

Drainage Statement

Proposed Glasshouse Development at

Lower Farm, Yapton

On behalf of

Agricultural Investments Limited

December 2025

Document History and Status

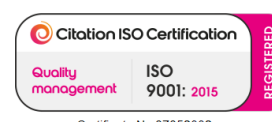
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1 Non Technical Summary

- 1.1 This Drainage Statement has been undertaken on behalf of Agricultural Investments Limited in support of Planning Application WA/65/24/PL for the addition of 3 no 5ha Glasshouses, ancillary structures and reservoir to the existing permission for 1 x 5ha glasshouse and reservoir on land at Lower Farm, Yapton, West Sussex.
- 1.2 This Statement is to be read in conjunction with the Flood Risk Assessment prepared by Aqua Callidus Consulting dated 22 July 2024 which accompanied the Planning Application for the proposed development.
- 1.3 This Statement expands upon the outline detail provide in the Flood Risk Assessment prepared by Aqua Callidus Consulting dated 22 July 2024. The detail provided in this statement has been prepared using FEH Data and the drainage systems modelled using Causeway Flow software to provide the detail required by West Sussex County Council and Arun District Council.
- 1.4 The proposed development will incorporate a total of six independent sustainable drainage systems.
- 1.5 Surface water collected from the access road, service yard, parking areas and other external works will be collected with surface water restricted to Q_{bar} greenfield runoff rates and discharged to the onsite ordinary watercourse which discharges to Little Tortington Stream to the east of the site.
- 1.6 Sufficient storage will be provided in each system to accommodate a 1:100 year +45% pluvial event.
- 1.7 Surface water collected from the glasshouse roofs will be discharged via a syphonic drainage system and stored within a reservoir to the east of the site and reused for irrigation.
- 1.8 The proposed reservoir has been sized with sufficient storage beyond the normal irrigation requirement (peak operational level) to accommodate a 1:100 year storm event including an additional 45% to account for the predicted effects of future climate change.
- 1.9 Only in the event that the irrigation water level within the reservoir is already at the peak operational level will a discharge be made from that facility at a suitably restricted rate to the ordinary watercourse to the south of the proposed reservoir.
- 1.10 Foul drainage will be discharged to the existing public foul sewer located beneath the B2132 Yapton Lane to the southwest of the site.

- 1.11 This report concludes that a suitable surface water and foul water drainage system can be constructed to suitably accommodate the anticipated flows from the proposed development and provide suitable attenuation and onsite storm water storage.

2 Planning Policy Context

2.1 National Planning Policy Framework

2.1.1 With regard to planning and flood risk the National Planning Policy Framework states that *‘when determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment.*

Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- b) the development is appropriately flood resistant and resilient, such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
- c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- d) any residual risk can be safely managed; and*
- e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.’*

2.1.2 With regard to major developments the NPPF states that *‘major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

- a) take account of advice from the lead local flood authority;*
- b) have appropriate proposed minimum operational standards;*
- c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- d) where possible, provide multifunctional benefits.’*

2.1.3 Major development is defined as follows:

‘For housing, development where 10 or more homes will be provided, or the site has an area of 0.5 hectares or more. For non-residential development it means

additional floorspace of 1,000m² or more, or a site of 1 hectare or more, or as otherwise provided in the Town and Country Planning (Development Management Procedure) (England) Order 2015.'

2.2 Lead Local Flood Authority

2.2.1 West Sussex County Council became a Lead Local Flood Authority under the Flood and Water Management Act 2010 and was given a series of new responsibilities including the role of statutory consultee for surface water management for Major Planning Applications.

2.2.2 As part of their role West Sussex County Council updated their Policy for the Management of Surface Water in November 2018.

2.2.3 That document has been reviewed in the preparation of this report.

2.1 Non Technical Standards for SuDS

2.1.1 The Non Technical Standards for SuDS dated March 2015 are intended to be used in conjunction with the National Planning Policy Framework.

2.1.2 With regards to peak runoff **Non Statutory Standard S2** states that *'for greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.'*

2.2 Arun District Council

2.2.1 Arun District Council have produced a Surface Water Drainage Design Checklist, the current version of Full Surface Water Drainage Design Checklist version 6 dated 13 September 2024 has been reviewed in the preparation of this report.

3 Existing Site

3.1 Site Location

3.1.1 The development site is located on land at Lower Farm, Yapton, West Sussex at Ordnance Survey reference SU 980 052. The nearest postcode is BN18 0GD.



Image 1: Site Location

3.1.2 The site is surrounded by agricultural land to the north, south and east and bounded on its western side by the B2132 Yapton Lane beyond which is the Tokar Industrial Estate.

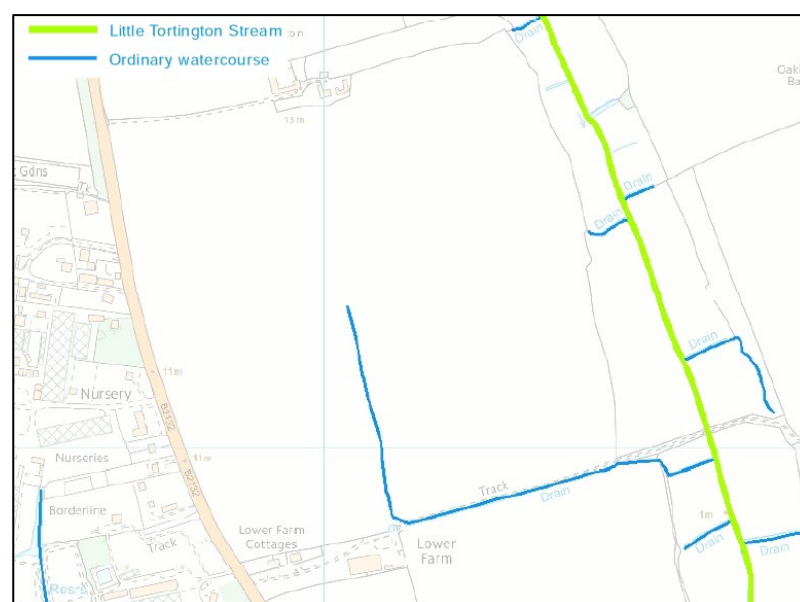


Image 2: Local Watercourses

- 3.1.3 There is an ordinary watercourse adjacent to the southern site boundary which discharges to Little Tortington Stream.
- 3.1.4 Little Tortington Stream flows north to south within the eastern side of the site.
- 3.1.5 There are connections to Little Tortington Stream from the development site which are identified on the mapping within Arun District Council's level 1 Strategic Flood Risk Assessment (extract show above) which are identified as ordinary watercourses.
- 3.1.6 There is also a further ordinary watercourse oriented north to south within the site which discharges into the watercourse at the southern site boundary.
- 3.1.7 It has been confirmed by the site owner that that watercourse only carries water when fields are saturated.
- 3.1.8 A copy of the site location plan is located in Appendix 1 at the rear of this report.

3.2 Site Description

- 3.2.1 The site is approximately 52.75ha in area and currently comprises undeveloped agricultural land.
- 3.2.2 Existing ground levels are highest at the northwest corner of the site at approximately 13.5m AOD. The site falls towards its southeast corner to a level of approximately 1.0m AOD within the valley of little Tortington Stream.
- 3.2.3 A copy of the existing site layout plan is located in Appendix 2 at the rear of this report.

3.3 Existing Drainage

- 3.3.1 The site currently has no positive foul water drainage infrastructure.
- 3.3.2 Surface water currently discharges overland as a greenfield runoff to the onsite ordinary watercourses which in turn discharge to Little Tortington Stream.
- 3.3.3 Pre-developed greenfield runoff rates have been established using the HR Wallingford tool for Greenfield runoff estimation based on the FEH Statistical method for rainfall estimation.
- 3.3.4 The majority Hydrology of Soil Type (HOST) has been confirmed by the National Soil Resources Institute at Cranfield University as soil type 6 which is classified as *'Free draining permeable soils in unconsolidated loams or clays with low permeability and storage capacity.'*

Calculated by:	Steve Doughty
Site name:	23993
Site location:	Lower Farm Yapton

Site Details

Latitude:	50.83831° N
Longitude:	0.60634° W
Reference:	455823904
Date:	Nov 07 2024 11:59

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	1
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Methodology

Q _{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Calculate from dominant HOST
HOST class:	6
BFI / BFIHOST:	0.402
Q _{MED} (l/s):	4.79
Q _{BAR} / Q _{MED} factor:	1.14

Hydrological characteristics

	Default	Edited
SAAR (mm):	762	762
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q _{BAR} (l/s):	5.44	5.44
1 in 1 year (l/s):	4.63	4.63
1 in 30 years (l/s):	12.52	12.52
1 in 100 year (l/s):	17.36	17.36
1 in 200 years (l/s):	20.36	20.36

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Image 3: FEH Greenfield Runoff Calculation

3.3.5 The pre-developed greenfield runoff rates have been established as follows:

- Q_{bar} 5.44 l/s/ha
- 1:30 year 15.52 l/s/ha
- 1:100 year 17.36 l/s/ha

3.3.6 There are 150mm and 175mm diameter public foul sewers located beneath the B2132 Yapton Lane to the southwest of the site.

3.3.7 A copy of the sewer records is located in Appendix 3 at the rear of this report.

3.4 Geology and Groundwater

3.4.1 Site investigation was undertaken by Ground and Water Ltd between January and February 2021 to determine infiltration rates and monitor winter groundwater levels.

3.4.2 Three soakage test were undertaken in accordance with BRE 365 in close proximity to the existing onsite watercourse to the south of the proposed glasshouses.

3.4.3 Two of the test locations failed to return a soakage test result.

3.4.4 The third location returned a poor test result of 1.685×10^{-6} m/s on the first test and failed to return a soakage test result on the subsequent 2 tests.

3.4.5 Winter groundwater monitoring was also undertaken and generally confirmed groundwater levels in the region of 1m below ground level. In two instances groundwater was recorded within 300mm of ground level and a peak in one of those locations of 170mm below ground level.

Depth of Groundwater Strikes/Standing Groundwater Within Trial Holes			
Trial Hole	Date	Depth of Groundwater (m bgl)	Depth of Standpipe (m bgl)
WS1	30/01/2021	0.91	2.86
	27/02/2021	1.70	2.73
	27/03/2021	1.92	2.65
	20/04/2021	1.60	2.20
WS2	30/01/2021	0.17	2.46
	27/02/2021	0.74	2.14
	27/03/2021	1.03	2.09
	20/04/2021	0.70	2.30
WS3	30/01/2021	0.26	1.89
	27/02/2021	0.84	1.70
	27/03/2021	1.04	1.68
	20/04/2021	1.10	1.70

Table 1: Groundwater Monitoring Results

3.4.6 Extracts of the site investigation are located in Appendix 4 at the rear of this report.

4 Development Proposals

4.1 Description

4.1.1 The development proposals are for the construction of four no 5ha Glasshouses, ancillary structures and reservoir.

4.1.2 The areas of the various positively drained elements of the development and the reservoir are summarised as follows:

• Glasshouse Roof Areas	213,600m ²
• Reservoir Surface Area	33,300m ²
• Access Road Service Yard and Parking Areas	7,370m ²
• Gravel Parking Area	1,105m ²
• Gravel Perimeter Track	15,750m ²
• Silos	3,877m ²
• PV control and Batteries	480m ²
• Office	103m ²
• Access Road Detention Basin	593m ²

4.1.3 Surface water collected from the glass house roofs will be collected for reuse as irrigation water.

4.1.4 Ground investigation has been undertaken to determine the viability of discharging surface water by infiltration to ground but poor infiltration rates and high groundwater preclude this as a suitable method of discharging surface water.

4.1.5 Following the SuDS drainage hierarchy surface water (where not reused for irrigation) will be discharged at suitably restricted rates to the existing onsite watercourse.

4.1.6 The existing north-south watercourse within the site which accepts surface water when the fields are saturated will be redundant once there is a positive drainage system for the proposed development and will no longer be required.

4.1.7 It is proposed that that watercourse be backfilled subject to Ordinary Watercourse Consent.

4.1.8 A copy of the proposed site layout plan together with a drained areas plan is located in Appendix 5 at the rear of this report.

4.2 Surface Water Drainage System 1 - Western Perimeter Tracks

- 4.2.1 Surface water from the gravel perimeter track surrounding the western two glasshouses and silos will be collected within the permeable construction perimeter track prior to being discharged at a restricted rate to the water course to the south and ultimately to Little Tortington Steam.
- 4.2.2 The total positively drained area will be approximately 9,775m² and the equivalent Q_{bar} greenfield runoff at 5.44 l/s/ha is 5.3 l/s.
- 4.2.3 Calculations have been prepared in order to determine the depth of 30% voided construction of the perimeter track (which spans approximately 7,845m²) required to accommodate a 1:100 year return period storm including 45% climate change.
- 4.2.4 The storage volume required is approximately 898m³ and a depth of voided stone construction 410mm will be provided.

4.3 Surface Water Drainage System 2 - Eastern Perimeter Tracks

- 4.3.1 Surface water from the gravel perimeter track surrounding the eastern two glasshouses, silos and PV control system will be collected within the permeable construction perimeter track prior to being discharged at a restricted rate to the water course to the south and ultimately to Little Tortington Steam.
- 4.3.2 The total positively drained area will be approximately 10,813m² and the equivalent Q_{bar} greenfield runoff at 5.44 l/s/ha is 5.9 l/s.
- 4.3.3 Calculations have been prepared in order to determine the depth of 30% voided construction of the perimeter track (which spans approximately 7,904m²) required to accommodate a 1:100 year return period storm including 45% climate change.
- 4.3.4 The storage volume required is approximately 990m³ and a depth of voided stone construction 450mm will be provided.

4.4 Surface Water Drainage System 3 - Service Yard and Access Road

- 4.4.1 Surface water from the service yard and the majority of the main site access road will be collected within a voided subbase beneath the yard and access road prior to being discharged at a restricted rate via that watercourse to Little Tortington Steam.
- 4.4.2 The total positively drained area will be approximately 5,506m² and the equivalent Q_{bar} greenfield runoff at 5.44 l/s/ha is 3 l/s.
- 4.4.3 Calculations have been prepared in order to determine the depth of 30% voided subbase required beneath the paved areas (which span approximately 5,056m²) to accommodate a 1:100 year return period storm including 45% climate change.

4.4.4 The storage volume required is approximately 507m³ and a depth of voided stone construction 360mm will be provided.

4.5 Surface Water Drainage System 4 - Permeable Carpark and Access

4.5.1 Surface water from the permeable carpark and the remaining section of the site access road north of the watercourse will be collected within the voided construction of the carpark and the voided subbase beneath the access road prior to being discharged at a restricted rate via that watercourse to Little Tortington Steam.

4.5.2 The total positively drained area will be approximately 1,452m² and the equivalent Q_{bar} greenfield runoff at 5.44 l/s/ha is 0.8 l/s the restriction will be set in accordance with Arun District Council's Surface Water Drainage Design Checklist version 6 at 2 l/s.

4.5.3 Calculations have been prepared in order to determine the depth of 30% voided construction of the permeable carpark (which spans approximately 1,105m²) required to accommodate a 1:100 year return period storm including 45% climate change.

4.5.4 The storage volume required is approximately 106m³ and a minimum depth of voided stone construction 350mm will be provided with a level base at 10.476m AOD.

4.6 Surface Water Drainage System 5 - Access Road (South)

4.6.1 Surface water from the section of access road to the south of that ordinary watercourse will be collected within a voided subbase prior to being discharged at a restricted rate via that watercourse to Little Tortington Steam.

4.6.2 The total positively drained area of that section of access road will be approximately 1,620m² and the equivalent Q_{bar} greenfield runoff at 5.44 l/s/ha is 0.88 l/s, the restriction will be set in accordance with Arun District Council's Surface Water Drainage Design Checklist version 6 at 2 l/s.

4.6.3 Calculations have been prepared in order to determine the size of detention basin required to accommodate a 1:100 year return period storm including 45% climate change.

4.6.4 The surface area of the proposed detention basin has been included in the total catchment, in that case a surface area of 593m².

4.6.5 The detention basin will be constructed with 1:3 side slopes and provide 490m³ of storage.

4.6.6 A total depth of 736mm will be required to allow 300mm freeboard above the upper water level.

4.7 Surface Water Drainage System 6 - Reservoir

4.7.1 Rainwater from the glasshouse roofs will be collected and discharged to the irrigation reservoir via a syphonic drainage system and under normal circumstances will provide 100% rainwater recycling for irrigation.

4.7.2 The reservoir is sized with sufficient storage beyond the normal irrigation requirement to accommodate a 1:100 year storm event including an additional 45% to account for the predicted effects of future climate change.

4.7.3 Only in the event of a 1:100 year +45% pluvial event occurring while the irrigation water level within the reservoir is already at the peak operational level will a discharge be made from that facility to the ordinary watercourse to the south of the proposed reservoir outfall which in turn discharges to Little Tortington Stream.

4.7.4 The total impermeable area discharging to the reservoir (including its own surface area) will be approximately 24.69ha and the equivalent Q_{bar} greenfield runoff at 5.44 l/s/ha is 134l/s.

4.7.5 Taking account of the proposed discharge at systems 4 and 5 of 2l/s each the proposed restriction from the reservoir has been set at 131l/s to ensure that the total runoff from the combined surface water drainage systems remains at the predeveloped Q_{bar} equivalent.

4.7.6 Calculations have been prepared in order to determine the additional storage required beyond the operational irrigation requirement and the additional freeboard required to accommodate a 1:100 year return period plus 45% climate change storm occurring at a time when the irrigation reservoir has its maximum operational water already available.

4.7.7 The calculations confirm that with a restricted outflow of 131l/s the top 1.096m of the reservoir will be required to accommodate a 1:100 year +45% storm (including 300mm freeboard).

4.7.8 The various reservoir design levels are summarised as follows:

- Top of reservoir bank 13.035m AOD
- Top of 1:100 year + 45% storage 12.731m AOD
- Maximum Irrigation water level 11.935m AOD

4.7.9 Given the volume of the proposed reservoir the detailed design of that facility will need to be undertaken by a Panel Engineer as required by the Reservoirs Act 1975.

4.7.10 Copies of the drainage strategy plans and calculations are located in Appendix 6 at the rear of this report.

4.8 Foul Water Drainage

4.8.1 Foul drainage will be discharged to the existing public foul sewer located beneath the B2132 Yapton Lane to the southwest of the site.

4.9 Detailed Drainage Drawing Design Pack

4.9.1 A detailed drainage drawing design pack which includes detailed construction drawings together with watercourse long sections has been submitted alongside this Drainage Strategy in support of the detailed planning application.

4.9.2 A completed copy of Arun District Council's Surface Water Drainage Proposal Checklist is located in Appendix 7 at the rear of this report.

