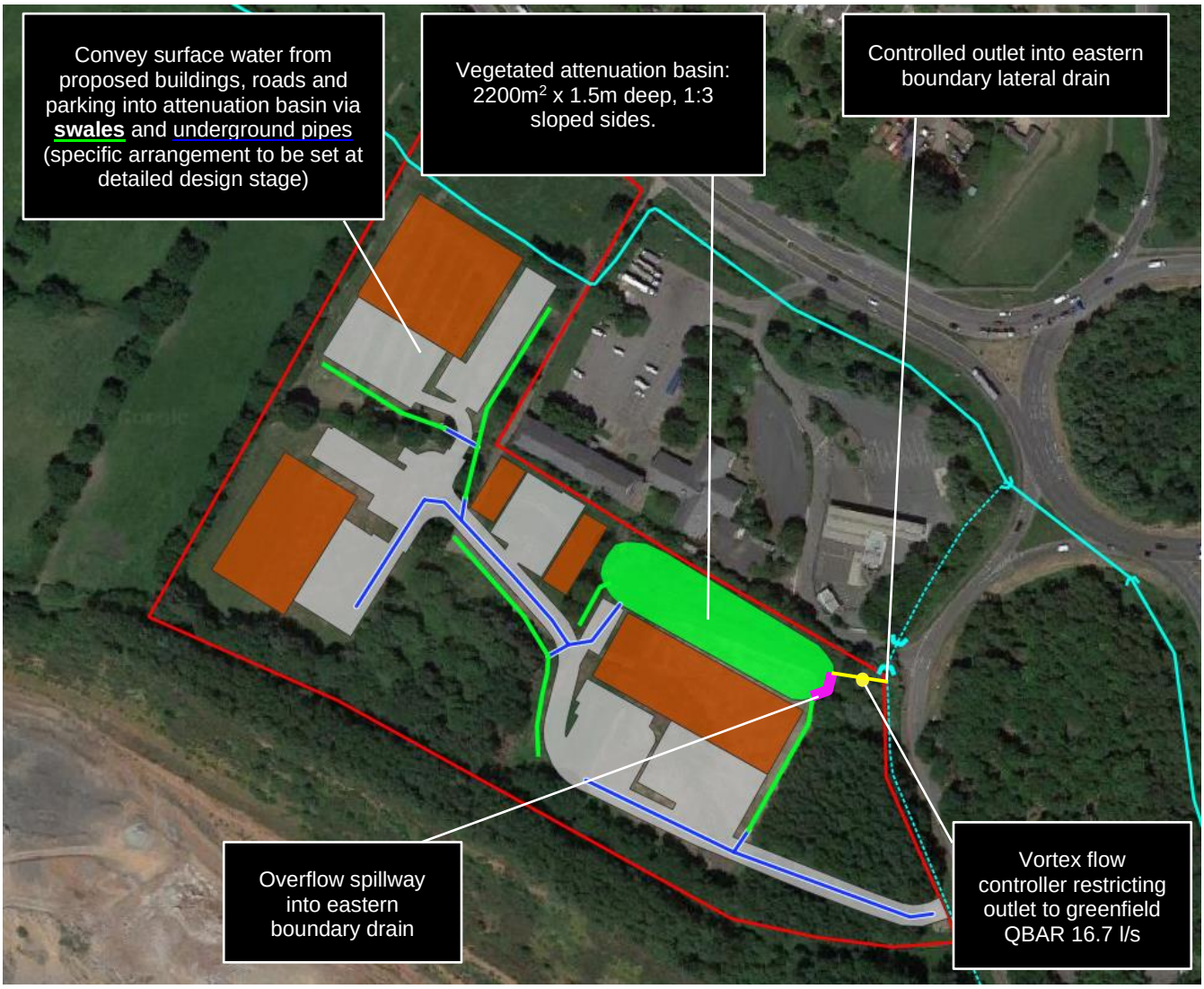

FIGURE 5: PLAN SHOWING THE CONCEPTUAL SURFACE WATER DRAINAGE SCHEME

By developing a SuDS treatment train as set out above the following benefits can be released: water quantity, **runoff** rate and volume can be managed by utilising a SuDS treatment train, including attenuation storage to temporarily contain surface water while discharge is appropriately controlled. The scheme can also manage flood risk, such that no flooding occurs for events up to and including the 1% AEP +40% CC. The scheme has the potential to also safely manage exceedance and **system failure** scenarios as overflow routes can be created within the site that direct water north or east into the perimeter drains where no vulnerable receptors are located.

