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Drainage Strategy

A30 Hotel Extension

WE03344.90

MRMU Property LLP

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MULTIDISIPLINARY ENGINEERING CONSULTANTS

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Project
A30 Hotel Extension, Bodmin; Drainage Strategy

Client Name
MRMU Property LLP

Issue Date/ Number	Status	Description of Amendments
11/11/2021/ P1	(S0) Draft	First Issue
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Executive Summary

Client	MRMU Property LLP
Site	A30 Hotel Extension, Bodmin
Site Location	The proposed development site is located approximately 8km south west of Bodmin, 2.6km north east of Roche and adjacent to the A30. Vehicular Access is proposed off the A30 and the existing access routes associated with the Cornwall Services. The site is currently surrounded to the north and west by the Cornwall Services and the A30, and to the south and east by drainage features associated with the Services and open agricultural fields with elements of renewable energy production.
Development	The development will comprise the extension of the existing hotel and would provide for 29 additional beds, plus a restaurant extension to provide for 44 new covers. The bedroom extension would be over 3 floors, with the restaurant being a single storey extension.
Flood Risks	Review of the Flood Risk implications of the development suggest that the site is within Flood Zone 1 and has no particular flood risks associated with minor watercourses or drainage ditches. Unmitigated Surface water flood risks have not been identified at the site and other sources of flooding are not expected to impact the site (including Groundwater, Utilities and Other Manmade sources). The proposed development is not expected to increase these flood risks to either onsite or offsite receptors.
Drainage	Following review of the initial drainage works for the site it has been confirmed that the area of the proposed bedroom extension has already been accounted for within the surface water drainage for the development. An extension of the system will be necessary to pick up the minimal (226m^2) increase in drained impermeable area associated with the restaurant extension. Flows will be picked up by the rainwater pipes and discharged into the existing system via a small additional section of gravity drain prior to discharge into the wider site network and eventually the Basin 3 leading to Basin 4. In order to maintain the final 300mm freeboard in Basin 4, and the peak discharge from the wider site of 30.6l/s, an extra 15mm needs to be added to the north and eastern edges of the Basin 4 earthworks to give a minimum peak of 138.719mAOD, with the orifice plate reduced to 116mm in diameter. Review of works done to Basin 4 as part of a previous phase confirms the level raising has already been achieved and therefore only the orifice plate needs replacing. All new surface water drainage features will be designed to safely manage the 1 in 100 year event with a 40% allowance for climate change; to match the existing drainage network onsite any additional flows will only be included within the full modelled network at 30% climate change.

Foul water flows will be discharged into the existing private onsite system for disposal via the existing onsite pumping station, lifting flows to the SWW foul sewer via the existing rising main within the Victoria Business Park to the west. The foul flows from this sewer are transferred further south to the Luxulyan sewerage treatment works, and this is located outside the Camel Catchment where there are particular concerns with regards to Phosphates. As such it not expected that additional measures will be required with regards to phosphate discharges from the proposed development.

It is understood the additional flows from the new hotel rooms have been accounted for within the original site drainage design but it is recommended that the capacity of the existing pumping station/ rising main will need to be checked to ensure that adequate capacity was installed to service the proposed extension, prior to detailed design.

1 Introduction

1.1 Background

Clarkebond (UK) Ltd (CB) was commissioned in October 2021 by Shane Rowe, on behalf of MRMU Property LLP, to produce a Drainage Strategy and Flood Risk Statement to support the development of an extension to the existing hotel at the Cornwall TRSA on the A30 Trunk Road, Bodmin. The proposed site is situated to the south of the A30, PL26 8UF.

This DS report will be submitted as part of a planning application and is intended to provide the Planning Authority and Lead Local Flood Authority (LLFA) information on surface and foul water management in order to satisfy the planning application process.

1.2 Proposed Development

The development will comprise the extension of the existing hotel and would provide for 29 additional beds, plus a restaurant extension to provide for 44 new covers. The bedroom extension would be over 3 floors, with the restaurant being a single storey extension.

The proposed site layout plan is provided in **Appendix A.**

1.3 Objectives

The objectives of the drainage strategy are to:

- Manage surface water runoff on site to minimise flood risk.
- Develop a suitable system to manage foul water flows.
- Manage surface water discharge from the site so that it does not pose a threat to adjacent properties or land.
- To ensure ongoing operation and maintenance of the surface water drainage system(s) through appropriate management/adoption.

1.4 Study Limitations

The information, views and conclusions drawn concerning the site are based, in part, on information supplied to Clarkebond by other parties. Clarkebond has proceeded in good faith on the assumption that this information is accurate. Clarkebond accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to Clarkebond from others.

2 The Study Area

2.1 Location, background, and existing land use

The proposed development site is located approximately 8km south west of Bodmin, 2.6km north east of Roche and adjacent to the A30. Vehicular Access is proposed off the A30 and the existing access routes associated with the Cornwall Services.

The site have an approximate National Grid Reference (NGR) of 200172, 62287, or a postcode of PL26 8UF. The approximate site location is shown in Figure 1.

Figure 1 : Site Location & Surrounding Areas (from Google Earth)

The proposed extension site covers an area of approximately 0.38 hectares, with the extension being approximately 500m^2 and the existing land use is the existing hotel (to be extended) and associated hardstanding.

The site is currently surrounded to the north and west by the Cornwall Services and the A30, and to the south and east by drainage features associated with the Services and open agricultural fields with elements of renewable energy production. The site is considered to be currently 72.3% impermeable.

2.2 Site Topography

The site falls relatively gently from south west to north east with levels in the south west at 146mAOD, falling to 142.5mAOD in the north east.

2.3 Site Soils, Geology and Hydrogeology

Soils and Geology

The anticipated ground conditions for the majority of the sites are based on the available geological information from the British Geological Society (BGS) which indicates that the site is underlain by Hornfelsed Slate And Hornfelsed Sandstone. from the Bovisand Formation formed approximately 393 to 411 million years ago in the Devonian Period. Superficial deposits in the form of Alluvium - Clay, Silt, Sand And Gravel may be present to the north and east.

Review of the LandIS soils guide suggests the site is underlain by Very acidic, loamy upland soils with a wet peaty surface and with very low fertility.

Hydrogeology and Groundwater

September 2021 was a 'normal' month for rainfall in Devon and Cornwall, with the area receiving rainfall equating to 101% of the long-term average rainfall (LTA). Monthly mean river flows were all at a 'normal' level. Groundwater levels were recorded as 'normal' or 'above normal' for the time of year, albeit in slight recession, and Soil moisture deficit was 14mm less than the LTA of 34mm. Reservoir storage decreased from 80% to 70% in line with expected predictions.

The Environment Agency Groundwater Map suggests the site is underlain by a Secondary A Bedrock aquifer and is in a Groundwater Vulnerability Zone, classified as Medium. The Environment Agency Groundwater Source Protection Zone Map shows that the site is not situated within a Groundwater Source Protection Zone.

2.4 Baseline Hydrology and Flood Zones

Local Watercourses and drainage ditches

Review of local mapping and topographic information shows there is no watercourses within the surrounding areas which currently, or potentially, could receive surface water flows from the site. Drainage from the site is directed to a number of linked swales/basins on the boundary which serve to attenuate flows prior to discharge to a ditch on the southern edge of the A30.

Flood Zones

The National Planning Policy Framework (NPPF) requires the use of the Sequential Test, a risk-based approach, which steers development towards the areas at lowest risk of flooding. This is defined by the Flood Zones set out in NPPF, ignoring the presence of defences:

- Flood Zone 1 – low probability of flooding (less than 1 in 1,000 annual probability of river or sea flooding in any year)
- Flood Zone 2 – medium probability of flooding (between a 1 in 100 and 1 in 1,000 annual probability of river flooding and between a 1 in 200 and 1 in 1,000 annual probability of sea flooding in any year)
- Flood Zone 3a – high probability (1 in 100 year or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any year)
- Flood Zone 3b – functional floodplain (where water is stored in times of flood, including water conveyance routes, annual probability of 1 in 20 or greater in any given year or is designed to flood in a 1 in 1,000 flood event).

EA Flood Maps

The EA flood map provides a broad scale assessment of flood risk for a geographical area. It evaluates risk as the product of the probability and the consequence of particular events. Probability is defined as the frequency and magnitude of floods that are generated by fluvial or tidal flows and intense rainfall activity. The consequence is defined as the impact of floodwater on receptors (people, property, land, etc).

The Environment Agency online Flood Map shows the site is within Flood Zone 1.

2.5 Surface Water Flooding

Surface water flooding is a result of overland flow that can follow a rainfall event, before the runoff enters a watercourse or sewer. This form of flooding is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has a low permeability.

The flood risk relates to both the conveyance of waters to the assessment site by overland flow from areas outside the site and also areas within the site itself, and the ponding of these waters in depressions in the topography.

Review of mapping produced by the EA for Surface Water flood risk indicates the there is a low risk of surface water flooding within the site itself, or just to the south. Review of the site suggests these flows are associated with roadways onsite, or the surface drainage features associated with the site, and as such these risk will be adequately mitigated by the existing and proposed drainage systems.

Research of historical records has not identified any records of surface water that specifically reference the site itself or immediate surrounds.

Therefore, based on this information the flood risk to the proposed development associated with surface water is considered to be low.

Critical Drainage Areas

A Critical Drainage Area (CDA) is an area that has critical drainage problems, and which has been notified to the Local Planning Authority as such by the Environment Agency in line with the National Planning Policy Framework (NPPF). In these locations there is a need for surface water to be managed to a higher standard than normal to ensure any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

The site is not within a Critical Drainage Area.

2.6 Other Risks of Flooding

A review of other sources of flood risk, including groundwater, sewers and man-made risks such as reservoirs and canals, has not identified any further flooding risks to the site and therefore these are considered negligible sources of flooding which might impact the site.

2.7 Existing Site Surface Water Drainage

The site is currently drained by a dedicated surface water network which conveys flows to the series of linked basins and swales on the south and east edges of the development. Flows are controlled by a flow control prior to discharge to a ditch adjacent to the south edge of the A30 for discharge further down the catchment.

