



Flood Risk Assessment and Drainage Strategy

Sterling Inks UK Ltd, Netherley Road, Tarbock Green, Prescott, L35 1QE

Presented to GDB Property Investment Ltd.

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Reference of Terms

Canal Failure

Canal failure can include a breach or overtopping of a canal system due to the effects of a high intensity rainfall event or structural failure that is not associated with a rainfall event. Such failure can be very dangerous as it can involve the rapid release of large volumes of water at high velocity, however, it is typically limited to reaches of canal that are raised above the surrounding ground level on one or both side and where watercourses or other structures pass beneath the canal. The size and nature of canals themselves can also have a hydraulic control on the mechanisms of flooding associated with a failure, resulting in a rapid peak in flow followed by a gradual reduction as the flow becomes restricted by the capacity of the canal itself to rapidly pass flow to the breach or failure point.

Fluvial Flooding

Fluvial flooding typically occurs when a river's capacity is exceeded, and the excess water overtops the river banks. It can also occur when the watercourse has a high level downstream, perhaps due to structures or blockage, thus limiting conveyance. This creates a back-up of water which can overtop the banks. Typical flooding issues occur when the natural floodplain has been urbanised and the river has been confined.

Groundwater Flooding

Groundwater flooding is caused by the emergence of water from beneath the ground at either point or diffuse locations when the natural level of the water table rises above ground level. This can result in deep and long-lasting flooding of low-lying or below-ground infrastructure such as underpasses and basements. Groundwater flooding can cause significant damage to property, especially in urban areas, and can pose further risks to the environment and ground stability.

Reservoirs Failure

Reservoir failure can be a particularly dangerous form of flooding as it results in the sudden release of large volumes of water that can travel at high velocity. This can result in deep and widespread flooding, potentially resulting in significant damage. The likelihood of reservoir flooding occurring is generally extremely low given that all large reservoirs are managed in accordance with the Reservoirs Act 1975. Under the Reservoirs Act 1975, a large raised reservoir is defined as one that holds over 25,000 cubic metres of water above the level of the surrounding land. The EA's online reservoir inundation map illustrates the maximum flood extents that could potentially occur in the event of a reservoir failure.

Sewer Flooding

Flooding from sewers primarily occurs when flow entering a system exceeds available capacity or if the network capacity has been reduced through blockage or collapse. In the case of surface water sewers that discharge to watercourses, the same effect can be caused as a result of high water levels in the receiving watercourse. As a result, water can begin to surcharge the sewer network, emerging at ground level through gullies and manholes and potentially causing flooding to highways and properties. If this occurs flooding can represent a significant hazard to human health due to the potential for contaminants in flood water.

Surface Water Runoff

Surface water runoff is defined as water flowing over the ground that has not yet entered a drainage channel or similar. It usually occurs as a result of an intense period of rainfall which exceeds the infiltration capacity of the ground. Typically, runoff occurs on sloping land or where the ground surface is relatively impermeable. The ground can be impermeable either naturally due to the soil type or geology, or due to development which places impervious material over the ground surface (e.g. paving and roads).

Tidal Flooding

Tidal flooding is caused by high tides coinciding with a low-pressure storm system which raises sea and tidal water levels, overwhelming coastal and river defences. This may be made worse by gale force winds blowing the raised body of water up tidal river basins some distance from the coast, due to floodwater being forced up the tidal reaches of rivers and estuaries. Such flooding may become more frequent in future years due to rising sea levels.

Executive Summary

Flood Risk Assessment and Summary	This FRA concludes that the baseline risk flood risk to the Site and the impact of the development on flood risk elsewhere is considered Low and acceptable from all sources and no mitigation is required.
Drainage Strategy Summary	The proposed development will reduce the impermeable drainage area across the Site from 7,221 m² to 4540 m², increasing permeable area on-site by 37 % and overall improving surface water run-off rates. Soakaways are not deemed to be feasible in this instance due to the underlying geology. Therefore, discharge of surface water to Greenbridge Lane Brook via the nearest available public / private sewer at a restricted greenfield rate of 5.29 l/s appears to be the most practical option. A drainage survey should be undertaken to confirm the drainage system currently serving the Site, to identify existing connections and if sufficient invert is present to support a gravity fed system. Where possible, existing connections to the sewer system can be utilised. Attenuation storage will be required on-site in order to restrict surface water discharge to greenfield run-off rates. A total attenuation volume of 240.00 m³ will be required to achieve the greenfield discharge rate of 5.34 l/s and to accommodate the 1 in 100 plus 40 %CC event. Alternatively, a variable flow control can be installed within the storage system, this would reduce the storage size of the attenuation system. Attenuation can be provided within the sub-grade of permeable paving or in the form of an underground attenuation tank located in the southern extent of the Site. This will need to be confirmed during the detailed design stage and once a drainage survey has been undertaken at the Site. Foul flows from the Site should be discharged to the nearest accessible public sewers. If no public sewers are present within the vicinity of the Site, a private sewage treatment plant will be required to provide the best alternative for the Site. Treated effluent should be discharged to Greenbridge Lane Brook via the nearest available public / private sewer, as detailed above.
Mitigation Measures	▲ Set finished floor levels at least 150mm above ground levels, as per building regulations; ▲ It is advised to carry out works during drier summer months to avoid encountering groundwater. If ground water is encountered dewatering activities can be undertaken to remove groundwater; ▲ Survey the public foul sewers to determine the existing drainage network and the requirement for new connections and a pumped solution; ▲ If a new surface water or foul connection to the public sewer system is deemed necessary (subject to detailed design), United Utilities should be contacted at the earliest opportunity to highlight any constraints involved in doing so. Preference should be made to discharging via an existing connection where possible; ▲ Provision should be made for a bio-disc treatment plant (or similar) which should be situated 7 m from dwellings, if required; ▲ Verify the attenuation volumes included in this report when undertaking detailed drainage design; and ▲ Make provision for sustainable drainage features in the lower southern extent of the Site.
This is intended as a summary only. Further detail and limitations of the assessment is provided within the main body of the Report.	

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1.0 Introduction

1.1 Appointment

- 1.1.1 Delta-Simons Environmental Consultants Limited ("Delta-Simons") was instructed by GDB Property Investment Ltd. (the "Client") to carry out a Flood Risk Assessment (FRA) and Drainage Strategy (DS) of a parcel of land located at Sterling Inks UK Ltd, Netherley Road, Tarbock Green, Prescott, L35 1QE (the "Site").

1.2 Project Understanding

- 1.2.1 On the Environment Agency (EA) Flood Map for Planning, the Site is shown to be located wholly within Flood Zone 1 (Low Probability), meaning the Site has a less than a 1 in 1000 annual probability of fluvial flooding (<0.1% annual exceedance probability (AEP)). As the proposed development constitutes as a 'major development' and therefore a FRA and DS is required to support the application.
- 1.2.2 The aim of this report is to assess the potential flood risk to the Site, the impact of the proposed development on flood risk elsewhere, and the proposed measures which could be incorporated to mitigate the identified risk. This report has been prepared in accordance with the guidance contained in the National Planning Policy Framework (NPPF) revised in 2019, and the National Planning Practice Guidance (NPPG) Flood Risk and Coastal Change.
- 1.2.3 Knowsley Metropolitan Borough Council (KBC) as Lead Local Flood Authority (LLFA) is a statutory consultee for major planning applications in relation to surface water drainage, requiring that all planning applications are accompanied by a Sustainable Drainage Strategy. The aim of the Sustainable Drainage Strategy is to identify water management measures, including Sustainable Drainage Systems (SuDS), to provide surface water runoff reduction and treatment.

1.3 Scope of Works

- 1.3.1 The scope of works has been as follows for this FRA:
- ▲ Assess flood risk from all sources using best available information, including review of EA data and mapping, topography and historical records;
 - ▲ Assess previous relevant available third-party studies, local authority plans or strategies;
 - ▲ Advise on flood mitigation measures and residual risks;
 - ▲ Assess access and egress routes;
 - ▲ Advise on availability of flood warnings; and
 - ▲ Prepare FRA report.
- 1.3.2 The proposed development will increase impermeable area and risk of surface water flooding to downstream receptors. Therefore, a DS with appropriate consideration for SuDS in line with CIRIA SuDS (C753) Guidance is required. The DS has included the following:
- ▲ Review existing conditions including sewer plans, British Geological Survey information and topographical information;
 - ▲ Review Lead Local Flood Authority (LLFA) (Knowsley Council) drainage policies;
 - ▲ Submit developer enquiry to LLFA, and United Utilities;
 - ▲ Analyse existing and proposed impermeable areas;
 - ▲ Calculate existing runoff rates (excluding existing drainage system modelling);
 - ▲ Assess method of surface water runoff disposal (soakaway / watercourse / sewer);
 - ▲ Establish surface water discharge rate in consultation with the LLFA / sewerage undertaker;

- ▲ Estimate required attenuation volume using MicroDrainage or similar;
- ▲ Assess and advise on suitable forms of SuDS;
- ▲ Advise on drainage system maintenance measures;
- ▲ Advise on surface water treatment methods;
- ▲ Establish method of foul water drainage;
- ▲ Prepare concept drainage sketch (where development plan is available as dwg. format); and
- ▲ Prepare DS report.

1.3.3 This report takes into account the following national and local policies:

- ▲ National Planning Policy Framework (NPPF) (2019)¹;
- ▲ National Planning Practice Guidance (NPPG) (2014)²;
- ▲ CIRIA Guidance: The SuDS Manual (C753) (2017)³; and
- ▲ Knowsley Local Plan Core Strategy 2016.

1.4 Sources of Information

1.4.1 The following sources of information have been reviewed and assessed for the purpose of this FRA:

- ▲ EA online flood maps⁴;
- ▲ British Geological Society (BGS) Interactive Map⁵;
- ▲ MAGIC Interactive Map⁶;
- ▲ Environmental Desk Study and Site Investigation – Woodford Industrial Limited (2000, Phase I Ground Investigation);
- ▲ Knowsley Metropolitan Borough Council Strategic Flood Risk Assessment (2009 SFRA);
- ▲ Knowsley Metropolitan Borough Council Preliminary Flood Risk Assessment (2011 PFRA);
- ▲ Phase II Investigation At Sterling Inks UK Ltd, Netherley Road, Tarbock Green, Prescott, L35 1QE – Peak Associates Environmental Consultants Ltd (2015, Phase II Ground Investigation);
- ▲ Phase III Investigation At Sterling Inks UK Ltd, Netherley Road, Tarbock Green, Prescott, L35 1QE – Peak Associates Environmental Consultants Ltd (2015, Phase III Ground Investigation);
- ▲ Knowsley Council Sustainable Drainage & Surface Water Management – Technical Guidance for Developers, August 2016;
- ▲ Knowsley Metropolitan Borough Council Preliminary Flood Risk Assessment – Addendum (2017 PFRA); and
- ▲ Knowsley Metropolitan Borough Council Local Flood Risk Management Strategy (2017 LFRMS).

1.5 Project Limitations

1.5.1 The wider Delta-Simons limitations are contained within Appendix A.

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf

2 <http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/>

3 https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

4 <https://flood-map-for-planning.service.gov.uk/>

5 <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

6 <http://www.magic.gov.uk/>

2.0 Site Description

2.1.1 The aim of this section of the report is to outline key environmental information associated with the baseline environment.



Illustrative Site Layout Plan

Co-ordinates	Centred approximately at National Grid Reference (NGR) 346365, 387663.	Area	0.80 ha
Site Location	The Site is located off Netherley Road (B5178) within the village of Tarbock Green which is approximately 2 km south of Huyton Quarry. The Site is situated within the jurisdiction of Knowsley Borough Council (KBC) within a predominantly rural setting, surrounded by agricultural land, residential properties and small industrial sites.		
Existing Site Conditions	Online mapping (including Google Maps / Google Streetview imagery accessed March 2020) shows that the Site is brownfield land, comprising a large industrial unit located in the north-east which currently houses Sterling Colour Operations and R&B Tanker Repairs with ancillary areas including car parking and storage. The 2000 Phase I GI report states that the Site is a former fuel filling station with four underground storage tanks (1 x diesel and 3 x petrol) located beneath the current car park. These tanks are reported to have been used pre 1984 and filled with a cement based slurry in 1986. The Site is bordered by an area of undeveloped greenfield land to the north, an area of undeveloped land to the east with residential properties and Tarbock Green Riding School beyond, Netherley Road to the south and residential and farm buildings to the west. Access to the Site is provided in the south from Netherley Road.		

	Hardstanding areas on-site currently occupy 7,221 m² or 88 % of the total Site area (8,234 m²) and the remaining permeable, soft landscaped areas occupy 1013 m² or 12%. Existing hardstanding and soft landscaped areas have been calculated from the 'Existing Site Plan', (DWG NO: 19-112-101) which is included in Appendix B.
Topography	A topographical survey undertaken by Barry Lowe Surveys Ltd in November 2014 (Project No: 9653) and provided by the Client has been made available in Appendix C. The topographical survey shows that the Site slopes from 13.29 to 13.57 metres Above Ordnance Datum (m AOD) in the northern extent of the to 12.70 to 12.94 m AOD in the southern extent of the Site, generally falling in a north to south direction. Topographic levels to m AOD have also been derived from a 1 m resolution Environment Agency (EA) composite 'Light Detecting and Ranging' (LiDAR) Digital Terrain Model (DTM). A review of LiDAR ground elevation data shows that the Site slopes from approximately 14.00 m AOD in the northern extent of the Site to approximately 13.00 m AOD in the southern extent. The wider area to the south of the Site is shown to fall in a south-easterly direction towards Greenbridge Lane Brook. The land to the north of the Site is shown to rise from 14.00 m AOD at the Site boundary to 17.00 m AOD and then fall down towards Dog Clog Brook, which is situated at 11 m AOD. A LiDAR extract is included in Appendix C.
Hydrology	The nearest watercourse is a Main River (responsibility of the EA to maintain) known as Greenbridge Lane Brook which is located approximately 100 m south-east to the Site and situated at approximately 11.00 m AOD. The brook flows in a south-westerly direction and drains into Netherley Brook. Netherley Brook (also a Main River) flows into Ditton Brook and then eventually discharges into the River Mersey, approximately 5km downstream to the Site. Other watercourses in the area include another Main River known as Dog Clog Brook, situated approximately 340 m to the north of the Site. The 2000 Phase I GI report states that a drainage ditch is present to the north-east of the Site and drains into Netherley Brook. This drainage ditch has not been identified on online mapping including google mapping and EA flood mapping.
Geology	British Geological Survey (BGS) online mapping (1:50,000 scale) indicates that the Site is underlain by superficial deposits of Devensian Till. The superficial deposits are identified as being underlain by a bedrock consisting of sandstone from the Kinnerton Sandstone Formation. There are no BGS borehole logs were identified to be located on or within the immediate vicinity of the Site. Ground Investigations works have been carried out at the Site between December 2000 by Woodford Industrial Ltd and March 2015 by Peak Associated Environmental Consultants Ltd. Six boreholes were drilled during Phase I and 2 GI's in 2000. Made ground was encountered at the surface of all six logs underlain with natural strata generally comprising greyish brown sandy clay becoming stiff brown and grey mottled clay with depth containing gravel and likely to be glacial boulder clay. Clay strata was recorded at a shallow depths and groundwater was encountered at 0.7 to 0.8 m below ground level (bgl) in two out of six logs. During the 2015 investigations, eight boreholes were advanced to a maximum depth of 3.0 m bgl in summary the logs encountered the following geology, groundwater was no encountered in any of the logs: ▲ <u>Made Ground</u>: Hardstanding was encountered in seven of the eight locations to 0.6 – 0.8 m bgl; and

	▲ <i><u>Natural Soil and Rock:</u> Soft brown silty clay with occasional pebbles, grave and plant material, becoming firm, then stiff orange/brown clay with grey sandy mottling to 0.6m - 3 m bgl.</i> <i>The geological mapping is available at a scale of 1:50,000 and as such may not be accurate on a Site-specific basis.</i>
Hydrogeology	According to the EA's Aquifer Designation data, obtained from MAGIC Map's online mapping [accessed March 2020], the Devensian Till is classified as a Secondary Undifferentiated Aquifer. Secondary Undifferentiated Aquifers are 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 underlying sandstone is described as a Principal Aquifer. Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.
Local Drainage	Public sewer records have been obtained from United Utilities and are included in Appendix D. United Utility (UU) sewer records suggest that there are no public sewers located within the vicinity of the Site. It is possible that nearby formerly private sewers have not been shown on the provided plans following the private sewer transfer in 2011 or that the sewer network in the area is privately owned and therefore not shown on UU plans. A Phase III Ground investigation (GI) report states that a clay drain was struck at 1.5 km bgl within a borehole located to the south-west of the existing building (Borehole Ref: WS26), suggesting a drainage network is present and underlying the Site. It is assumed that the surface water is drained via a privately owned sewer or a public sewer that is not shown on the provided plans, eventually draining into the Greenbridge Lane Brook. This should be confirmed with a drainage survey. The Phase I GI report states that the foul water generated on-site is drained to a settlement / septic tank located in the north-western extent of the Site, the settled effluent is then discharged into a local authority sewer.
Proposed Site Conditions	The proposed development is for residential use, involving the demolition of the existing industrial units and construction 14 dwellings with front and rear gardens, communal greenspace and associated car parking areas. A proposed development plan is included in Appendix E. The proposed development will result in a decrease in hardstanding areas in the form of concrete slabs and tarmac. Hardstanding will comprise 4540 m² or 55 % of the total Site area (8,234 m²). The remaining permeable, soft landscaped areas will occupy 3,694 m² or 45 % of the total Site area, a 37% increase in permeable area across the development scheme. Proposed hardstanding and soft landscaped areas have been calculated from 'proposed development plans' (DWG NO 19-112-103) provided by the Client.

3.0 Relevant Planning Policy and Guidance

3.1 Introduction

- 3.1.1 The aim of this section of the report is to discuss the main aspects of the local and national planning policies that are relevant to any proposed development on the Site and relevant guidance and legislation.

3.2 Assessment of Flood Risk

- 3.2.1 The flood risk from fluvial (Main Rivers) and coastal flooding is assessed through the use of the EA Flood Maps (flood risk from rivers or the sea). This map defines three zones of different flood risk, the third of which is subdivided into two categories:

- ▲ Zone 1 “Low probability of flooding” – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%);
- ▲ Zone 2 “Medium probability of flooding” – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year;
- ▲ Zone 3a “High probability of flooding” – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year; and
- ▲ Zone 3b “Functional floodplain” – A sub-part of Zone 3, this zone comprises land where water has to flow or be stored in times of flood. This zone is not normally included within the national Flood Map for Planning and is calculated where necessary using detailed hydraulic modelling.

