

KINGMOOR, WREXHAM

Drainage Strategy Report

Bryn Lane, Bowling Bank, Wrexham, LL13 9UT

Preliminary Report

KSW-BML-XX-XX-RP-C-0501

THURSDAY, 30TH MARCH, 2023

Contents Amendment Record

This report has been issued and amended as follows:

Revision	Description	Issued by	Checked by	Date
P05	Site Geology Appendix Updated	R. Abbott	A. Mavhunga	2023-03-30
P04	Updated appendices	R. Abbott	A. Mavhunga	2023-03-23
P03	Amendments to drainage design	R. Abbott	A. Mavhunga	2023-03-21
P02	Amendments to masterplan and drainage	R. Abbott	A. Mavhunga	2022-10-28
P01	First Issue for Planning Approval	R. Abbott	A. Mavhunga.	2022-07-29

Barnsley Marshall Limited have prepared this report in accordance with the instructions of their client, FI Real Estate Management, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

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1. Introduction

1.1 Project Background

Barnsley Marshall Ltd was appointed by FI Real Estate Management to provide a Flood Consequences Assessment & SuDS Drainage Strategy for the proposed development of 3 industrial units and an ecological area on 25.42Ha of land off Bryn Lane, Wrexham postcode LL13 9UT.

The report provides an assessment of flood risk from various sources on the proposed development based on Government and local authority guidance with regard to flood risk assessments.

The report is based on currently available information and preliminary discussions.

Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material deviation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

Where the proposed works to which this report refers are undertaken more than twelve months following the issue of this report, Barnsley Marshall shall reserve the right to re-validate the findings and conclusions by undertaking appropriate further investigations at no cost to Barnsley Marshall.

1.2 Scope of Drainage Strategy Report

In April 2015, the Government made changes to the National Planning Policy Framework which made Sustainable Urban Drainage Systems (SUDS) a material consideration in the determination of planning applications for new developments. This report has therefore been produced to support the Planning Application in accordance with the Town and Country Planning Order 2015.

The Strategy reviews the following information:

- Design and Construction Guidance Version 1 - Oct 2019
- Part H of the Building Regulations: Drainage and waste disposal
- BE EN12056 Part 2 Gravity Drainage Systems Inside Buildings
- Technical Advice Note 15: Development and Flood Risk (TAN15)
- CIRIA Report C753 SUDS Manual 2016.
- Non-statutory Technical Standards for Sustainable Drainage Systems, DEFRA, March 2015.
- BS EN 752:2008 Drain and sewer systems outside buildings.

- BS 8582:2013, Code of Practice for surface water management for development sites.
- BS 8533:2011, Assessing and managing flood risk in development – Code of practice.
- CIRIA C635 Designing for exceedance in urban drainage - good practice
- Flood Estimation Handbook (FEH) /Flood Studies Report (FSR) methods.
- Institute of Hydrology (IH) Reports No. 124.

2. Existing Site Details

2.1 Location and Description

The proposed development is located off Bryn Lane, Bowling Bank, Wrexham, LL13 9UT. The site is approximately 6.0km east of Wrexham city centre and is located in the North East area of Wrexham Industrial Estate. The site is bounded by existing conveyance ditches/watercourses along the western, northern and eastern sides of the site, which combine at the north-eastern corner of the site then flows in a north-easterly direction to River Dee approximately 3.1km from the site. The site is primarily a greenfield site, with some existing truck parking that can be accessed from Bryn Lane, refer to **Figure 1**.

Refer to **Appendix A** for the site location plan and proposed masterplan.



Figure 1: Development Site showing site boundary in red

(Source: Google Maps, 2022-07-26, 1300hrs)

2.2 Topography

The site generally slopes from south-west to the north-east towards the existing ditches. The southwestern corner of the site has an existing level of 28.51mAOD, and the north-eastern corner of the site has an existing level of 25.69mAOD, giving a fall of 2.82m over a distance of 600m, which approximates to a 0.47% longitudinal fall.

Two ditches border the site; one along the western and northern edge and the other along the eastern edge.

Refer to **Appendix B** for the site topography.

2.3 Existing Watercourses

The site is bounded by existing conveyance ditches/watercourses along the western, northern and eastern sides of the site, which combine at the north-eastern corner of the site then flows in a north-easterly direction to River Dee approximately 3.1km from the site. The site also has three exiting small ponds, which show no inflow or outflow to the watercourses mentioned above.

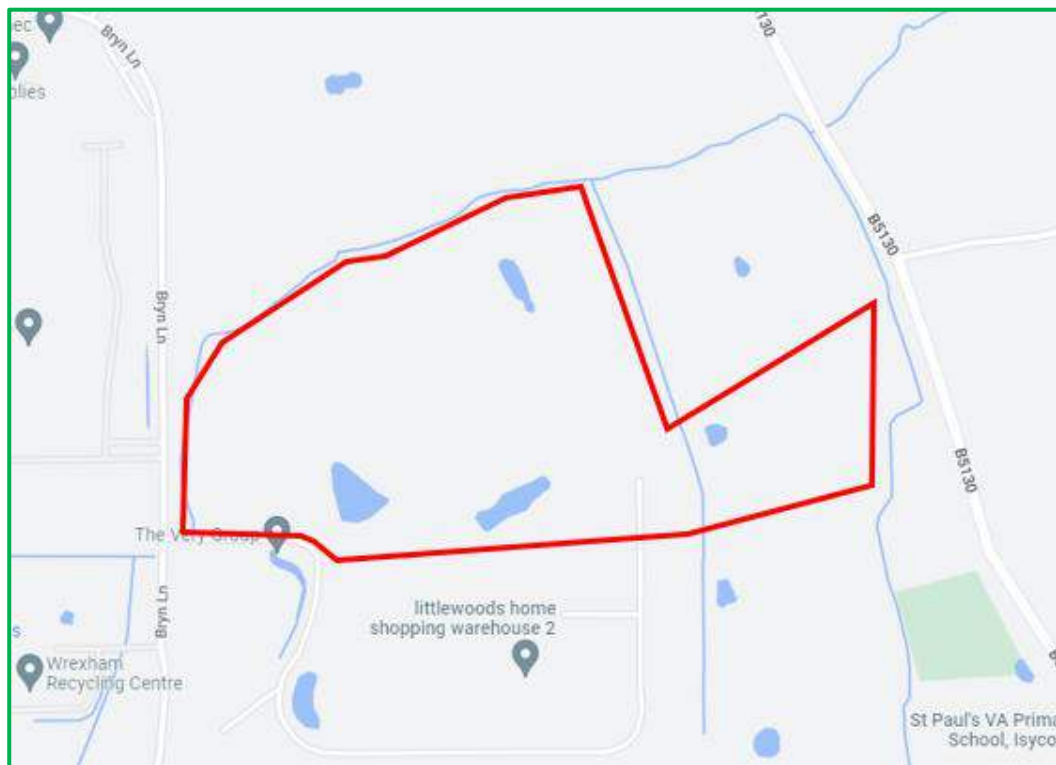


Figure 2: Rivers and Ponds within Site Extents

(Source: Google Maps, Accessed on 2022-07-26, 1640hrs)

2.4 Existing Public Drainage

There are no adopted sewers on site; the nearest existing public drainage is a DN150mm Welsh Water combined sewer approximately 150m south of the southwest corner of the site. From the provided Welsh Water sewer maps (refer to **Appendix G**), it can be seen that the two existing sewers are situated in the centre of Bryn Lane, south of the site.

2.5 Existing Private Drainage

There is no existing private drainage on site. A detailed CCTV & Drainage Survey shall be commissioned to determine whether sewers are on site, and propose remedial works if required to ensure continuity of the sewers during and after construction.

2.6 Site Geology

No Ground Investigation Survey had been carried out at the time this report was compiled. A search on British Geological Survey online showed that there are six boreholes within the site boundary, these are listed in **Table 1**, with their grid references and the ID numbers used within **Appendix C**. Other borehole locations around the site are shown in **Figure 3**.

Table 1: Boreholes within the site and their information

ID	Eastings	Northings	ID within Appendix C
SJ35SE47	339240	350210	S5
SJ35SE48	339240	350330	S7
SJ35SE51	339240	350500	S8
SJ35SE50	339360	350580	S9
SJ35SE49	339450	350420	S10
SJ35SE46	339450	350210	S6

A copy of the borehole results is contained in **Appendix C**.

The soil profile from the two boreholes indicate that the soil is predominantly clay for depths of 15m from the surface and would not support drainage via infiltration. However due to the dated nature of the boreholes, BRE Digest 365 Soakaway Tests shall be conducted at a number of locations across the site, and if infiltration is found to be possible, the proposed Geo-cellular Storage Tank and Ponds shall be designed as infiltration features, and the controlled outflows to the ditches shall be reduced, or if infiltration is good enough, there shall be no outfall from the ponds to the existing ditches.

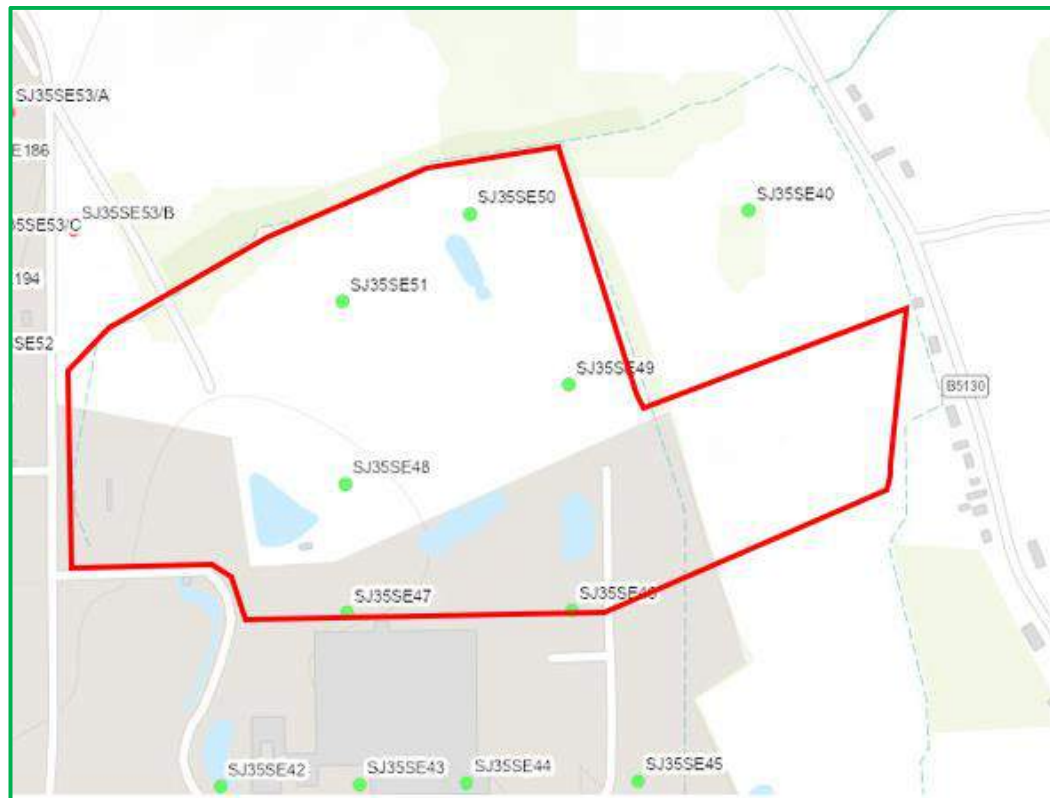


Figure 3: Historic Borehole Locations

(Source: British Geological Survey, Accessed on 2022-07-26, 1645hrs)

3. Drainage Strategy

3.1 Key Principles of SuDS

Figure 4 gives the key design principles critical for the implementation of SuDS:

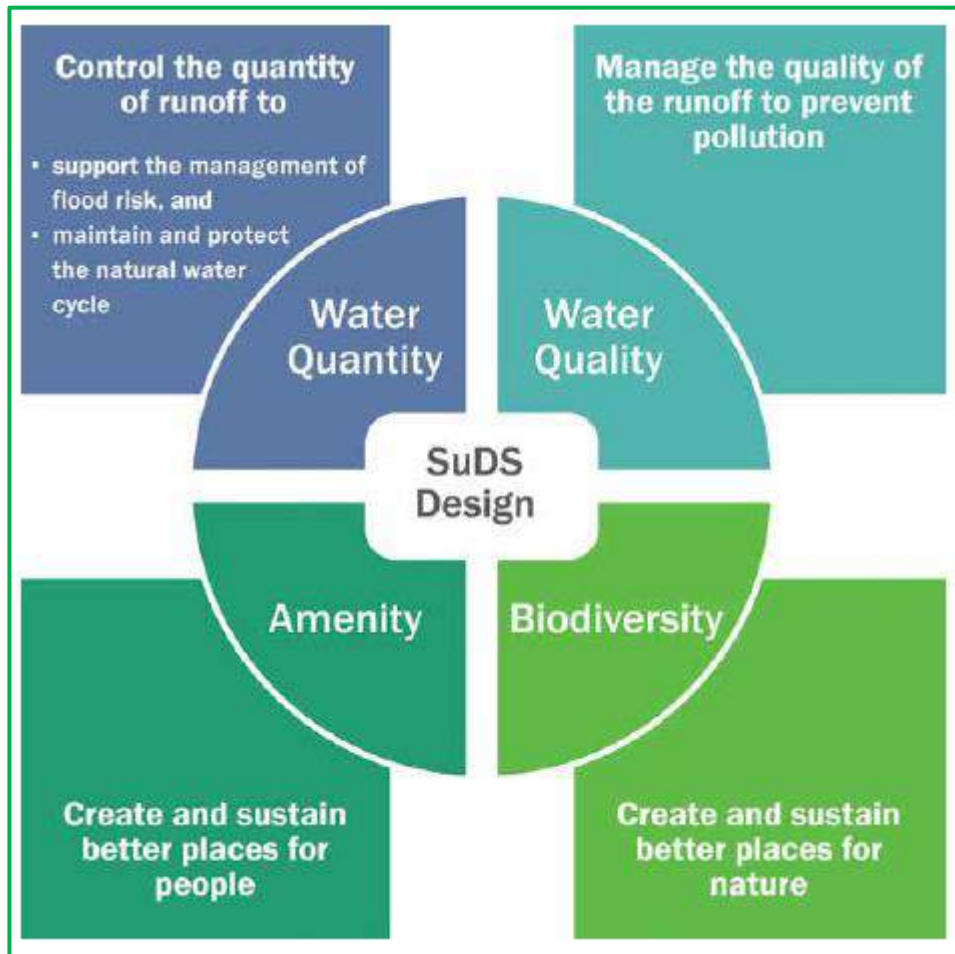


Figure 4: Four Main Categories of SuDS

(Source: CIRIA 753: The SuDS Manual)

Quantity Control : Achieved by controlling the quantity of surface water runoff reaching a watercourse, drainage system or sewer. Controlling runoff can aid in mitigating the risk of flooding. The benefits to quantity control include:

- Less surface water entering watercourses, thereby offsetting peak flows and reducing fluvial flood risk.
- Less surface water entering sewers, thereby freeing capacity and reducing flood risk
- Allows for adaption to climate change
- Allows for recharge of underground aquifer

Quality Control : Achieved by improving the quality of surface water reaching a watercourse, drainage system or sewer. The benefits to quality control include:

- Reduces of pollution levels in surface water bodies
- Protects groundwater resources from contamination
- Enables compliance with the Water Framework Directive

Biodiversity and Amenity Value : Achieved by introducing SuDS that enhance the existing biodiversity of the area and/or add amenity value to the community. The benefits include:

- Contributes to community health & wellbeing by providing green spaces with value in terms of landscape, recreation and walking routes
- Provides opportunities for multifunctional areas
- Provides wildlife habitat and ecological benefits
- Increases property values

These key design principles should be considered in all aspects of SuDS selection and design. All SuDS should aim to achieve **each of these principles**.

