



**Gravesend Live Fire Skills House,
Wharf Road,
Gravesend,
Kent**

Flood Risk & Drainage Assessment
A111364

September 2020
Prepared on behalf of
Metropolitan Police Service

3 Sovereign Square, Leeds, LS1 4ER
Tel: +44 (0)113 278 7111 Fax: +44 (0)113 219 2317
Email: Website: www.wyg.com

Registered Office: WYG Engineering Limited. Registered in England number: 1959704.
Registered Office: 3 Sovereign Square, Leeds, LS1 4ER VAT No: 431-0326-08.

Document Control

Document:	Flood Risk & Drainage Assessment
Project:	Gravesend Live Fire Skills House
Client:	Metropolitan Police Service
Job Number:	A111364
File Origin:	\\londondc02\X-Drive\Projects\2012\8101 C&S\A100000\A111364 - Gravesend Live Fire Skills House\40 Reports\48. Flood Risk and Drainage Assessment

Revision:	Draft for comment		
Date:	August 2020		
Prepared by:	Checked by:	Approved by:	
Juliet Brown	Colin Davidson	Colin Davidson	
Description of revision: -			

Revision:	For Planning		
Date:	September 2020		
Prepared by:	Checked by:	Approved by:	
Juliet Brown	Colin Davidson	Colin Davidson	
Description of revision:			

Revision:			
Date:			
Prepared by:	Checked by:	Approved by:	
Description of revision:			

Contents

1.0	Introduction	1
1.1	Purpose of this report	1
1.2	Requirement for this Report	1
1.2.1	Requirement for the Flood Risk Assessment.....	1
1.2.2	Requirement for the Drainage Assessment	1
1.3	Scope of this Report	2
1.3.1	Scope of the Flood Risk Assessment.....	2
1.3.2	Scope of the Drainage Assessment.....	2
1.4	Limitations of this report	2
2.0	Site Description	3
2.1	Existing Site	3
2.2	Existing Drainage	4
2.2.1	Main Rivers.....	4
2.2.2	Ordinary & Manmade Watercourses	5
2.2.3	Sewers.....	5
2.3	Ground Conditions.....	5
2.3.1	Geology.....	5
2.3.2	Hydrogeology	5
2.3.3	Ground Investigation.....	6
3.0	Flood Risk	7
3.1	Fluvial / Tidal Flooding.....	7
3.2	Surface Water & Overland Flows	9
3.3	Groundwater Flooding	10
3.4	Sewer Flooding	11
3.5	Reservoir Flooding.....	11

3.6	Summary of Flood Risk	11
4.0	Development Proposals	13
4.1	Proposed Development	13
4.2	Sequential & Exception Tests	13
4.3	Local Planning Policy	13
4.3.1	Gravesham Local Plan	13
4.3.2	Kent County Council Drainage and Planning Policy (December 2019)	14
4.4	Development & Flood Risk	14
4.4.1	Flood Risk to the Development	14
4.4.2	Finished Floor Levels	15
4.4.3	Flood Resilience Measures	15
4.4.4	Flood Warning / Evacuation	15
4.4.5	Flood Risk Arising from the Development	15
4.5	Surface Water Management	16
4.5.1	Drainage Hierarchy	16
4.5.2	Pre and Post-Development Areas	17
4.5.3	Pre and Post-Development Discharge Rates.....	17
4.5.4	Required Attenuation	17
4.5.5	Proposed Surface Water Drainage Strategy	18
4.6	Exceedance Flows	18
5.0	Sustainable Drainage.....	19
5.1	Review of SuDS Options	19
5.2	The SuDS Management Train	19
5.3	Proposed SuDS Principles.....	21
5.4	Water Quality.....	21
5.5	SuDS Maintenance.....	22
6.0	Foul Drainage Assessment	23

6.1	Proposed Foul Drainage Strategy	23
7.0	Consents Required	24
7.1	Environmental Permit	24
8.0	Conclusions & Recommendations	25
8.1	Conclusions.....	25
8.2	Recommendations	26

Appendices

Appendix A	–	Proposed Site Layout Plan
Appendix B	–	Topographical Survey
Appendix C	-	Existing Site Drainage Records
Appendix D	-	Environment Agency Product 6 Model Output Data
Appendix E	–	Greenfield Runoff Calculations
Appendix F	–	Quick Storage Estimates
Appendix G	–	Proposed Drainage Strategy Plan
Appendix H	–	Supporting Drainage Calculations

1.0 Introduction

1.1 Purpose of this report

WYG Engineering Ltd have been commissioned by the Metropolitan Police Service to undertake a Flood Risk & Drainage Assessment to support a full planning application to Gravesham Borough Council (GBC) for development of a Live Fire Training Facility within the existing Metropolitan Police Service Specialist Training Centre, Wharf Road, Gravesend.

The proposed site layout is contained within Appendix A.

1.2 Requirement for this Report

1.2.1 Requirement for the Flood Risk Assessment

The application site covers an area of approximately 0.15 ha and is located entirely within Flood Zone 3, i.e. land assessed as having a greater than 1 in 200 annual probability ($>0.5\%$ AEP¹) of tidal flooding; or greater than 1 in 100 annual probability ($>1\%$ AEP¹) of fluvial flooding in any one year. In accordance with the National Planning Policy Framework (NPPF) (Chapter 14)² a Flood Risk Assessment (FRA) is required to support planning where a development located within Flood Zone 2 or 3, even where the site area does not exceed than 1 ha³.

1.2.2 Requirement for the Drainage Assessment

The NPPF aims to ensure that development does not increase flood risk elsewhere and reduces flood risk where possible⁴. To this end, surface water runoff from a developed site should be managed to avoid increasing the risk of surface water flooding and, as far as it is practicable, reduce the risk to the site itself and areas elsewhere.

From 6 April 2015, Ministerial Statement HCWS 161 requires that planning policy and decisions on planning applications relating to major development are required to ensure that sustainable drainage systems (SuDS) are used for the management of surface water.

¹ The Annual Exceedance Probability (AEP) is the probability, expressed as a %, of a flood event occurring in any year. A large flood which may be calculated to have a 1% chance of occurring in any one year is described as 1% AEP.

² Ministry of Housing, Communities and Local Government (June 2019), *National Planning Policy Framework*

³ NPPF paragraph 163 Note 50

⁴ NPPF paragraph 155

1.3 Scope of this Report

1.3.1 Scope of the Flood Risk Assessment

The FRA will be undertaken in accordance with the national policy and guidance from the NPPF, Planning Practice Guidance (PPG) (Flood Risk and Coastal Change)⁵ and Environment Agency⁶ as well as local policy and guidance from GBC as Local Planning Authority (LPA) and Kent County Council (KCC) as Lead Local Flood Authority (LLFA).

The FRA will consider all potential sources of flood risk including Main Rivers, Ordinary Watercourses (not shown on the Environment Agency's flood maps), surface water and overland flow routes, groundwater, sewers, reservoirs and canals.

1.3.2 Scope of the Drainage Assessment

The drainage assessment will be undertaken in accordance with the Non-Statutory Technical Standards for Sustainable Drainage⁷ and KCC Design Guidance⁸. The assessment will inform a drainage strategy for the site such that surface water runoff and foul drainage from the development site are managed appropriately.

1.4 Limitations of this report

This report has been prepared by WYG Engineering Ltd on behalf of the Metropolitan Police Service in connection with the scope of the report as described in Section 1.4 above and takes into account the particular instructions and requirements. It is not intended for and should not be relied on by any third party and no responsibility is undertaken to any third party.

WYG Engineering Ltd accepts no duty or responsibility (including in negligence) to any party other than the Metropolitan Police Service and disclaims all liability of any nature whatsoever to any such party in respect of this report.

This report cannot be reproduced without WYG's written consent.

⁵ Ministry of Housing, Communities and Local Government (March 2014), *Flood risk and coastal change*

⁶ Environment Agency (February 2017), *Flood risk assessment in flood zone 1 and critical drainage areas*

⁷ DEFRA (March 2015), *Non-statutory technical standards for sustainable drainage systems*

⁸ *The Kent Design Guide Making it Happen – Sustainability (Drainage Systems)*

2.0 Site Description

2.1 Existing Site

The application site covers an area of approximately 0.15 ha and is located within the Metropolitan Police Service Specialist Training Centre, Wharf Road, Gravesend. The nearest postcode is DA12 2HN and the site's grid reference is TQ 67285 74235.

The Metropolitan Police Service Specialist Training Centre is bounded by a flood defence embankment and the River Thames Estuary to the north and industrial land to the west. The southern boundary of the site is formed by an access road and the Thames and Medway Canal and to the east of the site is the Eastcourt Marshes and Milton Rifle Range. An ordinary watercourse flows along the eastern edge of the site.

The site of the proposed works comprises a small area in the north eastern corner of the training centre currently occupied by hardstanding used for parking. A site location plan is shown as Figure 1 below.

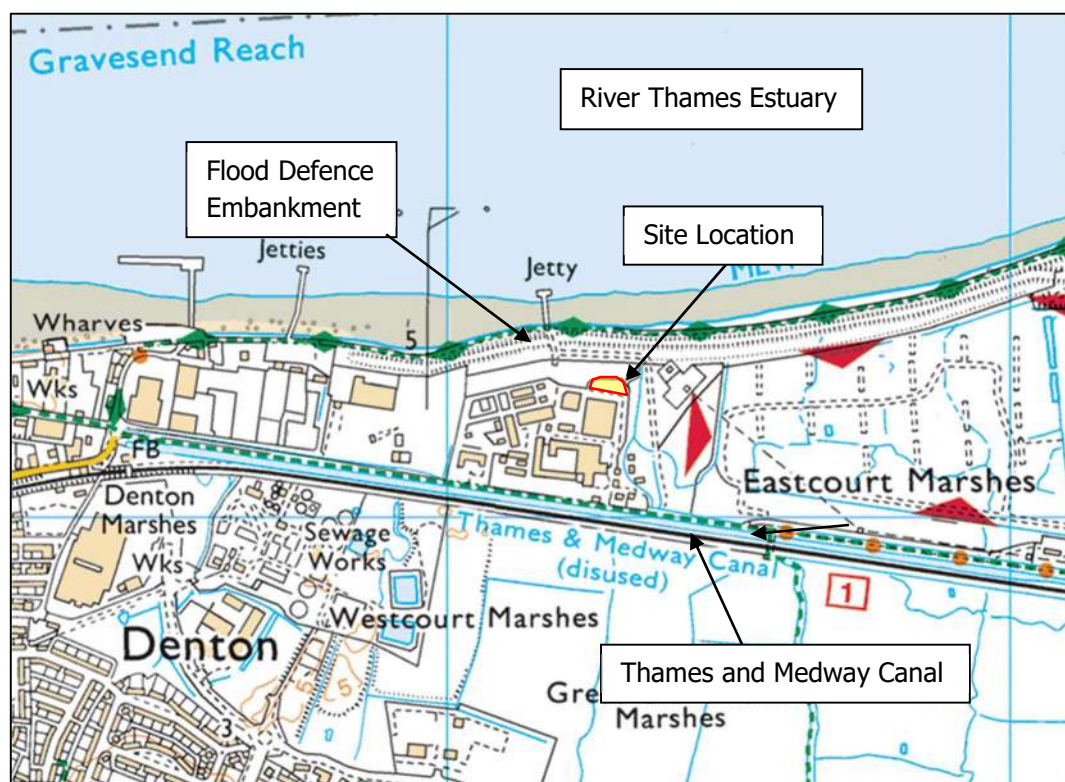


Figure 1 – Site Location Plan⁹

⁹ © Crown copyright and database rights 2020 Ordnance Survey 0100031673

The site of the proposed development is the most north easterly part of the training centre and is currently surfaced entirely with concrete and tarmac surfaces and is 100% impermeable. A large fence / hoarding is located along the northern edge of the site. A drawing showing ground levels within the site has been provided. This plan indicates that the site is relatively level, however the site does form a shallow valley with ground levels along the southern and northern boundaries sloping slightly down towards the central area. Ground levels in the base of the valley slope gently downwards towards the east where the lowest level of 2.25m AD is recorded. The highest ground level recorded is 2.59m AOD and is located toward the centre of the southern boundary adjacent to the existing access road / footway (River Road).

A copy of the topographical survey is included within Appendix B.

2.2 Existing Drainage

2.2.1 Main Rivers

The tidal River Thames estuary is located approximately 100m north of the site. There is however another main river located closer to the site as shown in Figure 2 below. This river forms part of a network of ditches and drains within the Eastcourt Marshes and includes a section of open watercourse to the east of the site and what is assumed to be a culverted section of watercourse flowing within the access road immediately south of the site.

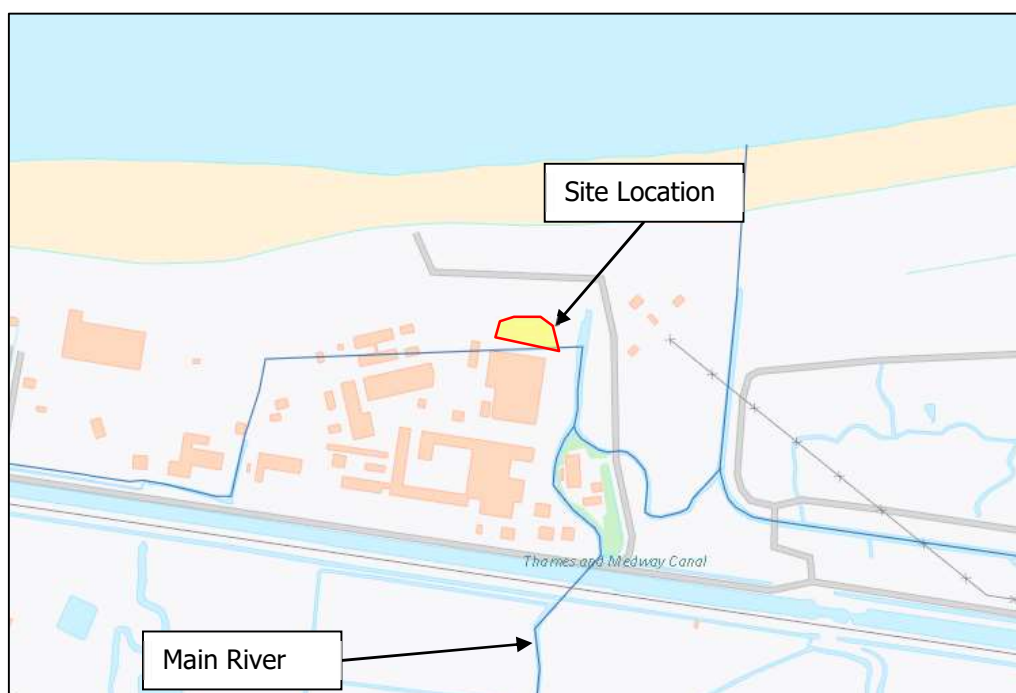


Figure 2 – Local Hydrology¹⁰

¹⁰ © Crown copyright and database rights 2020 Ordnance Survey 0100031673

2.2.2 Ordinary & Manmade Watercourses

Figure 2 above also indicates that there are a number of ordinary watercourses draining the marshes to the south and east of the Metropolitan Police Service Training Centre. It is understood that these drains are operated and maintained by the North Kent Marshes IDB.

The Thames and Medway Canal is located south of the training centre.

2.2.3 Sewers

Thames Water sewer record plans for the land surrounding the site have not been obtained however plans of the drainage network within the Metropolitan Police Service Training Centre have been provided and a copy of these plans is included within Appendix C.

Site drainage record plans indicate a surface water drain flows in an easterly direction along the access road south of the site (River Road). This drain outfalls to the watercourse via a headwall located south east of the site. Inspection of the existing drainage during a site visit has confirmed that the drain comprises a 300mm diameter pipe. There are two manholes located near to the site, one in the south west and the other in the south east. The depth from cover to invert is approximately 1.3m at the south western manhole and 1.45m at the south eastern manhole. Within the site there are 3 yard gullies which intercept runoff from the existing hardstandings, these are assumed to drain to the 300mm surface water drain within River Road.

The nearest foul manhole to the site is located approximately 160m to the south of the site in Central Road (in front of the Abseil tower).

2.3 Ground Conditions

2.3.1 Geology

A review of the British Geological Survey (BGS) online mapping¹¹ indicates that the site is underlain by Alluvium superficial deposits (Clay, Silt, Sand, and Peat) overlying the Lewes Nodular Chalk Formation and Newhaven Chalk Formation (undifferentiated).

2.3.2 Hydrogeology

DEFRA's 'Magic' mapping¹² indicates that the chalk is designated a Principal aquifer. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability,

¹¹ British Geological Survey (2019), *Geology of Britain viewer*

¹² DEFRA (2019), *Magic*

meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

The superficial deposits are designated a Secondary (undifferentiated) aquifer. These aquifers have been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

The site is not located within a groundwater Source Protection Zone (SPZ).

2.3.3 Ground Investigation

A Ground Investigation was undertaken by WYG between the 1st and 12th June 2020 and comprised two cable percussive boreholes, four window samples, groundwater and gas monitoring and laboratory analysis of samples.