3.3 National Planning Policy Framework

- 3.3.1 Flood risk in England is normally considered through the planning process in the NPPF (2019), produced by Ministry of Housing, Communities and Local Government.

- 3.3.2 The principle aim of the NPPF assessment of flood risk is that:

“Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere”.

- 3.3.3 The NPPF requires a FRA to be produced where development Sites are:

- ▲ Greater than one hectare in size;
- ▲ All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
- ▲ Or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the EA); and
- ▲ Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

- 3.3.4 The NPPF requires that developers consider not just the flood risk to the development but also the impact that the development might have on flood risk elsewhere. As well as Main Rivers and the sea, it is also necessary to consider flood risk from other sources, including surface water, groundwater, Ordinary Watercourses, artificial drainage systems, canals and reservoirs.

Sequential Test

- 3.3.5 A key part of the NPPF is that a proposed development must first pass a “Sequential Test” to demonstrate that the overall development proposal is appropriate in terms of flood risk. It ensures that a sequential approach is followed to guide new development to areas with the lowest probability of flooding.

Exception Test

- 3.3.6 The Exception Test determines whether the benefits of the proposed development will outweigh the potential flood risk.

Vulnerability Classification

- 3.3.7 In accordance with Table 2 of the NPPG: Flood Risk and Coastal Change, residential developments are considered to be 'more vulnerable'.

Table 1: Flood Risk Vulnerability Classification (from Table 3 of online Planning Practice Guidance)

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water-Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	✗	Exception Test required	✓	✓
Zone 3b	Exception Test required	✗	✗	✗	✓

✓ development is permitted

✗ development is not permitted

- 3.3.8 Table 3 of the NPPG (reproduced above as Table 1), states that 'more vulnerable' development is considered appropriate within Flood Zone 1. The development therefore passes the flood risk Sequential Test and the Exception Test does not need to be applied.

3.4 Local Policy

- 3.4.1 Knowsley Council's Local Plan Core Strategy (January 2016) contains the following policies relating to Flood Risk and Drainage:

3.4.2 Policy CS22: Sustainable and Low Carbon Development

'...Managing flood risk, including through the use of Sustainable Drainage Systems (SuDS) and flood resilient design for infrastructure and property'.

Policy CS24 Managing Flood Risk

1. New development that may cause an unacceptable risk of flooding on the site or elsewhere will not be permitted.
2. New development should preferably be located in areas of low probability of flooding. New development in areas of medium or high flood risk will only be permitted if evidence has been submitted demonstrating that the development could not be practicably located in an area of lower flood risk and if applicable the 'exception test' has been complied with, in accordance with national guidance.
3. All development which is within or otherwise affects an area of flood risk or is larger than one hectare in size shall be accompanied by a site-specific Flood Risk Assessment (FRA).

4. *New development shall include flood mitigation measures, where necessary, to manage flood risk associated with or caused by the development. These measures shall be derived from the Strategic Flood Risk Assessment (SFRA), relevant FRA(s) or a local strategy for flood risk management, and:*
 - a) *Be designed to contribute to the biodiversity of the borough unless it can be demonstrated that this would not be technically feasible;*
 - b) *Incorporate a Sustainable Drainage System;*
 - c) *Be fully described in the planning application;*
 - d) *Be funded by the developer, including long term maintenance.*
5. *The drainage of new development shall be designed to reduce surface water run-off rates to those associated with a green-field site by treating it at its source. The chosen method of implementation should take account of site size, ground contamination or conditions, and potential damage to adjacent buildings or sites.*

3.4.3 A Technical guidance document produced by KMBC for Sustainable Drainage & Surface Water Management states the following in relation to drainage:

Managing the Discharge of Surface Water Runoff

In line with Paragraph 80 of Section 10 of the Planning Practice Guidance, applicants should aim to discharge surface water from any development proposal as high up the discharge hierarchy as possible. Where preferential discharge points set out in the hierarchy cannot be achieved applicants must submit a robust justification, along with acceptable evidence, as to why for each level of the hierarchy is surpassed.

The limiting discharge figure for the proposed development should be used in the design of the drainage system to ensure that the minimum requirement that flows up to the 1 in 30 year critical rainfall event are retained within the system in line with Standard 7 of DEFRA's Technical Standards for Sustainable Drainage Systems.

For the 1 in 100 year critical rainfall event the drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur in any part of a building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development in line with Standard 8 of DEFRA's Technical Standards for Sustainable Drainage Systems.

As per Standard 9 of DEFRA's Technical Standards for Sustainable Drainage Systems, any excess flows and volumes of water resulting from rainfall in excess of a 1 in 100 year critical rainfall event are to be safely managed in exceedance routes which minimise risks to people and property and must be retained within the curtilage of the site.

Previously Developed (Brownfield) Sites

If a site has previously been developed it should be demonstrated that the drainage system is still operational for it to be classed as 'previously developed'/'brownfield'. Information should be obtained on the drainage system, such as pipe diameters, levels, gradients, lengths and hydraulic controls. These details should be used, along with the contributing area characteristics of the site to set up a drainage model (or to inform another assessment method) to evaluate the peak flow rates at the outfalls from the existing site for the design return periods.

Peak Flow Control: *The peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event in line with Standard 3 of DEFRA's Technical Standards for Sustainable Drainage Systems. The LLFA advises that a minimum of 50% reduction in the rate of discharge from the development prior to redevelopment should be applied to offer improvement; this is in accordance with Table 6.1 of Knowsley MBC's Strategic Flood Risk Assessment (SFRA) Level 2 (Page 73).*

Volume Control: *The runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event in line with Standard 5 of DEFRA's Technical Standards for Sustainable Drainage Systems.*

3.5 Consultation

- 3.5.1 A pre-planning opinion request was submitted to the EA in March 2020. A response was not provided at the time of writing, a response is awaited.
- 3.5.2 A consultation request was submitted to the LLFA in March 2020. A response awaited.
- 3.5.3 A developer enquiry has been submitted to United Utilities. A response is awaited.

4.0 Assessment of Flood Risk

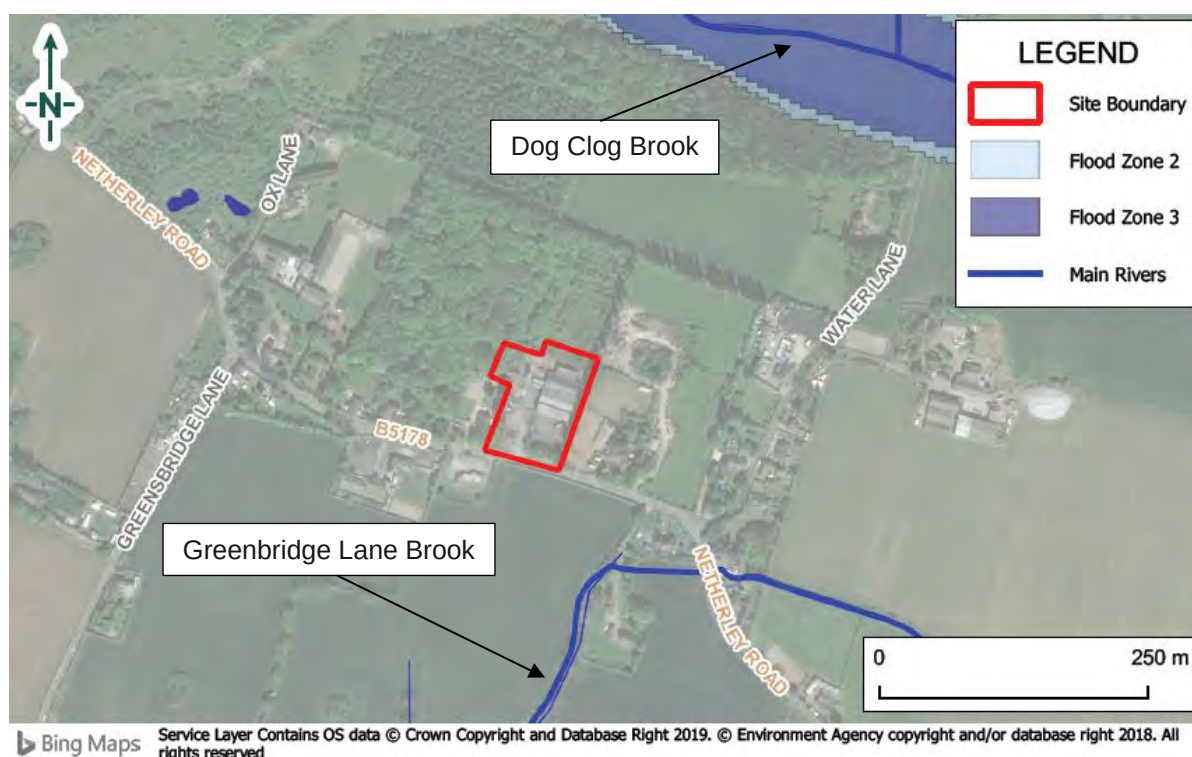
4.1 Tidal Flood Risk

- 4.1.1 The Site is situated at a minimum of 12.70 m AOD and therefore significantly above sea level. There are also no tidally influenced watercourses near the Site and so the Site is considered to be at **Negligible** risk from tidal flooding.

4.2 Fluvial Flood Risk

The nearest watercourse is Greenbridge Lane Brook which is located approximately 100 m south-east of the Site boundary and flows in a south-easterly direction towards Netherley Brook. Dog Clog Brook is located approximately 340 m to the north of the Site. The EA 'Flood Map for Planning' (Figure 1) suggests that the Site and its immediate surroundings are located wholly within Flood Zone 1 (Low Probability).

Figure 1: EA's 'Flood Map for Planning'



- 4.2.1 The mapping does not appear to have modelled flood extents associated with the Greenbridge Lane Brook. The Site is situated at a minimum of 12.70 m AOD, the brook at approximately 11.00 m AOD and is therefore 1.7 m below the Site. LiDAR analysis suggests that any out of channel flooding from the watercourse is unlikely to flow towards the Site, instead out of bank flow will follow local topography, flowing in a south-east direction and away from the Site.
- 4.2.2 The EA 'Flood Risk from Surface Water' map (Figure 2) provides a good indication of fluvial flood extents associated with Greenbridge Lane Brook, acting as a proxy for the EA 'Flood Map for Planning' when fluvial flood extents are not modelled. The mapping concurs with the LiDAR data, suggesting that flood water will follow local topography and direct flood water away from the Site.
- 4.2.3 The EA 'Historical Flood Map' indicates that the Site and its surrounding area is not within the extents of a historic fluvial flood event. There is also no indication of historic flooding impacting the Site within the 2009 SFRA or the 2017 PFRA.

- 4.2.4 Overall, based on the available information, the baseline fluvial water risk to the Site is considered **Low and Acceptable**.

4.3 Surface Water Flood Risk

- 4.3.1 The EA 'Flood Risk from Surface Water' map (Figure 2) indicates that the Site is predominantly at Very Low risk (0.1% AEP) from surface water flooding. An isolated pocket of Low risk (1% and 0.1% AEP) is present in the north-western corner and along Netherley Road.

Figure 2: EA's Long-Term Flood Risk Map (Flood Risk from Surface Water)



- 4.3.2 Flood depths are expected to remain below 300 mm across the Site and along Netherley Road during the extreme 0.1% AEP rainfall event. Flood depths below 300 mm are considered passable by pedestrians and vehicles and therefore access and egress is considered achievable from the Site.
- 4.3.3 There are no distinct flow routes in the area which would direct any potential surface water flooding towards the Site. A minor surface water flow path is present to the south of the Site, originating near the south-eastern corner of the Site, flowing eastwards along Netherley Road and then heading south towards Greenbridge Lane Brook. This flow path emerges during the 0.1% AEP rainfall event thus the chance of occurrence in any given year is low. In addition, google imagery indicates box drains are present along Netherley Road which will interrupt the flow of surface water, reducing any associated risk.
- 4.3.4 Standing water was observed at the Site during a Site walkover completed in February 2020 and considered to be associated with heavy rainfall prior to the walkover. The proposed development will increase areas of soft landscaping from 12 % to 45 %, increasing permeable area on-site, furthermore the proposed development will introduce a drainage system developed to modern standards and thus reducing the probability of surface water ponding following heavy rainfall events. Figure 4.1 in the 2011 PFRA shows areas across the borough that have been impacted by a past surface water flood event, there are no incidents of flooding shown at the Site or within the surrounding area.
- 4.3.5 It can therefore be concluded that the baseline surface water risk to the Site is considered **Low and Acceptable**.

4.4 Groundwater Flood Risk

- 4.4.1 The geology underlying the Site has been detailed in Section 2.0. Phase 1 and 2 GI's undertaken at the Site in 2000 and 2015 suggest that Made Ground was recorded to 0.6 and 0.8 m bgl. Made ground was underlain by natural strata largely comprising clay. Clay strata was recorded at shallow depths and groundwater encountered at 0.7 to 0.8 m below ground level (bgl) in two out of six logs during the investigations in 2000.
- 4.4.2 It is likely that the groundwater strikes were from perched groundwater sat within the Made Ground on top of low permeability superficial deposits. The presence of clay close to the surface will inhibit groundwater emergence at the surface, furthermore the presence of hardstanding across the Site will further limit the vertical migration of groundwater to the surface. No basement levels have been identified on proposed development plans, therefore the likelihood of groundwater seepage impacting the Site is considered low. There is no indication of historic groundwater flooding at the Site within third party reports assessed.
- 4.4.3 It can therefore be concluded that the baseline risk of groundwater flooding is considered **Low and Acceptable**.

4.5 Artificial Sources Flood Risk

Sewer Flooding

- 4.5.1 Sewer plans provided by United Utilities (Appendix D) suggest that there are no sewers underlying the Site or within the surrounding area. The 2011 PFRA has highlighted areas across the borough that have experienced surface water flooding incidents due to the lack of capacity in the sewer systems, there are no records of sewer flooding within the Prescott area. It can therefore be concluded that the baseline risk of sewer flooding is considered **Low and acceptable**.

Reservoir and Canal Flooding

- 4.5.2 There are no canals within the vicinity of the Site and the EA 'Flood Risk from Reservoirs' map shows that the Site is not within the extents of a reservoir breach or overtopping event.
- 4.5.3 The EA state that reservoir flooding is extremely unlikely to happen. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the EA ensure that reservoirs are inspected regularly, and essential safety work is carried out.
- 4.5.4 It can therefore be concluded that there is at **Negligible** risk of flooding from artificial sources.

4.6 Summary of Flood Risk

- 4.6.1 It can be concluded that the Site is at **Low to Negligible** risk of flooding from all sources. Therefore, no Site-specific mitigation measures are considered necessary. However, in accordance with Building Regulations, finished floor levels of the properties should be set 150mm above surrounding ground levels.

4.7 Residual Risks

- 4.7.1 A residual risk is an exceedance event, such as the 1 in 1000 year (0.1% AEP) flood event. As the Site and its surrounding area are located wholly within Flood Zone 1, in an area predicted to be outside the 1 in 1000 year (0.1% AEP) flood event, and far from flood extents associated with nearby watercourses, the probability of a such event impacting the Site is considered to be very low and, therefore, no further mitigation beyond what is proposed is required.

5.0 Drainage Strategy

5.1 Introduction

- 5.1.1 The Site is brownfield and currently occupied by industrial units in the north-east with car parking and soft landscaping in the external areas. Hardstanding areas currently occupy 7,221 m² or 88% of the total Site area.
- 5.1.2 Proposed development plans (Appendix E) indicate that the development will reduce the overall hardstanding across the Site to 4540 m² or 55 %, increasing permeable area on-site and thus reducing / improving existing surface water run-off rates.
- 5.1.3 Sewer plans obtained from United Utilities indicate that there are no public sewers within the vicinity of the Site. The Phase III GI report states that a clay drain was struck at 1.5 m bgl at a borehole located to the south-western corner of the existing building, indicating that there is a drainage network underlying the Site. Consultation with the Client has suggested that surface water run-off is drained via a privately owned sewer or a public sewer that are not shown on the provided plans, eventually draining into the Greenbridge Lane Brook. The existing drainage network serving the Site should be confirmed with a full drainage survey prior to development.
- 5.1.4 KMBC's require all new development to be accompanied with an appropriate drainage strategy, local policies relating to surface water drainage across the borough are detailed in Section 3.4. In order to limit surface water run-off to greenfield rates and/or provide a 50% betterment on existing rates, in line with local guidance, surface water discharge from the Site will be controlled.

5.2 Drainage Hierarchy

- 5.2.1 The recommended surface water drainage hierarchy (Paragraph 080 of the NPPG: Flood Risk and Coastal Change) is to utilise soakaway systems or infiltration as the preferred option, followed by discharging to an appropriate watercourse. If this is not feasible, the final option is to discharge to an existing public sewer.

Surface Water Discharge to Soakaway

- 5.2.2 The first consideration for the disposal of surface water is infiltration (soakaways and permeable surfaces). As described above, ground investigations indicate that Made Ground is present across the Site to 0.6 and 0.8 m bgl which is underlain by deposits of soft brown silty clay with occasional pebbles and gravel, becoming stiff orange/brown clay with depth.
- 5.2.3 Ground investigations indicate that clay is present at shallow depths across the Site, the presence of clay is generally not considered a suitable medium for infiltration due to its impermeable nature. Ground Investigation reports undertaken at the Site in 2000 and 2015 recorded Made Ground to 0.6 m and 0.8 m bgl and elevated levels of contamination within underlying sediment and groundwater, contaminated areas are also not considered a suitable for medium infiltration as it may lead to the mobilisation of underlying contaminants.
- 5.2.4 It can be concluded that soakaways may not be suitable for the discharge of surface water runoff in this instance.

Surface Water Discharge to Watercourse

- 5.2.5 Where soakaways are not suitable a connection to watercourse is the next consideration. The nearest watercourse is Greenbridge Lane Brook which is located approximately 100 m south-east of the Site and situated at 11.00 m AOD based on LiDAR data assessed 09/03/2020.
- 5.2.6 No public sewers are identified on sewer plans provided by United Utilities. It is possible that these assets have not been shown on the provided plans or that there are sewers in the area that are privately owned. The Phase III GI report states that a clay land drain was struck at 1.5 m bgl at borehole located to the south-eastern corner of the main unit, suggesting that there is an existing drainage network underlying the Site.