The drainage scheme will control water quality by the use of a SuDS treatment train that includes surface SuDS features which provide settlement time and promotes evapotranspiration. There will also be opportunity for water to naturally infiltrate into the ground as it passes through the system.

The proposed drainage system also provides the opportunity for amenity and biodiversity enhancement within the local environment, complementing the local habitat. On-surface SuDS features that are vegetated and landscaped provide diverse habitats for wildlife as well as create visually attractive green areas which can improve the well-being of people.

6.0 Conclusion

Outline planning permission is sought for the construction of 5 commercial / industrial units as well as access road and parking at Land at Cliffe Lane, Markfield LE67 9TE.

The site is within Flood Zone 1, the lowest risk zone, on the Environment Agency Flood map for planning.

A surface water flow path has been identified that passes through the north of the site. This risk has been managed by following a sequential approach to locate the more vulnerable aspects of the development to the lowest risk areas and setting finished floor levels at a suitable level.

Safe access and egress is expected in all but the most extreme flood scenario.

Viability has been shown for the use of SuDS to drain the proposed site and suitable components have been identified. A ‘proof of viability’ conceptual drainage scheme has been established and tested that would manage all runoff up to and including the 1% AEP plus climate change (40%) event.

It is concluded that the proposed development is appropriate for the flood risk and is not expected to increase the risk of flooding elsewhere.

7.0 Recommendations

- Set finished floor level of all buildings at least 150mm above surrounding ground in line with normal building practice, while also setting the finished floor level of Unit D at a minimum level of 193.3mAOD.
- Design a detailed SuDS drainage scheme in line with the drainage strategy set out in this report.
- Consult with the Lead Local Flood Authority regarding the discharge of surface water into the adjacent eastern boundary drain.
- Consult with the Lead Local Flood Authority regarding any consents needed for the proposed works to the flow path through the north of the site.
- Construction (Design and Management) Regulations 2015:
    - The revised CDM Regulations came into force in April 2015, which defines the duties for all parties involved in a construction project, including those promoting the development. One of the designer’s responsibilities is to ensure that the client organisation, in this instance MTS (Storage & Distribution) Ltd, is made aware of their duties (please see link for Commercial Client) under the CDM Regulations.

Appendix A – Topographic survey

Existing Topographical Survey

Scale 1 : 1250

0m 1.0 2 3.0 4 6 8 10m

SCALE 1:100

0m 2.0 4 6.0 8 12 16 20m

SCALE 1:200

Rev.	Revision Description	Drn	Chk	Apvd	Date

Startin & Co
PROPERTY DESIGN

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Client:

JMI Planning Ltd.

Title:

Land At Cliffe Lane
Markfield LE67 9TE
Existing Topographical Survey

Drawn by:	Date:	Index No.:
AjS	March 2021	

Scales:

As Shown Paper Size A1

Drawing No:	Revision
2021-014-001	

Appendix B – Proposed Plans

Indicative Site Layout 1:500

north

NOTES:
Figured dimensions must be taken in preference to scaled dimensions and any discrepancies must be referred to Urban Designs Ltd immediately.
Contractors, subcontractors and suppliers must verify all dimensions on site before commencing any work or making any workshop drawings.
Any indication of services is approximate only and full investigation should be carried out on site prior to commencing the works.
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CIAT CHARTERED PRACTICE

Schedule of Accommodation

UNIT A	3162m2
UNIT B1	340m2
UNIT B2	226m2
UNIT B3	226m2
UNIT C	2482m2
UNIT D	3058m2
	10532m2

KEY

Existing Tree retained

Tree to be removed

Rev	Description	Date	Ch
A	Amendments following comments from JMI Planning following FRA.	26.10.23	AR

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Drawing: Indicative Site Layout

Client: MTS (Storage and Distribution) Ltd

Job: Land At Cliffe Road
Markfield
Leicestershire

Scale: 1:500@A0 Drawn By: AR

Date: 24.08.23 Checked By:

Drawing No.
2023-775-P-01A

NOTES:
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Any indication of services is approximate only and full investigation should be carried out on site prior to commencing the works.
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View 1