2.8 Existing Site Foul Water Drainage

Foul water drainage onsite is manged by a dedicated gravity foul sewer system which conveys flows to an onsite pumping station located in the north east of the site. Flows from here are then lifted via rising main to a discharge point on the existing SWW Foul sewer within the Victoria Business Park.

2.9 Impact of Climate Change and future flood risk

The NPPF and supporting planning practice guidance on Flood Risk and Coastal Change sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change over the anticipated lifetime of the asset. These measures to take account of climate change can follow two generic approaches;

1. precautionary approach; incorporating mitigation measures for potential climate change now.
2. managed adaptive approach; making provision for mitigation measures to be undertaken at a future date when it is likely that there will be greater certainty on the effects of climate change on parameters such as river flow and rainfall.

In the UK precautionary allowances for net sea level rise and other parameters such as wind speed, wave height, river flow and rainfall intensity are provided by the UK Climate Impacts Programme (UKCIP, 2018). Historically simple uplift ratios (defined by Defra within Flood and Coastal Defence Appraisal Guidance FCDPAG3) have been used to make a baseline assessment of the potential impact of climate change on an asset. However, the use of a nationally uniform allowance particularly for peak river flow has been assessed for suitability under FD2020 and new regionalised climate change guidelines for flood management have been published by the EA in December 2019 specific to River Basin Districts and flood vulnerability classifications. Further updates on the 6th October 2021 allowed the estimation of peak river flow allowances for individual catchment groups within river basins, with instructions to use the 'Central' estimate for Site Specific Flood Risk Assessments (unless for Essential Infrastructure).

Where sites are at risk of flooding from fluvial, surface water or other modelled flood data as identified by the Environment Agency a site specific FRA will assess the impact of climate change notably increased sea level, rainfall intensity and peak river flow in more detail to determine potential impacts during the design life of assets identified as being vulnerable to flood risk.

Table 1: Predicted climate change variables within the South West

	2000-2035	2036-2065	2066-2095	2096-2125
Net sea level rise (mm/yr)	5.8-7.0	8.8-11.4	11.7-16.0	13.1-18.4
Offshore wind speed	+5%	+5%	+10%	+10%
Extreme wave height	+5%	+5%	+10%	+10%

	2020s	2050s	2080s
Peak river flow for West Cornwall and Fal Management Catchment	+18%	+27%	+52%

	2010-2039	2040-2059	2060-2115
Peak rainfall intensity	+5%-10%	+10%-20%	+20%-40%

As the site is within Flood Zone 1 at present and is highly unlikely to fall within Flood Zone 2 or 3 in the future during the design life of the development, assessment does not need to be made for peak river flows. However, allowances should be made for a potential increase in peak rainfall intensity within the development of a drainage strategy for this site. This is detailed further in Section 3.

3 Drainage

3.1 Background

Development usually increases the area of impermeable surfaces, promoting rapid runoff to surface water sewers/watercourses rather than percolation into the ground. The effect can be to increase both total and peak water flows, contributing to flooding. Following development, it is expected that the impermeable extent of the site will be increased slightly compared to the existing and consequently there will be an increase in surface water runoff from the site and the surface water drainage system will seek to manage this increase without increasing offsite flood risks.

The Environment Agency and local planning policy aim to reduce runoff from new developments as much as possible and aspire to achieve Greenfield i.e. undeveloped runoff rates. Greenfield runoff rates are often unachievable on Brownfield developments due to cohesive subsoil's, pollutant contamination and a lack of available space.

3.2 Flood and Water Management Bill

The Flood and Water Management Act 2010 sets out new legislation which gives the role of SuDS approval to the Local Planning Authority and in the case of major development to the Lead Local Flood Authority; Cornwall Council who is now required to act as a statutory consultee for surface water drainage for major developments.

As part of the LPAs role in determining planning applications the LPA makes the final decision about the suitability of the SuDS provision and whether it is proportionate to the level of flood risk affecting the site. Developers must demonstrate consideration of SuDS above other methods of surface water management.

This drainage strategy is put forward on the basis of current best practice, with consideration given to:

- Meeting local and national standards including implementation of a SuDS hierarchy, effective outfall to ground of watercourse and effective exceedance design
- Proposed minimum standards of operation are appropriate
- Clear arrangements are in place for on-going maintenance over the lifetime of the development
- Designed to ensure that the maintenance and operation requirements are economically proportionate

All private drainage will be constructed in accordance with current Building Regulations and Codes of Practice.

3.3 Offsite Discharge Runoff Rates

Greenfield runoff rates for the site have been calculated using the ICP-SUDS method through the MicroDrainage software and are given in Table 2 below.

This provides Greenfield Runoff rates of between 1.2 l/s for a 1-year event to 3.7 l/s for a 100-year event. To take into account climate change an extra 40% has been included onto the 100-year event resulting in a peak runoff rate of 5.2 l/s.

Existing Runoff are between 3.0 l/s for a 1-year event to 6.7 l/s for a 100-year event. To take into account climate change an extra 40% has been included onto the 100-year event resulting in a peak runoff rate of 9.4 l/s.

Over a typical storm duration of 6 hours, for a 1 in 100-year event, the Greenfield runoff equates to a volume of 88m^3. The existing runoff volume is expected to be 130m^3 (assessed using the UK Variable PR Method). The MicroDrainage calculations are provided in **Appendix C**.

Table 2 : Offsite runoff rates

	Greenfield runoff rates (l/s) (for 0.38ha site area)					
	Qbar	Q1	Q10	Q30	Q100	Q100 + 40%
Greenfield 0% impermeable	1.5	1.2	2.3	2.9	3.7	5.2
Existing 72.3% Impermeable	3.8	3.0	5.4	6.1	6.7	9.4

It is expected to formalise the existing surface water management system to manage the runoff using Sustainable Drainage Systems, (SuDS) where possible.

3.4 Sustainable Drainage Systems

Where practical, surface water drainage design should be in accordance with local planning policy.

The Environment Agency, LLFA and LPA strongly recommends that suitable surface water mitigation measures are incorporated into any proposed development plans in order to reduce and manage the surface water flood risk. This can be achieved by incorporating Sustainable Drainage Systems, (SuDS) into the development. The philosophy of SuDS is to mimic the natural drainage from a site before development and treat runoff to remove pollutants.

There are many complex issues surrounding the management of surface water at any site, such as: the physical characteristics of the catchment (e.g. slope), the nature of the rainfall event, the hydrology of the catchment, and the presence of any pollutants. Each site is different, thus individual and unique solutions need to be designed.

There are a number of different SuDS techniques that can be used individually or in combination in order to manage surface water for any specific site. It is suggested that individual SuDS be used in a management train in order to mimic the natural pattern of drainage as far as possible, this is outlined below (National SuDS Working Group 2004) in Table 3.

Table 3 : Hierarchy of SuDS Management Techniques

Hierarchy of Techniques	*Description*	*Examples*
Prevention	Runoff and pollution should be limited before occurrence Use of good site design for water storage and prevention of spills/leaks through housekeeping on site	Rainwater harvesting and subsequent above/below ground storage, rainwater interception systems present on development roofs. Minimising paved areas and the use of sweeping to remove surface dust from car parking areas.
Source Control	Runoff control at or near the source	Rainwater harvesting, pervious pavements, green roofs or soakaways for individual houses
Site control	Water management from several areas/sub-catchments. Offer methods of conveyance as well as areas for storage and filtration with aesthetic and wildlife benefits.	Routing water from roofs and car parks to one large soakaway or infiltration basin for the whole site. Filter drains, filter strips and swales for the conveyance. Basins, ponds and wetlands to store and filter.
Regional control	The management of runoff from several sites.	Detention ponds or wetlands

The type of SuDS system adopted should also take into account the future adoption and maintenance of the scheme. A body should be set up and responsible for the scheme with financial backing from the beneficiaries of the scheme. This should be decided before the site-specific SuDS scheme is designed and implemented in order to ensure the continued benefit of the system.

3.5 Potential for Sustainable Drainage Systems at the site

A review of potential SuDS techniques and application within the proposed development has been done in accordance with CIRIA report C753 Technical Detail to determine whether each technique could be viable within the site. This review is summarised in Table 4 with green cells indicating potential techniques that could be applied.

Table 4 : SuDS Management Techniques

Technique	*Potential for application*
Rainwater harvesting	*Rainwater harvesting can be used to store water either above or below ground for re-use as and when required for everyday non-potable uses such as washing machines, toilets or watering of gardens, amenity areas and green roofs.* The installation of rainwater harvesting to the extension is not expected to yield enough flows to have a financially beneficially impact on the development.

Technique	*Potential for application*
Green/ Blue roofs	*Green roofs provide a range of environmental benefits, such as attenuation of storm water, provision of wildlife and improvements in both air and water quality. They can be applied to all types of buildings though are better suited to roofs with a low pitch. Relatively high levels of ongoing maintenance requirements often result in green roofs being applied to buildings with a community interest.* The use of blue/ green roofs do not meet the design requirements of the proposed development.
Infiltration systems	*Infiltration can contribute to reducing runoff rates and volumes while supporting base flow and groundwater recharge processes and can include soakaways, infiltration trenches, infiltration blankets and infiltration basins. Bio retention systems and pervious paving can also be designed to allow basal infiltration.* Insufficient space is available within the site layout to incorporate infiltration with sufficient offsets from existing and proposed roads and buildings.
Proprietary treatment systems	*These manufactured products remove specified pollutants from surface water runoff. They are usually (but not always) subsurface structures and can often be complementary to landscaped features reducing pollutant levels in runoff and protecting the amenity and/or biodiversity functionality of downstream SuDS components.* No areas of vehicular hardstanding are proposed which would require additional treatment in the form of proprietary treatment systems. Roof water flows are expected to not need additional treatment prior to disposal.
Filter strips	*Filter strips are vegetated areas of sloping ground designed to drain water evenly off impermeable areas and filter out sediments and particulates. The provision of a second SuDS component is required downslope to take the sheet flow and provide safe exceedance flow routes.* The existing drainage and site layout render the site unsuitable for the use of filter strips.
Filter drains	*Filter drains are linear trenches filled with permeable material and usually containing a perforated pipe situated at the base of the trench in order to allow the infiltration of water and the subsequent conveyance away from the site. They are predominantly used adjacent to highways or car parking areas.* Filter drains are unlikely to suit the site layout and an alternative SuDS measure is preferred.