5.2.7 Consultation with the Client has suggested that surface water from the existing Site is discharged to Greenbridge Lane Brook via a public/private sewer utilising existing connection. A drainage survey should be undertaken to confirm the drainage network currently serving the Site, if existing connections are available and if there is sufficient fall between the Site and sewer system to support a gravity fed system. If sufficient fall is not available, a pumped system would be required.

5.2.8 If removal of surface water is not possible via existing connections, a new connection will be required. United Utilities should be contacted in the first instance to highlight any constraints in doing so.

Surface Water Discharge to Sewer

5.2.9 As described above, a connection to the watercourse via a public/ private sewer is considered an appropriate method of surface water removal, however, this will need to be confirmed with a drainage survey.

5.3 Surface Water Discharge

5.3.1 The existing brownfield runoff rates have been /estimated using the Revitalised Flood Hydrograph Model (ReFH2) method, provided as Appendix F. The 1 in 2 year event greenfield rate for the 0.8 ha development Site is 5.29 l/s.

Table 2: ReFH2 Existing Brownfield and Greenfield run-off rates

Return Period	Brownfield Runoff Rate (l/s)	Greenfield Runoff Rate (l/s)
1 in 2 year (QMed)	12.90	5.29
1 in 30 year	26.84	11.19
1 in 100 year	35.85	15.26

5.4 Attenuation Storage

5.4.1 In order to achieve a discharge rate of 5.29 l/s, attenuation storage will be required. Storage estimates have been provided using MicroDrainage and are included in Appendix G. An estimated storage volume of 240 m³ will be required for the 1 in 100 year plus 40% CC event and 103 m³ will be required to accommodate the 1 in 30 year event (as shown in table 3). The storage estimates are based on a flow rate of 5.29 l/s, storage within a tank or pond structure, an impermeable drainage area of 4540 m², a design head of 1 m and hydro brake flow control.

5.4.2 The local guidance states that peak run-off rates from the development '*..for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be close as reasonable practicable to the greenfield run-off rate from the development for the same rainfall event.*' A flow control designed with a variable discharge rate will reduce the total volume of attenuation required, this will be considered at the detailed design stage.

Table 3: Attenuation Storage Volumes (m³) for QMed Runoff Rate

Return Period	Attenuation Storage (m ³)
1 in 100 + 40% CC	240.00
1 in 30 year	103.00

5.4.3 The attenuation volumes are provided for indicative purposes only and should be verified at the detailed design stage.

5.5 Sustainable Drainage Systems

- 5.5.1 Attenuation storage should be provided in the form of Sustainable Drainage Systems (SuDS) where practical. The following SuDS options have been considered.

Soakaways

- 5.5.2 As described above, the use of soakaways is not considered to be feasible due to the geology and identified contamination underlying the Site.

Swales, Detention Basins and Ponds

- 5.5.3 Space is available on-site to utilise a pond, basin or swale as an above ground attenuation feature, this can be located in the potential open green spaces shown on the Proposed Site Plan (Appendix E) and / or the proposed green planting route immediately to the west of the proposed access road.
- 5.5.4 An open surface water attenuation feature such as a pond, basin or a swale in a residential area presents a safety risk; the hazards and appropriate mitigation should be considered at the detailed design stage.

Rainwater Harvesting

- 5.5.5 The attenuation benefits provided through the use of rainwater harvesting are considered to be limited and would only be realised when the tanks were not full. However, rainwater harvesting techniques could be incorporated within the final design.

Green Roofs

- 5.5.6 Green roofs are not identified on development plans. Given the nature of the proposed development, the significant additional cost involved in installing and maintaining green roofs and the additional works required to allow for the additional loading on the building, green roofs are not considered a practical option. The benefits achieved through installing a green roof would be disproportionate to the significant ongoing maintenance and construction costs involved.

Porous/Permeable Paving

- 5.5.7 Permeable paving could be incorporated within private roads and driveways. Storage would be provided within the sub-grade material prior to controlled release to the receiving sewer / watercourse, as shown in a Concept Drawing Sketch made available in Appendix H. The amount of storage offered by permeable paving is subject to sub-grade depth and Site gradient.
- 5.5.8 Based on an external paved area of approximately 1,891 m², a sub-grade depth of 0.5 m and a void ratio of 30%, there is potential to accommodate 283.65 m³ of attenuation storage (sufficient to accommodate the 1 in 100 year + 40% climate change event) within the sub-grade of permeable paving (assuming the base of the sub-grade will be formed at a level gradient). The use of permeable paving should be considered at the detailed design stage.

Underground Attenuation Tanks

- 5.5.9 Storage could be provided within underground attenuation tanks or within oversized pipes. Sufficient space for an underground tank is provided in the soft landscaped area in the southern half of the Site. The required invert level of the storage outfall must be confirmed during the detailed design stage to ensure a suitable gravity fed connection to the receiving sewer.

5.6 Preferred Drainage Scheme

- 5.6.1 As soakaways are not feasible, surface water runoff up to the 1 in 100 year plus 40 % climate change allowance event will be attenuated on Site and discharged to a public / private sewer. A drainage survey should be undertaken to confirm the exiting drainage system currently serving the Site to identify existing connections and if sufficient invert is present to support a gravity fed system. Where possible, existing connections to the sewer system can be utilised and if sufficient fall is not available, a pumped system would be required.

- 5.6.2 A total attenuation volume of 240.00 m³ will be required to achieve the greenfield discharge rate of 5.34 l/s and to accommodate the 1 in 100 plus 40 %CC event. This will be provided in the form of an underground storage tank located in the southern extent of the Site. The location of attenuation tank should be confirmed at the detailed design stage and once a drainage survey has been undertaken.
- 5.6.3 Alternatively, a variable flow control can be installed onto the storage system, this would reduce size of the attenuation system required on-site.
- 5.6.4 The proposed development and surface water drainage scheme will create betterment over the existing drainage system.

5.7 Event Exceedance

- 5.7.1 Storage will be provided for the 1 in 100 year plus 40% CC event. Storm events in excess of the 1 in 100 year plus 40 % CC event should be permitted to produce temporary shallow depth flooding within the car park / access road / landscaped areas. Finished floor levels will be set at a minimum of 150 mm above surrounding ground levels ensuring exceedance flooding will not affect the buildings.

5.8 Surface Water Treatment

- 5.8.1 In accordance with the CIRIA C753 publication 'The SuDS Manual' (2015), residential roofs have a 'very low' pollution hazard level, with low traffic roads classified as having a 'low' pollution hazard level. Table 4 below shows the pollution hazard indices for each land use.

Table 2: Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2*	0.2	0.05
Low Traffic Roads	Low	0.5	0.4	0.4

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

* Indices values range from 0-1.

** up to 0.8 where there is potential for metals to leach from the roof

- 5.8.2 Where practical, runoff from roofs and roads will be directed to permeable paving within car parking areas. Table 5 below demonstrates that permeable paving provides sufficient treatment.

Table 3: SuDS Mitigation Indices

Type of SuDS	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

- 5.8.3 It can be concluded that the inclusion of permeable paving will provide sufficient treatment. Where attenuation is provided in a below ground system (tank storage), treatment will need to be provided by a suitably sized separator.

5.9 Maintenance

- 5.9.1 Maintenance of communal drainage features such as permeable paving or an attenuation tank will be the responsibility of the Site owner. Maintenance of shared surface water drainage systems can be arranged through appointment of a Site management company.
- 5.9.2 Maintenance schedules for an attenuation tank and permeable paving are included in Appendix I. Maintenance of the separator will be as per the manufacturer's guidance.

5.10 Foul Water Discharge

- 5.10.1 The Phase I GI report states that the foul water generated on-site is to a settlement / septic tank located in the north-western extent of the Site, the settled effluent is then discharged into a local authority sewer. As the existing drainage network is unknown, a survey of the drainage system should be undertaken to determine the layout of the existing system.
- 5.10.2 If there are no readily accessible public sewers within the vicinity of the Site, a private sewage treatment plant will be required provide the best alternative for the Site. A biodisc treatment plant (or similar) would be a suitable option and would provide sufficient treatment for foul flows. Treated effluent should be discharged to Greenbridge Lane Brook via the existing connections detailed above. The sewerage treatment plant should be placed a minimum of 7m from habitable buildings. If a biodisc treatment plant (or similar) is required, the proposed layout may need to be amended to accommodate the treatment plant which can be located within landscaped areas or under the access road.

6.0 Conclusions and Recommendations

6.1 Conclusions

- 6.1.1 The Site is located within Flood Zone 1 on the Environment Agency (EA) 'Flood Map for Planning'— an area considered to have the lowest probability of fluvial flooding. The Site and its surrounding area is also shown to be located outside of the extreme 0.1% AEP flood event and EA mapping indicates there is low surface water risk to the Site.
- 6.1.2 This FRA concludes that the baseline risk flood risk to the Site and the impact of the development on flood risk elsewhere is considered **Low and acceptable** from all sources.
- 6.1.3 The proposed development will reduce the impermeable drainage area across the Site from 7,221 m² to 4540 m², increasing permeable area on-site by 37 % and overall improving surface water run-off rates.
- 6.1.4 Soakaways are not deemed to be feasible in this instance due to the underlying geology. Therefore, discharge of surface water to Greenbridge Lane Brook via the nearest available public / private sewer at a restricted greenfield rate of 5.29 l/s appears to be the most practical option.
- 6.1.5 A drainage survey should be undertaken to confirm the drainage system currently serving the Site, to identify existing connections and if sufficient invert is present to support a gravity fed system. Where possible, existing connections to the sewer system can be utilised.
- 6.1.6 Attenuation storage will be required on-site in order to restrict surface water discharge to greenfield run-off rates. A total attenuation volume of 240.00 m³ will be required to achieve the greenfield discharge rate of 5.34 l/s and to accommodate the 1 in 100 plus 40 %CC event. Alternatively, a variable flow control can be installed within the storage system, this would reduce the storage size of the attenuation system.
- 6.1.7 Attenuation can be provided within the sub-grade of permeable paving or in the form of an underground attenuation tank located in the southern extent of the Site. This will need to be confirmed during the detailed design stage and once a drainage survey has been undertaken at the Site.
- 6.1.8 Foul flows from the Site should be discharged to the nearest accessible public sewers. If no public sewers are present within the vicinity of the Site, a private sewage treatment plant will be required to provide the best alternative for the Site. Treated effluent should be discharged to Greenbridge Lane Brook via the nearest available public / private sewer, as detailed above.

6.2 Recommendations

- ▲ Set finished floor levels at least 150mm above ground levels, as per building regulations;
- ▲ Groundwater may be encountered during excavation. If ground water is encountered dewatering activities can be undertaken to remove groundwater. It is advised to carry out works during drier summer months to avoid encountering groundwater;
- ▲ Survey the public foul sewers to determine the existing drainage network and the requirement for new connections and a pumped solution;
- ▲ If a new surface water or foul connection to the public sewer system is deemed necessary (subject to detailed design), United Utilities should be contacted at the earliest opportunity to highlight any constraints involved in doing so. Preference should be made to discharging via an existing connection where possible;
- ▲ Provision should be made for a biodisc treatment plant (or similar) which should be situated 7 m from dwellings, if required;
- ▲ Verify the attenuation volumes included in this report when undertaking detailed drainage design; and
- ▲ Make provision for sustainable drainage features in the lower southern extent of the Site.

Appendix A – Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Appendix B – Existing Site Plans



Site Area - red line	8374.6m ²
Site Ownership - Blue line	16939m ²
Existing Building footprint :	1400.8m ²
Existing tank area :	28.3m ²
Existing Hardstanding :	5502m ²
Existing Soft landscaping :	1004m ²

- NOTES
- This drawing is copyright of Condy and Lofthouse Ltd. and may not be reproduced in any way without their specific permission.
- All dimensions are to be checked on site. Do not scale from this drawing, work to figured dimensions only. Any queries please contact the architects.
- MATERIALS PROHIBITED
- Materials prohibited from use, except where used in accordance with 'Good Practice in the Selection of Construction Materials (March 2011)' or unless required by the Contract:
- a)

high alumina cement in the structural elements;
- b)

wood wool slabs in permanent formwork to concrete;
- c)

calcium chloride admixtures for use in reinforced concrete;
- d)

asbestos or asbestos-containing products, as defined in the 'Control of Asbestos at Work Regulations, as amended 2012' or any other statutory modification or re-enactment thereof;
- e)

any naturally occurring or man made mineral fibres (for example, rock-wool or slag wool) with a thickness of 3 microns or less and a length of 200 microns or less, unless they are appropriately sealed to prevent migration of fibres;
- f)

aggregates for use in reinforced concrete which do not comply with:

'BS EN 12620:2002: Properties of aggregates used in concrete.'

'BS EN 13139:2002: Properties of aggregates used in mortar.'

'BS EN 13055 (Parts 1 & 2): properties of lightweight aggregates.'

'Guidance on avoiding alkali-silica reaction and limitations on alkali content in BRE Digest 330 (2004)' & 'Concrete Society Technical Report 30 (1999)';
- g)

lead, lead paint or any other materials containing lead which may be ingested, inhaled or absorbed, except where copper alloy fittings also containing lead are specifically required in drinking water pipework by any relevant statutory requirement or where lead flashings or other lead roof coverings are specifically provided for in the Contract;
- h)

urea formaldehyde foam or materials which may release formaldehyde in quantities which may be hazardous with reference to the limits set by the Health and Safety Executive;
- i)

calcium silicate bricks or tiles;
- j)

vermiculite unless it is established as being fibre-free; calcium silicate bricks or tiles;
- k)

any products containing cadmium referred to in Statutory Instrument 'SI 2006/3311 Control on dangerous substances and preparations Regulations 2006'. Reference should also be made to 'HSE IDG391 Cadmium and you';
- l)

any new timber treated with pentachlorophenol;
- m)

non galvanised mild steel structural fixings for building elements particularly susceptible to erosion;
- n)

concrete used in circumstances where it is susceptible to alkali/silica reaction;
- o)

materials containing chlorofluorocarbons (CFC's);
- p)

solvent based paints except where water based paints are unsuitable for unavailable;
- q)

any new materials not in accordance with statutory requirements, British Standards, Codes of Practice and good building practice current at the date of incorporation of the relevant materials into the Works or the specifications thereof.

THIS DRAWING IS BASED ON TOPOGRAPHICAL SURVEY UNDERTAKEN BY BARRY LOWE SURVEYS LTD 24/11/2014.

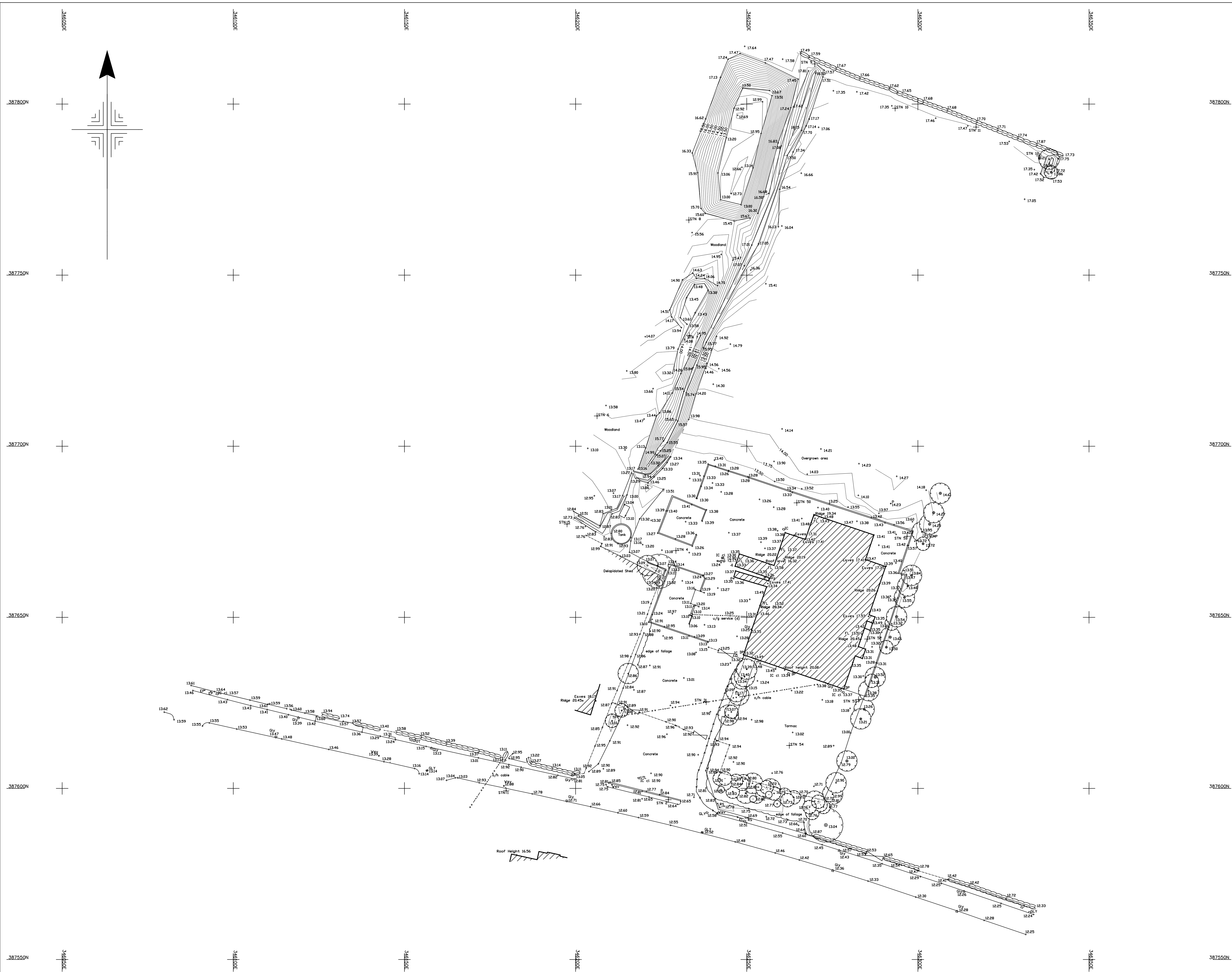
ALL DIMENSIONS TO BE CHECKED ON SITE BEFORE COMMENCEMENT OF ANY WORKS.

