Sustainable Drainage

Design Statement

One Healthcare Hatfield

Revision 2.0

May 2016

The Environmental Protection Group

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Contents

1. BACKGROUND

1.1 General

One Healthcare is constructing a new private healthcare facility on vacant land at Plot 6000, Hatfield Business Park, located off Hatfield Avenue, Hatfield. The proposed development comprises approximately 3800m^2 of buildings and 4420m^2 of hard-standing consisting of car parks, access roads, service yards and footpaths. The site is immediately bounded to the north by Manor Road, with residential properties beyond, an existing Porsche car show room is present to the south east and Hatfield Avenue to the southwest, with mainly office premises beyond.

A site investigation report *Plot 6030, Infiniti, Hatfield Business Park-251188-01 (00)* prepared by RSK for the south-western half of Plot 6000 is the most recent investigation report available at the time of compiling this report.

This RSK report states that the predominant ground conditions are:

- 0-0.23m bgl of Clayey Topsoil over
- 0.16-2.3m bgl of Glacial Till – slightly sandy Clay
- 1.3-9+m bgl of Glacial Outwash – occasionally clayey, gravelly Sand
- >20m bgl Lewis Nodular Chalk / Seaford Chalk Formation (Upper Chalk)

The measured infiltration rates for the Glacial Outwash near the top surface is recorded as 3.22E-5 m/s.

Based on the recorded soil strata, it is considered that disposal of surface water via soakaways is feasible on this site in conjunction with a limited discharge (refer below).

Plot 6000 has existing surface and foul water connections to the business park's private drainage systems. The connections are located under the existing entrance in the southern corner of the site. The existing greater development-wide SuDS drainage system consists of a network of over-sized large pipes that discharge into two balancing ponds to the west of the site, which eventually connect to the public drainage network via flow-controlled discharges. The business park management company have stated that the existing Business Park SuDS drainage system has been designed to receive a peak discharge surface water discharge of 55 l/s from the proposed Plot 6000.

1.2 Sustainable Drainage Systems (SuDS)

The use of sustainable drainage systems to reduce the impact of development on the natural water environment has become increasingly common over the past decade, in response to government guidance and the proactive approach of regulatory agencies such as the Environment Agency (EA) and the National Planning Policy Framework. Limited discharge consents for surface water outfalls are now routinely applied to development sites across the UK and the rate of water leaving development sites is controlled using storage techniques such as ponds, tanks and pervious pavements. The volume of water is also reduced by using infiltration techniques such as soakaways, where ground conditions permit.

Runoff from developments contains a cocktail of pollutants including hydrocarbons, heavy metals and organic material and these reduce the quality of water entering rivers and streams and harm wildlife. It must be addressed by the development industry and site-specific drainage solutions need to be developed that provide an appropriate combination of SuDS features to effectively remove pollution and adequately control run-off volumes to prevent potential flooding to property and infrastructure both within and beyond each development.

The majority of pollution occurs from relatively frequent rainfall events (less than 1 in 1 year return period) or from the first part of larger events (known as the first flush) and these need to be captured and treated. Thus the performance of the SuDS needs to be assessed for a wide range of storm events. The SuDS system should also seek to provide bio-diversity and amenity benefits and the use of features such as ponds and swales in conjunction with specific plant species can often provide habitats for wildlife species that have been identified within local conservation action plans. These can often (but not always) be effectively designed into a drainage scheme by utilising space that is already earmarked for landscaping. However site levels, local topography and the nature of the development will dictate how feasible or desirable it is to include such surface SuDS features.

2. DRAINAGE PROPOSALS

2.1 Engineering Challenges

The key engineering challenges for this site from a drainage design perspective are:

- The permeable gravel outwash strata horizon is located 1.3 - 2.3m bgl
- The existing discharge chamber is shallow relative to some areas of the site
- This healthcare development is to be constructed in two phases

Accordingly, EPG has reviewed the information provided and considered an approach based on previous experience of similar sites and current SuDS guidance provided in the NPPF, CIRIA C609, CIRIA C635, CIRIA C697, (Environment Agency Report P2-261/20/TR) and similar specific SuDS guidance documents, which recommend a hierarchical approach to the management of potentially contaminated surface water, with the emphasis on the use of Source Control techniques and a treatment train as the preferred option.