View 2

View 3

Key Plan

Rev	Description	Date	CB
A	Amendments following comments from JMI Planning following FRA.	26.10.23	AR

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Drawing: Indicative Site Views

Client: MTS (Storage and Distribution) Ltd

Job: Land At Cliffe Road
Markfield
Leicestershire

Scale: 1:500@A0 Drawn By: AR

Date: 24.08.23 Checked By:

Drawing No.
2023-775-P-02

Appendix C – MicroDrainage Source Control Results

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.145	0.145	11.0	222.0	O K
30 min Summer	0.184	0.184	14.3	284.0	O K
60 min Summer	0.224	0.224	15.5	346.9	O K
120 min Summer	0.260	0.260	15.9	404.9	O K
180 min Summer	0.277	0.277	16.1	431.2	O K
240 min Summer	0.286	0.286	16.2	446.6	O K
360 min Summer	0.296	0.296	16.2	462.0	O K
480 min Summer	0.300	0.300	16.3	469.0	O K
600 min Summer	0.301	0.301	16.3	470.8	O K
720 min Summer	0.300	0.300	16.3	469.3	O K
960 min Summer	0.294	0.294	16.2	460.3	O K
1440 min Summer	0.277	0.277	16.1	431.4	O K
2160 min Summer	0.247	0.247	15.8	383.0	O K
2880 min Summer	0.220	0.220	15.4	340.1	O K
4320 min Summer	0.184	0.184	14.3	283.2	O K
5760 min Summer	0.163	0.163	12.7	250.3	O K
7200 min Summer	0.149	0.149	11.4	227.5	O K
8640 min Summer	0.138	0.138	10.3	210.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.960	0.0	195.4	19
30 min Summer	20.886	0.0	263.2	34
60 min Summer	13.233	0.0	359.4	62
120 min Summer	8.216	0.0	449.7	122
180 min Summer	6.188	0.0	509.8	180
240 min Summer	5.055	0.0	556.4	206
360 min Summer	3.766	0.0	623.2	270
480 min Summer	3.054	0.0	674.5	338
600 min Summer	2.595	0.0	717.0	406
720 min Summer	2.272	0.0	753.5	476
960 min Summer	1.842	0.0	814.6	610
1440 min Summer	1.371	0.0	907.5	880
2160 min Summer	1.021	0.0	1035.1	1256
2880 min Summer	0.827	0.0	1116.9	1616
4320 min Summer	0.615	0.0	1238.6	2332
5760 min Summer	0.499	0.0	1358.1	3056
7200 min Summer	0.424	0.0	1442.1	3752
8640 min Summer	0.372	0.0	1513.2	4496

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Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	0.129	0.129	9.4	197.6	O K
15 min Winter	0.162	0.162	12.5	248.5	O K
30 min Winter	0.206	0.206	15.2	318.6	O K
60 min Winter	0.252	0.252	15.8	391.1	O K
120 min Winter	0.294	0.294	16.2	458.9	O K
180 min Winter	0.314	0.314	16.3	491.6	O K
240 min Winter	0.324	0.324	16.4	509.1	O K
360 min Winter	0.331	0.331	16.4	520.1	O K
480 min Winter	0.333	0.333	16.5	523.7	O K
600 min Winter	0.331	0.331	16.4	520.7	O K
720 min Winter	0.327	0.327	16.4	513.6	O K
960 min Winter	0.314	0.314	16.4	492.4	O K
1440 min Winter	0.282	0.282	16.1	439.9	O K
2160 min Winter	0.235	0.235	15.6	363.9	O K
2880 min Winter	0.198	0.198	15.0	305.6	O K
4320 min Winter	0.161	0.161	12.5	247.7	O K
5760 min Winter	0.141	0.141	10.6	215.0	O K
7200 min Winter	0.127	0.127	9.1	194.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.333	0.0	1571.8	5240
15 min Winter	31.960	0.0	221.9	19
30 min Winter	20.886	0.0	298.0	33
60 min Winter	13.233	0.0	404.3	62
120 min Winter	8.216	0.0	505.5	120
180 min Winter	6.188	0.0	572.8	176
240 min Winter	5.055	0.0	625.1	230
360 min Winter	3.766	0.0	699.9	288
480 min Winter	3.054	0.0	757.4	364
600 min Winter	2.595	0.0	805.0	442
720 min Winter	2.272	0.0	845.9	518
960 min Winter	1.842	0.0	914.4	664
1440 min Winter	1.371	0.0	1019.1	940
2160 min Winter	1.021	0.0	1160.7	1320
2880 min Winter	0.827	0.0	1252.7	1672
4320 min Winter	0.615	0.0	1390.2	2376
5760 min Winter	0.499	0.0	1522.0	3064
7200 min Winter	0.424	0.0	1616.3	3816