B Boundary updated to suit survey information. Additional landscaping added	Nov 2019
A Updated to provide further survey information	Oct 2019
* First Issue	Aug 2019
REVISION DETAILS	
Preliminary	date / by
For Approval	
Tender	
Construction	
CLIENT	
G D B Property Investments Ltd	
PROJECT	
Land at Woodend, Netherley Road, Tarbock Green, Prescot L35 1QE	
DRAWING TITLE	
Existing Site Plan	
SCALE	
1:500@A3	DB Aug 2019
DRAWING NO.	
19-112-101	B



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Appendix C – Topographical Survey and LiDAR Plan



Legend

BL BOLLARD

BS BUS STOP

CATV CABLE TV COVER

CL COVER LEVEL

OPS CONCRETE PAVING SLAB

DP DRAIN PIPE

DS DOOR STOP

EL ELECTRICITY COVER

EP ELECTRICITY POLE

ER EARTH ROD

FH FIRE HYDRANT

FL FLOOR LEVEL

FS FLAG STAFF

G GAS COVER

GLY GULLY

GSV GAS STOP VALVE

IC INSPECTION COVER

IL INVERT LEVEL

LB LITTER BIN

LP LAMP POST

MKR MARKER

NB NOTICE BOARD

P POST

PH POST HOLE

PLP PEDESTRIAN LAMP POST

RE RODDING EYE

RS ROAD SIGN

STN SURVEY STATION

STY STAY WIRE

T TELECOMMUNICATIONS COVER

TL TRAFFIC LIGHT

TP TELEGRAPH POLE

UTL UNABLE TO LIFT

UTM UNABLE TO MEASURE

VP VENT PIPE

WL WATER LEVEL

WP WASTE PIPE

WSV WATER STOP VALVE

FENCE TYPES

B/W BARBED WIRE

C/B CLOSE BOARD

P/W POST AND WIRE

P/R POST AND RAIL

C/L CHAIN LINK

C/P CHESTNUT PALE

C/W CHICKEN WIRE

M/R METAL RAIL (SECURITY TYPE)

P/F PANEL FENCE

C/I CORRUGATED IRON

I/R IRON RAILING

RWL RETAINING WALL

Notes

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ANY SERVICES SHOWN ARE AS LOCATED BY EITHER GROUND PENETRATING RADAR (GPR) OR BY RADIODETECTION SCANNER IN EITHER ACTIVE (A) OR PASSIVE MODE (P). DUE TO SUBSOIL CONDITIONS AND OTHER FACTORS THE UNDERGROUND SERVICE INFORMATION SHOWN MAY NOT REPRESENT A COMPREHENSIVE RECORD AND ALL CONTRACTORS SHOULD PROCEED WITH CAUTION BEFORE EXCAVATION

xx --- xx --- xx DENOTES OVERHEAD CABLES

x --- x --- DENOTES UNDERGROUND SERVICES

LEVELS AT ROAD KERBS ARE TAKEN AT CHANNEL LEVELS UNLESS OTHERWISE REQUESTED

STATION CO-ORDINATES

STN 1 E 346179.727 N 387599.301 H 12.932

STN 2 E 346227.117 N 387596.695 H 12.720

STN 3 E 346238.166 N 387625.280 H 12.939

STN 4 E 346229.311 N 387669.487 H 13.223

STN 5 E 346197.501 N 387677.250 H 12.890

STN 6 E 346206.281 N 387708.847 H 13.597

STN 7 E 346233.231 N 387732.389 H 14.464

STN 8 E 346233.080 N 387766.107 H 15.840

STN 9 E 346269.883 N 387811.726 H 17.815

STN 10 E 346293.354 N 387798.772 H 17.531

STN 11 E 346316.995 N 387793.262 H 17.734

STN 12 E 346335.447 N 387784.849 H 17.658

STN 50 E 346264.620 N 387683.463 H 13.394

STN 51 E 346296.850 N 387673.677 H 13.407

STN 52 E 346285.240 N 387643.657 H 13.358

STN 53 E 346282.679 N 387626.001 H 13.326

STN 54 E 346262.444 N 387612.548 H 12.902

BARRY LOWE SURVEYS LTD

3 YEOMANRY ROAD

BATTLEFIELD ENTERPRISE PARK

SHREWSBURY

SHROPSHIRE SY1 3EH

TEL/FAX 01743 443388

Client

NIGEL THORNS PLANNING CONSULTANCY

Title

WOODEND, NETHERLEY ROAD, PRESCOTT

Scale

1 : 500

Date

24/11/14

Job No

9653

Dwg No

01

Rev.

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Surveyed by

CS/LD/JS

Checked

CS

Scanned

YES (ACTIVE)

Levels are related to . . .

O.S DATUM (VRS)



Bing Maps Service Layer Contains OS data © Crown Copyright and Database Right 2019. © Environment Agency copyright and/or database right 2019. All rights reserved. Attribution statement: © Environment Agency copyright and/or database right 2019. All rights reserved.

	TITLE: LiDAR Data 20-0008.01 Tarbock Green. Prescott		DRAWN BY: AB		PROJECT NO: 20-0008.01
			CHECKED BY: JR		FIGURE NO: X
			DATE: 11 March 2020		
			SCALE (@A4): 1:1700		

Appendix D – United Utilities Sewer Plan

How to contact us:

**United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP**

Telephone: 0370 7510101

E-mail: propertysearches@uuplc.co.uk

**Your Ref: NETHERLEY ROAD
Our Ref: UUPS-ORD-154623
Date: 09/03/2020**

Location: SARA NETHERLEY ROAD, TARBOCK GREEN, PRESCOT, L35 1QE

I acknowledge with thanks your request dated 02/03/2020 for information on the location of our services.

Please find enclosed plans showing the approximate position of United Utilities' apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read United Utilities' access statement before you start work to check how it will affect our network. <http://www.unitedutilities.com/work-near-asset.aspx>.

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please [contact us](#).

Yours Faithfully,



Karen McCormack
Property Searches Manager

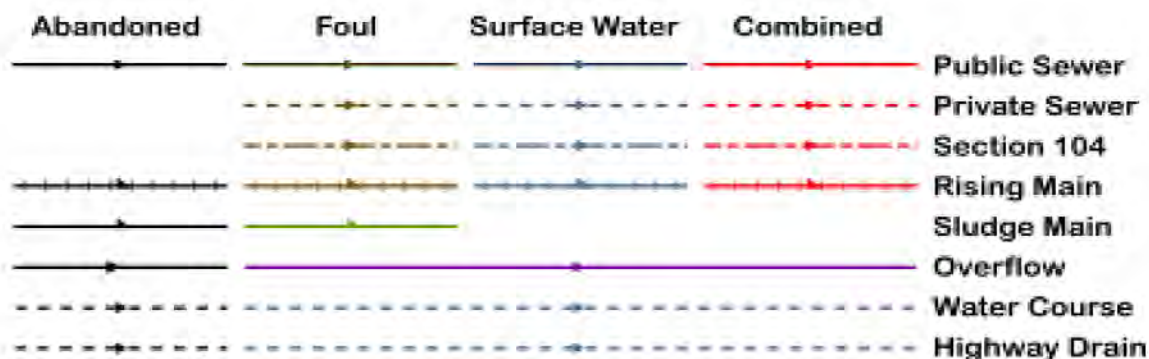
TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
- This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
- In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
- The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
- The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
- This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
- No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
- If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
- This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

Wastewater Symbolology



All point assets follow the standard colour convention: **red** – combined **brown** - foul
blue – surface water **purple** - overflow

- | | |
|------------------|--------------------------|
| Manhole | Side Entry Manhole |
| Head of System | Outfall |
| Extent of Survey | Screen Chamber |
| Rodding Eye | Inspection Chamber |
| Inlet | Bifurcation Chamber |
| Discharge Point | Lamp Hole |
| Vortex | T Junction / Saddle |
| Penstock | Catchpit |
| Washout Chamber | Valve Chamber |
| Valve | Vent Column |
| Air Valve | Vortex Chamber |
| Non Return Valve | Penstock Chamber |
| Soakaway | Network Storage Tank |
| Gully | Sewer Overflow |
| Cascade | Ww Treatment Works |
| Flow Meter | Ww Pumping Station |
| Hatch Box | Septic Tank |
| Oil Interceptor | Control Kiosk |
| Summit | |
| Drop Shaft | Change of Characteristic |
| Orifice Plate | |



Date: 09/03/2020

Extract from Map of Public Sewers

Printed By:
Property Searches

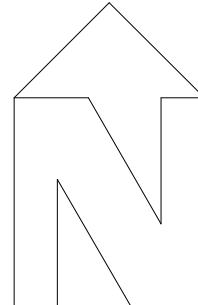
SARA NETHERLEY ROAD, PRESCOT, L35 1QE



The position of underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. The actual positions may be different from those shown on the plan and private pipes, sewers or drains may not be recorded. United Utilities Water PLC will not accept any liability for any damage caused by the actual positions being different from those shown.

© United Utilities Water PLC 2017. The plan is based upon the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office, Crown copyright 100022432 and United Utilities Water PLC copyrights are reserved. Unauthorised reproduction will infringe these copyrights.

Appendix E – Proposed Development Plan



- NOTES
1. The drawings are copyright of Candy & Lofthouse Ltd. and may not be reproduced in any form without their written permission.
2. All dimensions are to be checked on site. Work in figure dimensions only. Any square given unless otherwise stated.
- MATERIALS PROHIBITED
- Materials prohibited from use, except when used in accordance with Good Practice in the selection of Construction Materials (BS8545:2015) or where required by the Contract.
1. High strength concrete to the structural standards.
2. Steel reinforcement to be provided in concrete.
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THIS DRAWING IS BASED ON TOPOGRAPHICAL SURVEY UNDERTAKEN BY BARRY LOWE SURVEYS LTD 24/11/2014.

ALL DIMENSIONS TO BE CHECKED ON SITE BEFORE COMMENCEMENT OF ANY WORK.



Schedule of Accommodation	
3no. House Type A	4b/7p @ 136m²
1no. House Type B	4b/7p @ 135m²
6no. House Type C	3b/6p @ 126m²
4no. House Type D/D1	3b/5p @ 96m²
14no. New Dwellings Total	
14no Live/Work Units @ 15m² ea	
Car Parking 200%	
Site Area - red line	
7980m²	

Landscaping Key	
	Rear Gardens / Private Amenity
	Front Gardens and planting / Private Amenity
	Communal greenery
	Low level planting and new hedgerows
	Existing Trees
	Proposed Trees

Updated to suit planning comments	Jan 2020
Amended to suit streetscape drawing and live unit roofscape updated	Nov 2019
Amended to suit house plan designs	Nov 2019
First Issue	Oct 2019
REVISION DETAILS	
● Preliminary	
○ For Approval	
○ Tender	
○ Construction	
G D B Property Investments Ltd	
Land at Woodend, Netherley Road, Tarbock Green, Prescot L35 1QE	
Proposed Site Plan	
12008A1	08 Oct 2019
19-112-103	©
CLA	
Candy & Lofthouse Architects	
T: 0151 207 4371 • F: 0151 207 7087	

Appendix F – ReFH2 Runoff Calculations

Inputs	
Area	0.82 Ha
BFI Host	0.351

ReFH2 RUNOFF RATES*		
Return Period (Years)	Urbanised peak flow (l/s) (Existing)	As-rural Peak Flow (l/s)
1	11.54	4.74
2	12.9	5.29
5	17.45	7.16
10	20.83	8.59
30	26.84	11.19
50	30.23	12.7
75	33.35	14.11
100	35.85	15.26
200	43.03	18.66
1000	63.75	29.17

*Runoff Rates printed from the ReFH2 Flood Modelling software package

Appendix G – MicroDrainage Attenuation Calculations

Delta-Simons				Page 1			
Suite 4A Portland Street Manchester, M1 3BE		20-0008.01 Tarbock Green 1 in 30 yr					
Date 09/03/2019 File Proj100+40 1% runoff.SRCX		Designed by AB Checked by JR					
Innovyze		Source Control 2019.1					
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.666	0.666	15.3	0.0	15.3	48.0	O K
30 min Summer	9.823	0.823	15.3	0.0	15.3	59.2	Flood Risk
60 min Summer	9.869	0.869	15.3	0.0	15.3	62.6	Flood Risk
120 min Summer	9.789	0.789	15.3	0.0	15.3	56.8	Flood Risk
180 min Summer	9.689	0.689	15.3	0.0	15.3	49.6	O K
240 min Summer	9.583	0.583	15.3	0.0	15.3	42.0	O K
360 min Summer	9.414	0.414	15.3	0.0	15.3	29.8	O K
480 min Summer	9.296	0.296	15.2	0.0	15.2	21.3	O K
600 min Summer	9.223	0.223	14.9	0.0	14.9	16.1	O K
720 min Summer	9.183	0.183	14.5	0.0	14.5	13.1	O K
960 min Summer	9.152	0.152	12.1	0.0	12.1	10.9	O K
1440 min Summer	9.122	0.122	9.1	0.0	9.1	8.8	O K
2160 min Summer	9.100	0.100	6.7	0.0	6.7	7.2	O K
2880 min Summer	9.088	0.088	5.5	0.0	5.5	6.3	O K
4320 min Summer	9.074	0.074	4.1	0.0	4.1	5.3	O K
5760 min Summer	9.065	0.065	3.4	0.0	3.4	4.7	O K
7200 min Summer	9.060	0.060	2.9	0.0	2.9	4.3	O K
8640 min Summer	9.056	0.056	2.6	0.0	2.6	4.0	O K
10080 min Summer	9.053	0.053	2.3	0.0	2.3	3.8	O K
15 min Winter	9.765	0.765	15.3	0.0	15.3	55.1	Flood Risk
30 min Winter	9.940	0.940	15.3	0.0	15.3	67.7	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	72.646	0.0	61.8	0.0	22		
30 min Summer	47.233	0.0	80.4	0.0	33		
60 min Summer	29.330	0.0	99.8	0.0	52		
120 min Summer	17.297	0.0	117.8	0.0	86		
180 min Summer	12.644	0.0	129.1	0.0	120		
240 min Summer	10.109	0.0	137.6	0.0	152		
360 min Summer	7.362	0.0	150.4	0.0	212		
480 min Summer	5.873	0.0	159.9	0.0	268		
600 min Summer	4.928	0.0	167.8	0.0	322		
720 min Summer	4.270	0.0	174.4	0.0	376		
960 min Summer	3.409	0.0	185.7	0.0	496		
1440 min Summer	2.491	0.0	203.5	0.0	736		
2160 min Summer	1.831	0.0	224.4	0.0	1100		
2880 min Summer	1.479	0.0	241.7	0.0	1460		
4320 min Summer	1.104	0.0	270.6	0.0	2204		
5760 min Summer	0.904	0.0	295.6	0.0	2936		
7200 min Summer	0.779	0.0	318.2	0.0	3672		
8640 min Summer	0.692	0.0	339.4	0.0	4400		
10080 min Summer	0.629	0.0	359.5	0.0	5024		
15 min Winter	72.646	0.0	69.2	0.0	23		
30 min Winter	47.233	0.0	90.0	0.0	34		
©1982-2019 Innovyze							

Delta-Simons						Page 2	
Suite 4A Portland Street Manchester, M1 3BE			20-0008.01 Tarbock Green 1 in 30 yr				
Date 09/03/2019 File Proj100+40 1% runoff.SRCX			Designed by AB Checked by JR				
Innovyze			Source Control 2019.1				
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	9.995	0.995	15.3	0.0	15.3	71.6	Flood Risk
120 min Winter	9.880	0.880	15.3	0.0	15.3	63.3	Flood Risk
180 min Winter	9.734	0.734	15.3	0.0	15.3	52.9	Flood Risk
240 min Winter	9.564	0.564	15.3	0.0	15.3	40.6	O K
360 min Winter	9.319	0.319	15.3	0.0	15.3	23.0	O K
480 min Winter	9.195	0.195	14.7	0.0	14.7	14.1	O K
600 min Winter	9.161	0.161	12.9	0.0	12.9	11.6	O K
720 min Winter	9.143	0.143	11.3	0.0	11.3	10.3	O K
960 min Winter	9.121	0.121	9.1	0.0	9.1	8.7	O K
1440 min Winter	9.099	0.099	6.7	0.0	6.7	7.1	O K
2160 min Winter	9.082	0.082	4.9	0.0	4.9	5.9	O K
2880 min Winter	9.072	0.072	4.0	0.0	4.0	5.2	O K
4320 min Winter	9.061	0.061	3.0	0.0	3.0	4.4	O K
5760 min Winter	9.054	0.054	2.4	0.0	2.4	3.9	O K
7200 min Winter	9.050	0.050	2.1	0.0	2.1	3.6	O K
8640 min Winter	9.046	0.046	1.9	0.0	1.9	3.3	O K
10080 min Winter	9.044	0.044	1.7	0.0	1.7	3.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	29.330	0.0	111.8	0.0	56		
120 min Winter	17.297	0.0	131.9	0.0	92		
180 min Winter	12.644	0.0	144.6	0.0	130		
240 min Winter	10.109	0.0	154.2	0.0	162		
360 min Winter	7.362	0.0	168.5	0.0	218		
480 min Winter	5.873	0.0	179.1	0.0	264		
600 min Winter	4.928	0.0	187.9	0.0	318		
720 min Winter	4.270	0.0	195.4	0.0	376		
960 min Winter	3.409	0.0	207.9	0.0	496		
1440 min Winter	2.491	0.0	227.9	0.0	736		
2160 min Winter	1.831	0.0	251.3	0.0	1096		
2880 min Winter	1.479	0.0	270.7	0.0	1444		
4320 min Winter	1.104	0.0	303.1	0.0	2188		
5760 min Winter	0.904	0.0	331.0	0.0	2880		
7200 min Winter	0.779	0.0	356.4	0.0	3608		
8640 min Winter	0.692	0.0	380.1	0.0	4352		
10080 min Winter	0.629	0.0	402.7	0.0	5016		
©1982-2019 Innovyze							

Delta-Simons		Page 4
Suite 4A Portland Street Manchester, M1 3BE	20-0008.01 Tarbock Green 1 in 30 yr	
Date 09/03/2019 File Proj100+40 1% runoff.SRCX	Designed by AB Checked by JR	
Innovyze Source Control 2019.1		

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 9.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	72.0	1.000	72.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0176-1530-1000-1530
Design Head (m)	1.000
Design Flow (l/s)	15.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	176
Invert Level (m)	8.995
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	15.3
Flush-Flo™	0.324	15.3
Kick-Flo®	0.704	12.9
Mean Flow over Head Range	-	13.0