4.10 Water Quality

4.10.1 The proposed development is for commercial use. In accordance with CIRIA report C753 - The SuDS Manual, the pollution hazard level for this type of development ranges between low and medium depending on the use / area of the site.

4.10.2 The surface water scheme will include mitigation to ensure that surface water is suitably treated and any pollution risk adequately managed prior to irrigation reuse or in the event of a restricted discharge to the local watercourses.

4.10.3 Table 26.2 in Chapter 26 of CIRIA report C753 The SuDS Manual provides Pollution Hazard Indices for varying land types. Those of relevance to the development proposals are as follows:

Land Use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Commercial / Industrial roofs	Low	0.3	0.2	0.05
Commercial yards and delivery areas	Medium	0.7	0.6	0.7
Non-residential car parking with infrequent change	Low	0.5	0.4	0.4
Low-traffic roads	Low	0.5	0.4	0.4

Table 2: Pollution Hazard Indices

4.10.4 The Pollution Mitigation Indices which are of relevance to the development proposals are as follows:

SuDS Type	Total suspended solids (TSS)	Metals	Hydrocarbons
Filter drain	0.4	0.4	0.4
Permeable pavement	0.7	0.6	0.7
Pond (Reservoir)	0.7	0.7	0.5
Detention Basin	0.5	0.5	0.6
Propriety Treatment Systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area		

Table 3: Pollution Mitigation Indices

4.10.5 Where multiple drainage components are used in series the individual mitigation index of secondary and tertiary components is lowered by 50% due to reduced performance associated with primary treatment.

Systems 1 & 2 Permeable Access Tracks	Total suspended solids (TSS)	Metals	Hydrocarbons
Permeable pavement	0.7	0.6	0.7

System 3 Service Yard	Total suspended solids (TSS)	Metals	Hydrocarbons
Filter drain (Voided Subbase)	0.4	0.4	0.4
Klargester AquaTreat SWT010 Separator (at 50%)	0.35	0.25	0.45
Total	0.75	0.65	0.85

System 4 Permeable Car Park	Total suspended solids (TSS)	Metals	Hydrocarbons
Permeable pavement	0.7	0.6	0.7

System 5 Site Access	Total suspended solids (TSS)	Metals	Hydrocarbons
Filter drain (Voided Subbase)	0.4	0.4	0.4
Detention Basin (at 50%)	0.25	0.25	0.3
Total	0.65	0.65	0.7

System 6 Glasshouse Roofs	Total suspended solids (TSS)	Metals	Hydrocarbons
Pond (Reservoir)	0.7	0.7	0.5

Table 4: Pollution Mitigation Provision

4.10.6 The combined elements of the surface water drainage proposals meet the target treatment level required for runoff with low to medium risk of pollution hazard thus demonstrating that the surface water drainage system for the site will adequately mitigate against the risk of pollution.

4.10.7 A Draft Drainage Maintenance and Management Manual has been submitted alongside this Drainage Strategy in support of the detailed planning application.

4.11 Risk to Others

4.11.1 The proposed surface water drainage system will be designed to current standards incorporating SuDS elements providing treatment, attenuation and storage which will minimise runoff leaving the site during times of heavy rain.

4.11.2 Allowance has been made for a 45% increase in rainfall intensities which accords with the latest figures published by the Environment Agency and with the requirements under the National Planning Policy Framework.

4.11.3 The proposed drainage system will incorporate sufficient treatment prior to final discharge thus mitigating the risk of pollution from the site.

4.11.4 The risk of surface water flooding to others due to the development proposals is reduced and the resultant risk is negligible.

4.11.5 Sewerage undertakers have an obligation to upgrade the existing networks if a connection to an equivalent or larger sized public sewer is technically achievable.

4.11.6 The residual risk of sewer flooding from this development for the foreseeable future is therefore negligible.

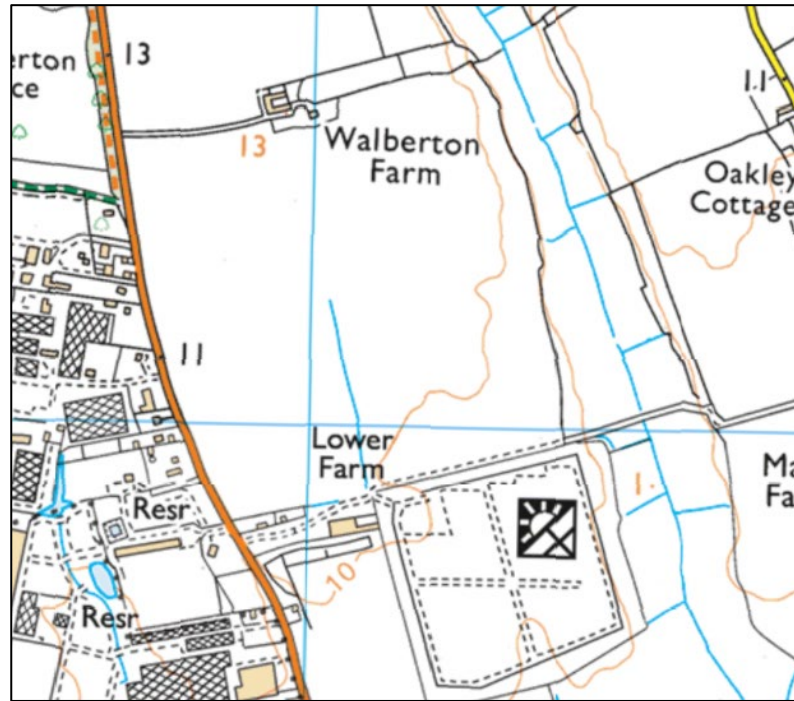


Image 4: Local Topography

4.12 Surface Water Exceedance Routes

4.12.1 In the event that part of the onsite surface water drainage network was to become blocked or suffer a failure due to lack of maintenance or in event of a storm return period in excess of the 100 year +45% design surface water would migrate overland towards the existing onsite ordinary watercourse and to Little Tortington Ditch.

4.12.2 There is no associated flood risk to the downstream catchment.

4.12.3 A plan showing exceedance event flow routes is located in Appendix 8 at the rear of this report.

5 Conclusions

- 5.1 A SuDS drainage system is proposed which accords with the requirements of national and local policy and will be primarily focused on 100% reused of rainwater captured from the glasshouse roofs for irrigation.
- 5.2 The proposed development will incorporate a total of six independent sustainable drainage systems.
- 5.3 Surface water collected from the access road, service yard, parking areas and other external works will be collected with surface water restricted to Q_{bar} greenfield runoff rates and discharged to the onsite ordinary watercourse which discharges to Little Tortington Stream to the east of the site.
- 5.4 Sufficient storage will be provided in each system to accommodate a 1:100 year +45% pluvial event.
- 5.5 Surface water collected from the glasshouse roof will be discharged via a syphonic drainage system and stored within a reservoir to the east of the site.
- 5.6 Under normal circumstances 100% of water collected from the glasshouse roofs will be reused for irrigation and there will be no discharge of surface water from the site.
- 5.7 Only in the event of a 1:100 year +45% pluvial event occurring while the irrigation water level within the reservoir is already at the peak operational level will a discharge be made from that facility to the ordinary watercourse to the south of the proposed reservoir at a suitably restricted rate.
- 5.8 Sufficient additional storage will be provided within the reservoir above the level of the peak operational irrigation water for all storm return periods up to and including the 1:100 year future year rainfall event with 45% allowance for climate change.
- 5.9 Water quality improvement will be provided to mitigate against any risk to the receiving watercourses in the event that a restricted overflow is ever required.
- 5.10 Foul drainage will be discharged to the existing public foul sewer located beneath the B2132 Yapton Lane to the southwest of the site.
- 5.11 A suitable surface water and foul water drainage system can be constructed to suitably accommodate the anticipated flows from the proposed development and provide suitable attenuation and onsite storm water storage.

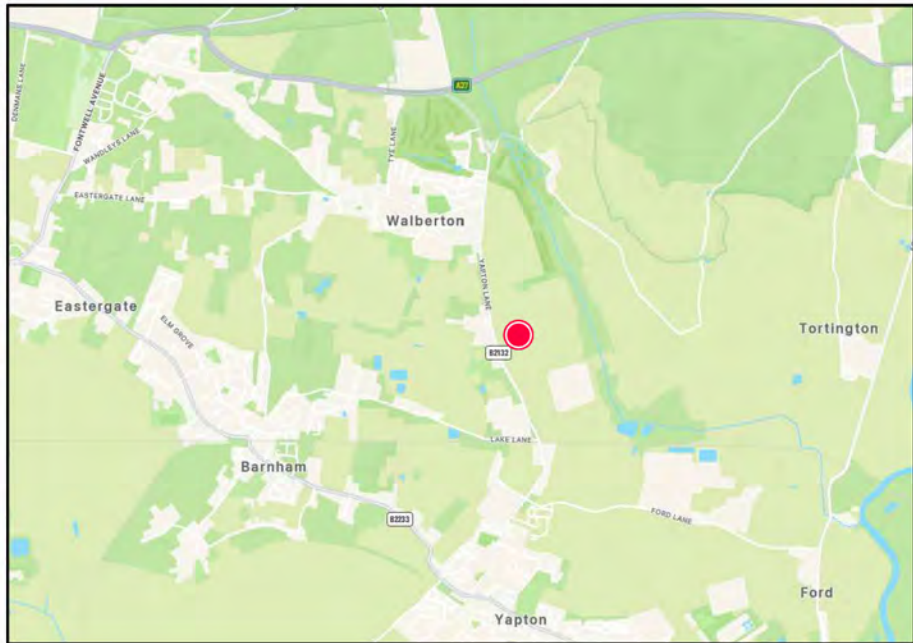
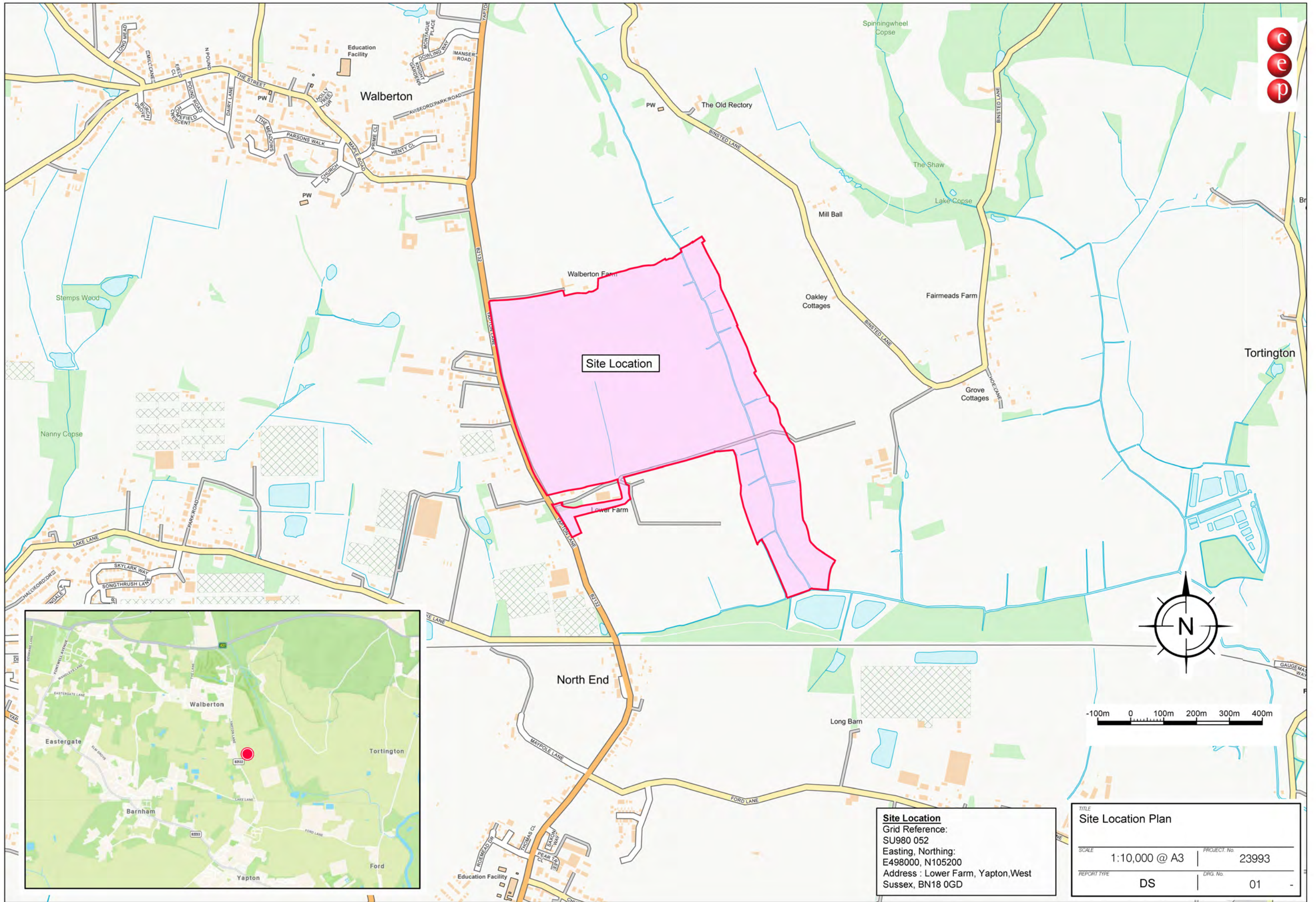
6 List of Appendices, Images and Tables

Appendix 1	Site Location Plan
Appendix 2	Existing Site Layout Plan
Appendix 3	Sewer Records
Appendix 4	Extracts of Site Investigation
Appendix 5	Proposed Site Layout Plan and Drained Areas Plan
Appendix 6	Drainage Strategy Plans and Calculations
Appendix 7	Arun District Council's Surface Water Drainage Proposal Checklist
Appendix 8	Surface Water Exceedance Route plan

Image 1	Site Location
Image 2	Local Watercourses
Image 3	FEH Greenfield Runoff Calculation
Image 4	Local Topography

Table 1	Groundwater Monitoring Results
Table 2	Pollution Hazard Indices
Table 3	Pollution Mitigation Indices
Table 4	Pollution Mitigation Provision

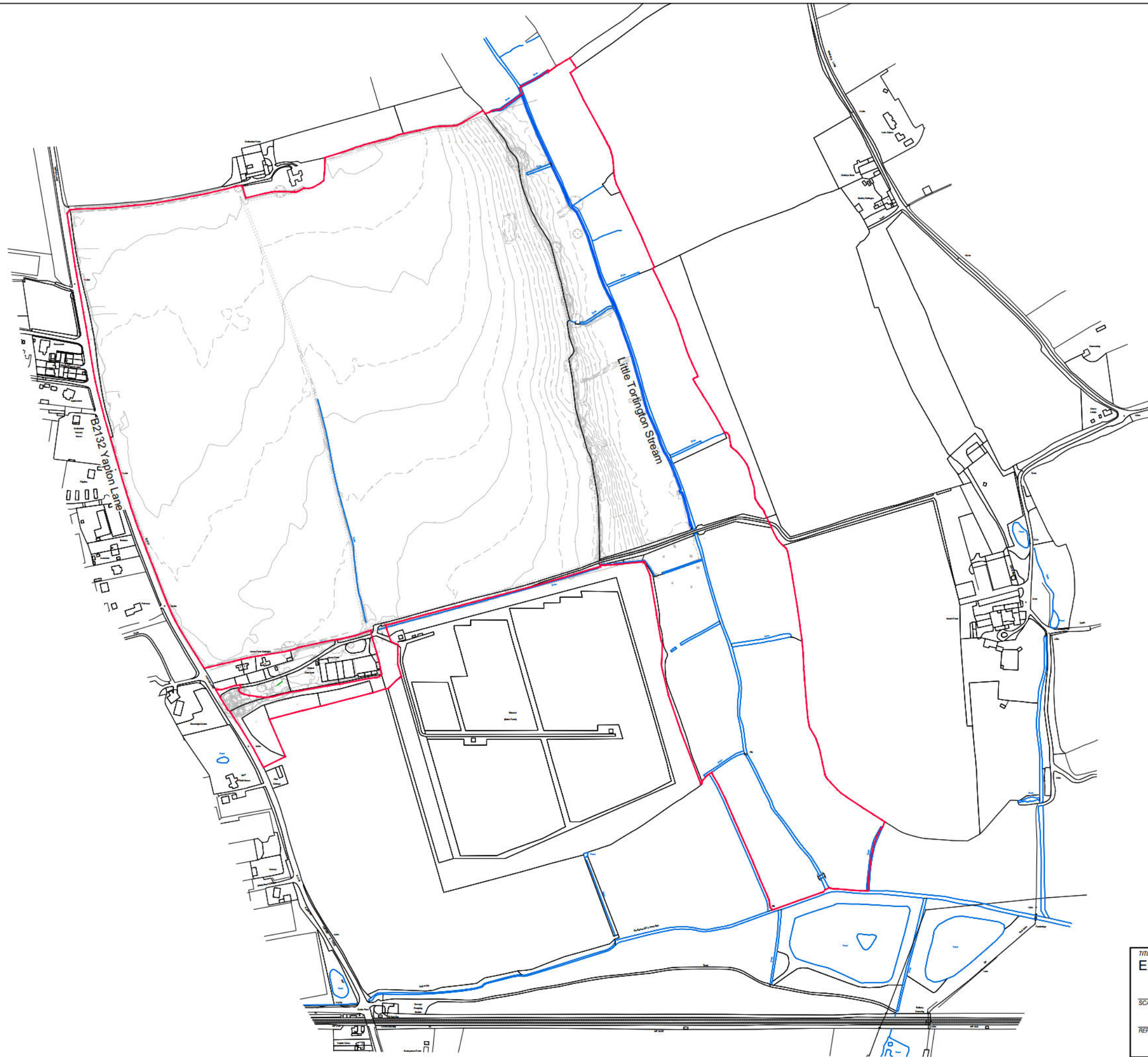
Appendix 1
Site Location Plan



Site Location
Grid Reference:
SU980 052
Easting, Northing:
E498000, N105200
Address : Lower Farm, Yapton, West
Sussex, BN18 0GD

TITLE	
Site Location Plan	
SCALE	PROJECT No.
1:10,000 @ A3	23993
REPORT TYPE	DRG. No.
DS	01

Appendix 2
Existing Site Layout Plan



TITLE Existing Site Layout Plan			
SCALE	1:5,000 @ A3	PROJECT No.	23993
REPORT TYPE	DS	DRG. No.	02

Appendix 3
Sewer Records



Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0301	F	6.48	4.73	
0401	F	4.56	2.60	
1201	F	5.75	3.32	
1202	F	5.39	3.13	
1203	F	4.98	2.99	
1204	F	4.53	2.75	
1301	F	3.94	2.49	
1303	F	3.67	2.23	
1304	F	3.92	2.48	
1305	F	4.05	2.18	
1306	F	3.43	2.13	
1401	F	3.97	2.30	
1403	F	3.50	1.80	
1404	F	3.46	2.06	

