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Ysbyty Glan Clwyd: Nuclear Medicine Consolidation

Sustainable Drainage Statement

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Ysbyty Glan Clwyd: Nuclear Medicine Consolidation

Sustainable Drainage Statement

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Prepared by	**G Smith**
Description	**Report outlining the below ground drainage strategy for the development**
Status	**S2 – Suitable for Information**

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Revision	Date	Prepared By	Checked By	Approved By	Description
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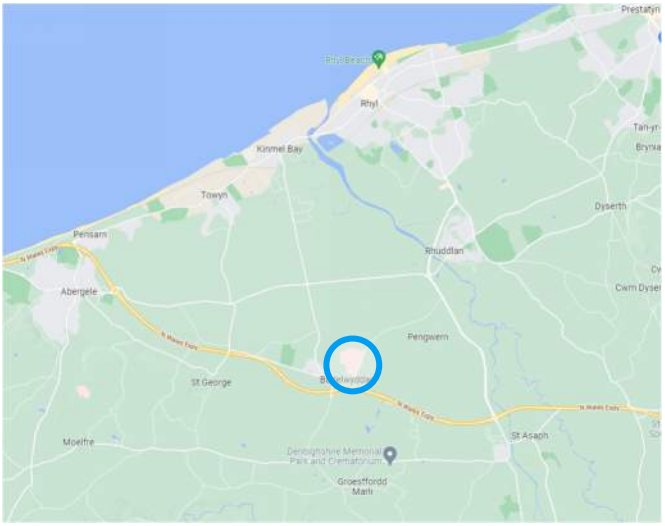
1. Introduction

Ramboll UK Ltd has been appointed to undertake a Drainage Strategy to support an outline planning application for the development of a new patient treatment facility within the existing Ysbyty Glan Clwyd campus, Rhuddlan Road, Bodelwyddan, Rhyl, Denbighshire, LL18 5UJ. Centred at the approximate National Grid Reference; *SJ 00250 75930*.

The Nuclear Medicine Consolidation (NMC) project is proposed to be constructed adjacent to the existing A&E and Radiology departments and comprise several consultation rooms and imaging cameras, associated plant rooms and external hardstanding.



National Grid Reference
SJ 00250 75930

X Co-ordinates
300250
Y Co-ordinates
375930

WhatThreeWords:
///
necklaces.placed.freezing

Figure 1.1: Site Location [1]

Figure 1.2: Proposed Development Area

[1] *Imagery taken from Google Earth, ©2023 Google*

2. Scope and Objectives

This Drainage Strategy report should be read in conjunction with all other planning documents.

The specific objectives of this assessment are to establish the following:

- Existing drainage systems on the Application Site
- Proposals for collection, treatment, and discharge of surface water from the Application Site
- Proposals for collection and discharge of foul water from the Application Site.

3. Limitations

This report has been prepared for the outline planning application and shall not be relied upon by any third party unless that party has been granted a contractual right to rely on this report for the purpose for which it was prepared.

The findings and opinions in the report are based upon information derived from a variety of information sources. Ramboll believes these information sources to be reliable and where possible has tried to verify the information.

This report has been prepared on the basis of the proposed end use defined by the Client at the time of writing. If this proposed end use or duration is altered, then it will be necessary to review the findings of this report.

It should be noted that some of the aspects considered in this study are subject to change with time. Therefore, if the development is delayed or postponed for a significant period then it should be reviewed to confirm that no changes have taken place, either at the Application Site or within relevant legislation.

4. Legislation and Design Guidance

4.1 Planning Policy

Planning Policy Wales (PPW) Edition 11 February 2021 sets out the land use polices of the Welsh Government, Section 6.6 specifically is in relation to Water and Flood Risk and is supplemented by a series of Technical Advice Notes (TANs), Welsh Government Circulars, and policy clarification letters, which together with PPW provide the national planning policy framework for Wales.

Section 6.6.17 of PPW states that all new developments of more than one dwelling or where the area exceeds more than 100m^2 requires, alongside the planning process, approval from the SuDS Approval Body (SAB) before construction can commence.

The provision of SuDS must be considered as an integral part of the design of the new development and considered at the earliest possible stage when formulating the new proposals. The development proposals should incorporate the design for surface water management, based on principles which work with nature to facilitate the natural functioning of the water cycle. Designing for multiple benefits and green infrastructure should be secured wherever possible.

4.2 Technical Advice Note 15

TAN 15: Development and Flood Risk (2004) should be referred to for policy advice on development and flood risk. However, an updated version of TAN 15 was released as Draft in 2021 but the rollout was subsequently paused pending a review and strengthening period being undertaken by the local authorities and Welsh Government.

TAN 15 reinforces planning policy with Section 8.10 mirroring that of PPW with regard to SAB requirements and interface with the planning process.

Along with the Revised TAN 15 policy, changes have also been made to the maps used to identify flood risk to a site. Historically, Development Advice Maps (DAMs) were used. For future developments, it is understood that these will no longer be updated and instead will be replaced by Natural Resources Wales (NRWs) Flood Maps for Planning (FMfP).

This report will look to address items raised in the 2004 and 2021 draft version.

4.3 Statutory Standards for Sustainable Drainage Systems

The Welsh National Statutory Standards for SuDS outline several key standards that must be implemented for all new developments. The standards are split into 6no. categories and all developments over 100m^2 must demonstrate compliance with the following standards. These standards are then reviewed by the SAB prior to granting approval for construction to commence.

- S1: Surface Water Run-off Destination
- S2: Surface Water Run-off Hydraulic Control
- S3: Water Quality
- S4: Amenity
- S5: Biodiversity
- S6: Design of Drainage for Construction, Operation and Maintenance

4.4 Strategic Flood Consequence Assessment

The Denbighshire Level 1 Flood Consequence Assessment (January 2018) discusses the risk of flooding that is likely to occur throughout Denbighshire from various sources. The report also discusses likely implications on sea levels due to climate change.

4.5 Climate Change

Regarding potential increases to predicted rainfall intensities over the design life of the building, the following Welsh Government guidance has been used to establish the design parameters.

Flood Consequence Assessments: Climate Change Allowances; September 2021. [2]

Table 2 - Change to extreme rainfall intensity (compared to a 1961-90 baseline)

Applies across all of Wales	Total potential change anticipated for 2020s (2015-2039)	Total potential change anticipated for 2050s (2040-2069)	Total potential change anticipated for 2080s (2070-2115)
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

Figure 4.1: Extract from Welsh Government Climate Change Allowances

[2] https://www.gov.wales/climate-change-allowances-and-flood-consequence-assessments [Last Accessed 01/09/2023]

The proposed design life for the development shall be a minimum of **50 years**. As such, using the upper estimate, an increase to rainfall intensity of **+40%** shall be applied to the M100-year annual exceedance probability storms.

Following pre-development consultation with the Lead Local Flood Authority (LLFA), they requested that the project considers +30% increase to rainfall intensity and an additional +10% allowance for Urban Creep.

Due to the high percentage of impermeable areas already accounted for within the scheme, limited potential for future landscape alterations, etc. no further allowance shall be made for urban creep within the surface design and therefore a single value of **+40%** increase shall be applied to the M100 year return period storms.

4.6 Welsh Health Technical Memoranda (WHTMs)

The National Health Service (NHS) in Wales have produced a series of design guides for existing and new developments/estates. They set out a minimum service provision regarding all aspects of the design and management of health sites as well as limitations or elements not suitable for inclusion within the design.

4.7 BREEAM, New Construction 2018

The requirements of Credit POL 03 under BREEAM accreditation, requires developments to meet certain criteria under 3no. separate headings:

- Flood Resilience
- Surface Water Runoff
- Minimising Watercourse Pollution

One of the primary constraints applied is that brownfield sites should be restricted provide a minimum 30% betterment to predevelopment flows and should, where practicable, be limited to the 1 in 1 year pre-development rate to reduce effects of run-off volumes.

4.8 Lead Local Flood Authority Requirements

Further to the allowances for Climate Change as discussed in Section 4.5, the LLFA also advised that FSR or FEH rainfall data can be used design the surface water drainage network.

Discharge should, where possible, be restricted to greenfield rates or where not possible, as low as reasonably practicable to minimise downstream flood risk.

Refer to Appendix 1 for details of consultation undertaken to date.

5. Site Description

5.1 Existing Site Overview

The site is bisected by an ordinary watercourse, flowing in a West-East direction before being conveyed in a pipe below the adjacent cardiac centre to the East. The watercourse is understood to be under Local Flood Authority ownership with the NHS Trust having riparian ownership rights and responsibilities.

The area to the north of the watercourse comprises primarily impermeable hardstanding that was formerly car-parking. More recently it has been used as a compound for the construction of surrounding buildings. Several temporary buildings occupy the site.

To the south is the bank of the watercourse, trees and vegetation and immediately bound by impermeable car-parking serving the wider hospital.

On the western boundary of the site there is a gabion retaining wall, beyond which at a lower level, there is parking for the accident and emergency department vehicles. This area was constructed in 2013. North of the site there is the existing imaging / radiology unit which was extended in 2015. To the east there is the cardiac centre which was built in 2013.

Refer to Appendix 2 for existing site layouts.

5.2 Existing Topography

The overall ground levels of Ysbyty Glan Clwyd typically lie between 7.50-11.00 mAOD, with a nominal fall South to North. The proposed development boundary lies generally between 9.90-11.00 mAOD and typically follows the same direction of fall.

The watercourse invert level is approximately 8.53 mAOD prior to entering the existing piped culvert in the East.

As noted above, there is a gabion basket retaining wall on the north-western boundary with the A&E department, where levels change from 11.0 m down to 9.9 m in the emergency vehicle parking area.

A copy of the topographical survey can be found within Appendix 2.

5.3 Flood Risk

Please refer to supplementary Flood Consequence Assessment (FCA) – *NMC-RAM-XX-XX-RP-C-07001* for a review of all flood risk to the site.

The site is located entirely within TAN15 Zone A (Flood Zone 1) with an overall risk of flooding considered to be low and therefore no further assessment is deemed necessary for the proposed development.

The proposed drainage system and external levels shall be designed to ensure water is routed away from the building, pipes achieve self-cleansing velocities, don't surcharge during M2-year storms, and do not flood during all storms up to and including M100-year + Climate Change.

Attenuation shall be provided and a suitably low pass forward flow rate incorporated into the scheme to reduce the impact on downstream receptors.

5.4 Existing Storm Water Drainage

The watercourse discharges into a DN225/300 pipe, increasing to DN525 immediately downstream of the headwall. The drain then flows Easterly beneath the North Wales Cardiac Centre and connects into the site wide storm infrastructure. From here it flows north through the main visitor carparks via a private DN900 drain before connecting into a water with Main River classification – Sarn Cut – approximately 360 m Northeast of the proposed NMC development.

The northern area of the site compound was historically a surface carpark served by a series of gullies and channels. More recently it was used as a contractor's compound. The adjacent roofs drain via rainwater pipes (RWPs) and connect into a DN150 carrier drain running beneath the existing buildings. The current carpark to the south is also drained via gullies and routed to the DN525 carrier drain for discharge into Sarn Cut.

An existing petrol interceptor has been identified within the proposed service yard/carpark. Archive drawings and utilities surveys indicate that this interceptor outfalls into the nearby existing surface water system, however the upstream catchment and connectivity is not yet known.

Further survey works may be required to confirm any upstream connectivity. Should the unit be confirmed to be redundant in the final scheme, it should be fully removed, and the ground reinstated to allow installation of the proposed drainage system.

5.5 Existing Foul Water Drainage

There are no known public sewers located within the Ysbyty Glan Clwyd Hospital Campus. The foul water from the site is understood to converge on site in a private pump station before being discharged into a Dwr Cymru Welsh Water (DCWW) network to the west of the site.