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

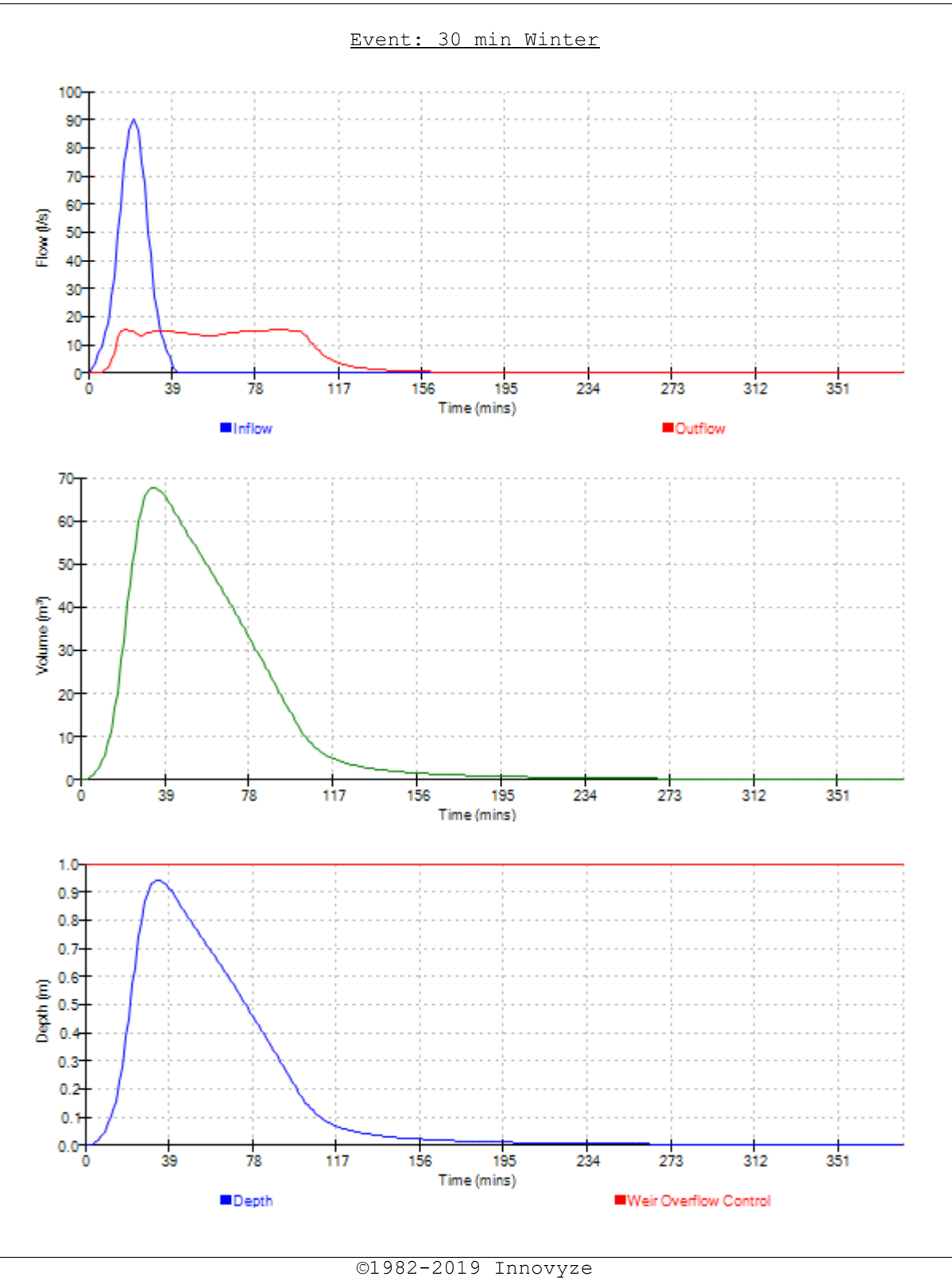
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.2	1.200	16.7	3.000	25.8	7.000	38.8
0.200	14.7	1.400	17.9	3.500	27.8	7.500	40.1
0.300	15.2	1.600	19.1	4.000	29.6	8.000	41.4
0.400	15.1	1.800	20.2	4.500	31.4	8.500	42.6
0.500	14.8	2.000	21.2	5.000	33.0	9.000	43.8
0.600	14.3	2.200	22.2	5.500	34.5	9.500	45.0
0.800	13.8	2.400	23.2	6.000	36.0		
1.000	15.3	2.600	24.1	6.500	37.5		

Weir Overflow Control

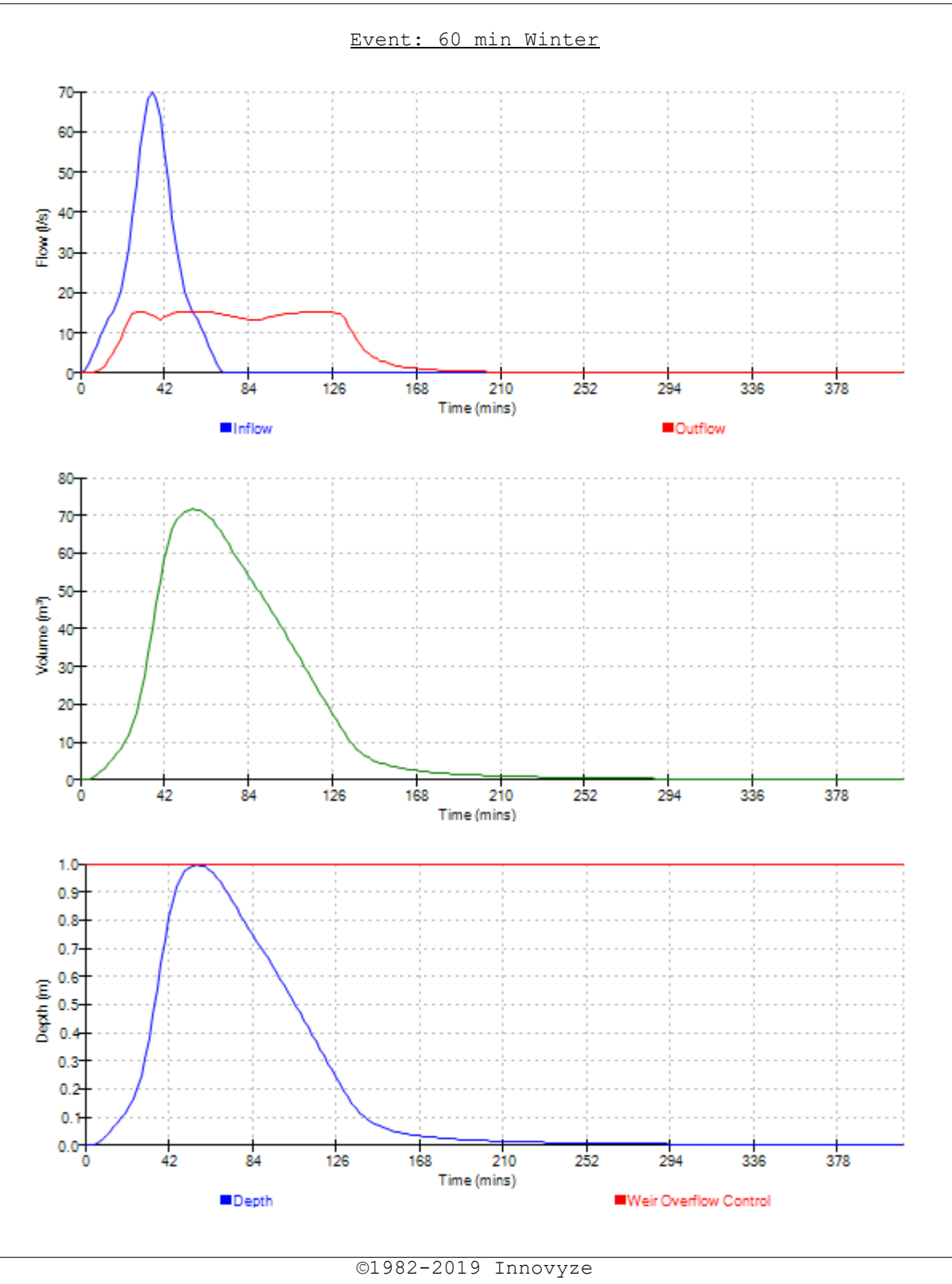
Discharge Coef 0.544 Width (m) 5.000 Invert Level (m) 10.000

©1982-2019 Innovyze

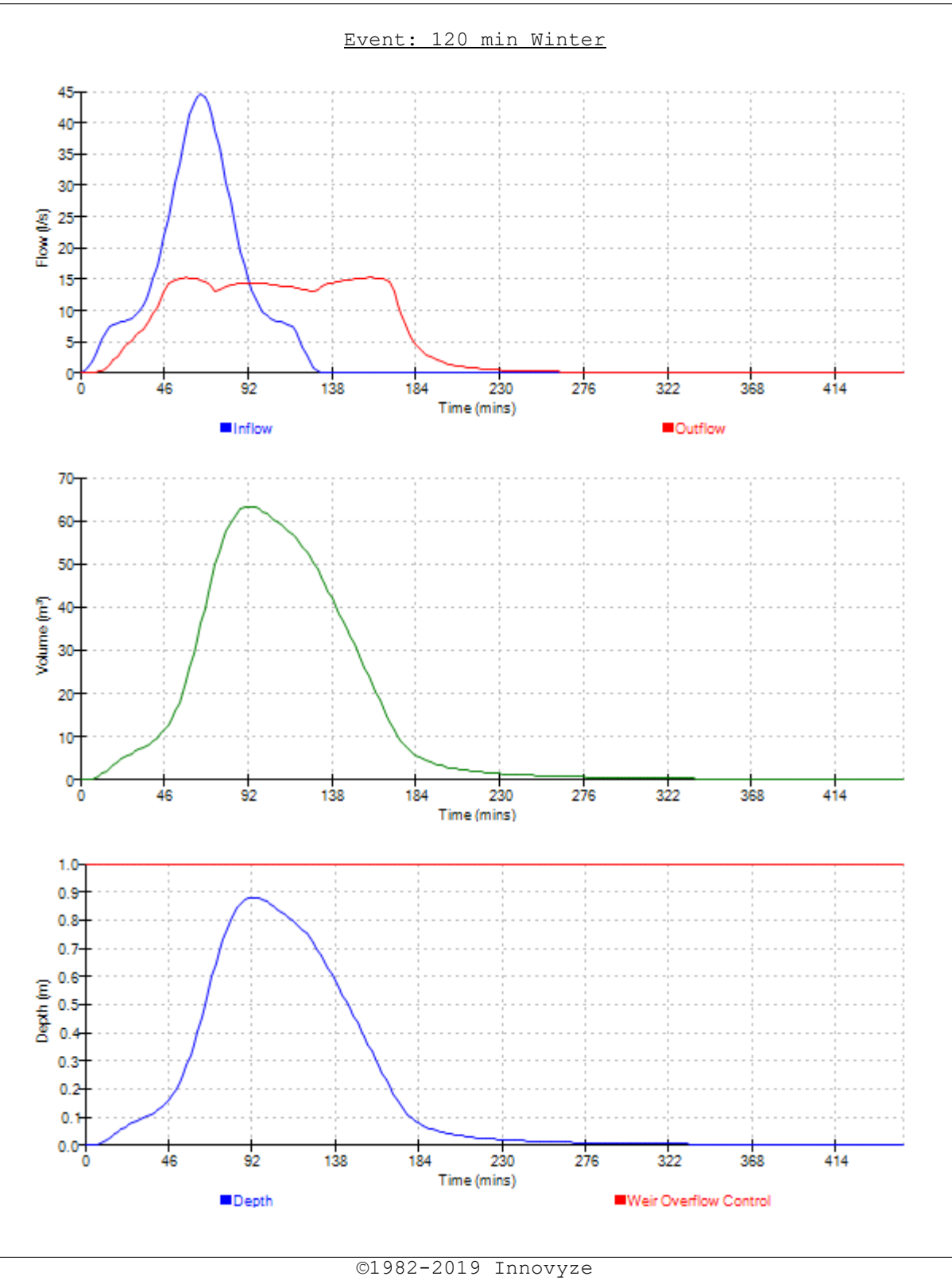
Delta-Simons		Page 5
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Portland Street	Tarbock Green	
Manchester, M1 3BE	1 in 30 yr	
Date 09/03/2019	Designed by AB	
File Proj100+40 1% runoff.SRCX	Checked by JR	
Innovyze	Source Control 2019.1	



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Suite 4A	20-0008.01	
Portland Street	Tarbock Green	
Manchester, M1 3BE	1 in 30 yr	
Date 09/03/2019	Designed by AB	
File Proj100+40 1% runoff.SRCX	Checked by JR	
Innovyze	Source Control 2019.1	



Delta-Simons		Page 7
Suite 4A	20-0008.01	
Portland Street	Tarbock Green	
Manchester, M1 3BE	1 in 30 yr	
Date 09/03/2019	Designed by AB	
File Proj100+40 1% runoff.SRCX	Checked by JR	
Innovyze	Source Control 2019.1	



Delta-Simons				Page 1			
Suite 4A Portland Street Manchester, M1 3BE		20-0008.01 Tarbock Green 1 in 30 yr					
Date 09/03/2019 File Proj30.SRCX		Designed by AB Checked by JR					
Innovyze		Source Control 2019.1					
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.548	0.548	5.3	0.0	5.3	56.4	O K
30 min Summer	9.701	0.701	5.3	0.0	5.3	72.2	Flood Risk
60 min Summer	9.824	0.824	5.3	0.0	5.3	84.9	Flood Risk
120 min Summer	9.863	0.863	5.3	0.0	5.3	88.9	Flood Risk
180 min Summer	9.847	0.847	5.3	0.0	5.3	87.3	Flood Risk
240 min Summer	9.825	0.825	5.3	0.0	5.3	85.0	Flood Risk
360 min Summer	9.776	0.776	5.3	0.0	5.3	80.0	Flood Risk
480 min Summer	9.725	0.725	5.3	0.0	5.3	74.7	Flood Risk
600 min Summer	9.674	0.674	5.3	0.0	5.3	69.4	O K
720 min Summer	9.616	0.616	5.3	0.0	5.3	63.4	O K
960 min Summer	9.508	0.508	5.3	0.0	5.3	52.4	O K
1440 min Summer	9.349	0.349	5.3	0.0	5.3	36.0	O K
2160 min Summer	9.209	0.209	5.2	0.0	5.2	21.5	O K
2880 min Summer	9.143	0.143	4.9	0.0	4.9	14.7	O K
4320 min Summer	9.102	0.102	4.0	0.0	4.0	10.6	O K
5760 min Summer	9.086	0.086	3.3	0.0	3.3	8.9	O K
7200 min Summer	9.077	0.077	2.9	0.0	2.9	7.9	O K
8640 min Summer	9.071	0.071	2.6	0.0	2.6	7.3	O K
10080 min Summer	9.066	0.066	2.3	0.0	2.3	6.8	O K
15 min Winter	9.620	0.620	5.3	0.0	5.3	63.9	O K
30 min Winter	9.793	0.793	5.3	0.0	5.3	81.7	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	72.646	0.0	61.8	0.0	25		
30 min Summer	47.233	0.0	80.4	0.0	39		
60 min Summer	29.330	0.0	99.8	0.0	66		
120 min Summer	17.297	0.0	117.7	0.0	122		
180 min Summer	12.644	0.0	129.1	0.0	158		
240 min Summer	10.109	0.0	137.6	0.0	190		
360 min Summer	7.362	0.0	150.4	0.0	256		
480 min Summer	5.873	0.0	159.9	0.0	326		
600 min Summer	4.928	0.0	167.7	0.0	396		
720 min Summer	4.270	0.0	174.4	0.0	462		
960 min Summer	3.409	0.0	185.6	0.0	586		
1440 min Summer	2.491	0.0	203.5	0.0	824		
2160 min Summer	1.831	0.0	224.4	0.0	1160		
2880 min Summer	1.479	0.0	241.6	0.0	1500		
4320 min Summer	1.104	0.0	270.6	0.0	2208		
5760 min Summer	0.904	0.0	295.5	0.0	2936		
7200 min Summer	0.779	0.0	318.2	0.0	3672		
8640 min Summer	0.692	0.0	339.4	0.0	4368		
10080 min Summer	0.629	0.0	359.5	0.0	5096		
15 min Winter	72.646	0.0	69.2	0.0	25		
30 min Winter	47.233	0.0	90.0	0.0	38		
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Suite 4A Portland Street Manchester, M1 3BE			20-0008.01 Tarbock Green 1 in 30 yr				
Date 09/03/2019 File Proj30.SRCX			Designed by AB Checked by JR				
Innovyze			Source Control 2019.1				
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	9.936	0.936	5.3	0.0	5.3	96.4	Flood Risk
120 min Winter	9.991	0.991	5.3	0.0	5.3	102.1	Flood Risk
180 min Winter	9.978	0.978	5.3	0.0	5.3	100.7	Flood Risk
240 min Winter	9.948	0.948	5.3	0.0	5.3	97.6	Flood Risk
360 min Winter	9.883	0.883	5.3	0.0	5.3	90.9	Flood Risk
480 min Winter	9.810	0.810	5.3	0.0	5.3	83.4	Flood Risk
600 min Winter	9.735	0.735	5.3	0.0	5.3	75.7	Flood Risk
720 min Winter	9.655	0.655	5.3	0.0	5.3	67.4	O K
960 min Winter	9.480	0.480	5.3	0.0	5.3	49.5	O K
1440 min Winter	9.258	0.258	5.3	0.0	5.3	26.6	O K
2160 min Winter	9.125	0.125	4.8	0.0	4.8	12.9	O K
2880 min Winter	9.100	0.100	3.9	0.0	3.9	10.3	O K
4320 min Winter	9.078	0.078	3.0	0.0	3.0	8.0	O K
5760 min Winter	9.068	0.068	2.4	0.0	2.4	7.0	O K
7200 min Winter	9.062	0.062	2.1	0.0	2.1	6.3	O K
8640 min Winter	9.057	0.057	1.9	0.0	1.9	5.9	O K
10080 min Winter	9.054	0.054	1.7	0.0	1.7	5.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	29.330	0.0	111.8	0.0	66		
120 min Winter	17.297	0.0	131.9	0.0	120		
180 min Winter	12.644	0.0	144.6	0.0	174		
240 min Winter	10.109	0.0	154.2	0.0	198		
360 min Winter	7.362	0.0	168.4	0.0	274		
480 min Winter	5.873	0.0	179.1	0.0	352		
600 min Winter	4.928	0.0	187.9	0.0	428		
720 min Winter	4.270	0.0	195.4	0.0	506		
960 min Winter	3.409	0.0	207.9	0.0	624		
1440 min Winter	2.491	0.0	227.9	0.0	844		
2160 min Winter	1.831	0.0	251.3	0.0	1132		
2880 min Winter	1.479	0.0	270.6	0.0	1476		
4320 min Winter	1.104	0.0	303.1	0.0	2204		
5760 min Winter	0.904	0.0	331.0	0.0	2944		
7200 min Winter	0.779	0.0	356.4	0.0	3680		
8640 min Winter	0.692	0.0	380.1	0.0	4384		
10080 min Winter	0.629	0.0	402.7	0.0	5080		
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Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 346274 387676 SJ 46274 87676
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.454