3.2 Discharge Hierarchy

Under the terms of Section H of the Building Regulations 2015, the SUDS Manual 2015 report C753, the disposal of surface water by means of soakaways should be considered as the primary method, refer to **Table 2**.

The main findings (refer to **section 2.6** of this report) were that drainage via infiltration is not feasible due to the presence of clay soils from the surface to depths greater than 5.0mbgl.

Table 2: Surface Water Discharge Hierarchy

Surface Water Discharge Hierarchy	
1	Reuse on site (i.e., rainwater harvesting)
2	Into the ground (infiltration)
3	To a surface water body
4	To a surface water sewer, highway drain, or another drainage system
5	To a combined sewer

3.3 Sustainable Drainage Systems Appraisal

A SuDS appraisal was conducted based on the SuDS hierarchy given in **Table 2**. **Table 3** gives the results of the appraisal.

Table 3: Scheme Appraisal of SuDS Drainage Features

SuDS Feature	Is feature suitable for the proposed site?	Comment
Soakaway	NO	Clay soils.
Green/Brown Roofs	NO	Proposed roofs too steep for green roofs, also a maintenance liability.
Filter Trench/Drain	NO	Swales proposed instead.
Swale	YES	Proposed as last SuDS feature before discharge to existing ditches.
Permeable Paving	YES	Proposed within car parking bays – with drainage collection pipe at the bottom.
Infiltration Basin	NO	Clay soils.
Detention Basin	NO	Spatial constraints and layout make use of Detention Basin unsuitable.
Bioretention System (Rain Garden / Stormwater Planters)	NO	Spatial constraints and layout make use of Bioretention Systems unsuitable.
Pond	NO	Spatial constraints and layout make use of Pond unsuitable.
Storage System: Geo-cellular or Tank	YES	Provided to store extra runoff that could not be accommodated by the pond.

Based on the selected SuDS features as per **Table 3**, the main SuDS features associated with the proposed drainage strategy are summarised below:

Permeable Pavement: Permeable pavement underlaid by a drainage blanket (0-40mm sub-base) wrapped in impermeable geo-membrane will allow runoff to undergo cleansing by the sand layer and sub-base. The permeable pavement shall be System C to BS 7533-13:2009 Figure 4, with an impermeable liner and collection pipe at the base of the sub-base.

Figure 5 gives a section through permeable pavement System C.

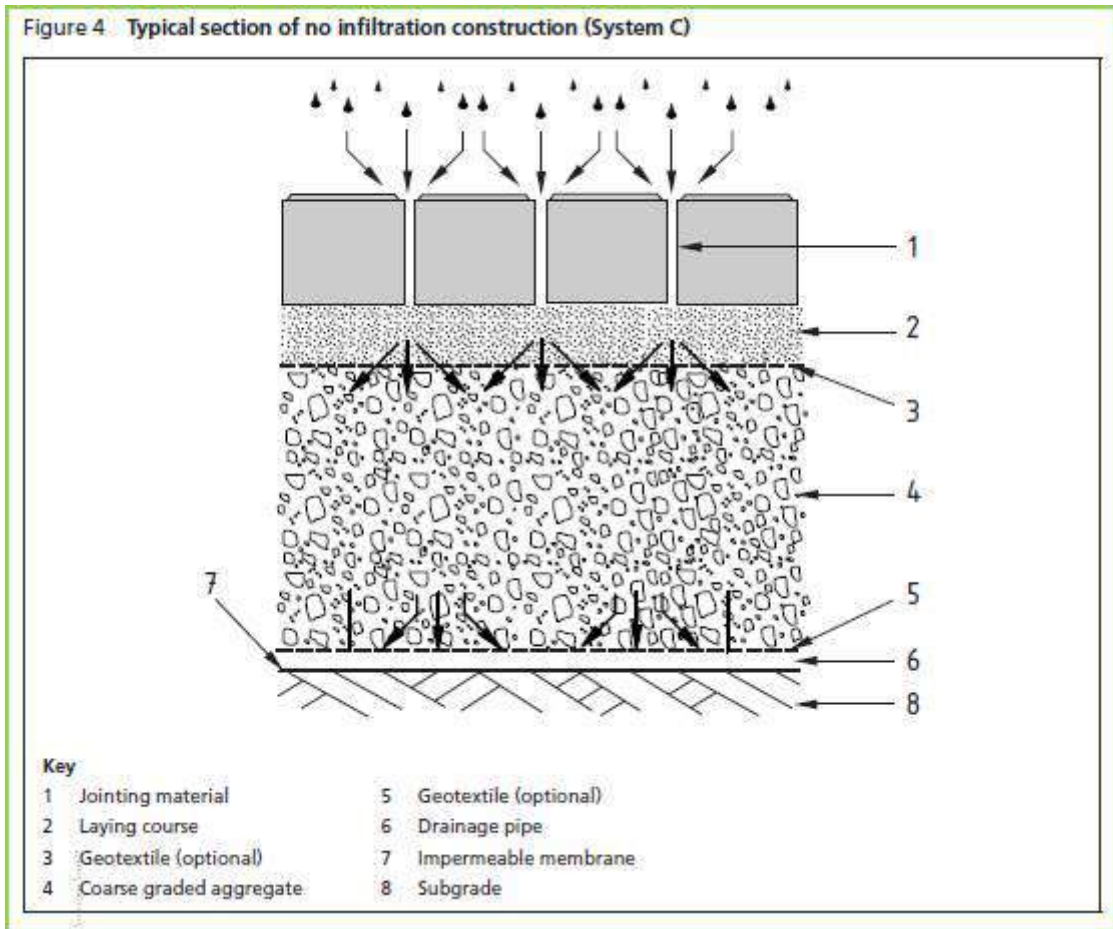


Figure 5: Permeable Pavement System C – for no infiltration

(Source: BS 7533-13:2009 Figure 4)

Flow Control Device: Runoff from the development to existing ditches shall be controlled to maximum 116.6 l/s for all storm events up to and including the 100-year + 40% CC storm event by three (3) Hydro-brake Outflow Controls located at the downstream end of the proposed stormwater networks as shown on the drainage plan layout in **Appendix D**.

The SuDS Approval Body shall be consulted and fully briefed on the proposed drainage strategy so they can provide a formal Discharge Consent to the existing ditches.

Rigistorm Separate Catchpit: The catchpits with 450mm deep sumps have been strategically placed to capture debris and silt before the runoff reaches locations where it would be onerous to remove the silt.

Swales: Provide chemical treatment, and must have reeds and/or special grass (like Perennial Rye) to Landscape Architect's specification. The flora (planted grass/lawn/reeds) within the Pond/Swale areas absorb the pollutants via

photosynthesis and reduce pollutant concentrations in the runoff. The microbial action of any fauna (bacteria/slugs) within the pond/swale areas also cause chemical cleansing of the runoff and enhance water quality. The ponds/swales also provide physical treatment via adsorption of suspended solids to the flora (grass/lawn/reeds).

3.4 Surface Water Drainage Strategy

The proposed development has a plan area of 25.42Ha, with approximately 14.6ha being impermeable, and 10.7ha being reserved for an ecological zone. The IH124 method was used to estimate the greenfield runoff rates from the site since the site is less than 200Ha. *Because the site is also less than 50ha, the ICP SUDS tool in Micro-drainage Source Control module was used to calculate the greenfield runoff rates.* The tool uses the IH124 approach to calculate the greenfield runoff for 50ha, then linearly interpolate to get the flows for smaller catchments. The 1-year, 30-year, and 100-year Greenfield runoff rates were found to be 116.6 l/s, 233.6 l/s, and 288.8 l/s respectively, refer to **Appendix E**.

Qbar is 132.5 l/s for both rural and urban.

It is recommended that, to prevent increased flows post-development and offer an improvement to existing downstream flash flooding, runoff from the development shall be controlled to the 1-year Greenfield Runoff Rate of 116.6 l/s maximum for all storm events up to and including the 100-year + 40% CC storm event.

Figure 6 gives a summary of the proposed SuDS Drainage Strategy.

The SuDS Approval Body shall be consulted and fully briefed on the proposed drainage strategy so they can provide a formal Discharge Consent to the existing ditches before construction begins.

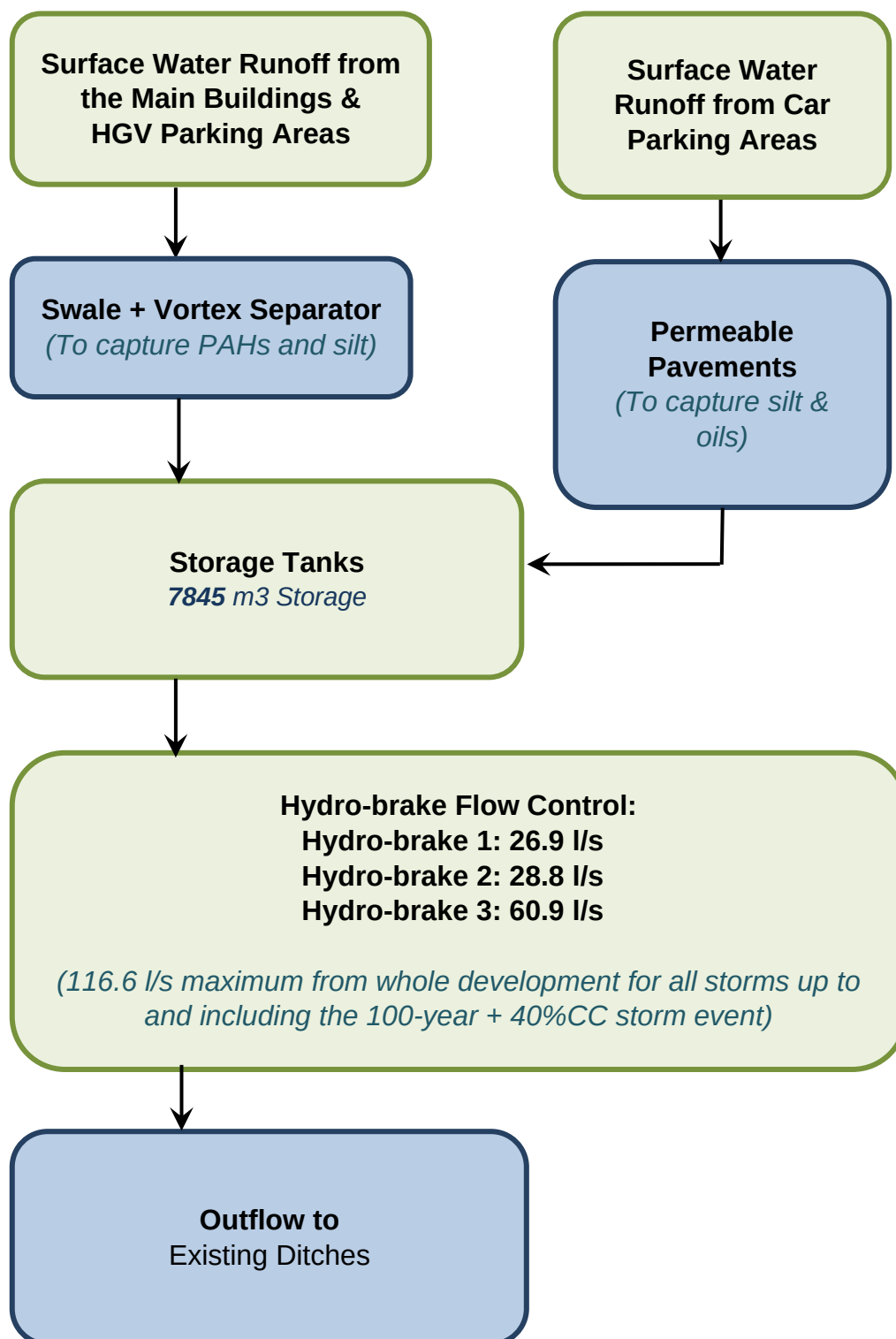


Figure 6: SuDS Drainage Strategy Summary

3.5 Pollution Control and Water Quality

The following pollution control devices have been proposed:

❖ **Permeable Pavement Areas:**

Treat pollutants from Parking Bays

Permeable pavement underlaid by a drainage blanket (0-40mm sub-base) wrapped in permeable geotextile will allow runoff to undergo filtration through the sand layer, sub-base and sub-grade before reaching the water table. Permeable Pavement is the primary Pollution Control feature for this SuDS scheme. Any spilled polycyclic aromatic hydrocarbons are filtered through the pavement layers before reaching the sub-grade. Refer to **Appendix D** for areas to receive permeable pavement and construction make-up.

❖ **Swales:**

Treat effluent from whole site

Work as treatment plants for both dissolved and solid-bound pollutants. The flora (planted grass/lawn/reeds) within the pond/swale absorb the pollutants via photosynthesis and reduce the concentrations in the runoff. The reeds also provide physical treatment via adsorption of suspended soils to the flora (grass/lawn/reeds). Refer to **Appendix D** for swale details.

❖ **Catchpit:**

Capture silt & debris

Catchpits have been strategically placed to capture debris and silt before the runoff reaches areas which would make it difficult to cleanse the system of the pollutants.

Vortex Separator /Downstream Defender:

Capture PAHs, silt & debris

The Vortex Separators have been strategically placed to capture and PAHs, silt and debris from the HGVs & Cars parking areas before the runoff reaches the proposed Storage Tanks.

CIRIA report C753, The SuDS Manual, says on page 567 'To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for each contaminant type).'

Table 4 shows Table 26.2 of the SuDS Manual, which gives the pollution hazard indices for various land uses.

Table 4: Pollution hazard indices for different land use classifications

TABLE 26.2 Pollution hazard indices for different land use classifications				
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

Notes

- 1 Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009).
- 2 These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help determine the most appropriate approach to the development of a design solution.

Table 5 shows Table 26.3 of the SuDS Manual, which gives indicative SuDS mitigation indices for discharges to surface waters.

Table 5: Indicative SuDS mitigation indices for discharges to surface waters

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters				
Type of SuDS component	Mitigation indices¹			
	TSS	Metals	Hydrocarbons	
Filter strip	0.4	0.4	0.5	
Filter drain	0.4 ²	0.4	0.4	
Swale	0.5	0.6	0.6	
Bioretention system	0.8	0.8	0.8	
Permeable pavement	0.7	0.6	0.7	
Detention basin	0.5	0.5	0.6	
Pond ⁴	0.7 ³	0.7	0.5	
Wetland	0.8 ³	0.8	0.8	
Proprietary treatment systems ^{5,6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.			

Notes

- 1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.
- 2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
- 3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
- 4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.
- 5 See **Chapter 14** for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: <http://tinyurl.com/qf7yuj7>
- 6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Table 6 gives a summary analysis of the adequacy of the proposed SuDS drainage in addressing pollution control and water quality.

Table 6: Mitigation versus hazard indices for proposed layouts

SuDS Drainage Layout	SuDS device/Land Use	TSS	Metals	Hydro-carbons	Remark
Permeable Pavement	Permeable Pavements	0.7	0.6	0.7	OK, SuDS element provides sufficient treatment.
	Cars Parking Area	0.5	0.4	0.4	
Swales & Vortex Separators	Swales & Vortex Separators	1.2	1.3	1.1	OK, SuDS elements provide sufficient treatment.
	Buildings' Roofs & HGVs Parking Area	1.1	1.1	0.95	

3.6 Spillage Management

The probability of an oil spillage on this site is higher within the HGV Parking Areas, refer to proposed Masterplan. Should any accidental oil spillage take place, the effluent from the HGVs Parking Area flows into the proposed swale along the north site of the proposed building. A catchpit with Penstock located at the downstream end of the swale is sealed by lowering the penstock, thus containing the spillage to the swale. The oil can then be sucked up and the swale cleansed before opening the penstock. Use of the swale and Penstock Catchpit absolves the need for a Bypass Oil Interceptor. Vortex Separators shall be introduced just upstream of proposed Storage Tanks to capture any remnant PAHs and silt before the runoff enters the tanks.