There are several existing private foul drainage networks within the vicinity of the proposed development, however it is not known what flow currently passes through each system and therefore the residual capacity of the network is unknown.

A CCTV survey has been undertaken and the results are to be reviewed in conjunction with additional topographical and utilities surveys. A summary of the findings and any proposed remedial works shall be identified during the next stage.

Details of the capacity, condition and construction of the existing on-site private pump station is not currently known. It is assumed that the Client will undertake an assessment of this critical infrastructure to assist with the detailed design of Nuclear Medicine, and any future projects within Ysbyty Glan Clwyd.

6. Proposed Development

6.1 Proposed Site Overview

The proposed nuclear medicine building will, at ground floor level, include two gamma cameras and a PET CT camera as well as associated ancillary spaces that include treatment areas, offices, and a reception. Plant will be located at first floor level, with part of this being within an enclosed plant room and part being in an open plant enclosure with a louvered plant screen. There will be minimal external works to the building, primarily service drop off and tie-ins back to the existing hospital estate.

The building will be situated towards the south of the hospital campus, adjacent to the existing Accident & Emergency and Radiology departments. Proximity to the existing hospital building is critical for the operation of the unit and transfer of patients between facilities. As such it is proposed that the existing watercourse will require building over or diverting to allow the facility to be erected in this location.

A finished floor level (FFL) of 10.850 mAOD has currently been proposed to allow the building to tie into existing thresholds and limit the requirement for large retaining walls/ramps. The current design approach shall be to culvert the watercourse beneath the proposed structure.

A separate study is being undertaken regarding the feasibility of different options pertaining to this watercourse and proximity to the proposed development (i.e. building over). This study is being undertaken with consultation with the LLFA.

6.2 Proposed Surface Water Drainage

Regarding Sustainable Urban Drainage Systems (SuDS), the design will be developed in line with the SuDS Approval Body's (SAB) requirements and Welsh Government policy. The design will need to address each of the 6 no. standards for sustainable drainage – including water quantity (flow and volume), water quality, amenity, biodiversity and construction, operation & maintenance.

The inclusion of SuDS shall be reviewed in detail at the next stage in conjunction with existing services, ground investigation results, topography and proposed site layouts.

In line with current legislation and planning requirements, the proposed development will need to restrict surface water flows to as close to greenfield rates as possible. Due the small site area, equivalent greenfield rates are low (i.e. QBAR = c. 1.3 l/s).

Restricting run-off to particularly low flow rates can often lead to very small orifice diameters. These in turn are more susceptible to blockage and therefore increase the flood risk to the site. As such, a minimum flow rate of 5 l/s is usually targeted – subject to agreement from the LLFA/SAB.

As with the foul/radioactive network, there will be a requirement to provide two separate surface water systems to fit around the dissecting watercourse. Each system will therefore have its own attenuation structure and flow control unit. The split of the discharge and attenuation volumes will be confirmed during detailed design and will consider run-off from the roof and hardstanding areas.

At this stage, an allowance should be made for approximately ***120-190m³*** of storage, based on a total discharge rate of ***5 l/s*** into the existing system. This shall primarily be provided using underground tanks due to limited space for surface SuDS features.

Restricting the surface water flows to greenfield rates will also result in an improvement on the pre-development scenario for which there is no known attenuation or flow restriction currently in place. This will therefore increase the capacity within the existing network and reduce the burden on the system during larger storms.

It is anticipated that there will be limited opportunity for infiltration to occur on site due to proximity to roads, buildings, retaining walls and critical services, and discharge of radioactive wastewater. However, there may be the potential to include areas of pervious surfacing, particularly surrounding new car-parking provisions.

In general, the risk of pollution will be limited on site owing to the small carparking numbers and minimal service yard activities. The pollution risk shall be reviewed in line with the Simple Index Approach as outlined in the CIRIA SuDS Manual C753 at the next stage. Any additional pollution mitigation will subsequently be included in the design.

Initial discussions were held with the Local Flood Authority regarding key design parameters. It is recommended that a pre-development application with the SAB shall be undertaken to outline and confirm the drainage strategy.

There will be a requirement for a full SAB application to be submitted prior to commencement of work on site. Further details of the documentation requirements shall be discussed at the next stage.

Refer to Appendix 3 for details of the proposed surface water drainage strategy.

Refer to Appendix 4 for preliminary attenuation calculations.

6.3 Proposed Foul Water Drainage

6.3.1 Strategy

The proposed development shall produce small quantities of 'domestic' wastewater arising from staff and patient WCs, etc. However, the majority of wastewater shall arise from the clinical part of the building, for which a specialist drainage system is required.

As part of the specialist clinical use for the building, there will be a requirement to discharge small doses of liquid radioactive waste into the underground drainage network. This shall predominately be through the use of WCs and hand basins designated for patients who have been administered radioactive isotopes as part of their treatment. This wastewater shall hereby be referred to as 'hot' wastewater.

A radiation specialist has been appointed and subsequently consulted by Ramboll regarding any specialist measures that may affect the civil and structural engineering disciplines. Including specialist pipework, lockable and sealed manholes, review of existing trade effluent licences, etc.

A gravity connection into the existing site wide network is currently assumed to be viable, pending final setting of proposed building finished floor levels (FFLs). Should the building FFL be

lowered, it may be necessary to install a wastewater lifting station, however this will be avoided where possible.

For the purpose of this design, it has been assumed that the foul pumping station has enough residual capacity to accommodate the flows from the proposed building without increasing pass forward flow rate into the DCWW public sewer. This shall be confirmed by the client/site team at the next stage.

Refer to Appendix 3 for details of the proposed foul water drainage strategy.

6.3.2 Flow Rates

Daily flow volumes or peak and average flow rates are not yet known – pending confirmation of final building occupancy/treatment numbers and quantity of water discharging appliances that will be incorporated into the building (i.e. basins, WCs, floor gullies, etc.).

However, estimating the number of appliances, it is possible to check the required pipe sizing and therefore suitability of the proposed connection points into the existing network.

In accordance with BS EN 12056-2, System III design and using the architectural ground floor plan, it is possible to estimate the number of appliances that may be present. Note this is indicative and subject to further design review at the next stage.

- WCs: 7 no. (x 1.5DU)
- Wash hand Basins (WHBs): 24 no. (x 0.3DU)
- Cleaners/Kitchen Sinks: 3 no. (x 1.3DU)
- Drench Shower: 1no. (x 2.0 DU)*
- Floor Gullies: 4no. (x 1.2DU)

**tbc pending drench shower flow rates*

Using a frequency factor (K) of 1.0 (congested use), the peak wastewater flows may be in the region of:

$$Q_{ww} = K\sqrt{\sum DU}$$

$$Q_{ww} = 1.0\sqrt{\sum 28.4\ DU}$$

$$\boldsymbol{Q_{ww} = 5.3\ l/s}$$

Whilst the above flow is indicative, it would typically fall within the capacity of a DN150 gravity drain. The average flow rate through the system is likely to be lower than this figure and will vary throughout the day.

Due to the presence of the watercourse running through the site, the wastewater flows will be split between two separate outfalls (North and South). As such the flows entering any single existing drainage run will therefore be less than the overall loading and will help to reduce the impact to any existing capacity in the sewer network.

Dwr Cymru Welsh Water (DCWW) and Natural Resources Wales (NRW) shall be consulted with regard to the discharge destination and flow rates of the domestic foul and 'hot' wastewater.

[end of main body of report]

Appendix 1
Consultation

Gavin Smith

From: Alex Bebbington <alex.bebbington@denbighshire.gov.uk>
Sent: 23 February 2023 11:59
To: Gavin Smith
Cc: Daniel Jones
Subject: RE: Pre-development Advice - Ysbyty Glan Clwyd: NMC

Hi Gavin,

Just to confirm.

The watercourse would be classified as an 'ordinary watercourse', and therefore in our position as the **Land Drainage Authority**, works to it would most likely need consent under the Land Drainage Act section 23.

The hospital/health board/landowner would be classed as the '***riparian landowner'*** and would have responsibilities such as to ensure flow isn't impeded.

An ordinary watercourse consent application can be found here;
https://www.denbighshire.gov.uk/en/documents/planning-and-building-regulations/planning/ordinary-watercourse-consent-application-form.pdf

Hope that clarifies matters.

With kind regards,
Alex

From: Daniel Jones
Sent: 23 February 2023 11:37
To: Gavin Smith <Gavin.Smith@ramboll.co.uk>
Cc: Land Drainage Consultations <landdrainage.consultations@denbighshire.gov.uk>; Alex Bebbington <alex.bebbington@denbighshire.gov.uk>
Subject: RE: Pre-development Advice - Ysbyty Glan Clwyd: NMC

Good Afternoon Gavin,

- What rainfall methodology is accepted/preferred – FSR or FEH 2013/22?
  Both are accepted.
- Rainfall intensity increase due to climate change to be +40%
  30% CC + 10% Urban Creep.
- What the required betterment would be to pre-development surface water flows?
  Can these be calculated using a % betterment for the brownfield area and then greenfield rates for the remaining area.
  We would expect discharge flows to be restricted to the greenfield runoff rate, if this cannot be achieved we will require evidence. Flows must be restricted to as low as practicably possible.
- Would the site require a SAB pre-app and full application being submitted
  Optional, however, we currently do not charge a fee for pre-applications.
- Any other limitations/requirements that may be applicable
  Nothing stands out at this stage.

My colleague, Alex Bebbington (copied in), will be in touch regarding the ownership of the ditch and whether any works to or around the ditch will require ordinary watercourse consent.

Kind regards,

Daniel Jones BSc (Hons)
Swyddog Perygl Llifogydd / Flood Risk Officer
Cyngor Sir Ddinbych / Denbighshire County Council
Priffyrdd a Gwasanaethau Amgylcheddol / Highways & Environmental Services
Ffon/Phone: 01824 706822 / 07824 409601
Gwefan/Website: www.sirddinbych.gov.uk / www.denbighshire.gov.uk

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From: Gavin Smith [mailto:Gavin.Smith@ramboll.co.uk]
Sent: 21 February 2023 12:17
To: Land Drainage Consultations <landdrainage.consultations@denbighshire.gov.uk>
Subject: Pre-development Advice - Ysbyty Glan Clwyd: NMC

Good Afternoon

We are currently looking into the feasibility of a new medical building to be located within the Ysbyty Glan Clwyd hospital campus, near to the existing A&E entrance. As part to the site planning phase, we are seeking some initial advice from yourselves before we develop a strategy and submit SAB pre-app, etc.

The proposed site is dissected by a surface water ditch that we understand to discharge into a private surface water drain on site. The drain then runs through the hospital site, before discharging into Sarn Cut to the Northeast. The ditch is not shown on the NRW Main River map, and we understand that this would therefore likely

be classified as an ordinary watercourse. However, we are unclear as to if this is under private ownership (i.e. by the NHS Trust) or if this is under the jurisdiction of the LLFA.

Our understanding is that the ditch collects run-off from the on-site private roads and further survey work is being planned to confirm this and the ditch dimensions. Part of the ditch is already culverted beneath access roads, etc. and there may be works required to potentially culvert, divert or even build-over this as part of the new development. Further details/consultation will be undertaken in due course.

In the meantime, please can you advise if this ditch is indeed private, or if it falls within LLFA ownership. If the latter, would any works to or around the ditch require Ordinary Watercourse Consent?