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
From:	To:	From:	To:	From:	To:
0	4 0.151	4	8 0.151	8	12 0.151

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Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 9.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	103.0	1.000	103.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-5300-1000-5300
Design Head (m)	1.000
Design Flow (l/s)	5.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	8.995
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.3
Flush-Flo™	0.295	5.3
Kick-Flo®	0.641	4.3
Mean Flow over Head Range	-	4.6

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

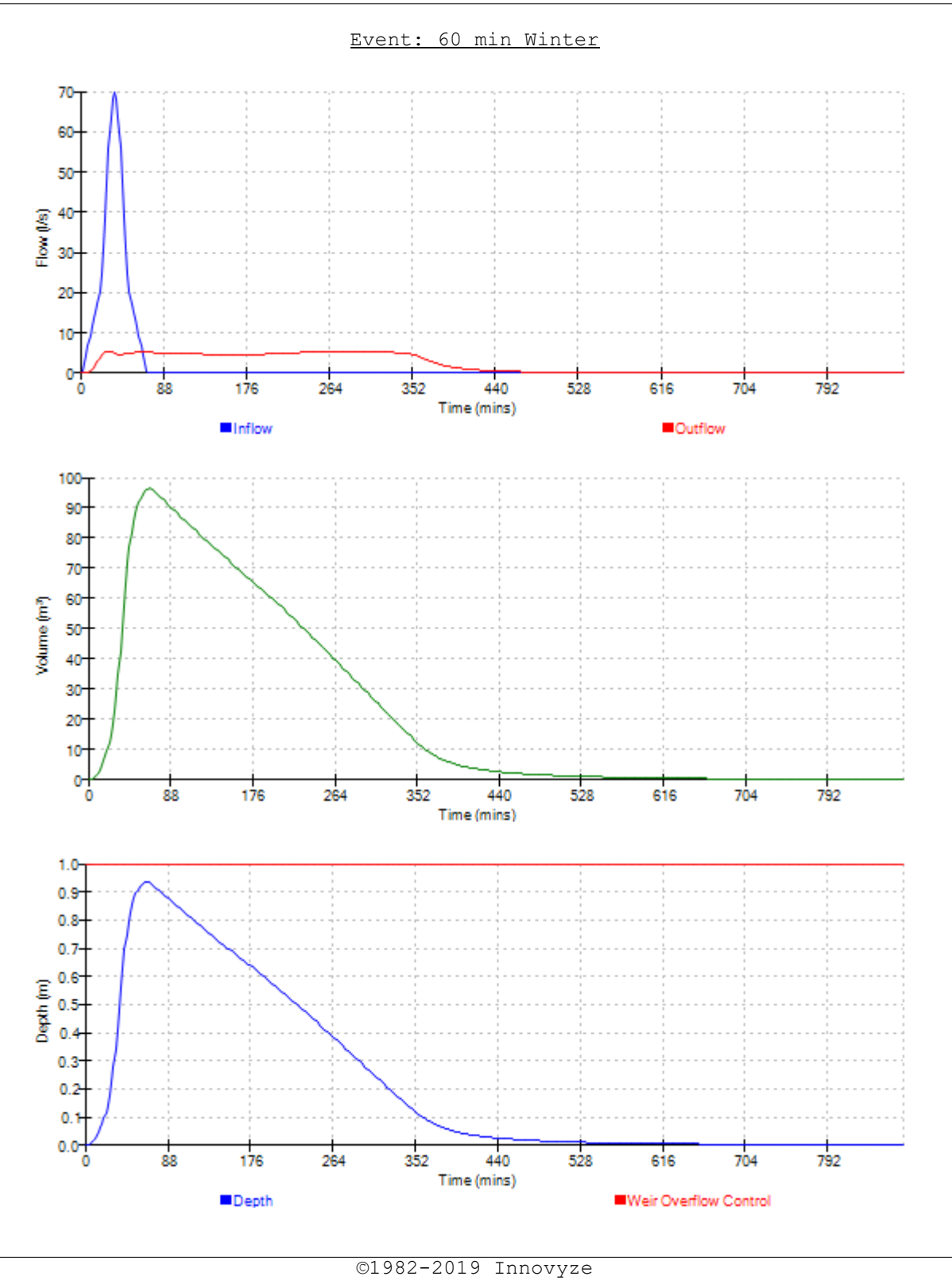
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	5.8	3.000	8.9	7.000	13.3
0.200	5.2	1.400	6.2	3.500	9.5	7.500	13.7
0.300	5.3	1.600	6.6	4.000	10.2	8.000	14.1
0.400	5.2	1.800	7.0	4.500	10.7	8.500	14.6
0.500	5.0	2.000	7.3	5.000	11.3	9.000	15.0
0.600	4.6	2.200	7.7	5.500	11.8	9.500	15.4
0.800	4.8	2.400	8.0	6.000	12.3		
1.000	5.3	2.600	8.3	6.500	12.8		

Weir Overflow Control

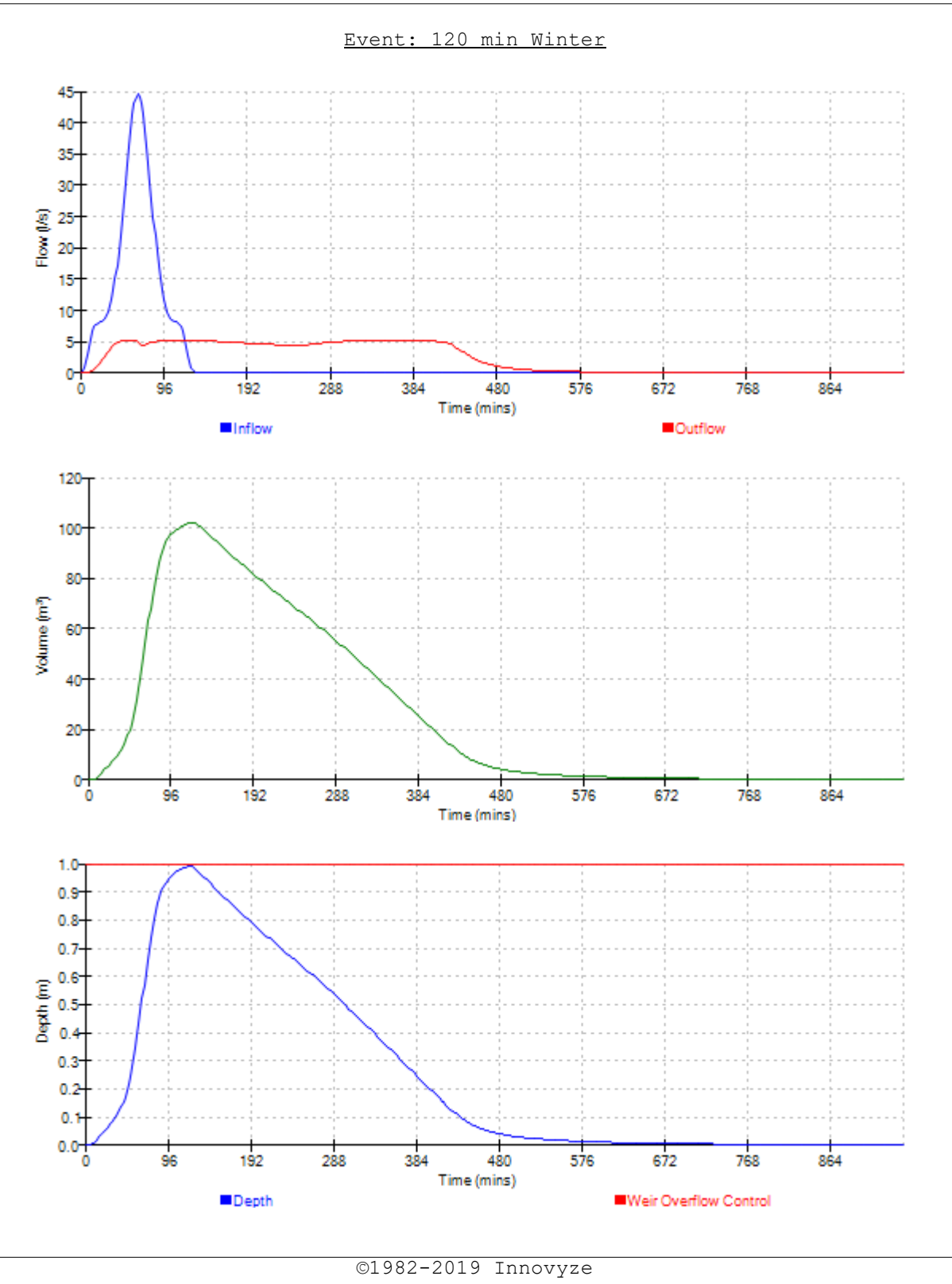
Discharge Coef 0.544 Width (m) 5.000 Invert Level (m) 10.000

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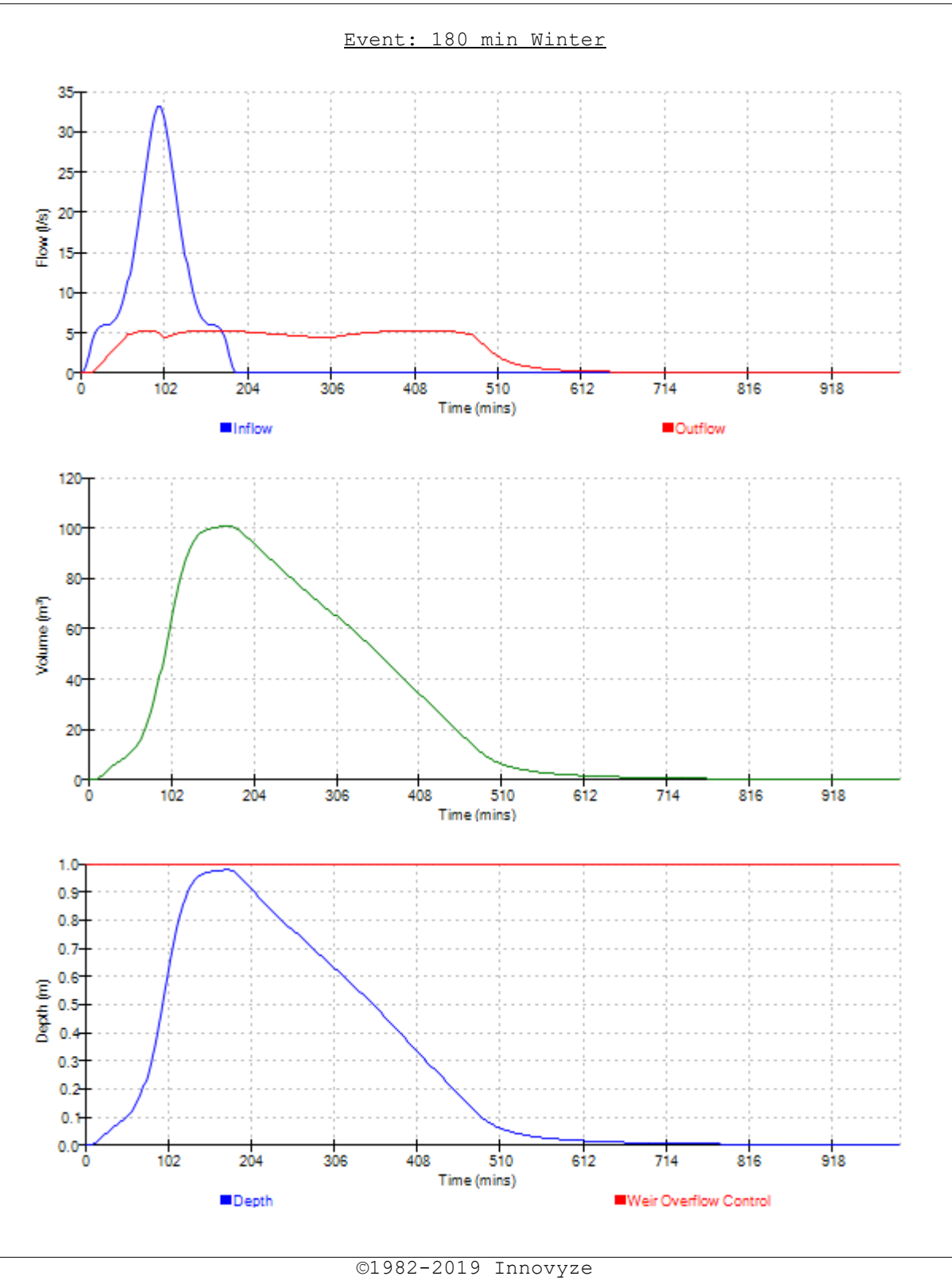
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Innovyze	Source Control 2019.1	