Any minor spills within the Cars Parking Area will be treated by the Permeable Pavement as the runoff filters through the layers to the collection pipe at the bottom of the sub-base.

3.7 Exceedance Flows

Exceedance flows are those flows generated by flooding of part or all of the drainage scheme due to storm events in excess of the design storm event [100-year + 40% CC storm event].

Exceedance flood water will find its way to existing ditches running along the western, northern, and eastern edges of the site.

Refer to **Appendix F** for FloodFlow Analysis Plan Layout.

3.8 Foul Drainage Strategy & Phosphorous Control

Foul drainage from the industrial units shall flow by gravity to a proposed Foul Pumping Station onsite, from which it shall be pumped and discharged to an existing Welsh Water Public Foul Sewer at the south-western edge of the site.

Natural Resources Wales produced an updated white paper in July 2022 titled: ***'Advice to planning authorities for planning applications affecting phosphorus sensitive river Special Areas of Conservation.'***

Within this document, there is a section which poses the following question:

'What development proposals are unlikely to increase phosphorus levels within a river SAC?'

The section then provides a list of site characteristics which classify a site as not likely to have a significant effect on a river SAC in relation to phosphorus inputs, as there is unlikely to be a source of additional phosphorus.

‘The following developments can be screened out as not likely to have a significant effect on a river SAC in relation to phosphorus inputs, as there is unlikely to be a source of additional phosphorus or pathway for impacts:

-  *any development that does not increase the volume and phosphorus concentration of wastewater*
-  *any development that improves existing water quality discharges by:*
 - *reducing the phosphorus concentration of wastewater without increasing volume or*
 - *by decreasing the volume of wastewater produced without increasing the concentration of phosphorus.*
-  *developments intended to provide services, facilities, commercial sites, or places of employment (e.g., community buildings, schools etc.) for a local population already served by residential connections to existing public or private sewers discharging within the SAC river catchment.’*

Kingmoor falls within the category highlighted in purple above by virtue of it being an industrial site which will tap mostly local staff - from Wrexham and surrounding areas. It is therefore acceptable to discharge foul sewage from the proposed site directly into the existing Welsh Water public foul sewer based on phosphorous compliance.

An S106 WIA Direct Connection consent shall be obtained before construction begins.

3.9 Maintenance and Operation

A SuDS Operation and Maintenance Manual has been produced and issued as a separate document from this report. The Manual shall be revised post-construction to suit as-built drainage (which should be in accordance with details approved at planning stage) and added to the Health and Safety File.

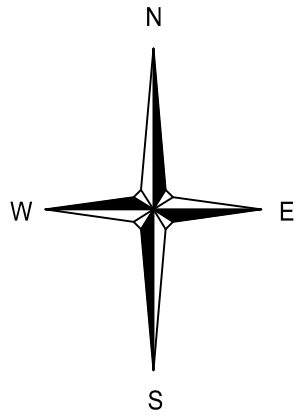
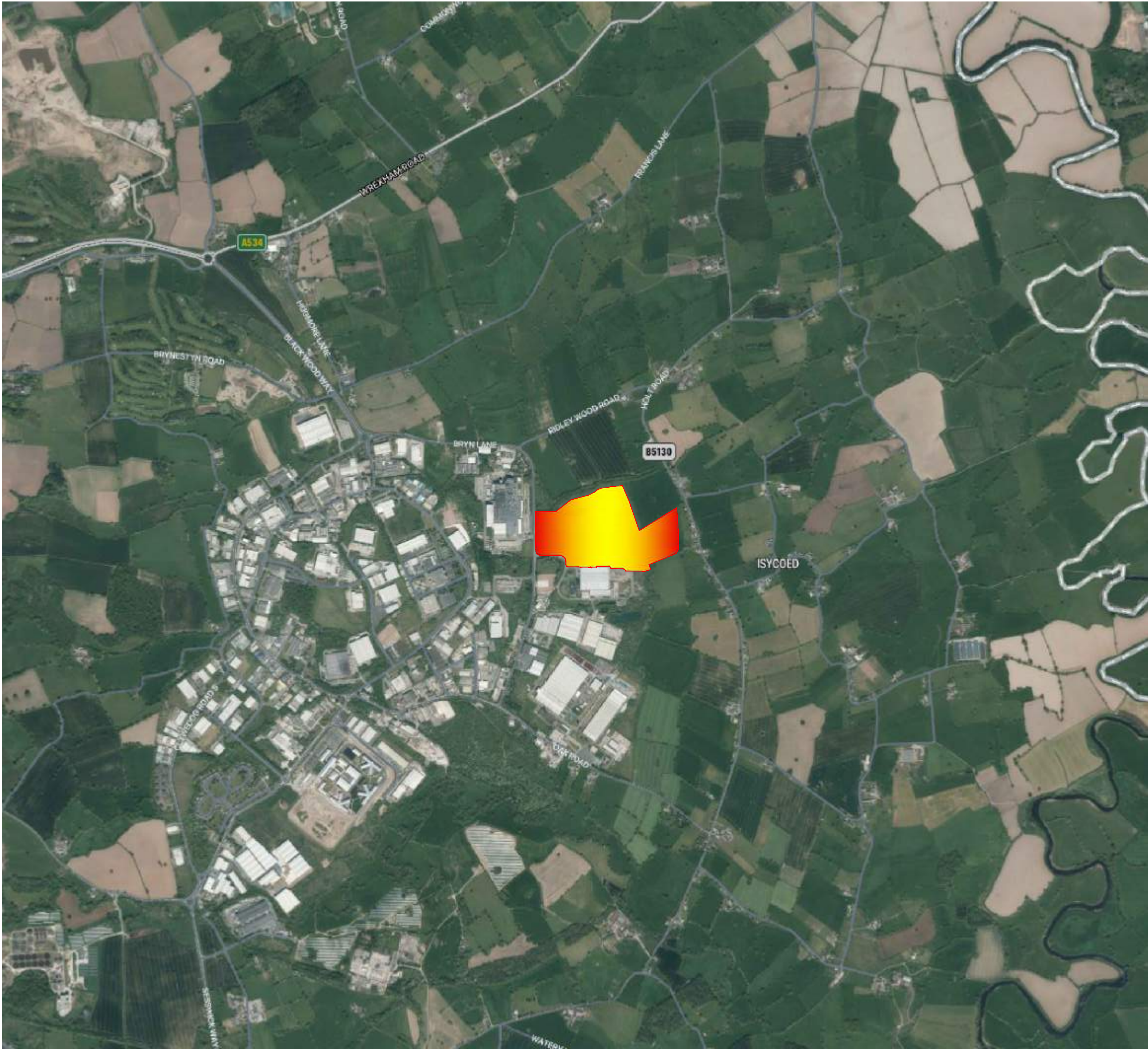
Please refer to report **KSW-BML-XX-XX-RP-C-0502** SuDS Operation and Maintenance Manual for details of Owner and Maintainer of the assets, and recommended maintenance regime for the drainage assets.

APPENDICES



Appendix A

Site Location Plan and Masterplan



Safety, Health & Environmental Information:

In addition to the hazards and risks normally associated with the types of work detailed on this drawing, please note the significant hazards identified by symbols below,



INDICATES A RESIDUAL RISK AS A WARNING



INDICATES A RESIDUAL RISK FOR INFORMATION

and described below:

Construction/Maintenance/Cleaning/Demolition
Refer to Drawing:

General Notes:

1. Do not scale from this drawing.
2. All dimensions are in millimetres (mm), all levels in metres (m) unless noted otherwise.
3. Discrepancies or omissions are to be reported to the Engineer prior to work commencing.
4. Materials and workmanship are to comply in all respects with current British Standard Specifications, Codes of Practice, and Building Regulations Approved Documents.
5. The copyright of this drawing is vested in the Engineer and must not be copied or reproduced without written consent.
6. The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points before work commences.
7. This drawing is to be read in conjunction with all relevant specifications and drawings issued by the Engineer, Architect and other Specialists.

P01	DH/AM	09/02/22	Preliminary Issue
Rev	By / Chk'd	Date	Description

PRELIMINARY DRAWING
This drawing is not to be used for construction

Client



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Project

Kingmoor Site, Wrexham

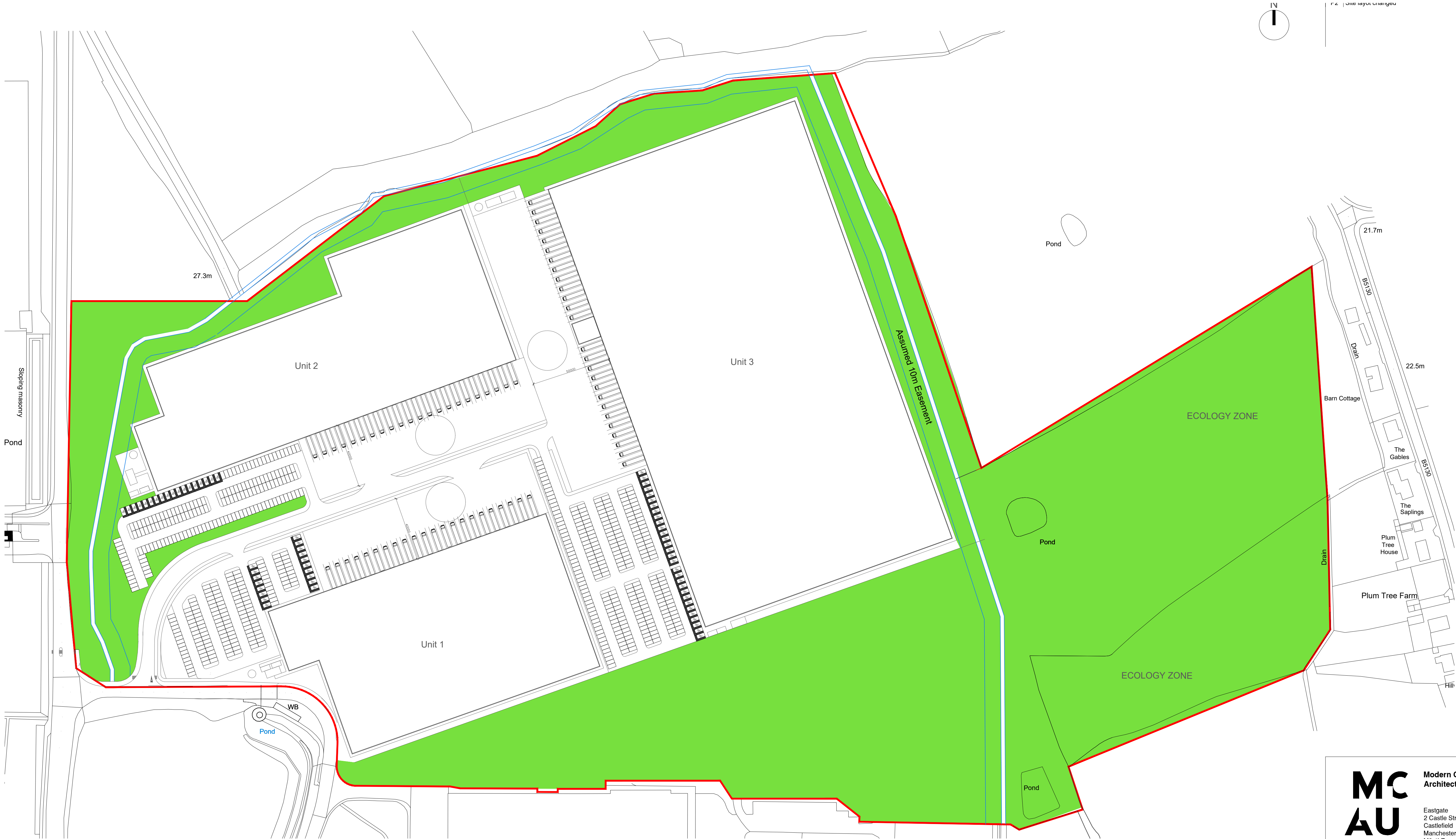
Drawing

Site Location Plan

By	DH/AM	Date	09/02/2022
Drawing No.	KSW-BML-XX-XX-DR-C-0100		Revision P01
BML Job No.	1000-03		Status -

Drawing Scale at A1: N.T.S

CAD Filename: C:\Users\DH\Documents\BarnsleyMarshall\BML-XX-XX-XX-DR-C-0100\BML-XX-XX-XX-DR-C-0100.dwg



Total Site Area : 254,287 sqm
Total Ecology Area: 114,489 sqm
Ecology Zone as site percentage: 45% approx

Unit	Use	Ground Floor Area	Mezz Office Area (5%)	Storage Mezz Area (7.5%)	Unit Total Area
1	B8	17,187sqm / 185,000sqft	859sqm / 9,250sqft	1,289sqm / 13,875sqft	19,335sqm / 208,125sqft
2	B8	19,045sqm / 205,000sqft	952sqm / 10,250sqft	1,428sqm / 15,375sqft	21,425sqm / 230,625sqft
3	B8	46,451sqm / 500,000sqft	2,322sqm / 25,000sqft	3,483sqm / 37,500sqft	52,257sqm / 562,500sqft

Development Total	93,019sqm / 1,001,250sqft
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Unit	Parking Number
1	175 spaces including 18 accessible
2	183 spaces including 18 accessible
3	296 spaces including 30 accessible

MC

AU

Modern City

Architecture & Urbanism

Eastgate

2 Castle Street

Castlefield

Manchester

M3 4LZ

t: 0161 974 7203

e: info@mcau.co.uk

www.mcau.co.uk

Client
F.I. Real Estate Management

Project
Kingmoor Wrexham

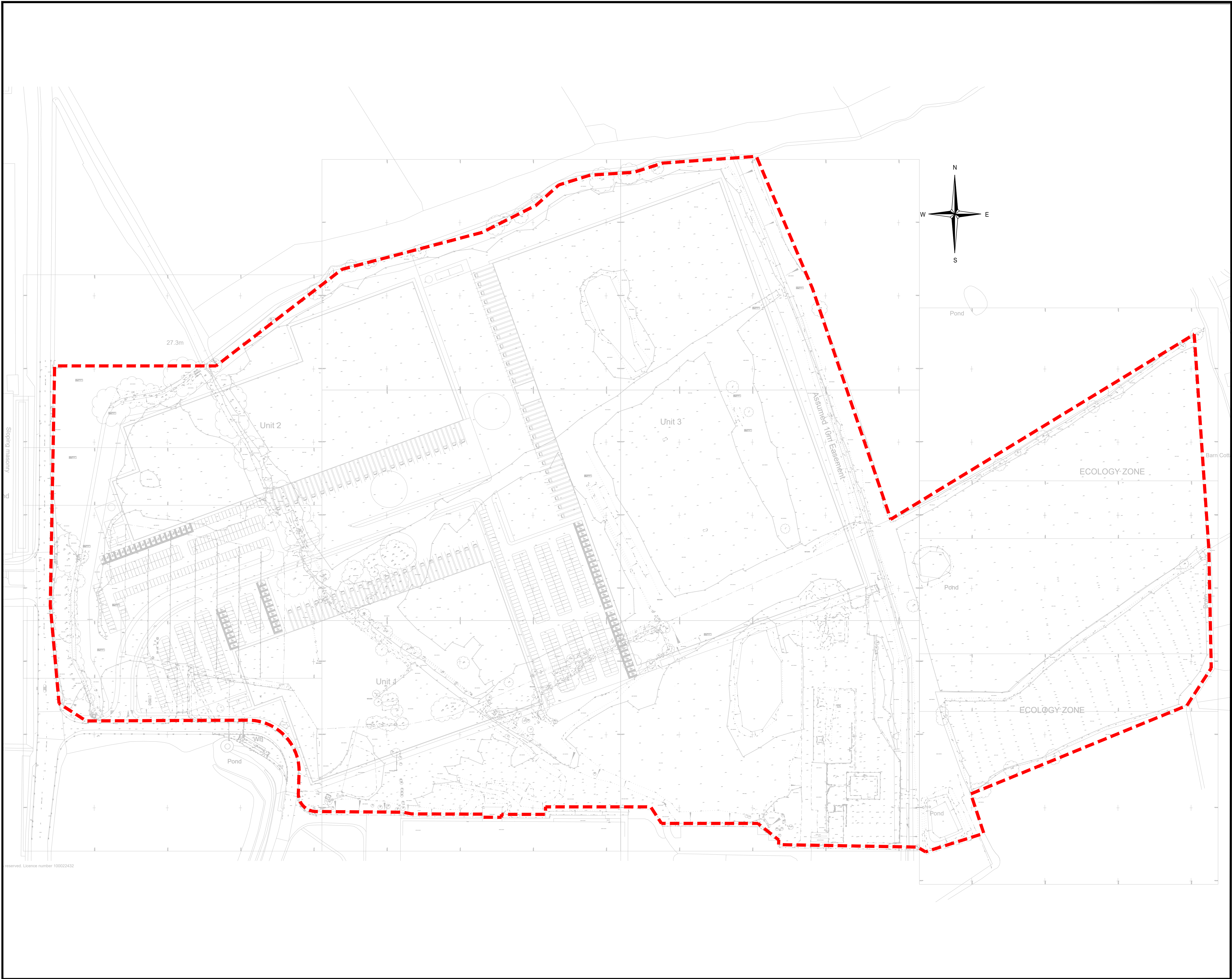
Description
Proposed 3 Unit Site Plan

Status INFORMATION		
Scale	Drawn By	Date
1:1250@A1	PJ	AUG22
Job Number	Drawing Number	Revision
1204	02-001	P2