Figure 1: Extract showing Main Rivers to West and Northeast, with site/ditch highlighted

Taken from NRW Online Maps

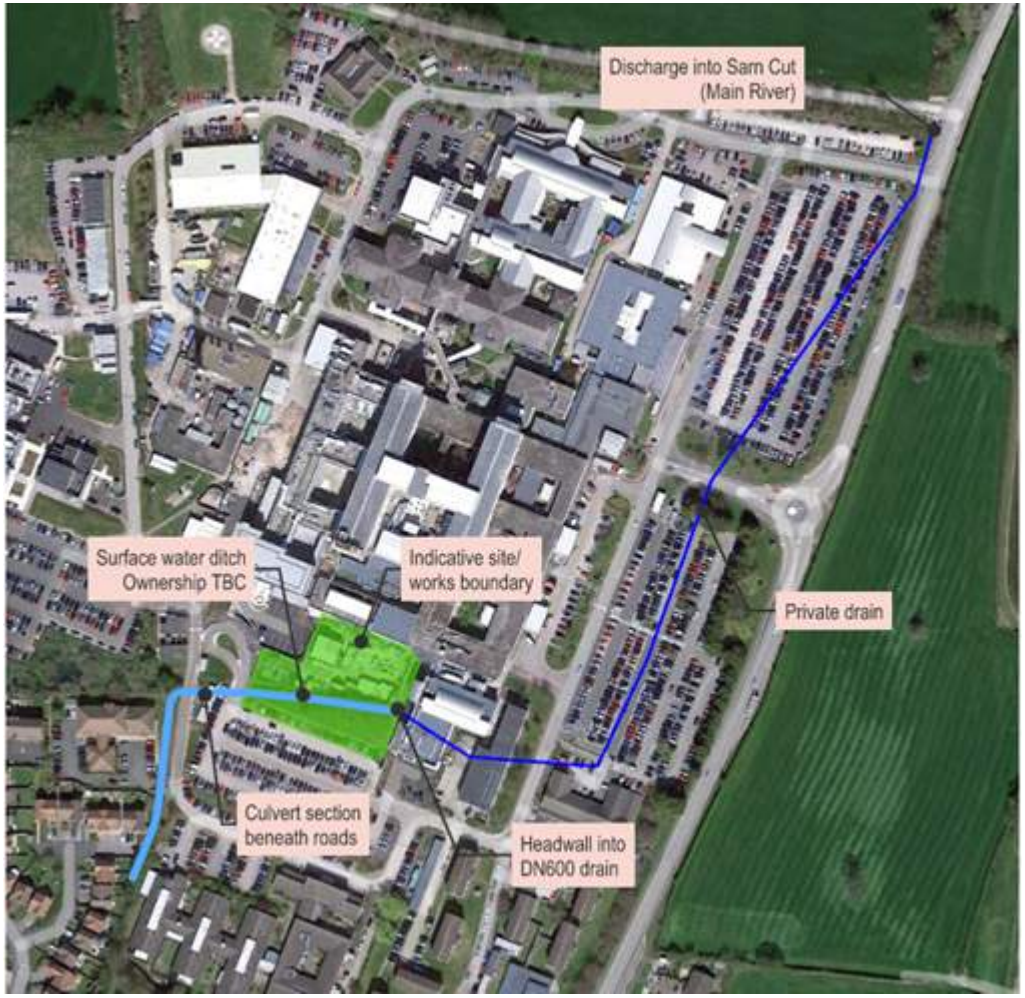

Figure 2: Extract showing approximate route of ditch and SW drain through site in relation to site boundary

Taken from Google Earth

In terms of future design parameters for the new development, please could you also confirm the following items?

- What rainfall methodology is accepted/preferred – FSR or FEH 2013/22?
- Rainfall intensity increase due to climate change to be +40%
- What the required betterment would be to pre-development surface water flows?
  Can these be calculated using a % betterment for the brownfield area and then greenfield rates for the remaining area.

- Would the site require a SAB pre-app and full application being submitted
- Any other limitations/requirements that may be applicable

We will consult with NRW and DCWW regarding the discharge of SW and FW flows into the respective networks.

Many thanks in advance. Should you have any questions please don't hesitate to contact me.

Kind regards
Gavin Smith

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1622362 - Infrastructure

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Classification: Confidential

named above and do not necessarily represent the views of Denbighshire County Council. However, as a Public Body, Denbighshire County Council may be required to disclose this e-mail [or any response to it] under legislative provisions.

Appendix 2
Existing Site Layouts

N
PLAN GRID NORTH

File Name: Layerserv0001771_U.dwg

NOTES:

All levels relate to OS (Newyln) Datum, Established using Network RTK. Survey plotted on a plane Local Grid, Orientated to National Grid.

Services shown as "From Statutory Authority Plans" line styles are taken from Statutory Records plans supplied by the relevant regional authority. These services were not located and are shown for indicative purposes only.

Please note survey control established for mapping only. Control shouldn't be used by third parties without confirmation from Layer Surveys.

Tree Spreads are symbolic only and are representative of the average spread.

Only manholes and services visible at time of survey shown. Drainage information must be checked and verified with local authority records prior to work commencing.
Please note all drainage information and chamber position have be taken from CCTV condition survey.

Supplied drawing from client added to background.

LEGEND:

AV	AIR VALVE	PP	PETROL PUMP
BT	BT INSPECTION COVER	RE	RODDING EYE
CB	CONTROL BOX	RWP	RAINWATER PIPE
CCTV	CCTV CAMERA POST	SOF	SOFFIT LEVEL
COM	COMMUNICATIONS COVER	SV	STOP VALVE
CTV	CABLE TV COVER	TCB	TELEPHONE CALL BOX
DC	DRAINAGE CHANNEL	TL	TRAFFIC LIGHT
DP	DOWN PIPE	TLB	TRAFFIC LIGHT BOX
DR	DRAIN	TP	TELEGRAPH POLE
EIC	ELEC INSPECTION COVER	WM	WATER METER
ELB	ELECTRIC BOX	WO	WATER OUTLET
ER	EARTH ROD	WST	WATER STOP TAP
EP	ELECTRICITY POLE	WSV	WATER STOP VALVE
FFL	FINISHED FLOOR LEVEL	EOT	END OF TRACE
FH	FIRE HYDRANT	OSA	OUT OF SURVEY AREA
G	GULLY	UTL	UNABLE TO LIFT
GLT	GROUND LIGHT	UTS	UNABLE TO SONDE
GST	GAS TAP	UTT	UNABLE TO TRACE
GSV	GAS VALVE	S/L	SIGNAL LOSS
IC	INSPECTION COVER	BLK	BLOCKED
IL	INVERT LEVEL	NFH	NO FURTHER GPR CONTACTS
KO	KERB OUTLET	BD	BACKDROP PIPE
LP	LAMP POST	NVP	NO VISIBLE PIPE
MH	MANHOLE	ToP	TOP OF PIPE
MKR	MARKER		EOT SYMBOL
OP	OUTFALL PIPE		INDICATES DIRECTION
PN	PYLON		GPR EOT SYMBOL

BT
CABLE DUCT
CABLE TV
CCTV
TELECOMS
EARTH ROD STRIP
ELECTRIC
FIBRE-OPTICS
FUEL LINE
GPR DETECTION LINE
MAINS GAS
MAINS WATER
SEWER CW
SEWER FW
SEWER SW
TRAFFIC SIGNAL CABLE
UNIDENTIFIED TRACE
UNIDENTIFIED CABLE
UNIDENTIFIED PIPE
VEHICLE DETECTION CABLE
Rail

Linetypes With Suffixes (S) (A) (R) show Statutory Authority, Assumed and Recorded Underground Data.

DISCLAIMER:

At Layer Surveys we use skilled and experienced staff, modern up to date techniques and top of the range electromagnetic and radar technology to locate and trace sub-surface utilities. However the performance of the equipment employed in non-invasive surveys can be adversely affected by factors outside the control of Layer Surveys. Therefore Layer Surveys cannot guarantee that all utilities present on site have been located. It is the responsibility of the Client to consult regional authority records and undertake trial digs where appropriate.

Where similar services run in close proximity it may be impossible to separately trace individual services as the trace signal can experience interference. In such cases, services will be shown as a single, annotated line. The displayed depth will refer to the shallowest detected utility.

Successful tracing of non-conductive materials may be limited. Drainage gulleys are dye tested where possible to prove connectivity but it is not always possible to introduce the sonde due to narrow pipe sizes and/or accumulated silt.

Depth information of underground services/features are generally accurate to within +/- 10% (i.e. a pipe at 2m deep may be accurate to +/-200mm) but this cannot be guaranteed. Depths shown usually refer to the top of the service. Gravity sewer and drain depths are usually to invert (base of drainage channel) unless otherwise stated.

Some above ground features may have been obscured at time of survey. It is not always possible to operate the Ground Penetrating Radar in areas including, but not limited to, dense vegetation, rubble, debris and/or rough/uneven ground.

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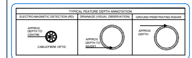

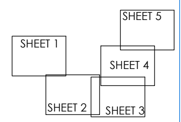

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Client
BAM Construction

Project Title
Glan Clwyd Hospital
Rhuddlan Road
Bodelwyddan
Rhyl, LL18 5UJ

Drawing Ref.	Surveyed	Checked
1771_U	A.L/T.W	Layer Surveys

Scale	Date	Drawn	No.	Size	Rev
1:200	June 23	I.T	01	A0	

PLAN GRID NORTH

File Name: Layerserv0001771_U.dwg

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COM	COMMUNICATIONS COVER	SV	STOP VALVE
CTV	CABLE TV COVER	TCB	TELEPHONE CALL BOX
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ER	EARTH ROD	WST	WATER STOP TAP
EP	ELECTRICITY POLE	WSV	WATER STOP VALVE
FFL	FINISHED FLOOR LEVEL	EOT	END OF TRACE
FH	FIRE HYDRANT	OSA	OUT OF SURVEY AREA
G	GULLY	UTL	UNABLE TO LIFT
GLT	GROUND LIGHT	UTS	UNABLE TO SONDE
GST	GAS TAP	UTT	UNABLE TO TRACE
GSV	GAS VALVE	S/L	SIGNAL LOSS
IC	INSPECTION COVER	BLK	BLOCKED
IL	INVERT LEVEL	NFH	NO FURTHER GPR CONTACTS
KO	KERB OUTLET	BD	BACKDROP PIPE
LP	LAMP POST	NVP	NO VISIBLE PIPE
MH	MANHOLE	ToP	TOP OF PIPE
MKR	MARKER		EOT SYMBOL
OP	OUTFALL PIPE		INDICATES DIRECTION
PN	PYLON		GPR EOT SYMBOL

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CABLE DUCT
CABLE TV
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EARTH ROD STRIP
ELECTRIC
FIBRE-OPTICS
FUEL LINE
GPR DETECTION LINE
MAINS GAS
MAINS WATER
SEWER CW
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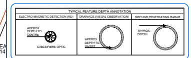

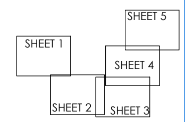

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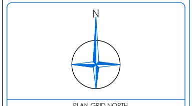

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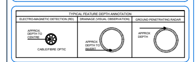