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Suite 4A Portland Street Manchester, M1 3BE			20-0008.01 Tarbock Green 1 in 100 + 40% CC																																																																																																																																																																																																																																																																																																																								
Date 09/03/2019 File Proj100+40 1% runoff.SRCX			Designed by AB Checked by JR																																																																																																																																																																																																																																																																																																																								
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<u>Summary of Results for 100 year Return Period (+40%)</u> <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Control (l/s)</th><th>Max Overflow (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>9.592</td><td>0.592</td><td>15.3</td><td>0.0</td><td>15.3</td><td>98.8</td><td>O K</td></tr><tr><td>30 min Summer</td><td>9.763</td><td>0.763</td><td>15.3</td><td>0.0</td><td>15.3</td><td>127.4</td><td>Flood Risk</td></tr><tr><td>60 min Summer</td><td>9.876</td><td>0.876</td><td>15.3</td><td>0.0</td><td>15.3</td><td>146.4</td><td>Flood Risk</td></tr><tr><td>120 min Summer</td><td>9.873</td><td>0.873</td><td>15.3</td><td>0.0</td><td>15.3</td><td>145.8</td><td>Flood Risk</td></tr><tr><td>180 min Summer</td><td>9.841</td><td>0.841</td><td>15.3</td><td>0.0</td><td>15.3</td><td>140.4</td><td>Flood Risk</td></tr><tr><td>240 min Summer</td><td>9.800</td><td>0.800</td><td>15.3</td><td>0.0</td><td>15.3</td><td>133.7</td><td>Flood Risk</td></tr><tr><td>360 min Summer</td><td>9.707</td><td>0.707</td><td>15.3</td><td>0.0</td><td>15.3</td><td>118.1</td><td>Flood Risk</td></tr><tr><td>480 min Summer</td><td>9.602</td><td>0.602</td><td>15.3</td><td>0.0</td><td>15.3</td><td>100.5</td><td>O K</td></tr><tr><td>600 min Summer</td><td>9.512</td><td>0.512</td><td>15.3</td><td>0.0</td><td>15.3</td><td>85.6</td><td>O K</td></tr><tr><td>720 min Summer</td><td>9.434</td><td>0.434</td><td>15.3</td><td>0.0</td><td>15.3</td><td>72.5</td><td>O K</td></tr><tr><td>960 min Summer</td><td>9.315</td><td>0.315</td><td>15.3</td><td>0.0</td><td>15.3</td><td>52.5</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>9.192</td><td>0.192</td><td>14.6</td><td>0.0</td><td>14.6</td><td>32.0</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>9.146</td><td>0.146</td><td>11.6</td><td>0.0</td><td>11.6</td><td>24.3</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>9.124</td><td>0.124</td><td>9.4</td><td>0.0</td><td>9.4</td><td>20.8</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>9.102</td><td>0.102</td><td>7.0</td><td>0.0</td><td>7.0</td><td>17.0</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>9.090</td><td>0.090</td><td>5.7</td><td>0.0</td><td>5.7</td><td>14.9</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>9.081</td><td>0.081</td><td>4.8</td><td>0.0</td><td>4.8</td><td>13.6</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>9.076</td><td>0.076</td><td>4.3</td><td>0.0</td><td>4.3</td><td>12.6</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>9.071</td><td>0.071</td><td>3.9</td><td>0.0</td><td>3.9</td><td>11.9</td><td>O K</td></tr><tr><td>15 min Winter</td><td>9.673</td><td>0.673</td><td>15.3</td><td>0.0</td><td>15.3</td><td>112.3</td><td>O K</td></tr><tr><td>30 min Winter</td><td>9.865</td><td>0.865</td><td>15.3</td><td>0.0</td><td>15.3</td><td>144.4</td><td>Flood Risk</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>Overflow Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>133.291</td><td>0.0</td><td>113.4</td><td>0.0</td><td>24</td></tr><tr><td>30 min Summer</td><td>87.861</td><td>0.0</td><td>149.5</td><td>0.0</td><td>37</td></tr><tr><td>60 min Summer</td><td>54.883</td><td>0.0</td><td>186.8</td><td>0.0</td><td>62</td></tr><tr><td>120 min Summer</td><td>32.411</td><td>0.0</td><td>220.6</td><td>0.0</td><td>102</td></tr><tr><td>180 min Summer</td><td>23.735</td><td>0.0</td><td>242.4</td><td>0.0</td><td>134</td></tr><tr><td>240 min Summer</td><td>18.979</td><td>0.0</td><td>258.4</td><td>0.0</td><td>168</td></tr><tr><td>360 min Summer</td><td>13.773</td><td>0.0</td><td>281.3</td><td>0.0</td><td>238</td></tr><tr><td>480 min Summer</td><td>10.930</td><td>0.0</td><td>297.7</td><td>0.0</td><td>300</td></tr><tr><td>600 min Summer</td><td>9.124</td><td>0.0</td><td>310.6</td><td>0.0</td><td>362</td></tr><tr><td>720 min Summer</td><td>7.866</td><td>0.0</td><td>321.3</td><td>0.0</td><td>422</td></tr><tr><td>960 min Summer</td><td>6.221</td><td>0.0</td><td>338.8</td><td>0.0</td><td>536</td></tr><tr><td>1440 min Summer</td><td>4.477</td><td>0.0</td><td>365.7</td><td>0.0</td><td>754</td></tr><tr><td>2160 min Summer</td><td>3.234</td><td>0.0</td><td>396.4</td><td>0.0</td><td>1108</td></tr><tr><td>2880 min Summer</td><td>2.579</td><td>0.0</td><td>421.5</td><td>0.0</td><td>1472</td></tr><tr><td>4320 min Summer</td><td>1.892</td><td>0.0</td><td>463.9</td><td>0.0</td><td>2204</td></tr><tr><td>5760 min Summer</td><td>1.531</td><td>0.0</td><td>500.5</td><td>0.0</td><td>2936</td></tr><tr><td>7200 min Summer</td><td>1.308</td><td>0.0</td><td>534.3</td><td>0.0</td><td>3672</td></tr><tr><td>8640 min Summer</td><td>1.155</td><td>0.0</td><td>566.1</td><td>0.0</td><td>4400</td></tr><tr><td>10080 min Summer</td><td>1.043</td><td>0.0</td><td>596.6</td><td>0.0</td><td>5088</td></tr><tr><td>15 min Winter</td><td>133.291</td><td>0.0</td><td>127.0</td><td>0.0</td><td>24</td></tr><tr><td>30 min Winter</td><td>87.861</td><td>0.0</td><td>167.5</td><td>0.0</td><td>37</td></tr></table>								Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status	15 min Summer	9.592	0.592	15.3	0.0	15.3	98.8	O K	30 min Summer	9.763	0.763	15.3	0.0	15.3	127.4	Flood Risk	60 min Summer	9.876	0.876	15.3	0.0	15.3	146.4	Flood Risk	120 min Summer	9.873	0.873	15.3	0.0	15.3	145.8	Flood Risk	180 min Summer	9.841	0.841	15.3	0.0	15.3	140.4	Flood Risk	240 min Summer	9.800	0.800	15.3	0.0	15.3	133.7	Flood Risk	360 min Summer	9.707	0.707	15.3	0.0	15.3	118.1	Flood Risk	480 min Summer	9.602	0.602	15.3	0.0	15.3	100.5	O K	600 min Summer	9.512	0.512	15.3	0.0	15.3	85.6	O K	720 min Summer	9.434	0.434	15.3	0.0	15.3	72.5	O K	960 min Summer	9.315	0.315	15.3	0.0	15.3	52.5	O K	1440 min Summer	9.192	0.192	14.6	0.0	14.6	32.0	O K	2160 min Summer	9.146	0.146	11.6	0.0	11.6	24.3	O K	2880 min Summer	9.124	0.124	9.4	0.0	9.4	20.8	O K	4320 min Summer	9.102	0.102	7.0	0.0	7.0	17.0	O K	5760 min Summer	9.090	0.090	5.7	0.0	5.7	14.9	O K	7200 min Summer	9.081	0.081	4.8	0.0	4.8	13.6	O K	8640 min Summer	9.076	0.076	4.3	0.0	4.3	12.6	O K	10080 min Summer	9.071	0.071	3.9	0.0	3.9	11.9	O K	15 min Winter	9.673	0.673	15.3	0.0	15.3	112.3	O K	30 min Winter	9.865	0.865	15.3	0.0	15.3	144.4	Flood Risk	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)	15 min Summer	133.291	0.0	113.4	0.0	24	30 min Summer	87.861	0.0	149.5	0.0	37	60 min Summer	54.883	0.0	186.8	0.0	62	120 min Summer	32.411	0.0	220.6	0.0	102	180 min Summer	23.735	0.0	242.4	0.0	134	240 min Summer	18.979	0.0	258.4	0.0	168	360 min Summer	13.773	0.0	281.3	0.0	238	480 min Summer	10.930	0.0	297.7	0.0	300	600 min Summer	9.124	0.0	310.6	0.0	362	720 min Summer	7.866	0.0	321.3	0.0	422	960 min Summer	6.221	0.0	338.8	0.0	536	1440 min Summer	4.477	0.0	365.7	0.0	754	2160 min Summer	3.234	0.0	396.4	0.0	1108	2880 min Summer	2.579	0.0	421.5	0.0	1472	4320 min Summer	1.892	0.0	463.9	0.0	2204	5760 min Summer	1.531	0.0	500.5	0.0	2936	7200 min Summer	1.308	0.0	534.3	0.0	3672	8640 min Summer	1.155	0.0	566.1	0.0	4400	10080 min Summer	1.043	0.0	596.6	0.0	5088	15 min Winter	133.291	0.0	127.0	0.0	24	30 min Winter	87.861	0.0	167.5	0.0	37
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status																																																																																																																																																																																																																																																																																																																				
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30 min Summer	9.763	0.763	15.3	0.0	15.3	127.4	Flood Risk																																																																																																																																																																																																																																																																																																																				
60 min Summer	9.876	0.876	15.3	0.0	15.3	146.4	Flood Risk																																																																																																																																																																																																																																																																																																																				
120 min Summer	9.873	0.873	15.3	0.0	15.3	145.8	Flood Risk																																																																																																																																																																																																																																																																																																																				
180 min Summer	9.841	0.841	15.3	0.0	15.3	140.4	Flood Risk																																																																																																																																																																																																																																																																																																																				
240 min Summer	9.800	0.800	15.3	0.0	15.3	133.7	Flood Risk																																																																																																																																																																																																																																																																																																																				
360 min Summer	9.707	0.707	15.3	0.0	15.3	118.1	Flood Risk																																																																																																																																																																																																																																																																																																																				
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Delta-Simons		Page 4
Suite 4A Portland Street Manchester, M1 3BE	20-0008.01 Tarbock Green 1 in 100 + 40% CC	
Date 09/03/2019 File Proj100+40 1% runoff.SRCX	Designed by AB Checked by JR	
Innovyze Source Control 2019.1		

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 9.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	167.0	1.000	167.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0176-1530-1000-1530
Design Head (m)	1.000
Design Flow (l/s)	15.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	176
Invert Level (m)	8.995
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	15.3
Flush-Flo™	0.324	15.3
Kick-Flo®	0.704	12.9
Mean Flow over Head Range	-	13.0

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

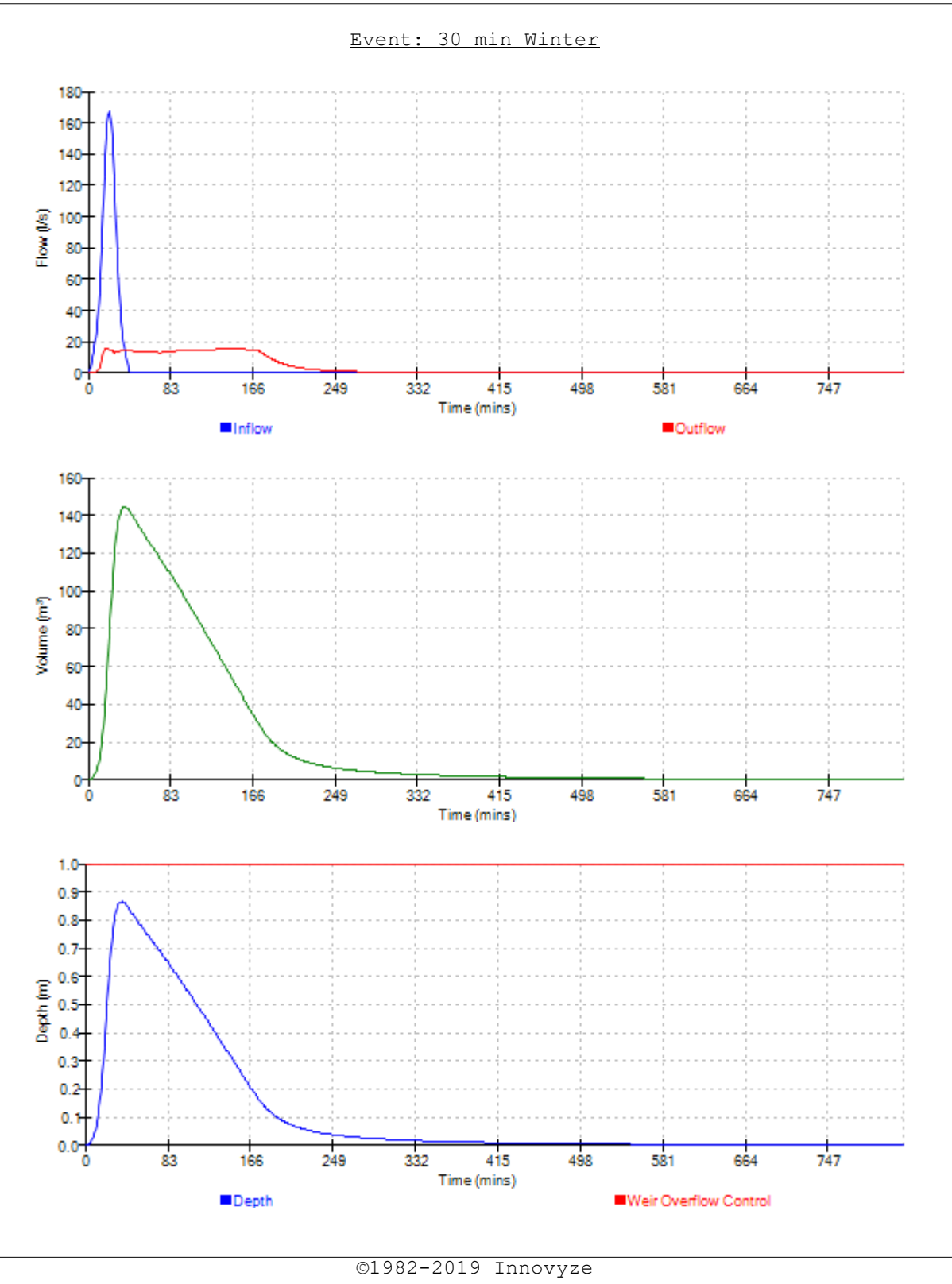
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.2	1.200	16.7	3.000	25.8	7.000	38.8
0.200	14.7	1.400	17.9	3.500	27.8	7.500	40.1
0.300	15.2	1.600	19.1	4.000	29.6	8.000	41.4
0.400	15.1	1.800	20.2	4.500	31.4	8.500	42.6
0.500	14.8	2.000	21.2	5.000	33.0	9.000	43.8
0.600	14.3	2.200	22.2	5.500	34.5	9.500	45.0
0.800	13.8	2.400	23.2	6.000	36.0		
1.000	15.3	2.600	24.1	6.500	37.5		

Weir Overflow Control

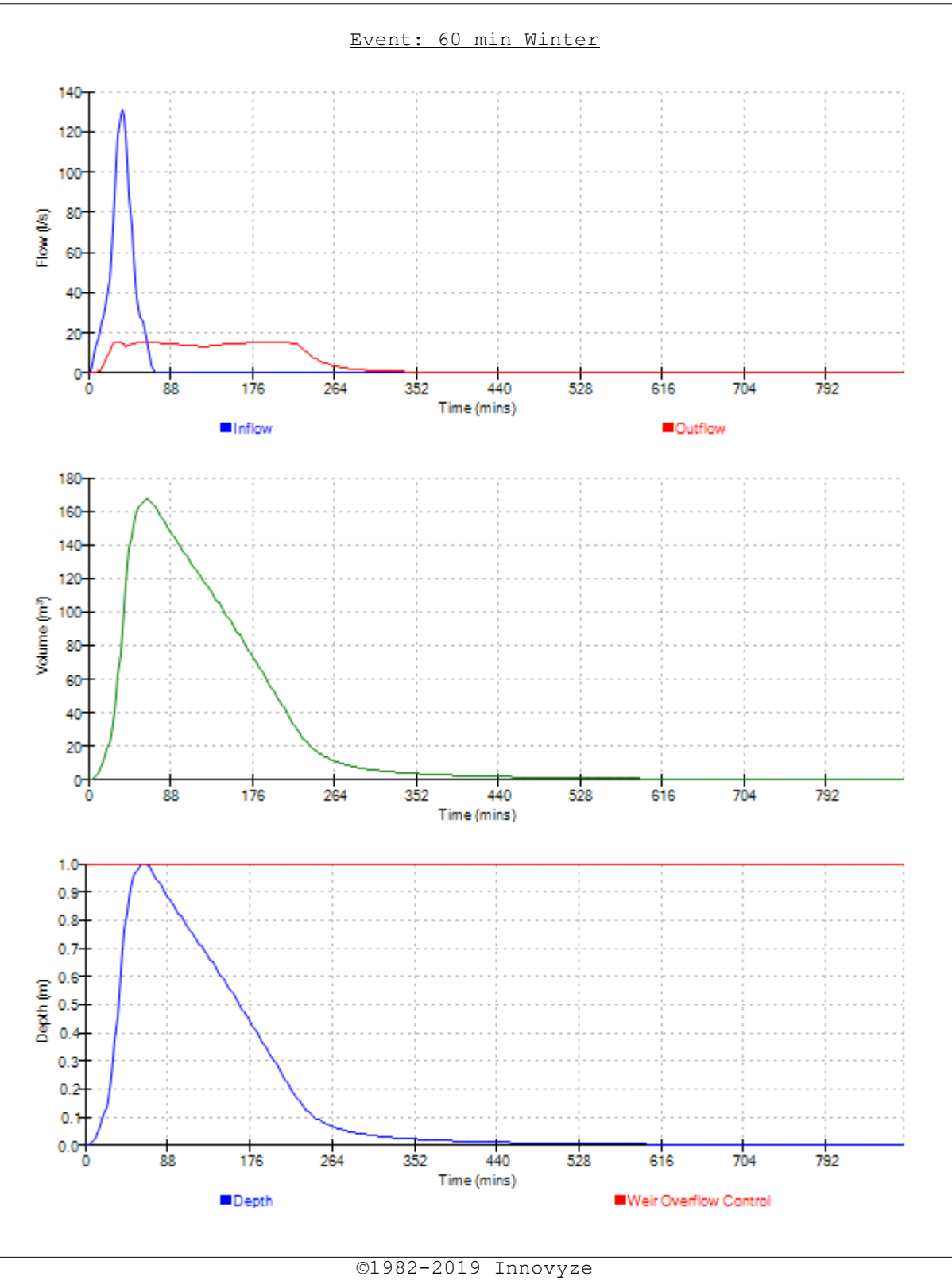
Discharge Coef 0.544 Width (m) 5.000 Invert Level (m) 10.000

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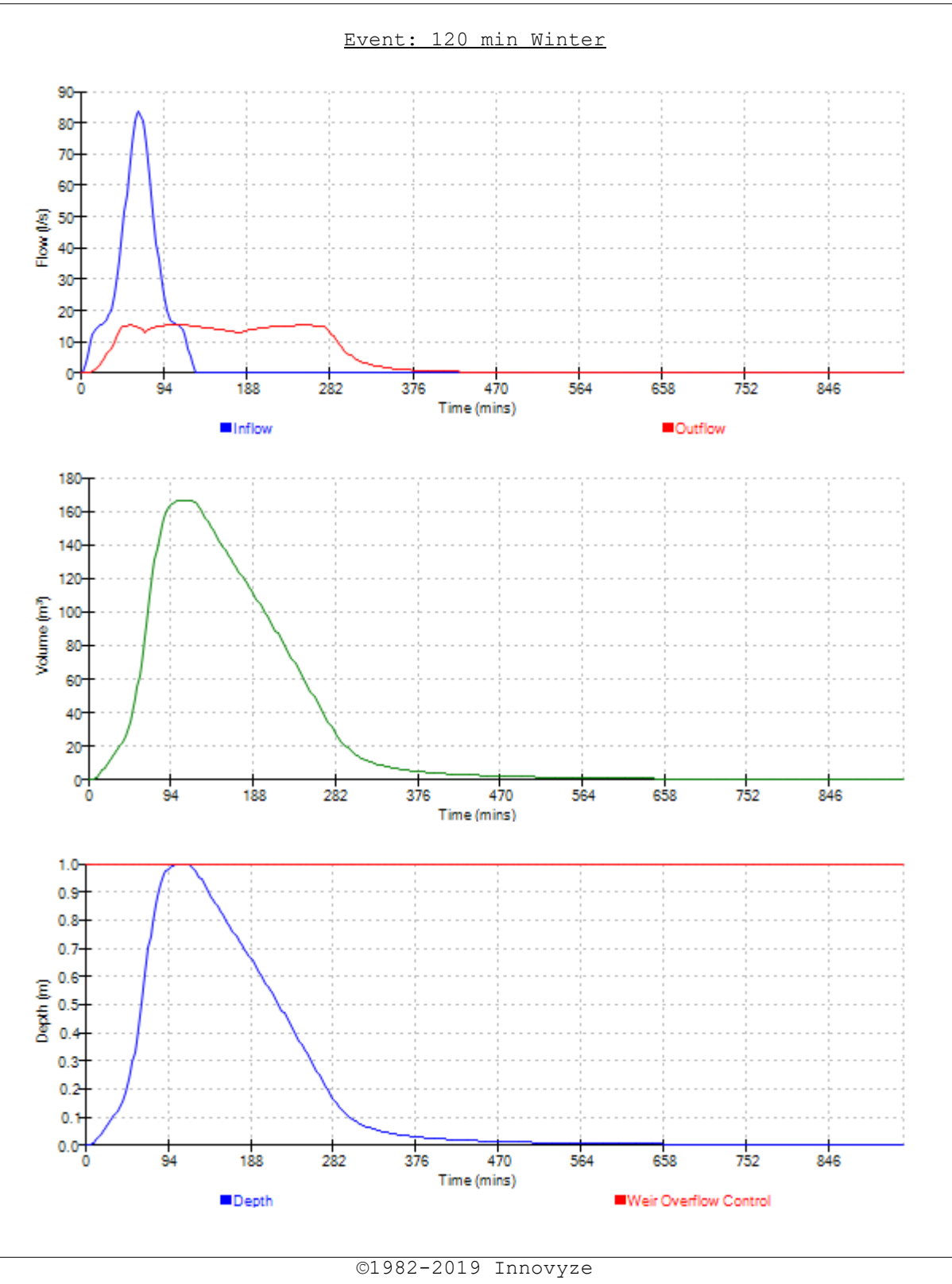
Delta-Simons		Page 5
Suite 4A	20-0008.01	
Portland Street	Tarbock Green	
Manchester, M1 3BE	1 in 100 + 40% CC	
Date 09/03/2019	Designed by AB	
File Proj100+40 1% runoff.SRCX	Checked by JR	
Innovyze	Source Control 2019.1	