Ground conditions at the site were found to be consistent with the British Geological Survey mapping. Made ground was encountered at all locations and comprised 100-150mm of asphalt with 160-450mm of subbase material beneath, overlying a further 350-520mm of generally coarse made ground (potentially a capping layer).

Superficial deposits below the made ground were observed to form two distinctly different layers. At the top (approx. 0.8 – 13.5m bgl) is a layer of very soft silt / clay with a band of Peat running through it. The lower layer of superficial deposits comprises of coarse material; brown sandy flint gravel with occasional to frequent flint cobbles (13.5m bgl – 20.8m bgl).

The white Chalk bedrock was encountered at a depth of approximately 20.8m bgl and continued beyond the depth of the boreholes which terminated at approximately 30m bgl.

Groundwater was encountered in the superficial deposits at a depth of approximately 2m bgl. The groundwater level is considered to be under tidal influence.

Groundwater monitoring within the boreholes indicated that groundwater is artesian at the site with levels rising and falling with the tide. It appears that the less permeable superficial deposits form a capping layer which currently confines the groundwater to a depth of approximately 2.0m bgl. Where the boreholes punched through the capping, groundwater rose to the surface.

3.0 Flood Risk

3.1 Fluvial / Tidal Flooding

Fluvial flood risk is the risk arising from Main Rivers and Ordinary Watercourses. A floodplain is the area that would naturally be affected by flooding if a river rises above its banks. In England, floodplains are divided into flood zones for planning purposes. These show the extent of the natural floodplain area at risk of inundation if there were no flood defences or certain other manmade structures and channel improvements. They are divided as follows:

- Flood Zone 3 shows land having a 1 in 100 year or greater annual probability ($>1\%$ AEP) of river flooding or 1 in 200 year or greater annual probability of tidal flooding ($>0.5\%$ AEP). This is the extreme flood.
- Flood Zone 2 shows land having between a 1 in 1,000 year annual probability (0.1% AEP) and 1 in 100 year annual probability (1% AEP) of river flooding / 1 in 200 year annual probability (0.5% AEP) of tidal flooding.
- Flood Zone 1 shows land having a less than 1 in 1,000 year annual probability of river flooding ($<0.1\%$ AEP), i.e. where flooding from rivers and the sea is very unlikely.

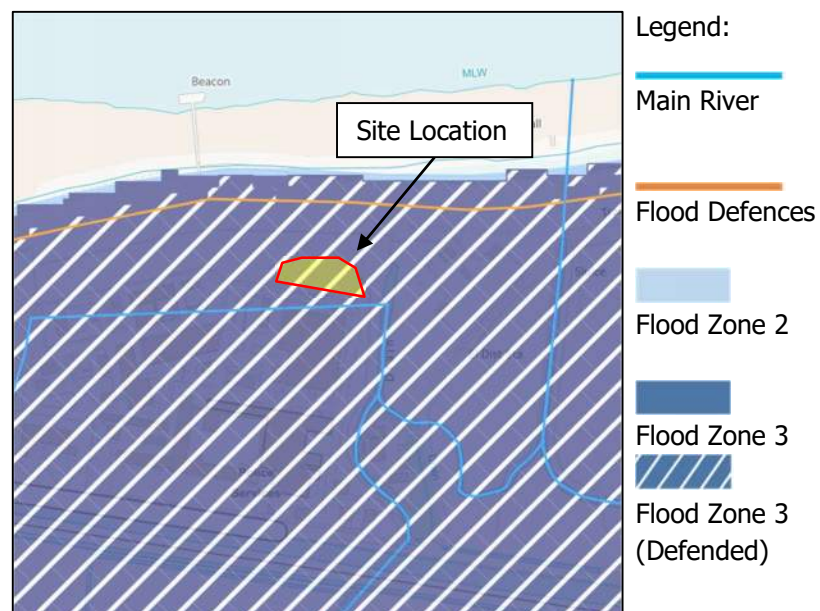


Figure 2 – Environment Agency Flood Map for Planning (August 2020)

The Flood Map for Planning indicates that the site is located entirely within Flood Zone 3, however, it should be noted that the extent of flooding shown on the EA flood map relates to

the area that would be at risk of flooding assuming that no flood defences are present. As shown on the EA Flood Risk Map for Planning, the site and surrounding area does benefit from flood defences and is therefore at a lower risk of flooding from the tidal River Thames.

The Thames Barrier and tidal flood defences along the River Thames provide protection to approximately 125km² of Central London in addition to land adjacent the Thames estuary downstream of the barrier from tidal surges. The main flood defence embankment by this site has a crest level of 6.3m AOD.

The EA has supplied model data from the Thames Estuary TE2100 scheme which indicates current day in channel river levels of 5.71m AOD for the 0.1% event at the nearest node to the site (node 3.27). By 2120 the in channel 0.1% flood level is predicted to rise to 7.13m AOD. The main flood defence embankment by this site has a crest level of 6.3m AOD and therefore currently provides a level of protection to the site in excess of the 1 in 1,000 year level (0.1%) and according to the TE2100 study the existing defences will continue to provide a 1 in 1,000 year level of defence up to 2070.

The defence is operated and maintained by the Environment Agency ensuring consistent protection for areas at risk, however, there is still a residual risk of damage occurring to the defences causing them to be breached leading to flooding of land behind them (albeit less extensive than the undefended flood outline shown on the EA Flood Risk Map).

The site and land to the east has been affected by tidal flooding in the past according to the EA historical flooding map, however it is understood that this relates to a time before the current flood embankment was constructed.

The Environment Agency's Product 6 (Model Output Data) package was received in August 2020 and is presented within Appendix D. Model output data from the Thames Tidal Downriver Beach Inundation Modelling has been used to analyse the flood risk to the site if a breach of defences were to occur. The data indicates that the entirety of the site would be at risk and the maximum flood levels reached on site are shown in Table 1.

Table 1 – Maximum Water Levels for the 2115 Epoch

	1 in 200 year	1 in 1000 year
Flood Level (m AOD)	4.583	4.689
Flood Depth (m)	2.27	2.37

The Flood Hazard Rating generated using the breach model flood depths and velocities is in excess of 5.0 throughout the site indicating that a breach in the tidal defences would represent

a danger to all. The residual risk of tidal flooding will need to be considered as part of the site proposals and measures put in place to manage the risk. This is discussed further in section 4.4 of this report.

3.2 Surface Water & Overland Flows

Surface water flooding occurs where high rainfall events exceed the drainage capacity in an area (i.e. sewer system and/or watercourse), leading to flooding.

The EA distinguishes between four levels of surface water flood risk as defined below:

- Very low risk is defined as an area of land which has an annual chance of flooding (or Annual Exceedance Probability [AEP] of less than 0.1%;
- Low risk is defined as an area of land which has an AEP between 0.1% and 1%;
- Medium risk is defined as an area of land which has an AEP between 1% and 3.3%; and
- High risk is defined as an area of land which has an AEP greater than 3.3%.

An extract of the Environment Agency's Flood Risk from Surface Water Map is shown as Figure 3 below. It indicates that there is a low risk of surface water flooding to the site. There are no overland flow paths or significant areas of surface water ponding within the site.

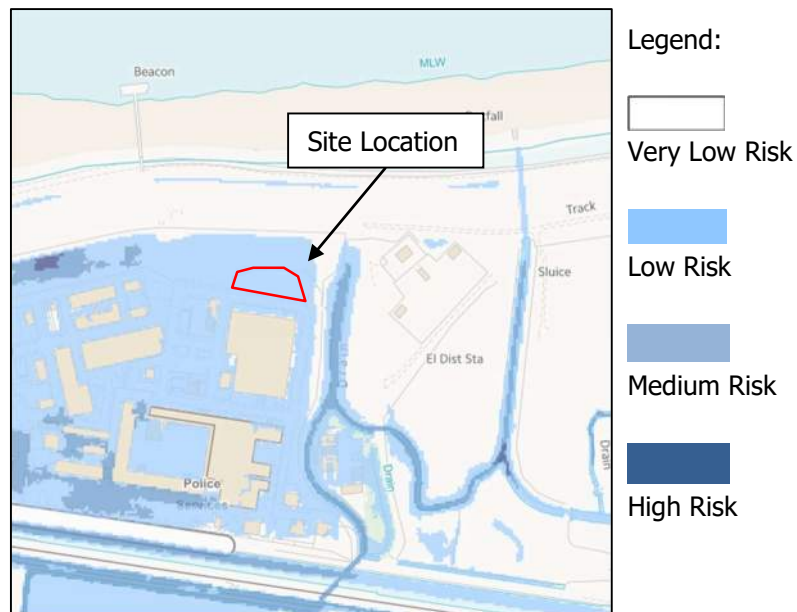


Figure 3 – Environment Agency Flood Risk from Surface Water Map (August 2020)

Further inspection of the EA Flood Risk Map for Surface Water reveals that the site is unlikely to flood during events up to the 1 in 100 year annual probability, however flood depths for the 1 in 1,000 year annual probability could exceed 300mm depths within much of the site. The surface water velocity associated with this event is less than 0.25m/s.

Considering the likelihood and severity of surface water flooding at the site in the context of the less vulnerable use proposed, the risk is not deemed significant, however further mitigation is proposed within section 4.4.

3.3 Groundwater Flooding

Groundwater flooding occurs when water levels in the ground rise above the land surface. This type of flooding is most likely to occur in areas above an aquifer.

Groundwater is a major source of flooding in some parts of Kent; this is generally areas underlain by chalk aquifers; however, Kent has not experienced any significant floods from groundwater since 2011. KCC's Preliminary Flood Risk Assessment highlighted that groundwater flooding has most notably occurred in the Nailbourne Valley, approximately 60km east of the site. Groundwater was encountered within the site's superficial deposits. Groundwater monitoring undertaken as part of the ground investigation found that at times of

high tide, groundwater in the site will rise to the ground surface where boreholes were drilled under artesian pressure. A layer of less permeable superficial deposits under the site currently provides a capping layer which keeps the groundwater confined at a depth of approximately 2m bgl.

There is no recorded history of ground water flooding at the site and in view of the less vulnerable use proposed, the risk of groundwater flooding is not considered significant provided that the existing capping layer of impermeable material is retained.

3.4 Sewer Flooding

Sewer flooding occurs when intense rainfall overloads the sewer system capacity and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. This risk is predominantly associated with combined sewers and surface water sewers.

The drainage network serving the surrounding Training Centre are of relatively small diameter and therefore pose relatively low risk compared with other sources of flooding. There are no records of sewer flooding in the vicinity of the site, therefore the risk of flooding from sewers is considered to be low.

3.5 Reservoir Flooding

Flooding from reservoirs occurs when a reservoir dam is overtopped or breaches due to structural failure. The consequence of such an event would be severe but the probability of a catastrophic dam failure is considered to be extremely low.

The Environment Agency's Flood Risk from Reservoirs Map indicates that the site is not at risk of flooding from a reservoir failure.

3.6 Summary of Flood Risk

Based on the above, it can be seen that the site is at low risk of flooding from all sources when the benefits of the existing tidal defences are taken into account. There is however a residual risk of tidal flooding which would result from a failure of the defences. Whilst this is considered unlikely the consequences would be significant and therefore mitigation is proposed.

It is also essential to ensure that no increase in flood risk occurs downstream of the site or on adjacent areas as a result of the development; this matter is discussed in more detail within Section 4.

4.0 Development Proposals

4.1 Proposed Development

A full planning application is being submitted for the development of a Live Fire Training facility, comprising a two storey building with roof access and a single storey support building. The proposals will also include associated hardstanding, access and utility infrastructure. Appendix A includes the proposed site layout.

4.2 Sequential & Exception Tests

One of the aims of the NPPF is to steer development away from zones of high flood risk towards Flood Zone 1. In accordance with Table 3 of the PPG (Flood Risk and Coastal Change), the proposed land and use for Police Stations (non operational during flooding) is classed as 'less vulnerable'. As a less vulnerable land use located within Flood Zone 3a, the proposed development is acceptable, subject to adequate mitigation, and the Sequential Test is passed. The Exception Test is not required to be passed.

4.3 Local Planning Policy

4.3.1 Gravesham Local Plan

The Gravesham Local Plan Core Strategy¹³, adopted in 2014, includes Policy CS 18 (Climate Change) which covers Flood Risk, Water Quality and Sustainable Drainage.

Development will be directed sequentially to those areas at least risk of flooding. Proposals in areas at risk of flooding must be accompanied by a Flood Risk Assessment and a Flood Risk Management Plan (if required) to demonstrate that they are adequately defended and safe over their lifetime. Planning permission will be refused for schemes which do not pass the sequential and exception tests.

- The Council will seek to minimise the impact of drainage from new development on waste water systems. In particular, the Council will:
- Require that surface water run-off from all new development has, as a minimum, no greater adverse impact than the existing use; and

¹³ Gravesham Borough Council (September 2014), Gravesham *Local Plan Core Strategy*

- Require the use of Sustainable Drainage Systems on all developments where technically and financially feasible.

The Local Plan 5 Year Review September 2019 concluded that Policy CS 18 conforms with NPPF 2019 and does not require modification.

4.3.2 Kent County Council Drainage and Planning Policy (December 2019)

In this document KCC sets out its Drainage and Environmental Policies as part of its role as Lead Local Flood Authority (LLFA). Key policies are as follows:

- SuDS Policy 1 – Follow the drainage hierarchy;
- SuDS Policy 2 – Deliver effective drainage design;
- SuDS Policy 3 – Maintain existing drainage flow paths & watercourses;
- SuDS Policy 4 – Seek to reduce and avoid existing flood risk;
- SuDS Policy 5 – Drainage sustainability and resilience;
- SuDS Policy 6 – Sustainable Maintenance;
- SuDS Policy 7 – Safeguard water quality;
- SuDS Policy 8 – Design for amenity and multi-functionality;
- SuDS Policy 9 – Enhance Biodiversity.

The KCC policies have been considered as part of the drainage strategy for the proposed development as set out within the following sections.

4.4 Development & Flood Risk

4.4.1 Flood Risk to the Development

As discussed in Section 3.9, the site is considered to be at low risk of flooding from all sources. The development is however located in an area adjacent to tidal flood defences and is at residual risk of flooding occurring as a result of a failure of the defences either by overtopping or breach.

Measures intended to manage the residual risk of tidal flooding and provide protection against the risk of surface water flooding are outlined below.

4.4.2 Finished Floor Levels

Finished floor levels for the proposed buildings at ground floor level are to be set a minimum of 150mm above existing ground levels to protect the buildings from surface water flooding.

Whilst ground floor finished floor levels would ideally be set 300mm above the 1 in 200 year + climate change breach flood level; in this instance this would equate to a level of 4.838m AOD and would not be practical (existing ground levels are in the order of 2.4m AOD). In view of the proposed site use and low probability of flooding raising ground floor levels above the breach flood level is not considered appropriate.

Both proposed buildings have either a first floor level or roof access which could be located above the breach flood level and provide a safe place of refuge should this be required.

4.4.3 Flood Resilience Measures

In view of the depth of flooding which could result from a breach of defences and the low likelihood of this occurring, flood resistance measures are not considered appropriate for this development due to structural implications.

Flood resilient measures are however recommended for this development including the use of flood resilient materials at ground floor level (where appropriate) and the routing of electrical services at a higher level within the building. These measures will limit the damage caused and allow the building to return to use more rapidly in the event of flooding.

4.4.4 Flood Warning / Evacuation

It is recommended that The Metropolitan Police Service register with the EA to receive flood warnings at this site location if this is not already in place; this will allow preparations to be made in advance of potential flooding incidents.

There is not considered to be a safe access route out of the site during the extreme climate change breach event. Flood warnings will provide sufficient opportunity for evacuation ahead of a significant tidal surge. In the unlikely event of a rapid unexpected breach in flood defences it is advised that occupants of the site take refuge at first floor level or above.

4.4.5 Groundwater

The design and construction of below ground foundations and drainage features will need to maintain the continuous impervious layer to prevent groundwater emergence at the surface.

4.4.6 Flood Risk Arising from the Development

The proposals include the provision of new roof areas and hardstanding. It is therefore necessary to manage surface water runoff on site to avoid increasing the risk of flooding to areas elsewhere by the introduction of these new impermeable surfaces, as required by the NPPF and the local KCC policies.

4.5 Surface Water Management

4.5.1 Drainage Hierarchy

The management of runoff should be considered via a sequential approach, in line with Building Regulations¹⁴ and KCC Drainage Planning Policy 1. The following options for the disposal of surface water runoff have been considered, in order of preference:

- Discharge to an adequate soakaway or some other adequate infiltration system (i.e. to ground);
- Discharge to a watercourse; and
- Discharge to a sewer.

Discharge to Ground

The ground conditions described in Section 2.3.4 indicate made ground overlying superficial deposits of soft Silt / Clay and Peat up to a depth of approximately 13.5m. These ground conditions together with relatively shallow groundwater would not support infiltration drainage.