Foul Gravity Sewer

Combined Gravity Sewer

Covered Water Course or Treated Effluent

Surface Water Gravity Sewer

Rising Main, Vacuum or Siphon

Combined Outfall

Foul Outfall

Surface Water Outfall

Surface Water Inlet

Combined Pumping Station

Surface Water Pumping Station

Foul Pumping Station

Water Treatment Works

Section 154 Area Building Over Agreement Area

Foul Manhole

Combined Manhole

Surface Water Manhole

Side Entry Manhole, Separation Chamber, Dummy Manhole or Surface Water Subway

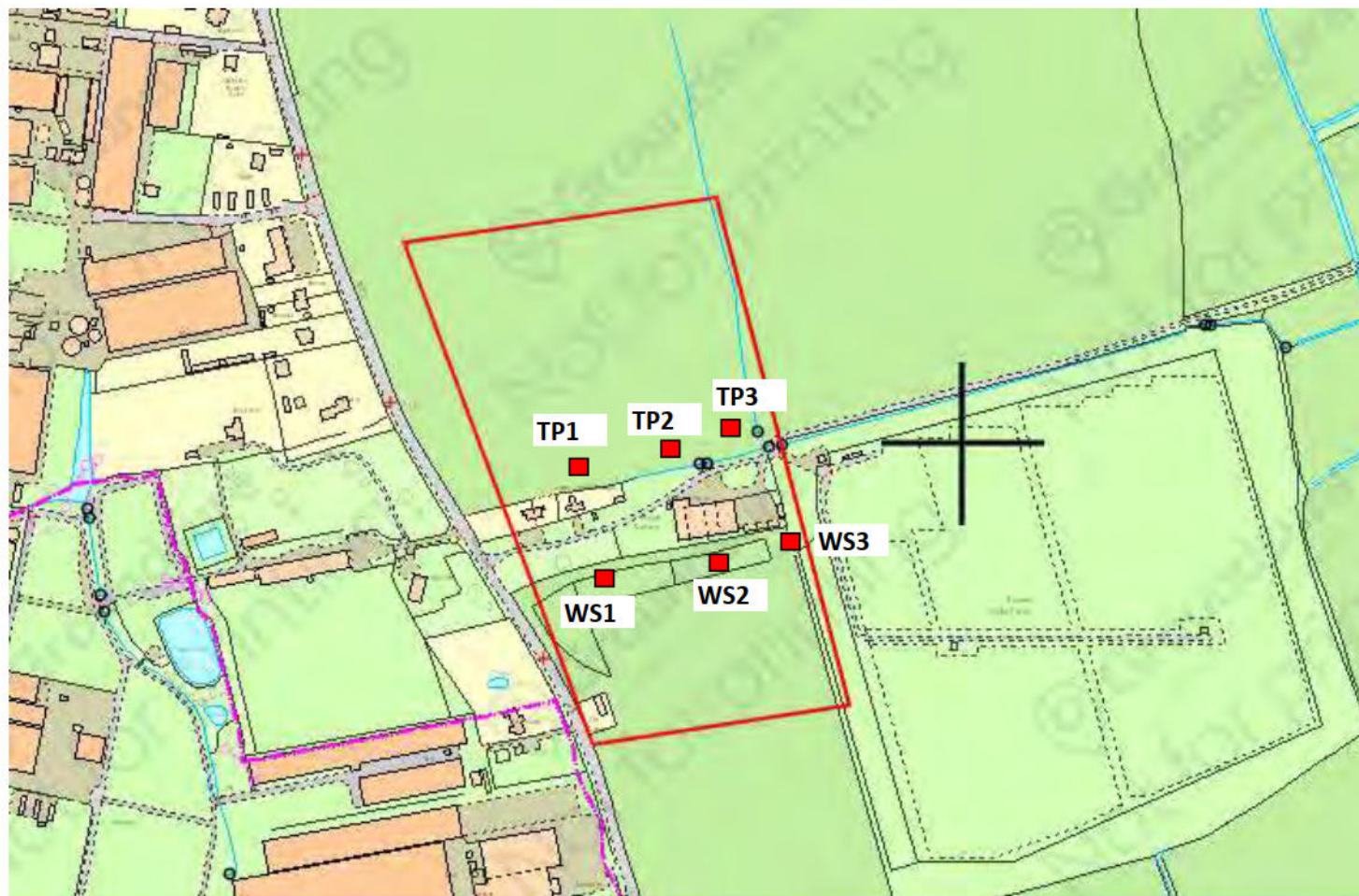
mat@civil.co.uk

23375 Binstead Farm



Appendix 4
Extracts of Site Investigation

N



Not To Scale

Figure 1

Project:

Lower Farm, Walberton, Arundel BN18 0AS

Berry Farming Ltd c/o John Hall Consulting

Date:

April 2021

Trial Hole Location Plan

Ref:

GWPR4084





Ground and Water Limited
Unit 2
The Long Barn, Norton Farm
Selborne Road
Selborne, Alton
Hampshire
GU34 3NB

natasha.kearl@groundandwater.co.uk

Soakage Letter Report

CLIENT	Berry Farming Ltd c/o John Hall Consulting
SITE ADDRESS	Lower Farm, Walberton, Arundel, BN18 0AS
REPORT REFERENCE	GWPR4084 The terms and conditions of this report are shown within Appendix A.
ENGINEER	Natasha Kearn, Ground and Water Limited
GENERAL	Ground and Water Ltd were instructed by John Hall Consulting on the 26 th January 2021 to conduct Soakaway Testing for a site known as Lower Farm, Walberton, Arundel, BN18 0AS. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref. GWQ6040 dated the 25 th November 2020.
SCOPE OF WORKS	Site works were undertaken on the 4 th February 2021 and comprised the machine excavation of 3No. Trial Pits, referenced (TP1 – TP3) to a depth of 0.80m bgl. A trial hole location plan can be seen in Figure 1 and the trial hole logs can be seen in Appendix B.
PROPOSED DEVELOPMENT	At the time of reporting, February 2021, the proposed development was understood to comprise the construction of a large glass house within the north of the site and a reservoir within the south of the site.

GROUND CONDITIONS ENCOUNTERED	Summary of Strata Encountered (TP1 – TP3)			
	Strata	Depth Encountered (m bgl)	Final Depth (m bgl)	Thickness (m)
	TOPSOIL (ALL TRIAL HOLES): Generally comprised a brown slightly sandy to sandy silty CLAY. The sand was fine to medium.	GL	0.10 – 0.15	0.10 – 0.15
	UNDIFFERENTIATED RIVER TERRACE DEPOSITS (ALL TRIAL HOLES): Generally comprised an orangish-brown sandy CLAY. The sand was fine to coarse.	0.10 - 0.15	0.80	0.65 - 0.70

GROUNDWATER It should be noted that soakaway tests were undertaken during a time when there was significant standing water on the surface and during a period of heavy rain. It is therefore possible that water from the surface may enter the pits and lead to erroneous results. A tabulated summary of the depth of standing water and water seepage noted can be viewed below.

Depth of Standing Water and Water Seepage within Trial Holes	
Trial Hole	Standing Water level at time of filling pits (m bgl)
TP1	0.70
TP2	0.70
TP3	0.65

ROOTS A tabulated summary of the depth of root penetration can be viewed below.

Depth of Root Penetrated Soils Observed Within Trial Holes		
Trial Hole	Fresh Roots (m bgl)/ fresh rootlets	Decayed roots (m bgl)
TP1	0.30	None
TP2	0.30	None
TP3	0.40	None

INFILTRATION TESTS

Soakage testing, in accordance with the principles of BRE365, were attempted within TP1 – TP3 at 0.80m bgl. Due to presence of standing water at the base of the trial pits in TP2 and TP3 and the heavy rainfall, the water levels minimally fluctuated throughout the day. TP1 – TP3 were bottomed out within the cohesive soils of the Undifferentiated River Terrace Deposits.

The starting depths and end depths recorded are tabulated below.

BRE 365 Soakage Test Results - Recorded Infiltration Rates m/s			
Trial Hole	Starting Depth (m bgl)	End Depth (m bgl)	Time taken (minutes)
TP1	0.240	0.365	305
TP2	0.180	0.185	345
TP3	0.165	0.170	350

No infiltration rate could be calculated due to the water level rising within the trial pits of TP2 and TP3. However, it was possible to calculate an infiltration rate for TP1.

BRE 365 Soakage Test Results - Recorded Infiltration Rates m/s			
Trial Hole	Test 1	Test 2	Test 3
TP1	1.685×10^{-6}	-	-

* Due to the slow infiltration rates within the soils, TP1 could not be completed with the 3 fillings required for BRE365 compliance. It should also be noted that to comply with BRE365 the water must drain within 24 hours which was not possible within these soils.

A review of the Environment Agency website revealed the site was underlain by a **Secondary A Aquifer** associated with the superficial deposits of the Undifferentiated River Terrace Deposits, overlying a **Unproductive Strata**, comprising the bedrock deposits of the London Clay Formation.

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities.

Secondary Aquifers include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. **Secondary A Aquifers** comprise permeable layers capable of supporting water supplies at a local rather than strategic scale, in some cases forming an important source of base flow to rivers. These are generally aquifers that were formerly classified as Minor Aquifers by the Environment Agency.

Unproductive Strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Examination of the Defra records showed that the site did not fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

It was understood that all of the run off from the Glass House will be filtered via pipes to the reservoir.

Please feel free to contact us should you have any queries regarding the information enclosed within this letter report.

Yours sincerely,



Depth of Groundwater Strikes/Standing Groundwater Within Trial Holes			
Trial Hole	Date	Depth of Groundwater (m bgl)	Depth of Standpipe (m bgl)
WS1	30/01/2021	0.91	2.86
	27/02/2021	1.70	2.73
	27/03/2021	1.92	2.65
	20/04/2021	1.60	2.20
WS2	30/01/2021	0.17	2.46
	27/02/2021	0.74	2.14
	27/03/2021	1.03	2.09
	20/04/2021	0.70	2.30
WS3	30/01/2021	0.26	1.89
	27/02/2021	0.84	1.70
	27/03/2021	1.04	1.68
	20/04/2021	1.10	1.70

Please feel free to contact us should you have any queries regarding the information enclosed within this letter report.

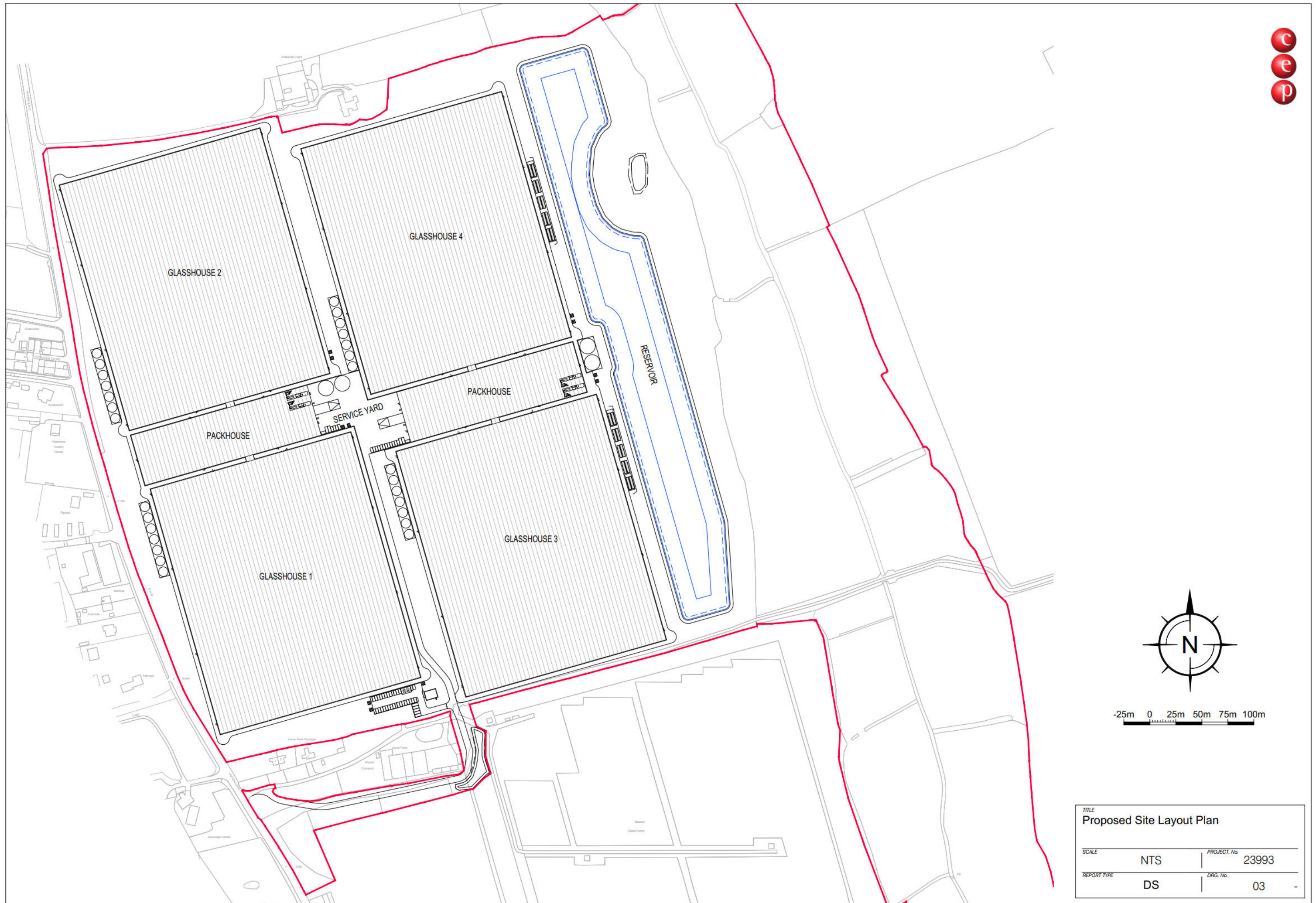
Yours sincerely,



Natasha Kearn BSc.,
Geotechnical and Geo-environmental Engineer
For and on behalf of Ground and Water Limited

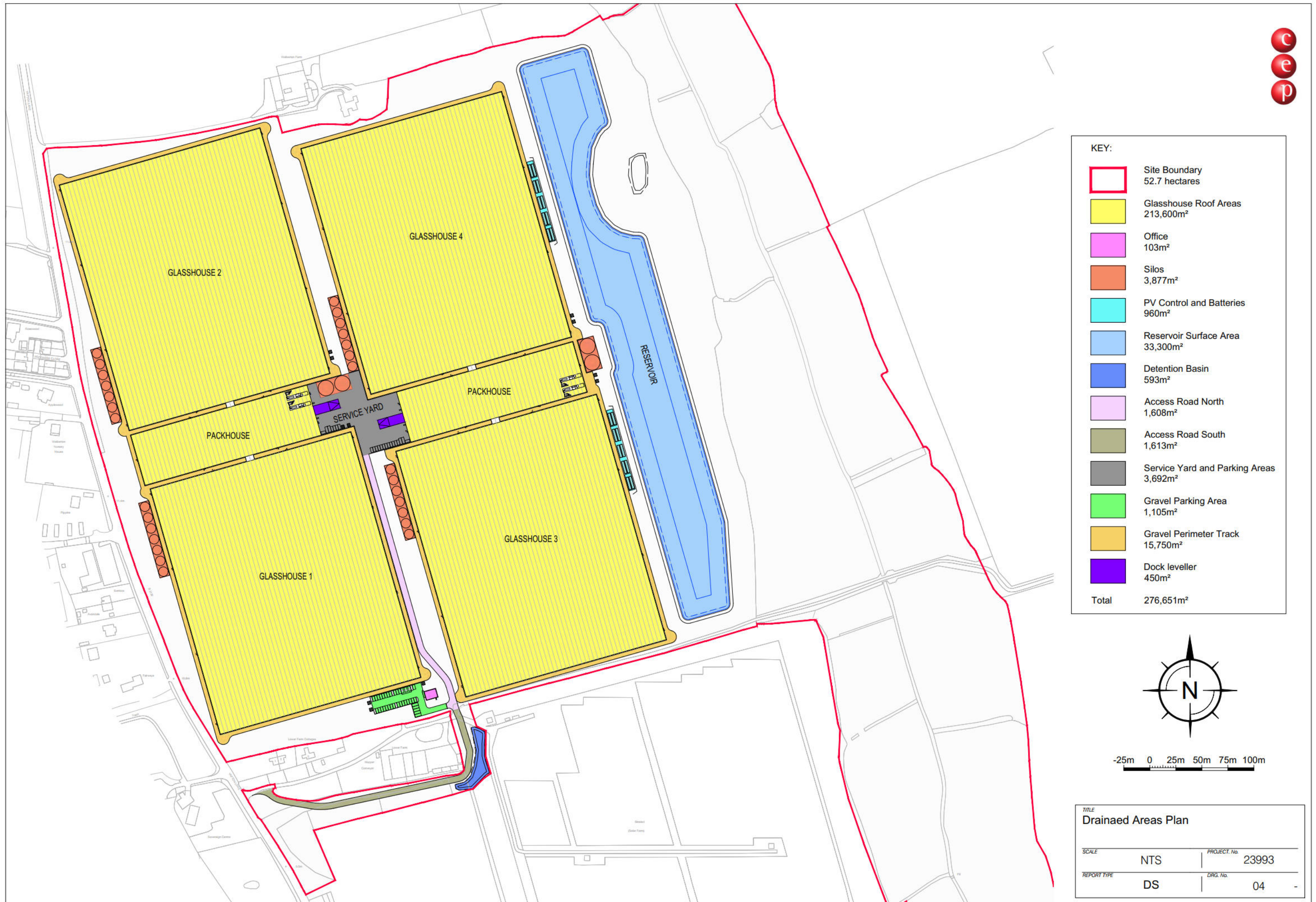
Figure 1 Trial Hole Location Plan
Appendix A Conditions and Limitations
Appendix B Trial Hole Logs