Delta-Simons		Page 6
Suite 4A	20-0008.01	
Portland Street	Tarbock Green	
Manchester, M1 3BE	1 in 100 + 40% CC	
Date 09/03/2019	Designed by AB	
File Proj100+40 1% runoff.SRCX	Checked by JR	
Innovyze	Source Control 2019.1	



Delta-Simons		Page 7
Suite 4A	20-0008.01	
Portland Street	Tarbock Green	
Manchester, M1 3BE	1 in 100 + 40% CC	
Date 09/03/2019	Designed by AB	
File Proj100+40 1% runoff.SRCX	Checked by JR	
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Delta-Simons

Suite 4A
Portland Street
Manchester, M1 3BE

20-0008.01
Tarbock Green
1 in 100 yr + 40% CC

Date 09/03/2019
File Proj100+40.SRCX

Designed by AB
Checked by JR

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Source Control 2019.1

Page 1



Summary of Results for 100 year Return Period (+40%)							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.467	0.467	5.3	0.0	5.3	107.9	O K
30 min Summer	9.611	0.611	5.3	0.0	5.3	141.2	O K
60 min Summer	9.745	0.745	5.3	0.0	5.3	172.0	Flood Risk
120 min Summer	9.830	0.830	5.3	0.0	5.3	191.8	Flood Risk
180 min Summer	9.862	0.862	5.3	0.0	5.3	199.1	Flood Risk
240 min Summer	9.869	0.869	5.3	0.0	5.3	200.8	Flood Risk
360 min Summer	9.851	0.851	5.3	0.0	5.3	196.5	Flood Risk
480 min Summer	9.824	0.824	5.3	0.0	5.3	190.4	Flood Risk
600 min Summer	9.797	0.797	5.3	0.0	5.3	184.0	Flood Risk
720 min Summer	9.769	0.769	5.3	0.0	5.3	177.6	Flood Risk
960 min Summer	9.714	0.714	5.3	0.0	5.3	165.0	Flood Risk
1440 min Summer	9.602	0.602	5.3	0.0	5.3	139.1	O K
2160 min Summer	9.457	0.457	5.3	0.0	5.3	105.6	O K
2880 min Summer	9.349	0.349	5.3	0.0	5.3	80.7	O K
4320 min Summer	9.215	0.215	5.2	0.0	5.2	49.8	O K
5760 min Summer	9.149	0.149	4.9	0.0	4.9	34.5	O K
7200 min Summer	9.120	0.120	4.6	0.0	4.6	27.8	O K
8640 min Summer	9.107	0.107	4.2	0.0	4.2	24.6	O K
10080 min Summer	9.097	0.097	3.8	0.0	3.8	22.4	O K
15 min Winter	9.526	0.526	5.3	0.0	5.3	121.5	O K
30 min Winter	9.689	0.689	5.3	0.0	5.3	159.2	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	133.291	0.0	113.3	0.0	26		
30 min Summer	87.861	0.0	149.3	0.0	40		
60 min Summer	54.883	0.0	186.8	0.0	68		
120 min Summer	32.411	0.0	220.6	0.0	126		
180 min Summer	23.735	0.0	242.3	0.0	184		
240 min Summer	18.979	0.0	258.4	0.0	242		
360 min Summer	13.773	0.0	281.3	0.0	324		
480 min Summer	10.930	0.0	297.6	0.0	386		
600 min Summer	9.124	0.0	310.5	0.0	448		
720 min Summer	7.866	0.0	321.3	0.0	516		
960 min Summer	6.221	0.0	338.8	0.0	654		
1440 min Summer	4.477	0.0	365.7	0.0	924		
2160 min Summer	3.234	0.0	396.3	0.0	1296		
2880 min Summer	2.579	0.0	421.4	0.0	1648		
4320 min Summer	1.892	0.0	463.8	0.0	2336		
5760 min Summer	1.531	0.0	500.5	0.0	3000		
7200 min Summer	1.308	0.0	534.3	0.0	3680		
8640 min Summer	1.155	0.0	566.1	0.0	4408		
10080 min Summer	1.043	0.0	596.5	0.0	5144		
15 min Winter	133.291	0.0	126.9	0.0	26		
30 min Winter	87.861	0.0	167.1	0.0	40		

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Delta-Simons		Page 4
Suite 4A Portland Street Manchester, M1 3BE	20-0008.01 Tarbock Green 1 in 100 yr + 40% CC	
Date 09/03/2019 File Proj100+40.SRCX	Designed by AB Checked by JR	
Innovyze Source Control 2019.1		

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 9.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	231.0	1.000	231.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-5300-1000-5300
Design Head (m)	1.000
Design Flow (l/s)	5.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	8.995
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.3
Flush-Flo™	0.295	5.3
Kick-Flo®	0.641	4.3
Mean Flow over Head Range	-	4.6

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

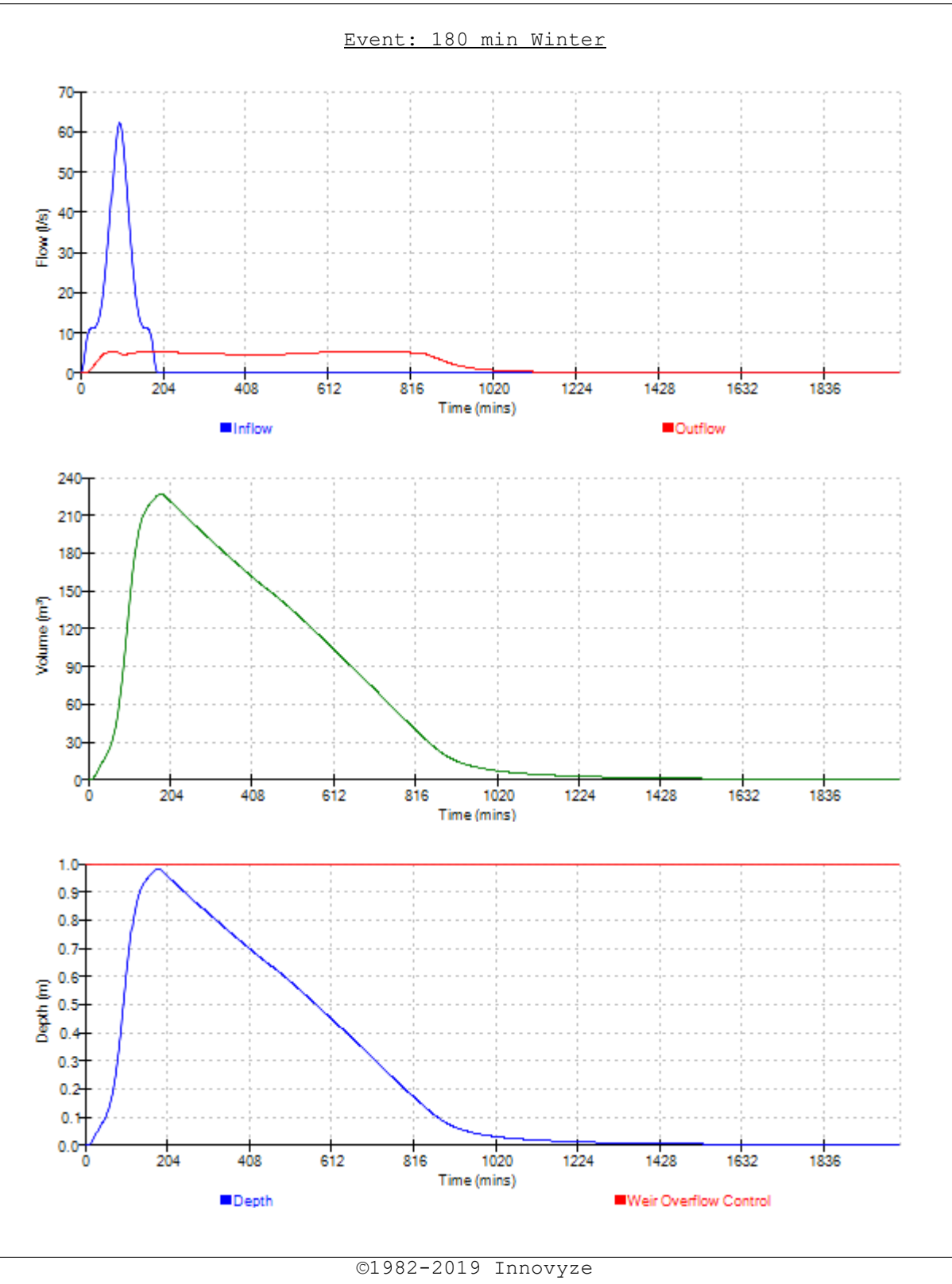
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	5.8	3.000	8.9	7.000	13.3
0.200	5.2	1.400	6.2	3.500	9.5	7.500	13.7
0.300	5.3	1.600	6.6	4.000	10.2	8.000	14.1
0.400	5.2	1.800	7.0	4.500	10.7	8.500	14.6
0.500	5.0	2.000	7.3	5.000	11.3	9.000	15.0
0.600	4.6	2.200	7.7	5.500	11.8	9.500	15.4
0.800	4.8	2.400	8.0	6.000	12.3		
1.000	5.3	2.600	8.3	6.500	12.8		

Weir Overflow Control

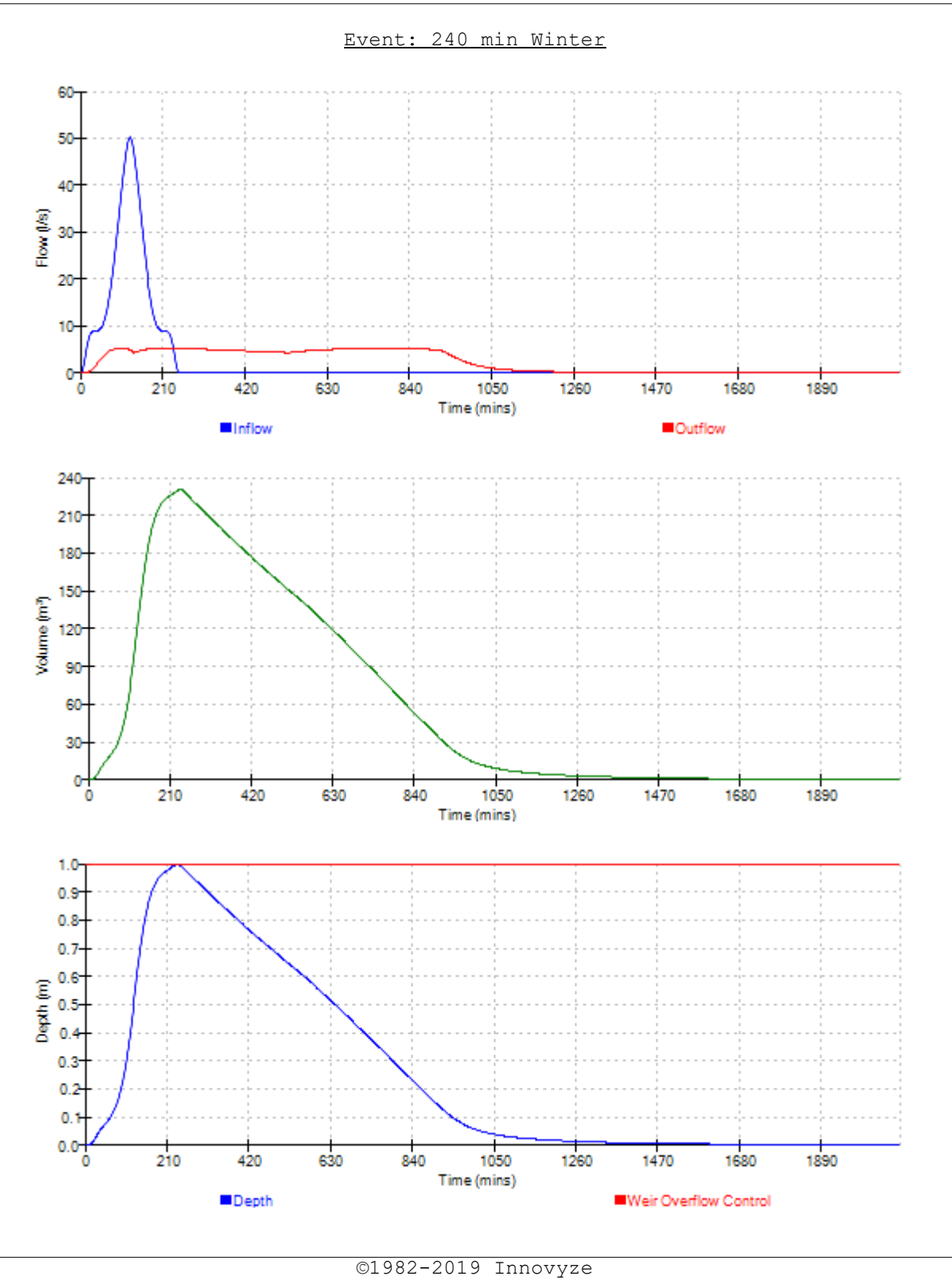
Discharge Coef 0.544 Width (m) 5.000 Invert Level (m) 10.000

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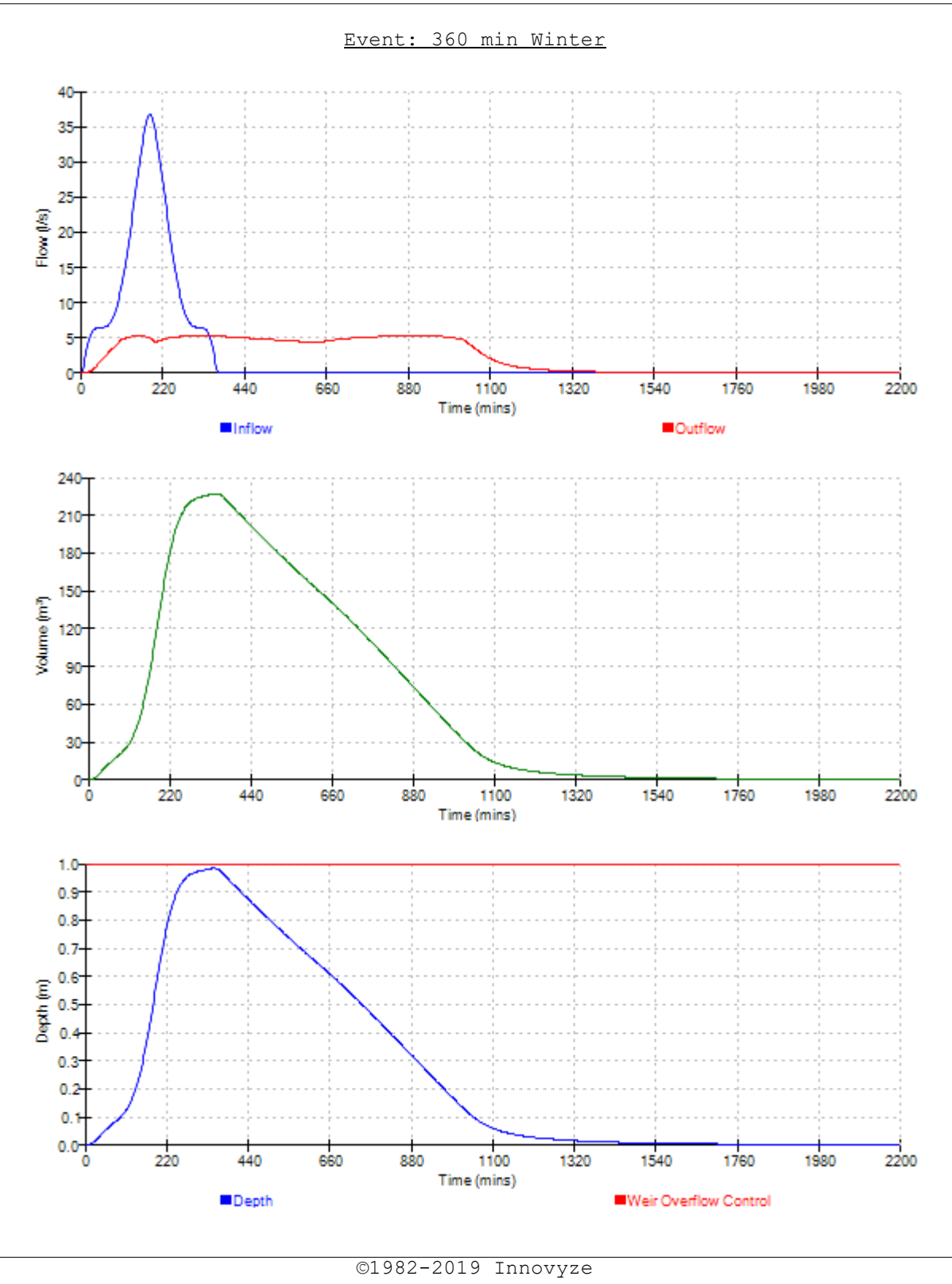
Delta-Simons		Page 5
Suite 4A Portland Street Manchester, M1 3BE	20-0008.01 Tarbock Green 1 in 100 yr + 40% CC	
Date 09/03/2019 File Proj100+40.SRCX	Designed by AB Checked by JR	
Innovyze	Source Control 2019.1	



Delta-Simons		Page 6
Suite 4A Portland Street Manchester, M1 3BE	20-0008.01 Tarbock Green 1 in 100 yr + 40% CC	
Date 09/03/2019 File Proj100+40.SRCX	Designed by AB Checked by JR	
Innovyze	Source Control 2019.1	



Delta-Simons		Page 7
Suite 4A Portland Street Manchester, M1 3BE	20-0008.01 Tarbock Green 1 in 100 yr + 40% CC	
Date 09/03/2019 File Proj100+40.SRCX	Designed by AB Checked by JR	
Innovyze	Source Control 2019.1	



Appendix H – Concept Drainage Sketch



Site Plan Provided by Client

Appendix I – SuDs Maintenance Schedule

Permeable Paving Maintenance Schedule

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on Site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional Maintenance	Stabilise and move contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level or the paving	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Inspect for evidence of poor operation and / or weed growth – if required, take remedial action	Three-monthly, 48hr after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Ref. Table 20.15, CIRIA C753 'The SuDS Manual'

Attenuation Storage Tank Maintenance Schedule

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Ref. Table 21.3, CIRIA C753 'The SuDS Manual