Drainage Strategy Report (DSR) For:

Proposed new commercial unit at Mardon Park, Baglan, Neath Port Talbot, SA12 7AX.

Prepared for:

GBV Properties Ltd

REF: 11250-DSR - 1

DATE: 19/02/2021

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Purpose of the Report

The purpose of the report is to describe the proposed strategies for the discharge of surface water emanating from the development proposals; in support of a full SuDS Approval Body (SAB) application for Neath Port Talbot Council. The SAB consent legislation came into effect on 7th January 2019, when the Welsh Government introduced Schedule 3 of the Flood and Water Management Act 2010.

1 INTRODUCTION

1.1 Site Location

Vale Consultancy has been instructed by GBV Properties (*The Client)* to undertake a DSR for the proposed new commercial unit at Mardon Park, Baglan, Neath Port Talbot, SA12 7AX (***273919E, 192653N***). The proposal is for development of a new commercial / industrial unit with a building footprint of approximately **2240m²** on reclaimed land which is considered to be ***brownfield.*** The extent of the site curtilage is approximately **6000m²** or **0.6ha**.

The site is located at Mardon Park; eastwards of Baglan Town. Notable features in the vicinity include the M4 (approx. 400m east), The River Neath (approx. 900m north west) and Baglan power station (approx. 500m west). The site is bounded by Mardon Park Rd to the north, an industrial unit to the east, Rd No 3 to the south and an unnamed road to the west. Access to the site is provided from Central Avenue and Mardon Park Rd. **Refer to the Site Location Plan in Appendix A**.

Historically, much of the land use surrounding the site (predominantly westwards) was occupied, and served the BP Petrochemical Plant at Baglan Bay. However, the site is currently disused land comprising Landscaped Ground and overgrown vegetation.

The following drainage strategy will cover the hydraulic design criteria of the surface water drainage network only.

Figure 1: Site Location Satellite Plan

1.2 Proposed Development

The proposal is for the development of a new commercial unit with associated parking and service yard within the 0.6ha curtilage of the site.

The proposed unit has a building footprint of approximately 2240m². The proposed development has a total impermeable area of 4740m² or 78% of the total site area. The remaining 1275m² (22%) of the site will be permeable comprising SuDS features including bioretention swales and permeable (*CellWebb*) parking spaces. These measurements have been taken from the DWG file provided by the client.

Refer to the Proposed Development Plan in Appendix B.

1.3 Existing Topography

The local topography is relatively flat and there is only a fall of approximately 1m across the whole site. A topographical survey of the site has been undertaken and is included in Appendix C. Reference to the topographical survey indicates a maximum level of 8.20m AOD and a minimum level of 7.07m AOD. The wider topography generally slopes from east to west – towards the sea at Baglan Bay.

Topographic levels to metres Above Ordnance Datum (m AOD) have been derived from a 1m resolution NRW composite 'Light Detecting and Ranging' (LiDAR) Digital Terrain Model (DTM). A review of LiDAR data corroborates the findings of the topographical survey. A LiDAR extract is included in Appendix C.

1.4 Existing Geology

Six trial pits were excavated (approx. 0.8m deep) around the site perimeter and soakaway tests were undertaken in accordance with BRE 365 specification in order to determine the suitability of infiltration. The trial pits revealed that the site is underlain by hardcore (engineered) topsoil generally to 0.2m and then sand to at least 0.8m. No groundwater was encountered.

Soakaway tests concluded that infiltration on site is a viable option due to the very high infiltration rates observed. The infiltration rates observed are summarised in Table 1 below.

Table 1 – Summary of Infiltration Rates

Trial Pit	Infiltration Rate	Average Infiltration Rate	Lowest Coefficient Observed (m/s)	Lowest Coefficient Observed (m/hr)	Factored Infiltration Rate (m/h)
1	2.78×10^{-4}	3.14×10^{-4}	2.78×10^{-4}	1	0.667
2	2.78×10^{-4}				
3	3.33×10^{-4}				
4	3.33×10^{-4}				
5	3.33×10^{-4}				
6	3.33×10^{-4}				

Taking a precautionary approach, the *lowest* infiltration rate has been used for design purposes.

Refer to Appendix D – Soakaway Test Report.

The trial pits indicate that the underlying substrate comprises of hardcore topsoil and sand.

Upon reviewing the British Geological Survey (BGS) records, superficial deposits are identified as Blown Sand at the site. Bedrock is listed as South Wales Middle Coal Measures Formation comprising mudstone, siltstone and sandstone. BGS records also identify extensive Landscaped Ground of variable composition across the site. Landscaped Ground is defined as an area where the land surface (neutral or artificial) has been extensively remodelled, but where it is impracticable or impossible to delineate separate zones of made ground, worked ground, or disturbed ground.

The Cranfield University 'Soilscapes' map (accessed August 2020) indicates that the site is underlain by freely draining sandy soils at the location of the site.

1.5 Flood Risk

The Natural Resources Wales (NRW) Flood Risk Map confirms that the site is located outside of the extreme flood extent (Flood Zone 1), meaning it has a less than 0.1% annual probability of flooding from Rivers and Sea.

The NRW Flood Risk Map confirms that the site is not at risk of flooding from Surface Water and Small Watercourses.

The Welsh Government Development Advice Map indicates the site to be in Zone A – an area considered to be at little or no risk of fluvial or coastal / tidal flooding.

Refer to NRW Flood Maps, Appendix E.

There are no other sources of flood risk, therefore the flood risk to the site is considered to be very low.

2 DRAINAGE SYSTEMS ASSESSMENT

2.1 Existing Drainage Systems

A site investigation was undertaken by Vale Consultancy on the 5th of August 2020 which incorporated the soakaway tests.

It is assumed that the site is not currently served by any formal drainage as none was observed and the land is currently disused.

No Dwr Cymru Welsh Water (DCWW) asset plans have been acquired for the site and the surrounding area.

Although the site is currently disused vacant land, and considered to be 100% permeable; it is classified as a ***brownfield*** or ***previously developed*** site. It is assumed that surface water infiltrates into the highly permeable underlying ground, unfettered.

There are currently ditches located along some extents of the site perimeter; most notably along the entire extent of the western and northern site boundaries. It is likely that these ditches informally provide surface water drainage to the site and help to convey surface water runoff around and off of the site via infiltration.

There are no other surface water features within the close vicinity of the site. Baglan Brook is located approximately 530m north of the site and discharges into the River Neath further downstream (north) at approximately 273210E, 193274N.

2.2 Legislation

The Flood and Water Management Act 2010 (Schedule 3), requires new developments to include SuDS features that comply with national standards. The Welsh Governments published statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (2018), which became mandatory as of 7th January 2019, and determines the most effective way of embedding SuDS principles in new developments. The statutory national standards are accepted by local authorities that they have taken account of the Welsh Government planning advice on Development and Flood Risk, and the impact of surface water runoff from the development, which is based on limiting the peak runoff rate and runoff volume for extreme events for the 1 in 100-year return period *plus* climate change. In aiming to replicate 'greenfield' runoff rates for extreme events, this will help to ensure that flood risk is not increased by the development proposals.

This surface water drainage strategy will comply with the Statutory National Standards for Sustainable Drainage Systems (SuDS) for Wales including the Standard Principles and itemised ***Standards 1 to 6*** as outlined in sections ***3.1.1 – 3.1.6***.

In accordance with best practice and the Welsh Government Publication titled: "Statutory standards for sustainable drainage (SuDS) in Wales – designing, constructing, operating and maintaining surface water drainage" systems: G2:23 and G2:24. Runoff rate for previously developed sites should replicate the predeveloped site (greenfield) or at least a 30% betterment should be considered as an absolute minimum from the runoff rate from the previously developed site contributing catchment area).

3 PROPOSED SURFACE WATER DRAINAGE SYSTEMS

As already mentioned, the proposal is to develop a commercial unit on the currently disused *brownfield* site. The proposed development will increase the impermeable area of the site by approximately **78%**. For the purposes of the surface water drainage strategy design the site is considered to be ***brownfield*** or ***previously developed***.

The drainage strategy only covers the hydraulic design criteria of the surface water drainage network.

The proposed SuDS drainage solution is designed to mimic the characteristics of the sites current arrangement as much as possible. The proposal includes vegetated conveyance (dry) swales to be constructed along the perimeters of the site boundary; thus utilising the existing ditches and excellent percolation conditions provided by the underlying substrate.

The swales will comprise of shallow depressions in the ground which will be interconnected via underdrains and vegetated with a variety of plants, shrubs and grass. The dry bioretention swales will be interconnected with drainage pipes (underdrains) to maximise the efficiency and capacity of the system, and also to minimise the chances of the system surcharging. Anecdotal evidence indicates that many developments in this area have adopted a similar approach and design to the drainage and management of surface water, with success.

For the purposes of this report these SuDS features are referred to as *Bioretention Swales 1 – 5*.

The SuDS drainage solution also proposes to incorporate ***CellWeb*** to cover some of the proposed parking bays within the eastern extent of the site and to be infilled with granular stone / gravel and thus providing a permeable SuDS solution. This porous surface also provides a water quality treatment function. Although these SuDS features have capacity to provide attenuation storage; this is not required as the bioretention swales provide sufficient storage for the whole site (1 in 100-year event plus 40% CC event).

Refer to Drawing 11250_500_01 in Appendix G for the proposed surface water drainage layout illustrating how surface water is collected and conveyed towards their discharge location.

The Bioretention Swales will be interconnected via perforated drainage pipes to enable conveyance of surface water from one to another and thus reducing the risk of the system surcharging.

From here, flows will percolate into the highly permeable underlying substrate via infiltration, as per the existing scenario. Although the existing site is considered to be ***brownfield***, it is considered to be 100% permeable and thus replicates the pre-existing or historical greenfield conditions.

The proposed contributing impermeable areas and the SuDS features serving surface water drainage for them are summarised below in Table 2.

Refer to the Contributing (catchment) Areas Plan, Appendix G.

Table 2 – Summary of Contributing Areas

Contributing Impermeable Area (m^2)	SuDS Feature	Base Area of SuDS Feature (m^2)	Depth of SuDS Feature Required (m)
1500	*Bioretention Swale 1*	334	0.1
1200	*Bioretention Swale 2*	156	0.3
710	*Bioretention Swale 3*	106	0.25
770	*Bioretention Swale 4*	90	0.35
560	*Bioretention Swale 5*	160	0.1

Appendix G also includes a construction details drawing, flow exceedance plan and contributing areas plan.

Proposed / Considered SuDS:

Swales

Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. When incorporated into site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits.

A dry swale is a vegetated conveyance channel, designed to include a filter bed of prepared soil that overlays an underdrain system. This underdrain provides additional treatment and conveyance capacity beneath the base of the swale, and prevents waterlogging.

The enhanced drainage beneath the swale can provide increased flow and storage capacity, extra interception performance, a reduced risk of localised ponding and marshy areas developing where gradients are flat, and improved conditions for infiltration (where ground conditions allow). The underdrain allows multiple swales to be connected.

Dry swales can be vegetated with a variety of plants, flowers and grasses to provide amenity spaces.

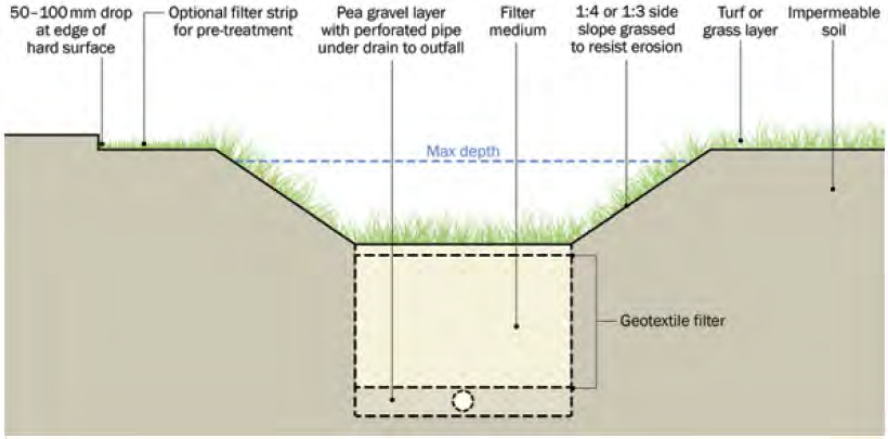


Figure 2 – CIRIA C753 Figure 17.2 – Typical dry swale

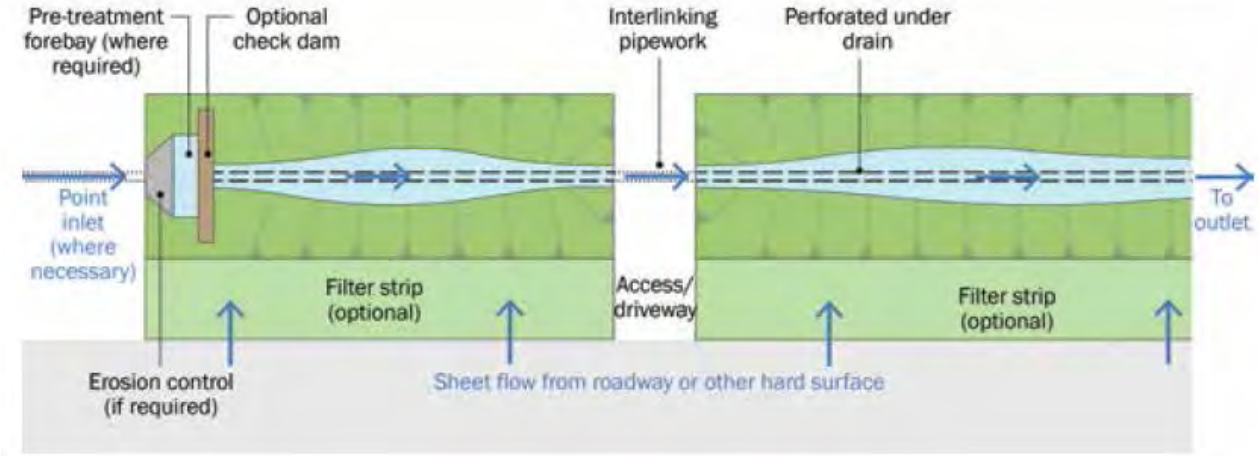


Figure 3 – CIRIA C753 Figure 17.5 – Typical plan view of a swale

Incorporated into design

Trees

Trees can be planted within a range of infiltration SuDS components (e.g. bioretention systems, detention basins, swales) to improve their performance, or they can be used as standalone features within soil-filled tree pits, tree planters or structural soils.

Tree pits and planters can be designed to collect and attenuate runoff by providing additional storage within the underlying structure. The soils around trees can also be used to filter out pollutants from runoff directly. This chapter is concerned specifically with the use of trees in planting beds, pits, structural soils below pavements and similar structures as part of the surface water management system.

Discounted – Due to potential for sufficient and alternative SuDS components and also spatial constraints

Soakaways

Soakaways are excavations that are filled with a void – forming material that allows the temporary storage of water before it soaks into the ground. Historically, small soakaways draining runoff from a single property were either filled with rubble or lined with brickwork and were sited below gardens and drives with no formal provision for access and inspection. Many small soakaways are now constructed with geocellular units available from builders' merchants pre-wrapped in geotextile. The geocellular units provide good overall storage capacity compared to rubble fill, and they allow the size of the structure required for any application to be minimised.

Discounted – Due to potential for sufficient bioretention areas

Porous asphalt

Porous asphalt can be used as an independent surface or to provide a stronger base to concrete block permeable pavements where it is to be trafficked frequently by trucks. Porous asphalt surfacing reduces traffic noise. Figure 3 overleaf reflects a system where all the rainfall passes into the substructure (where it may be stored temporarily) from where it infiltrates into the soil beneath. Normally, there will be no discharge from the system to a sewer or watercourse. Although porous asphalt will not be used in this case, *CellWeb* will be used for some of the parking spaces in the eastern site extent; to be infilled with granular stone / gravel thus providing a permeable SuDS solution.

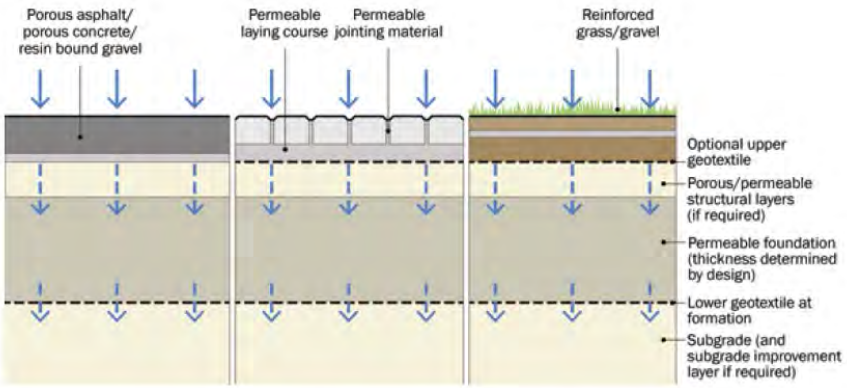


Figure 4 – CIRIA C753 Figure 20.12 – Pervious pavement system types: Type A – total infiltration

Incorporated into design

Water Butts

Within the site curtilage the simple water conservation / rainwater harvesting technique could be provided by off the shelf water butts which will collect some of the roof water runoff from the unit (min size 0.5m³), and when full the overflow arrangement will convey excess water away from the building and over the planted basins.

Scope to be included yet not essential

3.1.1 S1: SuDS hierarchy of surface water discharge locations

The following receptors have been considered for surface water runoff on site, in order of SuDS preference. The aim of SuDS Standards is to ensure that the most effective drainage scheme is delivered with the most preferred levels of surface water destination, where the design can move to the next means of discharge only under exception criteria.

1. Surface Water collection for reuse.
2. Discharge by infiltration into ground
3. Discharge into open surface water body
4. Discharge into surface water sewer, highway drain, or other drainage system
5. Discharge into combined sewer.

Priority Level 1 - Surface water collected for reuse:

Rainwater harvesting has not been used as there is no foreseeable demand for non-potable water within the development proposals. There is no foreseeable need to harvest water as DCWW has not identified any potential stresses on the mains water supply. The use of rainwater harvesting is not a cost-effective / viable option for managing surface water runoff in comparison to the water supply benefit for this development.

No solution, move to next Priority Level

Priority Level 2 – Discharge via infiltration:

Soakaway tests were undertaken in six trial pits around the perimeter of the site. The trial pit excavations confirmed that the underlying soils comprised of hardcore (engineered) topsoil and then sand.

The soakaway tests were undertaken in accordance with BRE 365. Infiltration on site has been found to be a viable option due to the very high infiltration rates observed. After a 10 minute period trial pits 1-6 had completely drained during each test.

Refer to **Table 2** – Summary of infiltration rates and the **Soakaway Test Report** in **Appendix D.**

Priority Level 2 solution, priority levels 3-5 are less desirable so are therefore not explored or required.

3.1.2 S2: Surface Water Runoff Hydraulic Control

The proposed SuDS drainage system will maintain the characteristics of the sites current surface water drainage arrangement as much as possible which reflects the original sites greenfield conditions.

The proposed SuDS drainage system has been designed to accommodate the 1 in 100 year event plus 40% CC.

Urban creep has not been incorporated into hydraulic design calculations as the proposed development has been maximised within the site curtilage.

Interception

Conveyance swales and dry vegetated swales deliver Interception because there is usually no runoff from them for the majority of small rainfall events. The water soaks into the surface vegetated soil layers and into the underlying soils or other media, and is removed by evapotranspiration and infiltration. The extent of the volumetric reduction in runoff will depend on the infiltration rate of the surrounding soil, the capacity of any underlying filter media, the catchment area, the area of the swale, the type of vegetation and the climate.

The proposed surface water drainage system will deliver Interception via two key processes;

- Infiltration
- Evapotranspiration using temporary shallow ponding or storage within the soil or upper aggregate layers.

Where SuDS are designed to infiltrate more than 5mm from the contributing catchment for all events, then Interception will be effectively delivered.

A review of Table 24.6 of CIRIA C753 The SuDS Manual confirms that swales and permeable pavements are considered a viable interception method that can be assumed to be compliant for zero runoff for the first 5mm rainfall for 80% of events during the summer and 50% in winter.

For instance; *Any filter strip / swale that is unlined, has a gradient less than 1 in 100 and has an infiltration capability greater than 1 x 10^{-6} m/s can be assumed to comply with Interception for a contributing area up to 25 times the area, or a larger area where infiltration capacities and design characteristics allow.*

And;

All permeable pavements, whether lined or not, can be assumed to comply, provided there is no extra area drained to the permeable pavement.

And;

Where the infiltration capacity of the ground below the pavement is greater than 1 x 10^{-6} m/s, up to 5 times the permeable pavement area can be added as extra contributing area.

Flows

As already mentioned, the site is considered as ***brownfield*** or ***previously developed*** land despite it's currently prevailing disused state.

Swales can help reduce flow rates from a site by facilitating infiltration and / or by providing attenuation storage.

The proposed SuDS drainage system is designed to revert back to the pre-developed or greenfield characteristics of the sites surface water drainage arrangement whilst also reducing the rate and volume of surface water runoff with the incorporation of SuDS features including swales and permeable granular stone parking spaces.

Attenuation Storage

The surface water drainage system is designed for the 1 in 100 year plus 40% climate change (CC) event. Reference to the hydraulic design calculations included in **Appendix F** illustrate that the design is sufficient for the design event (1 in 100 year plus 40% CC).

The *Bioretention Swales* will provide surface water attenuation storage for the 1 in 100-year event plus 40% CC. They are linked via perforated underdrains to reduce the risk of the system surcharging i.e. due to blockages.

Reference to the hydraulic calculations indicate that the swales will comfortably accommodate the design event and need only have a depth of between 100 – 350mm. Refer to **Table 2** and the **Hydraulic Design Calculations** which show the depths to accommodate the ***hmax*** (maximum depth of water) values for the critical storm durations. The depth (depression) of 100 – 350mm also helps facilitate populate the swales with plants and vegetation.

Exceedance Event

As already mentioned, the surface water drainage system has been designed for the 1 in 100 year plus 40% CC event. In the highly unlikely event of the system surcharging or becoming over-capacitated during storm events in excess of the design storm event; provision has been made for 'controlled' and shallow surface water flooding around the site. Refer to the **Flow Exceedance Plan** in **Appendix G**.

Hydraulic Control

The permeable granular stone parking surface occupying some of the parking spaces has been calculated and designed using CIRIA C753 Equation 25.1 and 25.2 which analyses the maximum water height to be expected for a plane infiltration system. An additional factor of safety of 3 has been incorporated into the calculations. The hydraulic design calculations indicate that the system can sufficiently accommodate the 1 in 100 -year event plus 40% CC. Where the ***hmax*** values are negative; this is due to the infiltration rate being greater than the inflow rate into the system.

The dry swales have been calculated and designed using CIRIA C753 Equation 25.4 which determines the maximum depth of water for 3D infiltration systems.

The site is not currently served by any formal surface water drainage system. The proposed SuDS system will therefore provide betterment over the current unfettered arrangement. **Refer to Hydraulic Design Calculations, Appendix F**.

3.1.3 S3: Water Quality

The existing sites drainage system did not provide any water quality improvement. For 'commercial yard / delivery areas' and 'other roof' areas pollutant levels are expected to be medium and low as illustrated in **Table 3** below (overleaf). These indices are in accordance with the CIRIA C753 publication 'The SuDS Manual' (2015).

Table 3 – Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Other roofs (typically commercial/industrial roofs)	Low	0.5	0.4	0.4

From a review of Table 4 below, it can be concluded that the inclusion of the relevant SuDS features will provide sufficient treatment.

Table 4 – SuDS Mitigation Indices

	Mitigation Indices		
Type of SuDS	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Infilled CellWeb	0.7	0.6	0.7
Swale	0.5	0.6	0.6
Bioretention Swales	0.8	0.8	0.8

The proposed design will ensure that surface water runoff will pass through planted bioretention swales and / or permeable granular filled parking spaces. These SuDS components will separate the smaller particles and chemicals from the surface water discharge as it filters through.

Planted dry swales can provide effective water treatment such as the removal of fine sediments and associated pollutants which are trapped within the surface vegetation and groundcover. As surface water passes through the filter medium beneath further removal of fine particles and contaminants takes place. A wide range of water quality improvements can be achieved by using vegetated surfaces as part of SuDS.

Grass is particularly effective at dealing with sediments and pollution where sheet flow is used, and planted components that dry out between each rainfall event are an efficient means of promoting bioremediation. Therefore, the extensive soft landscaped areas across the site provide additional water quality treatment.

As outlined by CIRIA C753 The SuDS Manual, Conveyance and dry swales provide the following treatment to surface water runoff:

- Coarse to medium sediments and associated pollutants (such as nutrients, free oils / grease and metals) can be removed by filtration through surface vegetation and groundcover.
- Fine particulates and associated contaminants can be removed by infiltration through the underlying soil and / or filter medium layers. This provides treatment by filtration, dissolved pollutant removal by sorption of pollutants to the filter medium, and some biological uptake by vegetation and subsoil biota.
- Organic contaminants can be removed through photolysis and volatilisation.

The proposed SuDS components will be sufficient in removing contaminants and pollutants for the proposed site and will only have a positive impact on the receiving water quality when compared to the existing scenario.

3.1.4 S4: Amenity

The use of planted swales will provide attractive, high quality landscaped strips that will be used to serve the site. The SuDS components will effectively drain surface water as close to the source as possible. The use of these SuDS components also provides significant aesthetic benefits that surround the perimeters of the site for visitors and occupants alike.

Bioretention areas can deliver water-efficient landscaping and are also potentially beneficial to the local microclimate by cooling air through evapotranspiration. They also provide an important water quality and cleansing function.

Exposure to green spaces and features can help to promote good mental health which is of particularly relevance in industrial / commercial settings. The permeable *CellWeb* surface occupying some of the parking spaces provides an important source of access, turning and parking for site occupants.

Surface water management systems that integrate surface water features can be more readily modified than underground systems, and therefore are more adaptable providing greater resilience to climate change. The scheme will be mostly above ground SuDS features. Benefits of blue / green features also include cooling the ambient air which reduces the urban heat island effect.

Within the site constraints the proposed solution looks to maximise amenity benefits.

3.1.5. S5: Biodiversity

The use of vegetated dry swales can help to provide a new quality habitat for wildlife, having a positive contribution to biodiversity in the area. The use of planting native species can support local biodiversity by providing habitat and food for invertebrates and birds. Furthermore, ephemeral water bodies can be a specific requirement for the life cycle of some plants and animals. The use of planting native species can support local biodiversity. Plant species should be selected to suit the existing landscape characteristics of the site and / or meet its visual and design intent.

Swales can include a variety of planting (including wildflower grass seed mixes in areas where the grass length is not required to be regularly maintained) that will help make a positive contribution to urban biodiversity – providing habitat and food for insects, invertebrates and birds.

Native plant species should normally be used in providing a dense and durable cover of vegetation that creates appropriate habitat for indigenous species. A planting schedule has been developed giving recommended plant species suitable to the environment which can be incorporated into the dry swales.

Refer to **Appendix H** – **Planting Schedule**.

3.1.6. S6: Operation and Maintenance Requirements

To ensure SuDS components continue to operate reliably, regular inspection and maintenance should be carried out. In most cases, appropriate information should be provided by the relevant manufacturer on what has been installed, how it works, when to inspect it and whether maintenance will be required. CIRIA C753 The SuDS Manual also provides information on the operation and maintenance requirements for various SuDS components.

Conventional surface water drainage features such as gullies, channels, silt traps and manholes should be inspected as an absolute minimum annually, and where practicable after intense storm events, with silt removal. Maintenance of the guttering and RWP's is key to sufficiently collecting the surface water.

The bioretention / swale areas will require regular maintenance to ensure continuing operation to design performance standards. Maintenance of swales is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a swale over and above what is necessary for standard public open space.

The major maintenance requirement for dry swales is mowing. Mowing should ideally retain grass lengths of 75 – 150mm across the main treatment surface, to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. However, longer vegetation lengths, where appropriate, are not considered to pose a significant risk to functionality.

The following (overleaf) **Figures 5 and 6** show CIRIA C753 The SuDS Manuals maintenance requirements for the SuDS components relevant to the proposals for this site. It is recommended that the persons responsible for the maintenance of the SuDS drainage systems follows the requirements below, unless specific maintenance information is provided by the manufacturer or installer during or after construction.

Furthermore, a standalone **Management and Maintenance Plan** with maintenance costs is included as **Appendix I**.

The maintenance contractor will be Greenwise Construction.

TABLE 17.1 Operation and maintenance requirements for swales

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Figure 5: CIRIA C753 Table 17.1 – Operation and maintenance requirements for swales

TABLE 20.15 Operation and maintenance requirements for pervious pavements

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

Figure 6: CIRIA C753 Table 20.15 – Operation and maintenance requirements for pervious pavements

4 CONCLUSIONS

The proposal is for the development of a new commercial unit with associated parking and service yard within the 0.6ha curtilage of the site.

The site is considered to be ***brownfield*** and is not currently served by any formal surface water drainage. Instead, surface water drainage and treatment is unfettered.

The proposed site surface water drainage design incorporates natural SuDS solutions comprising of vegetated dry conveyance swales (*Bioretention areas 1-5*) and some areas of ***CellWeb*** infilled with granular stone.

100% of the surface water run-off on-site will discharge back into the underlying substrate. This provides a betterment in comparison to the existing unfettered surface water discharge. The SuDS system has been designed based on the 1 in 100 year event + 40% climate change allowance.

The surface water drainage system will provide sufficient storage for the 1 in 100 year plus 40% climate change event. Attenuation will be provided by the dry conveyance swales. However, and as illustrated within the hydraulic design calculations, the surface water system has more than enough capacity for the design event and is not shown to 'fill' or surcharge.

The scheme seeks to be cost effective, easily maintainable, improve amenity and biodiversity where possible and improve surface water runoff from the area.

It is concluded that the drainage strategy as outlined by this DSR complies with the Statutory National Standards for Sustainable Drainage Systems (SuDS) for Wales including the Standard Principles and itemised ***Standards 1 to 6*** as required by the SuDS Scheme Application for SuDS Approving Body (SAB) Approval – Wales.

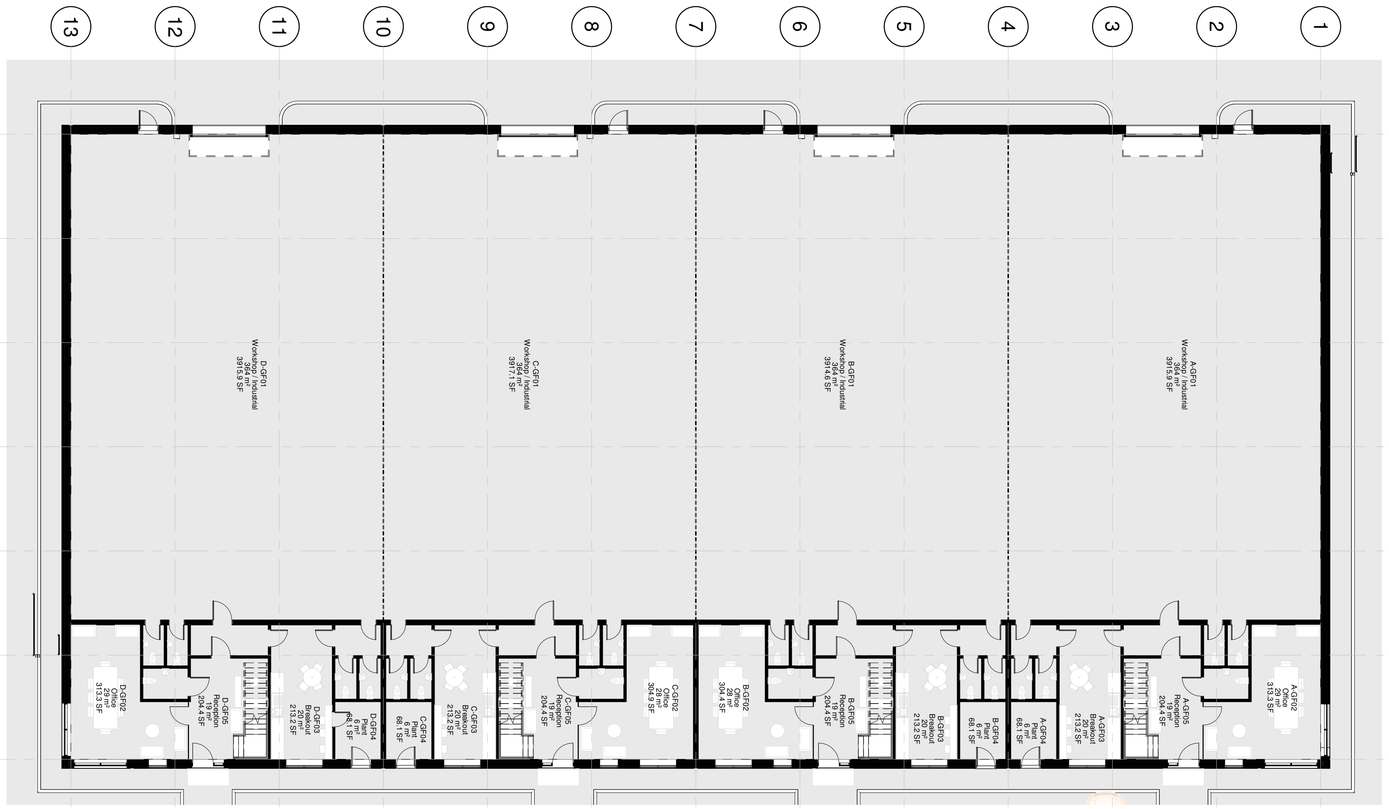
APPENDIX A: Site Location & Existing Site Plan

Existing Site Plan

APPENDIX B: Proposed Development Plans

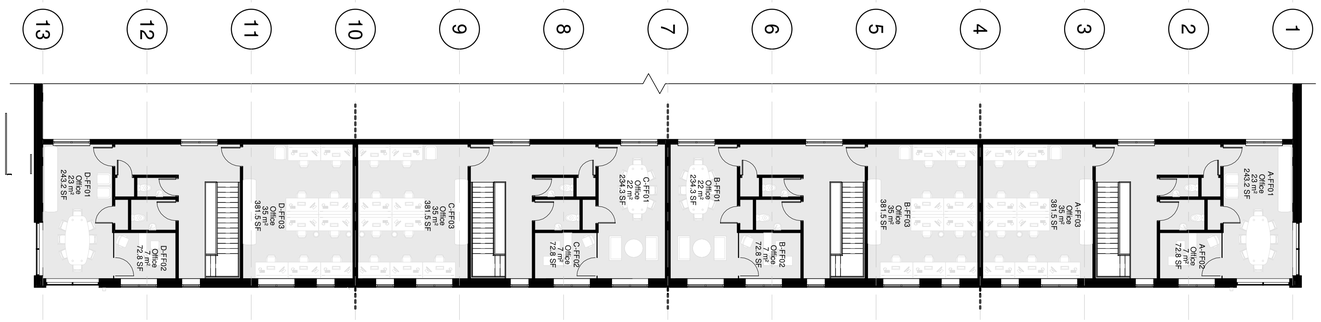
GROUND FLOOR LEVEL

1 : 150



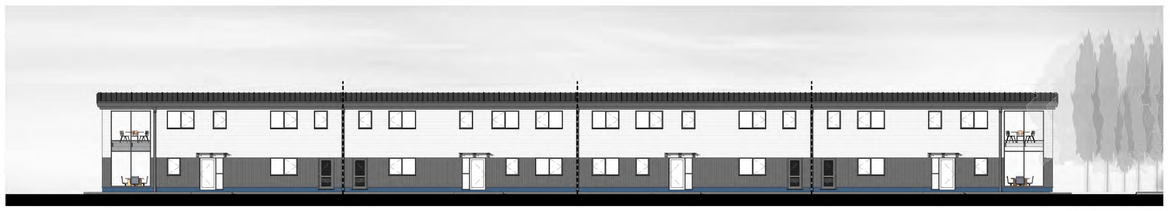
FIRST FLOOR LEVEL

1 : 150



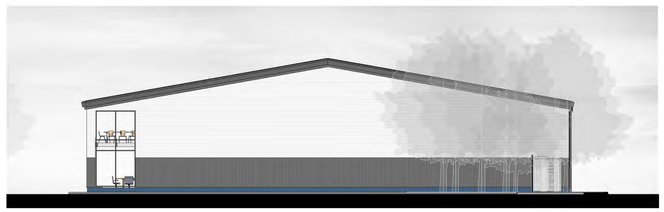
VIEW 1

VIEW 2



SOUTH EAST ELEVATION

1 : 200

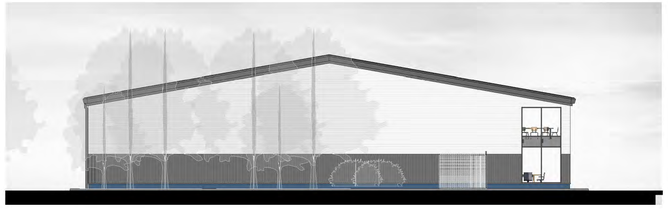


NORTH EAST ELEVATION

1 : 200

NORTH WEST ELEVATION

1 : 200



SOUTH WEST ELEVATION

1 : 200

Rev	Description	Date

STATUS | PURPOSE OF ISSUE

i.m. Design Studio
Chartered Institute of Architectural Technologists Registered Practice
27 Park Avenue,
Skewen, SA106RU

PROJECT

Mardon Park
Baglan Energy Park
South Wales

TITLE

UNIT A

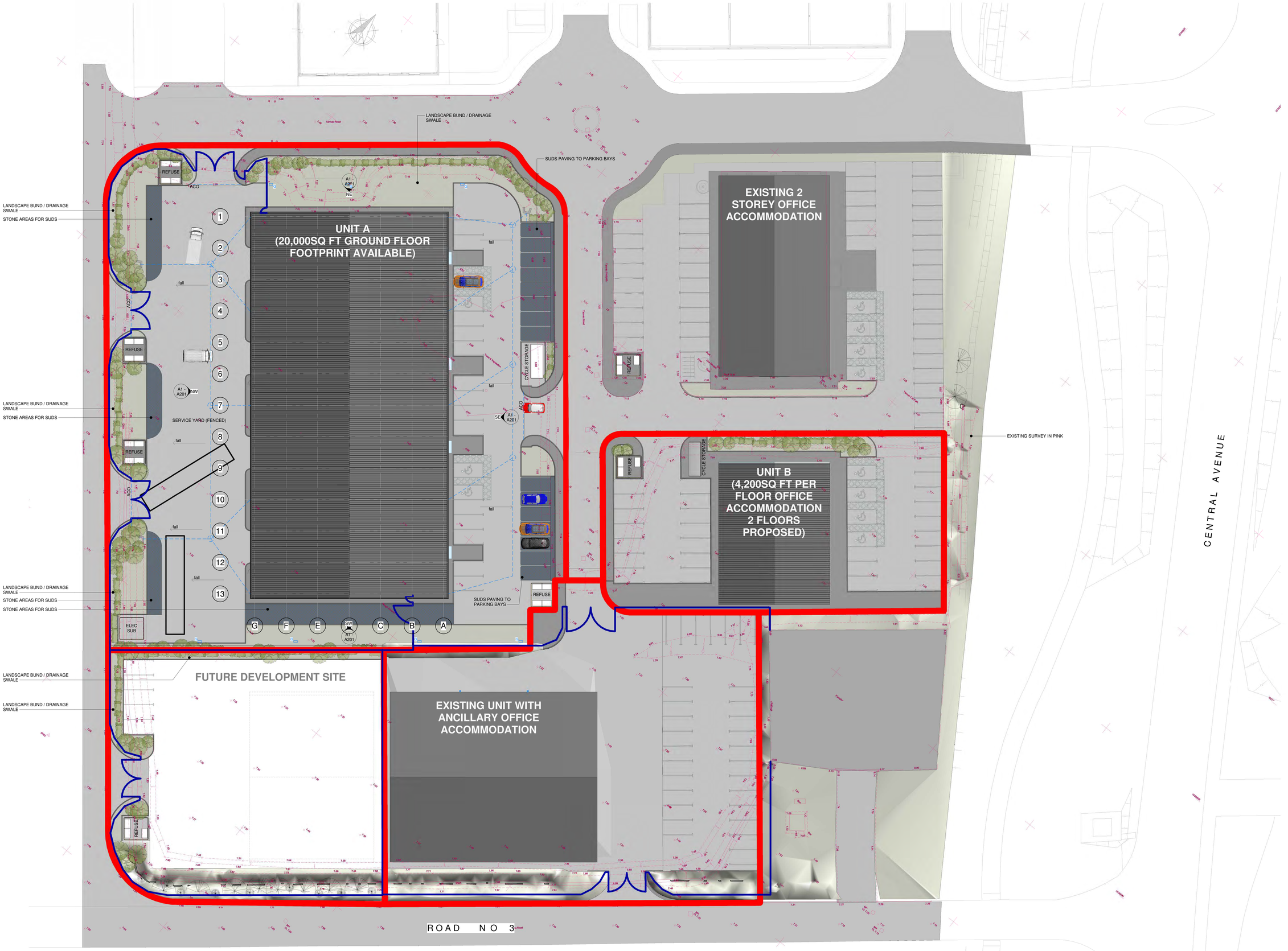
CLIENT

Greenwise Construction Ltd

DRAWN BY	CHECKED BY	DATE
JM	Checker	30/06/20

SCALE (@ A1)	PROJECT NUMBER
As indicated	Project Number

DRAWING NUMBER **A1 - A201** | REV



SITE MASTERPLAN (project orientation)
1 : 200

Rev	Description	Date
A	SW arrangement added	Oct 20
B	Landscaping extent altered and suds areas added	Jan 21

STATUS | PURPOSE OF ISSUE

i.m. Design Studio
Chartered Institute of Architectural Technologists: Registered Practice
27 Park Avenue,
Skewen, SA106RU

PROJECT
Mardon Park
Baglan Energy Park,
South Wales

TITLE
MASTERPLAN

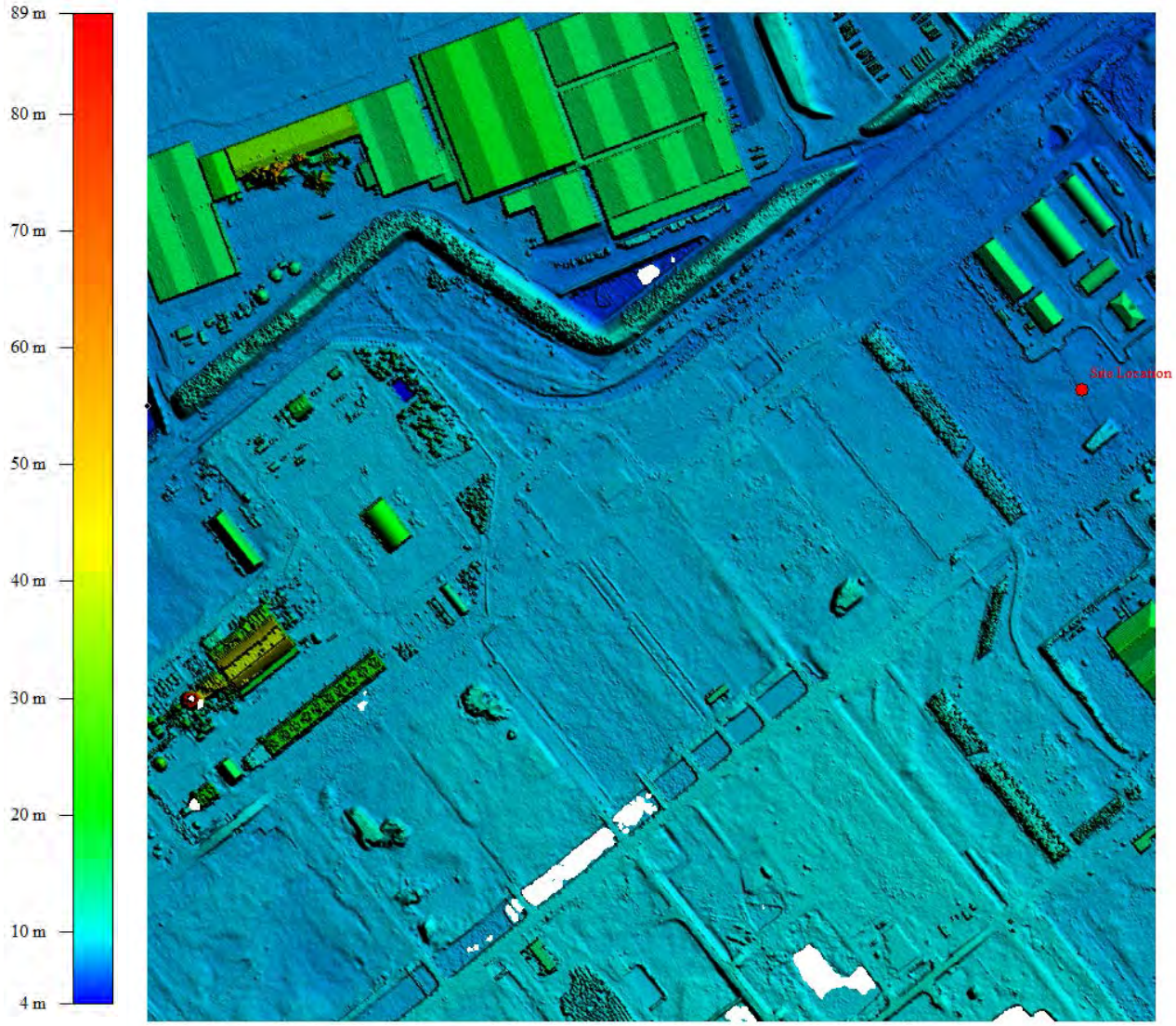
CLIENT
Greenwise Construction Ltd

DRAWN BY	CHECKED BY	DATE
JM		30/06/20

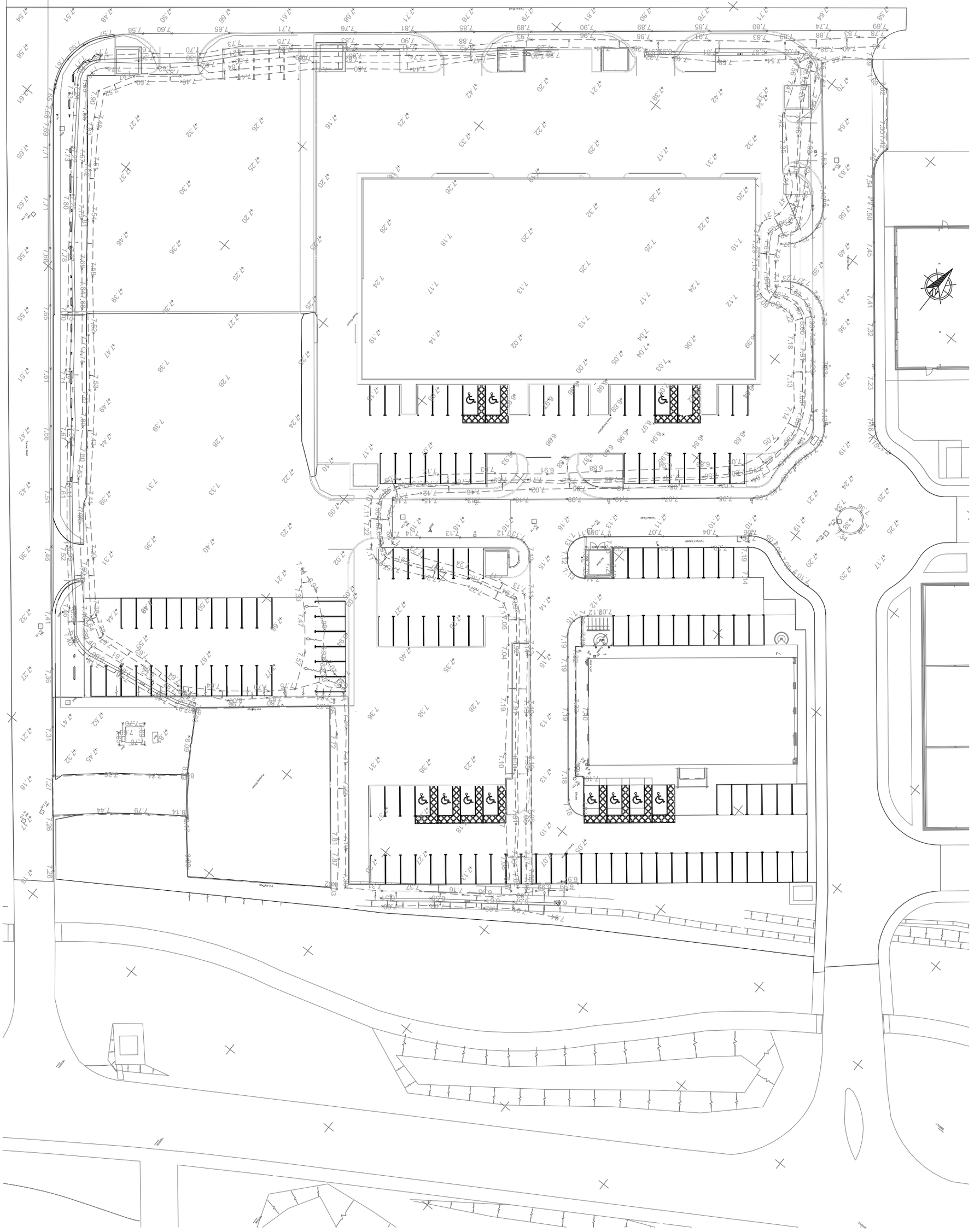
SCALE (@ A0)	PROJECT NUMBER
1 : 200	Project Number

DRAWING NUMBER	REV
A0 - A200	B

APPENDIX C: Site Topography



LiDAR Extract – Digital Terrain Model (DTM) to metres above ordnance datum (m AOD)



APPENDIX D: Soakaway Test Report

Infiltration Test For:

Mardon Park Phase 2, Baglan

SA12 7AX

Prepared for:

GreenWise Construction

REF: 11250 - 1

DATE: February 2021

Vale Consultancy

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Document Control

Project	**Mardon Park, Baglan**
Client	**GreenWise Construction**
Vale Consultancy Ref:	**11250 - 1**

Document Checking:

Prepared By:	**Richard Peskett**	**Signed:**	
Checked By:	**Leighton Roberts**	**Signed:**	
Verified By:	**Matt Jones**	**Signed:**	

Issue	Date	Status
01	February 2021	First issue
02		
03		

1 Contents

1 Introduction

1.1 Brief

Vale Consultancy has been instructed by GreenWise Construction (*The Client*) to undertake soil infiltration tests to the BRE 365 digest standard at the Mardon Park site at **273919E, 192653N**.

Six infiltration tests have been proposed around the site to determine the local geology and permeation rates on site. These tests will be approximately 0.5m^3 in size and tested a maximum of 3 times or as many as possible in the timeframe allowed.

Refer to **Appendix A** – Site Trial Pits.

1.2 Site Investigations

The site currently comprises undeveloped land immediately adjacent to Mardon Park, Baglan, SA12 7AX. The proposal is for development of a new commercial unit with a building footprint of approximately 2183m².

The six trial pits are located around the site perimeter as illustrated in **Appendix A**. The tests were performed on the 5th August 2020 by Vale Consultants. At the time of testing the weather was overcast and dry - no rain was present at any point from the beginning to the end of the testing process.

Refer to **Appendix C** – Site photographs.

2 Site findings

The following tests were performed to the BRE 365 Digest Standard and to the best of the ability of those involved, subject to site constraints and weather conditions.

2.1 Trial pit soil conditions

Six pits were dug to a depth of approximately 0.8m without issue and no groundwater was found in any of the pits. The trial pits revealed that the site is underlain by hardcore topsoil and sand. The findings encountered were logged at the following approximate depths:

Pit 1
Topsoil: *0 - 0.1m* - Topsoil
Superficial soils: *0.1 - 0.225m* - Hardcore
Superficial soils: *0.225m – 0.82m* - Sand
Bedrock: *Not encountered*

Pit 2
Topsoil: *0 - 0.1m* - Topsoil
Superficial soils: *0.1 - 0.25m* - Hardcore
Superficial soils: *0.25m – 0.69m* - Sand
Bedrock: *Not encountered*

Pit 3

Topsoil:	*0 - 0.1m*	- Topsoil
Superficial soils:	*0.1 - 0.25m*	- Hardcore
Superficial soils:	*0.25m – 0.87m*	- Sand
Bedrock:	*Not encountered*	

Pit 4

Topsoil:	*0 - 0.1m*	- Topsoil
Superficial soils:	*0.1 - 0.25m*	- Hardcore
Superficial soils:	*0.25m – 0.9m*	- Sand
Bedrock:	*Not encountered*	

Pit 5

Topsoil:	*0 - 0.1m*	- Topsoil
Superficial soils:	*0.1 - 0.25m*	- Hardcore
Superficial soils:	*0.25m – 0.84m*	- Sand
Bedrock:	*Not encountered*	

Pit 6

Topsoil:	*0 - 0.1m*	- Topsoil
Superficial soils:	*0.1 - 0.25m*	- Hardcore
Superficial soils:	*0.25m – 0.82m*	- Sand
Bedrock:	*Not encountered*	

Cranfield University Soilscapes online mapping indicates freely draining sandy soils at the location of the site.

Upon reviewing the British Geological Survey (BGS) records superficial deposits are identified as Blown Sand at the site. Bedrock is listed as South Wales Middle Coal Measures Formation comprising mudstone, siltstone and sandstone. BGS records also identify extensive Landscaped Ground of variable composition across the site. Landscaped Ground is an area where the land surface (natural or artificial) has been extensively remodelled, but where it is impracticable or impossible to delineate separate zones of made ground, worked ground, or disturbed ground.

2.2 Test results

The following tests were performed 3 times at the six trial pits which all drained in a very short period of time.

3.0 Conclusions

Infiltration on site has been found to be a viable option due to the very high infiltration rates observed. For every single test the trial pits had completely drained within 10 minutes. Refer to **Appendix B – Infiltration test results**.

APPENDIX A: Site Trial Pits

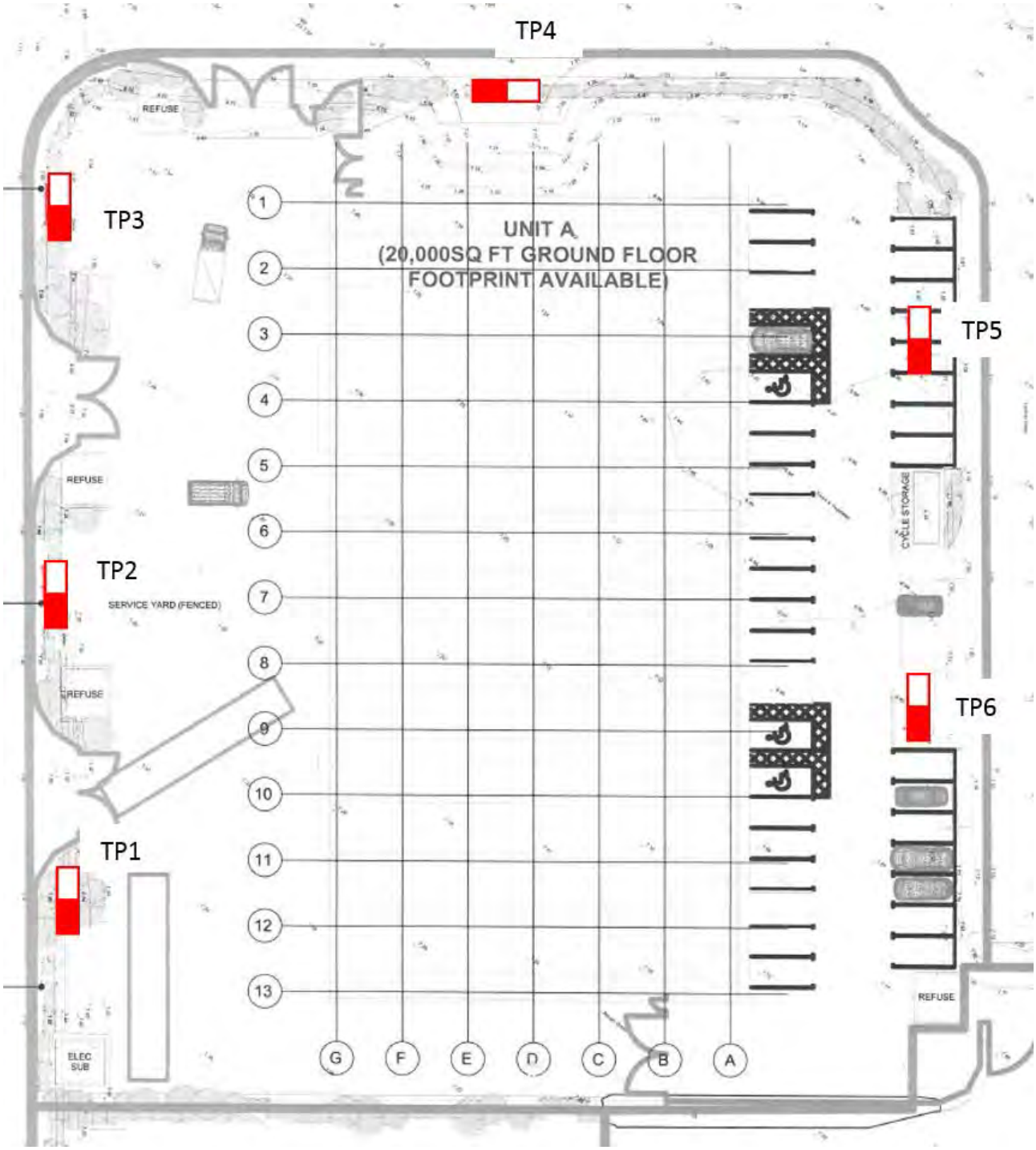

Figure 1 - Trial pit locations

Trial Pit	Latitude	Longitude
1	51.618128	-3.8225656
2	51.618327	-3.8228325
3	51.618500	-3.8230766
4	51.618691	-3.8227051
5	51.618788	-3.8222457
6	51.618573	-3.8219695

Figure 2 - GPS co-ordinates of trial pit locations

Trial Pit	Infiltration Rate
1	2.78×10^{-4}
2	2.78×10^{-4}
3	3.33×10^{-4}
4	3.33×10^{-4}
5	3.33×10^{-4}
6	3.33×10^{-4}

Figure 3 – Summary of Infiltration Rates

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APPENDIX B: Infiltration Test Results

Trial Pit 1		**Date:**	05/08/2020
		Performed by:	
Dimensions	(m)	**Weather:**	Dry and overcast
Width	0.5	**Topsoil:**	Hardcore (engineered)
Length	1	**Superficial soil:**	Sand
Effective storage depth	0.5	**Comments:**	

Test No.	**Time (min)**	**Depth (mm)**
1	0	110
	1	96
	2	81
	3	70
	4	59
	5	44
	6	28
	7	16
	8	2
	9	-
	10	-

Vp75-25 =	0.05	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	233	s
f =	**2.78×10^{-4}**	**m/s**

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Trial Pit 1		**Date:**	05/08/2020
		Performed by:	
Dimensions	(m)	**Weather:**	Dry and overcast
Width	0.5	**Topsoil:**	Hardcore (engineered)
Length	1	**Superficial soil:**	Sand
Effective storage depth	0.11	**Comments:**	

Test No.	**Time (min)**	**Depth (mm)**
2	0	110
	1	97
	2	83
	3	72
	4	59
	5	46
	6	30
	7	19
	8	6
	9	-
	10	-

Vp75-25 =	0.05	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	237	s
f =	**2.78×10^{-4}**	**m/s**

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Trial Pit 1		Date:	05/08/2020
		Performed by:	Matt Jones
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.11	Comments:	

Test No.	Time (min)	Depth (mm)
3	0	110
	1	96
	2	83
	3	76
	4	67
	5	58
	6	46
	7	31
	8	22
	9	11
	10	3
	11	-
	12	-
	13	-
	14	-
	15	-

Vp75-25 =	0.05	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	244	s
f =	**2.78×10^{-4}**	**m/s**

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Trial Pit 2		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.13	Comments:	

Test No.	Time (min)	Depth (mm)
1	0	135
	1	124
	2	110
	3	93
	4	73
	5	52
	6	33
	7	15
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	242	s
f =	**2.78×10^{-4}**	**m/s**

Trial Pit 2		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.13	Comments:	

Test No.	Time (min)	Depth (mm)
2	0	135
	1	125
	2	109
	3	95
	4	72
	5	54
	6	33
	7	17
	8	3
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	243	s
f =	**2.78×10^{-4}**	**m/s**

Trial Pit 2		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.13	Comments:	

Test No.	Time (min)	Depth (mm)
3	0	135
	1	128
	2	112
	3	96
	4	75
	5	55
	6	38
	7	21
	8	7
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	248	s
f =	**2.78×10^{-4}**	**m/s**

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Trial Pit 3		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
1	0	125
	1	109
	2	94
	3	69
	4	37
	5	16
	6	-
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	185	s
f =	**3.33×10^{-4}**	**m/s**

Trial Pit 3		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
2	0	125
	1	111
	2	95
	3	68
	4	39
	5	19
	6	3
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	190	s
f =	**3.33×10^{-4}**	**m/s**

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Trial Pit 3		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
3	0	125
	1	110
	2	97
	3	68
	4	44
	5	21
	6	7
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	186	s
f =	**3.33×10^{-4}**	**m/s**

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Trial Pit 4		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.13	Comments:	

Test No.	Time (min)	Depth (mm)
1	0	130
	1	111
	2	92
	3	64
	4	34
	5	7
	6	-
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	176	s
f =	**3.3×10^{-4}**	**m/s**

Trial Pit 4		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.13	Comments:	

Test No.	Time (min)	Depth (mm)
2	0	130
	1	113
	2	94
	3	66
	4	34
	5	12
	6	-
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	180	s
f =	**3.3×10^{-4}**	**m/s**

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Trial Pit 4		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.13	Comments:	

Test No.	Time (min)	Depth (mm)
3	0	130
	1	115
	2	97
	3	68
	4	40
	5	17
	6	2
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	179	s
f =	**3.3×10^{-4}**	**m/s**

Trial Pit 5		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
1	0	125
	1	115
	2	102
	3	86
	4	61
	5	22
	6	-
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	209	s
f =	**3.33×10^{-4}**	**m/s**

Trial Pit 5		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
2	0	125
	1	114
	2	105
	3	89
	4	62
	5	25
	6	-
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	214	s
f =	**3.33×10^{-4}**	**m/s**

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Trial Pit 5		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
3	0	125
	1	117
	2	106
	3	87
	4	66
	5	27
	6	3
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	211	s
f =	**3.33×10^{-4}**	**m/s**

Trial Pit 6		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
1	0	125
	1	118
	2	107
	3	90
	4	67
	5	35
	6	6
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	178	s
f =	**3.33×10^{-4}**	**m/s**

Trial Pit 6		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
2	0	125
	1	119
	2	108
	3	90
	4	71
	5	38
	6	11
	7	-
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	185	s
f =	**3.33×10^{-4}**	**m/s**

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Trial Pit 6		Date:	05/08/2020
		Performed by:	
Dimensions	(m)	Weather:	Dry and overcast
Width	0.5	Topsoil:	Hardcore (engineered)
Length	1	Superficial soil:	Sand
Effective storage depth	0.12	Comments:	

Test No.	Time (min)	Depth (mm)
3	0	125
	1	119
	2	109
	3	92
	4	74
	5	40
	6	21
	7	2
	8	-
	9	-
	10	-

Vp75-25 =	0.06	m^3
As50 =	0.5	$L\ m^2$
tp75-25 =	182	s
f =	**3.33×10^{-4}**	**m/s**

APPENDIX C: Site Photos

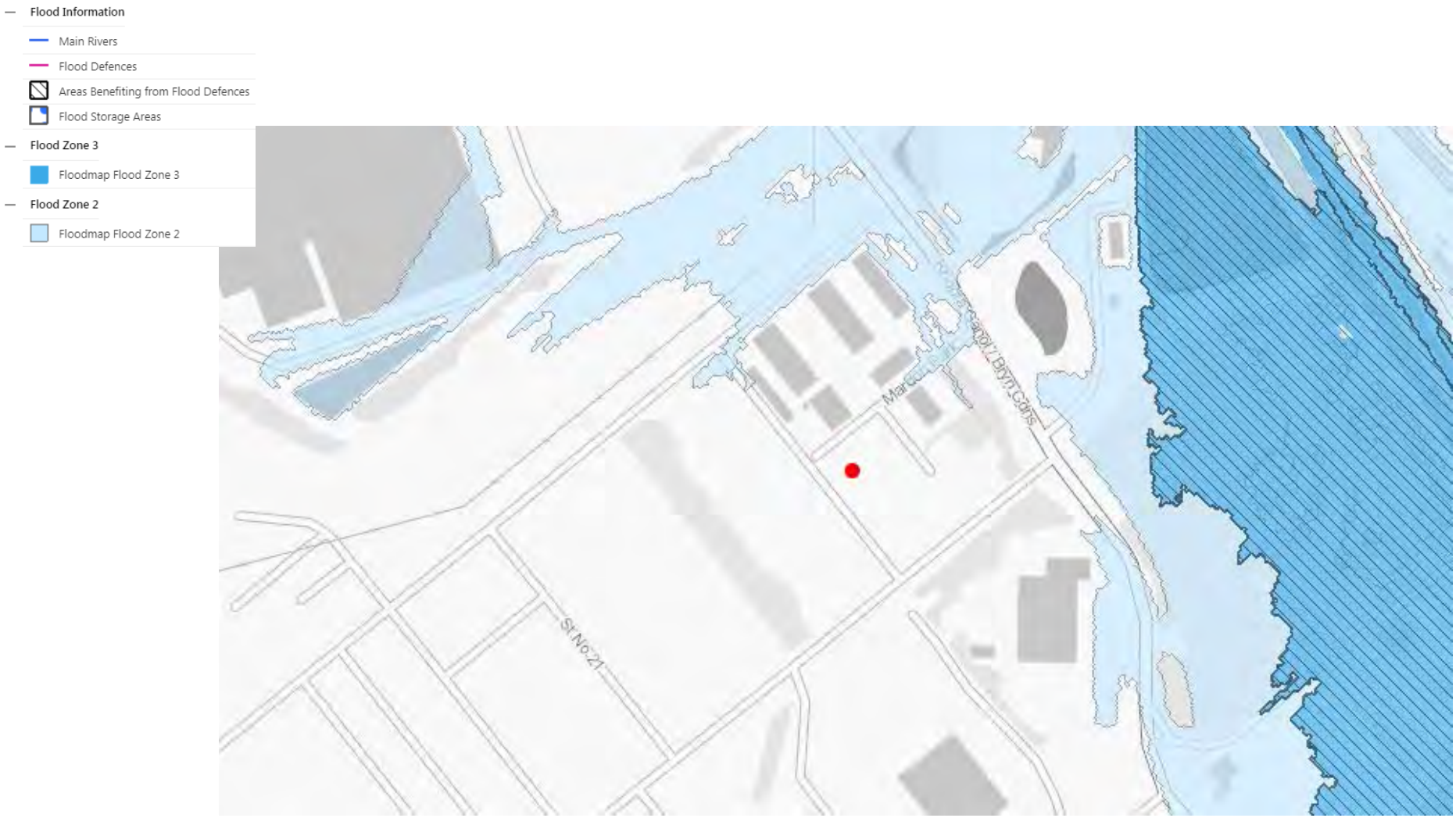
Figure 3 – Existing Site

Figure 4 – Existing Site

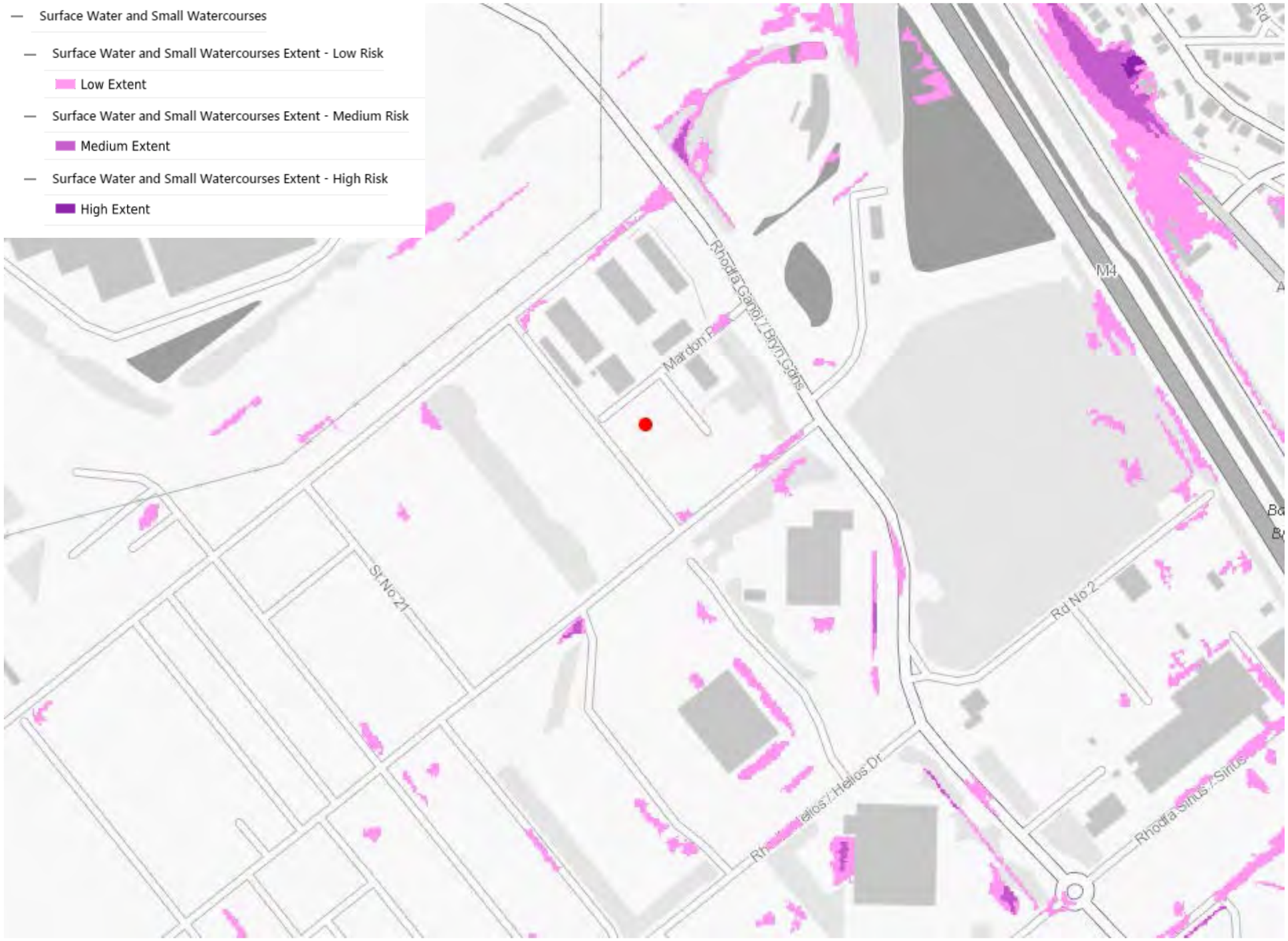
Figure 5 – Trial Pit

Figure 6 – Trial Pit Drained. Good illustration of the Sand substrate

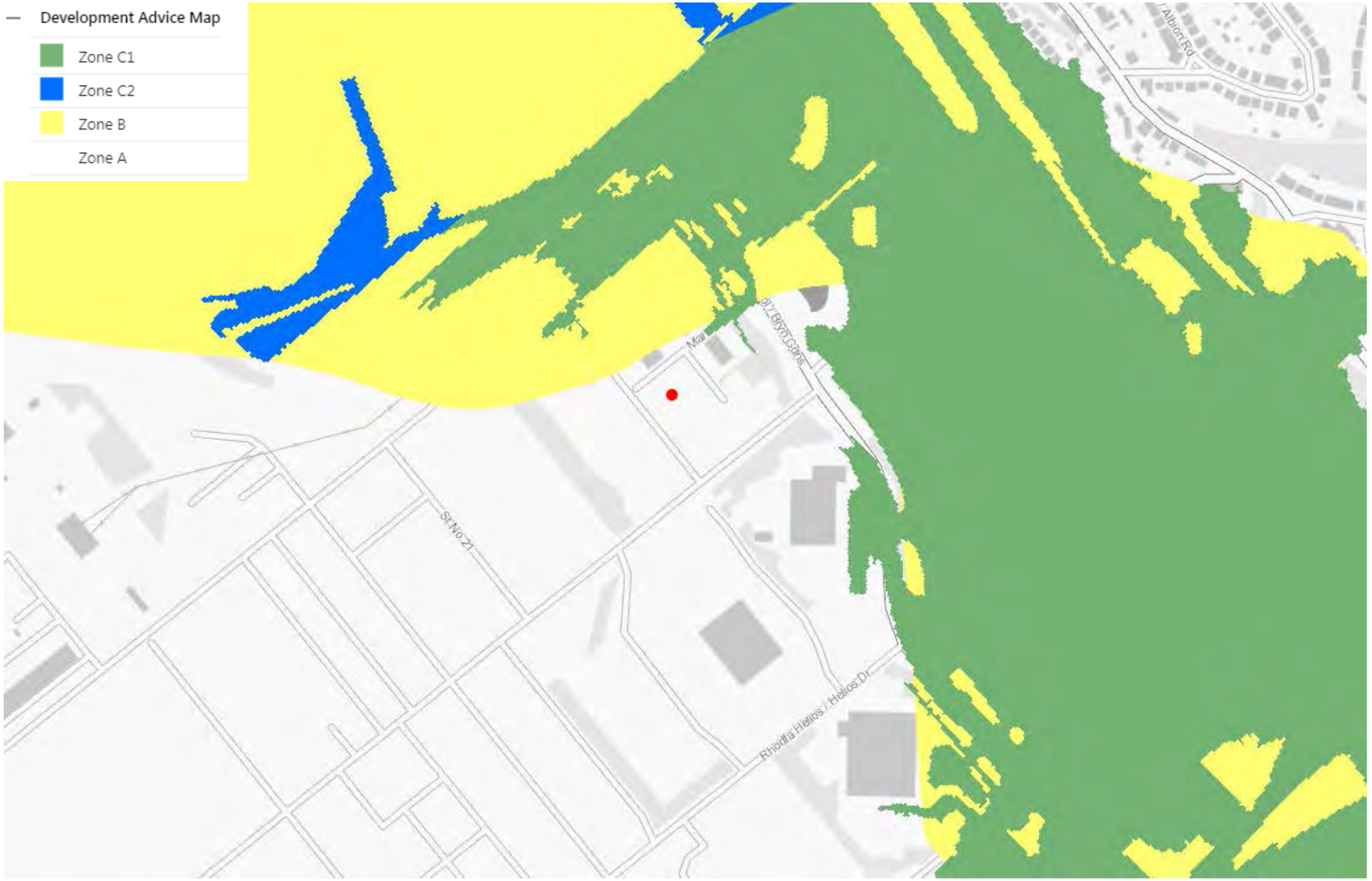
APPENDIX E: NRW Flood Maps



NRW Flood Map – Risk of Flooding from Rivers & Sea



NRW Flood Map – Risk of Flooding from Surface Water and Small Watercourses



NRW – Development Advice Map

APPENDIX F: Hydraulic Design Calculations

Project: Mardon Park, Baglan
Date: 10/02/2021
SuDS Element: Bioretention Basin 1

Prepared by: R Peskett
Checked by: F Payne
Verified by: M Jones

Detention Basin Infiltration Storage Design

Hydraulic Design Parameters

Town/City	Rainfall method	Storm duration D (hours)	Return Period (Years)	Rainfall depth (mm)
Baglan	FEH 2013 (exported from FEH Web Service)	0.25	100	19.07
		0.5	100	26.89
		0.75	100	32.19
		1	100	36.31
		2	100	43.49
		4	100	52.58
		6	100	58.76
		10	100	67.41
		12	100	70.72
		24	100	84.32

Infiltration Storage Calculation

Base Area (m2) =	334.00	Base perimiter (m) =	135.00
Catchment Area (m2) =	1500.00	Climate change factor =	1.4
Infiltration rate (m/h) =	1.00	Void ratio =	0.95
Factor of Safety =	1.50		

Storm duration (mins)	Depth of rainfall (mm) 100 year storm + 40% CC	Rainfall intensity (m/h)	a (m)	b (h^{-1})	h_{max} (m)
5	40.05	0.4806	-2.86	0.43	0.100
10	56.47	0.3388	-1.29	0.43	0.088
15	67.60	0.2704	-0.53	0.43	0.053
30	76.25	0.1525	0.78	0.43	-0.150
60	91.33	0.0913	1.46	0.43	-0.506
120	110.42	0.0552	1.86	0.43	-1.067
240	123.40	0.0308	2.13	0.43	-1.743
360	141.56	0.0236	2.21	0.43	-2.040
600	148.51	0.0149	2.31	0.43	-2.277
1440	177.07	0.0074	2.39	0.43	-2.392

Therefore critical storm duration = 5 mins

Infiltration rate (m/s) =	2.78E-04

Design note

Calculation based on CIRIA SuDS Manual 2015 equation 25.4.
h_{max} is the maximum depth of water for the stated parameters.
A maximum depth of 0.1m is calculated which is less than the 0.15m deep basin. Pass.
A factor of safety of 1.5 is applied as per the Statutory National Standards for SuDS.

General notes:
1. Outflow discharge rate is dependant on site specific requirements.
2. Void ratio is dependant on storage structure i.e. Detention Basin - 0.95, Geocellular - 0.95, Permeable paving - 0.32.
3. Climate change factor e.g. 30% = 1.3, 40% = 1.4.

Key

Input

Project: Mardon Park, Baglan
Date: 10/02/2021
SuDS Element: Bioretention Basin 2

Prepared by: R Peskett
Checked by: F Payne
Verified by: M Jones

Detention Basin Infiltration Storage Design

Hydraulic Design Parameters

Town/City	Rainfall method	Storm duration D (hours)	Return Period (Years)	Rainfall depth (mm)
Baglan	FEH 2013 (exported from FEH Web Service)	0.25	100	19.07
		0.5	100	26.89
		0.75	100	32.19
		1	100	36.31
		2	100	43.49
		4	100	52.58
		6	100	58.76
		10	100	67.41
		12	100	70.72
		24	100	84.32

Infiltration Storage Calculation

Base Area (m2) =	156.00	Base perimiter (m) =	75.00
Catchment Area (m2) =	1200.00	Climate change factor =	1.4
Infiltration rate (m/h) =	1.00	Void ratio =	0.95
Factor of Safety =	1.50		

Storm duration (mins)	Depth of rainfall (mm) 100 year storm + 40% CC	Rainfall intensity (m/h)	a (m)	b (h^{-1})	h_{max} (m)
5	40.05	0.4806	-5.60	0.51	0.232
10	56.47	0.3388	-3.34	0.51	0.270
15	67.60	0.2704	-2.24	0.51	0.267
30	76.25	0.1525	-0.36	0.51	0.080
60	91.33	0.0913	0.62	0.51	-0.246
120	110.42	0.0552	1.20	0.51	-0.763
240	123.40	0.0308	1.59	0.51	-1.378
360	141.56	0.0236	1.70	0.51	-1.621
600	148.51	0.0149	1.84	0.51	-1.831
1440	177.07	0.0074	1.96	0.51	-1.962

Therefore critical storm duration = 10 mins

Infiltration rate (m/s) =	2.78E-04

Design note

Calculation based on CIRIA SuDS Manual 2015 equation 25.4.
h_{max} is the maximum depth of water for the stated parameters.
A maximum depth of 0.270m is calculated which is less than the 0.3m deep basin. Pass.
A factor of safety of 1.5 is applied as per the Statutory National Standards for SuDS.

General notes:
1. Outflow discharge rate is dependant on site specific requirements.
2. Void ratio is dependant on storage structure i.e. Detention Basin - 0.95, Geocellular - 0.95, Permeable paving - 0.32.
3. Climate change factor e.g. 30% = 1.3, 40% = 1.4.

Key

Input

Project: Mardon Park, Baglan
Date: 10/02/2021
SuDS Element: Bioretention Basin 3

Prepared by: R Peskett
Checked by: F Payne
Verified by: M Jones

Detention Basin Infiltration Storage Design

Hydraulic Design Parameters

Town/City	Rainfall method	Storm duration D (hours)	Return Period (Years)	Rainfall depth (mm)
Baglan	FEH 2013 (exported from FEH Web Service)	0.25	100	19.07
		0.5	100	26.89
		0.75	100	32.19
		1	100	36.31
		2	100	43.49
		4	100	52.58
		6	100	58.76
		10	100	67.41
		12	100	70.72
		24	100	84.32

Infiltration Storage Calculation

Base Area (m2) =	106.00	Base perimiter (m) =	70.00
Catchment Area (m2) =	710.00	Climate change factor =	1.4
Infiltration rate (m/h) =	1.00	Void ratio =	0.95
Factor of Safety =	1.50		

Storm duration (mins)	Depth of rainfall (mm) 100 year storm + 40% CC	Rainfall intensity (m/h)	a (m)	b (h^{-1})	h_{max} (m)
5	40.05	0.4806	-3.36	0.70	0.189
10	56.47	0.3388	-1.92	0.70	0.210
15	67.60	0.2704	-1.23	0.70	0.196
30	76.25	0.1525	-0.03	0.70	0.009
60	91.33	0.0913	0.59	0.70	-0.295
120	110.42	0.0552	0.95	0.70	-0.717
240	123.40	0.0308	1.20	0.70	-1.127
360	141.56	0.0236	1.28	0.70	-1.256
600	148.51	0.0149	1.36	0.70	-1.362
1440	177.07	0.0074	1.44	0.70	-1.440

Therefore critical storm duration = 10 mins

Infiltration rate (m/s) =	2.78E-04

Design note

Calculation based on CIRIA SuDS Manual 2015 equation 25.4.
h_{max} is the maximum depth of water for the stated parameters.
A maximum depth of 0.210m is calculated which is less than the 0.3m deep basin. Pass.
A factor of safety of 1.5 is applied as per the Statutory National Standards for SuDS.

General notes:
1. Outflow discharge rate is dependant on site specific requirements.
2. Void ratio is dependant on storage structure i.e. Detention Basin - 0.95, Geocellular - 0.95, Permeable paving - 0.32.
3. Climate change factor e.g. 30% = 1.3, 40% = 1.4.

Key

Input

Project: Mardon Park, Baglan
Date: 10/02/2021
SuDS Element: Bioretention Basin 4

Prepared by: R Peskett
Checked by: F Payne
Verified by: M Jones

Detention Basin Infiltration Storage Design

Hydraulic Design Parameters

Town/City	Rainfall method	Storm duration D (hours)	Return Period (Years)	Rainfall depth (mm)
Baglan	FEH 2013 (exported from FEH Web Service)	0.25	100	19.07
		0.5	100	26.89
		0.75	100	32.19
		1	100	36.31
		2	100	43.49
		4	100	52.58
		6	100	58.76
		10	100	67.41
		12	100	70.72
		24	100	84.32

Infiltration Storage Calculation

Base Area (m2) =	90.00	Base perimiter (m) =	40.00
Catchment Area (m2) =	770.00	Climate change factor =	1.4
Infiltration rate (m/h) =	1.00	Void ratio =	0.95
Factor of Safety =	1.50		

Storm duration (mins)	Depth of rainfall (mm) 100 year storm + 40% CC	Rainfall intensity (m/h)	a (m)	b (h^{-1})	h_{max} (m)
5	40.05	0.4806	-6.99	0.47	0.268
10	56.47	0.3388	-4.27	0.47	0.320
15	67.60	0.2704	-2.95	0.47	0.326
30	76.25	0.1525	-0.68	0.47	0.143
60	91.33	0.0913	0.49	0.47	-0.184
120	110.42	0.0552	1.19	0.47	-0.722
240	123.40	0.0308	1.66	0.47	-1.402
360	141.56	0.0236	1.80	0.47	-1.688
600	148.51	0.0149	1.96	0.47	-1.946
1440	177.07	0.0074	2.11	0.47	-2.108

Therefore critical storm duration = 10 mins

Infiltration rate (m/s) =	2.78E-04

Design note

Calculation based on CIRIA SuDS Manual 2015 equation 25.4.
h_{max} is the maximum depth of water for the stated parameters.
A maximum depth of 0.103m is calculated which is less than the 0.35m deep basin. Pass.
A factor of safety of 1.5 is applied as per the Statutory National Standards for SuDS.

General notes:
1. Outflow discharge rate is dependant on site specific requirements.
2. Void ratio is dependant on storage structure i.e. Detention Basin - 0.95, Geocellular - 0.95, Permeable paving - 0.32.
3. Climate change factor e.g. 30% = 1.3, 40% = 1.4.

Key

Input

Project: Mardon Park, Baglan
Date: 10/02/2021
SuDS Element: Bioretention Basin 5

Prepared by: R Peskett
Checked by: F Payne
Verified by: M Jones

Detention Basin Infiltration Storage Design

Hydraulic Design Parameters

Town/City	Rainfall method	Storm duration D (hours)	Return Period (Years)	Rainfall depth (mm)
Baglan	FEH 2013 (exported from FEH Web Service)	0.25	100	19.07
		0.5	100	26.89
		0.75	100	32.19
		1	100	36.31
		2	100	43.49
		4	100	52.58
		6	100	58.76
		10	100	67.41
		12	100	70.72
		24	100	84.32

Infiltration Storage Calculation

Base Area (m2) =	160.00	Base perimiter (m) =	100.00
Catchment Area (m2) =	560.00	Climate change factor =	1.4
Infiltration rate (m/h) =	1.00	Void ratio =	0.95
Factor of Safety =	1.50		

Storm duration (mins)	Depth of rainfall (mm) 100 year storm + 40% CC	Rainfall intensity (m/h)	a (m)	b (h^{-1})	h_{max} (m)
5	40.05	0.4806	-1.09	0.66	0.058
10	56.47	0.3388	-0.30	0.66	0.031
15	67.60	0.2704	0.09	0.66	-0.013
30	76.25	0.1525	0.75	0.66	-0.209
60	91.33	0.0913	1.09	0.66	-0.525
120	110.42	0.0552	1.29	0.66	-0.945
240	123.40	0.0308	1.43	0.66	-1.325
360	141.56	0.0236	1.47	0.66	-1.440
600	148.51	0.0149	1.52	0.66	-1.515
1440	177.07	0.0074	1.56	0.66	-1.559

Therefore critical storm duration = 10 mins

Infiltration rate (m/s) =	2.78E-04

Design note

Calculation based on CIRIA SuDS Manual 2015 equation 25.4.
h_{max} is the maximum depth of water for the stated parameters.
A maximum depth of 0.103m is calculated which is less than the 0.1m deep basin. Pass.
A factor of safety of 1.5 is applied as per the Statutory National Standards for SuDS.

General notes:
1. Outflow discharge rate is dependant on site specific requirements.
2. Void ratio is dependant on storage structure i.e. Detention Basin - 0.95, Geocellular - 0.95, Permeable paving - 0.32.
3. Climate change factor e.g. 30% = 1.3, 40% = 1.4.

Key

Input

Project: Mardon Park, Baglan
Date: 10/02/2021
SuDS Element: Permeable Parking Spaces

Prepared by: R Peskett
Checked by: F Payne
Verified by: M Jones

Plane Infiltration System Storage Design

Hydraulic Design Parameters

Town/City	M560 (mm)	r Value	Storm duration D (mins)	Z1	M5-D	Z2 (100 year return period)	Depth of rainfall 100 year
Baglan	18.00	0.3	5	0.31	5.58	1.82	10.16
			10	0.46	8.28	1.90	15.73
			15	0.56	10.08	1.94	19.56
			30	0.75	13.50	2.00	27.00
			60	1.00	18.00	2.03	36.54
			120	1.30	23.40	1.99	46.57
			240	1.71	30.78	1.92	59.10
			360	2.00	36.00	1.87	67.32
			600	2.40	43.20	1.81	78.19
			1440	3.35	60.30	1.67	100.70

Infiltration Storage Calculation

Base Area (m2) =	104.00	Factor of Safety =	3.00
Catchment Area (m2) =	104.00	Climate change factor =	1.4
Infiltration rate (m/h) =	1.0008	Void ratio =	0.30
Factored Infiltration rate (m/h) =	0.3336		

Storm duration (mins)	Depth of rainfall (mm) 100 year storm + 40% CC	Rainfall intensity (m/h)	Ratio of drained to infiltration area, R	h_{max} (m)
5	14.22	0.1706	1.00	-0.045
10	22.02	0.1321	1.00	-0.112
15	27.38	0.1095	1.00	-0.187
30	37.80	0.0756	1.00	-0.430
60	51.16	0.0512	1.00	-0.941
120	65.19	0.0326	1.00	-2.007
240	82.74	0.0207	1.00	-4.172
360	94.25	0.0157	1.00	-6.358
600	109.47	0.0109	1.00	-10.755
1440	140.98	0.0059	1.00	-26.218

Therefore critical storm duration = 10 mins

Infiltration rate (m/s) =	2.78E-04

Design note

Calculation based on CIRIA SuDS Manual 2015 equation 25.1 & 25.2.

h_{max} is the maximum depth of water for the stated parameters. Maximum water level of -0.045m. So a sub grade depth of 0.18m is sufficient - Pass.

h_{max} is a negative value due to the infiltration rate being greater than the inflow rate into the system.

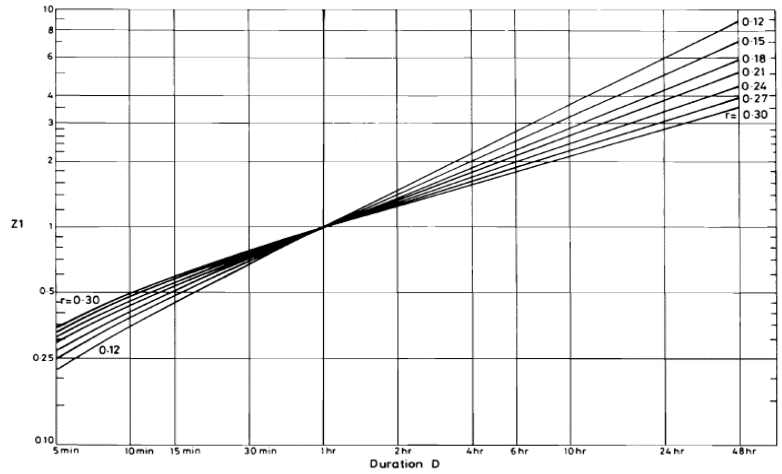
General notes:

1. Outflow discharge rate is dependant on site specific requirements.
2. Void ratio is dependant on storage structure i.e. Detention Basin - 1.00, Geocellular - 0.95, Permeable paving - 0.30.
3. Climate change factor e.g. 30% = 1.3, 40% = 1.4.

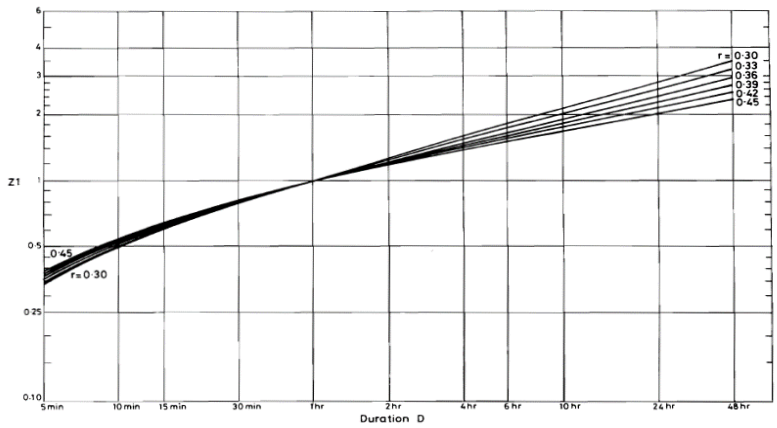
Key

Input

Z1 and Z2 Factors



Relation between Z1 and D for different values of r. ($0{\cdot}12 \leq r \leq 0{\cdot}30$)



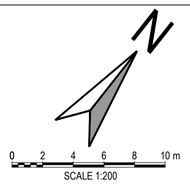
Relation between Z1 and D for different values of r. ($0{\cdot}30 \leq r \leq 0{\cdot}45$)

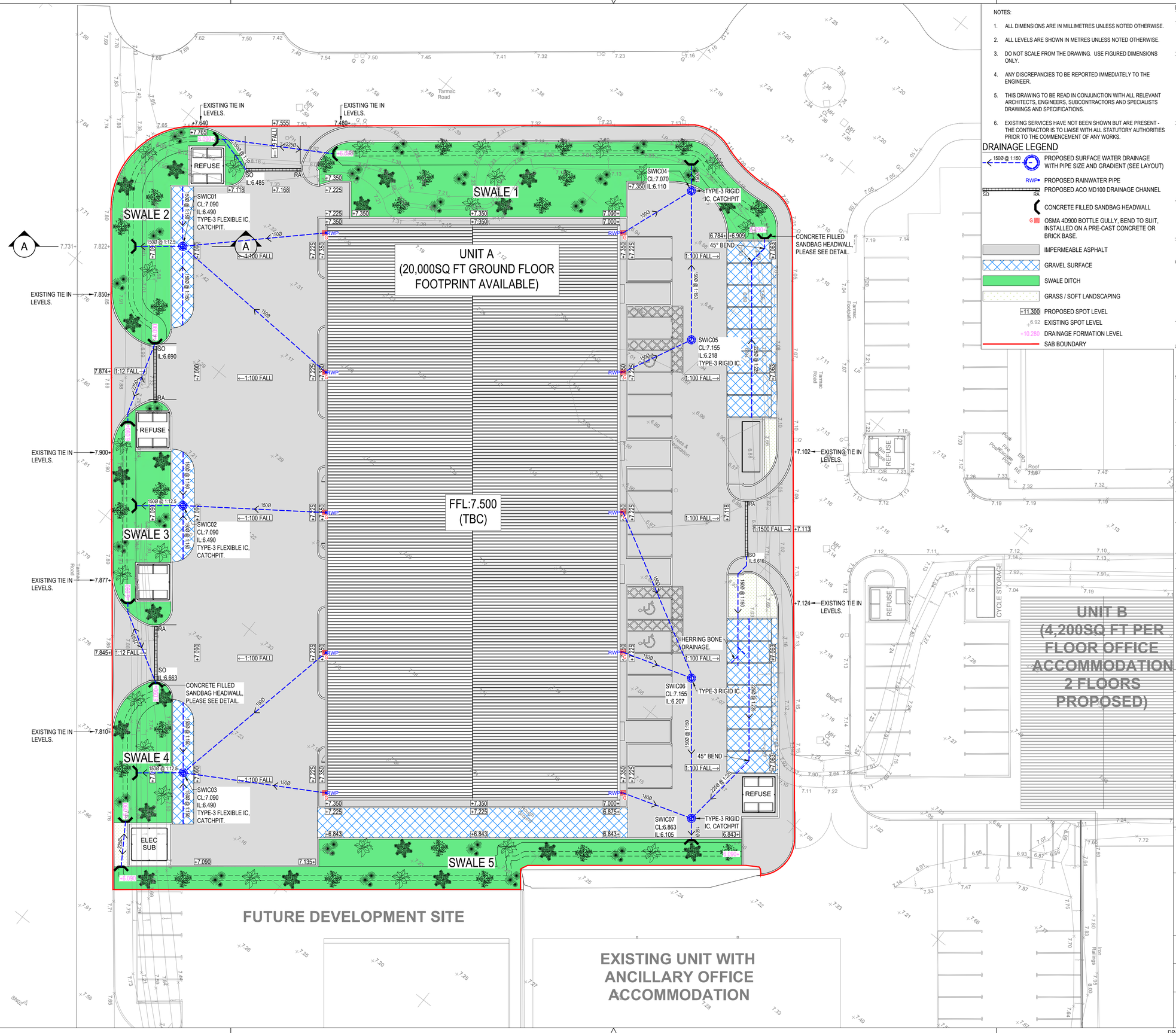
Table A1: Relationship between rainfall of return period T(MT) and M5 – England and Wales (ratio Z2)

M5 Rainfall mm	M1	M2	M3	M4	M5	M10	M20	M50	M100
5	0.62	0.79	0.89	0.97	1.02	1.19	1.36	1.56	1.79
10	0.61	0.79	0.90	0.97	1.03	1.22	1.41	1.65	1.91
15	0.62	0.80	0.90	0.97	1.03	1.24	1.44	1.70	1.99
20	0.64	0.81	0.90	0.97	1.03	1.24	1.45	1.73	2.03
25	0.66	0.82	0.91	0.97	1.03	1.24	1.44	1.72	2.01
30	0.68	0.83	0.91	0.97	1.03	1.22	1.42	1.70	1.97
40	0.70	0.84	0.92	0.97	1.02	1.19	1.38	1.64	1.89
50	0.72	0.85	0.93	0.98	1.02	1.17	1.34	1.58	1.81
75	0.76	0.87	0.93	0.98	1.02	1.14	1.28	1.47	1.64
100	0.78	0.88	0.94	0.98	1.02	1.13	1.25	1.40	1.54
150	0.78	0.88	0.94	0.98	1.01	1.12	1.21	1.33	1.45
200	0.78	0.88	0.94	0.98	1.01	1.11	1.19	1.30	1.40

APPENDIX G: Surface Water Drainage and Flow Exceedance Plan

Sheet ACAD - A1 rev. C





NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
3. DO NOT SCALE FROM THE DRAWING. USE FIGURED DIMENSIONS ONLY.
4. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ENGINEER.
5. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS, SUBCONTRACTORS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
6. EXISTING SERVICES HAVE NOT BEEN SHOWN BUT ARE PRESENT - THE CONTRACTOR IS TO LIAISE WITH ALL STATUTORY AUTHORITIES PRIOR TO THE COMMENCEMENT OF ANY WORKS.

DRAINAGE LEGEND

- 1500Ø @ 1:150 — PROPOSED SURFACE WATER DRAINAGE WITH PIPE SIZE AND GRADIENT (SEE LAYOUT)
- RWP — PROPOSED RAINWATER PIPE
- SO RA — PROPOSED ACO MD100 DRAINAGE CHANNEL
- CONCRETE FILLED SANDBAG HEADWALL
- G — OSMA 4D900 BOTTLE GULLY, BEND TO SUIT, INSTALLED ON A PRE-CAST CONCRETE OR BRICK BASE.
- IMPERMEABLE ASPHALT
- GRAVEL SURFACE
- SWALE DITCH
- GRASS / SOFT LANDSCAPING
- +11.300 — PROPOSED SPOT LEVEL
- 6.92 — EXISTING SPOT LEVEL
- +10.280 — DRAINAGE FORMATION LEVEL
- SAB BOUNDARY

NOTES:

1. MH COVERS AND FRAMES TO CONFORM TO BS EN 124:
   -HIGHWAYS AND FOOTWAYS TO FRONT OF BUILDINGS (D400)
   -FOOTWAYS TO REAR OF BUILDINGS (C250)
2. TYPE S BEDDING AND SURROUND TO ALL PIPES EXCEPT IN THE FOLLOWING CIRCUMSTANCES, IN WHICH TYPE Z BEDDING AND SURROUND ARE TO BE USED:
   -IN BACK GARDENS OF HOUSES WHERE DEPTH TO CROWN OF PIPE IS LESS THAN 0.35m.
   -IN AREAS OF THE REAR OF FLATS AND PARKING WHERE DEPTH TO CROWN IS LESS THAN 0.9m.
   -IN AREAS OF ROAD WHERE DEPTH IS LESS THAN 1.2m.
3. ALL EXISTING MANHOLE INVERTS TO BE CHECKED AND REPORTED TO THE ENGINEER PRIOR TO THE COMMENCEMENT OF DRAINAGE WORKS. EXISTING PIPE CONNECTIONS ARE TO BE CCTV SURVEYED AND INSPECTED BY THE ENGINEER AND LOCAL AUTHORITY. IF THE PIPE CONNECTION IS FOUND TO BE DAMAGED OR IN DISTRESS, THE CONTRACTOR IS TO CARRY OUT REMEDIAL WORKS OR PROVIDE A NEW CONNECTION TO THE EXISTING SEWER (PIPE SIZE AND GRADIENT TO BE DETERMINED BY THE ENGINEER.
4. THE GRADIENTS INDICATED AGAINST THE DRAIN RUNS ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL INSTALL DRAINS TO THE INVERT LEVELS SHOWN FOR EACH MANHOLE OR OTHER INDICATED POSITION.
5. ALL PLOT FOUL DRAINAGE TO BE MINIMUM 100mm DIAMETER UNLESS OTHERWISE NOTED.
6. ALL ADOPTABLE THERMOPLASTIC STRUCTURED WALL SEWER PIPE SHALL COMPLY WITH THE RELEVANT PROVISIONS OF BS EN 13476-1 AND WIS 4-35-01 AND BS EN 13476-2 OR BS EN 13476-3. PIPES SHALL BE BSI KITEMARKED OR HAVE EQUIVALENT THIRD PARTY CERTIFICATION. PIPES LESS THAN OR EQUAL TO 500mm DIA. SHALL HAVE A SHORT-TERM RING STIFFNESS OF NOT LESS THAN 8kN/m² (SN8).
7. ALL JOINTING IN ACCORDANCE WITH MANUFACTURERS TECHNICAL ADVICE & SPECIFICATION.
8. ALL NON ADOPTABLE DRAINAGE TO BE THE STANDARD UPVC 110mm, 160mm DRAINAGE AND MANUFACTURED TO BS-EN 1401 AND BS 4660 UNLESS NOTED OTHERWISE.
9. ALL PERMEABLE PAVING CELLS TO HOUSE LATERAL FIN DRAIN ALONG LOWER EDGE WITH 150Ø CONNECTION PIPE.
10. ALL STORM WATER DRAINAGE TO BE A MINIMUM OF 150mm DIAMETER UNLESS OTHERWISE NOTED.
11. SOIL & VENT PIPE LOCATION AND NUMBER TO BE CONFIRMED WITH ARCHITECT.
12. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS DRAWINGS, TOGETHER WITH THEIR LATEST SPECIFICATIONS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER (VALE CONSULTANCY) AS SOON AS POSSIBLE.
13. FIGURED DIMENSIONS ONLY TO BE USED. ANY QUERIES OR DISCREPANCIES TO BE REFERRED TO THE ENGINEER (VALE CONSULTANCY) IMMEDIATELY.
14. PRIOR TO ORDERING ANY MATERIALS THE CONTRACTOR IS TO CONFIRM MANUFACTURER/PIPE MATERIAL AND GRADE PROPOSED WITH WATER AUTHORITY.
15. TEMPORARY WORKS DESIGN BY OTHERS.
16. DESIGN RISK ASSESSMENTS AND METHOD STATEMENTS ARE TO BE PROVIDED TO THE PRINCIPLE CONTRACTOR PRIOR TO THE COMMENCEMENT OF ANY WORKS.

APPROVAL

rev.	drawn	chkd	apprvd	date	description
02	SU	MJ	LR	19.02.21	REVISED TO REFLECT CLIENT COMMENTS.
01	SU	MJ	LR	18.02.21	ISSUED FOR APPROVAL.

Client
GBV PROPERTIES

Project
MARDON PARK PHASE 3

Title
SAB DRAINAGE LAYOUT

Vale Consultancy
CONSULTING CIVIL & STRUCTURAL ENGINEERS
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Phone: 01656 863794 Email: enquiries@vale-consultancy.co.uk

date	drawn	checked	approved
18.02.21	SU	MJ 18.02.21	LR 18.02.21

scale @ A1	project no.
1:200	11250

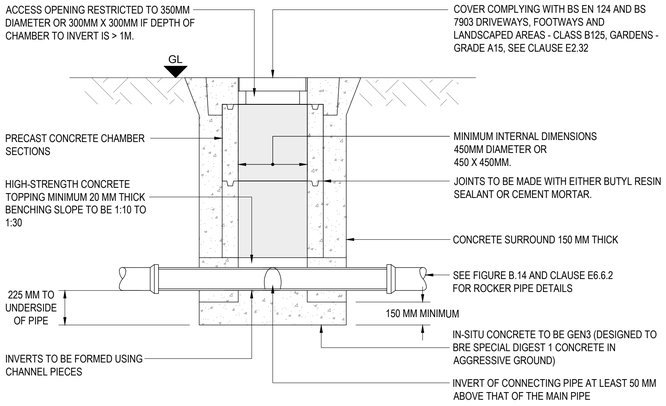
status	drg. no.	rev.
A	11250_SAB_500	02

DRAWING STATUS
A - Approval, AB - As-Built, C - Construction, D - Draft, P - Preliminary, T - Tender

ORIGINAL DRAWING SIZE 841 x 594

10 0 10 20 50 100mm NATURAL SCALE

A1



TYPICAL INSPECTION CHAMBER DETAIL (RIGID MATERIAL DETAIL) - TYPE 3

ALTERNATIVE MAXIMUM DEPTH FROM COVER LEVEL TO SOFFIT OF PIPE 3M FOR AREAS NOT SUBJECT TO VEHICLE LOADING OR AREAS SUBJECT TO LIGHT VEHICLE LOADING, NON-ENTRY.

N.T.S.

PIPE DIA.	ROCKER PIPE LENGTH
100 - 600	0.60m
675 - 750	1.00m
OVER 750	1.25m

ROCKER PIPE DETAILS

TYPICAL INSPECTION CHAMBER DETAIL (FLEXIBLE MATERIAL) - TYPE 3

NTS

TYPE S BEDDING

GRANULAR BED AND SURROUND UNDER ROAD (BEDDING FACTION = 2.2)

SCALE 1:20

NOTES:
1. REFER TO SHW TABLE 5/3 AND SHW TABLE 6/1
2. BEDDING BENEATH AND AT SIDES OF THE PIPE TO BE WELL COMPACTED IN ACCORDANCE WITH CL 505.
3. CONCRETE CRADLES AND ARCHES MAY BE EXTENDED TO THE SIDES OF THE TRENCH.
4. GEOTEXTILES MAY BE USED WHERE DIRECTED OR APPROVED BY THE ENGINEER TO CONTAIN BEDDING MATERIAL IN CERTAIN SOILS EG. RUNNING SAND.
5. IN VERY WET CONDITIONS, WHERE DIRECTED OR APPROVED BY THE ENGINEER A TEMPORARY LAND DRAIN MAY BE LAID WITHIN THE GRANULAR BED.

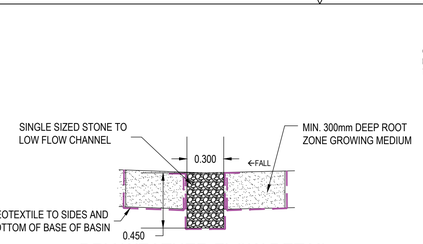
TYPE Z BEDDING

CONCRETE BED AND SURROUND (BEDDING FACTION = 2.6)

SCALE 1:20

NOTES: (TYPE Z ONLY)
6. WHERE PIPES WITH FLEXIBLE JOINTS ARE USED, THE 6. CONCRETE PROTECTION IS TO BE INTERRUPTED OVER ITS FULL CROSS SECTION AT INTERVALS NOT EXCEEDING 5 METRES (OR AS DIRECTED BY THE ENGINEER) BY A SHAPED FORMER OF BITUMEN IMPREGNATED COMPRESSIBLE FILLER. THESE INTERRUPTIONS SHALL COINCIDE WITH PIPE JOINTS. SEE DIMENSIONS FOR PIPE BEDDING TABLE FOR THICKNESS OF COMPRESSIBLE FILLER.
7. CONCRETE TO BE GRADE GEN 3. WHERE FLEXIBLE PIPES ARE USED. CARE MUST BE TAKEN
8. TO PREVENT THE PIPES FROM FLOATING.

BEDDING DETAILS

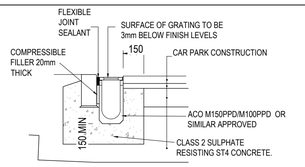


RWP TO GULLY

NTS

DRY WEATHER FLOW DETAIL

SCALE 1:25

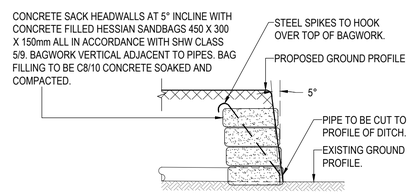


NOTES:

1. DRAINAGE CHANNELS TO BE ACO M150PPD OR SIMILAR APPROVED
2. FOUNDATION FOR CHANNELS TO BE LAID ON A ROLLED SUB-BASE OF 150mm MINIMUM THICKNESS.
3. GRATING LOAD CLASSIFICATION TO BE C250/ D400

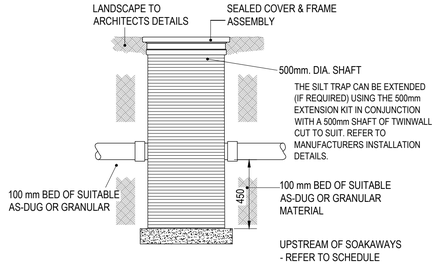
DRAINAGE CHANNEL DETAIL

SCALE 1:NTS



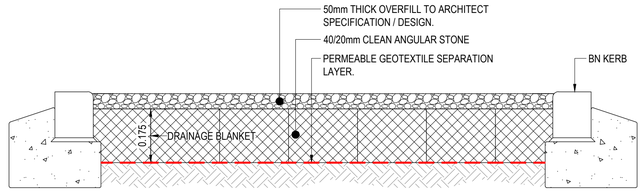
CONCRETE SACK HEADWALL DETAIL

SCALE 1:20



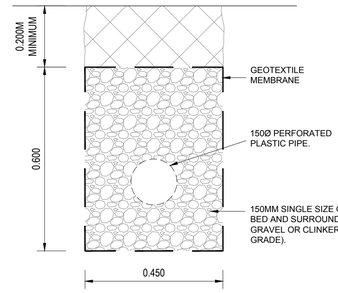
TYPICAL UPVC SILT TRAP CHAMBER INSTALLATION

SCALE 1:20



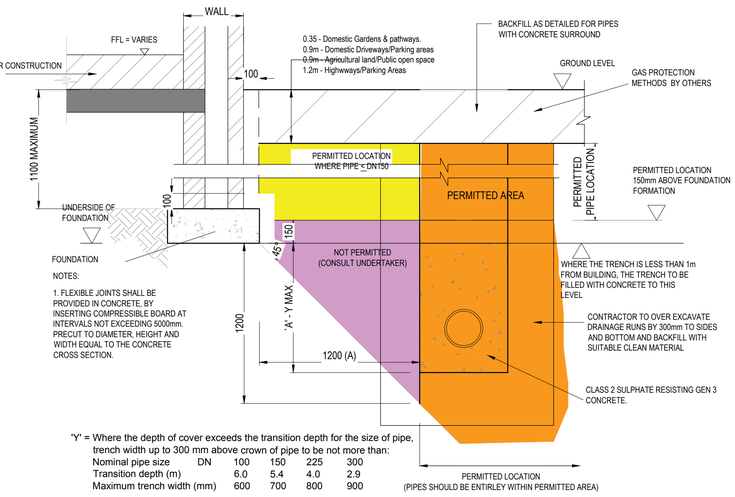
GRAVEL SURFACED PARKING CONSTRUCTION

SCALE 1:10



FILTER DRAIN STANDARD DETAIL

SCALE 1:10



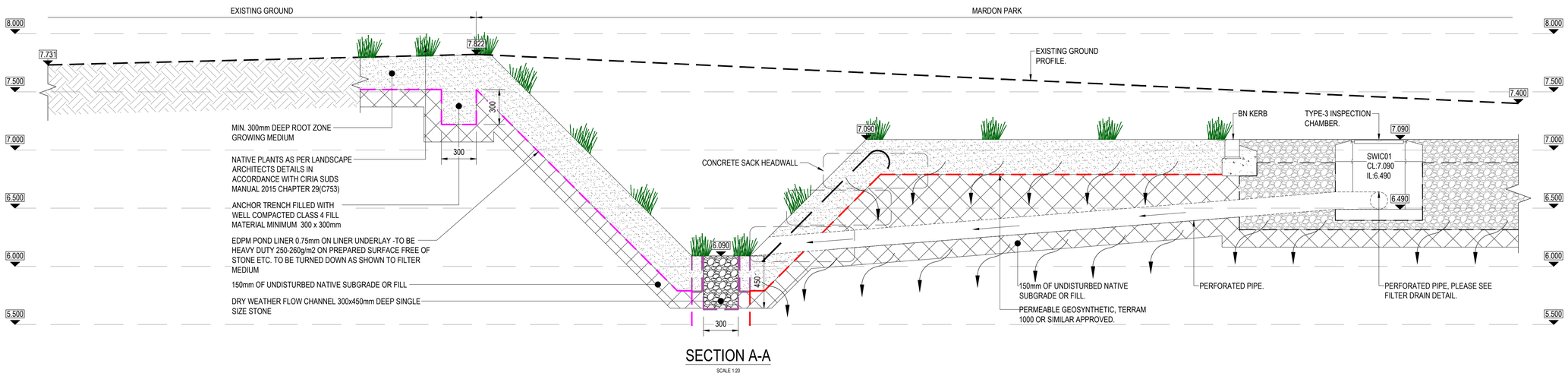
NOTES:

1. FLEXIBLE JOINTS SHALL BE PROVIDED IN CONCRETE, BY INSERTING COMPRESSIBLE BOARD AT INTERVALS NOT EXCEEDING 5000mm. PRECUT TO DIAMETER, HEIGHT AND WIDTH EQUAL TO THE CONCRETE CROSS SECTION.

'Y' = Where the depth of cover exceeds the transition depth for the size of pipe, trench width up to 300 mm above crown of pipe to be not more than:

Nominal pipe size	DN	100	150	225	300
Transition depth (m)		6.0	5.4	4.0	2.9
Maximum trench width (mm)		600	700	800	900

TYPICAL DRAINAGE DETAIL IN CLOSE PROXIMITY OF FOUNDATIONS



SECTION A-A

SCALE 1:20

NOTES:

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APPROVAL

0 500 1000 1500 2000 2500 mm

SCALE 1:50

rev.	drawn	chkd.	apprvd.	date	description
02	SU	MJ	LR	18.02.21	ISSUED FOR APPROVAL.
01	SU	MJ	LR	18.02.21	ISSUED FOR APPROVAL.

Client
GBV PROPERTIES LTD

Project
MARDON PARK PHASE 3

Title
SAB DRAINAGE CONSTRUCTION DETAILS

Vale Consultancy
CONSULTING CIVIL & STRUCTURAL ENGINEERS
29 Bocam Park, Old Field Road, Pencoed, Bridgend CF35 5LJ.
Phone: 01656 863794 Email: enquiries@vale-consultancy.co.uk

date	drawn	checked	approved
18.02.21	SU	MJ 18.02.21	LR 18.02.21

scale @ A1	project no.
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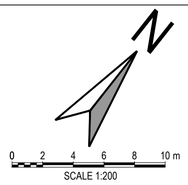
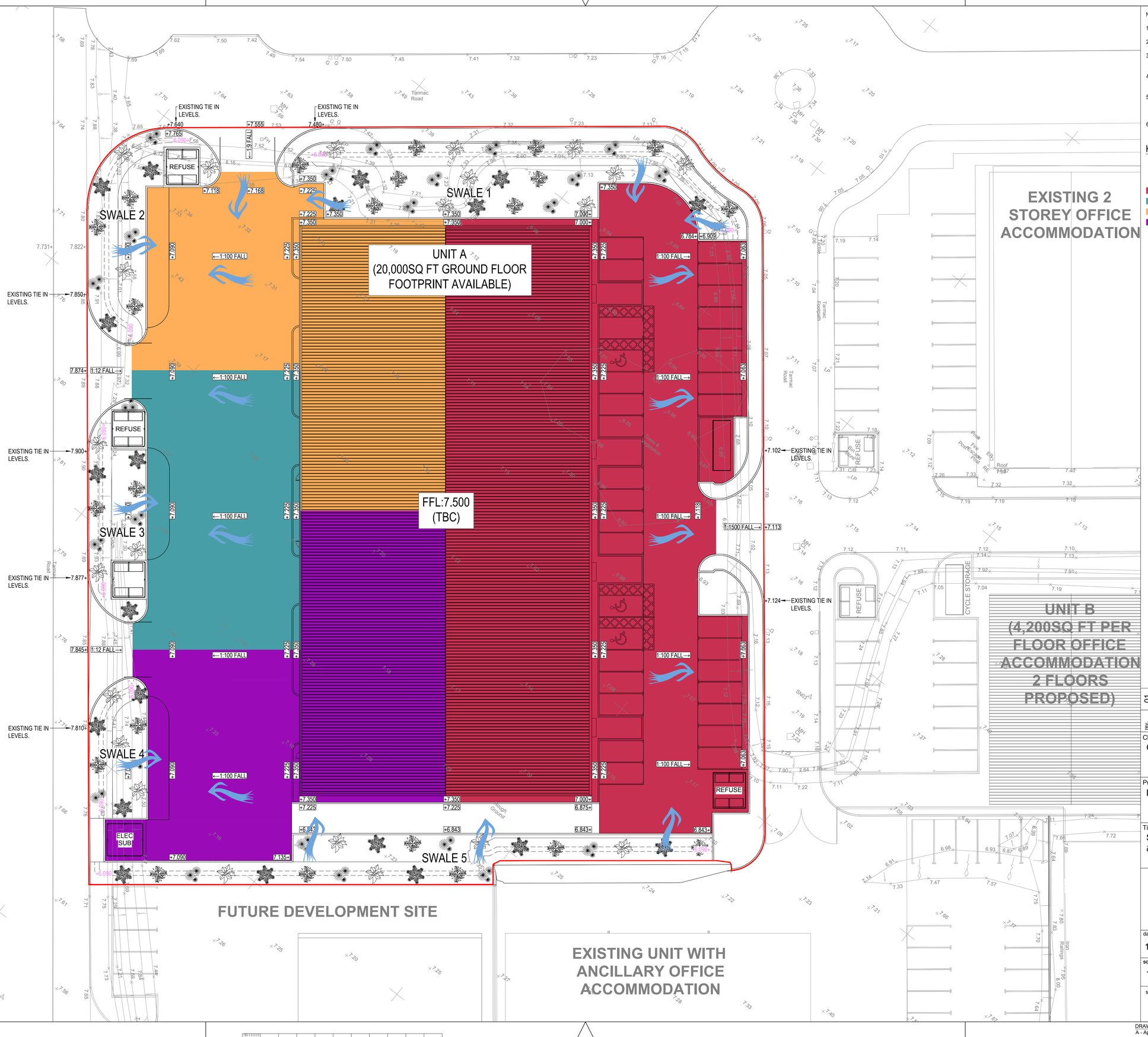
status	drg. no.	rev.
A	11250_SAB_501	02

DRAWING STATUS
A - Approval, AB - As-Built, C - Construction, D - Draft, P - Preliminary, T - Tender





NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
3. DO NOT SCALE FROM THE DRAWING. USE FIGURED DIMENSIONS ONLY.
4. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ENGINEER.
5. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS, SUBCONTRACTORS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
6. EXISTING SERVICES HAVE NOT BEEN SHOWN BUT ARE PRESENT - THE CONTRACTOR IS TO LIAISE WITH ALL STATUTORY AUTHORITIES PRIOR TO THE COMMENCEMENT OF ANY WORKS.

KEY

- FLOW EXCEEDANCE ARROW
- CATCHMENT AREA A = 2123m²
- CATCHMENT AREA B = 523m²
- CATCHMENT AREA C = 880m²
- CATCHMENT AREA D = 923m²

APPROVAL

rev.	drawn	chkd	apprvd.	date	description
01	SU	MJ	LR	18.02.21	ISSUED FOR APPROVAL.

Client
GBV PROPERTIES

Project
MARDON PARK PHASE 3

Title
SAB FLOW EXCEEDANCE & CONTRIBUTING AREA PLAN

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date	drawn	checked		approved	
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A	11250_SAB_502	01

DRAWING STATUS
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APPENDIX H: Planting Schedule

Bioretention Areas Planting Schedule:

Proposed new commercial unit at
Mardon Park, Baglan,
Neath Port Talbot,
SA12 7AX

Prepared for:

GBV Properties Ltd

REF: 11250-1

DATE: February 2021

Vale Consultancy
CONSULTING CIVIL & STRUCTURAL ENGINEERS

VALE CONSULTANCY
29 Bocam Park | Old Field Road
Pencoed | Bridgend | CF35 5LJ

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Document Control

Project	**Bioretention Areas for Mardon Park, Baglan**
Client	**GBV Properties Ltd**
Vale Consultancy Ref:	**11250-DSR-1**

Document Checking:

Prepared By:	**R Peskett**	**Signed:**	
Checked By:	**L Roberts**	**Signed:**	
Verified By:	**M Jones**	**Signed:**	

Issue	Date	Status
01	February 2021	First issue
02		
03		

1 Contents

1 Introduction

Sedges will make up most of the planting proposals and create habitat for a range of reptiles and invertebrates. The introduction of sedges and ferns will create a more simplified palette of plants able to cope with the change of soil conditions dependant on drainage surges.

The following list of plants have been selected as appropriate for use within the conveyance swales because of their resilience within the intended environment and will also contribute towards local biodiversity.

2 Planting Schedule

2.1 Marginals / Aquatics

Angelica Sylvestris 'Wild angelica'

Baldelia ranunculoides 'Lesser water plantain'

Botomus umbellatus 'Flowering rush'

Carex pendula 'Sedge'

Carex divulsa 'Sedge'

Carex pendula 'Sedge'

Iris pseudocorus / Iris laevigata

Lythrum salicaris 'Purple loosestrife'

Mentha aquatica 'Watermint'

Osmunda regalis 'Regal fern'

Ranunculus lingua grandiflora 'Greater spearwort'

Salix ca

Arum italicum *lords and ladies*

Botomus umbellatus *flowering rush*

Caltha palustris *marsh marigo*
Mentha aquatica *watermint*

Molinia caerulea *moor grass*

Myostis palustris *water forget-me-not*

Nymphaea alba *water lily*

Oenanthe fistulosa *tub*

2.2 Shrubs around the top edges of the features – the dry parts

Caryopteris clandon 'Heavenly Blue'

Lavandula angustifoia 'Hidcote'

Perovskia atriplicifolia 'Blue Spire'

Spiraea japonica 'Anthony Waterer'

Verbena bonariensis 'Purpletop vervain'

Ranunculus aquatis *water crowfoot*

Sparganium erectum *branched bur reed*

APPENDIX I: SuDS Maintenance & Management Plan

Management and Maintenance Plan for Sustainable Drainage (SuDS):

Proposed new commercial unit at Mardon Park, Baglan, Neath Port Talbot, SA12 7AX

Prepared for:

GBV Properties Ltd

REF: 11250-1

DATE: February 2021

Vale Consultancy

CONSULTING CIVIL & STRUCTURAL ENGINEERS

Document Control

Project	Mardon Park, Baglan
Client	GBV Properties Ltd
Vale Consultancy Ref:	11250-1

Document Checking:

Prepared By:	R Peskett	Signed:	
Checked By:	F Payne	Signed:	
Verified By:	L Roberts	Signed:	

Issue	Date	Status
1	February 2021	First issue

Contents

1. INTRODUCTION AND MANAGEMENT RESPONSIBILITIES

1.1. This SuDS Management and Maintenance Plan has been prepared by Vale Consultancy in support of a SuDS scheme for the proposed development of an industrial unit at Mardon Park, Baglan, Neath Port Talbot, SA12 7AX. The specification, planting regime and type of plants within the landscape features serving the development will be by specialists.

1.2. The proposal is for the development of a new commercial unit with associated parking and service yard within the 0.6ha curtilage of the site.

1.3. The scheme incorporates a sustainable drainage system for surface water runoff, which consists of infilled (stone) *CellWeb* and vegetated dry swales. The method for disposal of surface water runoff is infiltration.

1.4. The purpose of this document is to set out the overall management objectives for the common external areas and retained structural vegetation within the dry swales and to describe the long-term maintenance required to allow the planting to flourish and reach its design potential.

1.5. All references to planting treatments are based on the SAB submission drawings:

- *11250-500: Drainage Layout*
- *11250-501: Drainage Details*

1.6. Maintenance is to be carried out by Greenwise Construction.

2. MANAGEMENT RESPONSIBILITIES

2.1. Greenwise Construction shall be responsible for the implementation of the Landscape Management and Maintenance Plan. If deemed necessary, all landscape operations shall be undertaken by a suitable and qualified landscape contractor appointed by the Site Owner. The site will be owned by GreenWise Construction.

2.2. All inspections and maintenance work must be recorded. This allows for future assessment of the maintenance activities and their response to the system. It can also provide protection against legal claims should the system be exceeded in a storm event leading to flooding elsewhere.

3. MANAGEMENT OBJECTIVES

2.1. The site shall be managed and maintained as an attractive, tidy, and safe finish to all landscape elements. The proposed structure planting will give a cohesive site character, provide a visual buffer, and provide green framework to the newly built development.

2.2. The proposed planting shall enhance the biodiversity and nature conservation interests.

2.3. The Site Owner shall ensure establishment and long-term health of all landscape elements for the benefit of the site occupants and visual amenity of the area.

2.4. Best Health & Safety practices shall always be used.

2.5. To monitor standards and make amendments where required, it is expected that the Site Owner will review the management work (with reference to this document) at least quarterly for the first year and annually thereafter.

3 INSPECTION AND MAINTENANCE ACCESS

3.1. Access for inspection and maintenance can be gained from Mardon Park, off Central Avenue. Parking and access are incorporated into the proposed development. This can be utilised and will provide parking and access for maintenance vehicles and any necessary machinery required for maintenance.

4 MAINTENANCE VISITS OR INSPECTIONS

4.1. The Site Owner or appointed maintenance contractor shall carry out a minimum of 20 maintenance visits or inspections per year to check drainage components and ensure plant establishment and health. Visits shall be twice monthly during March to October, and monthly during the rest of the year. Additional visits may be needed to deal with extreme weather conditions or specific horticultural requirements.

5 GENERAL

5.1. All materials and workmanship are to be to the highest possible standards and shall be in accordance with relevant British Standards, good horticultural and arboricultural practices, and the landscape specification.

5.2. The Site Owner shall employ suitably qualified staff for all work and when using sprays and mechanical equipment. All equipment shall be kept in a sound condition, fit for use and purpose.

5.3. The Site Owner and their appointed contractors shall comply with all relevant Health and Safety regulations and good working practices.

5.4. The Site Owner / appointed contractor shall take care when work is beside any structure or paved area and will, at their own cost, be responsible for making good any damage caused.

5.5. All work shall be carried out while soil and weather conditions are suitable.

5.6. Weeds, pruning's, leaves, rubbish and other arisings shall be removed from site for composting, where possible. No material shall be left on site, and the area shall be left in a neat and tidy condition after each visit.

5.7. Entomological or disease infestation shall be dealt with as required and shall be checked at each visit. Control shall be either by spraying with approved chemicals, pruning all dead wood by cutting back to an outward pointing bud or by removal of the affected plants.

5.8. Watering during the first two years after planting may be necessary during times of drought in summer months and, when watering is required, it shall be carried out on a regular basis to suit climatic conditions. If conditions are severe or soils are particularly free-draining, careful monitoring and more frequent watering may be necessary to maintain good plant health and avoid plant failure.

5.9. All shrubs / hedges shall be pruned to remove deadwood, overhanging / tangled and damaged branches. Winter flowering shrubs shall be pruned in spring. Shrubs flowering in March-July shall be pruned immediately after the flowering period and shrubs flowering in July-October shall be cut back to old wood in winter. Shrubs that require spring pruning to provide seasonal colour shall be pruned in March and shrubs that require seasonal pruning to promote continual flowering will be pruned appropriately.

5.10. Plants shall be re-firmed when necessary to ensure that plants are securely planted and upright.

5.11. Bark mulch levels shall be maintained, being topped up when necessary to a minimum depth of 50mm. Any spillages shall be swept back on to the bed from surrounding areas, ensuring no plants are smothered.

5.12. Edge valleys in beds shall be maintained to reduce mulch spillage and grass edges shall be cut at each maintenance visit.

6 ORNAMENTAL PLANTING

Specific objectives:

- To ensure early establishment and healthy growth
- To maintain a dense canopy cover
- To maintain year-round appearance and visual interest

Maintenance Operations:

6.1. All bioretention areas shall be maintained substantially free of weeds. Work shall be done either manually or with appropriate selective weed killer in accordance with manufacturer's recommendations. If weed killer is used the dead weeds shall be removed at the next maintenance visit. Care must be taken to avoid damage to adjacent planting and grass and replaced immediately if affected by weed killer.

6.2. Once established, shrubs shall be selectively thinned or reduced in height as appropriate by removal or pruning to allow room for growth and avoid overcrowding / overshadowing and create a natural form rather than cube or cloud shapes. Care shall be taken to avoid over

pruning and so creating obvious gaps in the shrub beds.

6.3. Ground cover plants shall be clipped or pruned if necessary, to give a neat and tidy finish and contained within the planting bed. Work to remove dead vegetation shall be carried out during the winter months.

6.4. Pruning of herbaceous planting:

In spring cut stems close to the 'crown' or 'dormant' top of the plant, avoiding the removal of new shoots.

- Tidy up the base of the plant, removing dead foliage and debris.
- Remove all material from site.
- Apply a 50mm layer of fine horticultural mulch. This will help moisture retention in the soil, contribute to weed suppression and allow delicate stems to grow.
- Leave dried flower head over winter for relevant species e.g. ornamental grasses.

6.5. Fertilising:

- One application, just before or at the time of spring growth.
- A balanced fertiliser is required, one high in Phosphorus (which encourages blooming as well as strong roots and disease resistance). Fertilisers high in nitrogen should not be used as nitrogen promotes excess foliage at the expense of flowers and roots which can result in weak stems

7 GRASSED AREAS

Specific objectives

- To create an attractive grass sward with height and colour
- To provide habitats for reptiles, insects, bees & butterflies

Maintenance Operations

7.1. Refer to the planting schedule for guidance on the proposed extent of grass/plants to be used in the swales.

7.2. Cutting to be carried out using appropriate large wheeled, rotary mower to avoid injury to reptiles unless specified otherwise.

7.3. Remove any litter, debris, stones, and earth clods larger than 25mm in any dimension prior to mowing.

7.4. Sward heights to be kept to minimum 5cm with two cuts per year in May and September after the first year.

7.5. No fertiliser or nutrients to be added.

7.6. Top dress if required with additional appropriate native origin seed if slow to establish.

7.7. When necessary grass areas shall be sprayed with a suitable approved selective herbicide in accordance with the manufacturer's recommendations to control injurious or invasive weeds. Alternatively, spot treatment weeding of isolated weed growth may be carried out by hand or herbicide application. All arisings shall be removed from site.

7.8. Reinstatement by re-seeding of damaged, defective, or bare areas shall be carried out as appropriate. Any dips or holes within the grass shall be filled as above to restore even falls and reseeded, as necessary.

7.9. Where necessary compacted areas shall be aerated with appropriate equipment in autumn.

7.10. Depressions to be filled in over time by adding a top dressing and over-seeding, using a sandy soil.

7.11. Year One

- First cut to 5cm March/April (Spring Seeding 1st cut in May)
- Cut every 2 months or when sward reaches 15cm
- Final cut September/October
- Allow cut grass to dry and disperse seed before removing arisings
- The requirements in the first year are to control weeds and reduce competition from grasses. Cut the sward to a height of 5 cm every two months or when the sward reaches 15 cm. Remove all cut material to avoid smothering the sward. Where persistent weeds are a problem, spot treat with Glyphosate or dig-out

7.12. Future years

- One cut in May and September to 5cm
- Remove all cuttings
- Allow cut grass to dry and disperse seed before removing arisings
- The requirements in future years is to maintain a species diverse sward of value to wildlife

7.13. The site may require further cuts in the autumn period to remove untidy growth in an extended growing season.

8 PLANT REPLACEMENT

8.1. An annual inspection of trees and shrubs shall be undertaken in September of each subsequent year after planting to assess the condition of stock and prepare a list of necessary remedial work and replacement planting. Replacement planting shall be implemented in

accordance with the planning requirements.

8.2. All work shall be carried out by appropriately qualified horticultural operatives with adequate insurance. All work shall be carried out in accordance with good horticultural practice and B.S. standards. All debris arising from the works shall be removed from site.

8.3. Any new replacement planting shall be tagged so the local SAB, the Site Owner are aware that these plants will have a further one year's defect liability period.

8.4. Replacement shrub planting shall take place in the following November-February, dormant winter period during suitable weather conditions. All stock shall be of the same size and species as originally specified.

8.5. Approval of all remedial and replacement work shall be obtained before commencing any remedial work.

9 LITTER COLLECTION

9.1. All hard surfacing shall be swept as necessary, and all rubbish removed from site.

9.2. Litter picking/clearance shall take place during each maintenance visit and all waste shall be removed from site.

9.3. During autumn maintenance visits all fallen leaves shall be collected and removed from site.

10 HARD SURFACES

11.1. A common-sense approach to the maintenance of the *CellWeb* will be adopted, the maintenance program as outlined as follows and is designed to ensure the structural and hydraulic performance of the *CellWeb* system.

11.2. The management company is to inspect each of the respective assigned areas of the hard landscape for which they have responsibility on a six-monthly basis to identify and repair any damaged areas.

11.3. Seasonal maintenance (leaf and snow clearance, de-icing). To be proactively managed with the checking of weather reports.

11.4. Surfaces to be always kept weed and litter free. Spray paved areas every 5 years or as required with herbicide to keep weed free.

11.5. Drainage systems associated with hard surfaces to be inspected annually and maintenance work undertaken, as necessary.

11.6. Visually inspect the surface on a regular basis typically 2 per year (Spring and Autumn). Ensure no displacement of any organic matter has occurred on the surface, particularly after heavy precipitation. The paving should be agitated (e.g. brushed, vacuumed, etc.) at least once a year, ideally in the spring to ensure no vegetation of any sort can grow and develop in the voids.

Note: If the infiltration rate of the paving becomes prolonged, allowing ponding to develop, the laying course material may require cleaning/replacing. This should happen every 35-50 years.

11.7. Repair any subsidence or breakages promptly in accordance with best practice, manufacturer's guidance and using matching materials.

11.8. Inspect and repair all edging on a regular basis making good any damage or wear promptly to maintain the good upkeep of the development.

11 TRADITIONAL DRAINAGE

12.1. A monthly site inspection should be carried out, checking for any areas that are not operating correctly and collecting/removing litter and debris.

12.2. All rainwater pipes, linear drains, gullies and inspection chambers should be inspected biannually, typically spring and autumn.

12.3. Any excessive sediment build-up in rainwater pipes, linear drains, gullies or inspection chambers causing blockage or poor performance shall be cleared and cleaned as required.

12 SUMMARY OF INSPECTION AND MAINTENANCE

14.1. The following briefly summarises the frequency and type of inspections and maintenance required for the SuDS components and drainage system used in this scheme:

14.2. General

- General inspections of SuDS areas (swales, *CellWeb* paving, inlets and outlets) – every 2 weeks between March to October and monthly for the rest of the year and shall include litter collection.
- Biannual check of traditional drainage including rainwater pipes, linear drains, gullies and inspection chambers.

14.3. Stone infilled *CellWeb*

- Initial inspection – within 3 months of completion
- Visual inspection - 2 times a year
- General brushing of surface - once a year
- Weed removal – as required
- Remediate areas of Rutting and depressions – as required
- Rehabilitate surface with brushing and water jetting when clogging becomes apparent – as required, typically every 10 - 15 years
- Replace surface and binder layers if rehabilitation fails due to significant clogging – expect every 50 years
- Inspection for performance and clogging and ancillary drainage components – once

a year

14.4. Bioretention areas (Swales)

- Inspect surfaces for silting and ponding, record de-watering time to determine if any remedial work is required – annually
- Pruning, weed removal and plant replacement, assess plants for disease infection, poor growth and invasive species – annually
- Inspect inlets for damage or blockage at general inspections
- Clear inlet/outlets of sediment build-up – as required

13 LIFETIME MANAGEMENT AND MAINTENANCE COSTS

15.1. The costs associated with the management and maintenance of the SuDS system over the 60-year design life of the scheme has been estimated based on the inspection and maintenance activities in section 14 are as follows:

15.2. General

- General 2 weekly inspection (incl. litter removal) – 1 hour for each inspection – 1560 inspections over 60 years @ £15 each - £23,400
- Biannual check of traditional drainage including rainwater pipes, linear drains, gullies and inspection chambers @ £15 each - £1,800

15.3. CellWeb

- Annual brush/sweep – 60 sweeps at £0.12 / m² x 186m² - £1340
- Weed kill every 5 years @ £0.90 / m² x 186m² - £2008
- Brush/water jetting rehabilitation every 15 years @ £2.50 / m² x 186m² - £1860

15.4. Bioretention Areas (swales)

- Annual pruning / fertilising and inspection for plant replacement over 60 years @ £70 / day - £8,400

15.5. The total sum of management and maintenance costs for the proposed SuDS over a 60-year design life - £38, 808 or circa £646 a year

Appendix A

Imported topsoil criteria

Reference documents BS 8545 2014
BS 3882 2015
BS 8601 2012
BS 3998 2010
BS 5837 2012
BS 4043 1989
BS 4428 1989
BS 3936-1 1992

Defra leaflet: *CONSTRUCTION CODE OF PRACTICE FOR THE SUSTAINABLE USE OF SOILS ON CONSTRUCTION SITES*

Imported Topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds. Imported Topsoil shall meet the following physical and chemical criteria:

- Soil texture: loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 55%.
- pH value shall be between 5.5 and 7.0.
- Percent organic matter (OM): 2.0-5.0%, by dry weight.
- Soluble salt level: Less than 2 mm ho/cm.
- Soil chemistry suitable for growing the plants specified.
- Imported Topsoil shall be a harvested soil from fields or development sites. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where Coarse Sand, composted organic material or chemical additives has been added to the soil to meet the requirements of this specification section shall not be acceptable. Retained soil peds shall be the same color on the inside as is visible on the outside. Imported soil must be supplied with Product data and certificates: For each type of manufactured product, submit data and certificates for the product.