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Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Winter	0.117	0.117	8.1	179.1	O K
10080 min Winter	0.110	0.110	7.3	167.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	0.372	0.0	1696.6	4504
10080 min Winter	0.333	0.0	1763.8	5240

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 3.800

Time (mins) From:	**To:**	**Area (ha)**
0	5	3.800

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Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1500.0	1.500	2200.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0176-1670-1500-1670
Design Head (m)	1.500
Design Flow (l/s)	16.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	176
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	16.7	Kick-Flo®	0.961	13.5
Flush-Flo™	0.440	16.7	Mean Flow over Head Range	-	14.4

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	6.2	1.200	15.0	3.000	23.2	7.000	34.9
0.200	15.1	1.400	16.2	3.500	25.0	7.500	36.1
0.300	16.3	1.600	17.2	4.000	26.7	8.000	37.3
0.400	16.6	1.800	18.2	4.500	28.2	8.500	38.4
0.500	16.6	2.000	19.1	5.000	29.7	9.000	39.4
0.600	16.4	2.200	20.0	5.500	31.1	9.500	40.5
0.800	15.5	2.400	20.9	6.000	32.4		
1.000	13.8	2.600	21.7	6.500	33.7		

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.348	0.348	16.5	547.7	O K
30 min Summer	0.443	0.443	16.7	706.6	O K
60 min Summer	0.535	0.535	16.7	863.8	O K
120 min Summer	0.618	0.618	16.7	1009.9	O K
180 min Summer	0.658	0.658	16.7	1082.0	O K
240 min Summer	0.681	0.681	16.7	1122.0	O K
360 min Summer	0.703	0.703	16.7	1162.8	O K
480 min Summer	0.709	0.709	16.7	1172.6	O K
600 min Summer	0.706	0.706	16.7	1167.4	O K
720 min Summer	0.702	0.702	16.7	1159.7	O K
960 min Summer	0.690	0.690	16.7	1138.2	O K
1440 min Summer	0.658	0.658	16.7	1081.6	O K
2160 min Summer	0.603	0.603	16.7	983.0	O K
2880 min Summer	0.547	0.547	16.7	884.7	O K
4320 min Summer	0.445	0.445	16.7	709.4	O K
5760 min Summer	0.361	0.361	16.6	569.8	O K
7200 min Summer	0.298	0.298	16.2	465.2	O K
8640 min Summer	0.250	0.250	15.8	387.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.451	0.0	517.0	20
30 min Summer	51.051	0.0	678.5	34
60 min Summer	31.749	0.0	882.9	64
120 min Summer	19.153	0.0	1067.5	124
180 min Summer	14.094	0.0	1179.2	182
240 min Summer	11.286	0.0	1259.3	242
360 min Summer	8.254	0.0	1381.4	362
480 min Summer	6.603	0.0	1472.9	480
600 min Summer	5.550	0.0	1546.6	548
720 min Summer	4.814	0.0	1608.6	602
960 min Summer	3.843	0.0	1709.2	722
1440 min Summer	2.795	0.0	1853.9	984
2160 min Summer	2.031	0.0	2068.6	1388
2880 min Summer	1.618	0.0	2196.0	1788
4320 min Summer	1.173	0.0	2379.8	2552
5760 min Summer	0.933	0.0	2545.3	3280
7200 min Summer	0.781	0.0	2661.6	3960
8640 min Summer	0.675	0.0	2757.9	4664