Appendix 5
Proposed Site Layout Plan
and Drained Areas Plan



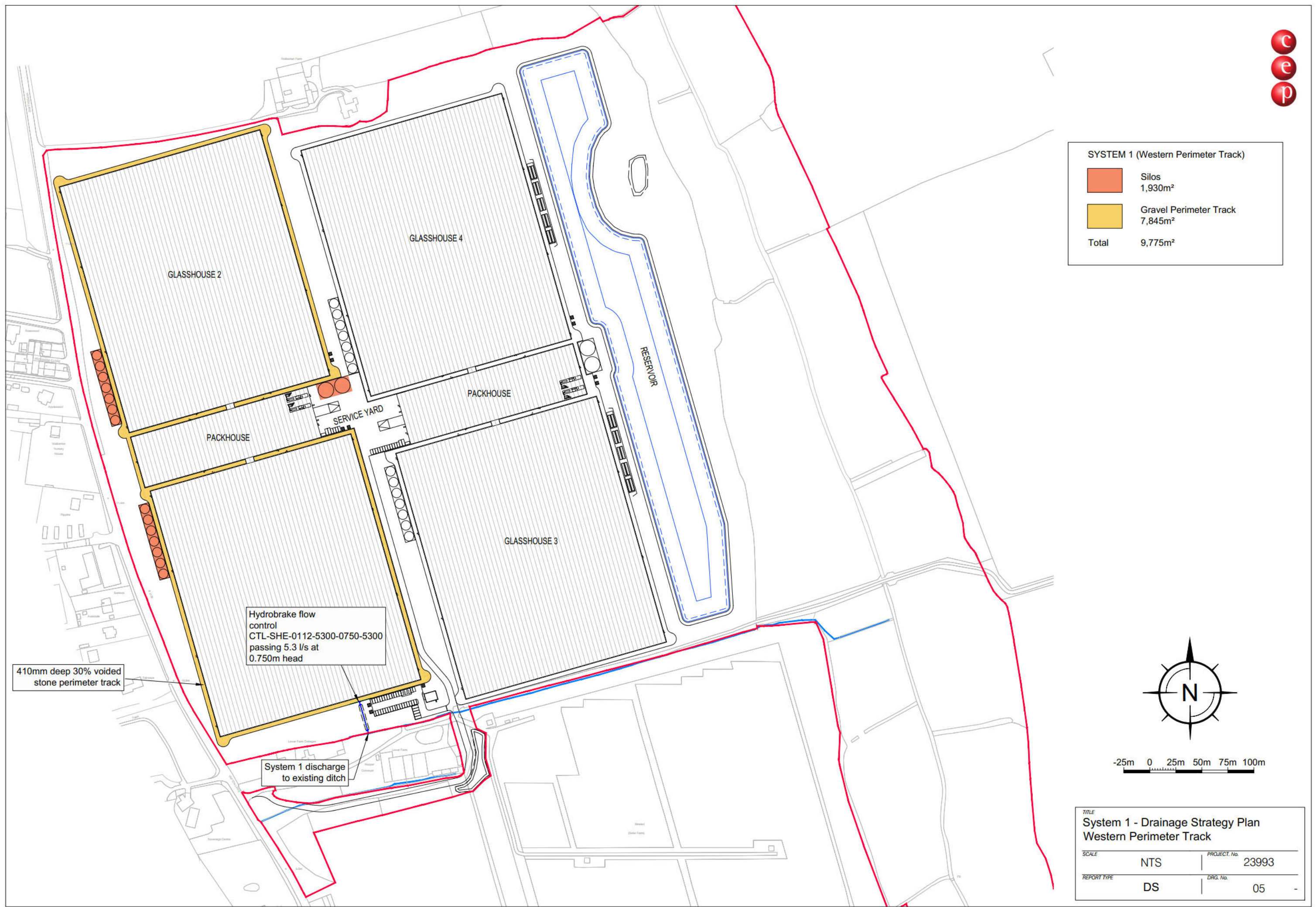
-25m 0 25m 50m 75m 100m

TITLE			
Proposed Site Layout Plan			
SCALE	NTS	PROJECT No.	23993
REPORT TYPE	DS	DRG. No.	03



Appendix 6

Drainage Strategy Plans and Calculations



SYSTEM 1 (Western Perimeter Track)	
	Silos 1,930m ²
	Gravel Perimeter Track 7,845m ²
Total	9,775m ²



-25m 0 25m 50m 75m 100m

TITLE	
System 1 - Drainage Strategy Plan Western Perimeter Track	
SCALE	NTS
PROJECT No.	23993
REPORT TYPE	DS
DRG. No.	05

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Inverts
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.500
CV	1.000	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	150.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
HB 1-1	0.978	5.00	11.600	1200	498011.930	104906.004	0.750
HW 1-2			10.439		498012.689	104903.343	0.300
HW 1-3			10.496		498019.770	104878.510	0.666
HW 1-4			10.439		498020.280	104876.720	0.628
Junction 1-5			10.440		498020.631	104875.480	0.630

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	HB 1-1	HW 1-2	2.767	0.600	10.850	10.139	0.711	3.9	150	5.01	56.4
1.001	HW 1-2	HW 1-3	25.823	0.025	10.139	9.830	0.309	83.6	200	5.35	55.0
1.002	HW 1-3	HW 1-4	1.861	0.600	9.830	9.811	0.019	100.0	150	5.38	54.9
1.003	HW 1-4	Junction 1-5	1.289	0.025	9.811	9.810	0.001	2000.0	200	5.46	54.5

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	5.144	90.9	199.2	0.600	0.150	0.978	0.0	150	5.240
1.001	1.275	420.8	194.4	0.000	0.366	0.978	0.0	217	1.050
1.002	1.005	17.8	193.9	0.516	0.478	0.978	0.0	150	1.023
1.003	0.261	86.0	192.7	0.328	0.330	0.978	0.0	300	0.261

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	2.767	3.9	150	Circular	11.600	10.850	0.600	10.439	10.139	0.150
1.001	25.823	83.6	200	Channel	10.439	10.139	0.000	10.496	9.830	0.366
1.002	1.861	100.0	150	Circular	10.496	9.830	0.516	10.439	9.811	0.478
1.003	1.289	2000.0	200	Channel	10.439	9.811	0.328	10.440	9.810	0.330

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Node Type
1.000	HB 1-1	1200	Manhole	Adoptable	HW 1-2	Junction
1.001	HW 1-2		Junction		HW 1-3	Junction
1.002	HW 1-3		Junction		HW 1-4	Junction
1.003	HW 1-4		Junction		Junction 1-5	Junction

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	2160	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0

Node HB 1-1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	10.850	Product Number	CTL-SHE-0112-5300-0750-5300
Design Depth (m)	0.750	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.3	Min Node Diameter (mm)	1200

Node HB 1-1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	11.190
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	1560

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	7845.0	0.0	0.410	7845.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 93.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	HB 1-1	224	11.235	0.385	31.1	108.4150	0.0000	SURCHARGED
15 minute winter	HW 1-2	3	10.180	0.041	5.3	0.0000	0.0000	OK
2880 minute summer	HW 1-3	1320	9.886	0.056	5.3	0.0000	0.0000	OK
2880 minute summer	HW 1-4	1320	9.860	0.049	5.3	0.0000	0.0000	OK
2880 minute summer	Junction 1-5	1320	9.845	0.035	5.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	HB 1-1	Hydro-Brake®	HW 1-2	5.3				
15 minute winter	HW 1-2	1.001	HW 1-3	5.3	0.454	0.013	0.4261	
2880 minute summer	HW 1-3	1.002	HW 1-4	5.3	0.972	0.298	0.0101	
2880 minute summer	HW 1-4	1.003	Junction 1-5	5.3	0.391	0.062	0.0177	371.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 93.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	HB 1-1	232	11.261	0.411	41.6	167.6308	0.0000	SURCHARGED
30 minute summer	HW 1-2	3	10.180	0.041	5.2	0.0000	0.0000	OK
2880 minute summer	HW 1-3	1260	9.886	0.056	5.3	0.0000	0.0000	OK
2880 minute summer	HW 1-4	1260	9.860	0.049	5.3	0.0000	0.0000	OK
2880 minute summer	Junction 1-5	1260	9.845	0.035	5.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	HB 1-1	Hydro-Brake®	HW 1-2	5.2				
30 minute summer	HW 1-2	1.001	HW 1-3	5.4	0.466	0.013	0.4243	
2880 minute summer	HW 1-3	1.002	HW 1-4	5.3	0.972	0.298	0.0101	
2880 minute summer	HW 1-4	1.003	Junction 1-5	5.3	0.391	0.062	0.0177	443.6

Results for 10 year Critical Storm Duration. Lowest mass balance: 93.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	HB 1-1	352	11.330	0.480	50.8	330.0776	0.0000	FLOOD RISK
120 minute summer	HW 1-2	4	10.180	0.041	5.2	0.0000	0.0000	OK
720 minute winter	HW 1-3	150	9.886	0.056	5.3	0.0000	0.0000	OK
720 minute winter	HW 1-4	150	9.860	0.049	5.3	0.0000	0.0000	OK
720 minute winter	Junction 1-5	150	9.845	0.035	5.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	HB 1-1	Hydro-Brake®	HW 1-2	5.2				
120 minute summer	HW 1-2	1.001	HW 1-3	5.5	0.412	0.013	0.4243	
720 minute winter	HW 1-3	1.002	HW 1-4	5.3	0.972	0.298	0.0102	
720 minute winter	HW 1-4	1.003	Junction 1-5	5.3	0.391	0.062	0.0177	498.1

Results for 30 year Critical Storm Duration. Lowest mass balance: 93.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	HB 1-1	352	11.376	0.526	63.3	438.4535	0.0000	FLOOD RISK
30 minute winter	HW 1-2	3	10.180	0.041	5.3	0.0000	0.0000	OK
10080 minute summer	HW 1-3	4620	9.886	0.056	5.3	0.0000	0.0000	OK
10080 minute summer	HW 1-4	4620	9.860	0.049	5.3	0.0000	0.0000	OK
10080 minute summer	Junction 1-5	4620	9.845	0.035	5.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	HB 1-1	Hydro-Brake®	HW 1-2	5.3				
30 minute winter	HW 1-2	1.001	HW 1-3	5.4	0.487	0.013	0.4245	
10080 minute summer	HW 1-3	1.002	HW 1-4	5.3	0.972	0.298	0.0101	
10080 minute summer	HW 1-4	1.003	Junction 1-5	5.3	0.391	0.062	0.0177	1199.6

Results for 100 year Critical Storm Duration. Lowest mass balance: 93.70%

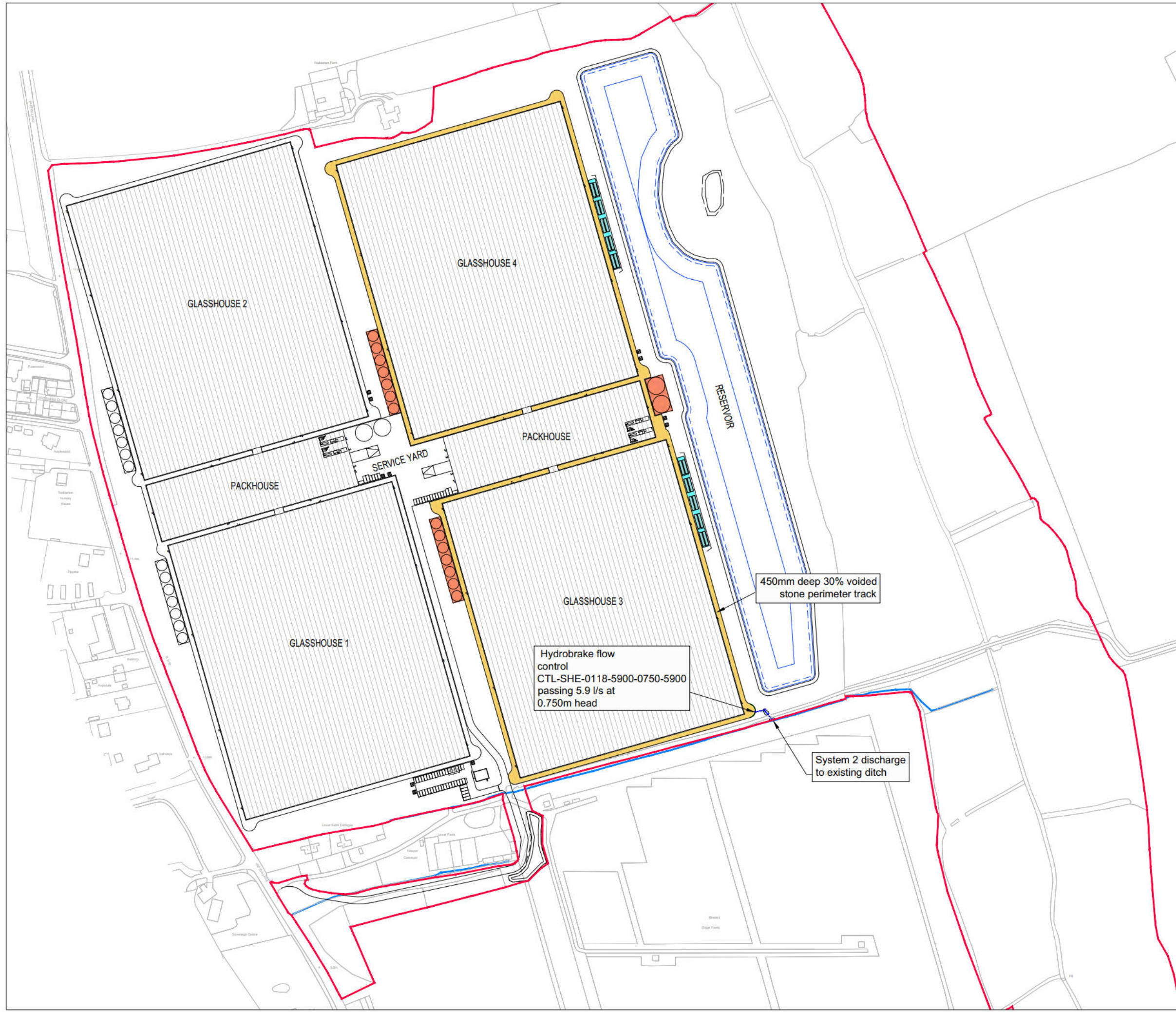
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	HB 1-1	472	11.433	0.583	62.0	573.4250	0.0000	FLOOD RISK
60 minute winter	HW 1-2	3	10.180	0.041	5.3	0.0000	0.0000	OK
960 minute summer	HW 1-3	135	9.886	0.056	5.3	0.0000	0.0000	OK
960 minute summer	HW 1-4	135	9.860	0.049	5.3	0.0000	0.0000	OK
960 minute summer	Junction 1-5	135	9.845	0.035	5.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	HB 1-1	Hydro-Brake®	HW 1-2	5.2				
60 minute winter	HW 1-2	1.001	HW 1-3	5.2	0.420	0.012	0.4262	
960 minute summer	HW 1-3	1.002	HW 1-4	5.3	0.972	0.298	0.0102	
960 minute summer	HW 1-4	1.003	Junction 1-5	5.3	0.391	0.062	0.0177	801.4

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 93.70%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	HB 1-1	705	11.571	0.721	64.5	897.9930	0.0000	FLOOD RISK
120 minute winter	HW 1-2	4	10.180	0.041	5.3	0.0000	0.0000	OK
7200 minute summer	HW 1-3	2760	9.886	0.056	5.3	0.0000	0.0000	OK
7200 minute summer	HW 1-4	2760	9.860	0.049	5.3	0.0000	0.0000	OK
7200 minute summer	Junction 1-5	2760	9.845	0.035	5.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	HB 1-1	Hydro-Brake®	HW 1-2	5.3				
120 minute winter	HW 1-2	1.001	HW 1-3	5.2	0.419	0.012	0.4240	
7200 minute summer	HW 1-3	1.002	HW 1-4	5.3	0.972	0.298	0.0101	
7200 minute summer	HW 1-4	1.003	Junction 1-5	5.3	0.391	0.062	0.0177	1799.9



SYSTEM 2 (Eastern Perimeter Track)	
	Silos 1,948m ²
	PV Control and Batteries 960m ²
	Gravel Perimeter Track 7,904m ²
Total	10,813m ²



TITLE System 2 - Drainage Strategy Plan Eastern Perimeter Track	
SCALE NTS	PROJECT No. 23993
REPORT TYPE DS	DRG. No. 06

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Inverts
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.500
CV	1.000	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	150.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
HB 2-1	1.081	5.00	11.600	1200	498316.588	104965.346	0.750
HW 2-2			8.780		498324.334	104966.699	0.300
HW 2-3			8.690		498327.500	104962.840	0.750
HW 2-4			8.665		498329.410	104960.500	0.755
Junction 2-5			8.630		498331.669	104957.755	0.722

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	HB 2-1	HW 2-2	7.863	0.600	10.850	8.480	2.370	3.3	150	5.02	56.3
1.001	HW 2-2	HW 2-3	4.992	0.025	8.480	7.940	0.540	9.2	200	5.05	56.2
1.002	HW 2-3	HW 2-4	3.021	0.600	7.940	7.910	0.030	100.0	150	5.10	56.0
1.003	HW 2-4	Junction 2-5	3.555	0.025	7.910	7.908	0.002	2000.0	200	5.32	55.1

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	5.573	98.5	220.0	0.600	0.150	1.081	0.0	150	5.676
1.001	3.834	1265.4	219.6	0.000	0.450	1.081	0.0	142	2.463
1.002	1.005	17.8	218.8	0.600	0.605	1.081	0.0	150	1.023
1.003	0.261	86.0	215.2	0.455	0.422	1.081	0.0	300	0.261

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	7.863	3.3	150	Circular	11.600	10.850	0.600	8.780	8.480	0.150
1.001	4.992	9.2	200	Channel	8.780	8.480	0.000	8.690	7.940	0.450
1.002	3.021	100.0	150	Circular	8.690	7.940	0.600	8.665	7.910	0.605
1.003	3.555	2000.0	200	Channel	8.665	7.910	0.455	8.630	7.908	0.422

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Node Type
1.000	HB 2-1	1200	Manhole	Adoptable	HW 2-2	Junction
1.001	HW 2-2		Junction		HW 2-3	Junction
1.002	HW 2-3		Junction		HW 2-4	Junction
1.003	HW 2-4		Junction		Junction 2-5	Junction

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	2160	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0

Node HB 2-1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	10.850	Product Number	CTL-SHE-0118-5900-0750-5900
Design Depth (m)	0.750	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.9	Min Node Diameter (mm)	1200

Node HB 2-1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	11.150
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	1560

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	7904.0	0.0	0.450	7904.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 93.73%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	HB 2-1	272	11.199	0.349	40.7	118.8138	0.0000	SURCHARGED
960 minute winter	HW 2-2	330	8.504	0.024	5.9	0.0000	0.0000	OK
960 minute winter	HW 2-3	330	8.000	0.060	5.9	0.0000	0.0000	OK
480 minute winter	HW 2-4	136	7.973	0.063	5.9	0.0000	0.0000	OK
480 minute winter	Junction 2-5	136	7.945	0.037	5.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute summer	HB 2-1	Hydro-Brake®	HW 2-2	5.9				
960 minute winter	HW 2-2	1.001	HW 2-3	5.9	0.430	0.005	0.0735	
960 minute winter	HW 2-3	1.002	HW 2-4	5.9	0.867	0.332	0.0206	
480 minute winter	HW 2-4	1.003	Junction 2-5	5.9	0.339	0.069	0.0636	247.2