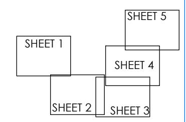

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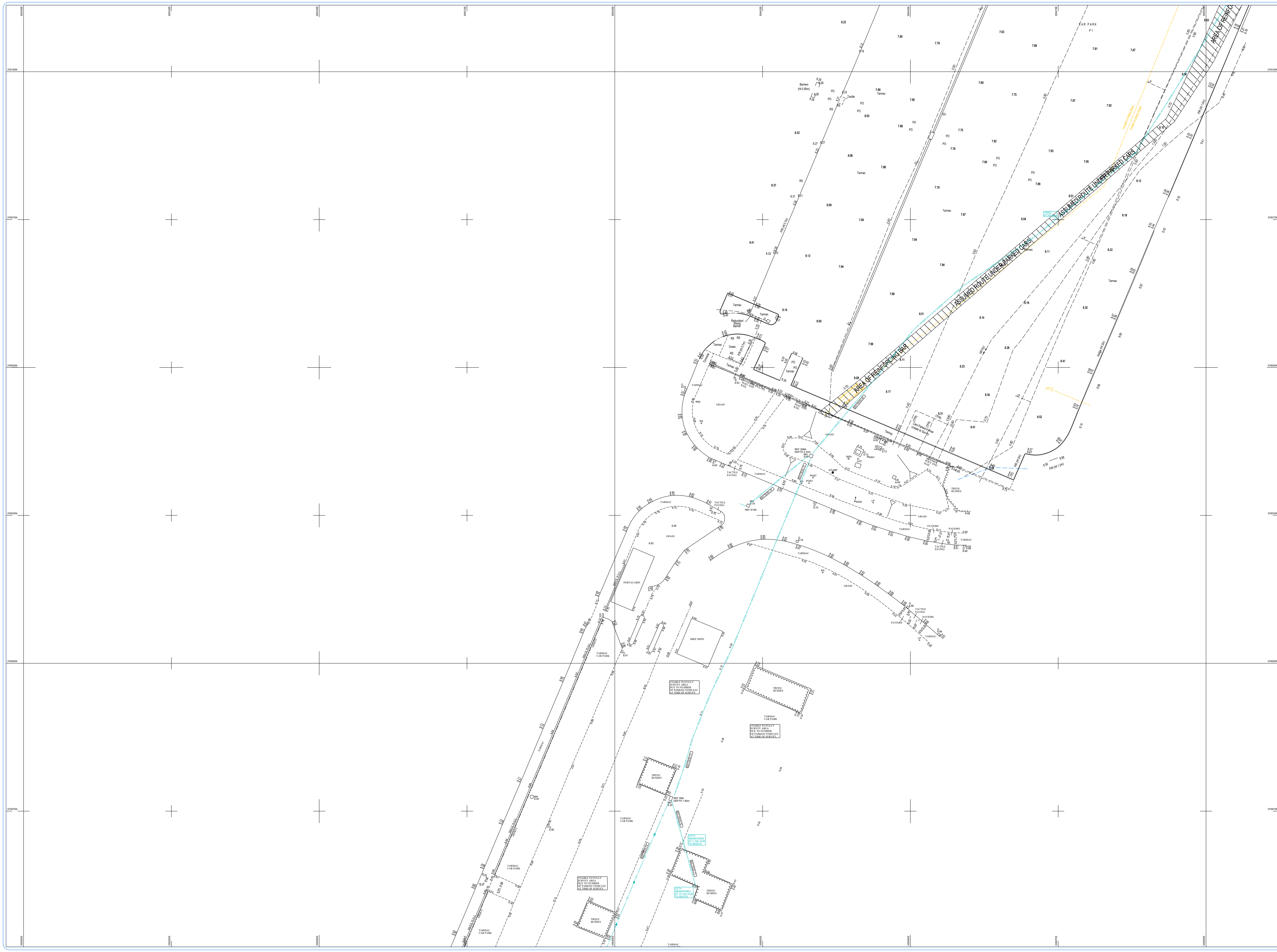

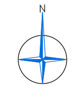

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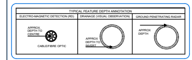

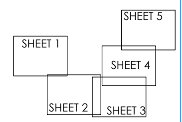

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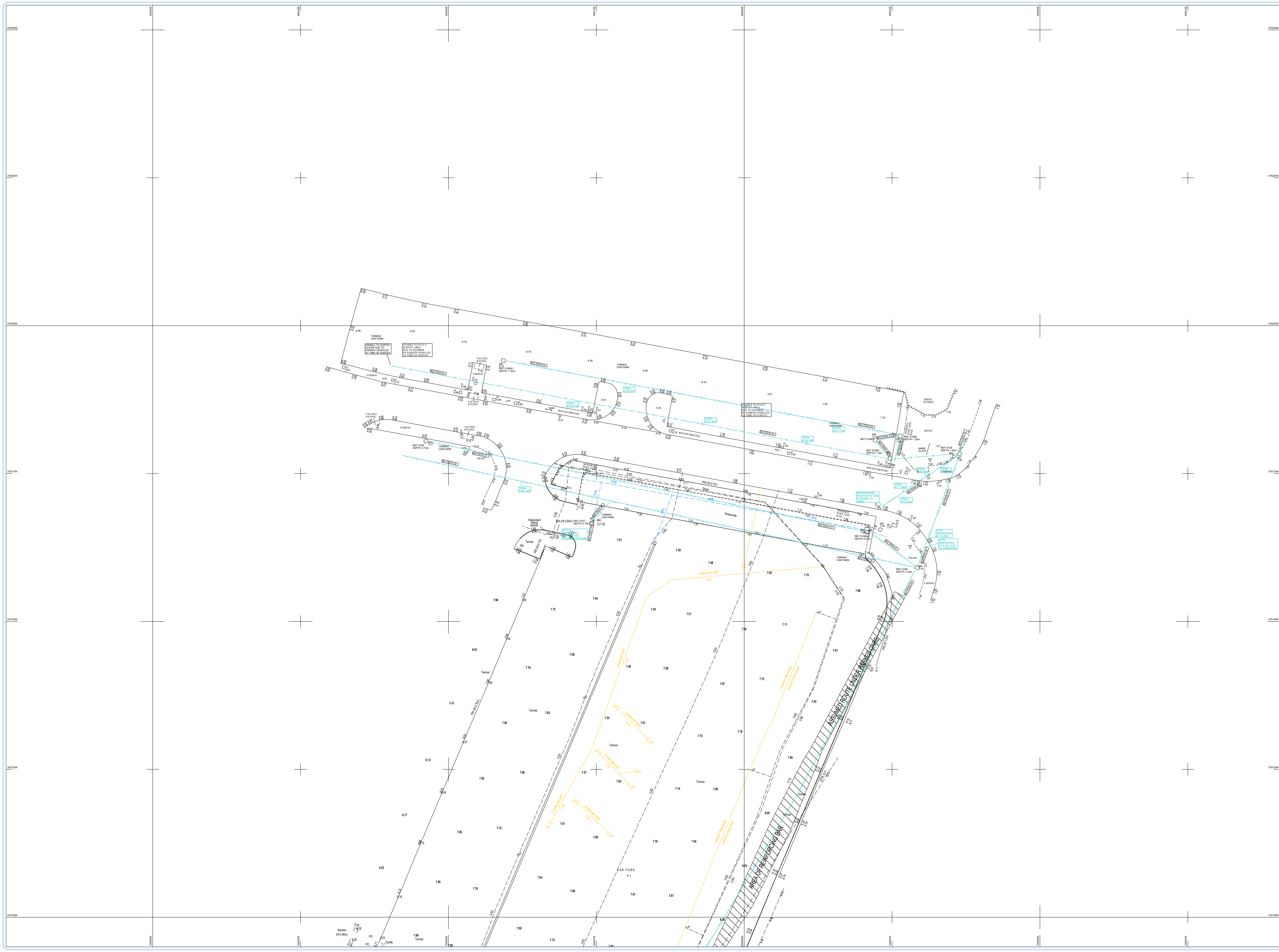

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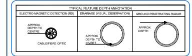

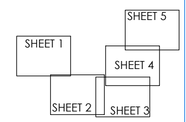

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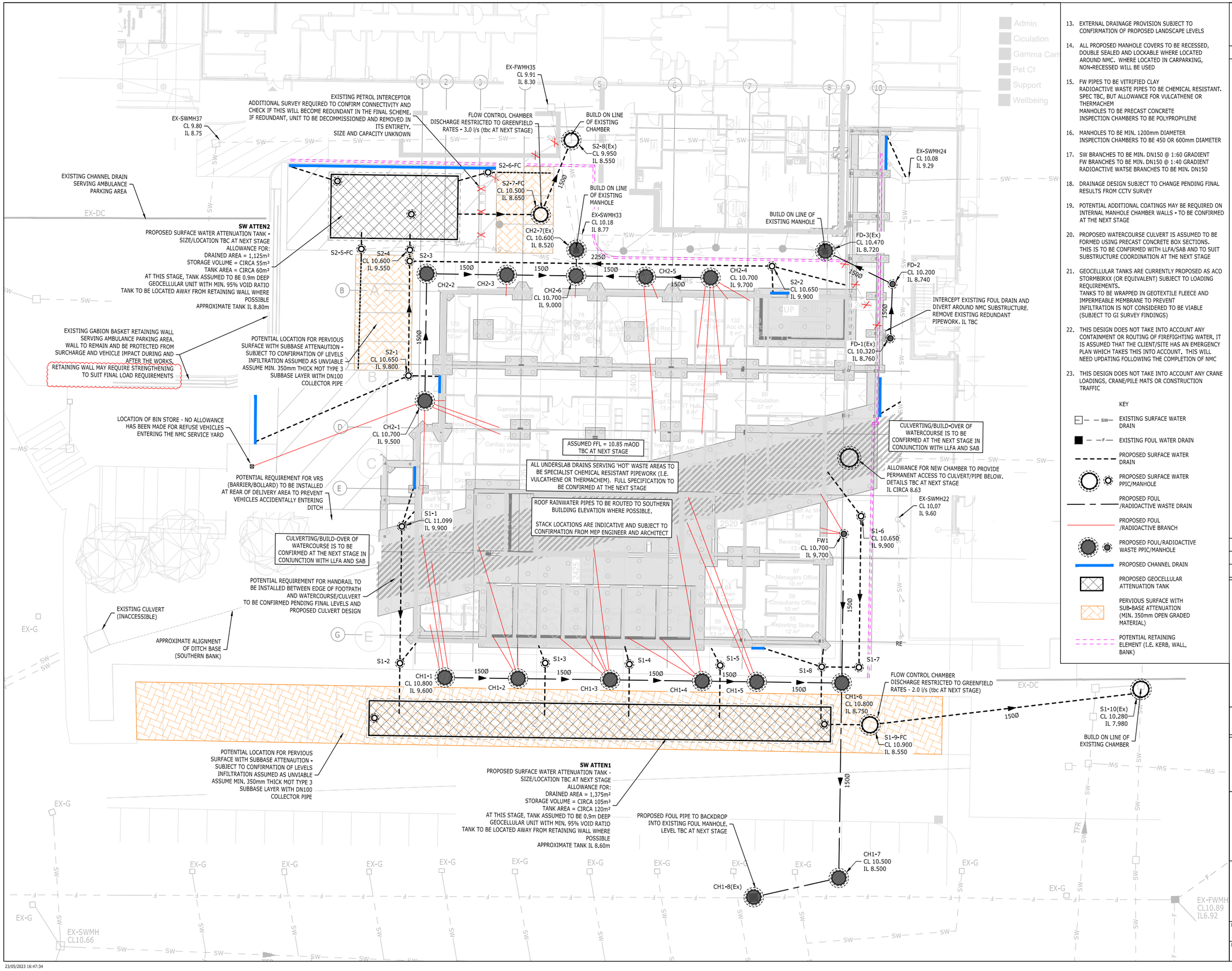
Appendix 3
Proposed Drainage Strategy