Technique	*Potential for application*
Swales	*Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. They are often used to drain roads, paths or car parks where it is convenient to collect distributed flows of runoff whilst enhancing access corridors or other open space.* While the local topography may be appropriate for the usage of swales the proposed site layout and usage is unlikely to make conveyance swales an appropriate drainage measure for this site.
Bio retention systems (including tree pits)	*These systems are generally used to provide interception but can incorporate attenuation storage to help manage runoff. As they are generally used for treatment and management from frequent rainfall events, rainfall from extreme events will often need to bypass these systems to prevent them being overwhelmed. Therefore, allowance will still need to be made for typical piped drainage to take exceedance flows but these would be in existence anyway for the conveyance of roof water and other non-adjacent highway drainage. Due to maintenance requirements there is a preference to group the bio retention systems together. Maintenance of the bio retention areas may provide opportunities for community involvement.* The use of bio-retention systems is unlikely to be appropriate given the proposed development size, usage and existing drainage constraints.
Pervious pavements	*Pervious pavement is suitable for pedestrian and vehicle traffic but in addition allows the infiltration of water through the surface and into underlying areas where it can either be stored temporally (within geocellular crates) before infiltrating into the ground or be redirected for reuse to the surface water drainage system or to a rainwater harvesting system if required. This system is highly suited to parking areas due to the benefits of filtration, adsorption, biodegradation and sedimentation provided by the treatment medium aswell as surface water attenuation.* No areas of vehicular hardstanding are proposed which would benefit from pervious surfacing.
Attenuation storage tanks	*Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. This option can be considered in conjunction with pervious paving.* Attenuation is already provided onsite by a series of tiered Basins and it is expected that the additional flows from the proposed development can be accommodated within these without additional below ground provision being required.

Technique	*Potential for application*
Detention basins	*Detention basins are landscaped depressions that are normally dry except during and immediately following storm events. They can be on line and dealing with surface water from regular events or off line and used for diverted flows once they reach a specified threshold. The basins can be vegetated or hard landscaped storage areas. Where the basin is vegetated they can benefit water quality through the removal of sediment and buoyant materials.* The site currently drains to a series of tiered Basins and it is expected that these will have sufficient capacity (perhaps with some minor alterations to the final basin profile) to accept the minor quantity of additional flows from the prosed development.
Ponds and wetlands	*Ponds and wetlands provide both attenuation and treatment of surface water runoff and should remain water filled throughout the year, and not simply fill in the event of a large runoff event, in order to provide a functioning ecosystem.* *They can provide aesthetic, amenity and biodiversity benefits.* The site is currently served by a series of tiered basins and the proposed development is too small to support the usage of a dedicated pond/ wetland drainage provision.

3.6 Proposed Drainage Management

Following development, the impermeable area of the site increases from the existing to approximately 85.7%.

Following review of the initial drainage works for the site it has been confirmed that the area of the proposed bedroom extension has already been accounted for within the surface water drainage for the development. An extension of the system will be necessary to pick up the minimal (226m^2) increase in drained impermeable area associated with the restaurant extension. Flows will be picked up by the rainwater pipes and discharged into the existing system via a small additional section of gravity drain prior to discharge into the wider site network and eventually the Basin 3 leading to Basin 4. In order to maintain the final 300mm freeboard in Basin 4, and the peak discharge from the wider site of 30.6l/s, an extra 15mm needs to be added to the north and eastern edges of the Basin 4 earthworks to give a minimum peak of 138.719mAOD, with the orifice plate reduced to 116mm in diameter. Review of works done to Basin 4 as part of a previous phase confirms the level raising has already been achieved and therefore only the orifice plate needs replacing. See as built survey provided within **Appendix D**.

All new surface water drainage features will be designed to safely manage the 1 in 100 year event with a 40% allowance for climate change; to match the existing drainage network onsite any additional flows will only be included within the full modelled network at 30% climate change.

A drawing showing the proposed surface water drainage strategy will be provided in **Appendix B**.

The proposed surface water discharge is not within the Camel Catchment; instead eventually discharging to the sea through the village of Par to the south east.

Exceedance

The main residual risk considered to apply to the proposed surface water scheme is that arising from exceedance of the new drainage system's capacity in weather conditions above the design standard. In such circumstances there is a risk of the proposed drainage system being unable to accommodate the excess run-off which instead flows overland.

Exceedance flows from will be directed away from the buildings and routed towards safe external areas (i.e. the onsite car parking and manoeuvring areas, and the greenspace to the south and east) where they can be temporarily stored until capacity become available in the drainage system.

3.7 Foul Water Strategy

In order of preference the method for sewage treatment and disposal as set out in the Environment Agency's Guidelines is as follows;

- Discharge to foul sewer;
- Discharge to drainage field/mound following primary treatment via septic tank or package sewage treatment plant;
- Discharge to watercourse following treatment via package sewage treatment plant;
- Discharge to cesspool.

Foul water flows will be discharged into the existing private onsite system for disposal via the existing onsite pumping station, lifting flows to the SWW foul sewer via the existing rising main within the Victoria Business Park to the west. The foul flows from this sewer are transferred further south to the Luxulyan sewerage treatment works, and this is located outside the Camel Catchment where there are particular concerns with regards to Phosphates. As such it not expected that additional measures will be required with regards to phosphate discharges from the proposed development.

It is understood the additional flows from the new hotel rooms have been accounted for within the original site drainage design but it is recommended that the capacity of the existing pumping station/ rising main will need to be checked to ensure that adequate capacity was installed to service the proposed extension, prior to detailed design.

It is possible that a sewer not deemed to be public could be crossing the sites. Should any sewer be found during construction works, an investigation of the sewer will be required by the local planning authority to ascertain its condition, the number of properties/developments served and potential means of access before any works commence.

3.8 Ownership and Maintenance

The details of the ownership and maintenance for all drainage on the site are required as part of the planning guidance, on this site it is proposed that:

- The maintenance and management of the proposed building (surface water and foul water) drainage systems and associated devices will remain in private ownership and will be the responsibility of the landlord/tenant;
- The maintenance responsibility for the site wide system is expected to remain as current.

4 Summary and Conclusion

4.1 Development

The development will comprise the extension of the existing hotel and would provide for 29 additional beds, plus a restaurant extension to provide for 44 new covers. The bedroom extension would be over 3 floors, with the restaurant being a single storey extension.

The proposed development site is located approximately 8km south west of Bodmin, 2.6km north east of Roche and adjacent to the A30. Vehicular Access is proposed off the A30 and the existing access routes associated with the Cornwall Services.

The proposed extension site covers an area of approximately 0.38 hectares, with the extension being approximately 500m^2 and the existing land use is the existing hotel (to be extended) and associated hardstanding. The site is currently surrounded to the north and west by the Cornwall Services and the A30, and to the south and east by drainage features associated with the Services and open agricultural fields with elements of renewable energy production.

4.2 Drainage

Following review of the initial drainage works for the site it has been confirmed that the area of the proposed bedroom extension has already been accounted for within the surface water drainage for the development. An extension of the system will be necessary to pick up the minimal (226m^2) increase in drained impermeable area associated with the restaurant extension. Flows will be picked up by the rainwater pipes and discharged into the existing system via a small additional section of gravity drain prior to discharge into the wider site network and eventually the Basin 3 leading to Basin 4. In order to maintain the final 300mm freeboard in Basin 4, and the peak discharge from the wider site of 30.6l/s, an extra 15mm needs to be added to the north and eastern edges of the Basin 4 earthworks to give a minimum peak of 138.719mAOD, with the orifice plate reduced to 116mm in diameter. Review of works done to Basin 4 as part of a previous phase confirms the level raising has already been achieved and therefore only the orifice plate needs replacing.

All new surface water drainage features will be designed to safely manage the 1 in 100 year event with a 40% allowance for climate change; to match the existing drainage network onsite any additional flows will only be included within the full modelled network at 30% climate change.

Foul water flows will be discharged into the existing private onsite system for disposal via the existing onsite pumping station, lifting flows to the SWW foul sewer via the existing rising main within the Victoria Business Park to the west. It is understood the additional flows from the new hotel rooms have been accounted for within the original site drainage design but it is recommended that the capacity of the existing pumping station/ rising main will need to be checked to ensure that adequate capacity was installed to service the proposed extension, prior to detailed design.

5 References

National Planning Policy Framework; *Department for Communities and Local Government, Communities and Local Government (2012);*

CIRIA report C753 The SuDS Manual v3; *CIRIA (2015)*;

6 Appendices

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MULTIDISIPLINARY ENGINEERING CONSULTANTS

Appendix A – Proposed Layout (1 Page)

LIST OF INFORMANTS :
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-
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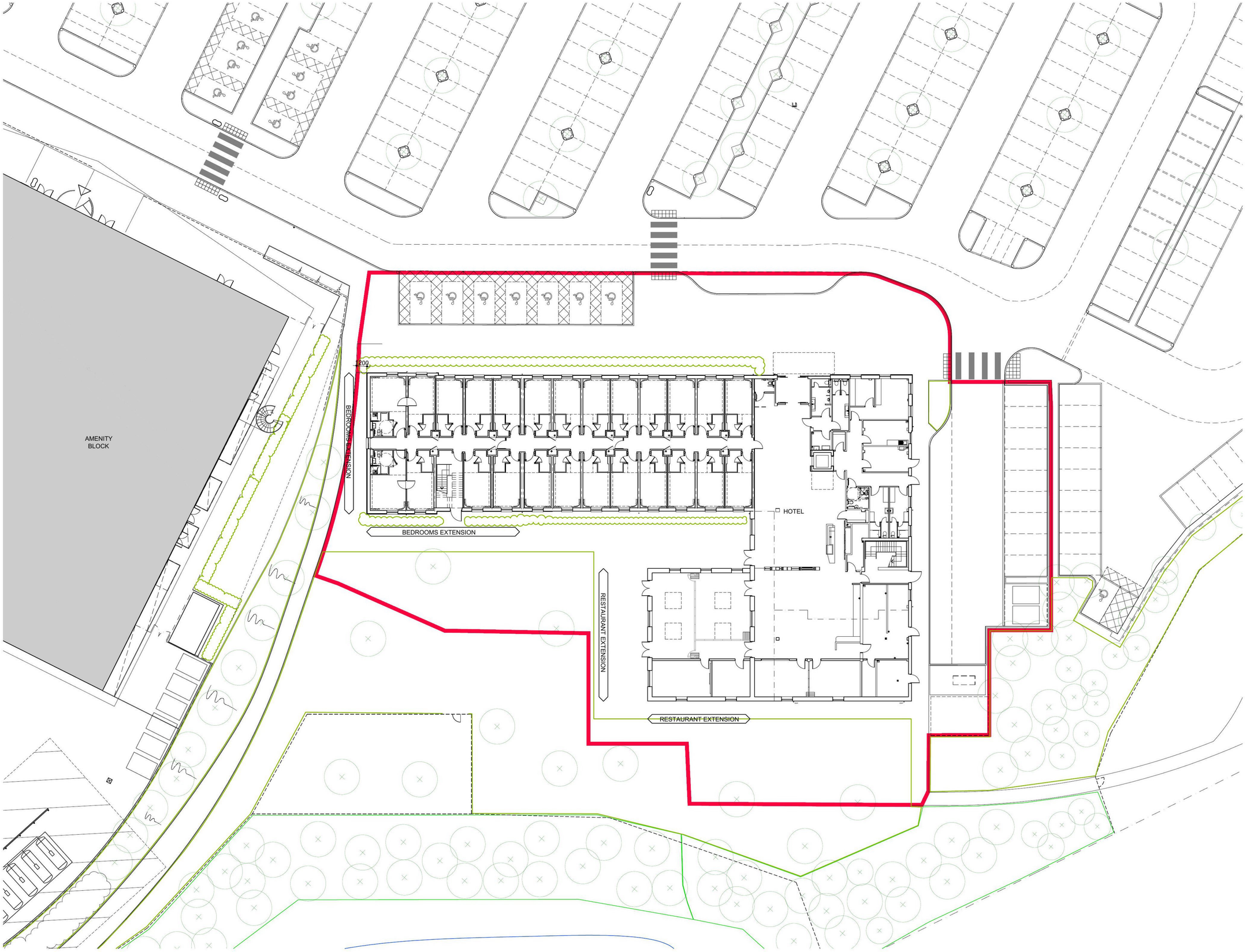
REVISIONS	DATE	DRN	REV
PRELIMINARY ISSUE	31.03.21	JM	A
EXISTING ESCAPE STAIR REPLACED WITH BEDROOM, NEW ESCAPE STAIR RELOCATED	19.04.21	JM	B
DIMENSION TO THE BOUNDARY ADDED	04.05.21	RM	C
HOTEL GF PLAN UPDATED	10.05.21	RM	D
WINDOWS ADDED TO RESTAURANT EXTENSION	11.05.21	RM	E
ESCAPE STAIR RELOCATED	13.05.21	JM	F



SCHEDULE OF ACCOMMODATION

GROUND FLOOR:
- HOTEL - RECEPTION / BREAKFAST / BAR / MEETING AREA / B.O.H./ 25 BEDROOMS

FIRST FLOOR:
- HOTEL - 38 BEDROOMS

SECOND FLOOR:
- HOTEL - 38 BEDROOMS

TOTAL 101 BEDROOM HOTEL (89 STANDALONE STANDARD ROOMS AND 6 STANDARD / 6 ACCESSIBLE ROOMS TO BE INTERCONNECTING)

North

0 2m 4m 6m 8m 10m

MountfordPigott

A30 VICTORIA JUNCTION TRSA - HOTEL

HOTEL EXTENSION PROPOSED SITE PLAN 1134-P211-F

1:200 @ A1/ 1:400 @ A3 MARCH 2021

DRAWN BY JM

Appendix B – Drainage Layout (2 Pages)

CDM RESIDUAL RISKS

The work shown on this drawing is both familiar to the designers and routinely safely built in similar circumstances by competent contractors.

Risks are not considered significant.

~~Relevant data is included in the Pre Construction Information Pack~~

Signed: BG Date: 10/11/21

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT DRAWINGS, SPECIFICATIONS AND REPORTS.
2. SURVEY INFORMATION SHOWN IS TAKEN FROM WESCOUNTRY LAND SURVEYS JOB NUMBER 7848 DATED JULY 2018. CLARKEBOND TAKE NO RESPONSIBILITY FOR THEIR CONTENT OR ACCURACY.
3. ALL WORKS ARE TO BE CONSTRUCTED IN ACCORDANCE WITH 'MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS' AND DESIGN AND CONSTRUCTION GUIDANCE, THE CIVIL ENGINEERING SPECIFICATION FOR THE WATER INDUSTRY 7TH EDITION, THE REQUIREMENTS OF SOUTH WEST WATER AND CURRENT BUILDING REGULATIONS AND CODES OF PRACTICE WHERE APPLICABLE.
4. CONTRACTOR TO LOCATE AND IDENTIFY ALL EXISTING SERVICES WITHIN THE WORKS AREA. THESE SERVICES ARE TO BE PROTECTED DURING THE COURSE OF THE WORKS AND ADJUSTED AS REQUIRED TO SUIT THE PROPOSED DEVELOPMENT IN COMPLIANCE WITH THE RELEVANT STATUTORY AUTHORITY.
5. ALL PIPEWORK LAID IN AREAS OF VEHICULAR ACCESS WITH LESS THAN 0.9m COVER ARE TO BE CONCRETE ENCASED WITH MINIMUM 150mm CONCRETE SURROUND OR PROTECTED VIA A REINFORCED CONCRETE COVER SLAB. PIPEWORK IN ALL OTHER AREAS WITH LESS THAN 0.6m COVER IS TO BE SIMILARLY PROTECTED.
6. COVER LEVELS SHOWN ARE TO THE CENTRE OF THE MANHOLE. CONTRACTOR TO ADJUST ACCORDINGLY.
7. INSPECTION CHAMBERS GREATER THAN 1.2m DEEP FROM COVER TO INVERT TO HAVE ACCESS RESTRICTED TO MAX 300x300 (350ø) IN ACCORDANCE WITH CURRENT BUILDING REGULATIONS.
8. LEVELS OF DRAIN CROSSING LOCATIONS ARE TO BE CHECKED ON SITE BEFORE CONSTRUCTION.
9. CONTRACTOR TO MAKE ALLOWANCE FOR SLIGHT ADJUSTMENTS TO BOTH HORIZONTAL AND VERTICAL ALIGNMENT TO SUIT PROPOSED ON-SITE SERVICES, DRAINAGE AND FOUNDATIONS.
10. ALL ABOVE GROUND DRAINAGE INCLUDING APPLIANCE FIT-OUT, GULLIES, WASTE PIPE CONNECTIONS, DISCHARGE STACKS, RAINWATER PIPES, ACCESS AND VENTILATION REQUIREMENTS, GUTTERS ETC. TO ARCHITECT'S AND M&E ENGINEERS DETAILS.
11. THE LEVEL AND ALIGNMENT OF ALL EXISTING SEWERS INCLUDING THE DETAILS OF ALL EXISTING MANHOLES ARE TO BE VERIFIED PRIOR TO THE COMMENCEMENT OF WORKS.
12. NEW SERVICES ARE TO BE INSTALLED IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITY AND LOCAL HIGHWAY AUTHORITY WHERE APPLICABLE.
13. ALL LEVELS SHOWN ARE TO ORDNANCE DATUM.

Rev	Detail	By	Chk	Date
	Revisions			

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Bristol Exeter London Abu Dhabi

Client: THE ROWE PARTNERSHIP

Project: A30 HOTEL EXTENSION TRUNK ROAD SERVICE AREA (TRSA) CORNWALL

Drawing Title: PROPOSED SITE PRIVATE DRAINAGE PLAN

Drawing Status: INFORMATION

Project No.	Discipline	Drawing No.
WE03344.90	C	101

Scale	Date	Revision
1:200 @ A1	NOV '21	–

Drawn	Checked	Sheet Size
BG	MKR	A1

INTERNAL BELOW GROUND FOUL DRAINAGE

1. ALL INTERNAL BELOW GROUND DRAINAGE TO BE MIN 100mm DIAMETER LAID AT MINIMUM 1IN40 FALLS. POSITIONS OF ALL WASTE PIPE LOCATIONS FOR CONNECTION TO BELOW GROUND DRAINAGE TO BE CONFIRMED BY ARCHITECT AND M&E ENGINEER.
2. MINIMUM INVERT LEVEL OF ALL WASTE PIPES TO BE 450mm BELOW FFL OR LOWEST CONNECTION.
3. EXTERNAL INSPECTION CHAMBERS/MANHOLES TO BE ADJUSTED AND/OR INTRODUCED TO SUIT INTERNAL WASTE PIPE LOCATIONS AND/OR FOUNDATIONS.
4. INTERNAL BRANCH CONNECTIONS SUBJECT TO BUILDING CONTROL APPROVAL.
5. DRAINAGE TO BE COORDINATED WITH FOUNDATIONS. SLEEVES OR CUT-OUTS TO BE PROVIDED AS NECESSARY.
6. WHERE A DRAIN RUN HAS LESS THAN 300mm COVER FROM THE CROWN OF THE PIPE TO THE UNDERSIDE OF THE SLAB IT SHOULD BE SURROUNDED IN CONCRETE AND CAST INTEGRAL WITH THE SLAB.

DRAINAGE CHANNELS

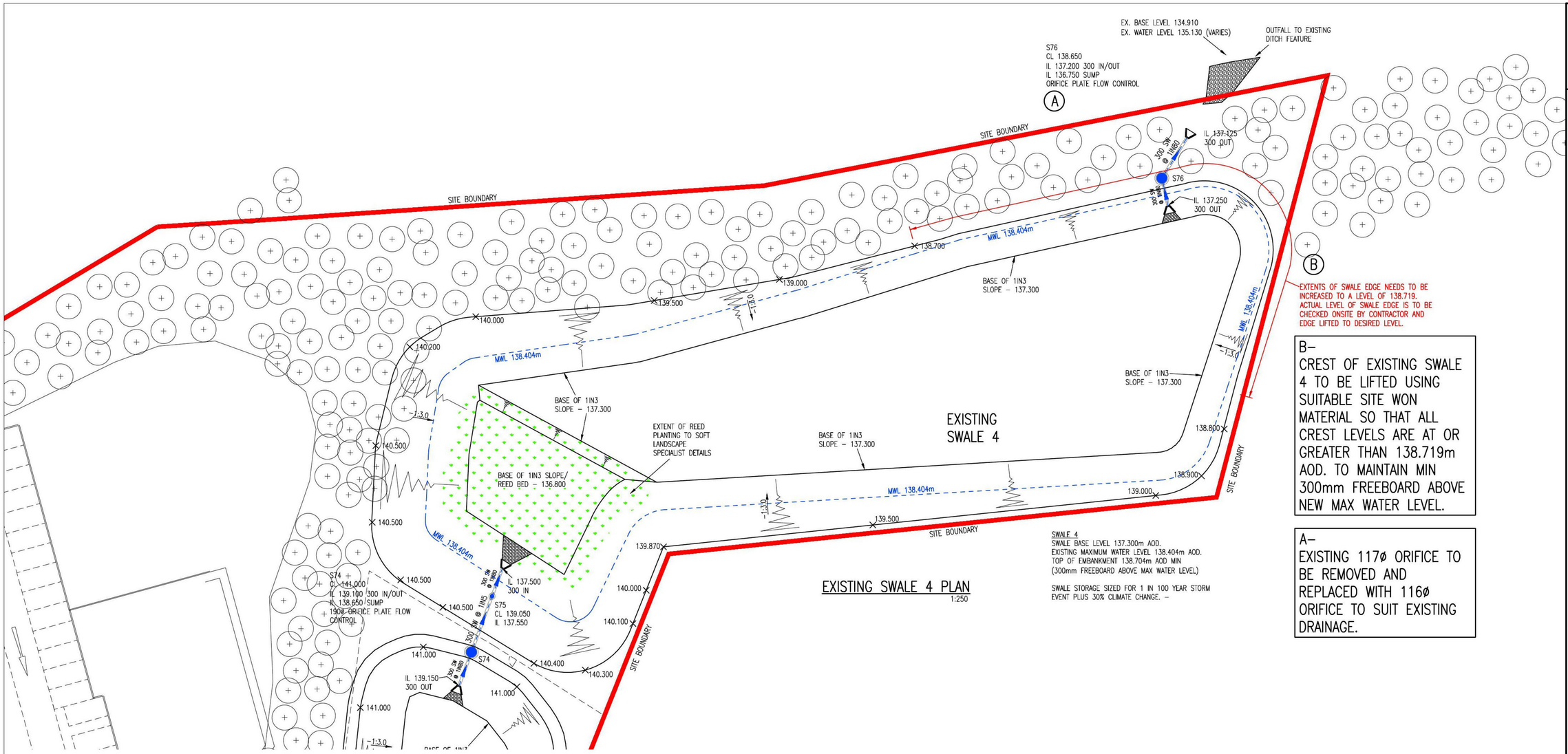
1. ACCESS TO BE PROVIDED AT THE HEAD AND END OF EACH DRAINAGE CHANNEL AND AT INTERMEDIATE POINTS AS RECOMMENDED BY THE MANUFACTURER.
2. SILT TRAPS/SUMPS TO BE PROVIDED AT ALL OUTLET LOCATIONS AND AT INTERMEDIATE POINTS AS RECOMMENDED BY THE MANUFACTURER.
3. ALL OUTLETS TO BE TRAPPED AND RODDABLE.
4. ALL CHANNELS TO BE INSTALLED AND MAINTAINED IN STRICT ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
5. ALL CHANNELS TO BE PROVIDED WITH LOAD CLASS D400 LOCKABLE HEELGUARD GRATINGS WITH ANTI-SHUNT MECHANISM.

KEY:

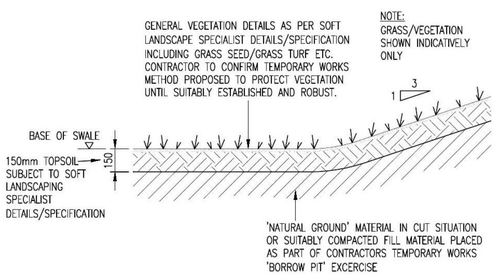
- EXISTING HOTEL SURFACE WATER SEWER & MANHOLE
- EXISTING HOTEL FOUL SEWER & MANHOLE
- EXISTING SURFACE WATER SYSTEM
- EXISTING FOUL WATER SYSTEM
- THRESHOLD DRAINS AT DOORS
- PROPOSED EXTENSION SURFACE WATER DRAINAGE

ALL RWP AND SVP LOCATIONS TO BE TAKEN FROM LATEST ARCHITECTS/M&E CONSULTANTS PLANS

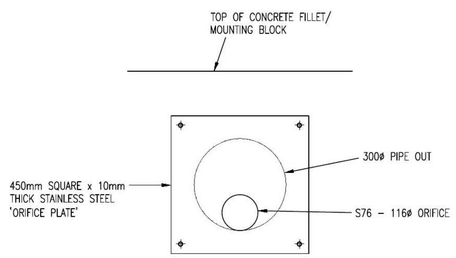
DWG INFO: N:\JBS1192\1.0\XX - A30 HOTEL EXTENSION 2021\01_MP\DR_DRAWING\EXTRA AREA



EXISTING SWALE 4 PLAN
1:250



TYPICAL EXISTING SWALE BASE/SIDE DETAIL NTS



PROPOSED ORIFICE PLATE DETAILS

CDM RESIDUAL RISKS

The work shown on this drawing is both familiar to the designers and routinely safely built in similar circumstances by competent contractors.

Risks are not considered significant.

~~Relevant data is included in the Pre-Construction Information Pack~~

Signed: B. GLOVER Date: NOVEMBER 2021

NOTES:

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13. ALL LEVELS SHOWN ARE TO ORDNANCE DATUM.

Rev	Detail	By	Chk	Date

Revisions

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Client
THE ROWE PARTNERSHIP

Project
A30 HOTEL EXTENSION
CAR PARK EXTENSION
CORNWALL

Drawing Title
EXISTING SWALE 4 PLAN ADJUSTMENT TO CREST LEVEL AND ORIFICE

Drawing Status
INFORMATION

Project No.	Discipline	Drawing No.
WE03344.90	C	100

Scale	Date	Revision
1:200 @ A1	NOV '21	–

Drawn	Checked	Sheet Size
BG	MKR	A1

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MULTIDISIPLINARY ENGINEERING CONSULTANTS

Appendix C – MicroDrainage Calculations (20 Pages)

Job Number	E05xxx		
Site Reference	A30 Hotel Extension		
Site Coordinates	200172, 62287		
Site Redline	0.384	(ha)	
Pre Development Impermeable	0.278	(ha)	
Post Development Impermeable	0.329	(ha)	Including Areas Draining to Soakaways
Post Development Impermeable	0.329	(ha)	Excluding Areas Draining to Soakaways
Postively Drained Greenspace	0.000	(ha)	
Urban Creep	0	%	
Total Positvely Drained	**0.329**	(ha)	
Area to Use in Drainage Model	**0.329**	(ha)	Excluding Soakaway Drained Areas
CDA?	No		
SAAR	1351	mm	
CWI	124.151		
M5-60	18.5		
SPR	30		
Soil	0.3		
R	0.284		
PR Greenfield (Percentage Runoff) (FSSR16)	34.29	%	From Greenfield Volume Tool
IF: Effective Impervious Area Factor	0.7		
PF: Soil Moisture Depth	200	mm	
6 Hour, 100 Year Rainfall Depth	66.834	mm	
NAPI	0	mm	
PR (UK Variable) Pre Development	50.60	%	
PR (UK Variable) Post Development	**59.96**	%	
Urban (Pre)	**0.723**		
Urban (Post) (for Rates)	**0.857**		
Urban (Post) (for Volume)	**0.857**		
Climate Change	40	%	
Brownfield Runoff Rate Betterment	0	%	

VOLUME

Greenfield Volume (FSSR16)	88	(m^3)
Pre Development Volume	130	(m^3)
Post Development Volume (UK Variable PR)	**154**	(m^3)
Long Term Storage Volume Required	**24**	(m^3)

RUNOFF

	Greenfield Rates (Redline) (l/s)	Pre Development Rates (Redline) (l/s)	Post Development Rates (Redline) (l/s)	Allowable Discharge Rates (l/s)	Allowable Greenfield Discharge Rates (l/s)
Qbar	1.5	3.8		**3.3**	**1.3**
Q1	1.2	3.0		**2.6**	**1.0**
Q10	2.3	5.4		**4.6**	**2.0**
Q30	2.9	6.1		**5.2**	**2.5**
Q100	3.7	6.7		**5.7**	**3.2**
Q100 + CC	**5.2**	**9.4**	**0.0**	**5.7**	**3.2**
L.T.S				**0.8**	**0.8**

Clarkebond		Page 1
Bickleigh House Park Five Business Centre Sowton Exeter	E05xxx A30 Hotel Extension Greenfield Runoff Rates	
Date 10/11/21 File	Designed by BG Checked by MKR	
Micro Drainage	Source Control 2017.1.2	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	10	Soil	0.300
Area (ha)	0.384	Urban	0.000
SAAR (mm)	1351	Region Number	Region 8

Results l/s

QBAR Rural	1.5
QBAR Urban	1.5
Q10 years	2.3
Q1 year	1.2
Q30 years	2.9
Q100 years	3.7

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.500
Ratio R	0.284
Areal Reduction Factor	1.00
Area (ha)	0.384
SAAR (mm)	1351
CWI	124.151
Urban	0.000
SPR	30.000

Results

Percentage Runoff (%)	34.29
Greenfield Runoff Volume (m^3)	88.000

ICP SUDS Mean Annual Flood

Input

Return Period (years)	10	Soil	0.300
Area (ha)	0.384	Urban	0.723
SAAR (mm)	1351	Region Number	Region 8

Results l/s

QBAR Rural	1.5
QBAR Urban	3.8
Q10 years	5.4
Q1 year	3.0
Q30 years	6.1
Q100 years	6.7

Cascade Summary of Results for POND 1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	POND 2 PLUS ADL INPUT.srcx	POND 2 PLUS ADL INPUT.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	147.259	0.759	44.3	173.0	O K
30 min Summer	147.429	0.929	48.9	225.2	O K
60 min Summer	147.542	1.042	51.7	263.2	O K
120 min Summer	147.595	1.095	53.0	281.8	O K
180 min Summer	147.582	1.082	52.7	276.9	O K
240 min Summer	147.546	1.046	51.8	264.5	O K
360 min Summer	147.472	0.972	50.0	239.2	O K
480 min Summer	147.397	0.897	48.1	215.1	O K
600 min Summer	147.327	0.827	46.2	193.4	O K
720 min Summer	147.263	0.763	44.4	174.2	O K
960 min Summer	147.152	0.652	41.2	142.8	O K
1440 min Summer	146.984	0.484	35.7	99.6	O K
2160 min Summer	146.827	0.327	29.6	63.2	O K
2880 min Summer	146.731	0.231	25.3	43.2	O K
4320 min Summer	146.633	0.133	19.8	23.8	O K
5760 min Summer	146.597	0.097	16.2	17.2	O K
7200 min Summer	146.576	0.076	13.7	13.3	O K
8640 min Summer	146.561	0.061	11.9	10.7	O K
10080 min Summer	146.550	0.050	10.7	8.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	104.459	0.0	207.1	19
30 min Summer	72.785	0.0	289.1	32
60 min Summer	48.563	0.0	385.3	52
120 min Summer	31.244	0.0	496.4	86
180 min Summer	23.704	0.0	564.7	120
240 min Summer	19.310	0.0	613.6	154
360 min Summer	14.481	0.0	689.9	220
480 min Summer	11.782	0.0	748.2	286
600 min Summer	10.029	0.0	796.5	348
720 min Summer	8.785	0.0	837.0	410
960 min Summer	7.120	0.0	904.8	532
1440 min Summer	5.281	0.0	1006.6	770
2160 min Summer	3.905	0.0	1116.3	1128
2880 min Summer	3.146	0.0	1199.1	1476
4320 min Summer	2.318	0.0	1325.7	2204
5760 min Summer	1.869	0.0	1425.0	2936
7200 min Summer	1.582	0.0	1507.8	3648
8640 min Summer	1.381	0.0	1579.6	4400
10080 min Summer	1.232	0.0	1643.8	5136

Cascade Summary of Results for POND 1.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	147.335	0.835	46.4	195.9	O K
30 min Winter	147.524	1.024	51.3	257.0	O K
60 min Winter	147.650	1.150	54.3	301.4	O K
120 min Winter	147.696	1.196	55.4	318.6	O K
180 min Winter	147.664	1.164	54.6	306.8	O K
240 min Winter	147.607	1.107	53.3	285.9	O K
360 min Winter	147.490	0.990	50.5	245.3	O K
480 min Winter	147.378	0.878	47.6	209.1	O K
600 min Winter	147.278	0.778	44.9	178.6	O K
720 min Winter	147.189	0.689	42.3	153.0	O K
960 min Winter	147.043	0.543	37.7	114.3	O K
1440 min Winter	146.851	0.351	30.7	68.6	O K
2160 min Winter	146.702	0.202	23.7	37.2	O K
2880 min Winter	146.629	0.129	19.5	23.0	O K
4320 min Winter	146.583	0.083	14.5	14.6	O K
5760 min Winter	146.559	0.059	11.7	10.3	O K
7200 min Winter	146.544	0.044	9.9	7.5	O K
8640 min Winter	146.532	0.032	8.6	5.6	O K
10080 min Winter	146.524	0.024	7.7	4.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	104.459	0.0	232.3	19
30 min Winter	72.785	0.0	323.6	32
60 min Winter	48.563	0.0	432.3	56
120 min Winter	31.244	0.0	555.9	92
180 min Winter	23.704	0.0	632.3	130
240 min Winter	19.310	0.0	687.1	166
360 min Winter	14.481	0.0	773.0	236
480 min Winter	11.782	0.0	838.5	302
600 min Winter	10.029	0.0	892.2	366
720 min Winter	8.785	0.0	937.6	428
960 min Winter	7.120	0.0	1013.6	548
1440 min Winter	5.281	0.0	1127.4	782
2160 min Winter	3.905	0.0	1250.3	1128
2880 min Winter	3.146	0.0	1343.2	1472
4320 min Winter	2.318	0.0	1484.7	2200
5760 min Winter	1.869	0.0	1596.2	2896
7200 min Winter	1.582	0.0	1688.8	3624
8640 min Winter	1.381	0.0	1769.3	4400
10080 min Winter	1.232	0.0	1841.1	5088

Cascade Rainfall Details for POND 1.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.284	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.059

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.530	4	8	0.529

Time Area Diagram

Total Area (ha) 0.000

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

Cascade Model Details for POND 1.srcx

Storage is Online Cover Level (m) 148.000

Tank or Pond Structure

Invert Level (m) 146.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	170.0	0.700	280.9	1.400	419.5	2.100	585.9
0.100	184.1	0.800	299.0	1.500	441.6	2.200	611.9
0.200	198.9	0.900	317.7	1.600	464.2	2.300	638.5
0.300	214.1	1.000	336.9	1.700	487.4	2.400	665.6
0.400	230.0	1.100	356.7	1.800	511.2	2.500	693.4
0.500	246.4	1.200	377.1	1.900	535.5		
0.600	263.4	1.300	398.0	2.000	560.4		

Orifice Outflow Control

Diameter (m) 0.155 Discharge Coefficient 0.600 Invert Level (m) 146.400

Cascade Summary of Results for POND 2 PLUS ADL INPUT.srcx

Upstream Structures	Outflow To	Overflow To
POND 1.srcx	POND 3_with Hotel extension.srcx	POND 3_with Hotel extension.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	143.427	0.227	57.9	236.6	O K
30 min Summer	143.508	0.308	60.6	325.7	O K
60 min Summer	143.590	0.390	63.3	418.1	O K
120 min Summer	143.654	0.454	65.3	492.4	O K
180 min Summer	143.671	0.471	65.8	511.5	O K
240 min Summer	143.666	0.466	65.7	506.3	O K
360 min Summer	143.656	0.456	65.3	493.9	O K
480 min Summer	143.641	0.441	64.9	476.3	O K
600 min Summer	143.622	0.422	64.3	454.9	O K
720 min Summer	143.601	0.401	63.6	430.5	O K
960 min Summer	143.554	0.354	62.2	377.5	O K
1440 min Summer	143.458	0.258	59.0	270.6	O K
2160 min Summer	143.336	0.136	54.7	139.4	O K
2880 min Summer	143.251	0.051	51.5	51.8	O K
4320 min Summer	143.200	0.000	45.5	0.0	O K
5760 min Summer	143.200	0.000	36.9	0.0	O K
7200 min Summer	143.200	0.000	31.2	0.0	O K
8640 min Summer	143.200	0.000	27.3	0.0	O K
10080 min Summer	143.200	0.000	24.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	104.459	0.0	471.8	22
30 min Summer	72.785	0.0	659.9	37
60 min Summer	48.563	0.0	879.6	66
120 min Summer	31.244	0.0	1133.7	124
180 min Summer	23.704	0.0	1286.9	180
240 min Summer	19.310	0.0	1400.9	216
360 min Summer	14.481	0.0	1575.7	276
480 min Summer	11.782	0.0	1705.6	340
600 min Summer	10.029	0.0	1817.5	406
720 min Summer	8.785	0.0	1912.3	470
960 min Summer	7.120	0.0	2064.3	600
1440 min Summer	5.281	0.0	2299.2	850
2160 min Summer	3.905	0.0	2547.8	1196
2880 min Summer	3.146	0.0	2736.2	1532
4320 min Summer	2.318	0.0	3025.7	0
5760 min Summer	1.869	0.0	3252.7	0
7200 min Summer	1.582	0.0	3441.6	0
8640 min Summer	1.381	0.0	3605.5	0
10080 min Summer	1.232	0.0	3751.9	0

Cascade Summary of Results for POND 2 PLUS ADL INPUT.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	143.457	0.257	59.0	269.8	O K
30 min Winter	143.550	0.350	62.0	373.2	O K
60 min Winter	143.647	0.447	65.1	483.2	O K
120 min Winter	143.728	0.528	67.5	578.8	Flood Risk
180 min Winter	143.752	0.552	68.2	608.1	Flood Risk
240 min Winter	143.751	0.551	68.2	607.0	Flood Risk
360 min Winter	143.731	0.531	67.6	583.2	Flood Risk
480 min Winter	143.705	0.505	66.8	552.2	Flood Risk
600 min Winter	143.672	0.472	65.8	512.5	O K
720 min Winter	143.634	0.434	64.7	468.2	O K
960 min Winter	143.552	0.352	62.1	375.6	O K
1440 min Winter	143.400	0.200	57.0	207.5	O K
2160 min Winter	143.236	0.036	50.9	36.0	O K
2880 min Winter	143.200	0.000	44.7	0.0	O K
4320 min Winter	143.200	0.000	33.1	0.0	O K
5760 min Winter	143.200	0.000	26.7	0.0	O K
7200 min Winter	143.200	0.000	22.6	0.0	O K
8640 min Winter	143.200	0.000	19.7	0.0	O K
10080 min Winter	143.200	0.000	17.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	104.459	0.0	530.8	22
30 min Winter	72.785	0.0	739.1	36
60 min Winter	48.563	0.0	987.8	66
120 min Winter	31.244	0.0	1268.7	122
180 min Winter	23.704	0.0	1441.5	178
240 min Winter	19.310	0.0	1566.5	230
360 min Winter	14.481	0.0	1761.7	290
480 min Winter	11.782	0.0	1915.7	362
600 min Winter	10.029	0.0	2037.7	432
720 min Winter	8.785	0.0	2137.8	502
960 min Winter	7.120	0.0	2311.7	634
1440 min Winter	5.281	0.0	2573.0	880
2160 min Winter	3.905	0.0	2853.7	1196
2880 min Winter	3.146	0.0	3065.6	0
4320 min Winter	2.318	0.0	3388.7	0
5760 min Winter	1.869	0.0	3643.2	0
7200 min Winter	1.582	0.0	3854.7	0
8640 min Winter	1.381	0.0	4038.3	0
10080 min Winter	1.232	0.0	4202.1	0

Cascade Rainfall Details for POND 2 PLUS ADL INPUT.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.284	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.358

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.679	4	8	0.679

Cascade Model Details for POND 2 PLUS ADL INPUT.srcx

Storage is Online Cover Level (m) 144.000

Tank or Pond Structure

Invert Level (m) 143.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1005.0	0.700	1254.9	1.400	1532.4	2.100	1837.7
0.100	1039.0	0.800	1292.8	1.500	1574.3	2.200	1883.6
0.200	1073.6	0.900	1331.3	1.600	1616.8	2.300	1930.0
0.300	1108.7	1.000	1370.4	1.700	1659.8	2.400	1977.0
0.400	1144.4	1.100	1410.1	1.800	1703.5	2.500	2024.6
0.500	1180.6	1.200	1450.3	1.900	1747.6		
0.600	1217.5	1.300	1491.1	2.000	1792.4		

Orifice Outflow Control

Diameter (m) 0.174 Discharge Coefficient 0.600 Invert Level (m) 142.500

Cascade Summary of Results for POND 3_with Hotel extension.srcx

Upstream Structures	Outflow To	Overflow To
POND 2 PLUS ADL INPUT.srcx POND 4 AMEND ORIFICE 116.srcx POND 1.srcx	POND 4 AMEND ORIFICE 116.srcx	POND 4 AMEND ORIFICE 116.srcx

Storm Event		Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15	min Summer	139.919	0.719	64.1	278.7	O K
30	min Summer	140.128	0.928	72.8	381.1	O K
60	min Summer	140.336	1.136	80.5	493.3	O K
120	min Summer	140.510	1.310	86.4	595.6	O K
180	min Summer	140.567	1.367	88.3	630.9	O K
240	min Summer	140.583	1.383	88.8	641.4	O K
360	min Summer	140.592	1.392	89.1	647.0	O K
480	min Summer	140.584	1.384	88.8	641.4	O K
600	min Summer	140.568	1.368	88.3	631.4	O K
720	min Summer	140.549	1.349	87.7	619.6	O K
960	min Summer	140.506	1.306	86.3	593.2	O K
1440	min Summer	140.410	1.210	83.1	535.8	O K
2160	min Summer	140.266	1.066	78.0	454.6	O K
2880	min Summer	140.143	0.943	73.4	389.0	O K
4320	min Summer	139.888	0.688	62.7	264.6	O K
5760	min Summer	139.699	0.499	53.5	182.0	O K
7200	min Summer	139.583	0.383	46.9	135.0	O K
8640	min Summer	139.502	0.302	41.7	104.0	O K

Storm Event		Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15	min Summer	104.459	0.0	737.6	22
30	min Summer	72.785	0.0	1030.3	37
60	min Summer	48.563	0.0	1374.4	64
120	min Summer	31.244	0.0	1770.2	122
180	min Summer	23.704	0.0	2011.4	178
240	min Summer	19.310	0.0	2187.2	204
360	min Summer	14.481	0.0	2460.5	266
480	min Summer	11.782	0.0	2665.3	334
600	min Summer	10.029	0.0	2839.1	402
720	min Summer	8.785	0.0	2985.8	470
960	min Summer	7.120	0.0	3224.5	606
1440	min Summer	5.281	0.0	3589.7	868
2160	min Summer	3.905	0.0	3979.4	1236
2880	min Summer	3.146	0.0	4273.4	1592
4320	min Summer	2.318	0.0	4725.7	2252
5760	min Summer	1.869	0.0	5080.1	2952
7200	min Summer	1.582	0.0	5375.2	3680
8640	min Summer	1.381	0.0	5631.4	4408

Cascade Summary of Results for POND 3_with Hotel extension.srcx

	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080	min Summer	139.444	0.244	37.6	82.6	O K
15	min Winter	139.983	0.783	66.9	309.0	O K
30	min Winter	140.207	1.007	75.8	422.6	O K
60	min Winter	140.430	1.230	83.7	547.9	O K
120	min Winter	140.622	1.422	90.0	665.9	O K
180	min Winter	140.694	1.494	92.2	712.6	O K
240	min Winter	140.713	1.513	92.8	725.5	Flood Risk
360	min Winter	140.721	1.521	93.1	730.3	Flood Risk
480	min Winter	140.705	1.505	92.6	719.9	Flood Risk
600	min Winter	140.676	1.476	91.7	701.1	O K
720	min Winter	140.642	1.442	90.6	678.6	O K
960	min Winter	140.564	1.364	88.2	628.9	O K
1440	min Winter	140.398	1.198	82.6	529.0	O K
2160	min Winter	140.178	0.978	74.7	407.2	O K
2880	min Winter	139.942	0.742	65.1	289.3	O K
4320	min Winter	139.641	0.441	50.3	158.1	O K
5760	min Winter	139.494	0.294	41.2	100.9	O K
7200	min Winter	139.412	0.212	35.1	71.1	O K
8640	min Winter	139.366	0.166	30.8	54.8	O K
10080	min Winter	139.345	0.145	27.5	47.7	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080	min Summer	1.232	0.0	5859.8	5136
15	min Winter	104.459	0.0	828.4	22
30	min Winter	72.785	0.0	1154.1	36
60	min Winter	48.563	0.0	1541.4	64
120	min Winter	31.244	0.0	1981.7	120
180	min Winter	23.704	0.0	2252.6	176
240	min Winter	19.310	0.0	2448.0	226
360	min Winter	14.481	0.0	2753.0	280
480	min Winter	11.782	0.0	2991.0	358
600	min Winter	10.029	0.0	3181.3	434
720	min Winter	8.785	0.0	3340.4	506
960	min Winter	7.120	0.0	3611.1	648
1440	min Winter	5.281	0.0	4018.9	910
2160	min Winter	3.905	0.0	4457.4	1276
2880	min Winter	3.146	0.0	4788.1	1564
4320	min Winter	2.318	0.0	5292.7	2256
5760	min Winter	1.869	0.0	5690.0	2952
7200	min Winter	1.582	0.0	6020.3	3672
8640	min Winter	1.381	0.0	6307.1	4400
10080	min Winter	1.232	0.0	6562.9	5096

Cascade Rainfall Details for POND 3_with Hotel extension.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.284	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.358

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.691	4	8	0.667

Cascade Model Details for POND 3_with Hotel extension.srcx

Storage is Online Cover Level (m) 141.000

Tank or Pond Structure

Invert Level (m) 139.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	315.0	0.700	461.0	1.400	634.7	2.100	836.1
0.100	334.2	0.800	484.1	1.500	661.7	2.200	867.1
0.200	353.9	0.900	507.8	1.600	689.4	2.300	898.7
0.300	374.2	1.000	532.0	1.700	717.6	2.400	930.9
0.400	395.0	1.100	556.8	1.800	746.4	2.500	963.6
0.500	416.4	1.200	582.2	1.900	775.7		
0.600	438.4	1.300	608.2	2.000	805.6		

Orifice Outflow Control

Diameter (m) 0.190 Discharge Coefficient 0.600 Invert Level (m) 139.100

Cascade Summary of Results for POND 4 AMEND ORIFICE 116.srcx

Upstream Structures	Outflow To	Overflow To
POND 3_with Hotel extension.srcx POND 2 PLUS ADL INPUT.srcx POND 1.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	137.576	0.276	15.8	546.2	O K
30 min Summer	137.681	0.381	18.3	763.6	O K
60 min Summer	137.799	0.499	20.7	1015.6	O K
120 min Summer	137.930	0.630	23.0	1300.4	O K
180 min Summer	138.005	0.705	24.3	1469.0	O K
240 min Summer	138.057	0.757	25.1	1587.6	O K
360 min Summer	138.133	0.833	26.3	1763.1	O K
480 min Summer	138.186	0.886	27.1	1885.2	O K
600 min Summer	138.226	0.926	27.6	1980.6	O K
720 min Summer	138.257	0.957	28.1	2055.0	O K
960 min Summer	138.295	0.995	28.6	2144.9	O K
1440 min Summer	138.296	0.996	28.6	2146.5	O K
2160 min Summer	138.271	0.971	28.3	2087.0	O K
2880 min Summer	138.234	0.934	27.7	1998.8	O K
4320 min Summer	138.151	0.851	26.5	1803.2	O K
5760 min Summer	138.074	0.774	25.4	1625.8	O K
7200 min Summer	138.005	0.705	24.3	1470.1	O K
8640 min Summer	137.946	0.646	23.3	1336.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	104.459	0.0	736.6	232
30 min Summer	72.785	0.0	1029.3	290
60 min Summer	48.563	0.0	1373.4	356
120 min Summer	31.244	0.0	1769.1	434
180 min Summer	23.704	0.0	2010.5	488
240 min Summer	19.310	0.0	2186.4	534
360 min Summer	14.481	0.0	2459.5	616
480 min Summer	11.782	0.0	2664.4	692
600 min Summer	10.029	0.0	2838.0	766
720 min Summer	8.785	0.0	2983.0	838
960 min Summer	7.120	0.0	3153.4	990
1440 min Summer	5.281	0.0	3309.2	1234
2160 min Summer	3.905	0.0	3978.8	1576
2880 min Summer	3.146	0.0	4272.3	1940
4320 min Summer	2.318	0.0	4724.3	2700
5760 min Summer	1.869	0.0	5078.1	3472
7200 min Summer	1.582	0.0	5373.8	4240
8640 min Summer	1.381	0.0	5630.5	4984

Cascade Summary of Results for POND 4 AMEND ORIFICE 116.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	137.893	0.593	22.4	1219.8	O K
15 min Winter	137.609	0.309	16.6	613.9	O K
30 min Winter	137.724	0.424	19.2	854.7	O K
60 min Winter	137.856	0.556	21.7	1137.7	O K
120 min Winter	137.998	0.698	24.2	1453.4	O K
180 min Winter	138.082	0.782	25.5	1643.4	O K
240 min Winter	138.139	0.839	26.4	1775.8	O K
360 min Winter	138.224	0.924	27.6	1974.7	O K
480 min Winter	138.284	0.984	28.5	2119.7	O K
600 min Winter	138.329	1.029	29.1	2227.6	O K
720 min Winter	138.363	1.063	29.5	2309.8	Flood Risk
960 min Winter	138.411	1.111	30.2	2428.8	Flood Risk
1440 min Winter	138.419	1.119	30.3	2446.3	Flood Risk
2160 min Winter	138.377	1.077	29.7	2344.3	Flood Risk
2880 min Winter	138.315	1.015	28.9	2192.6	O K
4320 min Winter	138.186	0.886	27.1	1884.8	O K
5760 min Winter	138.073	0.773	25.4	1623.7	O K
7200 min Winter	137.978	0.678	23.8	1407.2	O K
8640 min Winter	137.897	0.597	22.5	1228.4	O K
10080 min Winter	137.829	0.529	21.2	1079.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.232	0.0	5858.8	5736
15 min Winter	104.459	0.0	827.5	250
30 min Winter	72.785	0.0	1132.1	312
60 min Winter	48.563	0.0	1540.4	384
120 min Winter	31.244	0.0	1980.4	466
180 min Winter	23.704	0.0	2251.4	524
240 min Winter	19.310	0.0	2446.7	570
360 min Winter	14.481	0.0	2751.9	652
480 min Winter	11.782	0.0	2990.1	728
600 min Winter	10.029	0.0	3160.5	802
720 min Winter	8.785	0.0	3278.7	872
960 min Winter	7.120	0.0	3442.5	1016
1440 min Winter	5.281	0.0	3587.7	1290
2160 min Winter	3.905	0.0	4457.1	1648
2880 min Winter	3.146	0.0	4786.7	2056
4320 min Winter	2.318	0.0	5291.5	2868
5760 min Winter	1.869	0.0	5688.3	3672
7200 min Winter	1.582	0.0	6020.1	4456
8640 min Winter	1.381	0.0	6306.8	5216
10080 min Winter	1.232	0.0	6562.1	5968

Cascade Rainfall Details for POND 4 AMEND ORIFICE 116.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.284	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.000

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

Cascade Model Details for POND 4 AMEND ORIFICE 116.srcx

Storage is Online Cover Level (m) 138.650

Tank or Pond Structure

Invert Level (m) 137.300

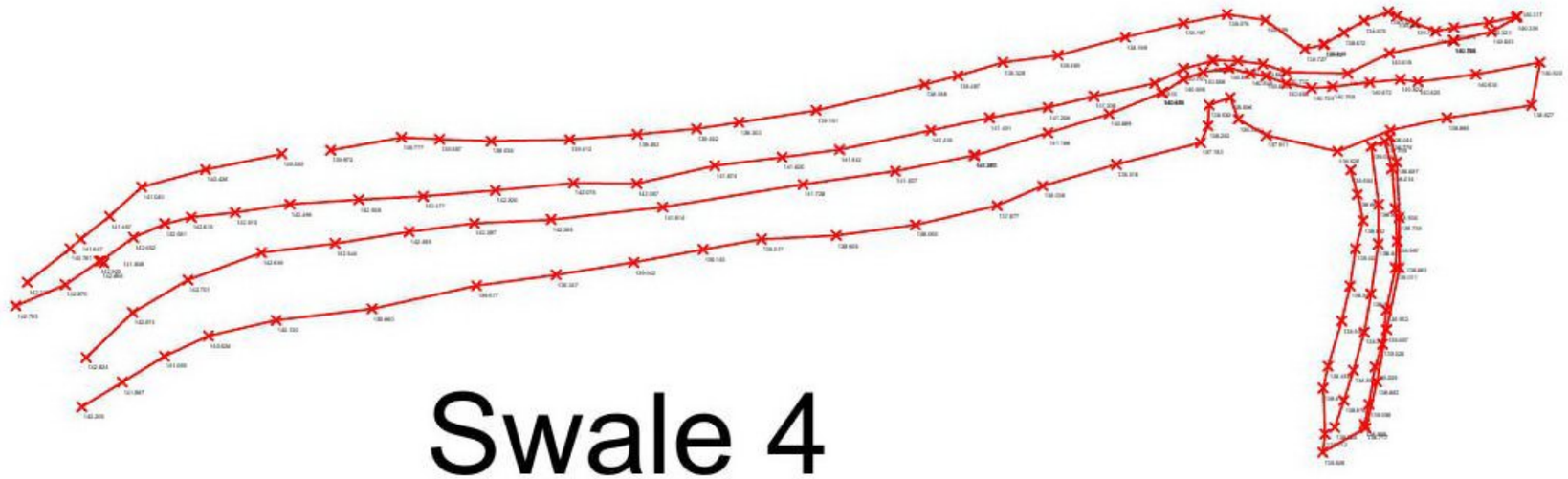
Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1915.0	0.700	2254.6	1.400	2622.0	2.100	3017.0
0.100	1961.8	0.800	2305.4	1.500	2676.7	2.200	3075.7
0.200	2009.2	0.900	2356.7	1.600	2732.0	2.300	3135.0
0.300	2057.2	1.000	2408.7	1.700	2787.9	2.400	3194.8
0.400	2105.7	1.100	2461.1	1.800	2844.3	2.500	3255.2
0.500	2154.8	1.200	2514.2	1.900	2901.3		
0.600	2204.4	1.300	2567.8	2.000	2958.9		

Orifice Outflow Control

Diameter (m) 0.116 Discharge Coefficient 0.600 Invert Level (m) 137.200

Appendix D – Basin/ Swale 4 Revised Survey (2 Pages)

N



Swale 4

Scale

10m 50m

Notes

All Levels and Measurments are in Metres

Any measurements are to be checked on site prior to Construction

Surveyor

NR Ses Ltd
34 Clifton Terrace
Hayle
Cornwall
TR27 4 BP

Client Project Name and Address

PDR Construction
HIEX
Roche
Cornwall

Drawing Title

Swales 3 and 4 As Built Survey

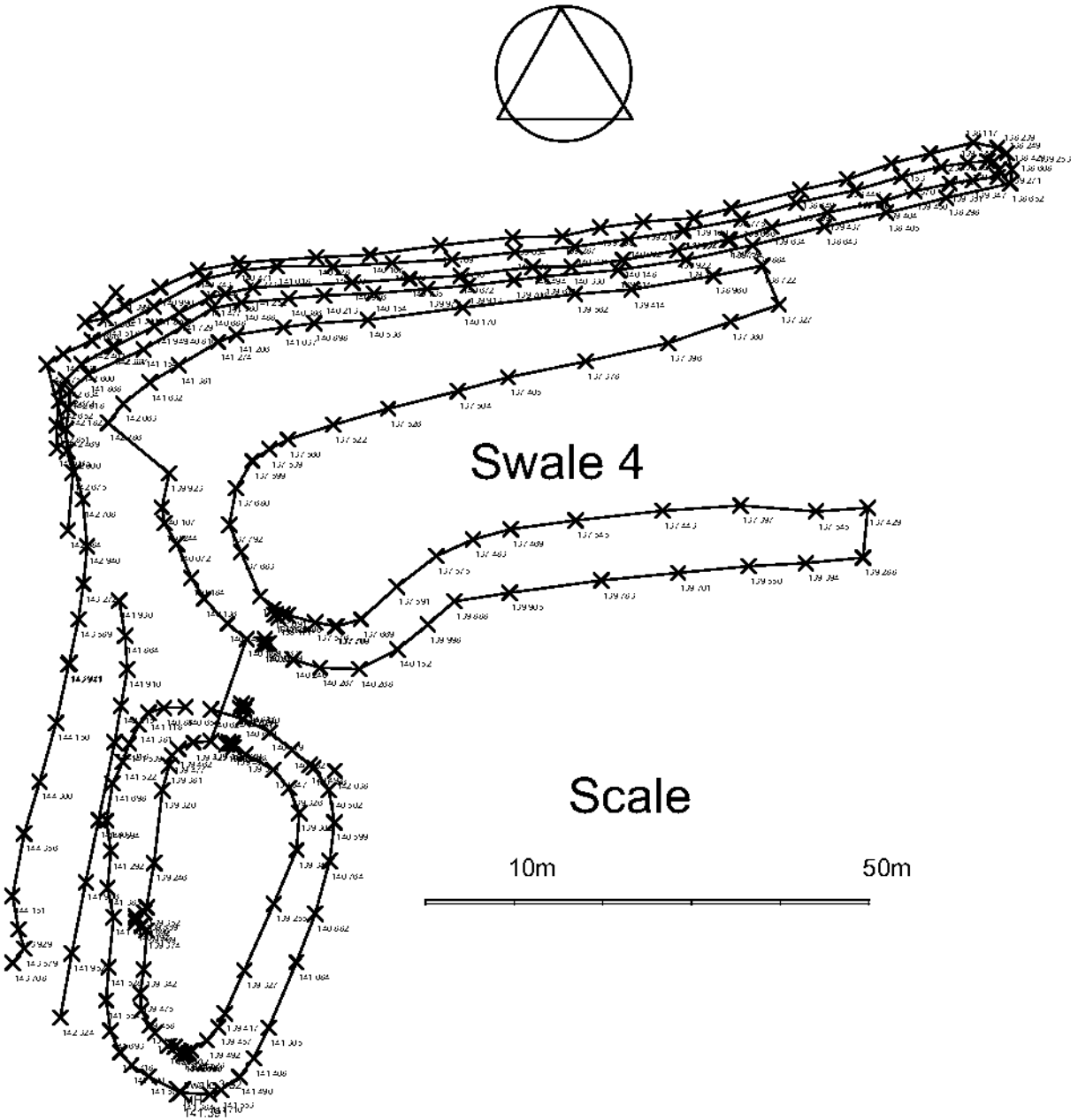
Date

1st May 2019

Scale

As Shown

N



Scale

10m 50m

Notes

All dimensions are in metres. Do not scale from this drawing.

All levels are to Ordnance Datum.

Any discrepancies are to be reported to the Engineer before work commences.

NR Ses Ltd
34 Clifton Terrace
Hayle
Cornwall
TR27 4BP

PDR Construction
HEX
Roche
Cornwall

Swales 3 and 4 As Built Survey

1st May 2019

As Shown

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