Appendix B

Site Topography



Safety, Health & Environmental Information:
In addition to the hazards and risks normally associated with the types of work detailed on this drawing, please note the significant hazards identified by symbols below,

 INDICATES A RESIDUAL RISK AS A WARNING

 INDICATES A RESIDUAL RISK FOR INFORMATION

and described below:

Construction/Maintenance/Cleaning/Demolition
Refer to Drawing:

- General Notes:**
1. Do not scale from this drawing.
 2. All dimensions are in millimetres (mm), all levels in metres (m) unless noted otherwise.
 3. Discrepancies or omissions are to be reported to the Engineer prior to work commencing.
 4. Materials and workmanship are to comply in all respects with current British Standard Specifications, Codes of Practice, and Building Regulations Approved Documents.
 5. The copyright of this drawing is vested in the Engineer and must not be copied or reproduced without written consent.
 6. The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points before work commences.
 7. This drawing is to be read in conjunction with all relevant specifications and drawings issued by the Engineer, Architect and other Specialists.

P01	RA/AM	31/10/2022	Preliminary Issue
Rev	By / Chkd	Date	Description

PRELIMINARY DRAWING
This drawing is not to be used for construction

Client

 **FI REAL ESTATE MANAGEMENT**

BarnsleyMarshall Limited
1 Birch Court
Blackpole East
Worcester
WR3 8SG

Tel: 01905 330660
Email: design@barnsleymarshall.co.uk
Web: www.barnsleymarshall.co.uk

 **BarnsleyMarshall**

Project
Kingmoor Site, Wrexham

Drawing
Site Geology

By	RA/AM	Date	31/10/2022
Drawing No.	KSW-BML-XX-XX-SK-C-0510		Revision P01
BML Job No.	1000-03		Status -

Drawing Scale at A1: 1:1250

CAD Filename: C:\Users\BML\Documents\BML\BML-Site-Plan\BML-Site-Plan.dwg

Insert 4
n.ts



Appendix C

Site Geology

NJ 33 516 48 1962 4858 North-west of Bush Farm, Iscrod 1st Aug, 1961

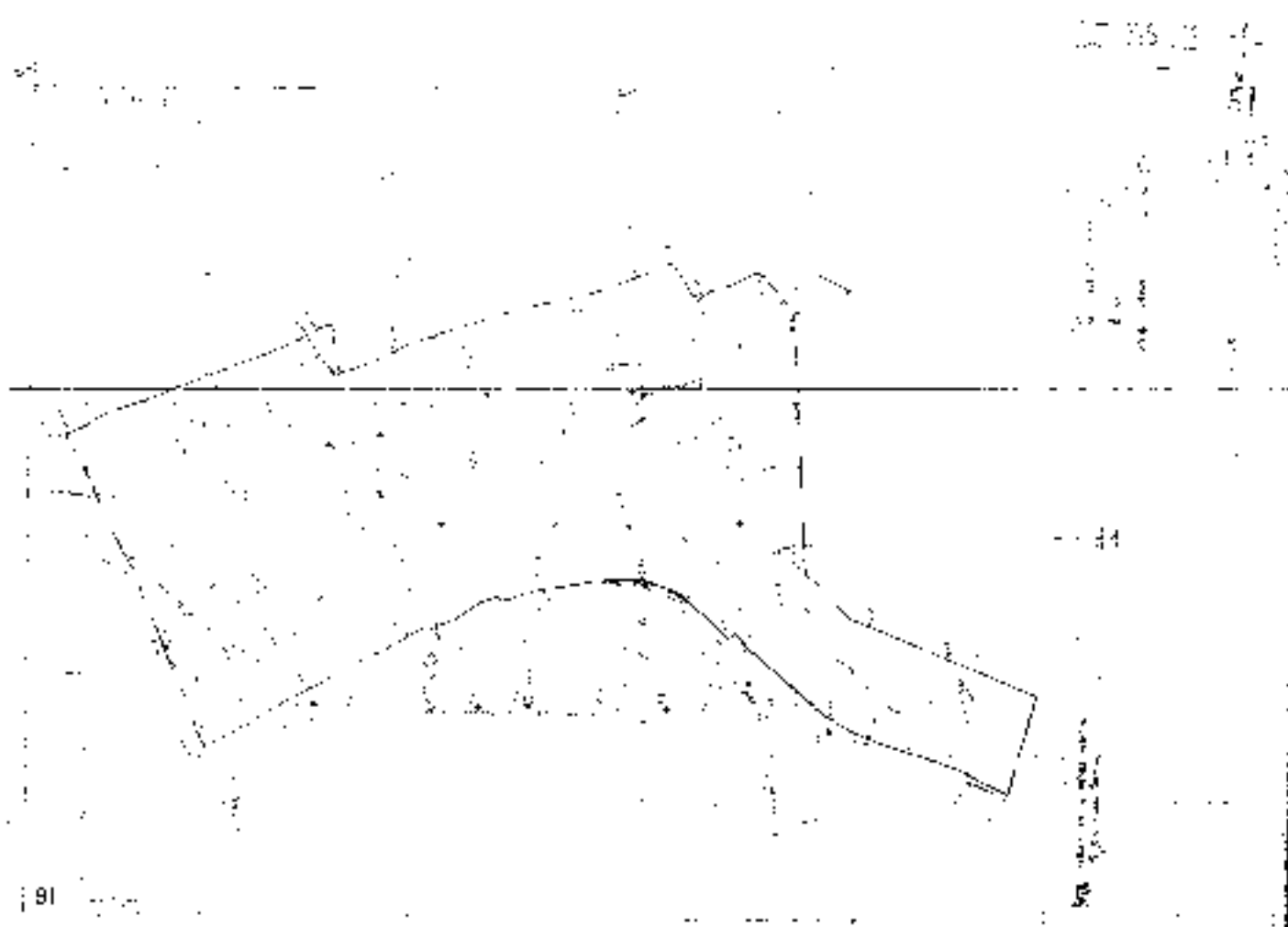
Surface level = 2.1m ± 0.1m
 Water temperature
 Shell and slug boxes (20) and diameter
 May, 57%

Water 10.0m

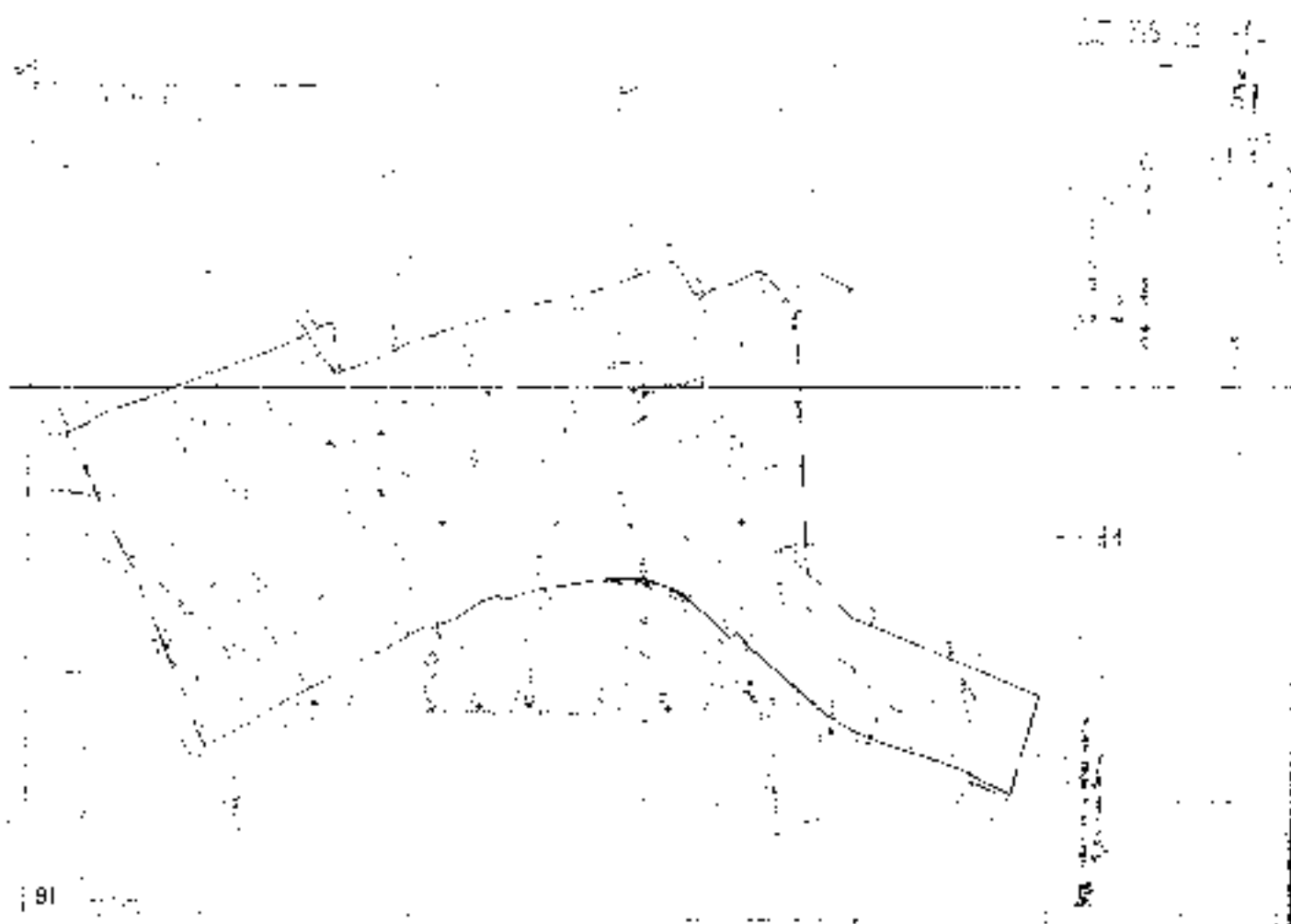
100%

Geological classification	Lithology	Thickness m	Depth m
	Sed	0.1	0.1
Sandstone	Clay, reddish-brown, greyish of saprophytic with extra-skeletal material subrounded clasts of marine sandstone and quartz material	1.5	1.6

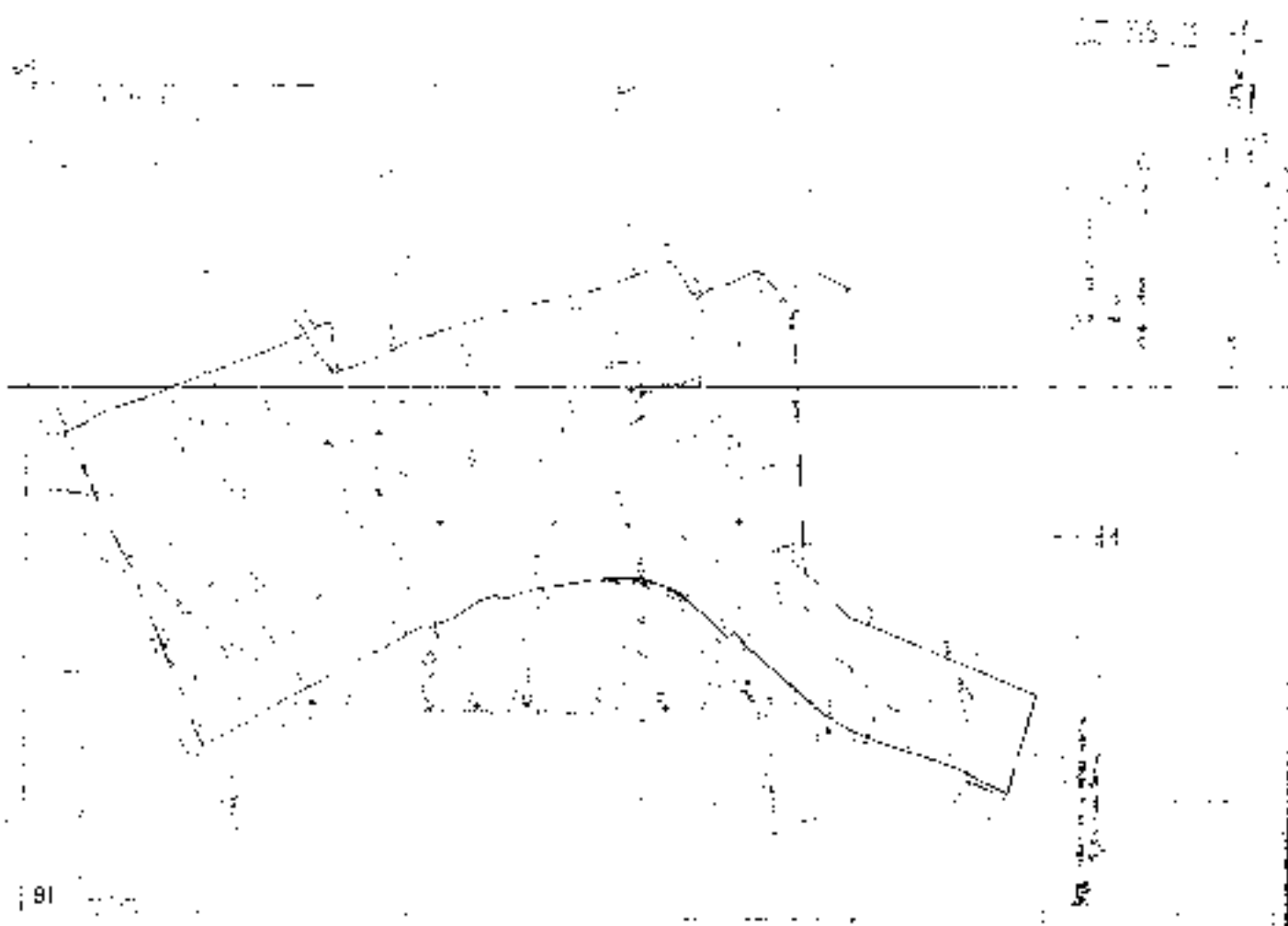
Lithology (Classification)	Description of Strata	Depth to Sample DATE	Sample No.	Drill - Log Remarks
LITHO SANDY CLAY (MAYBE TAN)	CLAY, REDDISH BROWN, STIFF (EXPOSED IN WATER 24). TIGHTLY SET, CRACKING POWDER, UNBANDDED LAMINAR LAMINAE & QUARTZITE CLASTS (C' 1/4 - 1/2 mm size) 5' to 7' 0" in thick. 60' or 65' in is blue mottled in water 1' in no change with depth	1800		
	BOREHOLE COMPLETED AT 1800			