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	0.215	0.215	15.3	332.3	O K
15 min Winter	0.388	0.388	16.6	614.3	O K
30 min Winter	0.494	0.494	16.7	793.4	O K
60 min Winter	0.596	0.596	16.7	971.1	O K
120 min Winter	0.690	0.690	16.7	1139.2	O K
180 min Winter	0.737	0.737	16.7	1224.3	O K
240 min Winter	0.764	0.764	16.7	1273.6	O K
360 min Winter	0.794	0.794	16.7	1329.1	O K
480 min Winter	0.806	0.806	16.7	1350.6	O K
600 min Winter	0.807	0.807	16.7	1352.7	O K
720 min Winter	0.801	0.801	16.7	1342.5	O K
960 min Winter	0.780	0.780	16.7	1303.5	O K
1440 min Winter	0.736	0.736	16.7	1222.3	O K
2160 min Winter	0.653	0.653	16.7	1072.9	O K
2880 min Winter	0.568	0.568	16.7	921.3	O K
4320 min Winter	0.414	0.414	16.7	658.4	O K
5760 min Winter	0.300	0.300	16.3	469.4	O K
7200 min Winter	0.225	0.225	15.5	348.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.597	0.0	2835.8	5344
15 min Winter	78.451	0.0	581.6	19
30 min Winter	51.051	0.0	761.3	34
60 min Winter	31.749	0.0	990.3	64
120 min Winter	19.153	0.0	1196.8	122
180 min Winter	14.094	0.0	1321.7	180
240 min Winter	11.286	0.0	1411.1	238
360 min Winter	8.254	0.0	1547.4	354
480 min Winter	6.603	0.0	1649.2	466
600 min Winter	5.550	0.0	1731.1	576
720 min Winter	4.814	0.0	1799.8	684
960 min Winter	3.843	0.0	1910.8	786
1440 min Winter	2.795	0.0	2067.4	1080
2160 min Winter	2.031	0.0	2317.7	1516
2880 min Winter	1.618	0.0	2460.6	1932
4320 min Winter	1.173	0.0	2668.8	2684
5760 min Winter	0.933	0.0	2851.7	3400
7200 min Winter	0.781	0.0	2982.4	4032

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Winter	0.186	0.186	14.5	286.4	O K
10080 min Winter	0.167	0.167	13.0	256.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	0.675	0.0	3090.9	4584
10080 min Winter	0.597	0.0	3180.2	5256

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 3.800

Time (mins) From:	To:	Area (ha)
0	5	3.800

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Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1500.0	1.500	2200.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0176-1670-1500-1670
Design Head (m)	1.500
Design Flow (l/s)	16.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	176
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	16.7	Kick-Flo®	0.961	13.5
Flush-Flo™	0.440	16.7	Mean Flow over Head Range	-	14.4

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	6.2	1.200	15.0	3.000	23.2	7.000	34.9
0.200	15.1	1.400	16.2	3.500	25.0	7.500	36.1
0.300	16.3	1.600	17.2	4.000	26.7	8.000	37.3
0.400	16.6	1.800	18.2	4.500	28.2	8.500	38.4
0.500	16.6	2.000	19.1	5.000	29.7	9.000	39.4
0.600	16.4	2.200	20.0	5.500	31.1	9.500	40.5
0.800	15.5	2.400	20.9	6.000	32.4		
1.000	13.8	2.600	21.7	6.500	33.7		

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.615	0.615	16.7	1003.9	O K
30 min Summer	0.784	0.784	16.7	1311.0	O K
60 min Summer	0.949	0.949	16.7	1621.6	O K
120 min Summer	1.101	1.101	16.7	1920.8	O K
180 min Summer	1.178	1.178	16.7	2075.2	O K
240 min Summer	1.223	1.223	16.7	2167.6	Flood Risk
360 min Summer	1.281	1.281	16.7	2287.7	Flood Risk
480 min Summer	1.312	1.312	16.7	2353.2	Flood Risk
600 min Summer	1.328	1.328	16.7	2387.4	Flood Risk
720 min Summer	1.335	1.335	16.7	2401.5	Flood Risk
960 min Summer	1.330	1.330	16.7	2392.2	Flood Risk
1440 min Summer	1.293	1.293	16.7	2312.8	Flood Risk
2160 min Summer	1.233	1.233	16.7	2189.2	Flood Risk
2880 min Summer	1.175	1.175	16.7	2069.3	O K
4320 min Summer	1.060	1.060	16.7	1838.3	O K
5760 min Summer	0.935	0.935	16.7	1595.4	O K
7200 min Summer	0.809	0.809	16.7	1356.3	O K
8640 min Summer	0.698	0.698	16.7	1153.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	142.699	0.0	949.7	20
30 min Summer	93.626	0.0	1220.3	35
60 min Summer	58.456	0.0	1631.7	66
120 min Summer	35.213	0.0	1959.3	124
180 min Summer	25.807	0.0	2145.3	184
240 min Summer	20.567	0.0	2269.2	244
360 min Summer	14.959	0.0	2443.3	362
480 min Summer	11.918	0.0	2538.4	482
600 min Summer	9.984	0.0	2562.6	602
720 min Summer	8.635	0.0	2546.1	722
960 min Summer	6.862	0.0	2496.4	960
1440 min Summer	4.956	0.0	2384.8	1240
2160 min Summer	3.574	0.0	3637.5	1620
2880 min Summer	2.831	0.0	3833.5	2020
4320 min Summer	2.035	0.0	4084.0	2852
5760 min Summer	1.609	0.0	4393.2	3680
7200 min Summer	1.340	0.0	4572.3	4392
8640 min Summer	1.154	0.0	4719.5	5104

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	0.600	0.600	16.7	978.9	O K
15 min Winter	0.683	0.683	16.7	1125.6	O K
30 min Winter	0.870	0.870	16.7	1470.9	O K
60 min Winter	1.051	1.051	16.7	1821.7	O K
120 min Winter	1.218	1.218	16.7	2159.0	Flood Risk
180 min Winter	1.304	1.304	16.7	2336.1	Flood Risk
240 min Winter	1.355	1.355	16.7	2443.8	Flood Risk
360 min Winter	1.422	1.422	16.7	2587.3	Flood Risk
480 min Winter	1.459	1.459	16.7	2669.6	Flood Risk
600 min Winter	1.481	1.481	16.7	2717.1	Flood Risk
720 min Winter	1.493	1.493	16.7	2742.3	Flood Risk
960 min Winter	1.497	1.497	16.7	2751.0	Flood Risk
1440 min Winter	1.464	1.464	16.7	2680.3	Flood Risk
2160 min Winter	1.390	1.390	16.7	2518.8	Flood Risk
2880 min Winter	1.316	1.316	16.7	2362.0	Flood Risk
4320 min Winter	1.158	1.158	16.7	2035.5	O K
5760 min Winter	0.987	0.987	16.7	1696.0	O K
7200 min Winter	0.785	0.785	16.7	1312.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.016	0.0	4839.4	5848
15 min Winter	142.699	0.0	1059.2	20
30 min Winter	93.626	0.0	1324.6	34
60 min Winter	58.456	0.0	1824.9	64
120 min Winter	35.213	0.0	2184.4	122
180 min Winter	25.807	0.0	2380.6	182
240 min Winter	20.567	0.0	2500.4	240
360 min Winter	14.959	0.0	2610.9	358
480 min Winter	11.918	0.0	2605.7	474
600 min Winter	9.984	0.0	2586.2	590
720 min Winter	8.635	0.0	2564.4	704
960 min Winter	6.862	0.0	2521.1	928
1440 min Winter	4.956	0.0	2439.3	1356
2160 min Winter	3.574	0.0	4069.4	1704
2880 min Winter	2.831	0.0	4283.1	2164
4320 min Winter	2.035	0.0	4459.2	3076
5760 min Winter	1.609	0.0	4920.8	3984
7200 min Winter	1.340	0.0	5122.2	4688

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Winter	0.620	0.620	16.7	1012.8	O K
10080 min Winter	0.482	0.482	16.7	773.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	1.154	0.0	5288.1	5368
10080 min Winter	1.016	0.0	5424.9	6048

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.800

Time (mins) From:	To:	Area (ha)
0	5	3.800

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Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1500.0	1.500	2200.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0176-1670-1500-1670
Design Head (m)	1.500
Design Flow (l/s)	16.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	176
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	16.7	Kick-Flo®	0.961	13.5
Flush-Flo™	0.440	16.7	Mean Flow over Head Range	-	14.4

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	6.2	1.200	15.0	3.000	23.2	7.000	34.9
0.200	15.1	1.400	16.2	3.500	25.0	7.500	36.1
0.300	16.3	1.600	17.2	4.000	26.7	8.000	37.3
0.400	16.6	1.800	18.2	4.500	28.2	8.500	38.4
0.500	16.6	2.000	19.1	5.000	29.7	9.000	39.4
0.600	16.4	2.200	20.0	5.500	31.1	9.500	40.5
0.800	15.5	2.400	20.9	6.000	32.4		
1.000	13.8	2.600	21.7	6.500	33.7		

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