2.2 Design Parameters

The following hydraulic and treatment parameters have been used within the design:

Location:	Hatfield	
FSR Data		
M5-60 rainfall depth:	20	mm
Rainfall ratio, r:	0.43	
Hard run-off areas:	4419	m^2
Roof run-off areas:	3771	m^2
Storm Events:	100	year return period – critical duration
Climate Change Factor	20	%
Infiltration rate:	6.02	$x10^{-6}$ Upper Glacial Till Clay
	3.22	$x10^{-5}$ Gravel Outwash
Peak discharge allowance:	55	l/s-maximum to development wide SuDS
Runoff coefficient roofs:	95	%
Runoff coefficient hard surfaces:	90	%
Long term storage volume	53	m^3

Min number of treatment stages: Roof & Un-trafficked Areas – One; Trafficked Areas- Two.

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3. OVERVIEW OF DRAINAGE PROPOSALS

3.1 Outline design

The outline drainage design proposed is shown in Figure 1.

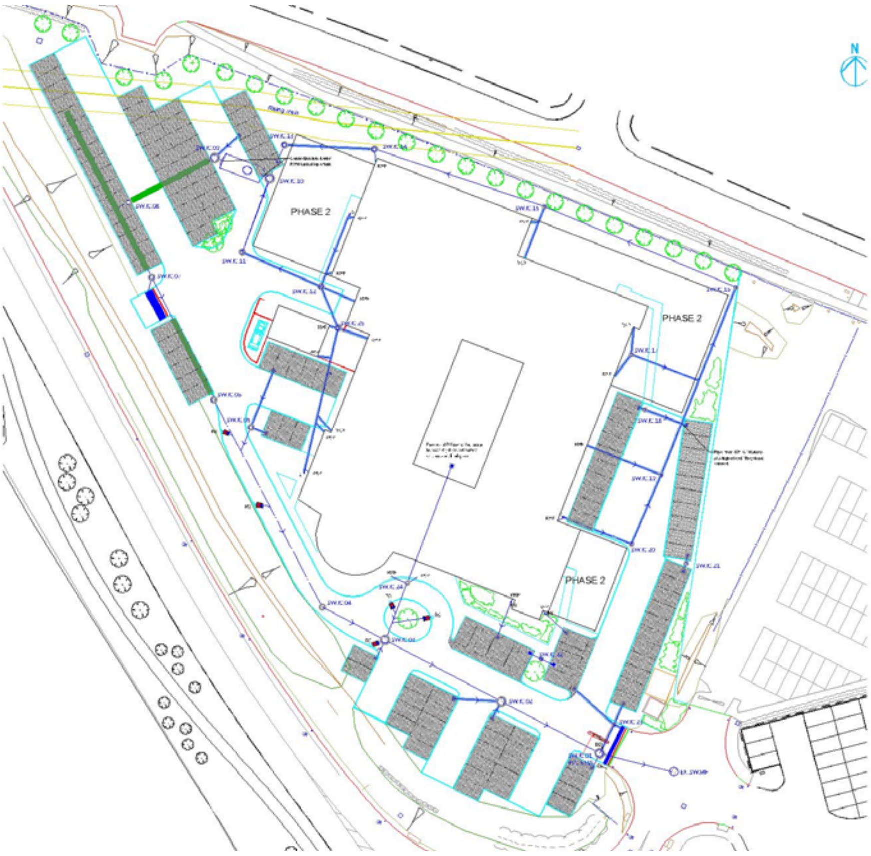

Figure 1 Latest layout and proposal

The rationale surrounding the proposed layout is based on achieving source control treatment of the run-off from potentially contaminated surfaces such as car parks, whilst optimizing the layout to overcome infiltration and level issues. The proposal is also based on positioning the storage around the site such that storage is provided as close to source as is feasible. By introducing source control systems (rather than end-of-pipe treatment) it is possible to minimise construction depths, reduce pipe sizes and minimize construction risks.