Results for 2 year Critical Storm Duration. Lowest mass balance: 93.73%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	HB 2-1	232	11.227	0.377	46.0	183.4227	0.0000	SURCHARGED
2880 minute winter	HW 2-2	1260	8.504	0.024	5.9	0.0000	0.0000	OK
2880 minute winter	HW 2-3	1260	8.000	0.060	5.9	0.0000	0.0000	OK
2880 minute winter	HW 2-4	1260	7.973	0.063	5.9	0.0000	0.0000	OK
2880 minute winter	Junction 2-5	1260	7.945	0.037	5.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	HB 2-1	Hydro-Brake®	HW 2-2	5.9				
2880 minute winter	HW 2-2	1.001	HW 2-3	5.9	0.430	0.005	0.0735	
2880 minute winter	HW 2-3	1.002	HW 2-4	5.9	0.867	0.332	0.0206	
2880 minute winter	HW 2-4	1.003	Junction 2-5	5.9	0.339	0.069	0.0636	502.8

Results for 10 year Critical Storm Duration. Lowest mass balance: 93.73%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	HB 2-1	352	11.302	0.452	56.2	361.3046	0.0000	FLOOD RISK
240 minute winter	HW 2-2	12	8.504	0.024	5.9	0.0000	0.0000	OK
720 minute summer	HW 2-3	165	8.000	0.060	5.9	0.0000	0.0000	OK
720 minute summer	HW 2-4	165	7.973	0.063	5.9	0.0000	0.0000	OK
720 minute summer	Junction 2-5	165	7.945	0.037	5.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	HB 2-1	Hydro-Brake®	HW 2-2	5.8				
240 minute winter	HW 2-2	1.001	HW 2-3	5.9	0.430	0.005	0.0734	
720 minute summer	HW 2-3	1.002	HW 2-4	5.9	0.867	0.332	0.0206	
720 minute summer	HW 2-4	1.003	Junction 2-5	5.9	0.339	0.069	0.0636	547.5

Results for 30 year Critical Storm Duration. Lowest mass balance: 93.73%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	HB 2-1	352	11.352	0.502	70.0	480.6197	0.0000	FLOOD RISK
180 minute winter	HW 2-2	8	8.504	0.024	5.9	0.0000	0.0000	OK
960 minute summer	HW 2-3	225	8.000	0.060	5.9	0.0000	0.0000	OK
960 minute summer	HW 2-4	225	7.973	0.063	5.9	0.0000	0.0000	OK
960 minute summer	Junction 2-5	225	7.945	0.037	5.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	HB 2-1	Hydro-Brake®	HW 2-2	5.9				
180 minute winter	HW 2-2	1.001	HW 2-3	5.9	0.431	0.005	0.0734	
960 minute summer	HW 2-3	1.002	HW 2-4	5.9	0.867	0.332	0.0206	
960 minute summer	HW 2-4	1.003	Junction 2-5	5.9	0.339	0.069	0.0636	709.5

Results for 100 year Critical Storm Duration. Lowest mass balance: 93.73%

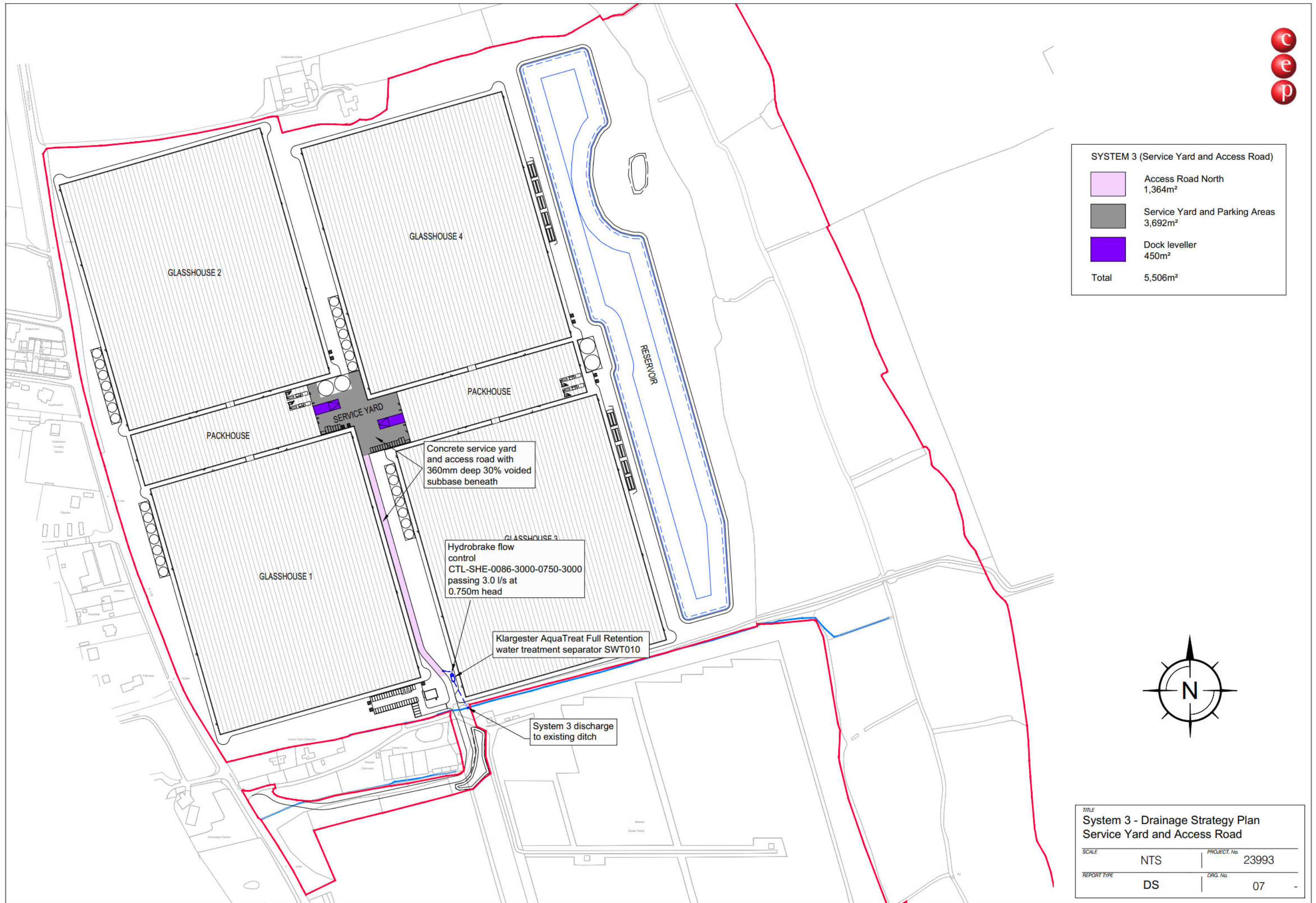
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	HB 2-1	472	11.416	0.566	68.6	631.5800	0.0000	FLOOD RISK
960 minute summer	HW 2-2	135	8.504	0.024	5.9	0.0000	0.0000	OK
960 minute summer	HW 2-3	135	8.000	0.060	5.9	0.0000	0.0000	OK
960 minute winter	HW 2-4	75	7.973	0.063	5.9	0.0000	0.0000	OK
960 minute winter	Junction 2-5	75	7.945	0.037	5.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	HB 2-1	Hydro-Brake®	HW 2-2	5.8				
960 minute summer	HW 2-2	1.001	HW 2-3	5.9	0.430	0.005	0.0735	
960 minute summer	HW 2-3	1.002	HW 2-4	5.9	0.867	0.332	0.0206	
960 minute winter	HW 2-4	1.003	Junction 2-5	5.9	0.339	0.069	0.0636	888.7

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 93.73%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	HB 2-1	705	11.567	0.717	71.3	989.6240	0.0000	FLOOD RISK
960 minute winter	HW 2-2	45	8.504	0.024	5.9	0.0000	0.0000	OK
7200 minute winter	HW 2-3	2520	8.000	0.060	5.9	0.0000	0.0000	OK
7200 minute winter	HW 2-4	2520	7.973	0.063	5.9	0.0000	0.0000	OK
7200 minute winter	Junction 2-5	2520	7.945	0.037	5.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	HB 2-1	Hydro-Brake®	HW 2-2	5.9				
960 minute winter	HW 2-2	1.001	HW 2-3	5.9	0.430	0.005	0.0735	
7200 minute winter	HW 2-3	1.002	HW 2-4	5.9	0.867	0.332	0.0206	
7200 minute winter	HW 2-4	1.003	Junction 2-5	5.9	0.339	0.069	0.0636	1997.8



Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Inverts
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.500
CV	1.000	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	150.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
HB 3-1	0.551	5.00	11.600		498092.266	104933.580	0.750
MH 3-2			11.600	1200	498100.078	104932.517	0.829
PI 3-3			11.600		498100.626	104930.593	1.130
PI 3-4			11.600		498102.645	104923.510	1.180
MH 3-5			10.079	1200	498113.960	104901.750	0.750
Junction 3-6			10.090		498116.317	104898.264	0.803

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	HB 3-1	MH 3-2	7.884	0.600	10.850	10.771	0.079	100.0	150	5.13	55.9
1.001	MH 3-2	PI 3-3	2.001	0.600	10.771	10.470	0.301	6.6	150	5.14	55.8
Petrol Interceptor	PI 3-3	PI 3-4	7.365	0.600	10.470	10.420	0.050	147.3	375	5.22	55.5
1.003	PI 3-4	MH 3-5	24.526	0.600	10.420	9.329	1.091	22.5	150	5.41	54.7
1.004	MH 3-5	Junction 3-6	4.208	0.600	9.329	9.287	0.042	100.2	150	5.48	54.4

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.005	17.8	111.2	0.600	0.679	0.551	0.0	150	1.023
1.001	3.934	69.5	111.2	0.679	0.980	0.551	0.0	150	4.007
Petrol Interceptor	1.490	164.6	110.5	0.755	0.805	0.551	0.0	225	1.593
1.003	2.133	37.7	109.0	1.030	0.600	0.551	0.0	150	2.173
1.004	1.004	17.7	108.4	0.600	0.653	0.551	0.0	150	1.022

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	7.884	100.0	150	Circular	11.600	10.850	0.600	11.600	10.771	0.679
1.001	2.001	6.6	150	Circular	11.600	10.771	0.679	11.600	10.470	0.980
Petrol Interceptor	7.365	147.3	375	Circular	11.600	10.470	0.755	11.600	10.420	0.805
1.003	24.526	22.5	150	Circular	11.600	10.420	1.030	10.079	9.329	0.600

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	HB 3-1		Junction		MH 3-2	1200	Manhole	Adoptable
1.001	MH 3-2	1200	Manhole	Adoptable	PI 3-3		Junction	
Petrol Interceptor	PI 3-3		Junction		PI 3-4		Junction	
1.003	PI 3-4		Junction		MH 3-5	1200	Manhole	Adoptable

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.004	4.208	100.2	150	Circular	10.079	9.329	0.600	10.090	9.287	0.653

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.004	MH 3-5	1200	Manhole	Adoptable	Junction 3-6		Junction	

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	2160	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0

Node HB 3-1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	10.850	Product Number	CTL-SHE-0086-3000-0750-3000
Design Depth (m)	0.750	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.0	Min Node Diameter (mm)	1200

Node HB 3-1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	11.015
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	1560

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	5056.0	0.0	0.360	5056.0	0.0	0.361	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 96.23%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	HB 3-1	224	11.054	0.204	17.5	60.0311	0.0000	SURCHARGED
240 minute winter	MH 3-2	224	10.792	0.021	3.0	0.0241	0.0000	OK
240 minute winter	PI 3-3	224	10.505	0.035	3.0	0.0000	0.0000	OK
15 minute winter	PI 3-4	3	10.449	0.029	3.0	0.0000	0.0000	OK
240 minute winter	MH 3-5	224	9.372	0.043	3.0	0.0489	0.0000	OK
240 minute winter	Junction 3-6	224	9.329	0.042	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	HB 3-1	Hydro-Brake®	MH 3-2	3.0				
240 minute winter	MH 3-2	1.001	PI 3-3	3.0	1.312	0.043	0.0046	
240 minute winter	PI 3-3	Petrol Interceptor	PI 3-4	3.0	0.671	0.018	0.0331	
15 minute winter	PI 3-4	1.003	MH 3-5	3.1	1.219	0.083	0.0799	
240 minute winter	MH 3-5	1.004	Junction 3-6	3.0	0.733	0.169	0.0172	100.3

Results for 2 year Critical Storm Duration. Lowest mass balance: 96.23%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	HB 3-1	232	11.076	0.226	23.4	92.8196	0.0000	SURCHARGED
180 minute summer	MH 3-2	136	10.792	0.021	3.0	0.0241	0.0000	OK
15 minute summer	PI 3-3	2	10.506	0.036	3.0	0.0000	0.0000	OK
30 minute summer	PI 3-4	3	10.449	0.029	3.0	0.0000	0.0000	OK
180 minute summer	MH 3-5	140	9.372	0.043	3.0	0.0490	0.0000	OK
180 minute summer	Junction 3-6	140	9.329	0.042	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	HB 3-1	Hydro-Brake®	MH 3-2	3.0				
180 minute summer	MH 3-2	1.001	PI 3-3	3.0	1.312	0.043	0.0047	
15 minute summer	PI 3-3	Petrol Interceptor	PI 3-4	3.0	0.825	0.018	0.0330	
30 minute summer	PI 3-4	1.003	MH 3-5	3.1	1.158	0.082	0.0802	
180 minute summer	MH 3-5	1.004	Junction 3-6	3.0	0.733	0.169	0.0172	121.3

Results for 10 year Critical Storm Duration. Lowest mass balance: 96.23%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	HB 3-1	352	11.135	0.285	28.6	182.5250	0.0000	SURCHARGED
15 minute winter	MH 3-2	17	10.792	0.021	3.0	0.0241	0.0000	OK
15 minute winter	PI 3-3	2	10.506	0.036	3.0	0.0000	0.0000	OK
30 minute winter	PI 3-4	3	10.449	0.029	3.0	0.0000	0.0000	OK
15 minute winter	MH 3-5	20	9.372	0.043	3.0	0.0490	0.0000	OK
15 minute winter	Junction 3-6	20	9.329	0.042	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	HB 3-1	Hydro-Brake®	MH 3-2	3.0				
15 minute winter	MH 3-2	1.001	PI 3-3	3.0	1.312	0.043	0.0048	
15 minute winter	PI 3-3	Petrol Interceptor	PI 3-4	3.0	0.786	0.018	0.0331	
30 minute winter	PI 3-4	1.003	MH 3-5	3.1	1.112	0.082	0.0803	
15 minute winter	MH 3-5	1.004	Junction 3-6	3.0	0.733	0.169	0.0172	89.4

Results for 30 year Critical Storm Duration. Lowest mass balance: 96.23%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	HB 3-1	352	11.174	0.324	35.7	242.2404	0.0000	SURCHARGED
15 minute summer	MH 3-2	13	10.792	0.021	3.0	0.0241	0.0000	OK
30 minute summer	PI 3-3	2	10.506	0.036	3.0	0.0000	0.0000	OK
30 minute winter	PI 3-4	3	10.449	0.029	3.0	0.0000	0.0000	OK
15 minute summer	MH 3-5	85	9.372	0.043	3.0	0.0490	0.0000	OK
15 minute summer	Junction 3-6	86	9.329	0.042	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	HB 3-1	Hydro-Brake®	MH 3-2	3.0				
15 minute summer	MH 3-2	1.001	PI 3-3	3.0	1.312	0.043	0.0047	
30 minute summer	PI 3-3	Petrol Interceptor	PI 3-4	3.0	0.777	0.018	0.0331	
30 minute winter	PI 3-4	1.003	MH 3-5	3.0	1.098	0.081	0.0803	
15 minute summer	MH 3-5	1.004	Junction 3-6	3.0	0.733	0.169	0.0172	114.2

Results for 100 year Critical Storm Duration. Lowest mass balance: 96.23%

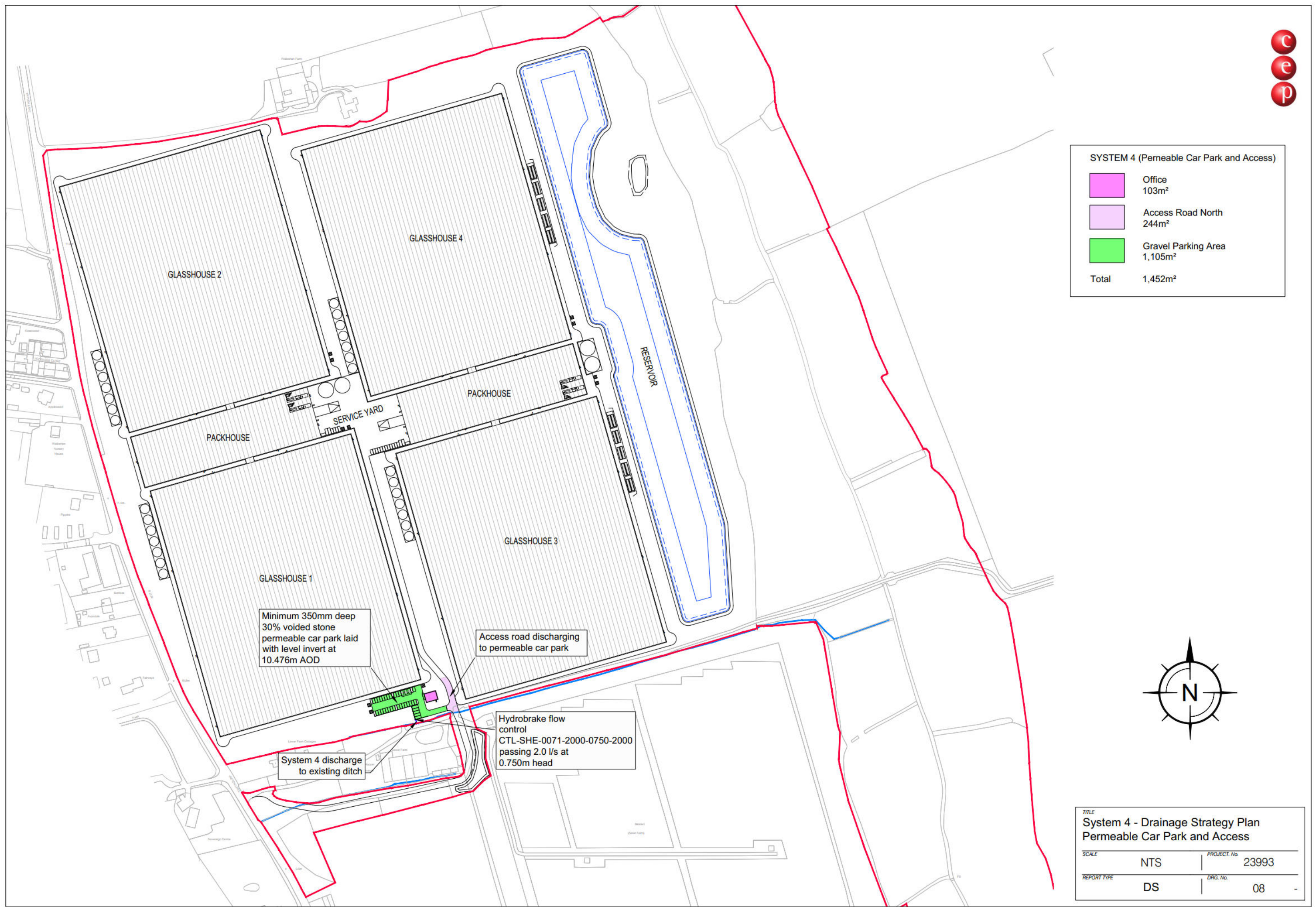
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	HB 3-1	472	11.224	0.374	35.0	317.8149	0.0000	SURCHARGED
15 minute summer	MH 3-2	236	10.792	0.021	3.0	0.0241	0.0000	OK
60 minute summer	PI 3-3	2	10.506	0.036	3.0	0.0000	0.0000	OK
60 minute winter	PI 3-4	3	10.449	0.029	3.0	0.0000	0.0000	OK
15 minute summer	MH 3-5	238	9.372	0.043	3.0	0.0490	0.0000	OK
15 minute summer	Junction 3-6	239	9.329	0.042	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	HB 3-1	Hydro-Brake®	MH 3-2	3.0				
15 minute summer	MH 3-2	1.001	PI 3-3	3.0	1.312	0.043	0.0047	
60 minute summer	PI 3-3	Petrol Interceptor	PI 3-4	3.0	0.800	0.018	0.0331	
60 minute winter	PI 3-4	1.003	MH 3-5	3.0	1.311	0.080	0.0803	
15 minute summer	MH 3-5	1.004	Junction 3-6	3.0	0.733	0.169	0.0172	141.6