Discharge to Watercourse

The nearest main river is an open ditch to the east of the site; part of a network of ditches that drain the Eastcourt Marshes. The EA rivers mapping indicates a section of watercourse to the south of the site that is assumed to be a culverted section of watercourse flowing within the access road. A discharge to this watercourse, where it falls within the ownership of the Metropolitan Police Service is feasible.

Discharge to Sewer

Site drainage record plans indicate a 300mm surface water drain that flows in an easterly direction along the access road south of the site (River Road). Runoff from the existing hardstanding areas of the site are understood to discharge to this drain via gully connections. In view of the depth, size and location of the drain, it is likely that this is the culverted section of the river shown on the EA mapping, however this would need to be confirmed. A restricted

¹⁴ HM Government (2010), *The Building Regulations 2010, Approved Document H (Part H3)*

discharge to the 300mm diameter drain / culvert in River Road is proposed in line with the existing drainage regime.

4.5.2 Pre and Post-Development Areas

Table 2 below summarises the existing and proposed development areas, estimated from the topographical survey and proposed site layout, respectively.

The site is currently surfaced entirely with concrete and tarmac surfaces and is 100% impermeable. The development involves two new buildings together with access and parking provision. The post-development impermeable area is estimated to be 100%.

Table 2 – Pre and Post-Development Areas

Status	Permeable Area (ha)	Impermeable Area (ha)
Pre-development	0.00	0.15
Post-development	0.00	0.15

4.5.3 Pre and Post-Development Discharge Rates

The greenfield runoff rates for the site have been obtained using Micro Drainage Source Control module and the results are shown below in Table 3, with full calculations contained within Appendix E.

Table 3 – Existing and Proposed Runoff Rates

Status	Qbar (l/s/ha)	Qbar (l/s)	1 in 1 year (l/s)	1 in 30 year (l/s)	1 in 100 year (l/s)
Pre-development (greenfield)	2.7	0.4	0.4	0.9	1.3
Post-development	-	2.0	2.0	2.0	2.0

The Non-Statutory Technical Standards for Sustainable Drainage requires that the rate of surface water runoff from greenfield sites must not exceed the runoff rate from the pre-developed greenfield site. However, as the site is brownfield a post-development discharge rate of 2 l/s has been proposed as a maximum, as the pre-development greenfield runoff rate would not be achievable for the site without increasing the risk of blockage to an unacceptable level.

4.5.4 Required Attenuation

In order to restrict runoff from the site to 2 l/s, it is necessary to provide attenuation within the new surface water drainage system on the site. The post-development attenuation

volumes have been estimated using Micro Drainage Quick Storage Estimates. The results are shown in Table 4, with full calculations contained within Appendix F.

Table 4 – Attenuation Estimates

Catchment	Impermeable Area (ha)	Restricted Discharge Rate (l/s)	Volume (m ³)		
			1 in 30 year	1 in 100 year	1 in 100 year + CC
Whole site	0.15	2.0	47	65	98

In order to minimise any flooding of the site, it is proposed to attenuate runoff on the site up to the 1 in 100 year event plus 40% allowance for climate change. These estimates have been used as a basis for the surface water drainage strategy of the site. The drainage strategy described in Section 4.5.5 is supported by further Micro Drainage calculations to demonstrate that the proposed method of draining the site provides sufficient attenuation storage.

4.5.5 Proposed Surface Water Drainage Strategy

A review of SuDS applicable to the site is undertaken within Section 5 below. In summary, it is proposed to provide attenuation up to the 1 in 100 year event plus 40% allowance for climate change within granular sub-grade storage beneath either a permeable paving surface or a conventional tarmac surface with gulley outlets connecting into the sub-grade storage via Permavoid type diffuser units. It is proposed to attenuate 110m³, based on a plan area of 820m² and 450mm depth of porous aggregate sub-base material with porosity of 0.3.

The surface water will discharge to an existing outfall to the watercourse via a new network of 150mm diameter perforated drains which will collect water from the base of the subgrade storage. A hydro-brake flow control chamber will be used to restrict discharge into the wider site's existing outfall pipe to 2 l/s.

The proposed surface water drainage plan is contained within Appendix G, with supporting Micro Drainage calculations contained within Appendix H.

4.6 Exceedance Flows

Exceedance flows above the 1 in 100 + 40% CC event are to be stored in a low section in eastern side of the site. There is a total volume of 4.6m³ with an average depth of 50mm.

As discussed above, there remains a residual risk of a storm event that exceeds the capacity of the drainage system, as events beyond the 1 in 100 year plus 40% allowance for climate change storm event will not be catered for explicitly.

5.0 Sustainable Drainage

5.1 Review of SuDS Options

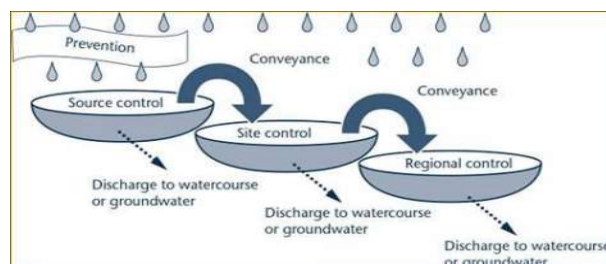
In order to comply with the national guidelines and policies set by the NPPF and the Non-Statutory Technical Standards for Sustainable Drainage¹⁵ and local policies and guidance from KCC, the design of the surface water drainage system should seek to maximise the use of SuDS techniques. This section reviews the suitability of the different SuDS features applicable to the application site.

5.2 The SuDS Management Train

The main purpose of a SuDS system is to manage the surface water runoff generated by a development within the site, attenuating the additional runoff whilst providing water quality treatment to the runoff and amenity and landscape benefits to the community. The different SuDS features can be categorised as follows:

- Source Control: manage runoff at its source
 - Water butts, green/brown roofs, permeable pavements, rainwater harvesting systems, bio-retention systems.
- Site Control: manage runoff generated by a wider area
 - Swales, ponds, infiltration devices, filter strip, French drains.
- Regional Control: manage runoff generated by several sites
 - Basins, ponds and wetlands

The following is an illustration of the SuDS principles and how they may be applied to a development via a SuDS Management Train.



¹⁵ DEFRA (March 2015), *Non-statutory technical standards for sustainable drainage systems*

Figure 4 – SuDS Management Train

Table 5 below summarises the suitability of the different SuDS features for the proposed development site.

Table 5 – Review of SuDS features for the proposed development site

SuDS Feature		Description	Applicability to the Site
Source Control	Water butts	Small storage tanks on building.	Unlikely to be appropriate.
	Rainwater harvesting	Recycling of water from roofs and impermeable areas.	May be appropriate.
	Green roofs	Vegetated roofs that reduce runoff and remove pollutants.	Not appropriate for this type of development.
	Pervious surfaces	Pavements that allow surface water to flow into underlying layers of the pavement and either infiltrate or drain to an on-site drainage network.	May be appropriate within proposed hard standing.
	Rain gardens & Bioretention systems	Shallow depressions with free draining soil and planted with vegetation that withstands occasional flooding.	Not appropriate for this type of development.
Site & Regional Control	Swales	Vegetated channels to convey, store and treat runoff.	Not appropriate for this type of development.
	Detention basins & ponds	Shallow areas of open space that temporarily hold water and collect silt.	
	Filter drains	Linear drains or trenches filled with granular material that allow infiltration to the surrounding ground.	Not appropriate for this type of development.
	Infiltration basin	Shallow depression that stores runoff before it infiltrates into the subsoil.	Not appropriate for this type of development.
	Infiltration devices	Generally granular trenches or soakaways that store water and allow infiltration to the surrounding ground.	Not appropriate for this type of development.

5.3 Proposed SuDS Principles

The proposed drainage strategy in Section 4.5.5 incorporates permeable paving with surface water discharging to a watercourse.

5.4 Water Quality

The SuDS design should seek to provide an appropriate management train of SuDS features to effectively mitigate the pollution risks associated with the proposed land uses.

In accordance with Table 26.2 of The SuDS Manual CIRIA C753, the pollution hazard level is considered to be 'Low' for the proposed land use. Therefore, the requirements for discharge to surface waters state that the 'Simple index approach' should be used. Step 1 of the simple index approach is to identify the pollution hazard indices for the proposed land use as set out in Table 6 below, which is an extract of Table 26.2.

Table 6 – Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change.	Low	0.5	0.4	0.4

Step 2 of the simple index approach is to select SuDS features with a total pollution mitigation index that equals or exceeds the pollution hazard index. Table 26.4 of The SuDS Manual states the mitigation indices for discharges to groundwater. These are shown below in Table 7 below.

Table 7 – SuDS Mitigation Indices

SuDS Feature	TSS	Metals	Hydrocarbons
Permeable paving	0.7	0.6	0.7

The treatment train of permeable paving does provide sufficient treatment to mitigate the potential pollution hazard indices.

It should be noted that alternative SuDS options may also be considered during the detailed design stage which achieves or exceeds the water quality objective. Provided that the mitigation indices of the treatment techniques are greater than or equal to the hazard indices

for the proposed development then there should be no reduction in the overall water quality within the receiving system.

5.5 SuDS Maintenance

By their nature, SuDS require regular maintenance to keep them working effectively. It is anticipated that responsibility for the maintenance of the SuDS will be undertaken by the site owner or assigned management company.

The responsible company will perform the maintenance tasks required by the various elements of the drainage scheme. Table 8 below shows the maintenance requirements of the potential SuDS features.

Table 8 – Maintenance tasks and frequency required

SuDS Feature	Maintenance Task	Recommended Frequency
Permeable Paving	- Brushing and vacuuming	- Every 12 months
	- Weed removal	- Every 12 months
	- Cleaning of gulleys (where relevant)	- Every 12 months
	- Rehabilitation of surface and upper substructure	- As required
	- Remediation of depressions and cracked blocks	- As required
	- Remediation of landscaping.	- As required

Suitable adoption and maintenance regimes for SuDS should be submitted in support of the reserved matters application. Prior to commencing the development, KCC, as LLFA, must approve a SuDS maintenance plan.

6.0 Foul Drainage Assessment

6.1 Proposed Foul Drainage Strategy

It is proposed to discharge foul drainage from the development to a new on-site package treatment plant. It is proposed that the treated effluent from the treatment plant will outfall to the adjacent watercourse via the existing drainage network. The new foul drainage will be privately maintained.

The proposed foul drainage plan is contained within Appendix G.

7.0 Consents Required

7.1 Environmental Permit

Under the Environmental Permitting (England and Wales) Regulations 2016, an environmental permit is required from the Environment Agency for any discharges of surface water and foul water to ground and surface water (known as water discharge activities).

Discharge of effluent from the proposed treatment plant to the existing drainage network and ultimately to the adjacent Main River will require an Environmental Permit.

If any construction associated with the proposed development is required with 8m of either the adjacent main river or any culverted sections of main river an Environmental Permit will be required for this also. The type and number of permits required should be checked with the Environment Agency.

8.0 Conclusions & Recommendations

8.1 Conclusions

This assessment has made the following conclusions.

- The site lies within Flood Zone 3, however benefits from existing flood defences which provide a level of protection up to the 1 in 1,000 year level.
- The Site is at low risk of flooding from all sources. There is however a residual risk of flooding as a consequence of a failure of the existing flood defences; whilst unlikely, such an event could result in significant flooding.
- There is a record of tidal flooding on site, however this is understood to date back before construction of the existing flood defences.
- In order to manage the risk residual risk of flooding it is proposed that ground floor levels are raised a minimum of 150mm above existing ground levels, safe refuge is provided at first floor level above the residual climate change flood level, site users sign up to receive flood warnings from the EA and flood resilience measures are incorporated into the ground floor design.
- The proposed land use for Police Stations (non operational during flooding) is classed as 'less vulnerable' under the NPPF. As a less vulnerable land use located within Flood Zone 3a, the proposed development is acceptable, subject to adequate mitigation, and the Sequential Test is passed.
- The Exception Test is not required to be passed.
- There are two main rivers close to the site. The River Thames estuary is located approximately 100m north of the site and there is another main river located closer to the site which forms part of a network of ditches and drains within the Eastcourt Marshes.
- Site drainage record plans indicate a surface water drain flows in an easterly direction along the access road south of the site (River Road) and the nearest foul manhole to the site is located approximately 160m south of the site.
- It is proposed to provide attenuation up to the 1 in 100 year event plus 40% allowance for climate change within granular sub-grade storage beneath either a permeable paving

surface or a conventional tarmac surface with gulley outlets connecting into the sub-grade storage via Permavoid type diffuser units.

- The surface water will discharge via an existing outfall to a watercourse via 150mm diameter perforated drains. A hydro-brake flow control chamber will be used to restrict discharge into the wider site's existing outfall pipe to 2 l/s.
- The proposed SuDS features will provide sufficient water quality treatment.
- It is proposed to discharge foul flows to a new privately maintained on-site package treatment plant. A discharge of treated effluent to the adjacent watercourse is proposed subject to an Environmental Permit.
- This assessment has identified that the proposed development can be implemented in accordance with the relevant flood risk and drainage national and local planning policies, subject to the highlighted recommendations below.

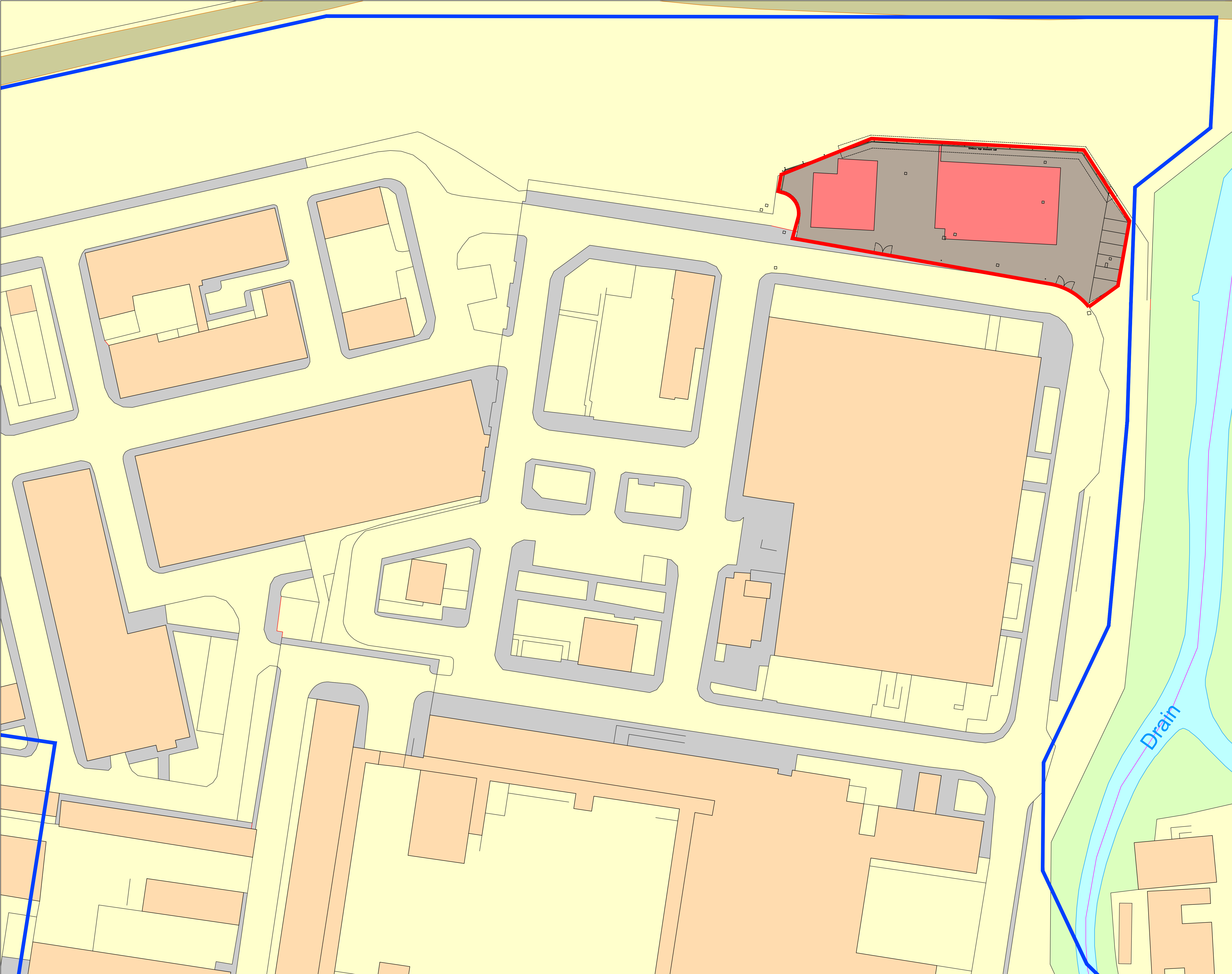
8.2 Recommendations

This assessment has made the following recommendations.