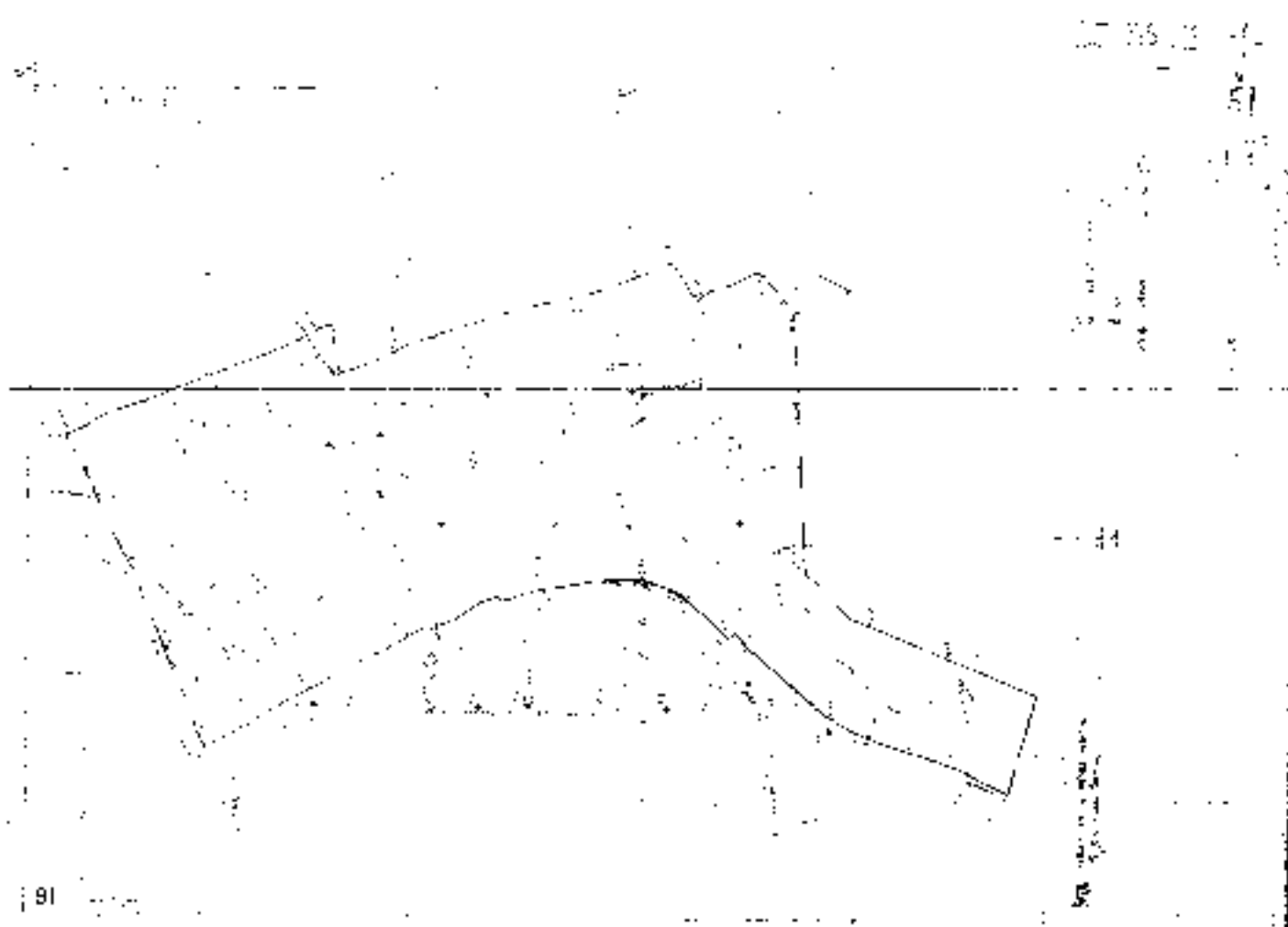




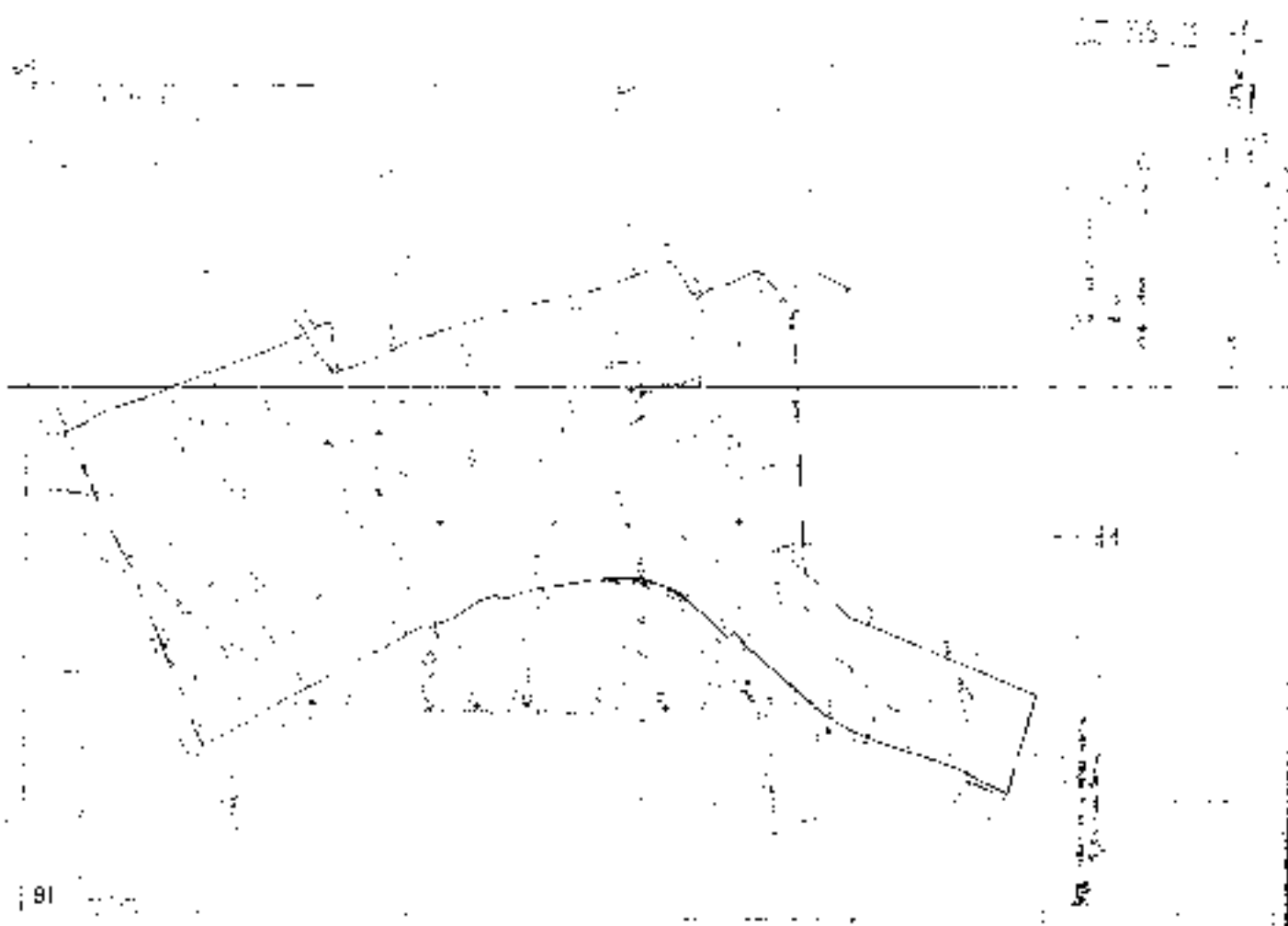




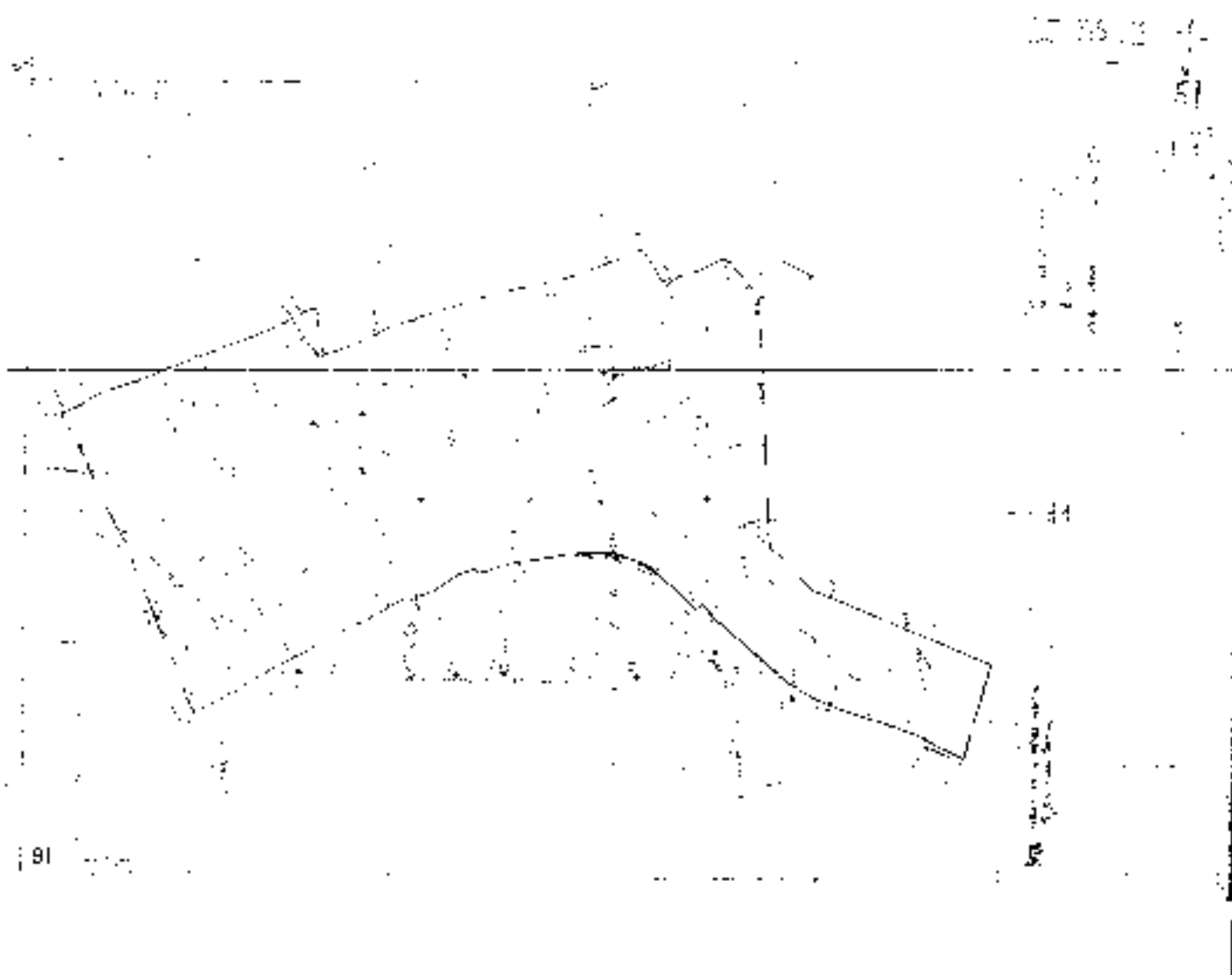










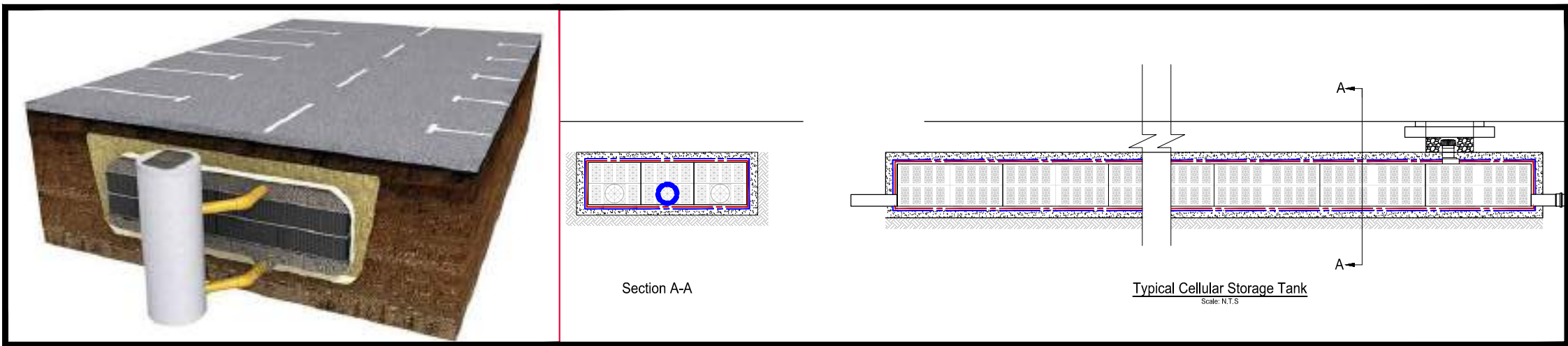




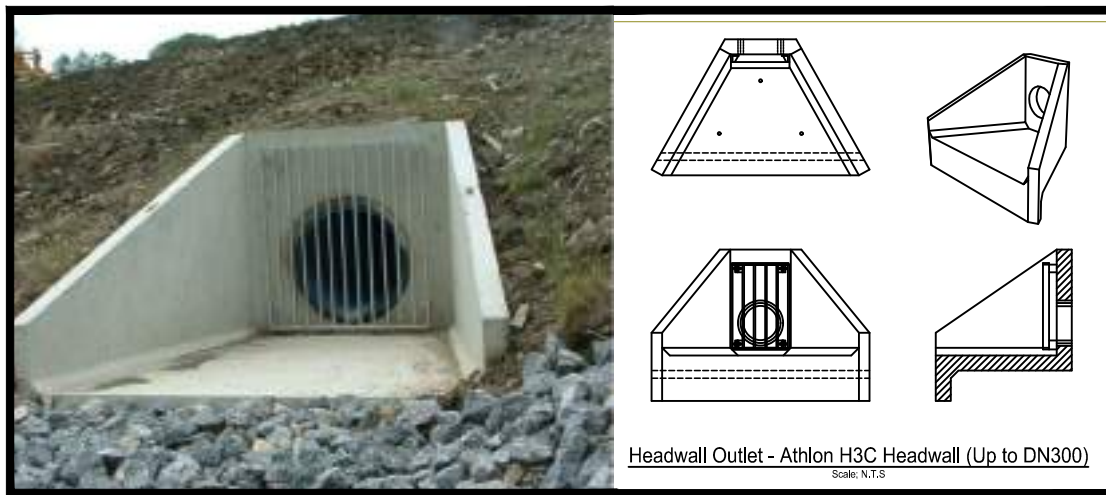


Appendix D

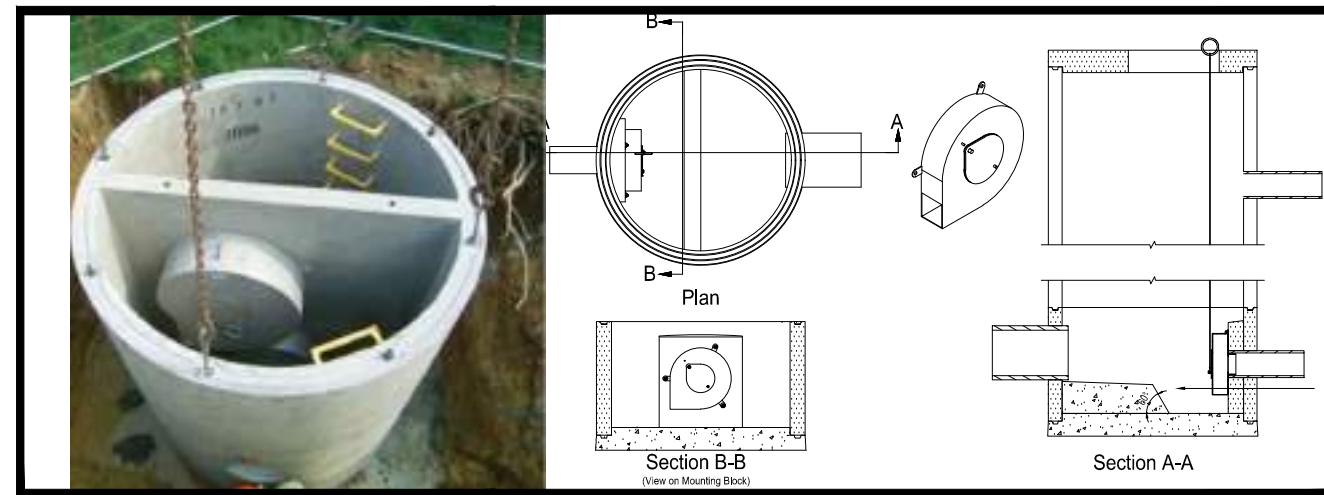
Drainage Strategy Drawings



Insert 1
n.t.s



Insert 2
n.t.s



Insert 3
n.t.s

Safety, Health & Environmental Information:
In addition to the hazards and risks normally associated with the types of work detailed on this drawing, please note the significant hazards identified by symbols below,
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Key