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 96.23%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
720 minute winter	HB 3-1	705	11.349	0.499	36.4	506.7788	0.0000	FLOOD RISK
15 minute summer	MH 3-2	632	10.792	0.021	3.0	0.0241	0.0000	OK
30 minute winter	PI 3-3	2	10.506	0.036	3.0	0.0000	0.0000	OK
60 minute winter	PI 3-4	3	10.449	0.029	3.0	0.0000	0.0000	OK
15 minute summer	MH 3-5	634	9.372	0.043	3.0	0.0490	0.0000	OK
15 minute summer	Junction 3-6	635	9.329	0.042	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	HB 3-1	Hydro-Brake®	MH 3-2	3.0				
15 minute summer	MH 3-2	1.001	PI 3-3	3.0	1.312	0.043	0.0047	
30 minute winter	PI 3-3	Petrol Interceptor	PI 3-4	3.0	0.788	0.018	0.0331	
60 minute winter	PI 3-4	1.003	MH 3-5	3.1	1.168	0.083	0.0803	
15 minute summer	MH 3-5	1.004	Junction 3-6	3.0	0.733	0.169	0.0172	212.3



TITLE			
System 4 - Drainage Strategy Plan			
Permeable Car Park and Access			
SCALE	NTS	PROJECT No.	23993
REPORT TYPE	DS	DRG. No.	08

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.500
CV	1.000	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	150.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
HB 4-1	0.145	5.00	10.826	1200	498066.051	104888.675	0.750
HW 4-2			10.150		498067.132	104884.930	0.750

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	HB 4-1	HW 4-2	3.898	0.600	10.076	9.400	0.676	5.8	150	5.02	56.3

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	4.224	74.6	29.5	0.600	0.600	0.145	0.0	65	3.977

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	3.898	5.8	150	Circular	10.826	10.076	0.600	10.150	9.400	0.600

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Node Type
1.000	HB 4-1	1200	Manhole	Adoptable	HW 4-2	Junction

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	2160	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0

Node HB 4-1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	10.076	Product Number	CTL-SHE-0071-2000-0750-2000
Design Depth (m)	0.750	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node HB 4-1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	10.476
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	480

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1105.0	0.0	0.350	1105.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 98.24%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	HB 4-1	124	10.503	0.427	7.9	9.7146	0.0000	SURCHARGED
15 minute summer	HW 4-2	1	9.400	0.000	2.0	0.0000	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)			
180 minute summer	HB 4-1	Hydro-Brake®	HW 4-2	2.0	23.5			

Results for 2 year Critical Storm Duration. Lowest mass balance: 98.24%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	HB 4-1	136	10.522	0.446	10.7	15.9488	0.0000	SURCHARGED
15 minute summer	HW 4-2	1	9.400	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
180 minute summer	HB 4-1	Hydro-Brake®	HW 4-2	2.0	31.9

Results for 10 year Critical Storm Duration. Lowest mass balance: 98.24%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	HB 4-1	176	10.584	0.508	12.6	36.4311	0.0000	FLOOD RISK
15 minute summer	HW 4-2	1	9.400	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
180 minute winter	HB 4-1	Hydro-Brake®	HW 4-2	2.0	54.7

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.24%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	HB 4-1	176	10.625	0.549	15.9	50.2770	0.0000	FLOOD RISK
15 minute summer	HW 4-2	1	9.400	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
180 minute winter	HB 4-1	Hydro-Brake®	HW 4-2	2.0	68.8

Results for 100 year Critical Storm Duration. Lowest mass balance: 98.24%

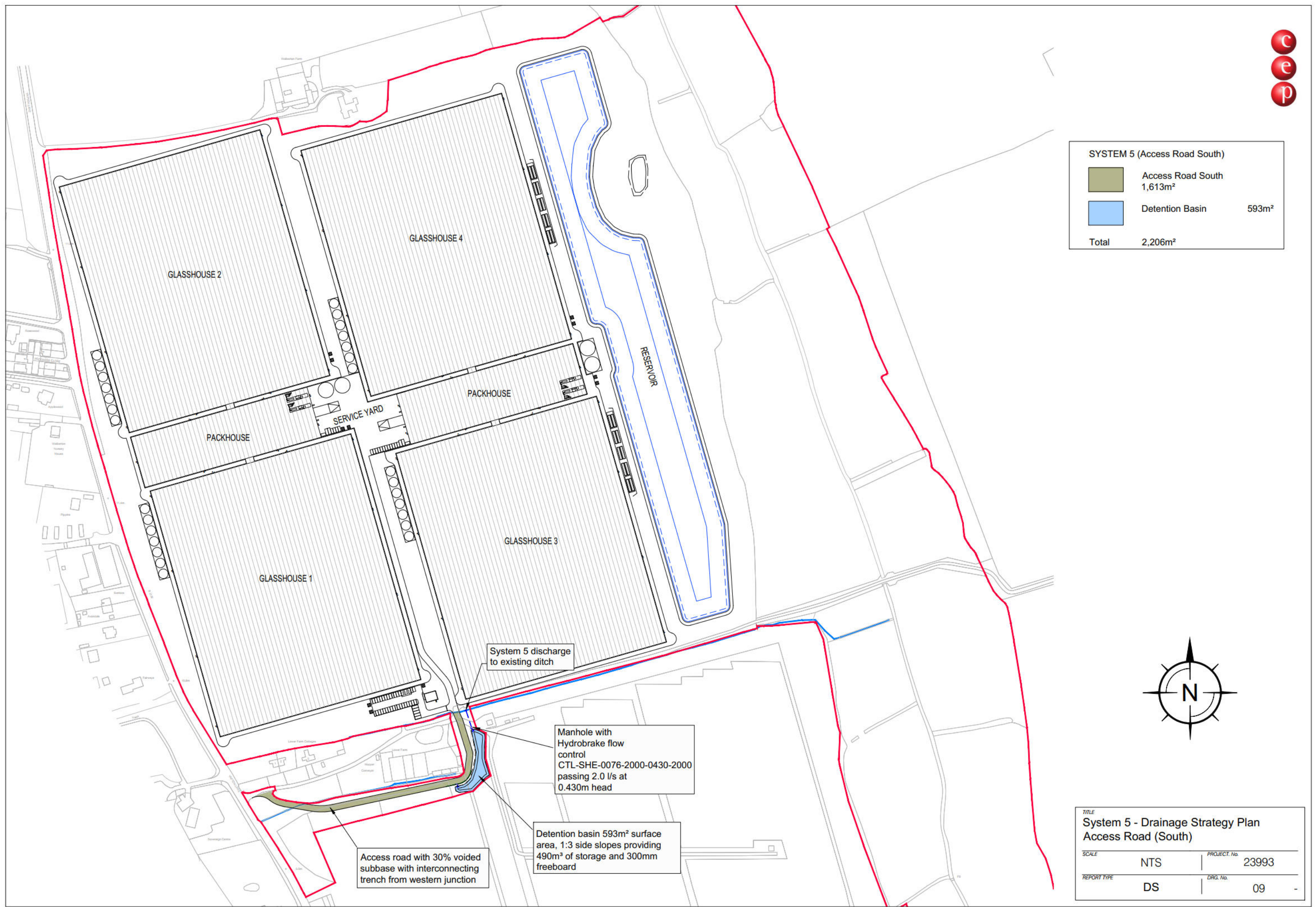
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	HB 4-1	180	10.674	0.598	19.7	66.4706	0.0000	FLOOD RISK
15 minute summer	HW 4-2	1	9.400	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
180 minute winter	HB 4-1	Hydro-Brake®	HW 4-2	2.0	85.3

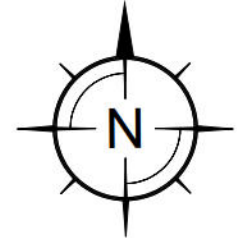
Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 98.24%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	HB 4-1	236	10.793	0.717	23.1	106.0930	0.0000	FLOOD RISK
15 minute summer	HW 4-2	1	9.400	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Discharge Vol (m³)
240 minute winter	HB 4-1	Hydro-Brake®	HW 4-2	2.0	132.1



SYSTEM 5 (Access Road South)		
	Access Road South	1,613m ²
	Detention Basin	593m ²
Total	2,206m ²	



TITLE		
System 5 - Drainage Strategy Plan Access Road (South)		
SCALE	NTS	PROJECT No. 23993
REPORT TYPE	DS	DRG. No. 09

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.500
CV	1.000	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	150.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
MH 5-1	0.221	5.00	9.748		498105.653	104826.621	0.592
HW 5-2			9.890		498106.631	104824.294	0.744
HB 5-3		5.00	9.839	1200	498119.885	104880.638	0.736
HW 5-4			9.950		498114.435	104897.360	0.919

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.000	MH 5-1	HW 5-2	2.524	0.600	9.156	9.146	0.010	245.0	300	5.04	56.2
1.000	HB 5-3	HW 5-4	17.588	0.600	9.103	9.031	0.072	245.0	300	5.29	55.2

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
2.000	1.000	70.7	44.9	0.292	0.444	0.221	0.0	174	1.057
1.000	1.000	70.7	0.0	0.436	0.619	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
2.000	2.524	245.0	300	Circular	9.748	9.156	0.292	9.890	9.146	0.444
1.000	17.588	245.0	300	Circular	9.839	9.103	0.436	9.950	9.031	0.619

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Node Type
2.000	MH 5-1		Junction		HW 5-2	Junction
1.000	HB 5-3	1200	Manhole	Adoptable	HW 5-4	Junction

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	2160	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0

Node HB 5-3 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	9.103	Product Number	CTL-SHE-0076-2000-0430-2000
Design Depth (m)	0.430	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node HB 5-3 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	66.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.103	Main Channel Slope (1:X)	1000.0
Safety Factor	2.0	Time to half empty (mins)	848	Main Channel n	0.035

Inlets
HW 5-2

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	418.0	0.0	0.736	593.3	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 97.65%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	MH 5-1	10	9.285	0.129	27.6	0.0000	0.0000	OK
30 minute summer	HW 5-2	20	9.207	0.061	24.8	0.0000	0.0000	OK
360 minute summer	HB 5-3	240	9.203	0.100	7.5	0.1135	0.0000	OK
15 minute summer	HW 5-4	1	9.031	0.000	0.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	MH 5-1	2.000	HW 5-2	27.5	1.613	0.389	0.0466	
30 minute summer	HW 5-2	Flow through pond	HB 5-3	18.5	0.094	0.007	15.1036	
360 minute summer	HB 5-3	Hydro-Brake®	HW 5-4	2.0				45.9

Results for 2 year Critical Storm Duration. Lowest mass balance: 97.65%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	MH 5-1	10	9.321	0.165	41.7	0.0000	0.0000	OK
360 minute summer	HW 5-2	248	9.227	0.081	10.9	0.0000	0.0000	OK
360 minute summer	HB 5-3	248	9.227	0.124	8.3	0.1402	0.0000	OK
15 minute summer	HW 5-4	1	9.031	0.000	1.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	MH 5-1	2.000	HW 5-2	41.6	1.793	0.589	0.0633	
360 minute summer	HW 5-2	Flow through pond	HB 5-3	8.3	0.030	0.003	39.1905	
360 minute summer	HB 5-3	Hydro-Brake®	HW 5-4	2.0				60.1

Results for 10 year Critical Storm Duration. Lowest mass balance: 97.65%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	MH 5-1	10	9.398	0.242	81.1	0.0000	0.0000	OK
240 minute winter	HW 5-2	232	9.296	0.150	15.6	0.0000	0.0000	OK
240 minute winter	HB 5-3	232	9.296	0.193	10.1	0.2185	0.0000	OK
15 minute summer	HW 5-4	1	9.031	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	MH 5-1	2.000	HW 5-2	86.1	2.159	1.218	0.1000	
240 minute winter	HW 5-2	Flow through pond	HB 5-3	10.1	0.046	0.004	70.2045	
240 minute winter	HB 5-3	Hydro-Brake®	HW 5-4	2.0				89.2

Results for 30 year Critical Storm Duration. Lowest mass balance: 97.65%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	MH 5-1	10	9.440	0.284	105.2	0.0000	0.0000	OK
240 minute winter	HW 5-2	236	9.343	0.197	19.6	0.0000	0.0000	OK
240 minute winter	HB 5-3	236	9.343	0.240	10.9	0.2712	0.0000	OK
15 minute summer	HW 5-4	1	9.031	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	MH 5-1	2.000	HW 5-2	110.3	2.542	1.560	0.1166	
240 minute winter	HW 5-2	Flow through pond	HB 5-3	10.9	0.050	0.004	91.7462	
240 minute winter	HB 5-3	Hydro-Brake®	HW 5-4	2.0				111.5

Results for 100 year Critical Storm Duration. Lowest mass balance: 97.65%

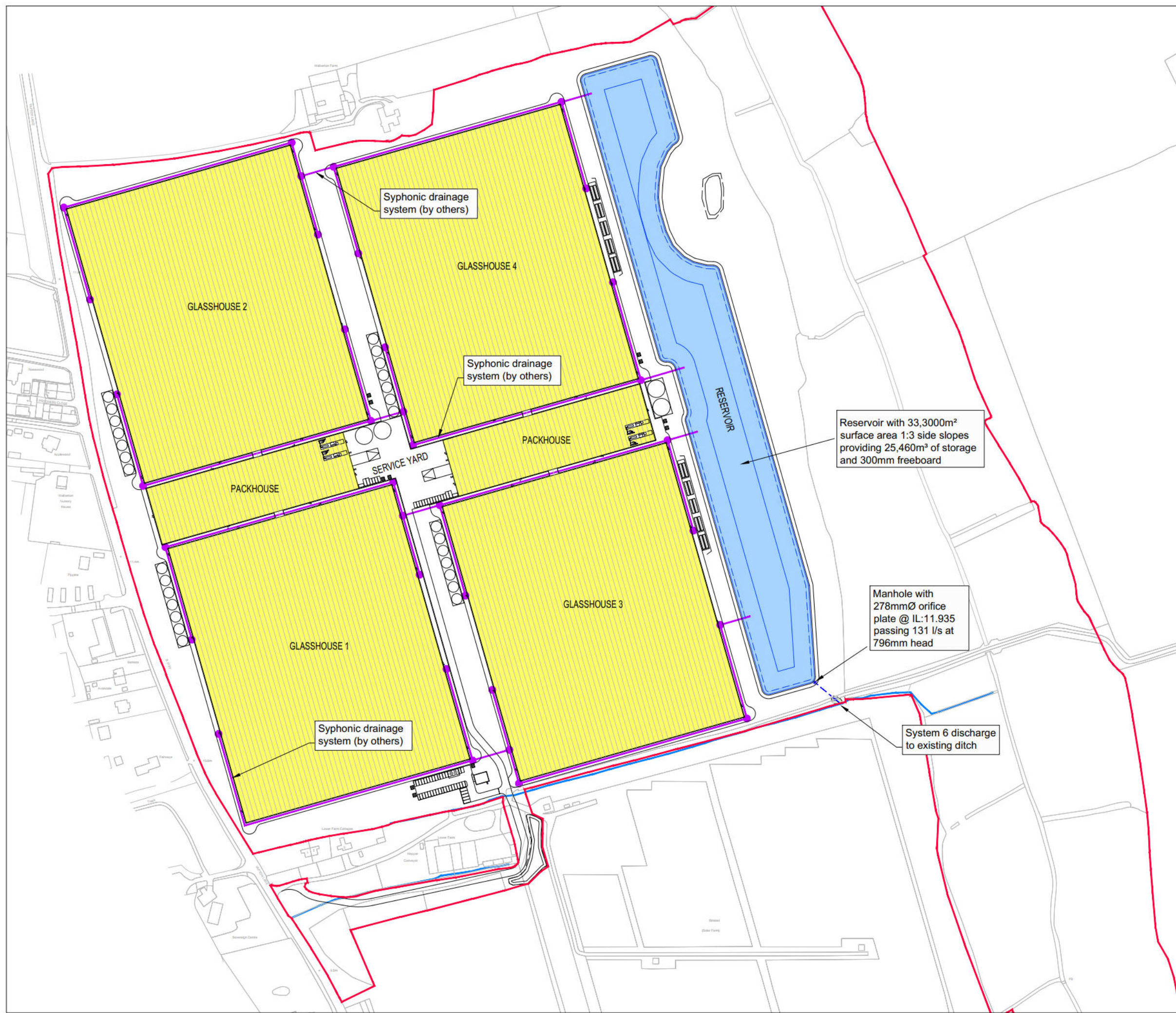
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	MH 5-1	9	9.450	0.294	131.4	0.0000	0.0000	OK
360 minute winter	HW 5-2	352	9.402	0.256	17.7	0.0000	0.0000	OK
360 minute winter	HB 5-3	352	9.402	0.299	9.9	0.3386	0.0000	OK
15 minute summer	HW 5-4	1	9.031	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	MH 5-1	2.000	HW 5-2	140.9	2.774	1.993	0.1229	
360 minute winter	HW 5-2	Flow through pond	HB 5-3	9.9	0.044	0.004	120.0384	
360 minute winter	HB 5-3	Hydro-Brake®	HW 5-4	2.0				150.5

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 97.65%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	MH 5-1	456	9.541	0.385	20.3	0.0000	0.0000	FLOOD RISK
480 minute winter	HW 5-2	472	9.536	0.390	20.2	0.0000	0.0000	OK
480 minute winter	HB 5-3	464	9.536	0.433	11.2	0.4895	0.0000	SURCHARGED
15 minute summer	HW 5-4	1	9.031	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	MH 5-1	2.000	HW 5-2	20.2	0.784	0.287	0.1777	
480 minute winter	HW 5-2	Flow through pond	HB 5-3	11.2	0.045	0.004	186.3952	
480 minute winter	HB 5-3	Hydro-Brake®	HW 5-4	2.0				230.9



SYSTEM 6 (Reservoir)	
	Glasshouse Roof Areas 213,600m ²
	Reservoir Surface Area 33,300m ²
Total	246,900m ²



TITLE			
System 6 - Drainage Strategy Plan Reservoir			
SCALE	NTS	PROJECT No.	23993
REPORT TYPE	DS	DRG. No.	10 A

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Inverts
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.500
CV	1.000	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	150.0		

Circular Link Type

Template	Freeform Carrier	Auto Increment (mm)	75
Shape	Circular	Follow Ground	x
Barrels	1		

Available Diameters (mm)

100 | 150

Channel Link Type

Template	Freeform Carrier	Auto Increment (mm)	100
Shape	Trapezoidal	Preferred Cover (m)	0.000
Barrels	1	Follow Ground	x
Height (mm)	300	Velocity	Manning
Side Slope (1:X)	3.0	ks (mm) / n	0.025

Available Diameters (mm)

200

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
OP 6-1	24.690	5.00	13.035	2100	498367.772	104993.180	1.100	11.935
MH 6-2			7.471	1200	498382.489	104980.962	0.900	6.571
HW 6-3			7.363		498385.175	104978.722	0.900	6.463
Junction 6-4			7.540		498389.963	104974.745	1.083	6.457

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	OP 6-1	MH 6-2	19.128	0.600	11.935	6.571	5.364	3.6	300	5.04	56.2
1.001	MH 6-2	HW 6-3	3.497	0.600	6.571	6.463	0.108	32.4	300	5.06	56.2
1.002	HW 6-3	Junction 6-4	6.224	0.025	6.463	6.457	0.006	1000.0	200	5.34	55.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	8.380	592.4	5018.7	0.800	0.600	24.690	0.0	300	8.487
1.001	2.772	195.9	5011.1	0.600	0.600	24.690	0.0	300	2.808
1.002	0.369	121.7	4908.8	0.600	0.783	24.690	0.0	300	0.368

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	2160	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m ³ /ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0

Node OP 6-1 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.790	Discharge Coefficient	0.600
Replaces Downstream Link	x	Design Flow (l/s)	134.0		
Invert Level (m)	11.935	Diameter (m)	0.278		

Node OP 6-1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	11.935
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	2040

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	31218.3	0.0	1.090	33300.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	OP 6-1	5940	12.193	0.258	110.3	8120.9610	0.0000	OK
10080 minute summer	MH 6-2	5940	6.701	0.130	51.5	0.1474	0.0000	OK
10080 minute summer	HW 6-3	5940	6.621	0.158	51.5	0.0000	0.0000	OK
10080 minute summer	Junction 6-4	5940	6.571	0.114	51.5	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute summer	OP 6-1	1.000	51.5	
10080 minute summer	MH 6-2	1.001	51.5	
10080 minute summer	HW 6-3	1.002	51.5	14482.2

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	OP 6-1	5940	12.225	0.290	127.8	9119.8770	0.0000	OK
10080 minute summer	MH 6-2	5940	6.718	0.147	62.6	0.1657	0.0000	OK
10080 minute summer	HW 6-3	5940	6.633	0.170	62.6	0.0000	0.0000	OK
10080 minute summer	Junction 6-4	5940	6.583	0.126	62.6	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute summer	OP 6-1	1.000	62.6	
10080 minute summer	MH 6-2	1.001	62.6	
10080 minute summer	HW 6-3	1.002	62.6	17023.9

Results for 10 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	OP 6-1	5940	12.310	0.375	169.8	11840.4900	0.0000	SURCHARGED
10080 minute summer	MH 6-2	5940	6.739	0.168	78.4	0.1898	0.0000	OK
10080 minute summer	HW 6-3	5940	6.648	0.185	78.4	0.0000	0.0000	OK
10080 minute summer	Junction 6-4	5940	6.597	0.140	78.4	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
10080 minute summer	OP 6-1	1.000	78.4	
10080 minute summer	MH 6-2	1.001	78.4	
10080 minute summer	HW 6-3	1.002	78.4	23112.1

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	OP 6-1	930	12.370	0.435	712.9	13776.1900	0.0000	SURCHARGED
960 minute winter	MH 6-2	930	6.751	0.180	87.9	0.2036	0.0000	OK
960 minute winter	HW 6-3	930	6.656	0.193	87.9	0.0000	0.0000	OK
960 minute winter	Junction 6-4	930	6.605	0.148	87.9	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	OP 6-1	1.000	87.9	
960 minute winter	MH 6-2	1.001	87.9	
960 minute winter	HW 6-3	1.002	87.9	10282.3

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	OP 6-1	930	12.479	0.544	888.3	17267.2300	0.0000	SURCHARGED
960 minute winter	MH 6-2	930	6.769	0.198	102.7	0.2244	0.0000	OK
960 minute winter	HW 6-3	930	6.668	0.205	102.7	0.0000	0.0000	OK
960 minute winter	Junction 6-4	930	6.616	0.159	102.7	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	OP 6-1	1.000	102.7	
960 minute winter	MH 6-2	1.001	102.7	
960 minute winter	HW 6-3	1.002	102.7	12881.8

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	OP 6-1	1380	12.731	0.796	918.6	25459.6900	0.0000	SURCHARGED
1440 minute winter	MH 6-2	1380	6.803	0.232	130.8	0.2630	0.0000	OK
1440 minute winter	HW 6-3	1380	6.687	0.224	130.8	0.0000	0.0000	OK
1440 minute winter	Junction 6-4	1380	6.635	0.178	130.8	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
1440 minute winter	OP 6-1	1.000	130.8	
1440 minute winter	MH 6-2	1.001	130.8	
1440 minute winter	HW 6-3	1.002	130.8	19821.7

Appendix 7

Arun District Council's

Surface Water Drainage Proposal Checklist

Surface Water Drainage Design Checklist

This checklist has been created to assist designers, by clearly defining our expectations and requirements for surface water drainage designs that are submitted to support planning applications. It is recommended that applicants and their designers take time, at the outset of the planning process, to familiarise themselves with the checklist and our guidance.

Surface water drainage must be adequately considered when formulating the layout of a site, therefore it is expected that surface water drainage information is submitted with all planning applications. Surface water drainage information may be requested for smaller proposals where drainage is expected to affect determination – for example, in the Lidsey Wastewater Treatment Catchment.

The items listed in the checklist cover our expectations for a fully detailed surface water drainage design. The final details of a design may be agreed via planning condition, or prior to determination of a full, or reserved matters planning application.

Applicants who submit all the information requested by the checklist, as early as possible in the planning process, benefit from quicker review times and less delays caused by requests for further information. The omission of information may lead to objection to, or refusal of planning applications or applications to discharge conditions.

Applicants for major development sites must be aware that West Sussex County Council [WSCC] acting as Lead Local Flood Authority [LLFA] are a statutory consultee for flood risk and surface water drainage design. It is important to consult WSCC guidance in addition to our guidance and this checklist.

A major planning application is defined as:

- The creation of 10 or more residential units,
- Residential development of on a site of 0.5 hectares or more (where the number of residential units is not yet known i.e. for outline applications),
- Non-Residential development or change of use on a site of at least 1 hectare,
- Creation or change of use of 1000 square metres or more of gross floor space (not including housing).

Applicants have the option to apply for confidential pre-application advice relating to their surface water drainage design from either Arun District Council or WSCC. Bespoke advice is not offered outside of a fee-paying application.

ADC pre-application advice: <https://www.arun.gov.uk/pre-application-advice>

WSCC pre-application advice: <https://www.westsussex.gov.uk/roads-and-travel/information-for-developers/flood-risk-management-pre-application-advice/>

Critical Items for Detailed Surface Water Drainage Design

A detailed checklist of our requirements follows this advice. However, we highlight that the failure to adequately address the following critical items will result in an **objection** to any application to discharge a surface water drainage design condition and will likely result in an objection on a full or reserved matters planning application.

It is expected that if any of these items are inadequately addressed by a submission then their correction may result in a redesign of the surface water drainage scheme. A redesign may have the potential for storage structures to increase in volume or plan area.

Critical Item	Reason
Winter groundwater monitoring data.	Adequate winter groundwater monitoring data must be supplied to evidence that infiltration designs have sufficient freeboard from the base of structures and the peak groundwater level. The same data is necessary to ensure that the potential for buoyancy has been adequately considered in attenuation designs.
Winter infiltration testing data.	Adequate winter infiltration testing must be supplied to justify the proposed discharge method and design infiltration rates. Infiltration tests must be completed strictly in accordance with BRE DG 365, CIRIA R156 or a similar approved method. Testing depths must account for peak groundwater levels and correspond with the location and depth of proposed infiltration features. Designs must be based upon the <u>slowest</u> infiltration rate evidenced closest to a proposed infiltration feature. Average design rates will not be accepted. The results of incomplete tests should not be extrapolated to obtain design values for infiltration rates.
The hierarchy for sustainable drainage.	The proposed discharge method must accord with the SuDS hierarchy as given below. Evidence must be supplied to justify the proposed discharge method. 1. Rainwater reuse where possible. 2. Complete discharge into the ground (infiltration). 3. Hybrid infiltration and restricted discharge to an appropriate water body or surface water sewer. 4. Restricted discharge to an appropriate water body. 5. Restricted discharge to a surface water sewer. 6. Restricted discharge to a combined sewer. A water body may be defined as a river, watercourse, ditch, culverted watercourse, reservoir, wetland or the sea. Engineers cannot support any proposed connection of surface water to the foul sewer.

Calculations	Calculations for pre-development run off rates must be based upon the positively drained area only. Proposed discharge rates must not increase flood risk on site or elsewhere. Discharge rates must be restricted to QBAR or 2 l/s/ha, depending on whichever is higher. Designs must be based on the most recently available rainfall data at the time of conditions being applied. FSR rainfall data will not be accepted. FEH rainfall data is based upon more recent records and continues to be updated. Designs must use the correct climate change allowances at the time of determination of the outline or full planning application. CV values for all events must be set to 1. This includes summer, winter, design, and simulation events. The correct allowance for urban creep must be applied. Additional storage must be set to zero unless it can be evidenced where this is provided. Infiltration half-drain times must be less than 24 hours. Infiltration design rates must be applied to the sides of soakaways, or to the base of infiltration blankets. Design rates must not be applied to both the base and sides of infiltration structures. A surcharged outfall must be modelled.
Natural catchments design.	The submission must define the natural drainage characteristics within, and hydraulically linked to, the site and demonstrate that the drainage proposals will integrate with and not compromise the function of the natural and existing drainage systems. The condition, performance (including capacity where appropriate) and ownership of any existing site surface water drainage infrastructure must be accurately reported. Appropriate easements to watercourses and other services must be shown on all plans. Where there are areas of flood risk from any source on the site, it must be shown how a sustainable surface water drainage design can be accommodated on the site without conflicting with those areas of flood risk. Designs must replicate the natural drainage catchments of the site. All surface water drainage designs must therefore drain via gravity to corresponding points of discharge. The use of pumps for surface water drainage is not sustainable and will not be supported.

Plans	Plan areas, depths and levels of drainage infrastructure must accurately correspond with the supporting calculations.
Water quality benefits.	An assessment of water quality is necessary to evidence that the proposed design provides adequate treatment of surface water.
Biodiversity and amenity benefits.	The surface water drainage design must provide biodiversity and amenity benefits.
Trees and planting	There should be no conflict between surface water drainage infrastructure and existing or proposed trees or planting. The design must consider the potential growth of proposed trees and adequate mitigation must be provided to protect drainage infrastructure where conflict <u>cannot</u> be avoided.

Full Detailed Surface Water Drainage Design Checklist

Site Name/Address:	Lower Farm, Yapton
Application Description:	Planning Application WA/65/24/PL for the addition of 3 no 5ha Glasshouses, ancillary structures and reservoir to the existing permission for 1 x 5ha glasshouse and reservoir

Policy and Guidance Information

Arun District Council Surface Water Drainage Guidance - <https://www.arun.gov.uk/surfacewater>

Land Drainage Consent – <https://www.westsussex.gov.uk/fire-emergencies-and-crime/dealing-with-extreme-weather/flooding/flood-risk-management/ordinary-watercourse-land-drainage-consent/> and <https://www.arun.gov.uk/land-drainage-consent/>

Arun District Council surface water pre-commencement conditions - <https://www.arun.gov.uk/planning-pre-commencement-conditions>

The SuDs Manual [C753] by CIRIA

Sustainable drainage systems: non-statutory technical standards' <https://assets.publishing.service.gov.uk/media/5a815646ed915d74e6231b43/sustainable-drainage-technical-standards.pdf>

Ground Investigation Results

Groundwater monitoring

- ☐ Plan showing location of monitoring points provided.
- ☐ Depths of holes detailed.
- ☐ Dates of observations and depth to groundwater recorded.
- ☐ Evidence of the strata within borehole or monitoring pits provided.

See Ground and Water Monitoring information Table 1 and Appendix 4 of the Drainage Statement

Requested to aid speed of assessment

- ☐ Plan showing the peak groundwater levels at each monitoring point in mAOD.
- ☐ Peak groundwater levels recorded in metres below ground level and mAOD.
- ☐ If in an area of possible tidal influence, provide a comparison of readings against tide times/levels.

Three monitoring points indicated on the Ground and Water information and plan located in Appendix 4 of the Drainage Statement.

Peak Level noted as 170mm below ground level in January 2021.

Infiltration testing

- ☐ Completed strictly in accordance with BRE DG 365, CIRIA R156 or a similar approved method.
- ☐ Plan showing location of trial pits provided.
- ☐ Pit dimensions provided.
- ☐ Depths of testing provided.
- ☐ Dates, times and readings of each test recorded.
- ☐ Calculations for the infiltration rate for each test provided.

- ☐ Evidence of the strata within trial pits provided.
- ☐ Test locations, and depths correspond with the expected location and depths of proposed infiltration features.

See Ground and Water Soakage Letter report located in Appendix 4 of the Drainage Statement.
Discussion on Groundwater noted in Section 3.4 and 4.1.4 of the Drainage Statement.

Requested to aid speed of assessment

- ☐ Depths of testing provided in m below ground level and mAOD.

See Ground and Water Soakage Letter report located in Appendix 4 of the Drainage Statement.

Other

As appropriate, dependent upon specific site conditions

- ☐ Geotechnical advice relating to the siting of infiltration features and risk of dissolution. (Usually where chalk strata is evidenced.) [N/A](#)
- ☐ Geotechnical advice relating to the risk of slope instability due to infiltration. [N/A](#)
- ☐ Geotechnical and structural advice where infiltration is proposed closer than 5m to buildings or structures. [N/A](#)
- ☐ Contamination evaluation assessment where infiltration is proposed in ground that may be contaminated. [N/A](#)
- ☐ Geotechnical advice where infiltration is proposed into made ground (to be generally avoided). [N/A](#)
- ☐ Geotechnical advice relating to infiltration capacity, and risk of settlement or instability where careful use of ground raising is proposed. [N/A](#)
- ☐ Specialist advice and confirmation of acceptability from the Environment Agency where the use of deep bore soakaways is proposed. [N/A](#)

Surface Water Drainage Statement

Disposal method (Select as appropriate)

- ☐ Rainwater reuse is proposed where possible. [Rainwater reuse from all roofs is proposed for irrigation.](#)
- ☐ Infiltration is proposed and maximised wherever possible. [Very poor / no infiltration possible together with high groundwater discounts infiltration to ground as a suitable means of surface water discharge.](#)
- ☐ Hybrid infiltration and restricted discharge to an appropriate water body or surface water sewer is proposed where a full infiltration design is not possible. [N/A](#)
- ☐ Restricted discharge to a water body is proposed where a full infiltration design is not possible. [This is the proposed surface water discharge option.](#)
- ☐ Restricted discharge to a surface water sewer is proposed where a full infiltration design is not possible and there are no nearby water bodies. [N/A](#)
- ☐ Restricted discharge to a public or private highway drainage network is proposed where a full infiltration design is not possible and there are no nearby water bodies or surface water sewers. [N/A](#)
- ☐ Restricted discharge to a public combined sewer is proposed where a full infiltration design is not possible and there are no water bodies, surface water sewers, highway, or private drainage systems nearby. [N/A](#)

Disposal method justification

- ☐ Infiltration has been adequately investigated, in winter, at appropriate and varying depths where appropriate, above peak recorded winter groundwater levels at the given location. [See Ground and Water Details from Winter 2021.](#)

- ☐ Onsite and boundary, open and culverted water bodies are investigated (location, mapping, network, flow direction, ownership/responsibility, depth, and condition). [See Existing Site Layout, Site Layout - Existing Watercourse and Existing Watercourse Section drawings 101, 102, 104 and 105.](#)
- ☐ Offsite nearby downstream water bodies are investigated (location, mapping, network, flow direction, ownership/responsibility, depth, and condition). [N/A](#)
- ☐ Surface water sewer network is investigated (location, mapping, network, flow direction, ownership/responsibility, depth, capacity, and condition). [N/A there is no local surface water sewer network.](#)
- ☐ Public and private downstream highway drainage networks are investigated (location, mapping, network, flow direction, ownership/responsibility, depth, capacity, and condition). [N/A, there is no surface water discharge to the highway network.](#)
- ☐ Combined downstream sewer network is investigated (location, mapping, network, flow direction, ownership/responsibility, depth, capacity, and condition). [N/A there is no combined sewer network locally.](#)
- ☐ Any relevant permissions or legal agreements from asset or landowners that are needed are identified and evidence of consents provided. [OWC consent for Ordinary Watercourse connections and removal of redundant watercourse. These will be applied for post Planning Application.](#)

Requested to aid speed of assessment

- ☐ Any previous relevant correspondence or pre-application advice from the Local Planning Authority [LPA] or the Lead Local Flood Authority [LLFA] regarding the surface water drainage design is included with the statement.

Existing Site

Essential

- ☐ It is clear what the natural drainage characteristics of the site and hydraulically linked areas are. [See Existing Site Layout Drawings 101 and 102 which include land levels and contours, the site falls to the southeast to Little Tortington Stream.](#)
 - ☐ Natural flow paths are identified on a plan (where applicable). [See Existing Watercourses and long sections provided on Site Layout - Existing Watercourse and Existing Watercourse Section drawings 104 and 105.](#)
 - ☐ Existing site drainage features are investigated – condition, performance, and ownership. [Existing watercourses and long sections provided on Site Layout - Existing Watercourse and Existing Watercourse Section drawings 104 and 105. All with the site boundary and ownership of Client \(Agricultural Investments Limited\).](#)
 - ☐ Environmentally sensitive receiving water bodies are identified – for example groundwater source protection zones. [No specific zoning or protection areas on or adjacent to the site – Little Tortington Stream and onsite ordinary watercourses are the receiving water bodies.](#)
 - ☐ Any appropriate easements to watercourses or other infrastructure are investigated. [None existing, see proposed Watercourse Easement plan for future maintenance Drawing 261.](#)
 - ☐ Existing and future flood risk from any source is detailed. [See Flood Risk Assessment by Aqua Callidus Consulting.](#)
- It is suggested that the above is achieved with the following, which may be combined where appropriate:
- ☐ An existing topographical plan. [See Existing Site Layout Plans 101 and 102.](#)
 - ☐ An existing drainage catchment plan. [See Existing Site Layout Drawings 101 and 102 which includes land levels and contours, the site falls to the southeast to Little Tortington Stream.](#)

- ☐ An existing site surface water drainage plan (where applicable). [Site Layout - Existing Watercourse and Existing Watercourse Section drawings 104 and 105.](#)
- ☐ Flood maps (fluvial, tidal, pluvial, groundwater, sewer, and reservoir) are supplied (or Flood Risk Assessment referred to).
[See Flood Risk Assessment by Aqua Callidus Consulting.](#)
- ☐ Confirmation and surveys of any existing drainage infrastructure on the site.
[See Existing Site Layout Drawings 101 and 102 and Site Layout - Existing Watercourse and Existing Watercourse Section drawings 104 and 105.](#)
- ☐ Full details of any known flooding on the site.
[See Flood Risk Assessment by Aqua Callidus Consulting.](#)

Proposed Design

Essential

- ☐ Statement confirming the proposed design criteria including fixed design calculation inputs for the SuDS system. Examples include:
 - Climate change allowances, [45%](#)
 - Urban creep allowance, [None, not residential development.](#)
 - CV values, [1](#)
 - Rainfall data, [FEH 2022](#)
 - MADD factor or additional storage. [None.](#)
- ☐ Natural catchments are followed.
[Yes, site falls to the south and southeast and this has been mimicked in the discharge locations, see drainage drawings 221, 222, 223 and 224.](#)
- ☐ Where phased construction is proposed, the phases correspond to natural catchments and can function independently from each other. [N/A](#)
- ☐ The design is gravity based with no use of pumps. [Confirmed.](#)
- ☐ Natural systems that deliver specific hydrological function, such as watercourses or wetlands, are preserved. [Existing watercourses to the south are preserved the watercourse that becomes redundant is proposed to be removed, see section 4.1.6 Drainage Statement.](#)
- ☐ Where there is existing drainage infrastructure on the site it is clearly explained or illustrated what is being retained, upgraded, or removed. [See drainage drawings 221, 222, 223 and 224.](#)
- ☐ Relevant restrictions relating to discharging to an environmentally sensitive receiving water body – for example a groundwater source protection zone - are investigated, reported and adhered to. [No specific zoning or protection areas on or adjacent to the site – Little Tortington Stream and onsite ordinary watercourses are the receiving water bodies. Water Quality for discharges detailed in the Drainage Statement Section 4.10 Water Quality.](#)
- ☐ Details of necessary off-site works and consents are provided. [N/A](#)
- ☐ It is shown how a surface water drainage design will not conflict with additional areas of flood storage or compensation. [N/A](#)
- ☐ Surface water flow entering the site from elsewhere is conveyed safely around or through the site without compromising the SuDS system. [N/A buffer around site boundary remains.](#)
- ☐ Where runoff from elsewhere is drained together with the site runoff, the contributing catchment is modelled as part of the drainage system. [N/A](#)
- ☐ If the surface water drainage is designed to flood in the 1% Annual Exceedance Probability [AEP] + Climate Change Allowance [CCA] event, then the flood volume is contained safely on site without flooding any part of a building or utility plant susceptible to water or affecting safe access or egress. [All surface water up to and including the 1%AEP + Climate change is contained within the proposed drainage system. See Calculations in the Drainage Statement Appendix 6.](#)
- ☐ The design provides and evidences interception drainage and is able to capture and retain on site the first 5mm of the majority of all rainfall events.

The perimeter paths and car park and access and yard utilise permeable paving or voided stone subbase which as confirmed in SuDS Manual section 20.5.2 confirm they provide interception as water soaks into the pervious surface, laying course and subbase and is released back into the atmosphere thorough evaporation once rain has stopped. The SuDS Manual sites studies in Table 20.3 SuDS Manual noting runoff typically does not occur from pervious pavements for rainfall events up to 5mm.

All roof water is intercepted and stored and reused for irrigation for all rainfall events.

- ☐ Water quality and treatment is adequately assessed – with an assessment appropriate for the scale and proposed use of the site. [See Drainage Statement Section 4.1](#)
- ☐ Adequate freeboard is provided between the top water level of any open storage features and the top of the bank. [See Proposed Reservoir Plan and Sections Drainage 251.](#)
- ☐ There are no clashes with other infrastructure. [Confirmed.](#)
- ☐ Self-cleansing velocities are achieved where pipes are proposed. [Confirmed see calculations in Drainage Statement Appendix 6.](#)
- ☐ 1m freeboard is provided between peak groundwater levels and the base of any infiltration feature. [N/A](#)

- ☐ The proposed discharge rate is explained and justified (for attenuation designs). [See Drainage Statement Sections 4.2-4.7](#)
- ☐ Where discharge is proposed to a public surface water or combined sewer, a capacity check confirming that the sewer can receive the proposed flows is submitted. [N/A](#)
- ☐ Adequate freeboard is provided between peak groundwater levels and the base of any attenuation feature (refer below if this is not possible). [Not possible all features are lined. See Construction Details drawings 501 and 502.](#)
- ☐ Where there is a risk that the base of an attenuation feature may penetrate peak groundwater levels, additional mitigation measures to prevent groundwater ingress are incorporated into the design and construction method statement. [All systems are lined to prevent groundwater ingress. See Construction Details drawings 501 and 502.](#)
- ☐ Where there is a risk that the base of an attenuation feature may penetrate peak groundwater levels the effects of buoyancy have been considered in the design. [Buoyancy has been considered as part the design, Voided stone construction construction is not buoyant and the Design storm storage in the irrigation reservoir is located above existing ground levels.](#)
- ☐ Amenity benefits are provided by the drainage system (assessed by others). [See Ecology Appraisal and Biodiversity Nett Gain Appraisal.](#)
- ☐ Biodiversity benefits are provided by the drainage system (assessed by others). [See Ecology Appraisal and Biodiversity Nett Gain Appraisal.](#)
- ☐ Landscaping has been designed to ensure ease of maintenance of drainage assets. [See Ecology Appraisal and Biodiversity Nett Gain Appraisal.](#)
- ☐ The justification and criteria for tree root avoidance and mitigation measures is clear, referencing adopting body standards where applicable. [See Root protection details.](#)
- ☐ Biodiversity and ecological enhancements do not impede the functionality, maintenance or capacity of the drainage system. [See Ecology Appraisal and Biodiversity Nett Gain Appraisal.](#)

- ☐ It is confirmed what elements of the SuDS will be private. [All will remain private see Draft Drainage Maintenance and Management Plan.](#)
- ☐ It is confirmed what the adoption arrangements for SuDS components will be. [All will remain private see Draft Drainage Maintenance and Management Plan.](#)
- ☐ A construction method statement for the SuDS system, appropriate to the scale of the development, is submitted. [This should be agreed as part of a suitably worded Planning Condition to be provided by the Principal Contractor prior to commencement of the SuDS System.](#)

☐ A maintenance plan for the SuDS system, appropriate to the scale of the development, is submitted. [Please refer to our SuDS Maintenance Checklist where this is stipulated by condition.] [See Draft Drainage Maintenance and Management Plan.](#)

☐ Any potential health and safety issues relating to SuDS implementation and management have been considered and managed.

[See Draft Drainage Maintenance and Management Plan.](#)

Preferred

☐ Ground raising is avoided where possible.

☐ The drainage system is considered by and contributes to the biodiversity net gain statement (assessed by others).

Impermeable Area/Catchment Plan

Essential

☐ Different drainage catchments are demarcated. [See Drainage Statement Appendix 6.](#)

☐ Where phased construction is proposed, each phase is shown on a plan. [N/A](#)

☐ An impermeable area plan is provided showing all positively drained areas including open surface water storage plan areas. [See Drainage Statement Appendix 5.](#)

Preferred

☐ Impermeable areas are shown in m² on the impermeable areas plan(s). [See Drainage Statement Appendix 5.](#)

☐ Demarcated impermeable areas correspond with the distribution of those areas in the supporting calculations. [See Drainage Statement Appendix 5 and Appendix 6.](#)

Surface Water Drainage Calculations

General

☐ The most recently applicable, or previously agreed FEH rainfall data is used. [FEH 2022 Used](#) [See Drainage Statement Appendix 6.](#)

☐ CV values for all events are set to 1. This includes summer, winter, design, and simulation events. [Cv value 1 used](#) [See Drainage Statement Appendix 6.](#)

☐ The correct climate change allowances, appropriate for the full lifetime of the development, have been applied to all calculations. [Included 45%](#)

☐ A 10% allowance for urban creep is applied to all residential roof areas. [N/A non residential.](#)

☐ 100% Annual Exceedance Probability [AEP] + Climate Change Allowance [CCA] (1 in 1 year) event calculations provided. [See Drainage Statement Appendix 6.](#)

☐ 10% AEP + CCA (1 in 10 year) event calculations provided showing that the incoming pipe to any infiltration feature is above this level. [See Drainage Statement Appendix 6.](#)

☐ 3.33% AEP + CCA (1 in 30 year) event calculations provided showing that the full surface water volume is contained within the designed system without flooding. [See Drainage Statement Appendix 6.](#)

☐ 1% AEP + CCA (1 in 100 year) event calculations provided showing that the full surface water volume is contained safely on site, without flooding any part of a building or utility plant susceptible to water or affecting safe access or egress. [See Drainage Statement Appendix 6.](#)

Infiltration

☐ Half drain times do not exceed 24 hours for the 10% AEP + CCA and 1% AEP + CCA events. [N/A](#)

- ☐ If half drain times exceed 24 hours for the 1% AEP + CCA event, then advice and agreement from the LPA has been sought and submitted. [N/A](#)
- ☐ The most precautionary design infiltration rate is used. [N/A](#)
- ☐ Design infiltration rates are applied to the sides of soakaways only [N/A](#).
- ☐ Design infiltration rates are applied to the base of permeable paving, infiltration blankets or basins only. [N/A](#)
- ☐ Where the design infiltration rate is applied to the base an appropriate factor of safety is applied. [N/A](#)

Attenuation and Restricted Discharge

- ☐ Greenfield run off rates are based upon the positively drained area of the site only. [See Drainage Statement Sections 3 and 4.](#)
- ☐ Discharge rates are restricted to QBAR or 2 l/s/ha, depending on whichever is higher, for all storms up to the 1% AEP + CCA event. [See Drainage Statement Sections 3 and 4 and Appendix 6.](#)
- ☐ Half drain times and available capacity in the drainage system for subsequent storms are considered. [Considered just over 24 hours worst case for 100 +45% therefore follow on storm ok.](#)
- ☐ Brownfield run off rates are based upon the positively drained area of the site only. [N/A](#)
- ☐ Brownfield sites aspire to achieve greenfield runoff rates and volumes, where infiltration is not viable. If the proposed run off rate is higher than the greenfield run off rate, then an acceptable justification is provided, and the rate has been agreed with any relevant bodies. [N/A](#)
- ☐ A surcharged outfall to a watercourse or sewer has been modelled. The surcharge level is the 1% AEP + CCA flood event for the receiving watercourse, or to the top of the bank if appropriate hydraulic modelling is not available. [N/A 1% AEP =CC flood event form FRA Flood maps at 6m AOD , lowest outlet to ordinary watercourses at 6.43m AOD](#)
- ☐ A surcharged outfall to a tidal waterbody has been modelled. The surcharge level is based upon present day extreme sea levels with an allowance for sea level rise applied. [N/A](#)

Requested to aid assessment

- ☐ FEH22 point descriptors for the site are provided.

Drainage Plans and Specifications

Essential

Plans are provided showing:

- ☐ The proposed design within the proposed site layout. [See drawings 221, 222, 223, 224, 231, 251.](#)
- ☐ Existing site sections and levels. [See Drawings 101, 102, 103, 104 and 105.](#)
- ☐ Proposed site sections and levels. [See Drawings 121 and 122.](#)
- ☐ Long and cross sections for the proposed drainage system including final finished floor levels. [See drawings 221, 222,223, 224, 231, 251.](#)
- ☐ Exceedance flow management routes. [See Drainage Statement Appendix 8.](#)
- ☐ Details of connections to watercourses and sewers. [See drawings 221, 222,223, 224, 231, 251, 521, 522, 523, 524, 525 and 526.](#)
- ☐ Maintenance access and any arisings storage and disposal arrangements. [See Drawing 261.](#)

These plans must be of sufficient detail that a reviewer can be confident that the design can be constructed without flood risk being increased on site or elsewhere.

Specifications are required for all materials used in the design. We suggest that this is best achieved and illustrated with site specific construction detail drawings. The combination of

construction details, with plans and sections, ensure that the proposed standard of construction will facilitate adoption and maintenance by an appropriate body and have structural integrity.

The following checklist is designed to demonstrate the level of detail required:

Easements

- ☐ 3m easements are shown from the top of the bank of all ordinary watercourses, and from the edge of all culverted watercourses on all plans. [See Watercourse Easement Drawing 261.](#)
- ☐ 8m easements are shown from the top of the bank of all main rivers on all plans - unless an alternative easement has been stipulated by the Environment Agency. [N/A](#)
- ☐ Any appropriate easements as stipulated by any public or private utility provider shown on all plans. [N/A](#)
- ☐ Infiltration features (aside from permeable paving that does not take any extra impermeable catchment such as a roof) are shown at least 5m from buildings or structures. [N/A](#)
- ☐ Maintenance easements are shown from the top of the bank from all open SuDS features on all plans. [See Watercourse Easement Drawing 261.](#)
- ☐ Existing trees and their root protection zones are shown on any drainage layout. [See drawings 221, 222, 223, 224, 231, 251.](#)
- ☐ Proposed trees and appropriate easements are shown on any drainage layout. [See drawings 221, 222, 223, 224, 231, 251.](#)

Detail

- ☐ It can be clearly determined what a pipe's diameter, pipe materials, gradients, flow directions and invert levels are from the plans. [See drawings 221, 222, 223, 224, 231, 251.](#)
- ☐ It can be clearly determined what an inspection chamber or manhole's cover level, invert level, cover loading grade and sump depth (where applicable) are from the plans. [See drawings 221, 222, 223, 224, 231, 251.](#)
- ☐ All infiltration or attenuation features (including permeable paving) are clearly labelled with their dimensions, invert/base levels and cover levels. [See drawings 221, 222, 223, 224, 231, 251 and 521, 522, 523, 524, 525 and 526.](#)
- ☐ Control structures are labelled with discharge rates, hydraulic head, invert and cover levels and ideally model number. [See drawings 221, 222, 223, 224, 231, 251 and 521, 522, 523, 524, 525 and 526.](#)
- ☐ Operational characteristics of any other mechanical features are detailed. [N/A](#)
- ☐ Measures to protect drainage from tree root damage are clearly shown on any drainage layout. [N/A](#)
- ☐ Any areas of necessary ground raising are clearly justified and demarked on a plan, with depths and levels. [See Cut and Fill drawing 151.](#)
- ☐ If the 1% AEP + CCA event floods, then the extent and depth of the flooding is shown on a site plan. This plan includes proposed external ground levels and finished floor levels of buildings. [N/A See Flood Risk Assessment by Aqua Callidus Consulting.](#)
- ☐ Potential flow routes off site are shown. The plan also includes proposed external ground levels, finished floor levels of buildings and designed slopes on all impermeable surfaces such as highways or car parks. [See Levels Drawings 111, 112, 113 and 114.](#)
- ☐ Cross sections and long sections of all open features are provided.
- ☐ Construction detail drawings are site specific.
- ☐ Construction detail drawings are provided for all components including but not limited to:
 - ☐ Infiltration structures
 - ☐ Attenuation structures
 - ☐ Manholes/inspection chambers

- ☐ Catchpits/silt traps
- ☐ Flow control devices
- ☐ Permeable paving
- ☐ Headwalls
- ☐ Channel drains
- ☐ Gullies
- ☐ Pipe bed and surround
- ☐ Pipe to pipe connections
- ☐ Filter strips or drains
- ☐ Swales
- ☐ Bio-retention systems
- ☐ Ponds and wetlands
- ☐ Tree pits and measures to protect drainage from root incursion
- ☐ Water treatment features
- ☐ Green roofs
- ☐ Measures to protect drainage from tree roots.
- ☐ Water butts or alternative methods of water reuse – also to be shown on plans.

See [Construction Details drawings 501, 502, 511, 512, 521, 522, 523, 524, 525 and 526.](#)

The following items are requested to aid assessment or confidence in construction:

- ☐ Where features have a non-uniform plan area, a plan showing the coordinates of the perimeter is provided.
- ☐ All drainage infrastructure is labelled to correspond with the supporting calculations.

See [Drainage Statement Appendix 6.](#)

Other

- ☐ Open feature planting specification is provided (to be assessed by others).

This checklist is designed to aid an applicant with their submission. The list is not exhaustive, and our engineers may request additional information to enable them to review a proposal to their satisfaction.

The checklist may also request information that an applicant does not feel is relevant to their submission. In this case the applicant can provide an explanation as to why they have omitted certain information in their drainage statement. However, the appraising engineer reserves the right to request this information if they believe it is necessary for their review.

Appendix 8

Surface Water Exceedance Route Plan



-25m 0 25m 50m 75m 100m

TITLE			
Surface Water Exceedance Route Plan			
SCALE	NTS	PROJECT No.	23993
		DRG. No.	11
REPORT TYPE	DS		-