13. EXTERNAL DRAINAGE PROVISION SUBJECT TO CONFIRMATION OF PROPOSED LANDSCAPE LEVELS
14. ALL PROPOSED MANHOLE COVERS TO BE RECESSED, DOUBLE SEALED AND LOCKABLE WHERE LOCATED AROUND NMC. WHERE LOCATED IN CARPARKING, NON-RECESSED WILL BE USED
15. FW PIPES TO BE VITRIFIED CLAY
RADIOACTIVE WASTE PIPES TO BE CHEMICAL RESISTANT. SPEC TBC, BUT ALLOWANCE FOR VULCATHENE OR THERMACHEM
MANHOLES TO BE PRECAST CONCRETE
INSPECTION CHAMBERS TO BE POLYPROPYLENE
16. MANHOLES TO BE MIN. 1200mm DIAMETER
INSPECTION CHAMBERS TO BE 450 OR 600mm DIAMETER
17. SW BRANCHES TO BE MIN. DN150 @ 1:60 GRADIENT
FW BRANCHES TO BE MIN. DN150 @ 1:40 GRADIENT
RADIOACTIVE WATSE BRANCHES TO BE MIN. DN150
18. DRAINAGE DESIGN SUBJECT TO CHANGE PENDING FINAL RESULTS FROM CCTV SURVEY
19. POTENTIAL ADDITIONAL COATINGS MAY BE REQUIRED ON INTERNAL MANHOLE CHAMBER WALLS - TO BE CONFIRMED AT THE NEXT STAGE
20. PROPOSED WATERCOURSE CULVERT IS ASSUMED TO BE FORMED USING PRECAST CONCRETE BOX SECTIONS. THIS IS TO BE CONFIRMED WITH LLFA/SAB AND TO SUIT SUBSTRUCTURE COORDINATION AT THE NEXT STAGE
21. GEOCELLULAR TANKS ARE CURRENTLY PROPOSED AS ACO STORMBIRXX (OR EQUIVALENT) SUBJECT TO LOADING REQUIREMENTS.
TANKS TO BE WRAPPED IN GEOTEXTILE FLEECE AND IMPERMEABLE MEMBRANE TO PREVENT INFILTRATION IS NOT CONSIDERED TO BE VIABLE (SUBJECT TO GI SURVEY FINDINGS)
22. THIS DESIGN DOES NOT TAKE INTO ACCOUNT ANY CONTAINMENT OR ROUTING OF FIREFIGHTING WATER. IT IS ASSUMED THAT THE CLIENT/SITE HAS AN EMERGENCY PLAN WHICH TAKES THIS INTO ACCOUNT. THIS WILL NEED UPDATING FOLLOWING THE COMPLETION OF NMC
23. THIS DESIGN DOES NOT TAKE INTO ACCOUNT ANY CRANE LOADINGS, CRANE/PILE MATS OR CONSTRUCTION TRAFFIC

KEY

- EXISTING SURFACE WATER DRAIN
- EXISTING FOUL WATER DRAIN
- PROPOSED SURFACE WATER DRAIN
- PROPOSED SURFACE WATER PPIC/MANHOLE
- PROPOSED FOUL /RADIOACTIVE WASTE DRAIN
- PROPOSED FOUL /RADIOACTIVE BRANCH
- PROPOSED FOUL/RADIOACTIVE WASTE PPIC/MANHOLE
- PROPOSED CHANNEL DRAIN
- PROPOSED GEOCELLULAR ATTENUATION TANK
- PERVIOUS SURFACE WITH SUB-BASE ATTENUATION (MIN. 350mm OPEN GRADED MATERIAL)
- POTENTIAL RETAINING ELEMENT (I.E. KERB, WALL, BANK)

Notes

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE MILLIMETRES U.N.O.
3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
5. THIS DRAWING HAS BEEN DEVELOPED USING THE FOLLOWING THIRD PARTY INFORMATION:
- EXISTING DRAINAGE RECORD DRAWINGS (Various)
- ARCHITECT GA - NMC-PDA-ZZ-00-DR-A-20100 REV P09
- UTILITIES SURVEYS (LAYER SURVEYS - 2021 & 2023)
- WIP FOUNDATION LAYOUTS (RAMBOLL)
6. THE PROPOSED SURFACE WATER NETWORK HAS BEEN DESIGNED TO DISCHARGE AT THE PRE-DEVELOPMENT GREENFIELD RATES FOR ALL STORMS UP TO AND INCLUDING M100 YEAR +40%. HOWEVER QBAR VALUE IS CIRCA 1.9 l/s AND THEREFORE PROPOSAL TO INCREASE DESIGN FLOW = **5.0 l/s** TO REDUCE BLOCKAGE RISK (tbc pending detailed design and consultations)
7. ESTIMATED STORAGE VOLUMES FOR NUCLEAR MEDICINE DEVELOPMENT HAVE BEEN CALCULATED BETWEEN **120-195m³** USING HYDRAULIC SOFTWARE. THIS IS BASED ON A DISCHARGE RATE OF 5 l/s
IF LLFA/SAB REQUIRE RESTRICTION TO QBAR, THE STORAGE VOLUMES MAY INCREASE TO CIRCA 175-275m³
8. THIS DESIGN IS SUBJECT TO APPROVAL BY THE LLFA AND SAB, AS WELL AS ACCEPTANCE FROM DCWW & NRW REGARDING DOMESTIC AND RADIOACTIVE WASTEWATER DISCHARGES
9. THE EXISTING FOUL NETWORK IS NOT BELIEVED TO BE DESIGNED FOR RADIOACTIVE DRAINAGE. HOWEVER, THERE IS NO PROPOSAL TO UPGRADE THE EXISTING INFRASTRUCTURE
10. LEVELS AND LOCATIONS OF DRAINS AND PIPES ARE INDICATIVE AND ARE TO BE COORDINATED WITH THE LANDSCAPE LAYOUT, BUILDING SUBSTRUCTURE, WATERCOURSE AND MEP SERVICES AT THE NEXT STAGE
11. EXTERNAL HARDSTANDING AREAS WILL REQUIRE ADDITIONAL SURFACE DRAINAGE PROVISIONS (CHANNEL DRAINS/GULLIES) THAT HAVE NOT BEEN SHOWN ON THIS SKETCH. THESE WILL BE CONFIRMED AT THE NEXT STAGE
12. PEAK AND AVERAGE FOUL & RADIOACTIVE WASTE FLOWS HAVE NOT YET BEEN CALCULATED. HOWEVER A PRELIMINARY ASSESSMENT BASED ON ANTICIPATED APPLIANCE NUMBERS ESTIMATED A PEAK FLOW CIRCA 5.3 l/s. THIS IS TO BE CONFIRMED AND RATIONALISED AT THE NEXT STAGE

Rev	Description	Date	By	Chk	App
P02	OBC ISSUE - SEE REV CLOUDS	23/05 2023	GS	-	-
P01	OBC ISSUE	09/05 2023	GS	-	-

bam

Designed for *Life* : Building for *Wales*
Cynllun *Oes* : Adeiladu Ar Gyfer *Cymru*

GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Betsi Cadwaladr University Health Board

S2 - SUITABLE FOR INFORMATION

NUCLEAR MEDICINE CONSOLIDATION PROJECT

RAMBOLL
tel 01244 311 855 chester@ramboll.co.uk
www.ramboll.co.uk

PROPOSED DRAINAGE STRATEGY

SHEET 1

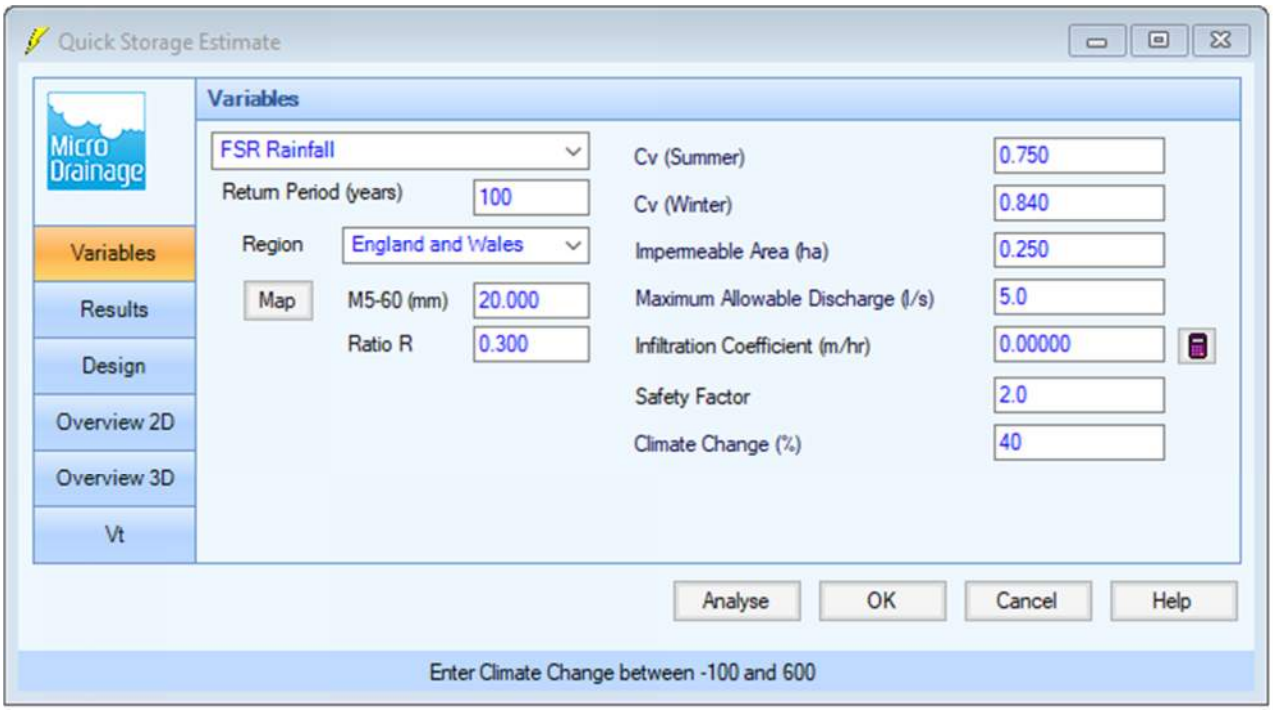
Project No:	Scale (@A1):	Drawn:	Date:
1620014943	1:150	SG	APR '23

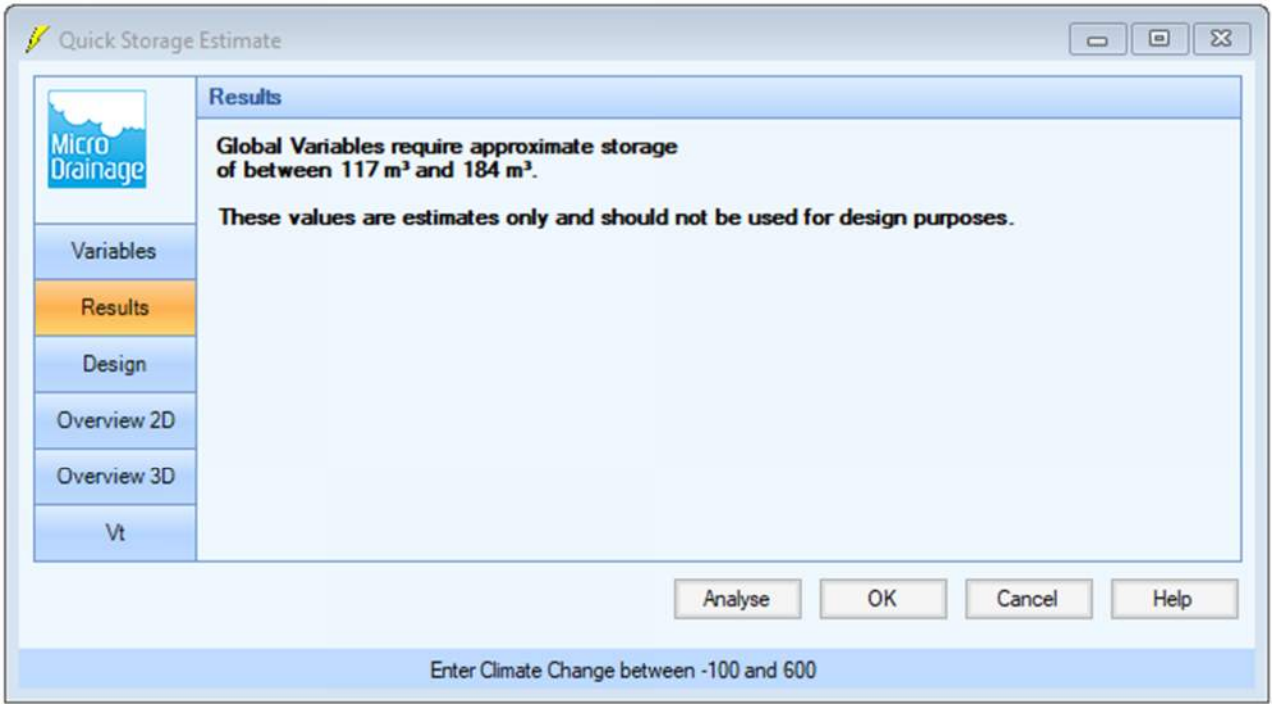
Drawing No: NMC-RAM-XX-XX-DR-C-00001
Rev: P02

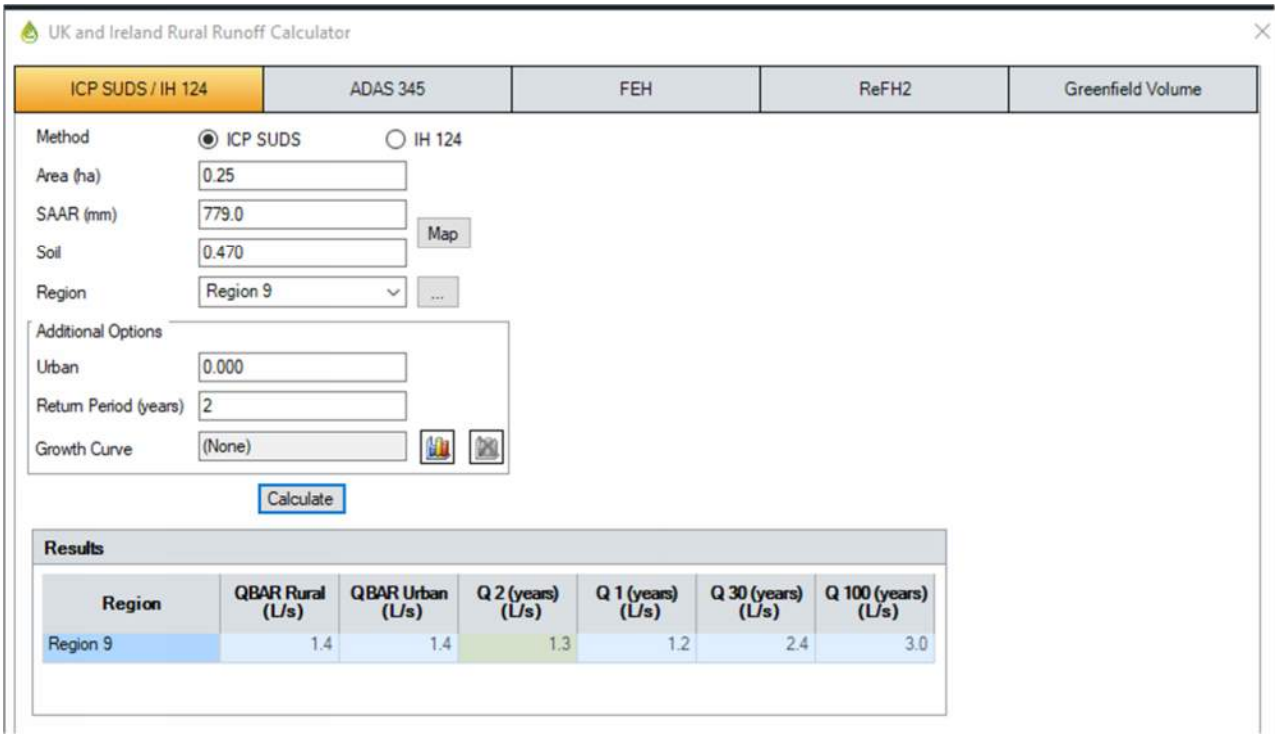
23/05/2023 16:47:34

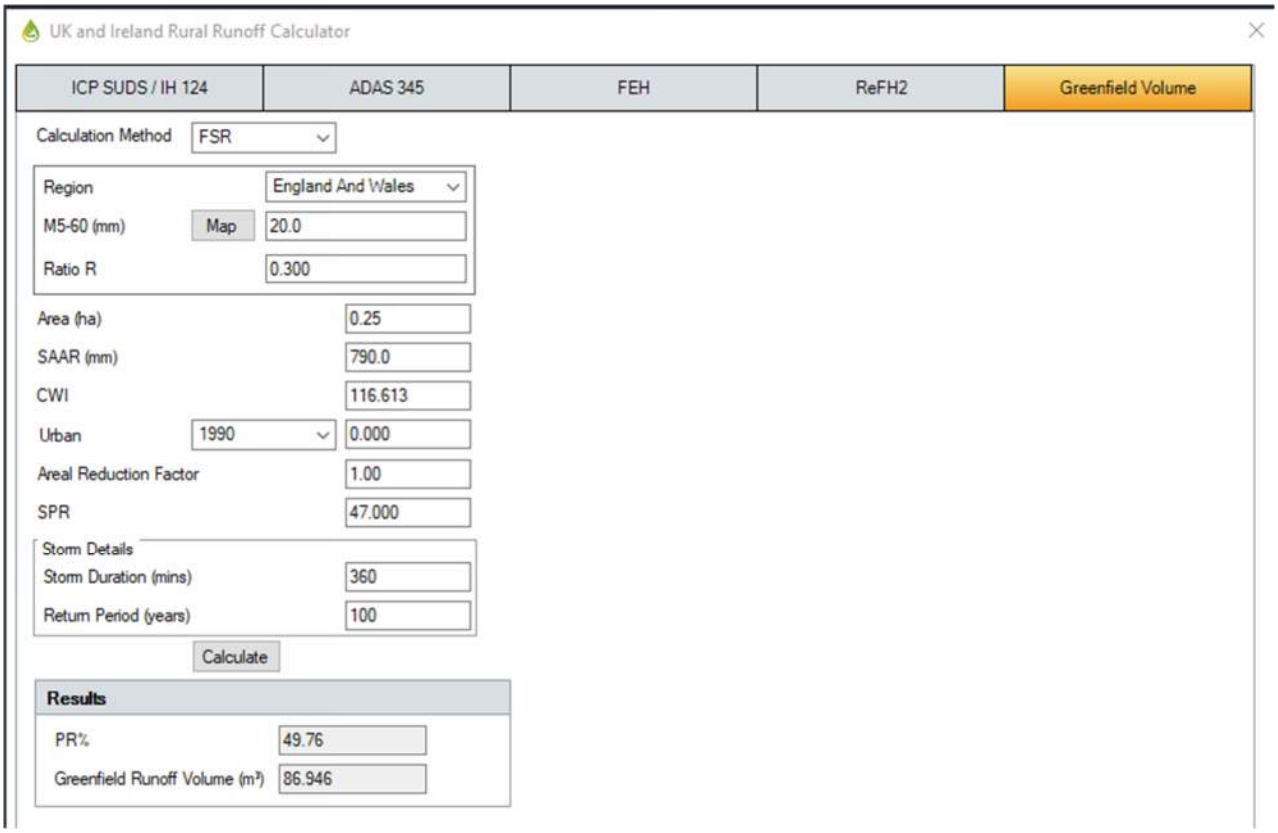
Appendix 4
SW Calculations

Nuclear Medicine Consolidation
SW Storage Estimates

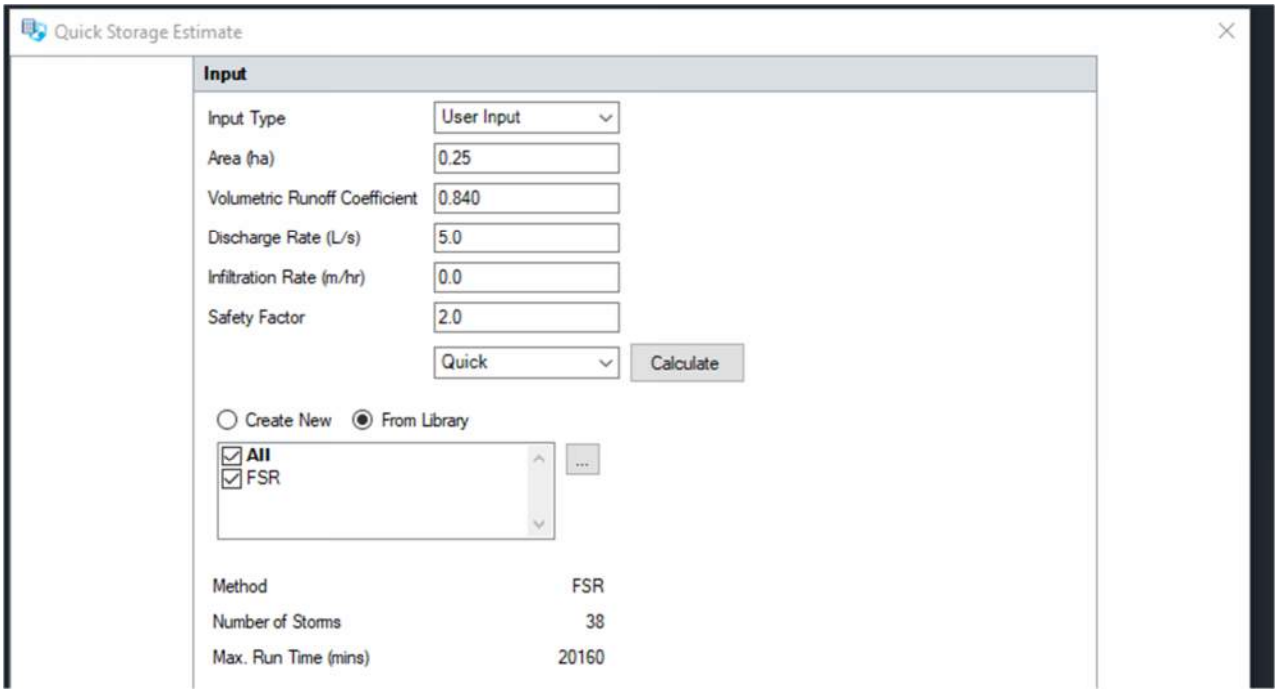


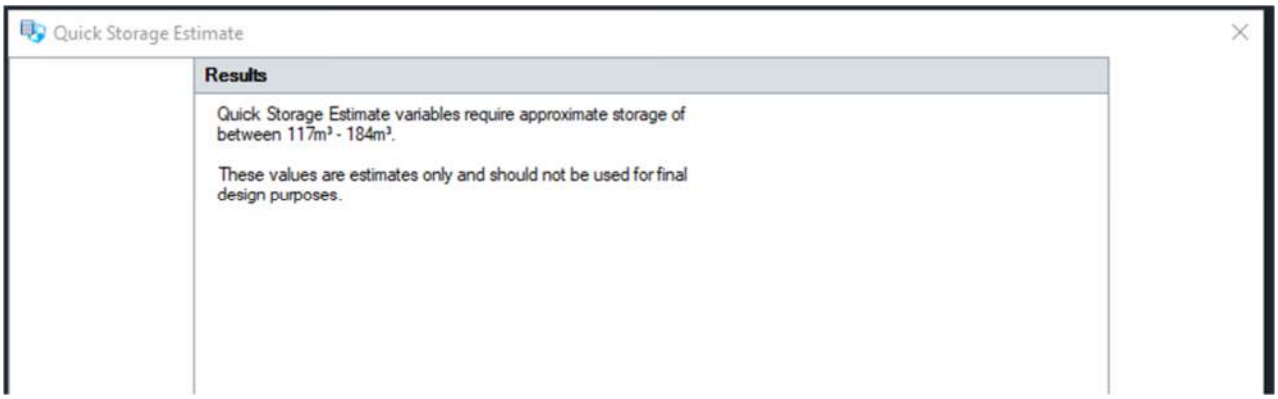



UK and Ireland Rural Runoff Calculator
ICP SUDS / IH 124
ADAS 345
FEH
ReFH2
Greenfield Volume
Method
ICP SUDS
IH 124
Area (ha) 0.25
SAAR (mm) 779.0
Soil 0.470
Region Region 9
Map
Additional Options
Urban 0.000
Return Period (years) 2
Growth Curve (None)
Calculate
Results
Region | QBAR Rural (L/s) | QBAR Urban (L/s) | Q 2 (years) (L/s) | Q 1 (years) (L/s) | Q 30 (years) (L/s) | Q 100 (years) (L/s)
Region 9 | 1.4 | 1.4 | 1.3 | 1.2 | 2.4 | 3.0

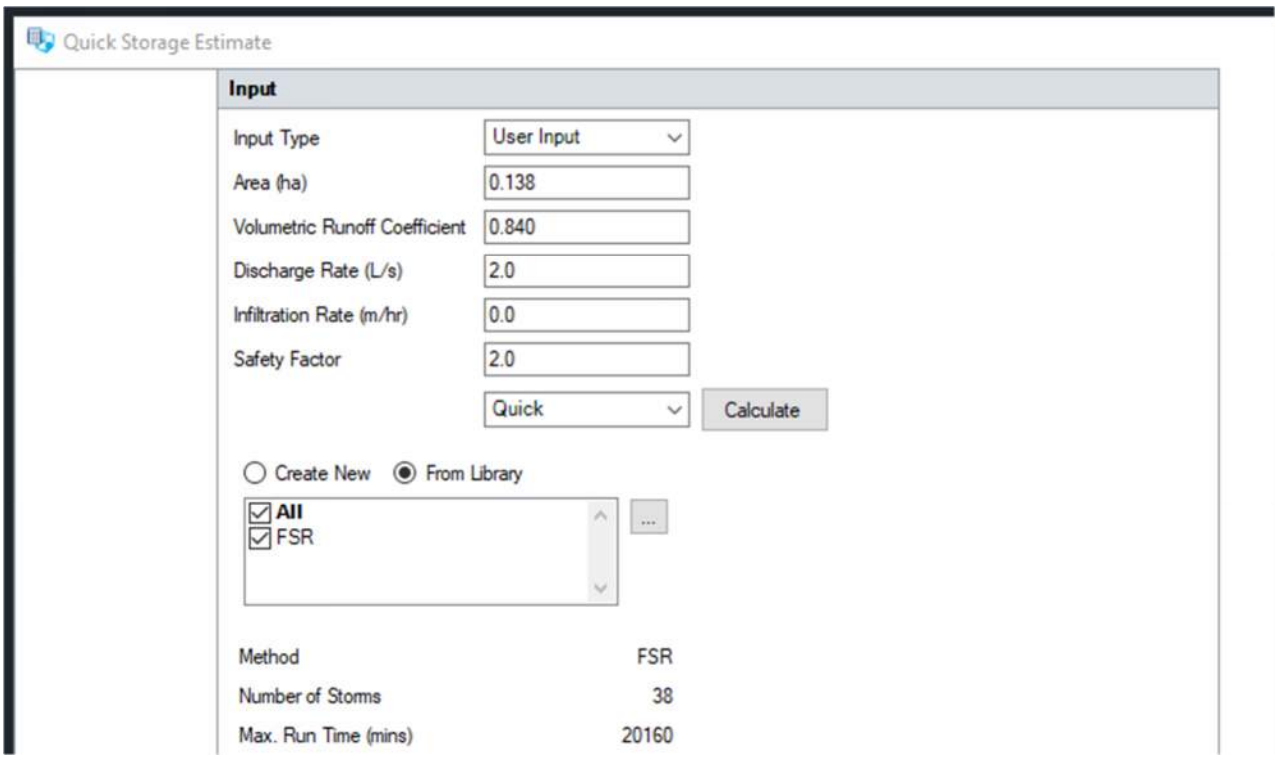

UK and Ireland Rural Runoff Calculator
ICP SUDS / IH 124
ADAS 345
FEH
ReFH2
Greenfield Volume
Calculation Method FSR
Region England And Wales
M5-60 (mm) Map 20.0
Ratio R 0.300
Area (ha) 0.25
SAAR (mm) 790.0
CWI 116.613
Urban 1990 0.000
Areal Reduction Factor 1.00
SPR 47.000
Storm Details
Storm Duration (mins) 360
Return Period (years) 100
Calculate
Results
PR% 49.76
Greenfield Runoff Volume (m³) 86.946

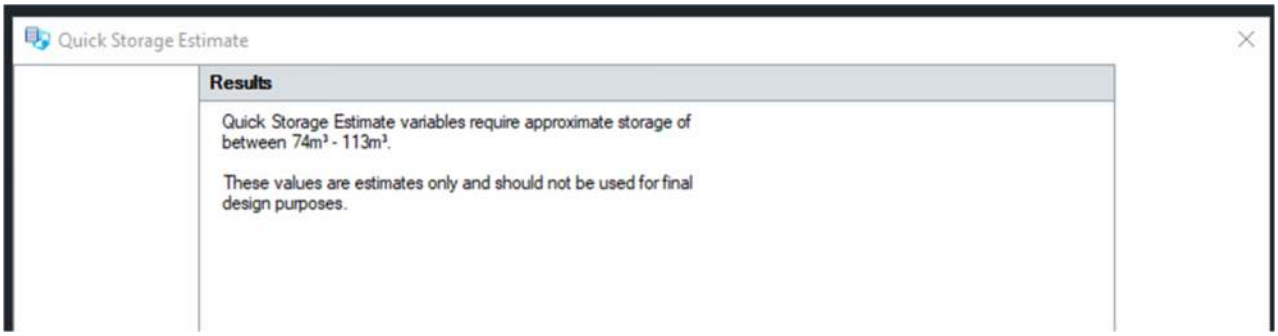
Overall Site



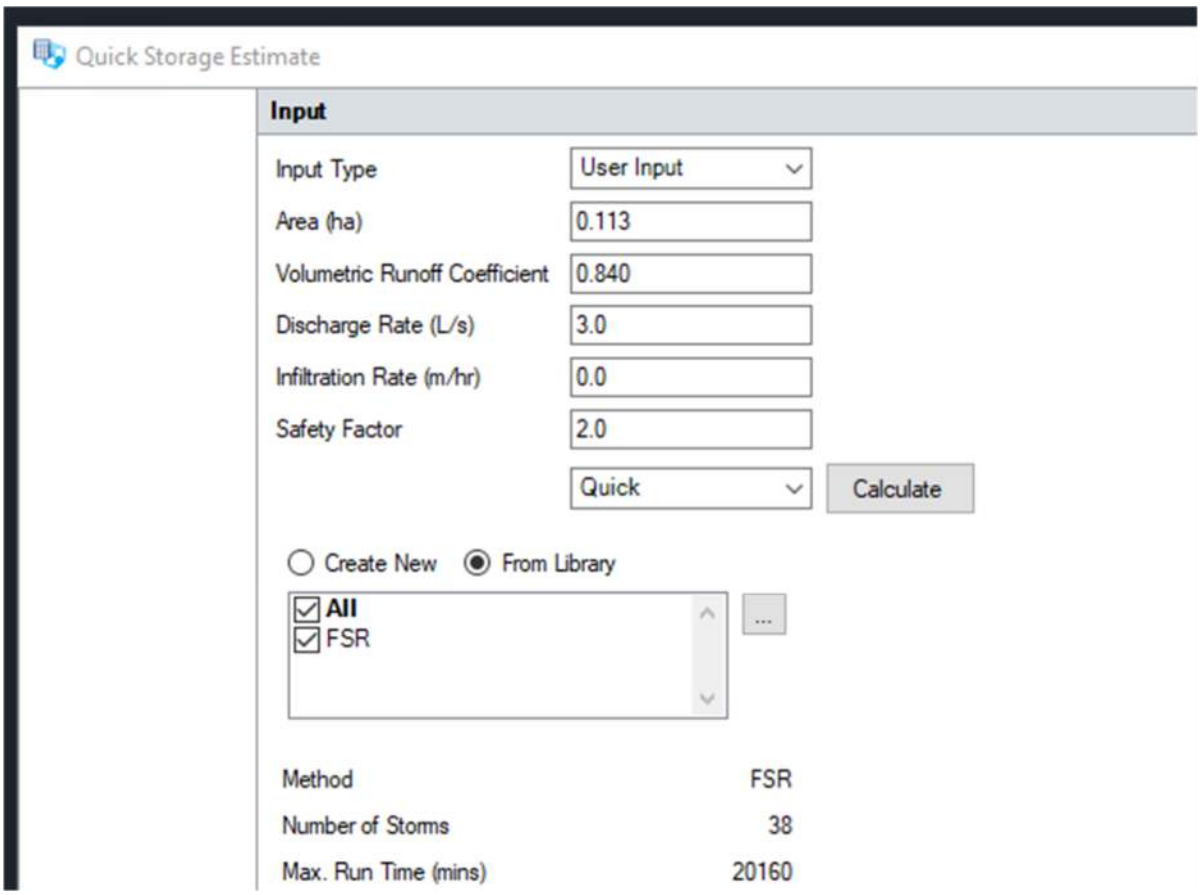


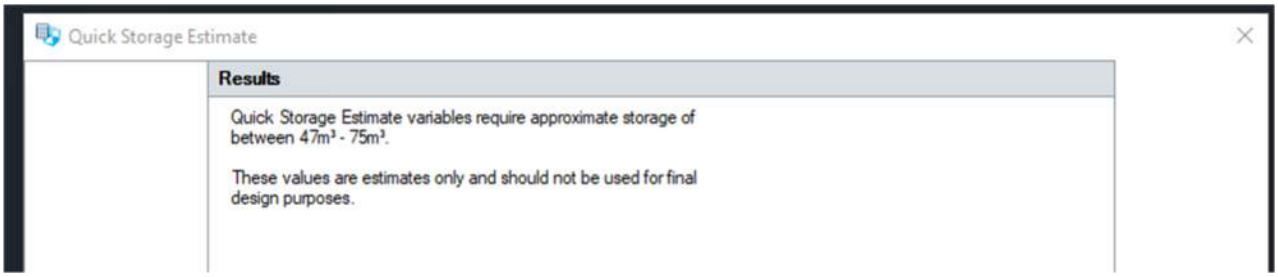
Tank 1 (South)


Quick Storage Estimate
Input
Input Type
User Input
Area (ha)
0.138
Volumetric Runoff Coefficient
0.840
Discharge Rate (L/s)
2.0
Infiltration Rate (m/hr)
0.0
Safety Factor
2.0
Quick
Calculate
Create New
From Library
All
FSR
...
Method
FSR
Number of Storms
38
Max. Run Time (mins)
20160


Quick Storage Estimate
Results
Quick Storage Estimate variables require approximate storage of between 74m³ - 113m³.
These values are estimates only and should not be used for final design purposes.

Tank 2 (Service Yard)





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

Half Drain Time : 410 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	8.773	0.273	0.0	1.8	1.8	31.1	O K
30 min Summer	8.870	0.370	0.0	1.8	1.8	42.2	O K
60 min Summer	8.973	0.473	0.0	1.8	1.8	54.0	O K
120 min Summer	9.072	0.572	0.0	1.8	1.8	65.2	O K
180 min Summer	9.114	0.614	0.0	1.8	1.8	70.0	O K
240 min Summer	9.135	0.635	0.0	1.8	1.8	72.4	O K
360 min Summer	9.149	0.649	0.0	1.8	1.8	73.9	O K
480 min Summer	9.146	0.646	0.0	1.8	1.8	73.6	O K
600 min Summer	9.140	0.640	0.0	1.8	1.8	72.9	O K
720 min Summer	9.130	0.630	0.0	1.8	1.8	71.9	O K
960 min Summer	9.108	0.608	0.0	1.8	1.8	69.3	O K
1440 min Summer	9.050	0.550	0.0	1.8	1.8	62.7	O K
2160 min Summer	8.960	0.460	0.0	1.8	1.8	52.4	O K
2880 min Summer	8.881	0.381	0.0	1.8	1.8	43.5	O K
4320 min Summer	8.760	0.260	0.0	1.8	1.8	29.6	O K
5760 min Summer	8.683	0.183	0.0	1.7	1.7	20.9	O K
7200 min Summer	8.635	0.135	0.0	1.6	1.6	15.4	O K
8640 min Summer	8.606	0.106	0.0	1.5	1.5	12.1	O K
10080 min Summer	8.589	0.089	0.0	1.4	1.4	10.2	O K
15 min Winter	8.806	0.306	0.0	1.8	1.8	34.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	124.925	0.0	31.9	18
30 min Summer	86.152	0.0	44.1	33
60 min Summer	56.713	0.0	58.5	62
120 min Summer	35.885	0.0	74.1	122
180 min Summer	26.921	0.0	83.4	182
240 min Summer	21.875	0.0	90.3	242
360 min Summer	16.309	0.0	101.0	360
480 min Summer	13.215	0.0	109.2	414
600 min Summer	11.214	0.0	115.8	476
720 min Summer	9.799	0.0	121.4	542
960 min Summer	7.911	0.0	130.7	676
1440 min Summer	5.836	0.0	144.5	950
2160 min Summer	4.293	0.0	159.8	1336
2880 min Summer	3.447	0.0	171.1	1704
4320 min Summer	2.530	0.0	188.2	2420
5760 min Summer	2.033	0.0	202.0	3112
7200 min Summer	1.717	0.0	213.2	3816
8640 min Summer	1.496	0.0	222.8	4488
10080 min Summer	1.332	0.0	231.4	5144
15 min Winter	124.925	0.0	35.8	18

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	8.917	0.417	0.0	1.8	1.8	47.5	O K
60 min Winter	9.036	0.536	0.0	1.8	1.8	61.1	O K
120 min Winter	9.150	0.650	0.0	1.8	1.8	74.1	O K
180 min Winter	9.200	0.700	0.0	1.8	1.8	79.7	O K
240 min Winter	9.226	0.726	0.0	1.8	1.8	82.8	O K
360 min Winter	9.248	0.748	0.0	1.8	1.8	85.3	O K
480 min Winter	9.248	0.748	0.0	1.8	1.8	85.2	O K
600 min Winter	9.236	0.736	0.0	1.8	1.8	83.9	O K
720 min Winter	9.225	0.725	0.0	1.8	1.8	82.6	O K
960 min Winter	9.194	0.694	0.0	1.8	1.8	79.2	O K
1440 min Winter	9.117	0.617	0.0	1.8	1.8	70.3	O K
2160 min Winter	8.968	0.468	0.0	1.8	1.8	53.3	O K
2880 min Winter	8.846	0.346	0.0	1.8	1.8	39.4	O K
4320 min Winter	8.688	0.188	0.0	1.7	1.7	21.4	O K
5760 min Winter	8.613	0.113	0.0	1.5	1.5	12.9	O K
7200 min Winter	8.584	0.084	0.0	1.4	1.4	9.6	O K
8640 min Winter	8.572	0.072	0.0	1.2	1.2	8.2	O K
10080 min Winter	8.564	0.064	0.0	1.1	1.1	7.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	86.152	0.0	49.5	33
60 min Winter	56.713	0.0	65.5	62
120 min Winter	35.885	0.0	83.0	120
180 min Winter	26.921	0.0	93.4	178
240 min Winter	21.875	0.0	101.2	236
360 min Winter	16.309	0.0	113.2	346
480 min Winter	13.215	0.0	122.3	452
600 min Winter	11.214	0.0	129.7	540
720 min Winter	9.799	0.0	136.0	570
960 min Winter	7.911	0.0	146.3	724
1440 min Winter	5.836	0.0	161.9	1038
2160 min Winter	4.293	0.0	179.0	1432
2880 min Winter	3.447	0.0	191.6	1812
4320 min Winter	2.530	0.0	210.9	2464
5760 min Winter	2.033	0.0	226.2	3112
7200 min Winter	1.717	0.0	238.8	3744
8640 min Winter	1.496	0.0	249.6	4408
10080 min Winter	1.332	0.0	259.2	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.138

Time (mins) From:	To:	Area (ha)
0	4	0.138

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Model Details

Storage is Online Cover Level (m) 10.500

Cellular Storage Structure

Invert Level (m) 8.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	120.0	0.0	0.901	0.0	0.0
0.900	120.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0064-2000-1200-2000
Design Head (m)	1.200
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	8.500
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.0	Kick-Flo®	0.573	1.4
Flush-Flo™	0.282	1.8	Mean Flow over Head Range	-	1.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.5
0.200	1.7	1.400	2.1	3.500	3.3	7.500	4.7
0.300	1.8	1.600	2.3	4.000	3.5	8.000	4.8
0.400	1.7	1.800	2.4	4.500	3.7	8.500	5.0
0.500	1.6	2.000	2.5	5.000	3.9	9.000	5.1
0.600	1.5	2.200	2.6	5.500	4.0	9.500	5.2
0.800	1.7	2.400	2.7	6.000	4.2		
1.000	1.8	2.600	2.8	6.500	4.4		

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

Half Drain Time : 164 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	8.895	0.395	0.0	2.9	2.9	24.4	O K
30 min Summer	9.027	0.527	0.0	2.9	2.9	32.5	O K
60 min Summer	9.153	0.653	0.0	2.9	2.9	40.3	O K
120 min Summer	9.244	0.744	0.0	2.9	2.9	46.0	O K
180 min Summer	9.253	0.753	0.0	2.9	2.9	46.5	O K
240 min Summer	9.246	0.746	0.0	2.9	2.9	46.1	O K
360 min Summer	9.220	0.720	0.0	2.9	2.9	44.5	O K
480 min Summer	9.180	0.680	0.0	2.9	2.9	42.0	O K
600 min Summer	9.138	0.638	0.0	2.9	2.9	39.4	O K
720 min Summer	9.096	0.596	0.0	2.9	2.9	36.8	O K
960 min Summer	9.015	0.515	0.0	2.9	2.9	31.8	O K
1440 min Summer	8.878	0.378	0.0	2.9	2.9	23.3	O K
2160 min Summer	8.740	0.240	0.0	2.9	2.9	14.8	O K
2880 min Summer	8.663	0.163	0.0	2.7	2.7	10.1	O K
4320 min Summer	8.600	0.100	0.0	2.3	2.3	6.2	O K
5760 min Summer	8.580	0.080	0.0	1.9	1.9	4.9	O K
7200 min Summer	8.569	0.069	0.0	1.6	1.6	4.3	O K
8640 min Summer	8.562	0.062	0.0	1.4	1.4	3.8	O K
10080 min Summer	8.557	0.057	0.0	1.2	1.2	3.5	O K
15 min Winter	8.946	0.446	0.0	2.9	2.9	27.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	124.925	0.0	26.4	18
30 min Summer	86.152	0.0	36.4	32
60 min Summer	56.713	0.0	48.0	62
120 min Summer	35.885	0.0	60.8	120
180 min Summer	26.921	0.0	68.4	160
240 min Summer	21.875	0.0	74.1	192
360 min Summer	16.309	0.0	82.9	258
480 min Summer	13.215	0.0	89.6	324
600 min Summer	11.214	0.0	95.0	390
720 min Summer	9.799	0.0	99.6	456
960 min Summer	7.911	0.0	107.2	580
1440 min Summer	5.836	0.0	118.6	824
2160 min Summer	4.293	0.0	130.9	1168
2880 min Summer	3.447	0.0	140.2	1524
4320 min Summer	2.530	0.0	154.3	2204
5760 min Summer	2.033	0.0	165.4	2936
7200 min Summer	1.717	0.0	174.6	3672
8640 min Summer	1.496	0.0	182.6	4376
10080 min Summer	1.332	0.0	189.6	5136
15 min Winter	124.925	0.0	29.6	18

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.098	0.598	0.0	2.9	2.9	36.9	O K
60 min Winter	9.249	0.749	0.0	2.9	2.9	46.2	O K
120 min Winter	9.357	0.857	0.0	2.9	2.9	52.9	O K
180 min Winter	9.372	0.872	0.0	2.9	2.9	53.8	O K
240 min Winter	9.359	0.859	0.0	2.9	2.9	53.1	O K
360 min Winter	9.325	0.825	0.0	2.9	2.9	51.0	O K
480 min Winter	9.274	0.774	0.0	2.9	2.9	47.8	O K
600 min Winter	9.211	0.711	0.0	2.9	2.9	43.9	O K
720 min Winter	9.135	0.635	0.0	2.9	2.9	39.2	O K
960 min Winter	9.002	0.502	0.0	2.9	2.9	31.0	O K
1440 min Winter	8.804	0.304	0.0	2.9	2.9	18.7	O K
2160 min Winter	8.653	0.153	0.0	2.6	2.6	9.5	O K
2880 min Winter	8.599	0.099	0.0	2.3	2.3	6.1	O K
4320 min Winter	8.573	0.073	0.0	1.7	1.7	4.5	O K
5760 min Winter	8.561	0.061	0.0	1.4	1.4	3.8	O K
7200 min Winter	8.555	0.055	0.0	1.1	1.1	3.4	O K
8640 min Winter	8.550	0.050	0.0	1.0	1.0	3.1	O K
10080 min Winter	8.547	0.047	0.0	0.9	0.9	2.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	86.152	0.0	40.8	32
60 min Winter	56.713	0.0	53.8	60
120 min Winter	35.885	0.0	68.1	118
180 min Winter	26.921	0.0	76.6	172
240 min Winter	21.875	0.0	83.0	204
360 min Winter	16.309	0.0	92.8	276
480 min Winter	13.215	0.0	100.3	354
600 min Winter	11.214	0.0	106.4	434
720 min Winter	9.799	0.0	111.6	498
960 min Winter	7.911	0.0	120.1	624
1440 min Winter	5.836	0.0	132.9	854
2160 min Winter	4.293	0.0	146.7	1188
2880 min Winter	3.447	0.0	157.0	1496
4320 min Winter	2.530	0.0	172.8	2204
5760 min Winter	2.033	0.0	185.3	2936
7200 min Winter	1.717	0.0	195.6	3616
8640 min Winter	1.496	0.0	204.5	4400
10080 min Winter	1.332	0.0	212.4	5088

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.113

Time (mins) From:	To:	Area (ha)
0	4	0.113

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Model Details

Storage is Online Cover Level (m) 10.500

Cellular Storage Structure

Invert Level (m) 8.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	65.0	0.0	0.901	0.0	0.0
0.900	65.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0079-3000-1200-3000
Design Head (m)	1.200
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	79
Invert Level (m)	8.500
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.0	Kick-Flo®	0.707	2.4
Flush-Flo™	0.348	2.9	Mean Flow over Head Range	-	2.6

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	2.3	1.200	3.0	3.000	4.6	7.000	6.8
0.200	2.8	1.400	3.2	3.500	4.9	7.500	7.0
0.300	2.9	1.600	3.4	4.000	5.2	8.000	7.3
0.400	2.9	1.800	3.6	4.500	5.5	8.500	7.5
0.500	2.8	2.000	3.8	5.000	5.8	9.000	7.7
0.600	2.7	2.200	4.0	5.500	6.1	9.500	7.9
0.800	2.5	2.400	4.1	6.000	6.3		
1.000	2.8	2.600	4.3	6.500	6.6		