	Drainage Sub - Catchment 1
	Drainage Sub - Catchment 2
	Drainage Sub - Catchment 3
	Dock Levellers Locations

P05	RA/AM	23/03/2023	Addition of New Pond
P04	RA/AM	20/03/2023	Treatment Pond 2 split to avoid new pond
P03	RA/AM	25/10/2022	Masterplan amended, Drainage amended to suit
P02	DH/AM	03/10/22	Foul Drainage revised to include treatment tanks
P01	DH/AM	29/07/22	Preliminary Issue
Rev	By / Chkd	Date	Description

PRELIMINARY DRAWING
This drawing is not to be used for construction

Client

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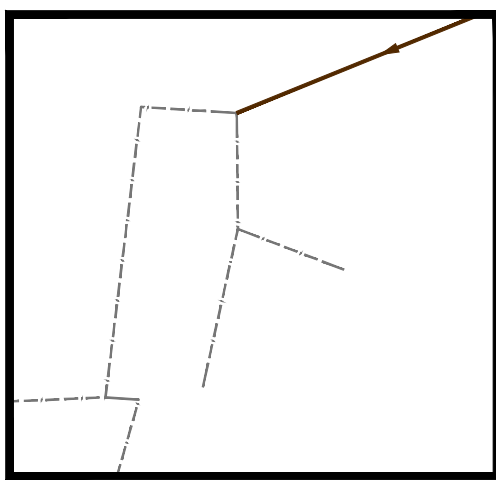
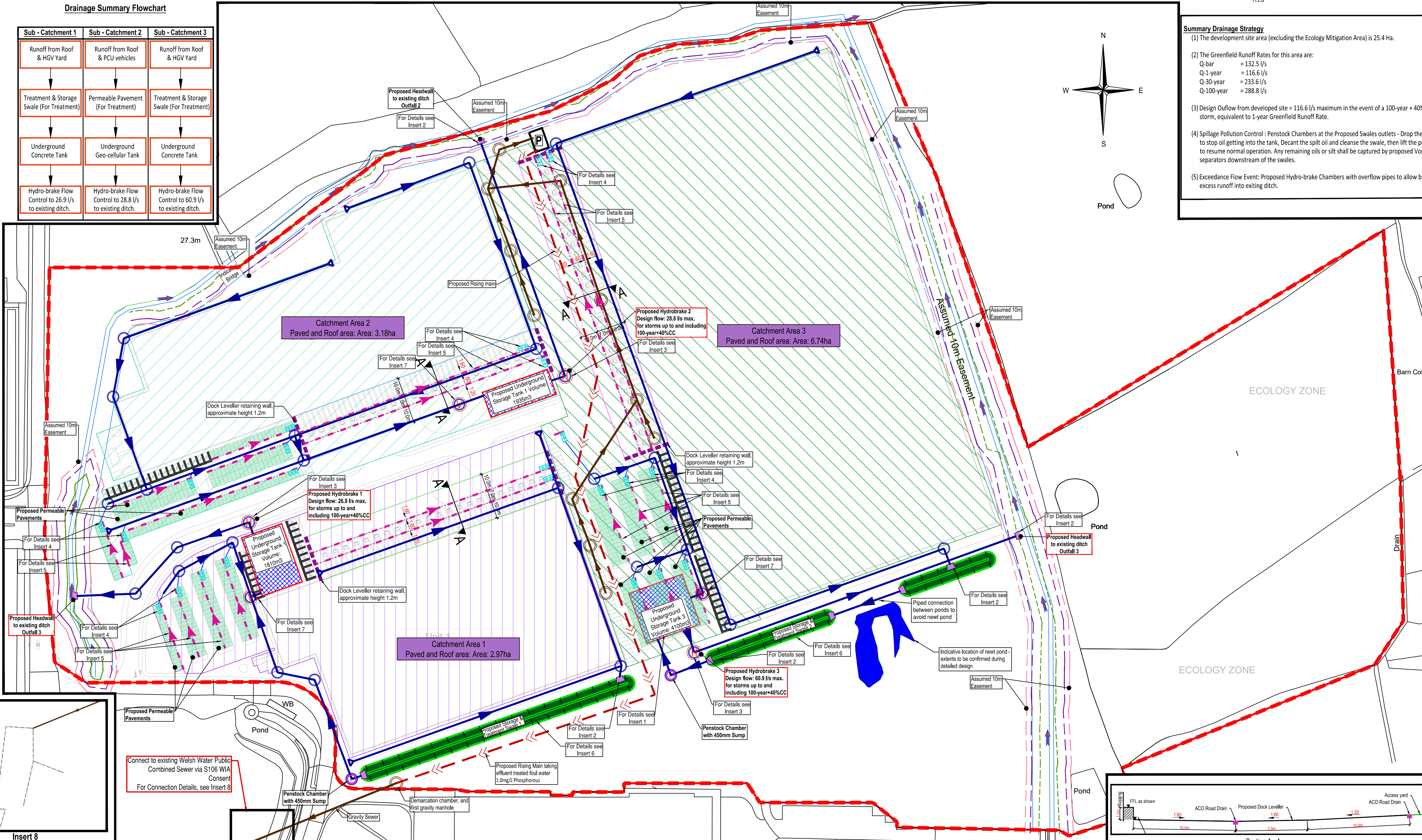
Project
Kingmoor Site, Wrexham

Drawing
High Level Drainage Strategy

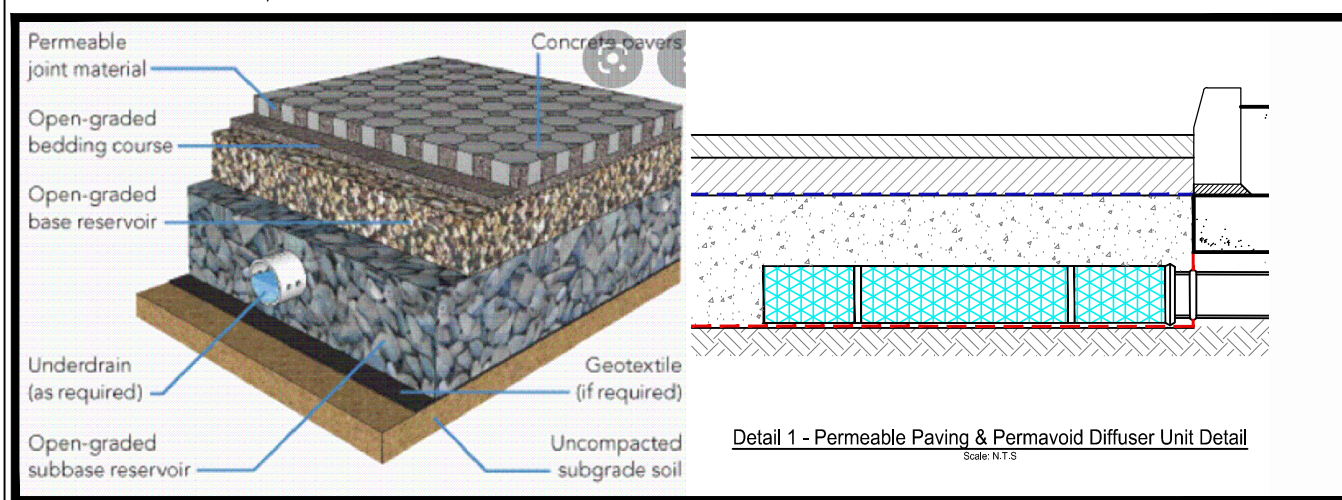
By	DH/AM	Date	09/02/2022
Drawing No.	KSW-BML-XX-XX-SK-C-0501	Revision	P05
BML Job No.	1000-03	Status	-
Drawing Scale at A1:	1:1250		
CAD Filename:	Y:\Project\0501\Engineer\04a_Drainage\Information - Strategy\DWG\0501-SK-C-0501-P05_High Level Drainage Strategy.dwg		
Insert 4	n.t.s		

Drainage Summary Flowchart

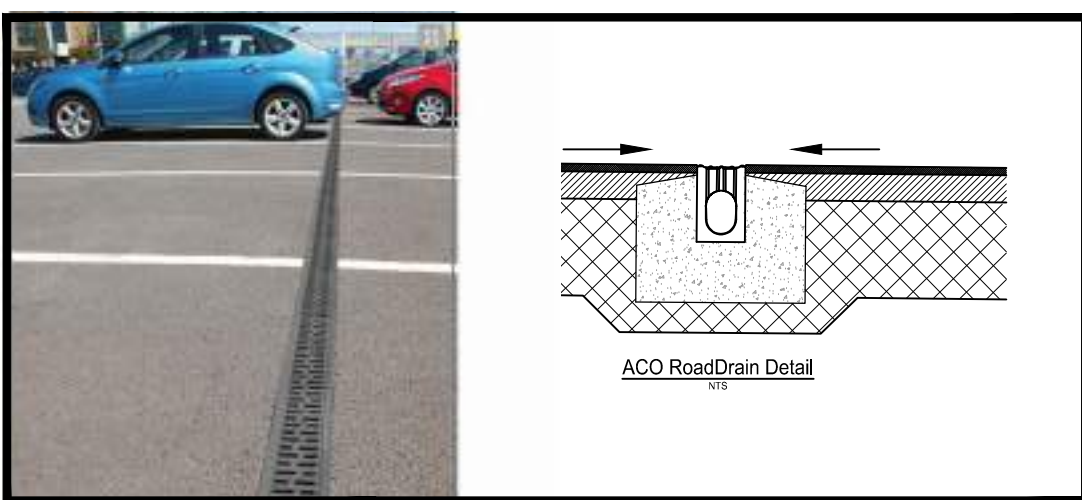
Sub - Catchment 1	Sub - Catchment 2	Sub - Catchment 3
Runoff from Roof & HGV Yard	Runoff from Roof & PCU vehicles	Runoff from Roof & HGV Yard
Treatment & Storage Swale (For Treatment)	Permeable Pavement (For Treatment)	Treatment & Storage Swale (For Treatment)
Underground Concrete Tank	Underground Geo-cellular Tank	Underground Concrete Tank
Hydro-brake Flow Control to 26.9 l/s to existing ditch.	Hydro-brake Flow Control to 28.8 l/s to existing ditch.	Hydro-brake Flow Control to 60.9 l/s to existing ditch.



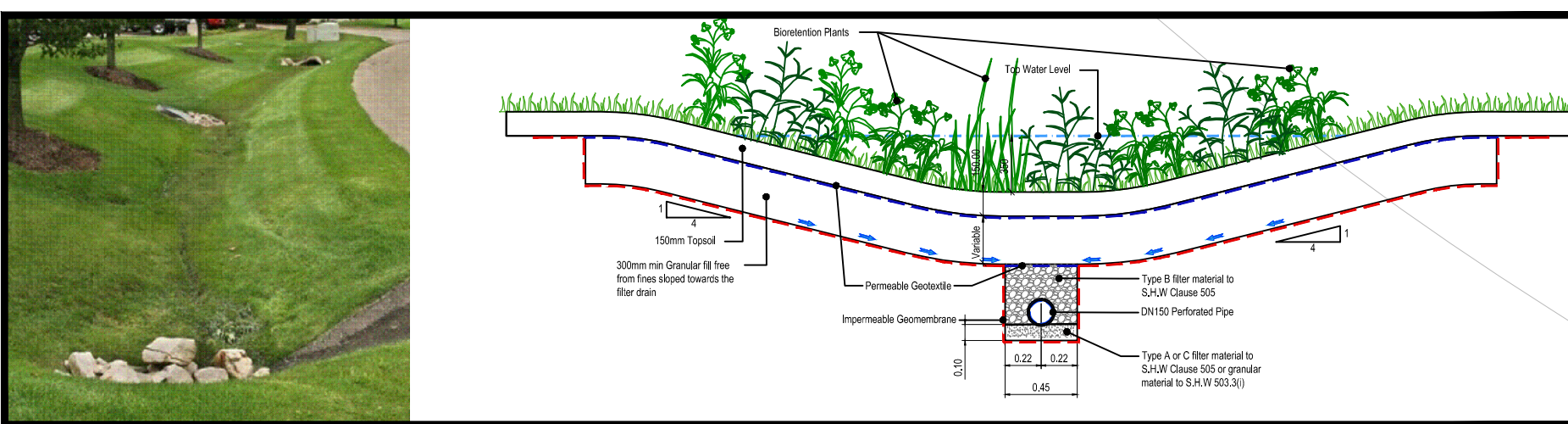
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Scale 1:10,000



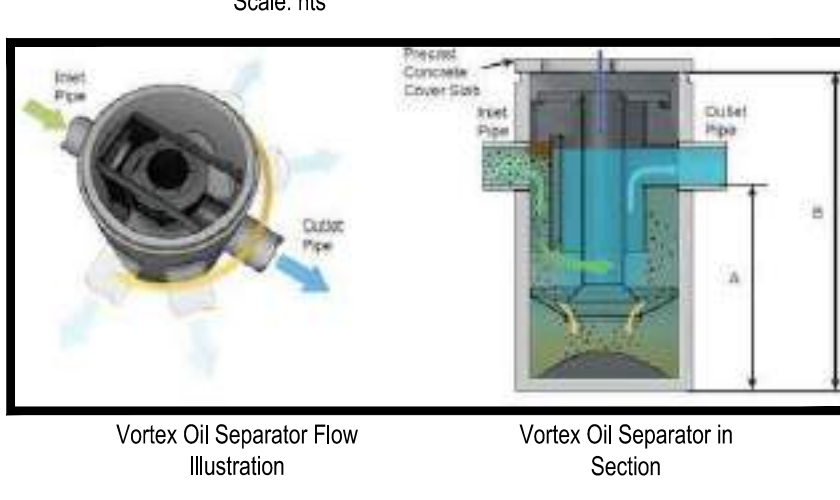
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n.t.s