Therefore the SuDS has been designed so that the surface water runoff from the east, north and west roofs will be collected and conveyed by pipework via catchpit inspection chambers to a 40000 litre rainwater harvesting tank located under the main west car park to the west of the building. The stormwater that overflows form this RWH tank will be discharged to a series of geocellular infiltration trench conduits. The stormwater is stored in the infiltration conduits until it can infiltrate into the gravel outwash soils below the site. This provides the required 53m^3 of long term storage to be discharged via infiltration. The west car park runoff is directed via surface falls onto permeable block paved parking bays where the stormwater quickly percolates into the porous sub-base storage layer below. The stormwater is then drained from the porous sub-base by a hydraulic aggregate connection to the infiltration trenches below. The excess stormwater in the infiltration trenches overflows to the piped drainage system, via a flow control chamber and is conveyed to the final flow control discharge chamber. In higher-order storm events the stormwater will surcharge out of the infiltration conduits and be temporarily stored in the porous sub-base below the parking bays until the storm subsides. The run off from the southern access road is collected by standard road gullies fitted with Permaceptor mini-interceptors. The southern roof runoff is collected in rainwater pipes and discharged to the conveyance pipework via either back inlet gullies or catchpit inspection chambers. The south and east car parks are designed to drain by permeable block paving in a similar manner to the west car park; however the stormwater is drained from the porous sub-base layer via Permavoid collectors. The site entrance is drained by a line of Permachannel slot drain and into a conduit that incorporates the Permavoid BioMat floating treatment system before linking into an adjacent permeable sub-base storage layer and then flows through the system to the collection points. The stormwater is collected by Permavoid diffusers and then conveyed in pipework via inspection chambers to a final discharge chamber fitted with a Permafilter-protected orifice flow control on the outlet that limits the discharge to 55 l/s. The stormwater is discharged from the site into the private development-wide SuDS drainage system via a new connection into the existing surface water manhole located beneath the roundabout to the southeast of the site.

The technical aspects of the treatment and hydraulic control of this design will be covered in more detail in the following sections of this report.

3.2 Pollution Removal

The site requires a minimum of two levels of treatment. The proposed treatment train provides this level of treatment at this site as follows:

1. Pervious Block Paving, Permachannel and Biomats in the Permavoid units or Permaceptor mini interceptors– 1 treatment stage

2. Geocellular Infiltration trenches encapsulated in Permafilter oil treating geotextile– 1 treatment stage.

The specific technical aspects of each of the treatment stages listed above are detailed below:

Combined collection and silt/oil separation/treatment channels (Permachannel)

The Permachannel is designed to collect water from a small impermeable area. The channel is isolated into 1m long sections and water does not flow along it like a normal channel drain. This prevents the development of high flow velocities along it. Its initial function is to 'still' the sheet-flow from each sub-catchment and to encourage silt deposition along the length of each channel. The outlets discharge from the side of the channel via a weir and baffle component, which separates oils and prevents the effluent and silt from progressing beyond the channel into the rest of the drainage system. A schematic of how this occurs is shown in Figure 2.

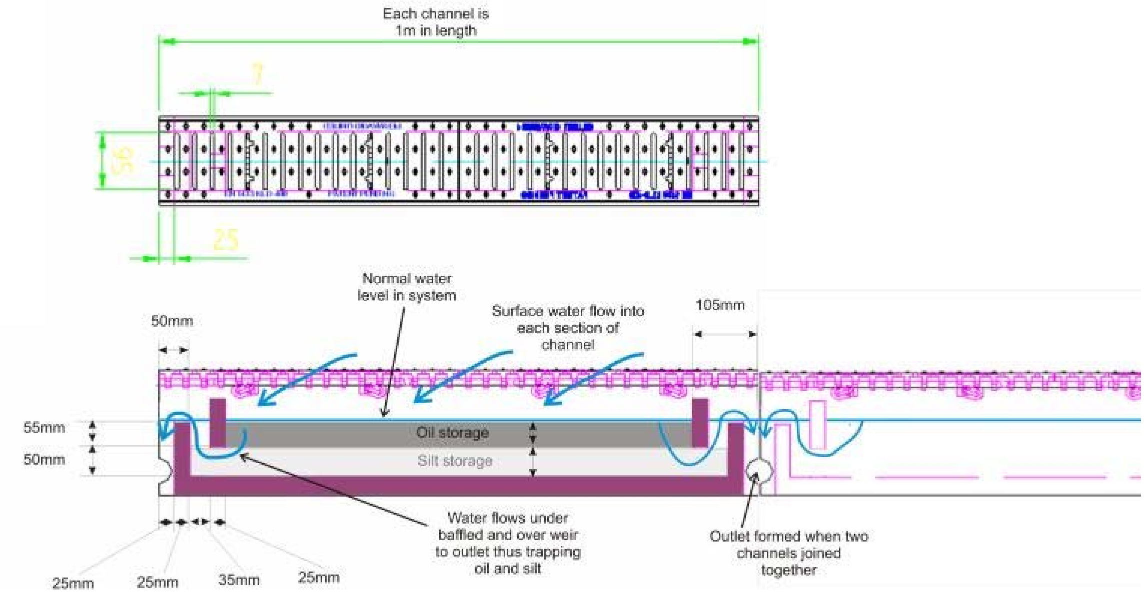

Figure 2 Silt and oil removal in the Permachannel system

The key benefits of this form of interception and treatment at source is the prevention of the development of high silt and effluent loadings within the drainage system, typical of conventional end-of line interceptor/separator systems. Consequently the effluent loading within the channels is very low and is degraded within the channels by natural aerobic processes.