- Under the Environmental Permitting (England and Wales) Regulations 2016, an environmental permit is required from the Environment Agency for water discharge activities (surface water and foul). The type of permit required should be checked with the Environment Agency.
- In order to manage the risk residual risk of flooding it is proposed that ground floor levels are raised a minimum of 150mm above existing ground levels, safe refuge is provided at first floor level above the residual climate change flood level, site users sign up to receive flood warnings from the EA and flood resilience measures are incorporated into the ground floor design.

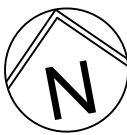
Appendices

Appendix A – Proposed Site Layout Plan



DRAWING COPYRIGHT© CLIFFORD TEE + GALE
DO NOT SCALE - A1 ORIGINAL
(PDF COPIES MAY BE RECEIVED AT
REDUCED SIZE AND NOT TO SCALE)
CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT
ALL OMISSIONS AND ERRORS TO CONTRACT ADMINISTRATOR
ALL DIMENSIONS ARE IN MILLIMETERS

Key
Site boundary: —
Extents of ownership: —



T1	Issued For Review	24/04/20
	drawn by ATW	checked by JRC



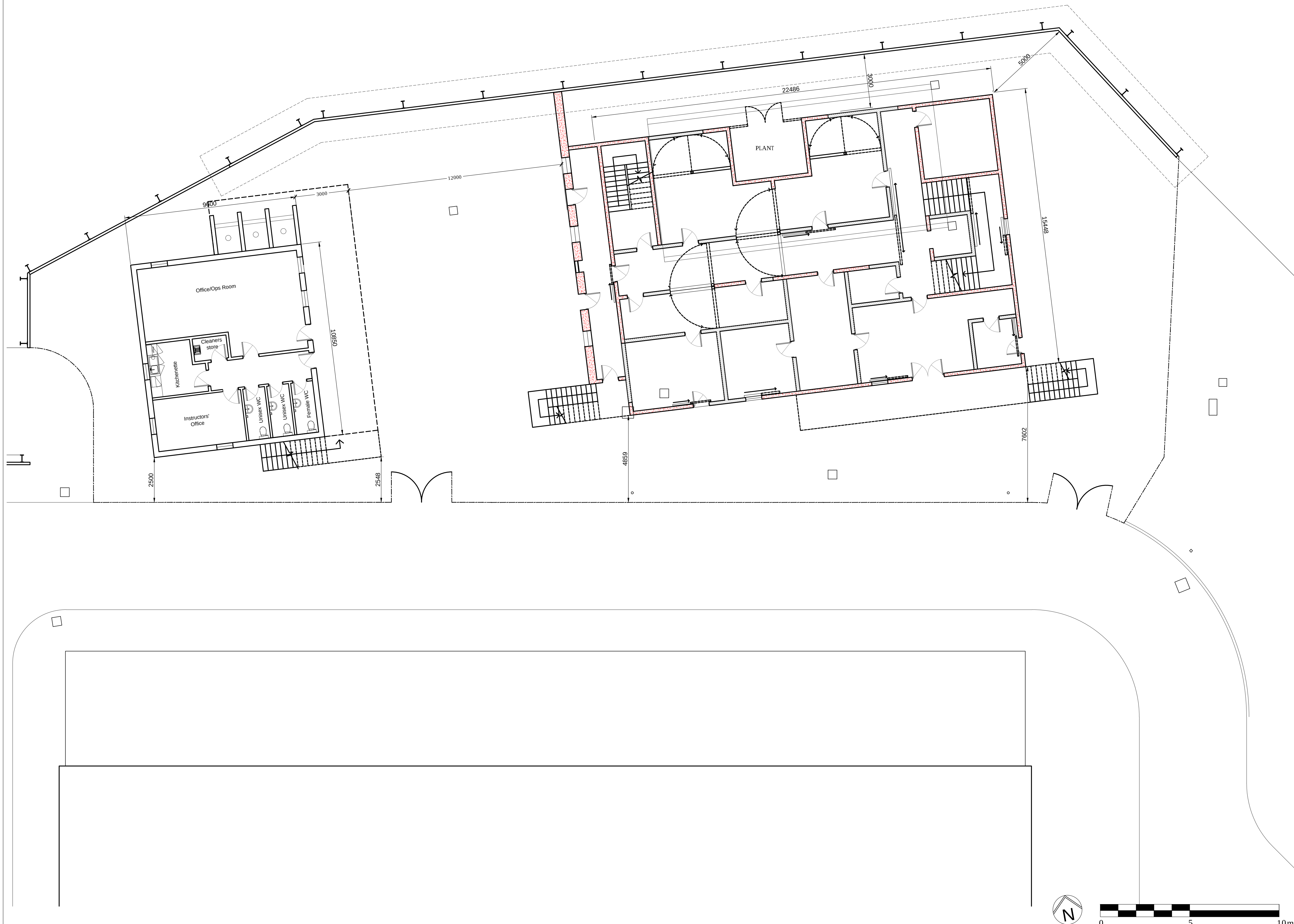
Clifford Tee + Gale
Architects & Surveyors
Spectrum House, Beehive Ring Rd,
Gatwick RH6 0LG
Tel: +44 (0)12 9356 9857

project
**Metropolitan Police
Service SFC SCO19
Gravesend**

title
Site Location Plan

date	Feb 2020	scale	1:200 @ A1
------	----------	-------	------------

job no.	drwg no.	rev
P18046	CTG-SP-0019	T1



FEASIBILITY ISSUE

A	Plans revised	30.11.18
A	Plans revised	21.11.18
drawn by	JC	checked by DJR



project

Metropolitan Police
Service SFC SCO19
Gravesend

title

Proposed Site Plan

date	scale
Nov 18	1:100 @ A1

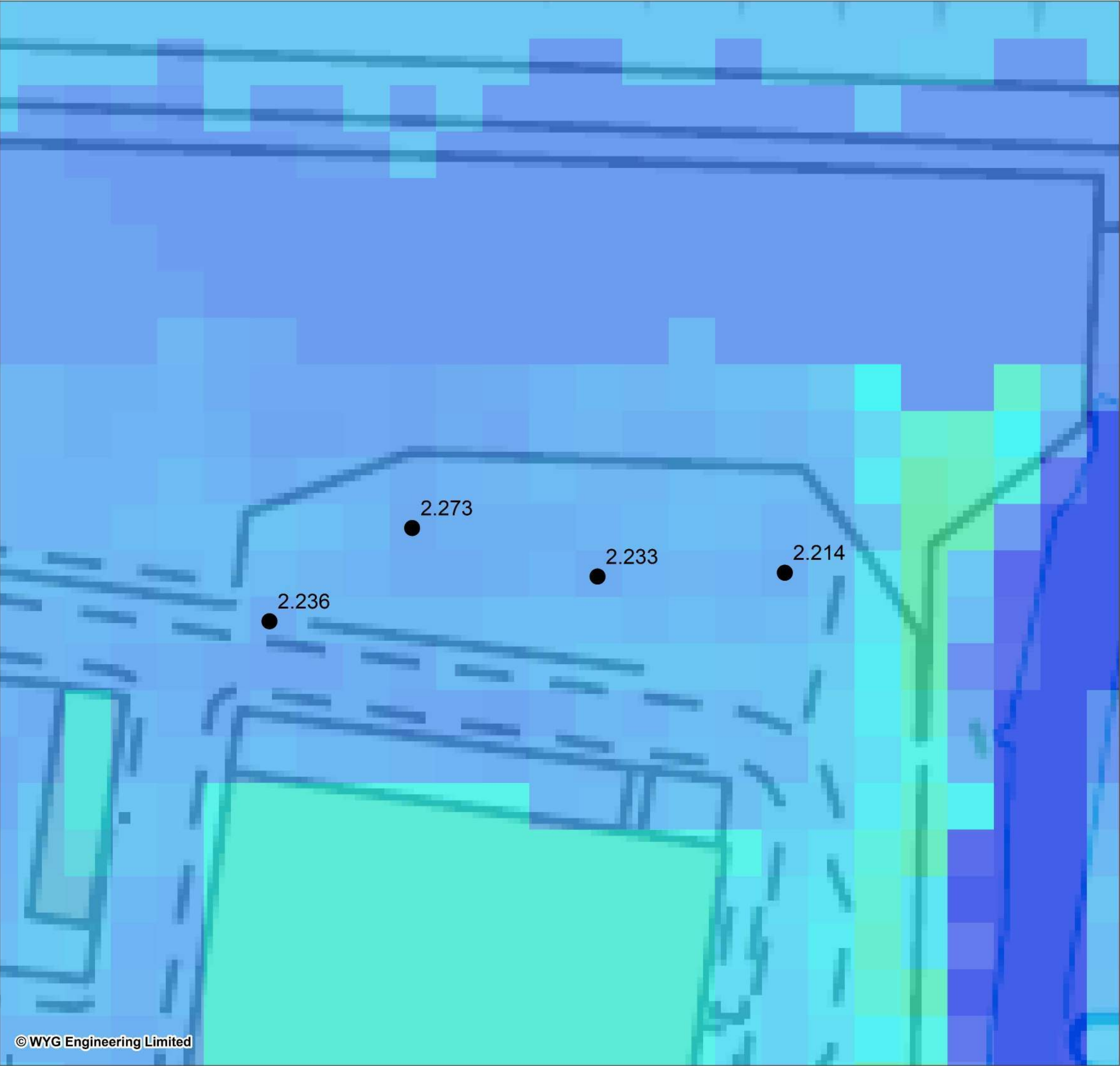
job no.	drwg no.	rev
P18046 / CTG-PL-0002		

Appendix B – Topographical Survey

Appendix C – Existing Site Drainage Records



Appendix D – Environment Agency Product 6 Model Output Data



EA Product 6 Model Output Data
Thames Estuary Breach Assessment

Gravesend Live Fire Skills House

Metropolitan Police Service

Notes:

Flood Extents are extracted from GIS data provided by the Environment Agency.

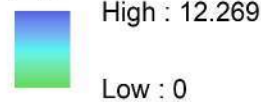
This drawing is for information only.



Key:

1 in 200 Year Breach Water Level (2115 Epoch)

(m)



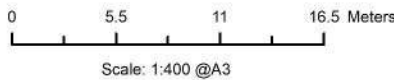
Drawn by: JB

Checked by:

Office: LEEDS

Drawing No. D101

Revision No. P1



06 August 2020

NGR: 567,283 E / 174,237 N

© Crown copyright and database rights [2020] Ordnance Survey 0100031673

© WYG Group Ltd





EA Product 6 Model Output Data
Thames Estuary Breach Assessment

Gravesend Live Fire Skills House

Metropolitan Police Service

Notes:

Flood Extents are extracted from GIS data provided by the Environment Agency.

This drawing is for information only.



Key:

1 in 200 Year Flood Level (2115 Epoch)

mAOD

High : 8.188

Low : 0

Drawn by: JB

Checked by:

Office: LEEDS

Drawing No. D102

Revision No. P1

0 10 20 30 Meters

Scale: 1:1,250 @A3

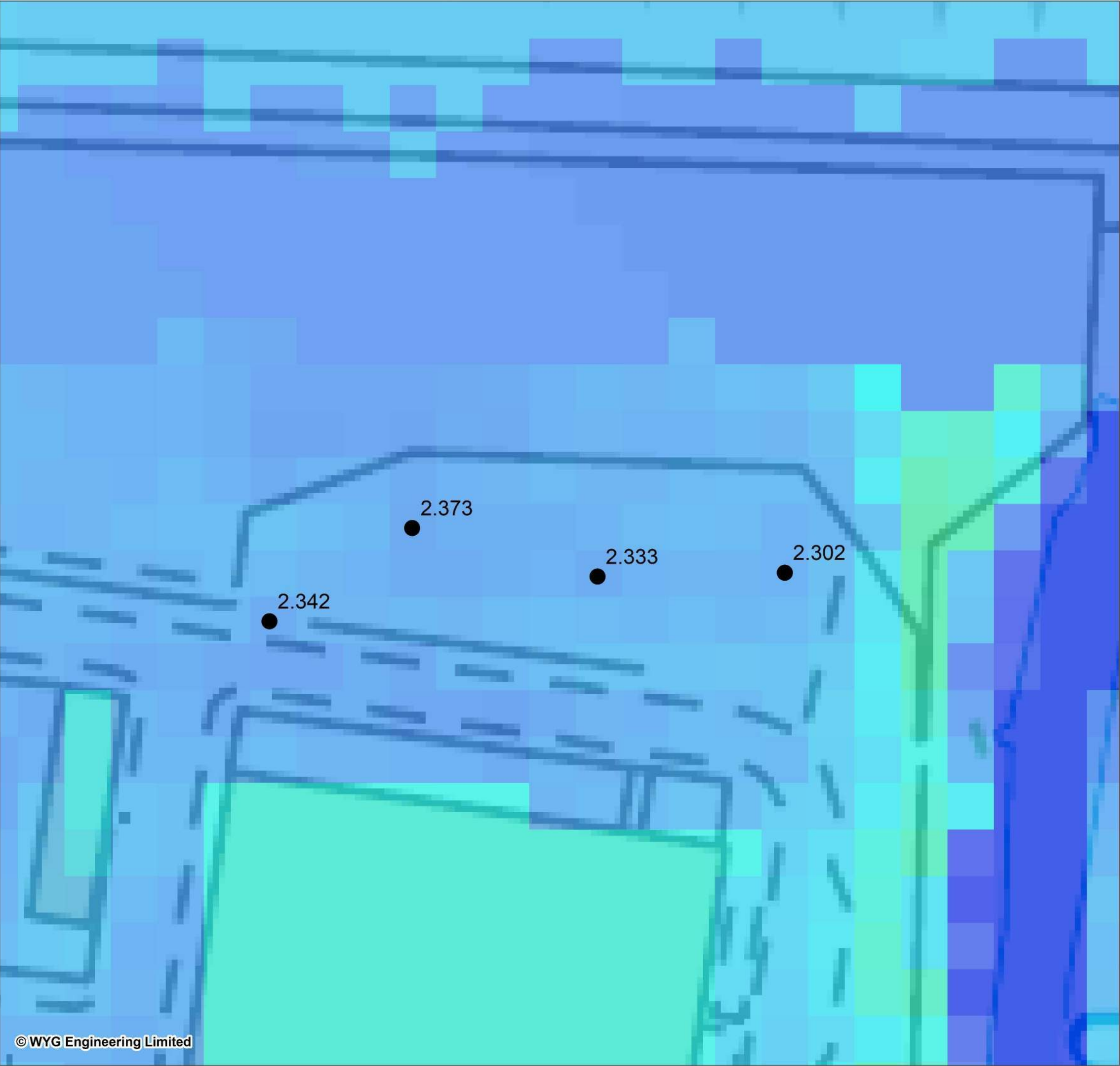
26 August 2020

NGR: 567,306 E / 174,222 N

© Crown copyright and database rights [2020] Ordnance Survey 0100031673

© WYG Group Ltd





EA Product 6 Model Output Data
Thames Estuary Breach Assessment

Gravesend Live Fire Skills House

Metropolitan Police Service

Notes:

Flood Extents are extracted from GIS data provided by the Environment Agency.

This drawing is for information only.



Key:

1 in 1000 Year Breach Water Level (2115 Epoch)

(m)



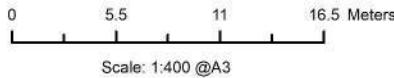
Drawn by: JB

Checked by:

Office: LEEDS

Drawing No. D102

Revision No. P1



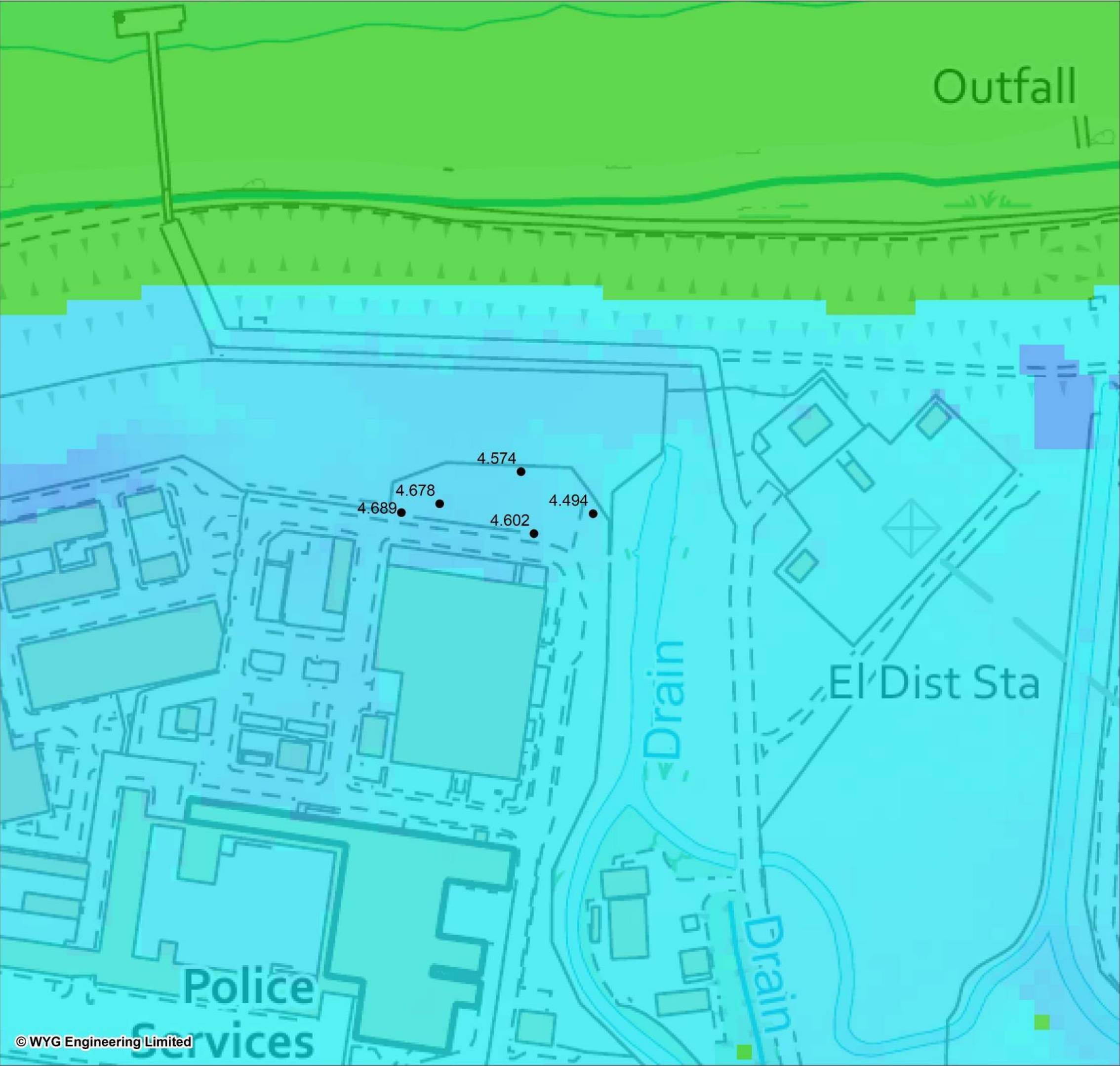
06 August 2020

NGR: 567,283 E / 174,237 N

© Crown copyright and database rights [2020] Ordnance Survey 0100031673

© WYG Group Ltd





EA Product 6 Model Output Data
Thames Estuary Breach Assessment

Gravesend Live Fire Skills House

Metropolitan Police Service

Notes:

Flood Extents are extracted from GIS data provided by the Environment Agency.

This drawing is for information only.



Key:

1 in 1000 Year Flood Level (2115 Epoch)

mAOD



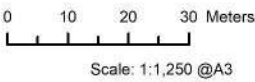
Drawn by: JB

Checked by:

Office: LEEDS

Drawing No. D102

Revision No. P1



26 August 2020

NGR: 567,306 E / 174,222 N

© Crown copyright and database rights [2020] Ordnance Survey 0100031673

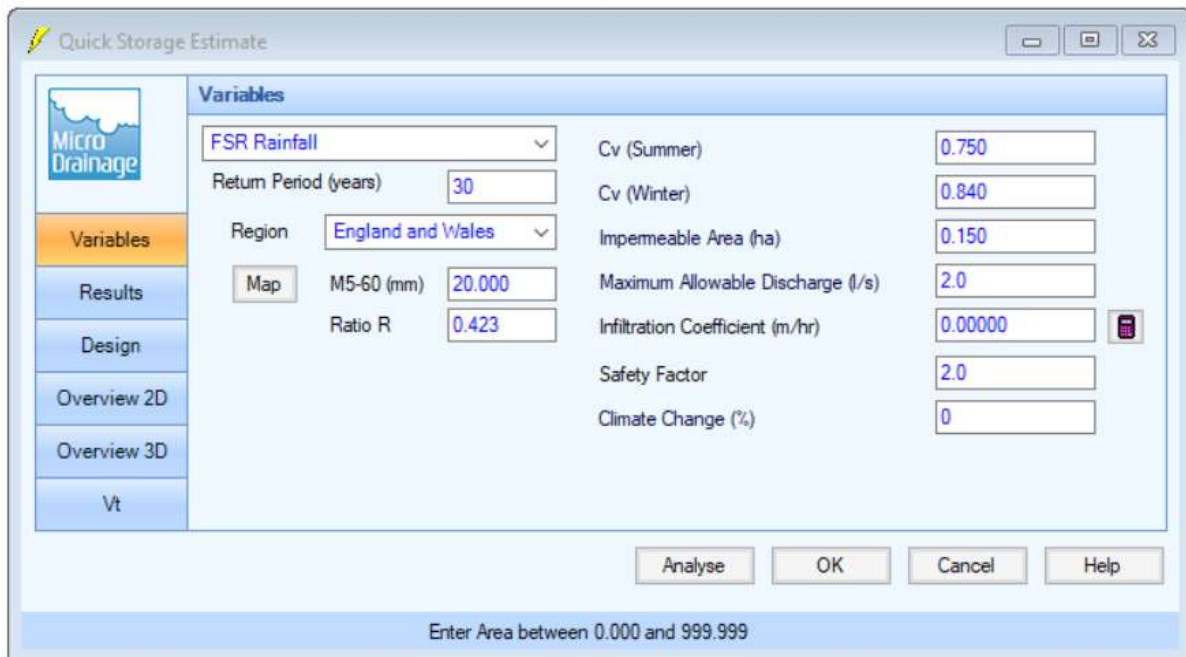
© WYG Group Ltd



Appendix E – Greenfield Runoff Calculations

WYG Group Limited		Page 1
.	Live Fire Skills House	
.	Gravesend	
.		
Date 20/07/2020 17:53	Designed by CD	
File	Checked by ME	
XP Solutions	Source Control 2019.1	
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.400 Area (ha) 0.150 Urban 0.000 SAAR (mm) 590 Region Number Region 6 Results 1/s QBAR Rural 0.4 QBAR Urban 0.4 Q100 years 1.3 Q1 year 0.4 Q30 years 0.9 Q100 years 1.3		
©1982-2019 Innovyze		

Appendix F – Quick Storage Estimates



Quick Storage Estimate

Variables

FSR Rainfall

Return Period (years)

Region

Map

Ratio R

Cv (Summer)

Cv (Winter)

Impermeable Area (ha)

Maximum Allowable Discharge (l/s)

Infiltration Coefficient (m/hr)

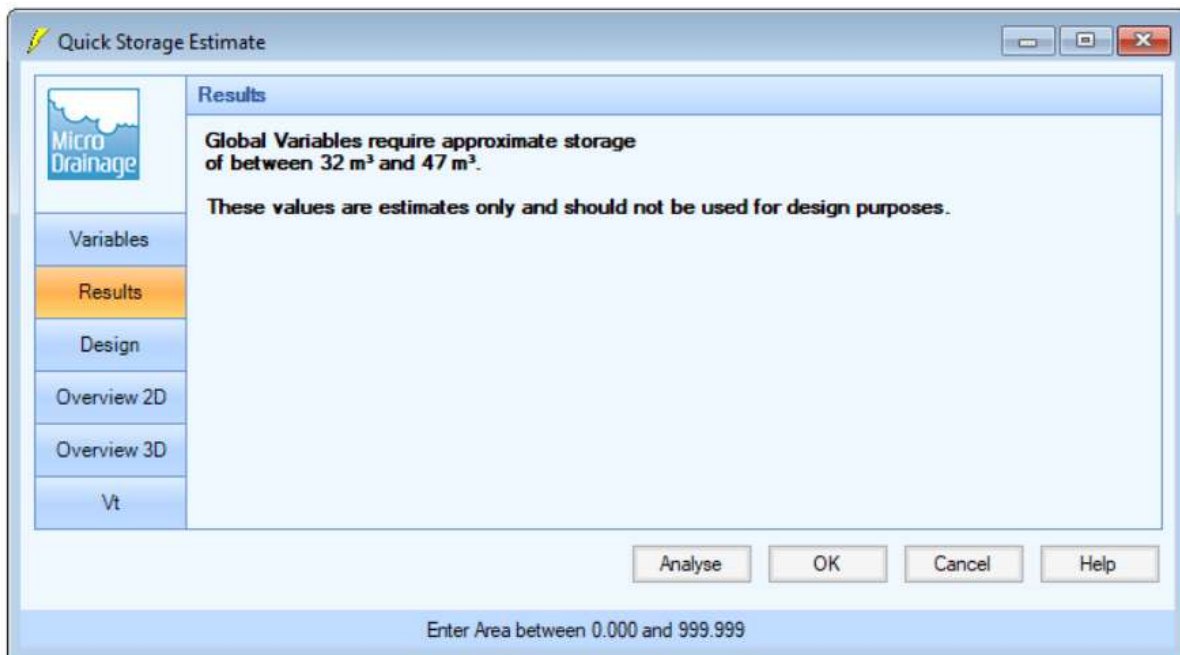
Safety Factor

Climate Change (%)

Analyse OK Cancel Help

Enter Area between 0.000 and 999.999

1 in 30 AEP Parameters



Quick Storage Estimate

Results

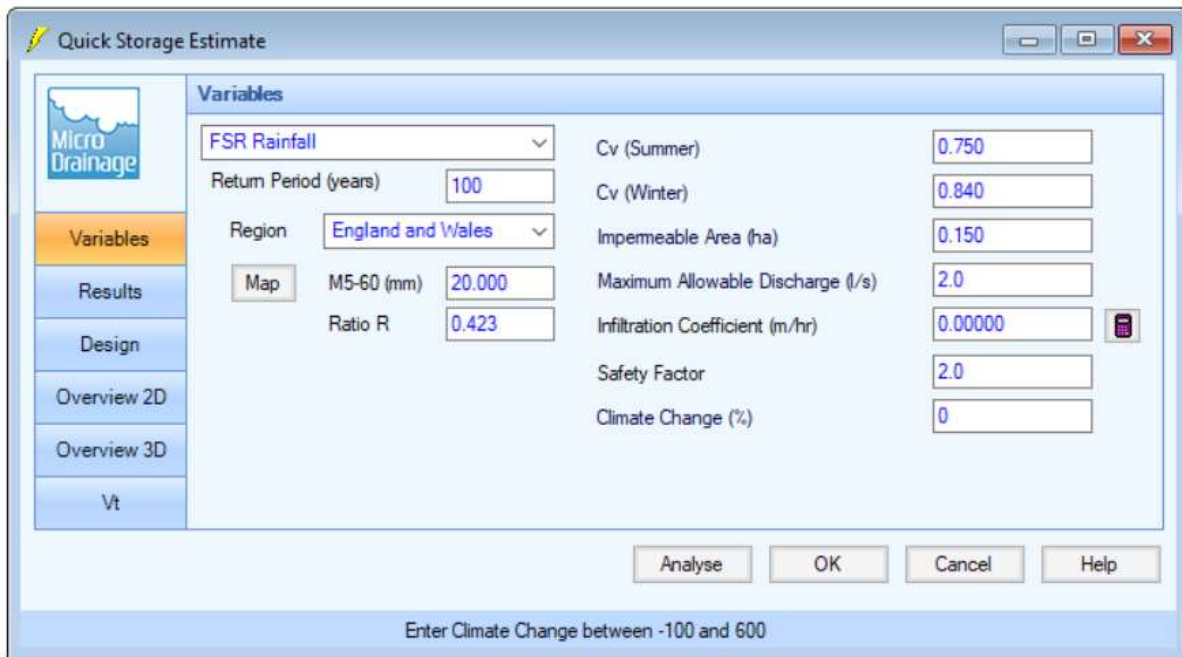
Global Variables require approximate storage of between 32 m³ and 47 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Area between 0.000 and 999.999

1 in 30 AEP Results



Quick Storage Estimate

Variables

FSR Rainfall

Return Period (years)

Region

Map M5-60 (mm)

Ratio R

Cv (Summer)

Cv (Winter)

Impermeable Area (ha)

Maximum Allowable Discharge (l/s)

Infiltration Coefficient (m/hr)

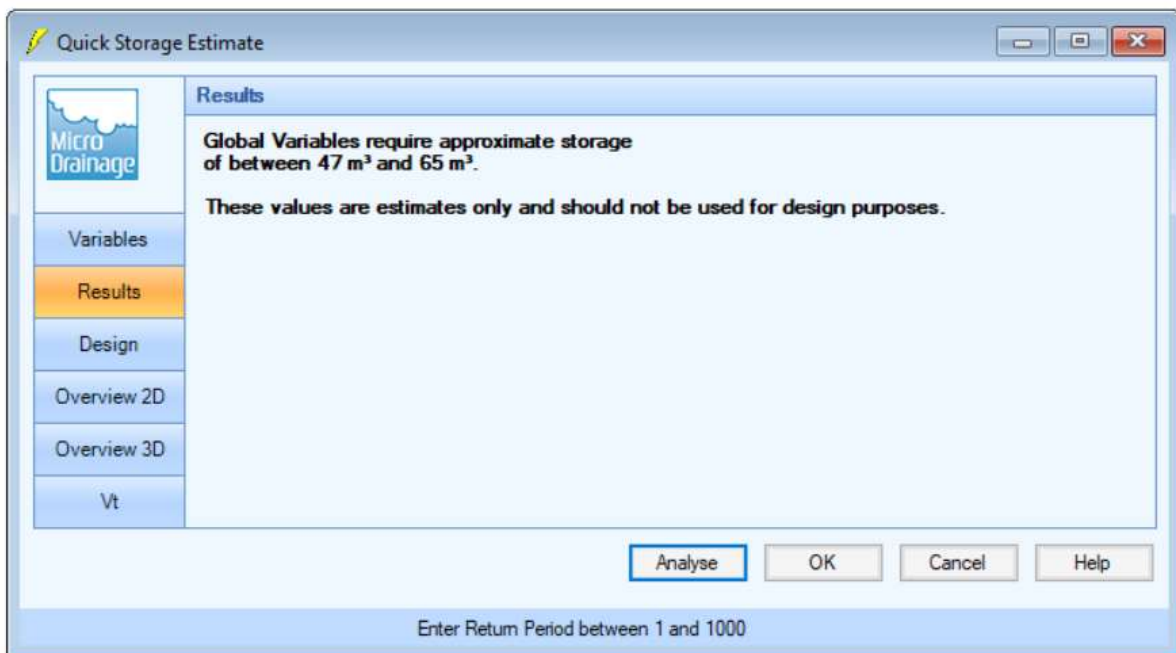
Safety Factor

Climate Change (%)

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

1 in 100 AEP



Quick Storage Estimate

Results

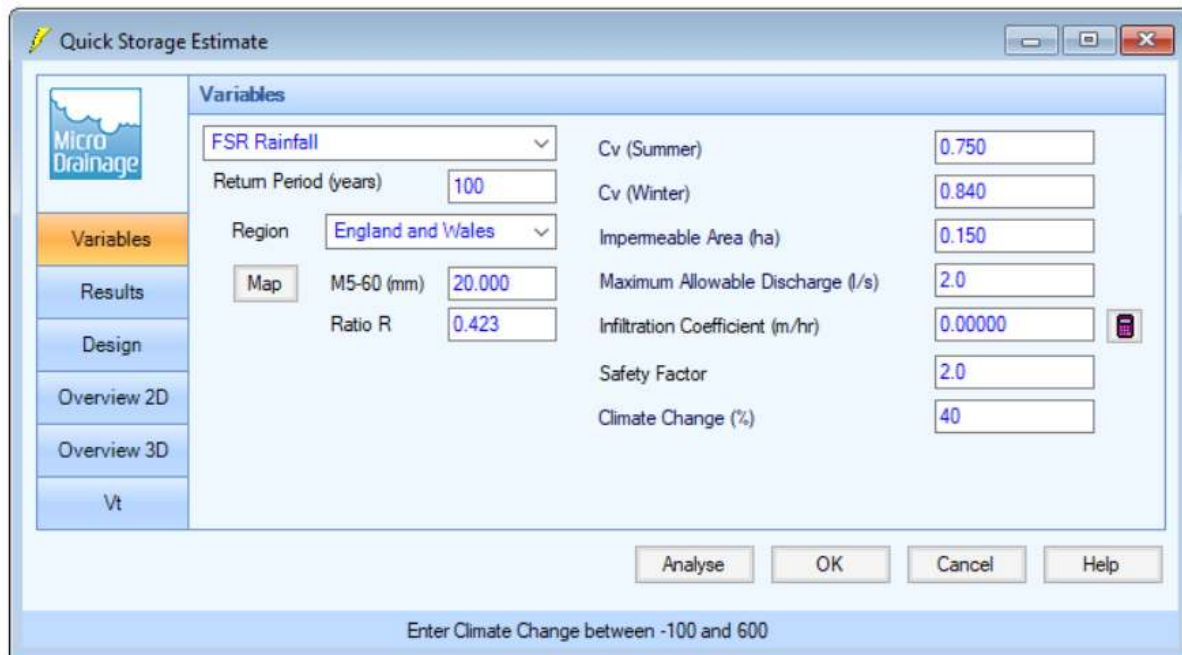
Global Variables require approximate storage of between 47 m³ and 65 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Return Period between 1 and 1000

1 in 100 AEP

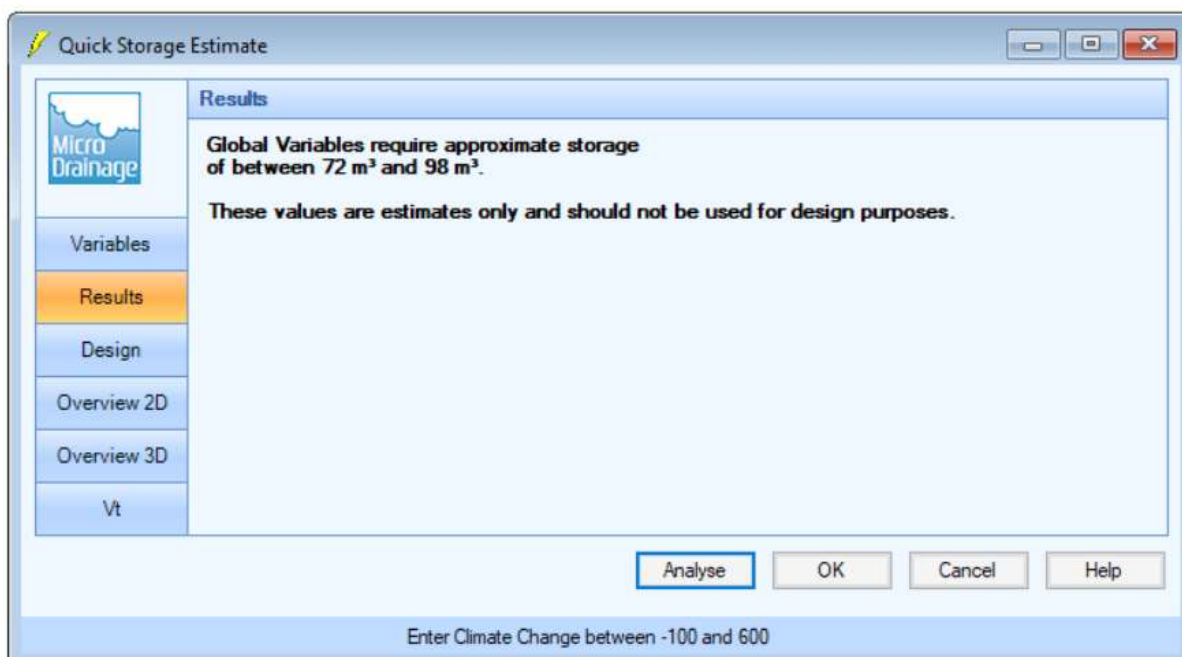


Variables	
FSR Rainfall	Cv (Summer) 0.750
Return Period (years) 100	Cv (Winter) 0.840
Region England and Wales	Impermeable Area (ha) 0.150
Map M5-60 (mm) 20.000	Maximum Allowable Discharge (l/s) 2.0
Ratio R 0.423	Infiltration Coefficient (m/hr) 0.00000
	Safety Factor 2.0
	Climate Change (%) 40

Buttons: Analyse, OK, Cancel, Help

Enter Climate Change between -100 and 600

1 in 100 AEP + 40% Climate Change Parameters



Results

Global Variables require approximate storage of between 72 m³ and 98 m³.

These values are estimates only and should not be used for design purposes.

Buttons: Analyse, OK, Cancel, Help

Enter Climate Change between -100 and 600

1 in 100 AEP + 40% Climate Change Results

Estimated Storage Requirements

1 in 30 AEP	-	47m ³
1 in 100 AEP	-	65m ³
1 in 100 AEP + 40% Climate Change	-	98m ³

Appendix G – Proposed Drainage Strategy Plan

NOTE

AN IMPERMEABLE MEMBRANE WILL BE REQUIRED AT THE BASE OF THE SUB-GRADE STORAGE AND ASSOCIATED COLLECTOR DRAIN TRENCHES TO PREVENT GROUNDWATER INFILTRATION.

PAVED SURFACE WITH GRANULAR SUB-GRADE STORAGE. SURFACE EITHER PERMEABLE BLOCK PAVERS, POROUS ASPHALT OR TRADITIONAL ASPHALT WITH INLET FROM LINEAR DRAINS (AS SHOWN).

STORAGE VOLUME APPROXIMATELY 110m³ BASED ON A PLAN AREA OF 820m², AND 450mm DEPTH OF POROUS AGGREGATE SUB-BASE MATERIAL WITH POROSITY OF 0.3.

RAINWATER PIPES TO CONNECT TO SUB-GRADE AGGREGATE VIA DIFFUSER UNIT

LINEAR DRAIN OUTLET TO CONNECT TO SUB-GRADE AGGREGATE VIA DIFFUSER UNIT

EXISTING SLAB DRAINAGE FEATURES / GULLEY OUTLETS TO BE INVESTIGATED PRIOR TO REMOVAL.

EXCEEDANCE FLOWS FOR 1 IN 100 YEAR +40% CC EVENT TO BE STORED IN LOW SPOT WITH AVERAGE DEPTH OF 50mm (TOTAL VOLUME 4.6m³ - SEE CALCULATIONS FOR DETAILS).

PACKAGE SEWERAGE TREATMENT PLANT, PRIVATELY MAINTAINED

NOTE

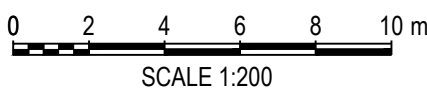
FOUL WATER TREATMENT TANK WILL REQUIRE CONTRACTOR DESIGNED CONCRETE ENCASEMENT TO PREVENT FLOTATION AND WITHSTAND GROUNDWATER PRESSURE. CAPPING TO BE SEALED AROUND THE TANK.

TREATED EFFLUENT TO CONNECT TO EXISTING PRIVATE DRAINAGE NETWORK IMMEDIATELY UPSTREAM OF THE OUTFALL

HYDRO-BRAKE FLOW CONTROL CHAMBER; MAXIMUM DISCHARGE RATE 2 l/s. DISCHARGE TO WATERCOURSE VIA EXISTING OUTFALL PIPE

EXISTING OUTFALL TO WATERCOURSE

GROUNDWATER
THE GROUND INVESTIGATION ENCOUNTERED GROUNDWATER IN THE SUPERFICIAL DEPOSITS AT DEPTHS OF BETWEEN 2.0 AND 2.1M bgl. IT APPEARS THAT LOW PERMEABILITY SUPERFICIAL SOILS / CAPPING ARE CONFINING GROUNDWATER. BH MONITORING INDICATES ARTESIAN FLOWS TO SURFACE AT HIGH TIDES.



CDM NOTES

THE DESIGNERS WOULD DRAW THE READERS ATTENTION TO KEY RESIDUAL HEALTH AND SAFETY RISKS THAT HAVE NOT BEEN ELIMINATED FROM THE DESIGNS SHOWN ON THE DRAWINGS BY THE DESIGN PROCESS. THESE RISKS ARE IDENTIFIED BELOW:

- EXISTING SITE TRAFFIC & PEDESTRIANS
- MANUAL HANDLING / LIFTING OF MATERIALS & EQUIPMENT
- EXISTING SERVICES (BURIED AND OVERHEAD)
- CONTAMINATED GROUND
- NOISE & DUST
- STOCKPILED MATERIAL

ANY CONSTRUCTION PERSONNEL INCLUDING OPERATIVES INTENDING TO CONSTRUCT THE DESIGNS SHOWN ON THIS DRAWING SHOULD ENSURE THAT THEY HAVE BEEN REGULARLY AND THOROUGHLY BRIEFED BY THE PRINCIPAL CONTRACTOR ON ALL HEALTH AND SAFETY MATTERS AND HAVE SIGHT OF:

- THE FULL DESIGNERS AND CONTRACTORS RISK ASSESSMENTS AND RISK REGISTERS.
- THE DEVELOPED CONSTRUCTION HEALTH AND SAFETY PLAN
- THE CONTRACTORS CONSTRUCTION METHOD STATEMENTS.

PRELIMINARY ISSUE

KEY:

- PROPOSED FILTER DRAIN TO DRAIN SUB-BASE (PERFORATED PIPE IN GRAVEL TRENCH)
- PROPOSED SURFACE WATER PIPE
- PROPOSED FOUL SEWER PIPE
- EXISTING SURFACE WATER PIPE
- PROPOSED TREATED EFFLUENT PIPE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED DIFFUSER BOX
- PROPOSED PERMEABLE PAVEMENT SUB-GRADE STORAGE
- S1 PROPOSED SURFACE WATER MANHOLE
- F1 PROPOSED FOUL SEWER MANHOLE
- EXISTING SURFACE WATER MANHOLE
- EXCEEDANCE FLOW ROUTE
- EXCEEDANCE FLOW STORAGE

NOTES

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT SPECIFICATION, INC. RISK ASSESSMENTS (SEE CDM NOTES) AND ALL OTHER RELATED DRAWINGS ISSUED BY THE ENGINEER.
- DO NOT SCALE FROM THIS DRAWING. WORK FROM FIGURED DIMENSIONS ONLY.
- ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN METRES UNLESS OTHERWISE STATED.
- THIS IS A DETAILED DRAINAGE STRATEGY ONLY, AND IS SUBJECT TO DETAILED DESIGN, PRIOR TO CONSTRUCTION.
- ALL COVER LEVELS, INVERT LEVELS, PIPE SIZES AND ATTENUATION VOLUMES ARE INDICATIVE ONLY AND SUBJECT TO DETAILED DESIGN.
- THIS DRAWING IS BASED ON THE FOLLOWING PLANS:
 - CLIFFORD TEE + GALE ARCHITECTS SITE LOCATION PLAN (REF CTG-SP-0019 T1)
 - CLIFFORD TEE + GALE ARCHITECTS GROUND FLOOR PLAN (REF CTG-PL-0022 T3)
 - ROSIER & RUSSELL BUILDING SERVICES SITE LAYOUT BELOW GROUND EXTERNAL MULTI-SERVICES - PLAN ZONE 4 (REF GR-RR-64-500-P-4-G-1 C2)
- THIS DRAINAGE STRATEGY IS BASED ON THE PRINCIPLES SET OUT IN THE FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY REPORT (REF. A111364 FLOOD RISK & DRAINAGE ASSESSMENT) AND IS SUBJECT TO LLFA AND THAMES WATER APPROVAL.
- SURFACE WATER RUN-OFF IS PROPOSED IS PROPOSED TO BE LIMITED TO A MAXIMUM OF 2 L/S DURING THE 1 IN 100 YR + 40% ALLOWANCE FOR CLIMATE CHANGE, VIA THE USE OF A HYDROBRAKE OR SIMILAR FLOW CONTROL DEVICE APPROVED BY THE ENGINEER.
- FURTHER DESIGN BY THE CONTRACTOR IS REQUIRED PRIOR TO CONSTRUCTION TO CONFIRM FINAL DETAILS AND SPECIFICATION. THIS WORK WILL NEED TO CONSIDER HOW THE INTEGRITY OF THE EXISTING CAPPING LAYER CAN BE MAINTAINED TO KEEP PREVENT GROUNDWATER EMERGENCE AND KEEP GROUNDWATER OUT OF THE SUB-SURFACE DRAINAGE. PROTECTION MEASURES WILL BE REQUIRED AT THE PROPOSED PACKAGE SEWERAGE TREATMENT TANK.
- DRAINAGE PROVISION TO BE UPDATED AS PART OF CONTRACTOR DESIGN TO SUIT SVP / RWP LOCATIONS WHICH ARE TO BE CONFIRMED BY THE ARCHITECT. MANHOLE COVER LEVELS AND INVERT LEVELS TO BE CONFIRMED, TO SUIT EXTERNAL LEVELS. FINAL EXTERNAL HARDSTANDING SPECIFICATION TO BE CONFIRMED.

P1	NOTES ADDED.	CD			11.09.20
REV	DESCRIPTION	BY	CHK	APP	DATE

METROPOLITAN POLICE SERVICE

GENEVA BUILDING,
LAKE VIEW DRIVE,
SHERWOOD BUSINESS PARK,
ANNESLEY, NOTTINGHAMSHIRE
NG15 0ED

TEL: +44 (0)1623 684 550
e-mail: nottingham@wyg.com

Project:

LIVE FIRE SKILLS HOUSE
GRAVESEND

Drawing Title:

DRAINAGE STRATEGY PLAN

Scale @ A2 1:200	Drawn CD	Date 22.07.20	Checked ME	Date 22.07.20	Approved ME	Date 22.07.20
Project No. A111364	Office 21	Type C	Drawing No. SK01	Revision P1		

Appendix H – Supporting Drainage Calculations

WYG Group Limited		Page 3
.	Live Fire Skills House	
.	Gravesend	
.		
Date 20/07/2020 23:41	Designed by CD	
File Source Control - Porus ...	Checked by ME	
XP Solutions		Source Control 2019.1

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.434	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.150

Time (mins)		Area
From:	To:	(ha)
0	4	0.150

©1982-2019 Innovyze

WYG Group Limited		Page 4
.	Live Fire Skills House	
.	Gravesend	
.		
Date 20/07/2020 23:41	Designed by CD	
File Source Control - Porus ...	Checked by ME	
XP Solutions	Source Control 2019.1	

Model Details

Storage is Online Cover Level (m) 2.400

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	13.0
Membrane Percolation (mm/hr)	1000	Length (m)	63.0
Max Percolation (l/s)	227.5	Slope (1:X)	100.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.800	Cap Volume Depth (m)	0.450

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0062-2000-1400-2000
Design Head (m)	1.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	62
Invert Level (m)	1.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	2.0
Flush-Flo™	0.272	1.6
Kick-Flo®	0.553	1.3
Mean Flow over Head Range	-	1.6

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	1.4	1.200	1.9	3.000	2.8	7.000	4.2
0.200	1.6	1.400	2.0	3.500	3.0	7.500	4.4
0.300	1.6	1.600	2.1	4.000	3.2	8.000	4.5
0.400	1.6	1.800	2.2	4.500	3.4	8.500	4.6
0.500	1.5	2.000	2.4	5.000	3.6	9.000	4.7
0.600	1.4	2.200	2.5	5.500	3.8	9.500	4.9
0.800	1.6	2.400	2.6	6.000	3.9		
1.000	1.7	2.600	2.7	6.500	4.1		

©1982-2019 Innovyze

WYG Group Limited		Page 1																																																																																																																																																																																																																																																																																		
. . . Live Fire Skills House Gravesend																																																																																																																																																																																																																																																																																				
Date 20/07/2020 23:45 Designed by CD File Source Control - Porus ... Checked by ME																																																																																																																																																																																																																																																																																				
XP Solutions																																																																																																																																																																																																																																																																																				
Source Control 2019.1																																																																																																																																																																																																																																																																																				
Summary of Results for 1 year Return Period Half Drain Time : 46 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>1.941</td><td>0.141</td><td>0.0</td><td>1.7</td><td>1.7</td><td>3.9</td><td>O K</td></tr><tr><td>30 min Summer</td><td>1.971</td><td>0.171</td><td>0.0</td><td>1.7</td><td>1.7</td><td>5.7</td><td>O K</td></tr><tr><td>60 min Summer</td><td>1.987</td><td>0.187</td><td>0.0</td><td>1.7</td><td>1.7</td><td>6.8</td><td>O K</td></tr><tr><td>120 min Summer</td><td>1.995</td><td>0.195</td><td>0.0</td><td>1.7</td><td>1.7</td><td>7.4</td><td>O K</td></tr><tr><td>180 min Summer</td><td>1.993</td><td>0.193</td><td>0.0</td><td>1.7</td><td>1.7</td><td>7.3</td><td>O K</td></tr><tr><td>240 min Summer</td><td>1.987</td><td>0.187</td><td>0.0</td><td>1.7</td><td>1.7</td><td>6.9</td><td>O K</td></tr><tr><td>360 min Summer</td><td>1.968</td><td>0.168</td><td>0.0</td><td>1.7</td><td>1.7</td><td>5.5</td><td>O K</td></tr><tr><td>480 min Summer</td><td>1.947</td><td>0.147</td><td>0.0</td><td>1.7</td><td>1.7</td><td>4.2</td><td>O K</td></tr><tr><td>600 min Summer</td><td>1.926</td><td>0.126</td><td>0.0</td><td>1.7</td><td>1.7</td><td>3.1</td><td>O K</td></tr><tr><td>720 min Summer</td><td>1.906</td><td>0.106</td><td>0.0</td><td>1.6</td><td>1.6</td><td>2.2</td><td>O K</td></tr><tr><td>960 min Summer</td><td>1.867</td><td>0.067</td><td>0.0</td><td>1.6</td><td>1.6</td><td>0.9</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>1.5</td><td>1.5</td><td>0.0</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>1.1</td><td>1.1</td><td>0.0</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.9</td><td>0.9</td><td>0.0</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.6</td><td>0.6</td><td>0.0</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.5</td><td>0.5</td><td>0.0</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.4</td><td>0.4</td><td>0.0</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.4</td><td>0.4</td><td>0.0</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.3</td><td>0.3</td><td>0.0</td><td>O K</td></tr><tr><td>15 min Winter</td><td>1.960</td><td>0.160</td><td>0.0</td><td>1.7</td><td>1.7</td><td>5.0</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>31.842</td><td>0.0</td><td>4.8</td><td>17</td></tr><tr><td>30 min Summer</td><td>20.519</td><td>0.0</td><td>7.4</td><td>31</td></tr><tr><td>60 min Summer</td><td>12.800</td><td>0.0</td><td>10.2</td><td>52</td></tr><tr><td>120 min Summer</td><td>7.814</td><td>0.0</td><td>13.4</td><td>84</td></tr><tr><td>180 min Summer</td><td>5.824</td><td>0.0</td><td>15.2</td><td>120</td></tr><tr><td>240 min Summer</td><td>4.721</td><td>0.0</td><td>16.8</td><td>154</td></tr><tr><td>360 min Summer</td><td>3.501</td><td>0.0</td><td>19.0</td><td>218</td></tr><tr><td>480 min Summer</td><td>2.818</td><td>0.0</td><td>20.4</td><td>282</td></tr><tr><td>600 min Summer</td><td>2.382</td><td>0.0</td><td>21.6</td><td>342</td></tr><tr><td>720 min Summer</td><td>2.076</td><td>0.0</td><td>22.7</td><td>398</td></tr><tr><td>960 min Summer</td><td>1.671</td><td>0.0</td><td>24.3</td><td>510</td></tr><tr><td>1440 min Summer</td><td>1.231</td><td>0.0</td><td>26.7</td><td>0</td></tr><tr><td>2160 min Summer</td><td>0.907</td><td>0.0</td><td>28.9</td><td>0</td></tr><tr><td>2880 min Summer</td><td>0.730</td><td>0.0</td><td>30.4</td><td>0</td></tr><tr><td>4320 min Summer</td><td>0.538</td><td>0.0</td><td>32.1</td><td>0</td></tr><tr><td>5760 min Summer</td><td>0.433</td><td>0.0</td><td>32.8</td><td>0</td></tr><tr><td>7200 min Summer</td><td>0.366</td><td>0.0</td><td>33.0</td><td>0</td></tr><tr><td>8640 min Summer</td><td>0.319</td><td>0.0</td><td>32.8</td><td>0</td></tr><tr><td>10080 min Summer</td><td>0.284</td><td>0.0</td><td>32.4</td><td>0</td></tr><tr><td>15 min Winter</td><td>31.842</td><td>0.0</td><td>5.9</td><td>17</td></tr></table>				Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status	15 min Summer	1.941	0.141	0.0	1.7	1.7	3.9	O K	30 min Summer	1.971	0.171	0.0	1.7	1.7	5.7	O K	60 min Summer	1.987	0.187	0.0	1.7	1.7	6.8	O K	120 min Summer	1.995	0.195	0.0	1.7	1.7	7.4	O K	180 min Summer	1.993	0.193	0.0	1.7	1.7	7.3	O K	240 min Summer	1.987	0.187	0.0	1.7	1.7	6.9	O K	360 min Summer	1.968	0.168	0.0	1.7	1.7	5.5	O K	480 min Summer	1.947	0.147	0.0	1.7	1.7	4.2	O K	600 min Summer	1.926	0.126	0.0	1.7	1.7	3.1	O K	720 min Summer	1.906	0.106	0.0	1.6	1.6	2.2	O K	960 min Summer	1.867	0.067	0.0	1.6	1.6	0.9	O K	1440 min Summer	1.800	0.000	0.0	1.5	1.5	0.0	O K	2160 min Summer	1.800	0.000	0.0	1.1	1.1	0.0	O K	2880 min Summer	1.800	0.000	0.0	0.9	0.9	0.0	O K	4320 min Summer	1.800	0.000	0.0	0.6	0.6	0.0	O K	5760 min Summer	1.800	0.000	0.0	0.5	0.5	0.0	O K	7200 min Summer	1.800	0.000	0.0	0.4	0.4	0.0	O K	8640 min Summer	1.800	0.000	0.0	0.4	0.4	0.0	O K	10080 min Summer	1.800	0.000	0.0	0.3	0.3	0.0	O K	15 min Winter	1.960	0.160	0.0	1.7	1.7	5.0	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	15 min Summer	31.842	0.0	4.8	17	30 min Summer	20.519	0.0	7.4	31	60 min Summer	12.800	0.0	10.2	52	120 min Summer	7.814	0.0	13.4	84	180 min Summer	5.824	0.0	15.2	120	240 min Summer	4.721	0.0	16.8	154	360 min Summer	3.501	0.0	19.0	218	480 min Summer	2.818	0.0	20.4	282	600 min Summer	2.382	0.0	21.6	342	720 min Summer	2.076	0.0	22.7	398	960 min Summer	1.671	0.0	24.3	510	1440 min Summer	1.231	0.0	26.7	0	2160 min Summer	0.907	0.0	28.9	0	2880 min Summer	0.730	0.0	30.4	0	4320 min Summer	0.538	0.0	32.1	0	5760 min Summer	0.433	0.0	32.8	0	7200 min Summer	0.366	0.0	33.0	0	8640 min Summer	0.319	0.0	32.8	0	10080 min Summer	0.284	0.0	32.4	0	15 min Winter	31.842	0.0	5.9	17
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status																																																																																																																																																																																																																																																																													
15 min Summer	1.941	0.141	0.0	1.7	1.7	3.9	O K																																																																																																																																																																																																																																																																													
30 min Summer	1.971	0.171	0.0	1.7	1.7	5.7	O K																																																																																																																																																																																																																																																																													
60 min Summer	1.987	0.187	0.0	1.7	1.7	6.8	O K																																																																																																																																																																																																																																																																													
120 min Summer	1.995	0.195	0.0	1.7	1.7	7.4	O K																																																																																																																																																																																																																																																																													
180 min Summer	1.993	0.193	0.0	1.7	1.7	7.3	O K																																																																																																																																																																																																																																																																													
240 min Summer	1.987	0.187	0.0	1.7	1.7	6.9	O K																																																																																																																																																																																																																																																																													
360 min Summer	1.968	0.168	0.0	1.7	1.7	5.5	O K																																																																																																																																																																																																																																																																													
480 min Summer	1.947	0.147	0.0	1.7	1.7	4.2	O K																																																																																																																																																																																																																																																																													
600 min Summer	1.926	0.126	0.0	1.7	1.7	3.1	O K																																																																																																																																																																																																																																																																													
720 min Summer	1.906	0.106	0.0	1.6	1.6	2.2	O K																																																																																																																																																																																																																																																																													
960 min Summer	1.867	0.067	0.0	1.6	1.6	0.9	O K																																																																																																																																																																																																																																																																													
1440 min Summer	1.800	0.000	0.0	1.5	1.5	0.0	O K																																																																																																																																																																																																																																																																													
2160 min Summer	1.800	0.000	0.0	1.1	1.1	0.0	O K																																																																																																																																																																																																																																																																													
2880 min Summer	1.800	0.000	0.0	0.9	0.9	0.0	O K																																																																																																																																																																																																																																																																													
4320 min Summer	1.800	0.000	0.0	0.6	0.6	0.0	O K																																																																																																																																																																																																																																																																													
5760 min Summer	1.800	0.000	0.0	0.5	0.5	0.0	O K																																																																																																																																																																																																																																																																													
7200 min Summer	1.800	0.000	0.0	0.4	0.4	0.0	O K																																																																																																																																																																																																																																																																													
8640 min Summer	1.800	0.000	0.0	0.4	0.4	0.0	O K																																																																																																																																																																																																																																																																													
10080 min Summer	1.800	0.000	0.0	0.3	0.3	0.0	O K																																																																																																																																																																																																																																																																													
15 min Winter	1.960	0.160	0.0	1.7	1.7	5.0	O K																																																																																																																																																																																																																																																																													
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)																																																																																																																																																																																																																																																																																
15 min Summer	31.842	0.0	4.8	17																																																																																																																																																																																																																																																																																
30 min Summer	20.519	0.0	7.4	31																																																																																																																																																																																																																																																																																
60 min Summer	12.800	0.0	10.2	52																																																																																																																																																																																																																																																																																
120 min Summer	7.814	0.0	13.4	84																																																																																																																																																																																																																																																																																
180 min Summer	5.824	0.0	15.2	120																																																																																																																																																																																																																																																																																
240 min Summer	4.721	0.0	16.8	154																																																																																																																																																																																																																																																																																
360 min Summer	3.501	0.0	19.0	218																																																																																																																																																																																																																																																																																
480 min Summer	2.818	0.0	20.4	282																																																																																																																																																																																																																																																																																
600 min Summer	2.382	0.0	21.6	342																																																																																																																																																																																																																																																																																
720 min Summer	2.076	0.0	22.7	398																																																																																																																																																																																																																																																																																
960 min Summer	1.671	0.0	24.3	510																																																																																																																																																																																																																																																																																
1440 min Summer	1.231	0.0	26.7	0																																																																																																																																																																																																																																																																																
2160 min Summer	0.907	0.0	28.9	0																																																																																																																																																																																																																																																																																
2880 min Summer	0.730	0.0	30.4	0																																																																																																																																																																																																																																																																																
4320 min Summer	0.538	0.0	32.1	0																																																																																																																																																																																																																																																																																
5760 min Summer	0.433	0.0	32.8	0																																																																																																																																																																																																																																																																																
7200 min Summer	0.366	0.0	33.0	0																																																																																																																																																																																																																																																																																
8640 min Summer	0.319	0.0	32.8	0																																																																																																																																																																																																																																																																																
10080 min Summer	0.284	0.0	32.4	0																																																																																																																																																																																																																																																																																
15 min Winter	31.842	0.0	5.9	17																																																																																																																																																																																																																																																																																
©1982-2019 Innovyze																																																																																																																																																																																																																																																																																				

WYG Group Limited		Page 2
.	Live Fire Skills House	
.	Gravesend	
.		
Date 20/07/2020 23:45	Designed by CD	
File Source Control - Porus ...	Checked by ME	
XP Solutions	Source Control 2019.1	

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	1.990	0.190	0.0	1.7	1.7	7.0	O K
60 min Winter	2.007	0.207	0.0	1.7	1.7	8.3	O K
120 min Winter	2.011	0.211	0.0	1.7	1.7	8.7	O K
180 min Winter	2.005	0.205	0.0	1.7	1.7	8.2	O K
240 min Winter	1.994	0.194	0.0	1.7	1.7	7.4	O K
360 min Winter	1.965	0.165	0.0	1.7	1.7	5.3	O K
480 min Winter	1.931	0.131	0.0	1.7	1.7	3.3	O K
600 min Winter	1.896	0.096	0.0	1.6	1.6	1.8	O K
720 min Winter	1.859	0.059	0.0	1.6	1.6	0.7	O K
960 min Winter	1.800	0.000	0.0	1.5	1.5	0.0	O K
1440 min Winter	1.800	0.000	0.0	1.1	1.1	0.0	O K
2160 min Winter	1.800	0.000	0.0	0.8	0.8	0.0	O K
2880 min Winter	1.800	0.000	0.0	0.6	0.6	0.0	O K
4320 min Winter	1.800	0.000	0.0	0.4	0.4	0.0	O K
5760 min Winter	1.800	0.000	0.0	0.4	0.4	0.0	O K
7200 min Winter	1.800	0.000	0.0	0.3	0.3	0.0	O K
8640 min Winter	1.800	0.000	0.0	0.3	0.3	0.0	O K
10080 min Winter	1.800	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	20.519	0.0	8.8	31
60 min Winter	12.800	0.0	11.9	58
120 min Winter	7.814	0.0	15.3	92
180 min Winter	5.824	0.0	17.6	130
240 min Winter	4.721	0.0	19.3	166
360 min Winter	3.501	0.0	21.8	234
480 min Winter	2.818	0.0	23.5	296
600 min Winter	2.382	0.0	24.9	352
720 min Winter	2.076	0.0	26.1	400
960 min Winter	1.671	0.0	28.0	0
1440 min Winter	1.231	0.0	30.7	0
2160 min Winter	0.907	0.0	33.4	0
2880 min Winter	0.730	0.0	35.2	0
4320 min Winter	0.538	0.0	37.5	0
5760 min Winter	0.433	0.0	38.7	0
7200 min Winter	0.366	0.0	39.3	0
8640 min Winter	0.319	0.0	39.5	0
10080 min Winter	0.284	0.0	39.4	0

WYG Group Limited

.

.

.

Date 20/07/2020 23:44

File Source Control - Porus ...

XP Solutions

Live Fire Skills House

Gravesend

Designed by CD

Checked by ME

Source Control 2019.1

Page 1



Summary of Results for 30 year Return Period

Half Drain Time : 152 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	2.092	0.292	0.0	1.8	1.8	16.6	O K
30 min Summer	2.134	0.334	0.0	1.8	1.8	21.8	Flood Risk
60 min Summer	2.164	0.364	0.0	1.8	1.8	25.8	Flood Risk
120 min Summer	2.175	0.375	0.0	1.8	1.8	27.4	Flood Risk
180 min Summer	2.171	0.371	0.0	1.8	1.8	26.9	Flood Risk
240 min Summer	2.165	0.365	0.0	1.8	1.8	25.9	Flood Risk
360 min Summer	2.149	0.349	0.0	1.8	1.8	23.8	Flood Risk
480 min Summer	2.134	0.334	0.0	1.8	1.8	21.8	Flood Risk
600 min Summer	2.119	0.319	0.0	1.8	1.8	19.9	Flood Risk
720 min Summer	2.104	0.304	0.0	1.8	1.8	18.0	Flood Risk
960 min Summer	2.074	0.274	0.0	1.8	1.8	14.6	O K
1440 min Summer	2.015	0.215	0.0	1.7	1.7	9.0	O K
2160 min Summer	1.934	0.134	0.0	1.7	1.7	3.5	O K
2880 min Summer	1.861	0.061	0.0	1.6	1.6	0.7	O K
4320 min Summer	1.800	0.000	0.0	1.3	1.3	0.0	O K
5760 min Summer	1.800	0.000	0.0	1.0	1.0	0.0	O K
7200 min Summer	1.800	0.000	0.0	0.8	0.8	0.0	O K
8640 min Summer	1.800	0.000	0.0	0.7	0.7	0.0	O K
10080 min Summer	1.800	0.000	0.0	0.6	0.6	0.0	O K
15 min Winter	2.114	0.314	0.0	1.8	1.8	19.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.157	0.0	17.9	18
30 min Summer	50.205	0.0	24.1	33
60 min Summer	30.811	0.0	30.4	62
120 min Summer	18.360	0.0	37.0	120
180 min Summer	13.429	0.0	40.9	148
240 min Summer	10.714	0.0	43.7	178
360 min Summer	7.765	0.0	47.6	246
480 min Summer	6.179	0.0	50.8	314
600 min Summer	5.173	0.0	53.2	380
720 min Summer	4.473	0.0	55.0	448
960 min Summer	3.553	0.0	58.2	578
1440 min Summer	2.566	0.0	62.8	822
2160 min Summer	1.852	0.0	67.2	1168
2880 min Summer	1.468	0.0	70.3	1496
4320 min Summer	1.058	0.0	74.2	0
5760 min Summer	0.838	0.0	76.6	0
7200 min Summer	0.699	0.0	78.0	0
8640 min Summer	0.603	0.0	78.8	0
10080 min Summer	0.532	0.0	79.2	0
15 min Winter	78.157	0.0	20.5	18

©1982-2019 Innovyze

WYG Group Limited		Page 2																																																																																																																																																																																																																																																								
. . .		Live Fire Skills House Gravesend																																																																																																																																																																																																																																																								
Date 20/07/2020 23:42 File Source Control - Porus ...		Designed by CD Checked by ME																																																																																																																																																																																																																																																								
XP Solutions		Source Control 2019.1																																																																																																																																																																																																																																																								
Summary of Results for 100 year Return Period <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Σ Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>30 min Winter</td><td>2.221</td><td>0.421</td><td>0.0</td><td>1.9</td><td>1.9</td><td>34.6</td><td>Flood Risk</td></tr><tr><td>60 min Winter</td><td>2.262</td><td>0.462</td><td>0.0</td><td>1.9</td><td>1.9</td><td>41.5</td><td>Flood Risk</td></tr><tr><td>120 min Winter</td><td>2.286</td><td>0.486</td><td>0.0</td><td>1.9</td><td>1.9</td><td>45.9</td><td>Flood Risk</td></tr><tr><td>180 min Winter</td><td>2.288</td><td>0.488</td><td>0.0</td><td>1.9</td><td>1.9</td><td>46.2</td><td>Flood Risk</td></tr><tr><td>240 min Winter</td><td>2.281</td><td>0.481</td><td>0.0</td><td>1.9</td><td>1.9</td><td>45.0</td><td>Flood Risk</td></tr><tr><td>360 min Winter</td><td>2.261</td><td>0.461</td><td>0.0</td><td>1.9</td><td>1.9</td><td>41.5</td><td>Flood Risk</td></tr><tr><td>480 min Winter</td><td>2.243</td><td>0.443</td><td>0.0</td><td>1.9</td><td>1.9</td><td>38.3</td><td>Flood Risk</td></tr><tr><td>600 min Winter</td><td>2.224</td><td>0.424</td><td>0.0</td><td>1.9</td><td>1.9</td><td>35.0</td><td>Flood Risk</td></tr><tr><td>720 min Winter</td><td>2.204</td><td>0.404</td><td>0.0</td><td>1.9</td><td>1.9</td><td>31.9</td><td>Flood Risk</td></tr><tr><td>960 min Winter</td><td>2.164</td><td>0.364</td><td>0.0</td><td>1.8</td><td>1.8</td><td>25.9</td><td>Flood Risk</td></tr><tr><td>1440 min Winter</td><td>2.083</td><td>0.283</td><td>0.0</td><td>1.8</td><td>1.8</td><td>15.6</td><td>O K</td></tr><tr><td>2160 min Winter</td><td>1.961</td><td>0.161</td><td>0.0</td><td>1.7</td><td>1.7</td><td>5.1</td><td>O K</td></tr><tr><td>2880 min Winter</td><td>1.832</td><td>0.032</td><td>0.0</td><td>1.6</td><td>1.6</td><td>0.2</td><td>O K</td></tr><tr><td>4320 min Winter</td><td>1.800</td><td>0.000</td><td>0.0</td><td>1.1</td><td>1.1</td><td>0.0</td><td>O K</td></tr><tr><td>5760 min Winter</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.9</td><td>0.9</td><td>0.0</td><td>O K</td></tr><tr><td>7200 min Winter</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.7</td><td>0.7</td><td>0.0</td><td>O K</td></tr><tr><td>8640 min Winter</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.6</td><td>0.6</td><td>0.0</td><td>O K</td></tr><tr><td>10080 min Winter</td><td>1.800</td><td>0.000</td><td>0.0</td><td>0.6</td><td>0.6</td><td>0.0</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>30 min Winter</td><td>65.739</td><td>0.0</td><td>37.2</td><td>32</td></tr><tr><td>60 min Winter</td><td>40.510</td><td>0.0</td><td>46.9</td><td>62</td></tr><tr><td>120 min Winter</td><td>24.133</td><td>0.0</td><td>56.5</td><td>118</td></tr><tr><td>180 min Winter</td><td>17.605</td><td>0.0</td><td>62.0</td><td>174</td></tr><tr><td>240 min Winter</td><td>14.001</td><td>0.0</td><td>66.0</td><td>226</td></tr><tr><td>360 min Winter</td><td>10.089</td><td>0.0</td><td>71.6</td><td>280</td></tr><tr><td>480 min Winter</td><td>8.000</td><td>0.0</td><td>75.8</td><td>356</td></tr><tr><td>600 min Winter</td><td>6.679</td><td>0.0</td><td>79.0</td><td>430</td></tr><tr><td>720 min Winter</td><td>5.760</td><td>0.0</td><td>81.7</td><td>504</td></tr><tr><td>960 min Winter</td><td>4.558</td><td>0.0</td><td>86.2</td><td>644</td></tr><tr><td>1440 min Winter</td><td>3.273</td><td>0.0</td><td>92.5</td><td>906</td></tr><tr><td>2160 min Winter</td><td>2.346</td><td>0.0</td><td>98.7</td><td>1236</td></tr><tr><td>2880 min Winter</td><td>1.851</td><td>0.0</td><td>103.0</td><td>1496</td></tr><tr><td>4320 min Winter</td><td>1.324</td><td>0.0</td><td>108.8</td><td>0</td></tr><tr><td>5760 min Winter</td><td>1.043</td><td>0.0</td><td>112.4</td><td>0</td></tr><tr><td>7200 min Winter</td><td>0.867</td><td>0.0</td><td>114.8</td><td>0</td></tr><tr><td>8640 min Winter</td><td>0.745</td><td>0.0</td><td>116.5</td><td>0</td></tr><tr><td>10080 min Winter</td><td>0.655</td><td>0.0</td><td>117.6</td><td>0</td></tr></table>				Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	30 min Winter	2.221	0.421	0.0	1.9	1.9	34.6	Flood Risk	60 min Winter	2.262	0.462	0.0	1.9	1.9	41.5	Flood Risk	120 min Winter	2.286	0.486	0.0	1.9	1.9	45.9	Flood Risk	180 min Winter	2.288	0.488	0.0	1.9	1.9	46.2	Flood Risk	240 min Winter	2.281	0.481	0.0	1.9	1.9	45.0	Flood Risk	360 min Winter	2.261	0.461	0.0	1.9	1.9	41.5	Flood Risk	480 min Winter	2.243	0.443	0.0	1.9	1.9	38.3	Flood Risk	600 min Winter	2.224	0.424	0.0	1.9	1.9	35.0	Flood Risk	720 min Winter	2.204	0.404	0.0	1.9	1.9	31.9	Flood Risk	960 min Winter	2.164	0.364	0.0	1.8	1.8	25.9	Flood Risk	1440 min Winter	2.083	0.283	0.0	1.8	1.8	15.6	O K	2160 min Winter	1.961	0.161	0.0	1.7	1.7	5.1	O K	2880 min Winter	1.832	0.032	0.0	1.6	1.6	0.2	O K	4320 min Winter	1.800	0.000	0.0	1.1	1.1	0.0	O K	5760 min Winter	1.800	0.000	0.0	0.9	0.9	0.0	O K	7200 min Winter	1.800	0.000	0.0	0.7	0.7	0.0	O K	8640 min Winter	1.800	0.000	0.0	0.6	0.6	0.0	O K	10080 min Winter	1.800	0.000	0.0	0.6	0.6	0.0	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	30 min Winter	65.739	0.0	37.2	32	60 min Winter	40.510	0.0	46.9	62	120 min Winter	24.133	0.0	56.5	118	180 min Winter	17.605	0.0	62.0	174	240 min Winter	14.001	0.0	66.0	226	360 min Winter	10.089	0.0	71.6	280	480 min Winter	8.000	0.0	75.8	356	600 min Winter	6.679	0.0	79.0	430	720 min Winter	5.760	0.0	81.7	504	960 min Winter	4.558	0.0	86.2	644	1440 min Winter	3.273	0.0	92.5	906	2160 min Winter	2.346	0.0	98.7	1236	2880 min Winter	1.851	0.0	103.0	1496	4320 min Winter	1.324	0.0	108.8	0	5760 min Winter	1.043	0.0	112.4	0	7200 min Winter	0.867	0.0	114.8	0	8640 min Winter	0.745	0.0	116.5	0	10080 min Winter	0.655	0.0	117.6	0
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status																																																																																																																																																																																																																																																			
30 min Winter	2.221	0.421	0.0	1.9	1.9	34.6	Flood Risk																																																																																																																																																																																																																																																			
60 min Winter	2.262	0.462	0.0	1.9	1.9	41.5	Flood Risk																																																																																																																																																																																																																																																			
120 min Winter	2.286	0.486	0.0	1.9	1.9	45.9	Flood Risk																																																																																																																																																																																																																																																			
180 min Winter	2.288	0.488	0.0	1.9	1.9	46.2	Flood Risk																																																																																																																																																																																																																																																			
240 min Winter	2.281	0.481	0.0	1.9	1.9	45.0	Flood Risk																																																																																																																																																																																																																																																			
360 min Winter	2.261	0.461	0.0	1.9	1.9	41.5	Flood Risk																																																																																																																																																																																																																																																			
480 min Winter	2.243	0.443	0.0	1.9	1.9	38.3	Flood Risk																																																																																																																																																																																																																																																			
600 min Winter	2.224	0.424	0.0	1.9	1.9	35.0	Flood Risk																																																																																																																																																																																																																																																			
720 min Winter	2.204	0.404	0.0	1.9	1.9	31.9	Flood Risk																																																																																																																																																																																																																																																			
960 min Winter	2.164	0.364	0.0	1.8	1.8	25.9	Flood Risk																																																																																																																																																																																																																																																			
1440 min Winter	2.083	0.283	0.0	1.8	1.8	15.6	O K																																																																																																																																																																																																																																																			
2160 min Winter	1.961	0.161	0.0	1.7	1.7	5.1	O K																																																																																																																																																																																																																																																			
2880 min Winter	1.832	0.032	0.0	1.6	1.6	0.2	O K																																																																																																																																																																																																																																																			
4320 min Winter	1.800	0.000	0.0	1.1	1.1	0.0	O K																																																																																																																																																																																																																																																			
5760 min Winter	1.800	0.000	0.0	0.9	0.9	0.0	O K																																																																																																																																																																																																																																																			
7200 min Winter	1.800	0.000	0.0	0.7	0.7	0.0	O K																																																																																																																																																																																																																																																			
8640 min Winter	1.800	0.000	0.0	0.6	0.6	0.0	O K																																																																																																																																																																																																																																																			
10080 min Winter	1.800	0.000	0.0	0.6	0.6	0.0	O K																																																																																																																																																																																																																																																			
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)																																																																																																																																																																																																																																																						
30 min Winter	65.739	0.0	37.2	32																																																																																																																																																																																																																																																						
60 min Winter	40.510	0.0	46.9	62																																																																																																																																																																																																																																																						
120 min Winter	24.133	0.0	56.5	118																																																																																																																																																																																																																																																						
180 min Winter	17.605	0.0	62.0	174																																																																																																																																																																																																																																																						
240 min Winter	14.001	0.0	66.0	226																																																																																																																																																																																																																																																						
360 min Winter	10.089	0.0	71.6	280																																																																																																																																																																																																																																																						
480 min Winter	8.000	0.0	75.8	356																																																																																																																																																																																																																																																						
600 min Winter	6.679	0.0	79.0	430																																																																																																																																																																																																																																																						
720 min Winter	5.760	0.0	81.7	504																																																																																																																																																																																																																																																						
960 min Winter	4.558	0.0	86.2	644																																																																																																																																																																																																																																																						
1440 min Winter	3.273	0.0	92.5	906																																																																																																																																																																																																																																																						
2160 min Winter	2.346	0.0	98.7	1236																																																																																																																																																																																																																																																						
2880 min Winter	1.851	0.0	103.0	1496																																																																																																																																																																																																																																																						
4320 min Winter	1.324	0.0	108.8	0																																																																																																																																																																																																																																																						
5760 min Winter	1.043	0.0	112.4	0																																																																																																																																																																																																																																																						
7200 min Winter	0.867	0.0	114.8	0																																																																																																																																																																																																																																																						
8640 min Winter	0.745	0.0	116.5	0																																																																																																																																																																																																																																																						
10080 min Winter	0.655	0.0	117.6	0																																																																																																																																																																																																																																																						
©1982-2019 Innovyze																																																																																																																																																																																																																																																										

WYG Group Limited						Page 1		
.			Live Fire Skills House					
.			Gravesend					
.								
Date 20/07/2020 23:41			Designed by CD					
File Source Control - Porus ...			Checked by ME					
XP Solutions			Source Control 2019.1					
<u>Summary of Results for 100 year Return Period (+40%)</u>								
Half Drain Time : 321 minutes.								
Storm Event		Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m³)	Status
15 min Summer		2.220	0.420	0.0	1.9	1.9	34.4	Flood Risk
30 min Summer		2.280	0.480	0.0	1.9	1.9	44.8	Flood Risk
60 min Summer		2.331	0.531	0.0	2.0	2.0	53.8	Flood Risk
120 min Summer		2.367	0.567	0.0	2.0	2.0	60.2	Flood Risk
180 min Summer		2.375	0.575	0.0	2.0	2.0	61.5	Flood Risk
240 min Summer		2.370	0.570	0.0	2.0	2.0	60.6	Flood Risk
360 min Summer		2.352	0.552	0.0	2.0	2.0	57.5	Flood Risk
480 min Summer		2.335	0.535	0.0	2.0	2.0	54.4	Flood Risk
600 min Summer		2.320	0.520	0.0	1.9	1.9	51.8	Flood Risk
720 min Summer		2.306	0.506	0.0	1.9	1.9	49.4	Flood Risk
960 min Summer		2.280	0.480	0.0	1.9	1.9	44.9	Flood Risk
1440 min Summer		2.233	0.433	0.0	1.9	1.9	36.6	Flood Risk
2160 min Summer		2.165	0.365	0.0	1.8	1.8	26.0	Flood Risk
2880 min Summer		2.100	0.300	0.0	1.8	1.8	17.6	Flood Risk
4320 min Summer		1.983	0.183	0.0	1.7	1.7	6.5	O K
5760 min Summer		1.879	0.079	0.0	1.6	1.6	1.2	O K
7200 min Summer		1.800	0.000	0.0	1.5	1.5	0.0	O K
8640 min Summer		1.800	0.000	0.0	1.2	1.2	0.0	O K
10080 min Summer		1.800	0.000	0.0	1.1	1.1	0.0	O K
15 min Winter		2.248	0.448	0.0	1.9	1.9	39.1	Flood Risk
Storm Event				Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer				142.146	0.0	35.8	18	
30 min Summer				92.034	0.0	47.6	33	
60 min Summer				56.713	0.0	59.7	62	
120 min Summer				33.786	0.0	71.6	122	
180 min Summer				24.646	0.0	78.6	180	
240 min Summer				19.601	0.0	83.8	238	
360 min Summer				14.125	0.0	90.6	290	
480 min Summer				11.201	0.0	95.8	354	
600 min Summer				9.350	0.0	100.0	420	
720 min Summer				8.064	0.0	103.5	488	
960 min Summer				6.381	0.0	109.2	624	
1440 min Summer				4.582	0.0	117.1	894	
2160 min Summer				3.285	0.0	125.4	1276	
2880 min Summer				2.592	0.0	130.8	1640	
4320 min Summer				1.854	0.0	138.8	2332	
5760 min Summer				1.461	0.0	143.9	2952	
7200 min Summer				1.213	0.0	147.4	0	
8640 min Summer				1.043	0.0	150.1	0	
10080 min Summer				0.917	0.0	152.0	0	
15 min Winter				142.146	0.0	40.6	18	
©1982-2019 Innovyze								

WYG Group Limited

.

.

.

Date 20/07/2020 23:41

File Source Control - Porus ...

Live Fire Skills House

Gravesend

Designed by CD

Checked by ME

XP Solutions

Source Control 2019.1

Page 2



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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	2.315	0.515	0.0	1.9	1.9	51.0	Flood Risk
60 min Winter	2.375	0.575	0.0	2.0	2.0	61.5	Flood Risk
120 min Winter	2.403	0.603	0.0	2.0	2.0	69.4	FLOOD
180 min Winter	2.405	0.605	0.0	2.0	2.0	71.4	FLOOD
240 min Winter	2.405	0.605	0.0	2.0	2.0	71.3	FLOOD
360 min Winter	2.402	0.602	0.0	2.0	2.0	67.9	FLOOD
480 min Winter	2.390	0.590	0.0	2.0	2.0	64.1	Flood Risk
600 min Winter	2.369	0.569	0.0	2.0	2.0	60.6	Flood Risk
720 min Winter	2.350	0.550	0.0	2.0	2.0	57.2	Flood Risk
960 min Winter	2.313	0.513	0.0	1.9	1.9	50.6	Flood Risk
1440 min Winter	2.242	0.442	0.0	1.9	1.9	38.2	Flood Risk
2160 min Winter	2.142	0.342	0.0	1.8	1.8	22.8	Flood Risk
2880 min Winter	2.042	0.242	0.0	1.7	1.7	11.4	O K
4320 min Winter	1.838	0.038	0.0	1.6	1.6	0.3	O K
5760 min Winter	1.800	0.000	0.0	1.3	1.3	0.0	O K
7200 min Winter	1.800	0.000	0.0	1.0	1.0	0.0	O K
8640 min Winter	1.800	0.000	0.0	0.9	0.9	0.0	O K
10080 min Winter	1.800	0.000	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	92.034	0.0	53.8	33
60 min Winter	56.713	0.0	67.3	62
120 min Winter	33.786	3.1	80.9	120
180 min Winter	24.646	4.8	88.8	176
240 min Winter	19.601	4.6	94.3	232
360 min Winter	14.125	1.8	102.1	336
480 min Winter	11.201	0.0	108.0	378
600 min Winter	9.350	0.0	112.7	454
720 min Winter	8.064	0.0	116.7	530
960 min Winter	6.381	0.0	123.0	676
1440 min Winter	4.582	0.0	131.9	964
2160 min Winter	3.285	0.0	141.2	1344
2880 min Winter	2.592	0.0	147.7	1700
4320 min Winter	1.854	0.0	156.8	2244
5760 min Winter	1.461	0.0	162.9	0
7200 min Winter	1.213	0.0	167.2	0
8640 min Winter	1.043	0.0	170.5	0
10080 min Winter	0.917	0.0	173.0	0

©1982-2019 Innovyze