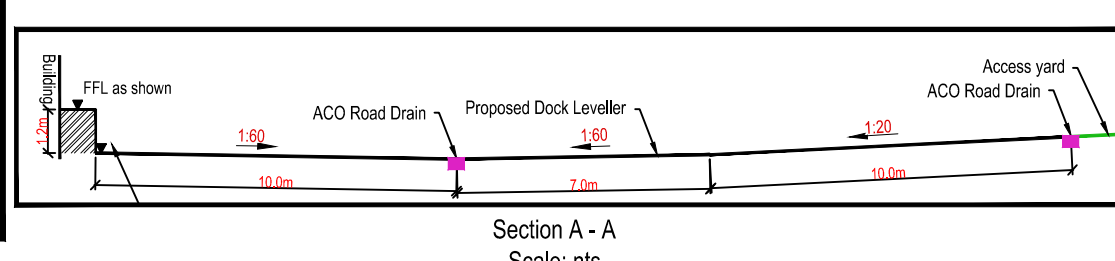
Insert 5
n.t.s



Insert 6
n.t.s



Insert 7
n.t.s



Section A - A
Scale: n.t.s

Appendix E

Hydraulic Calculations

Barnsley Marshall		Page 1
1 Birch Court Blackpole East Worcester, WR3 8SG		
Date 26/07/2022 12:26 File	Designed by AlexMavhunga Checked by	
Innovyze		Source Control 2020.1.3
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.450 Area (ha) 25.420 Urban 0.000 SAAR (mm) 810 Region Number Region 9 Results l/s QBAR Rural 132.5 QBAR Urban 132.5 Q100 years 288.8 Q1 year 116.6 Q30 years 233.6 Q100 years 288.8		
©1982-2020 Innovyze		

Barnsley Marshall					Page 1																																																																																																																									
1 Birch Court Blackpole East Worcester, WR3 8SG																																																																																																																														
Date 28/07/2022 13:52 File Unit 1 - 4100m3 Tank @ 6...																																																																																																																														
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Innovyze			Source Control 2020.1.3																																																																																																																											
<u>Summary of Results for 100 year Return Period (+40%)</u>																																																																																																																														
<table><thead><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Control (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr></thead><tbody><tr><td>15 min Summer</td><td>26.408</td><td>0.408</td><td>61.9</td><td>1393.4</td><td>O K</td></tr><tr><td>30 min Summer</td><td>26.552</td><td>0.552</td><td>62.4</td><td>1884.0</td><td>O K</td></tr><tr><td>60 min Summer</td><td>26.708</td><td>0.708</td><td>62.4</td><td>2417.3</td><td>O K</td></tr><tr><td>120 min Summer</td><td>26.865</td><td>0.865</td><td>62.4</td><td>2956.5</td><td>O K</td></tr><tr><td>180 min Summer</td><td>26.949</td><td>0.949</td><td>62.4</td><td>3240.5</td><td>O K</td></tr><tr><td>240 min Summer</td><td>26.994</td><td>0.994</td><td>62.4</td><td>3396.8</td><td>O K</td></tr><tr><td>360 min Summer</td><td>27.035</td><td>1.035</td><td>62.4</td><td>3537.1</td><td>O K</td></tr><tr><td>480 min Summer</td><td>27.048</td><td>1.048</td><td>62.4</td><td>3579.2</td><td>O K</td></tr><tr><td>600 min Summer</td><td>27.051</td><td>1.051</td><td>62.4</td><td>3591.6</td><td>O K</td></tr><tr><td>720 min Summer</td><td>27.050</td><td>1.050</td><td>62.4</td><td>3587.8</td><td>O K</td></tr><tr><td>960 min Summer</td><td>27.039</td><td>1.039</td><td>62.4</td><td>3548.1</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>26.994</td><td>0.994</td><td>62.4</td><td>3395.1</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>26.900</td><td>0.900</td><td>62.4</td><td>3074.1</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>26.796</td><td>0.796</td><td>62.4</td><td>2717.7</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>26.616</td><td>0.616</td><td>62.4</td><td>2104.4</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>26.481</td><td>0.481</td><td>62.4</td><td>1643.1</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>26.389</td><td>0.389</td><td>61.6</td><td>1328.7</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>26.329</td><td>0.329</td><td>60.4</td><td>1125.2</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>26.298</td><td>0.298</td><td>57.3</td><td>1016.3</td><td>O K</td></tr></tbody></table>							Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status	15 min Summer	26.408	0.408	61.9	1393.4	O K	30 min Summer	26.552	0.552	62.4	1884.0	O K	60 min Summer	26.708	0.708	62.4	2417.3	O K	120 min Summer	26.865	0.865	62.4	2956.5	O K	180 min Summer	26.949	0.949	62.4	3240.5	O K	240 min Summer	26.994	0.994	62.4	3396.8	O K	360 min Summer	27.035	1.035	62.4	3537.1	O K	480 min Summer	27.048	1.048	62.4	3579.2	O K	600 min Summer	27.051	1.051	62.4	3591.6	O K	720 min Summer	27.050	1.050	62.4	3587.8	O K	960 min Summer	27.039	1.039	62.4	3548.1	O K	1440 min Summer	26.994	0.994	62.4	3395.1	O K	2160 min Summer	26.900	0.900	62.4	3074.1	O K	2880 min Summer	26.796	0.796	62.4	2717.7	O K	4320 min Summer	26.616	0.616	62.4	2104.4	O K	5760 min Summer	26.481	0.481	62.4	1643.1	O K	7200 min Summer	26.389	0.389	61.6	1328.7	O K	8640 min Summer	26.329	0.329	60.4	1125.2	O K	10080 min Summer	26.298	0.298	57.3	1016.3	O K
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©1982-2020 Innovyze																																																																																																																														

Barnsley Marshall				Page 2	
1 Birch Court Blackpole East Worcester, WR3 8SG					
Date 28/07/2022 13:52 File Unit 1 - 4100m3 Tank @ 6...		Designed by AlexMavhunga Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	26.458	0.458	62.3	1564.3	O K
30 min Winter	26.620	0.620	62.4	2118.8	O K
60 min Winter	26.798	0.798	62.4	2724.3	O K
120 min Winter	26.979	0.979	62.4	3343.0	O K
180 min Winter	27.072	1.072	62.4	3662.0	O K
240 min Winter	27.125	1.125	62.4	3843.3	O K
360 min Winter	27.177	1.177	62.4	4019.3	O K
480 min Winter	27.196	1.196	62.4	4086.2	O K
600 min Winter	27.197	1.197	62.4	4088.5	O K
720 min Winter	27.189	1.189	62.4	4060.4	O K
960 min Winter	27.171	1.171	62.4	3998.8	O K
1440 min Winter	27.102	1.102	62.4	3764.7	O K
2160 min Winter	26.965	0.965	62.4	3297.6	O K
2880 min Winter	26.799	0.799	62.4	2729.2	O K
4320 min Winter	26.529	0.529	62.4	1808.5	O K
5760 min Winter	26.363	0.363	61.2	1241.1	O K
7200 min Winter	26.295	0.295	56.6	1007.2	O K
8640 min Winter	26.265	0.265	49.8	905.1	O K
10080 min Winter	26.244	0.244	44.6	834.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Winter	114.068	0.0	1477.8	26	
30 min Winter	77.827	0.0	2048.4	40	
60 min Winter	50.812	0.0	2803.9	68	
120 min Winter	32.076	0.0	3551.7	126	
180 min Winter	24.146	0.0	4015.3	182	
240 min Winter	19.594	0.0	4346.7	240	
360 min Winter	14.506	0.0	4828.5	352	
480 min Winter	11.720	0.0	5201.5	462	
600 min Winter	9.925	0.0	5503.7	566	
720 min Winter	8.658	0.0	5758.7	596	
960 min Winter	6.974	0.0	6174.4	742	
1440 min Winter	5.129	0.0	6775.8	1054	
2160 min Winter	3.764	0.0	7627.0	1512	
2880 min Winter	3.017	0.0	8149.4	1908	
4320 min Winter	2.204	0.0	8901.4	2604	
5760 min Winter	1.762	0.0	9559.8	3232	
7200 min Winter	1.481	0.0	10041.1	3824	
8640 min Winter	1.286	0.0	10451.3	4504	
10080 min Winter	1.142	0.0	10793.2	5240	
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Barnsley Marshall		Page 3																																										
1 Birch Court Blackpole East Worcester, WR3 8SG																																												
Date 28/07/2022 13:52 File Unit 1 - 4100m3 Tank @ 6...	Designed by AlexMavhunga Checked by																																											
Innovyze		Source Control 2020.1.3																																										
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>18.000</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.322</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+40</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 6.750 <table> <thead> <tr> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> </tr> <tr> <th>From: To:</th> <th>(ha)</th> <th>From: To:</th> <th>(ha)</th> <th>From: To:</th> <th>(ha)</th> </tr> </thead> <tbody> <tr> <td>0 4</td> <td>2.250</td> <td>4 8</td> <td>2.250</td> <td>8 12</td> <td>2.250</td> </tr> </tbody> </table>			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)	18.000	Shortest Storm (mins)	15	Ratio R	0.322	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+40	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	From: To:	(ha)	From: To:	(ha)	From: To:	(ha)	0 4	2.250	4 8	2.250	8 12	2.250
Rainfall Model	FSR	Winter Storms	Yes																																									
Return Period (years)	100	Cv (Summer)	0.750																																									
Region	England and Wales	Cv (Winter)	0.840																																									
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Summer Storms	Yes	Climate Change %	+40																																									
Time (mins)	Area	Time (mins)	Area	Time (mins)	Area																																							
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)																																							
0 4	2.250	4 8	2.250	8 12	2.250																																							
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Barnsley Marshall		Page 4
1 Birch Court Blackpole East Worcester, WR3 8SG		
Date 28/07/2022 13:52 File Unit 1 - 4100m3 Tank @ 6...	Designed by AlexMavhunga Checked by	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 28.000

Tank or Pond Structure

Invert Level (m) 26.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	3416.0	1.200	3416.0	1.201	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0321-6240-1200-6240
Design Head (m)	1.200
Design Flow (l/s)	62.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	321
Invert Level (m)	26.000
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	62.4	Kick-Flo®	0.917	54.8
Flush-Flo™	0.497	62.4	Mean Flow over Head Range	-	50.8

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	9.6	1.200	62.4	3.000	97.3	7.000	147.1
0.200	32.8	1.400	67.2	3.500	104.9	7.500	152.1
0.300	57.7	1.600	71.7	4.000	111.9	8.000	157.0
0.400	61.8	1.800	75.9	4.500	118.5	8.500	161.8
0.500	62.4	2.000	79.9	5.000	124.8	9.000	166.3
0.600	61.9	2.200	83.7	5.500	130.7	9.500	170.8
0.800	58.9	2.400	87.3	6.000	136.4		
1.000	57.1	2.600	90.7	6.500	141.8		

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1 Birch Court Blackpole East Worcester, WR3 8SG					
Date 28/07/2022 13:09 File Unit 2 - 1700m3 Tank @ 2...		Designed by AlexMavhunga Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	26.413	0.413	26.4	585.5	O K
30 min Summer	26.560	0.560	26.4	792.8	O K
60 min Summer	26.718	0.718	26.4	1017.0	O K
120 min Summer	26.878	0.878	26.4	1243.2	O K
180 min Summer	26.958	0.958	26.4	1356.3	O K
240 min Summer	27.000	1.000	26.4	1416.6	O K
360 min Summer	27.036	1.036	26.4	1466.8	O K
480 min Summer	27.043	1.043	26.4	1477.0	O K
600 min Summer	27.042	1.042	26.4	1475.6	O K
720 min Summer	27.037	1.037	26.4	1468.0	O K
960 min Summer	27.018	1.018	26.4	1441.5	O K
1440 min Summer	26.964	0.964	26.4	1364.6	O K
2160 min Summer	26.864	0.864	26.4	1224.1	O K
2880 min Summer	26.750	0.750	26.4	1061.8	O K
4320 min Summer	26.560	0.560	26.4	792.5	O K
5760 min Summer	26.416	0.416	26.4	589.6	O K
7200 min Summer	26.320	0.320	26.2	453.1	O K
8640 min Summer	26.259	0.259	25.6	366.8	O K
10080 min Summer	26.225	0.225	24.8	318.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.068	0.0	579.2	26	
30 min Summer	77.827	0.0	797.5	40	
60 min Summer	50.812	0.0	1069.9	70	
120 min Summer	32.076	0.0	1353.4	128	
180 min Summer	24.146	0.0	1529.3	186	
240 min Summer	19.594	0.0	1655.2	244	
360 min Summer	14.506	0.0	1838.5	362	
480 min Summer	11.720	0.0	1980.8	452	
600 min Summer	9.925	0.0	2096.3	508	
720 min Summer	8.658	0.0	2194.2	570	
960 min Summer	6.974	0.0	2354.6	700	
1440 min Summer	5.129	0.0	2591.2	978	
2160 min Summer	3.764	0.0	2884.9	1392	
2880 min Summer	3.017	0.0	3082.7	1772	
4320 min Summer	2.204	0.0	3370.4	2512	
5760 min Summer	1.762	0.0	3608.6	3184	
7200 min Summer	1.481	0.0	3791.2	3888	
8640 min Summer	1.286	0.0	3947.7	4504	
10080 min Summer	1.142	0.0	4079.9	5152	
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Barnsley Marshall				Page 2	
1 Birch Court Blackpole East Worcester, WR3 8SG					
Date 28/07/2022 13:09 File Unit 2 - 1700m3 Tank @ 2...		Designed by AlexMavhunga Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	26.465	0.465	26.4	658.0	O K
30 min Winter	26.630	0.630	26.4	892.1	O K
60 min Winter	26.810	0.810	26.4	1147.2	O K
120 min Winter	26.991	0.991	26.4	1403.7	O K
180 min Winter	27.083	1.083	26.4	1533.7	O K
240 min Winter	27.134	1.134	26.4	1606.2	O K
360 min Winter	27.181	1.181	26.4	1672.9	O K
480 min Winter	27.197	1.197	26.4	1694.4	O K
600 min Winter	27.193	1.193	26.4	1689.4	O K
720 min Winter	27.181	1.181	26.4	1672.1	O K
960 min Winter	27.156	1.156	26.4	1636.5	O K
1440 min Winter	27.076	1.076	26.4	1524.2	O K
2160 min Winter	26.930	0.930	26.4	1316.8	O K
2880 min Winter	26.752	0.752	26.4	1064.2	O K
4320 min Winter	26.464	0.464	26.4	657.6	O K
5760 min Winter	26.291	0.291	25.9	411.7	O K
7200 min Winter	26.220	0.220	24.2	310.9	O K
8640 min Winter	26.195	0.195	21.2	275.8	O K
10080 min Winter	26.178	0.178	19.0	251.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Winter	114.068	0.0	651.2	26	
30 min Winter	77.827	0.0	895.2	40	
60 min Winter	50.812	0.0	1199.6	68	
120 min Winter	32.076	0.0	1517.0	126	
180 min Winter	24.146	0.0	1714.0	182	
240 min Winter	19.594	0.0	1854.9	240	
360 min Winter	14.506	0.0	2060.1	352	
480 min Winter	11.720	0.0	2219.2	462	
600 min Winter	9.925	0.0	2348.5	566	
720 min Winter	8.658	0.0	2457.8	598	
960 min Winter	6.974	0.0	2637.0	742	
1440 min Winter	5.129	0.0	2900.2	1056	
2160 min Winter	3.764	0.0	3231.9	1516	
2880 min Winter	3.017	0.0	3453.8	1912	
4320 min Winter	2.204	0.0	3778.0	2604	
5760 min Winter	1.762	0.0	4042.5	3232	
7200 min Winter	1.481	0.0	4247.3	3752	
8640 min Winter	1.286	0.0	4423.2	4496	
10080 min Winter	1.142	0.0	4573.2	5160	
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Barnsley Marshall		Page 3																																										
1 Birch Court Blackpole East Worcester, WR3 8SG																																												
Date 28/07/2022 13:09 File Unit 2 - 1700m3 Tank @ 2...	Designed by AlexMavhunga Checked by																																											
Innovyze	Source Control 2020.1.3																																											
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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)	18.000	Shortest Storm (mins)	15																																									
Ratio R	0.322	Longest Storm (mins)	10080																																									
Summer Storms	Yes	Climate Change %	+40																																									
Time (mins)	Area	Time (mins)	Area	Time (mins)	Area																																							
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)																																							
0 4	0.950	4 8	0.950	8 12	0.950																																							
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Barnsley Marshall		Page 4
1 Birch Court Blackpole East Worcester, WR3 8SG		
Date 28/07/2022 13:09 File Unit 2 - 1700m3 Tank @ 2...	Designed by AlexMavhunga Checked by	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 28.000