Furthermore, due to the instant velocity control, emulsification of oils is reduced. The designed effluent treatment levels would be well within PPG3 requirements and outperform Class 1 interceptors/separators. Silt loading calculations demonstrate significant redundancy to take account of potential long-term (several years) maintenance neglect; also as the Permachannel traps oil and contaminated silt in an aerobic environment these are subject to biodegradation. The Permachannel system is typically used for the collection of potentially contaminated run-off from surfaces of car parks, access road or similar, and replaces the requirement for any conventional oil/petrol interceptors. It is equivalent to a permeable pavement or filter drain in its performance and ease of maintenance.

Floating Oil Treatment (Permafilter Bio-Mat)

Permafilter Bio-Mats are provided in the row of Permavoid units immediately adjacent to the Permachannels. The mats comprise a high strength, low density, oil attracting geosynthetic layer that floats on water and is designed to intercept and treat potential residual oils that may be present within emulsified surface water. The floating mats are pre-installed within the Permavoid units and are typically located adjacent to the water entry points from the Permachannel system to provide a second stage of treatment. The mats move up and down inside the boxes as the water level changes and provide a base for bacteria to degrade the oils. The performance of the mats and the establishment of bacteria on them have been demonstrated by testing at Coventry University.

Mini silt/oil source control gravity separators (Permaceptor)

Permaceptors are lightweight, high strength mini silt/oil separators designed to be incorporated within the pavement construction zone adjacent to road/yard gullies. The system would be connected to the outlet pipe from the gully and incorporates prefabricated weir and baffles to separate floating oils. A schematic of how this occurs is shown in Figure 3.

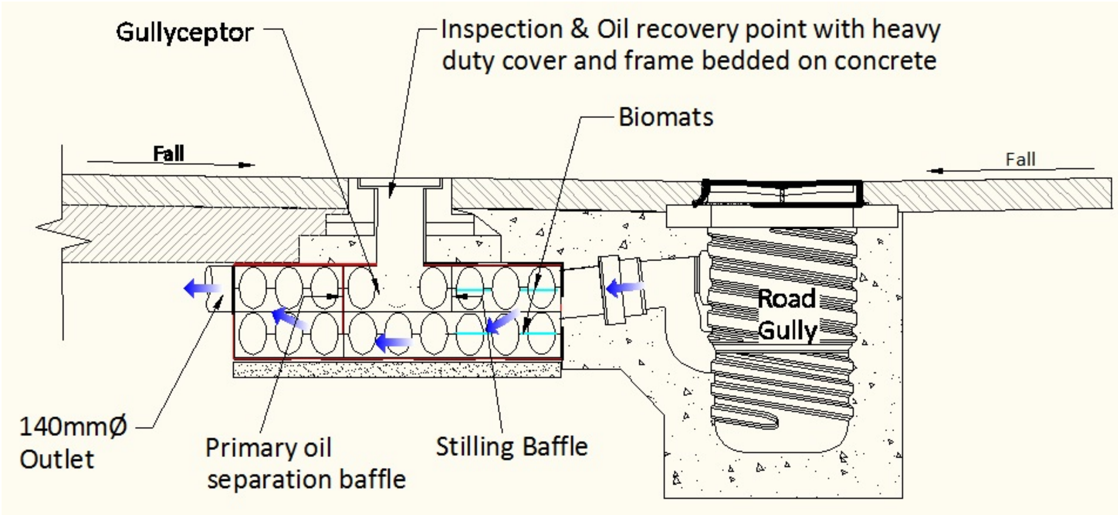

Figure 3 Silt and oil removal in the Permaceptor

Permaceptor gullies are a very efficient and effective source control treatment of sub-catchment run-off to meet the requirements of PPG3 treatment levels. These devices are proposed within the car park, where levels and falls are appropriate. The Permaceptor gullies are spaced to suit run-off volumes and silt/effluent loading requirements. Use of the Permaceptor system replaces the requirement for any conventional oil/petrol interceptors.

Permeable Concrete Block Paving

Permeable concrete block paving has an extensive track record as an effective sustainable drainage system providing direct infiltration, filtration and treatment of daily effluent loadings associated with car park run-off. The primary treatment mode is via filtration of the rainwater as it percolates between the paving blocks down through the sand bedding and treatment geotextile. Once the contaminated silt and oils are captured they are kept in an aerobic environment where they are degraded by naturally occurring bacteria.

Also due to the excellent percolation rates through the permeable block paving adjacent rainwater down pipes can discharge directly onto the surface of the block paving, which then provides the primary treatment stage.

The final pavement design will comply with ‘BS 7533’ and will depend greatly upon the strength and nature of the underlying soils.

Oil separation and retention and filtration via specialised geotextiles (Permafilter SuDS Geotextile)

The Permafilter SuDS geotextile is to be wrapped around the base and sides of the Permeable paving and infiltration trenches where the stormwater is discharging via direct infiltration. It comprises a non-woven, dimpled, needle punched geotextile that has been specifically designed for hydrocarbon pollution treatment in civil engineering applications (such as filtration, drainage and pavement reinforcement). The dimpled geotextile comprises a proprietary blend of polyester fibres that incorporate hydrophilic/oleophobic (water attracting / oil repellent) and hydrophobic/oleophillic (water attracting / oil repellent) properties to achieve oil retention to the upper surface. The Permafilter geotextile is capable of retaining oil contamination ranging from daily car drip losses up to catastrophic spillages e.g. originating from car oil-sump failures. The entrapped hydrocarbons are biodegraded by naturally occurring micro-organisms providing a self-cleansing and maintenance free mechanism.

Back Inlet Gullies

The rainwater down pipe discharges will be collected by back inlet gullies at the base. The back inlet gullies will still the flow of stormwater to allow the settling of silts in the gully pot. The back inlet gullies will also have an internal filter screen on the outlet to prevent larger detritus elements passing forward into the SuDS system.

Catchpit Inspection Chambers

Catchpit inspection chambers are a traditional SuDS device that reduces the velocity of the flow of stormwater flowing through the chamber to allow the settling of detritus and silts in the pit at the bottom of the inspection chamber.

3.3 Hydraulic conveyance and control

The SuDS system is designed to store below ground a 100yr return period storm event plus an additional 20% for climate change. System is designed to discharge via both infiltration and by a controlled discharge to the nearby existing private SuDS network.

The 53m3 of long-term storage identified in the Flood Risk Assessment Report is provided in the geocellular infiltration trenches and is discharge via infiltration.

The technical aspects of the hydraulic conveyance and control of the proposed SuDS are given below:

Modular Plastic Sub-Base Replacement Units (Permavoid)

Runoff from the entrances would be collected by Permachannel treatment channels and discharged to the adjacent Heavy Duty Permavoid attenuation conduit.

The Permavoid is a 150mm thick modular interlocking plastic unit storage system designed for use as a combined drainage component and sub-base replacement system and as such has exceptionally high compressive strength and bending resistance within joints to create a horizontal structural 'raft' within the pavement that is ideal for the shallow infiltration /attenuation.

The overlying pavement layers can be as slender as 130mm and the overall pavement as slender as 280mm, depending on the nature of traffic loading and underlying soil CBR values; the modular layer also insulates the pavement and avoids frost problems even in pavements less than 450mm thickness. The modules have a very high void ratio (95%) to achieve highly efficient water storage capacity.

Plastic Sub-Base Replacement Diffuser Units (Permavoid)

Runoff from the building roofs would be collected into downpipes and flow into either back inlet gullies incorporating an internal filter at the base or catchpit inspection chambers. The back inlet gullies or chambers discharge the filtered stormwater into the permeable sub-base via Heavy Duty Permavoid diffuser units encapsulated in a 2mm mesh fabric. The runoff will then diffuse out of the Heavy Duty Permavoid diffusers and into the modified granular sub-base layer. The Permavoid is a 150mm thick modular interlocking plastic unit storage system designed for use as a combined drainage component and sub-base replacement system and as such has exceptionally high compressive strength and bending resistance within joints to create a horizontal structural 'raft' within the pavement that is ideal for the shallow infiltration /attenuation.

The overlying pavement layers can be as slender as 130mm and the overall pavement as slender as 280mm, depending on the nature of traffic loading and underlying soil CBR values; the modular layer also insulates the pavement and avoids frost problems even in pavements less than 450mm thickness. The modules have a very high void ratio (95%) to achieve highly efficient water storage capacity.

Road Gullies with Permaceptors

Where levels and falls dictate Road Gullies with Permaceptors and diffusers are proposed. Permaceptors are lightweight, high strength mini silt/oil separators designed to be incorporated within the pavement construction zone adjacent to road/yard gullies. The system would be connected to the outlet pipe from the gully and incorporates prefabricated weir and baffles to separate out pollutants. The Permaceptor then discharges the treated stormwater to SuDS system by a 150mm diameter pipe connection.

Permeable Concrete Block Paving

Permeable concrete block paving has an extensive track record as an effective sustainable drainage system providing direct capture and infiltration, of car park run-off. The surface water is directed by surface falls onto the permeable block paving where it quickly percolates between the paving blocks down through the sand bedding and treatment geotextile, into the permeable sub-base infiltration layer below.

Also due to the excellent percolation rates through the permeable block paving adjacent rainwater down pipes can discharge directly onto the surface of the block paving.

The final pavement design will comply with 'BS 7533' and will depend greatly upon the strength and nature of the underlying soils.

Modular, Plastic Infiltration/Conveyance Tank Units

The captured stormwater from the roof and west car park area is then stored in Medium Duty geocellular units that comprise medium duty modular interlocking plastic water storage and conveyance units formed into shallow infiltration trench/tank structures. The will be encapsulated in the Permafilter SuDS geotextile.

The cover to these units can be as little as 300mm in non-trafficked areas, depending on the nature of traffic loading and underlying soil CBR values; the modular layer also insulates the pavement and avoids frost problems. The modules have a very high void ratio (95%) to achieve highly efficient water storage capacity.

Orifice Plate Flow Controls, and Protection Filters.

Flow controls are provided within the system at suitable points to ensure that water is held back and temporarily stored in the permeable sub-base. Each orifice is sized to give a proportion of the discharge rate appropriate to the drained area (sub-catchment) and the available storage volume. Orifice plates are used as they are simple flow control devices that restrict the flow of surface water through a conveyance system by narrowing the area the water can flow through at the entry to pipe-work. They are particularly appropriate in shallow drainage systems where the effect of large differences in hydraulic head on flow rate is negligible. For pre-screened surface water systems such as this one, orifice plates of diameters less than 100mm require a protection filter to protect the orifice from debris/ detritus that may make its way into the system. Permafilter flow controls incorporate removable protection filters on the upstream side of the orifice plates, where the orifice diameter is less than 100mm diameter to prevent clogging of the orifice.

4. CONCLUSIONS

The proposed SuDS design meets the requirements of the SuDS Manual.

The SuDS system is designed to store below ground a 100yr return period storm event plus an additional 20% for climate change. System is designed to discharge via both infiltration and by a controlled discharge to the nearby existing private SuDS network.

The site requires a minimum of two levels of treatment. The proposed treatment train provides this level of treatment at this site as follows:

1. Pervious Block Paving, Permachannel and Biomats in the Permavoid units or Permaceptor mini interceptors– 1 treatment stage

2. Geocellular Infiltration trenches encapsulated in Permafilter oil treating geotextile– 1 treatment stage.

As the system is shallow and close to the surface, it is easy to maintain (no more difficult than filter drains or permeable paving). If it clogs with silt localised ponding of water occurs on the surface to warn the owners of the site that maintenance is required. Water is diverted to adjacent channel sections where it will still be treated.

Storage is provided in a combination of geocellular infiltration conduits and shallow sub-base attenuation below the permeable parking bays across the site. The flow of water is controlled using strategically placed orifice plate controls at various points around the site to maximise the storage in each sub-catchment.

The 53m3 of long-term storage identified in the Flood Risk Assessment Report is provided in the geocellular infiltration trenches and is discharge via infiltration.

The proposed surface water drainage system combines conventional drainage principles and components with proprietary collection and attenuation systems. However, the use of source control treatment devices and shallow local to source tanks affords the following benefits:

From a design perspective, the above approach offers several general advantages including:

- The ability to adopt ‘source control’, a cornerstone of sustainable drainage ethos
- Infiltration discharge of the long-term storage volume
- H&S/CDM benefits associated with shallow non man-entry drainage

The positive impact of this design approach from a construction perspective includes:

- Reduction in excavation volumes and depths
- Reduction in construction time
- H&S/CDM benefits associated with predominantly shallow non man-entry excavations