Tank or Pond Structure

Invert Level (m) 26.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1416.0	1.200	1416.0	1.201	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0222-2640-1200-2640
Design Head (m)	1.200
Design Flow (l/s)	26.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	222
Invert Level (m)	26.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	26.4	Kick-Flo®	0.849	22.4
Flush-Flo™	0.396	26.4	Mean Flow over Head Range	-	22.3

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	7.4	1.200	26.4	3.000	41.0	7.000	61.8
0.200	21.9	1.400	28.4	3.500	44.2	7.500	63.9
0.300	26.0	1.600	30.3	4.000	47.1	8.000	65.9
0.400	26.4	1.800	32.1	4.500	49.9	8.500	67.9
0.500	26.1	2.000	33.7	5.000	52.5	9.000	69.8
0.600	25.7	2.200	35.3	5.500	54.9	9.500	71.7
0.800	23.6	2.400	36.8	6.000	57.3		
1.000	24.2	2.600	38.3	6.500	59.6		

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1 Birch Court Blackpole East Worcester, WR3 8SG					
Date 28/07/2022 13:41 File Unit 3 - 1790m3 Tank @ 2...		Designed by AlexMavhunga Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	26.413	0.413	27.8	616.4	O K
30 min Summer	26.560	0.560	27.8	834.6	O K
60 min Summer	26.718	0.718	27.8	1070.6	O K
120 min Summer	26.878	0.878	27.8	1308.9	O K
180 min Summer	26.958	0.958	27.8	1428.4	O K
240 min Summer	27.000	1.000	27.8	1492.0	O K
360 min Summer	27.036	1.036	27.8	1545.4	O K
480 min Summer	27.043	1.043	27.8	1556.5	O K
600 min Summer	27.043	1.043	27.8	1555.3	O K
720 min Summer	27.038	1.038	27.8	1547.7	O K
960 min Summer	27.019	1.019	27.8	1520.2	O K
1440 min Summer	26.965	0.965	27.8	1439.7	O K
2160 min Summer	26.866	0.866	27.8	1291.7	O K
2880 min Summer	26.752	0.752	27.8	1121.3	O K
4320 min Summer	26.562	0.562	27.8	838.4	O K
5760 min Summer	26.419	0.419	27.8	625.3	O K
7200 min Summer	26.323	0.323	27.6	481.8	O K
8640 min Summer	26.262	0.262	26.9	391.1	O K
10080 min Summer	26.229	0.229	26.1	340.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	114.068	0.0	608.4	26	
30 min Summer	77.827	0.0	838.1	40	
60 min Summer	50.812	0.0	1125.6	70	
120 min Summer	32.076	0.0	1423.9	128	
180 min Summer	24.146	0.0	1609.0	186	
240 min Summer	19.594	0.0	1741.5	244	
360 min Summer	14.506	0.0	1934.4	362	
480 min Summer	11.720	0.0	2084.1	452	
600 min Summer	9.925	0.0	2205.6	508	
720 min Summer	8.658	0.0	2308.6	570	
960 min Summer	6.974	0.0	2477.3	700	
1440 min Summer	5.129	0.0	2726.1	978	
2160 min Summer	3.764	0.0	3036.3	1392	
2880 min Summer	3.017	0.0	3244.4	1768	
4320 min Summer	2.204	0.0	3546.9	2512	
5760 min Summer	1.762	0.0	3798.3	3184	
7200 min Summer	1.481	0.0	3990.4	3888	
8640 min Summer	1.286	0.0	4155.0	4504	
10080 min Summer	1.142	0.0	4293.9	5152	
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Barnsley Marshall				Page 2	
1 Birch Court Blackpole East Worcester, WR3 8SG					
Date 28/07/2022 13:41 File Unit 3 - 1790m3 Tank @ 2...		Designed by AlexMavhunga Checked by			
Innovyze		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	26.464	0.464	27.8	692.7	O K
30 min Winter	26.630	0.630	27.8	939.2	O K
60 min Winter	26.810	0.810	27.8	1207.6	O K
120 min Winter	26.991	0.991	27.8	1478.0	O K
180 min Winter	27.083	1.083	27.8	1615.1	O K
240 min Winter	27.134	1.134	27.8	1691.5	O K
360 min Winter	27.181	1.181	27.8	1762.1	O K
480 min Winter	27.197	1.197	27.8	1785.0	O K
600 min Winter	27.193	1.193	27.8	1780.0	O K
720 min Winter	27.181	1.181	27.8	1762.1	O K
960 min Winter	27.157	1.157	27.8	1725.1	O K
1440 min Winter	27.078	1.078	27.8	1607.4	O K
2160 min Winter	26.931	0.931	27.8	1389.2	O K
2880 min Winter	26.753	0.753	27.8	1123.5	O K
4320 min Winter	26.467	0.467	27.8	696.6	O K
5760 min Winter	26.294	0.294	27.3	438.2	O K
7200 min Winter	26.223	0.223	25.5	332.9	O K
8640 min Winter	26.198	0.198	22.4	295.7	O K
10080 min Winter	26.181	0.181	20.0	270.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Winter	114.068	0.0	684.2	26	
30 min Winter	77.827	0.0	941.0	40	
60 min Winter	50.812	0.0	1262.1	68	
120 min Winter	32.076	0.0	1596.1	126	
180 min Winter	24.146	0.0	1803.3	182	
240 min Winter	19.594	0.0	1951.6	240	
360 min Winter	14.506	0.0	2167.6	352	
480 min Winter	11.720	0.0	2335.0	462	
600 min Winter	9.925	0.0	2471.0	566	
720 min Winter	8.658	0.0	2586.0	598	
960 min Winter	6.974	0.0	2774.5	742	
1440 min Winter	5.129	0.0	3051.1	1056	
2160 min Winter	3.764	0.0	3401.5	1516	
2880 min Winter	3.017	0.0	3635.0	1912	
4320 min Winter	2.204	0.0	3975.9	2604	
5760 min Winter	1.762	0.0	4255.0	3232	
7200 min Winter	1.481	0.0	4470.5	3752	
8640 min Winter	1.286	0.0	4655.5	4496	
10080 min Winter	1.142	0.0	4813.2	5152	
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Barnsley Marshall		Page 3																																										
1 Birch Court Blackpole East Worcester, WR3 8SG																																												
Date 28/07/2022 13:41 File Unit 3 - 1790m3 Tank @ 2...	Designed by AlexMavhunga Checked by																																											
Innovyze		Source Control 2020.1.3																																										
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>18.000</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.322</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+40</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 3.000 <table> <thead> <tr> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> </tr> <tr> <th>From: To: (ha)</th> <th></th> <th>From: To: (ha)</th> <th></th> <th>From: To: (ha)</th> <th></th> </tr> </thead> <tbody> <tr> <td>0 4 1.000</td> <td></td> <td>4 8 1.000</td> <td></td> <td>8 12 1.000</td> <td></td> </tr> </tbody> </table>			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)	18.000	Shortest Storm (mins)	15	Ratio R	0.322	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+40	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	From: To: (ha)		From: To: (ha)		From: To: (ha)		0 4 1.000		4 8 1.000		8 12 1.000	
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Barnsley Marshall		Page 4
1 Birch Court Blackpole East Worcester, WR3 8SG		
Date 28/07/2022 13:41 File Unit 3 - 1790m3 Tank @ 2...	Designed by AlexMavhunga Checked by	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 28.000

Tank or Pond Structure

Invert Level (m) 26.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1491.6	1.200	1491.6	1.201	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0227-2780-1200-2780
Design Head (m)	1.200
Design Flow (l/s)	27.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	227
Invert Level (m)	26.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	27.8	Kick-Flo®	0.854	23.6
Flush-Flo™	0.400	27.8	Mean Flow over Head Range	-	23.5

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

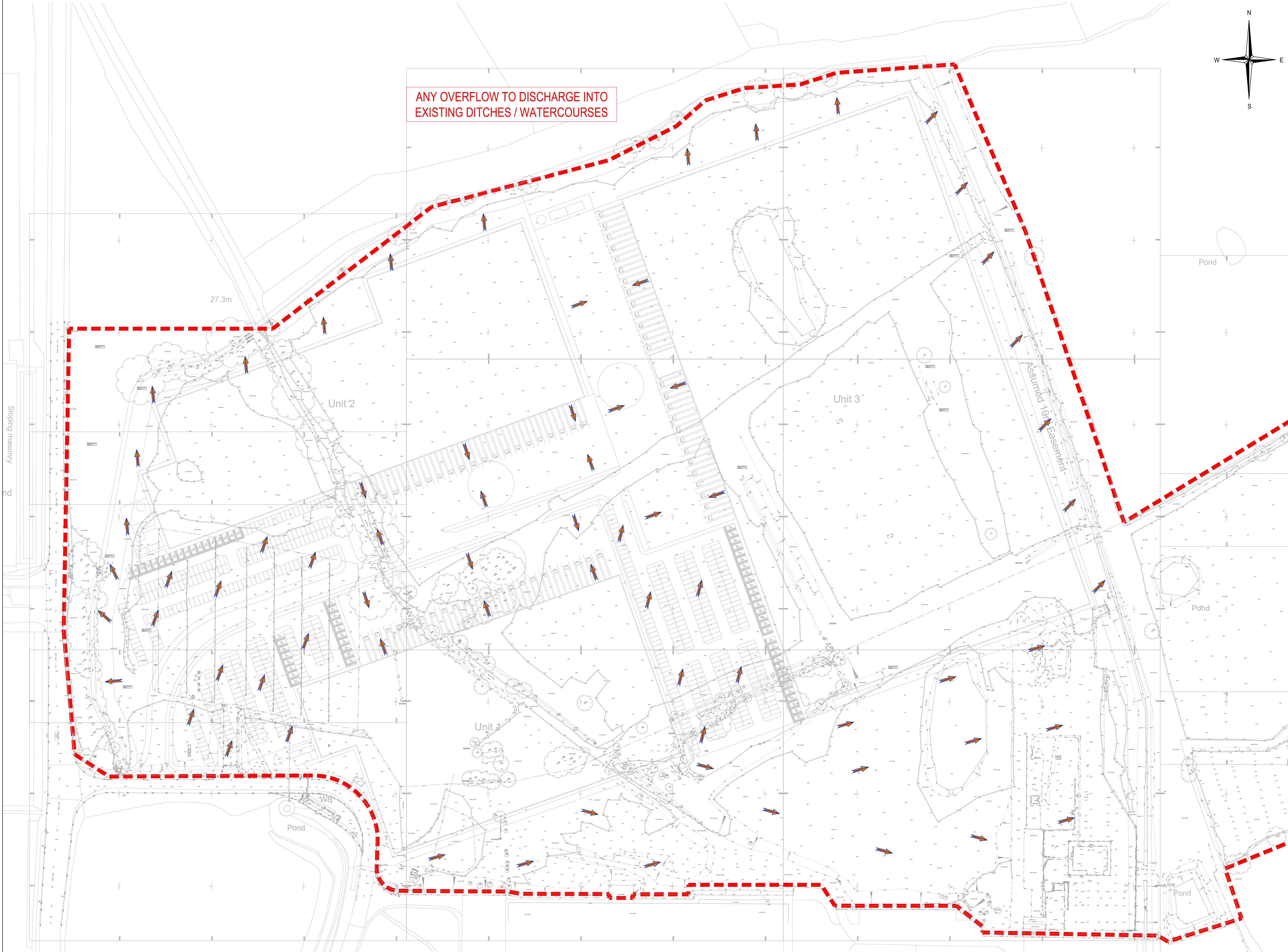
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.6	1.200	27.8	3.000	43.2	7.000	65.1
0.200	22.6	1.400	29.9	3.500	46.5	7.500	67.3
0.300	27.4	1.600	31.9	4.000	49.6	8.000	69.5
0.400	27.8	1.800	33.8	4.500	52.5	8.500	71.5
0.500	27.5	2.000	35.5	5.000	55.3	9.000	73.6
0.600	27.1	2.200	37.2	5.500	57.9	9.500	75.5
0.800	25.0	2.400	38.8	6.000	60.4		
1.000	25.5	2.600	40.3	6.500	62.8		

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Appendix F

Flood Flow Analysis



Safety, Health & Environmental Information:
In addition to the hazards and risks normally associated with the types of work detailed on this drawing, please note the significant hazards identified by symbols below,

 INDICATES A RESIDUAL RISK AS A WARNING

 INDICATES A RESIDUAL RISK FOR INFORMATION

and described below:

Construction/Maintenance/Cleaning/Demolition
Refer to Drawing:

- General Notes:**
1. Do not scale from this drawing.
 2. All dimensions are in millimetres (mm), all levels in metres (m) unless noted otherwise.
 3. Discrepancies or omissions are to be reported to the Engineer prior to work commencing.
 4. Materials and workmanship are to comply in all respects with current British Standard Specifications, Codes of Practice, and Building Regulations Approved Documents.
 5. The copyright of this drawing is vested in the Engineer and must not be copied or reproduced without written consent.
 6. The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points before work commences.
 7. This drawing is to be read in conjunction with all relevant specifications and drawings issued by the Engineer, Architect and other Specialists.

P02	RA/AM	27/10/2022	Amendments to Masterplan
P01	RA/AM	28/07/2022	Preliminary Issue
Rev	By / Chkd	Date	Description

PRELIMINARY DRAWING
This drawing is not to be used for construction

Client: _____

BarnsleyMarshall Limited
1 Birch Court
Blackpole East
Worcester
WR3 8SG
Tel: 01905 330550
Email: design@barnsleymarshall.co.uk
Web: www.barnsleymarshall.co.uk



Project: Kingmoor Site, Wrexham

Drawing: Indicative Flood Flow Analysis

By	RA/AM	Date	28/07/22
Drawing No.	KSW-BML-XX-XX-SK-C-0505	Revision	P02
BML Job No.	1000-03	Status	-
Drawing Scale at A1:	1:1000		
CAD Filename:	C:\Users\BML\Documents\BML\Drawings\1000-03\1000-03-SK-C-0505.dwg		



Appendix G

Welsh Water Sewer Maps



LEGEND

Clean Water

Sluice Val

Air Val, SINGLE

Tap

Pressure Reducing Valve

Meter

80LK Meter

1" FN

Cap

Existing Main

NON COMPANY

Sewerage External

Foul

Surface Water

Combined

Rising Main

Private

Treatment Works

Pumping Station

Special Purpose

Unknown End

Change, Combined Overflow

Outfall, FOUL

Lamp Hole, Foul

Private Sewer Transfer

Lateral Drain

Inspection Chamber

Dŵr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the company's apparatus. The onus of locating apparatus before carrying out any excavations rests entirely on you. The information which is supplied by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 which is based upon the best information available and, in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a water main, service pipe, sewer, lateral drain or disposal main and any associated apparatus laid before 1 September 1989, or, if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.

**EXACT LOCATION OF
ALL APPARATUS TO
BE DETERMINED ON
SITE**

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Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be Asbestos Cement (AC) or Pitch Fibre (PF). It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation