

Drainage Strategy Report

The Former Kings Beach Hotel

The Parade, Pagham, Bognor Regis PO21
4TW

for

Hall Developments Hardwick Road
Ltd (Hallson Homes)

A18237C

July 2018

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1.0 Introduction

1.1.1 Hall Developments Hardwick Road Ltd (Hallson Homes) is planning a proposed development on the site at The Former Kings Beach Hotel, The Parade, Pagham, Bognor Regis PO21 4TW.

1.1.2 The Planning Application (reference P/4/18/PL) was approved with conditions. Condition No.4 relates to drainage as follows:

"Planning Condition 4: Development shall not commence until full details of the proposed surface water drainage scheme have been submitted to and approved in writing by the Local Planning Authority. The design should follow the hierarchy of preference for different types of surface water drainage disposal systems as set out in Approved Document H of the Building Regulations, the recommendations of the SUDS Manual produced by CIRIA. Winter groundwater monitoring to establish highest annual ground water levels and Percolation testing to BRE 365, or similar approved, will be required to support the design of any Infiltration drainage. No building shall be occupied until the complete surface water drainage system serving the property has been implemented in accordance with the agreed details and the details so agreed shall be maintained in good working order in perpetuity."

1.1.3 The Stilwell Partnership has been instructed by Hall Developments Hardwick Road Ltd (Hallson Homes), to produce a Drainage Strategy report to support the Planning Application.

1.1.4 This report aims to demonstrate whether the development is at risk of any form of flooding. Also, that a reduction in surface water run-off from the site can be achieved.

1.1.5 An initial drainage strategy was undertaken by Opus International to support the Planning Application. This report will supersede the findings of that report and refer to any agreed principles taken forward in the design.

1.1.6 The general limitations of this assessment are that:

- A number of data sources have been used in compiling this report. Whilst The Stilwell Partnership (TSP) believe them to be trustworthy; it is unable to guarantee the accuracy of the information that has been provided by others.
- This report is based on information available at the time of preparation. There is potential for further information to become available, which may create a need to modify conclusions drawn in this report.

2.0 Location of Site

- 2.1.1 The proposed site is located off The Parade in Bognor Regis. A site location plan is enclosed at **Appendix A**.
- 2.1.2 The Local Authorities are Arun District Council (ADC) and West Sussex County Council (WSCC).

3.0 Site Description

3.1 Existing Site

- 3.1.1 The existing site is currently in use as a convenience store. A Topographical Survey for the site has been commissioned and can be found at **Appendix B**.
- 3.1.2 The existing site is reasonably flat with levels at approximately 4.60m AOD. The ground rises slightly in the south west corner to a level of 5.30m AOD.

3.2 Existing Drainage System

- 3.2.1 Sewer records have been obtained from Southern Water and can be found at **Appendix C**.
- 3.2.2 There is an existing 150mm diameter public foul water sewer running into Sea Lane from No. 55. The closest public manhole is No. 9402 with a cover level of 4.59m AOD and an invert level of 3.42m AOD.
- 3.2.3 There is an existing 150mm diameter public foul water sewer at the rear of No. 1 The Parade. The closest public manhole is No. 0407 with a cover level of 4.78m AOD and an unknown invert level.
- 3.2.4 There is an existing 150mm diameter public foul water sewer running in The Parade. The closest public manhole is No. 0401 with a cover level of 4.87m AOD and an invert level of 4.20m AOD.
- 3.2.5 There is an existing 150mm diameter public surface water sewer running around the development along The Parade and Sea Lane. The closest public manhole is No. 0351 with a cover level of 4.33m AOD and an invert level of 3.13m AOD.

3.3 Existing Geology

- 3.3.1 The geology of the site has been ascertained by reference to the 1:50,000 British Geological Survey website. The data provided on the website indicates the bedrock and superficial drift geology for the site.
- 3.3.2 The strata of the site (bedrock geology) comprises London Clay Formation, described as follows:

"London Clay Formation - Clay, Silt and Sand. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Palaeogene Period. Local environment previously dominated by deep seas. These sedimentary rocks are marine in origin. They are detrital and comprise coarse- to fine-grained slurries of debris from the continental shelf flowing into a deep-sea environment, forming distinctively graded beds."

3.3.3 The strata of the site (bedrock geology) comprises River Terrace deposits, described as follows:

"River Terrace Deposits (undifferentiated) - Sand, Silt and Clay. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by rivers. These sedimentary deposits are fluvial in origin. They are detrital, ranging from coarse- to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary (if in a coastal setting)."

3.3.4 A site-specific ground investigation was undertaken by Opus International to support the application. The report can be found at **Appendix D**. The report indicates the site to be on sandy clay, with poor infiltration properties

3.4 Hydrogeology Setting

3.4.1 The Environment Agency (EA) mapping service, as provided by Magic Map, indicates the aquifer designation for the bedrock and superficial drift geology and the groundwater vulnerability in the area. The mapping, as included at **Appendix E**, provide the following information for the site:

Geology Map	Site Description
Aquifer Designation (Bedrock)	Unproductive
Aquifer Designation (Superficial Drift)	Secondary A
Groundwater Vulnerability	Minor Aquifer High
Groundwater Source Protection Zone	None

3.5 Hydrology

3.5.1 The closest strategic watercourse is the English Channel, located 350m to the south east of the site.

3.6 Existing Surface Water Runoff

3.6.1 The site has been previously developed, but an analysis of the Greenfield run-off rate is appropriate and will be made for the developable site area of 0.25 hectares.

- 3.6.2 The Greenfield run-off rates have been calculated for the existing site. The existing site run-off rates have been calculated based on the Interim Code of Practice for Sustainable Drainage Systems, Chapter 6 using the Micro Drainage design software. The output from the software analysis can be found at **Appendix F**.
- 3.6.3 The Qbar (rural) value for the site is 1.3 litres per second. A conservative value of 50% hardstanding has been used to calculate the urban run-off from site. The Qbar (urban) value for the site is 2.5 litres per second.
- 3.6.4 A technical assessment has been made for the site of the most appropriate flow rate suiting the site constraints as follows:

Flow Rate (Standard)	Flow Rate (l/s)	Method of control	Constraints	Selected
Qbar Rural	1.3	-	Too low for a control	No
Qbar Urban	2.5	Hydro-Brake	1. Low flow rate indicates high level of silt removal required. 2. Hydrobrake chamber must be constructible.	No
3 x Qbar	3.9	Orifice	Minimum flow rate of 5.0 l/s to prevent blockages (or 50mm diameter orifice)	No
1 in 1 year MRM method	19.31	Orifice	Minimum flow rate of 5.0 l/s to prevent blockages (or 50mm diameter orifice)	No
1 in 30 year MRM method	46.04	Orifice	Minimum flow rate of 5.0 l/s to prevent blockages (or 50mm diameter orifice)	No
1 in 100 year MRM method	75.97	Orifice	Minimum flow rate of 5.0 l/s to prevent blockages (or 50mm diameter orifice)	No
-	2.0	Hydro-Brake	1. Low flow rate indicates high level of silt removal required. 2. Hydrobrake chamber must be constructible.	Yes
-	5.0	Orifice	Minimum flow rate of 5.0 l/s to prevent blockages (or 50mm diameter orifice)	No
Infiltration	0	None	Site must be suitable for infiltration	No

- 3.6.5 Infiltration has been discounted on the site due to the underlying strata.
- 3.6.6 The Opus drainage strategy has defined a flow of 6.1 litres per second for the development. However, this value is now superseded.
- 3.6.7 The Non-Statutory Technical SuDS Guidance 2015 indicates that greenfield run-off (or as close as practical) should be used if viable on the site, despite it being previously developed.
- 3.6.8 For this reason, we have selected 2.0 litres per second, the lowest rate achievable for a Hydro-Brake without risk of blockages for the site.

4.0 Proposed Development

4.1.1 The proposed development is for the construction of 3 new residential dwellings. The proposed site layout can be found at **Appendix G**.

4.2 Infiltration Potential

4.2.1 The geotechnical information provided in this report indicates that standard infiltration methods will not be suitable on site.

4.2.2 The table below summarises the potential for infiltration.

Low infiltration potential: There is a low potential for infiltration SuDS in parts of the Site. Comments: It is likely that the underlying geology at the Site, or in areas of the site, is relatively impermeable which would limit the effectiveness of a proposed infiltration SuDS scheme. Recommendations: Infiltration SuDS should be focused in more suitable parts of the site. If a site investigation confirms that infiltration SuDS are not possible at the site then attenuation SuDS with a controlled discharge into a nearby surface water feature or existing surface water drainage is recommended.	YES
Moderate infiltration potential: There is a moderate potential for infiltration SuDS in parts of the Site. Comments: It is likely that the permeability of the underlying material at the site would be suitable for infiltration drainage. However, there may be constraints on the use of infiltration SuDS because of any of the following: a high water-table, the limited thickness of the receiving formation, the potential for a significant range in permeability in the underlying geology and confirmation of the infiltration capacity is recommended. Recommendations: A site investigation is recommended to investigate groundwater levels and formation thickness and to confirm that infiltration rates at the site are sufficient to accommodate an infiltration SuDS feature. If a site investigation confirms that infiltration SuDS are possible at the Site then assorted options can be considered for infiltration SuDS and these include infiltration trenches, soakaways, swales, permeable pavements and infiltration basins without outlets.	NO
High infiltration potential: There is a high potential for infiltration SuDS in parts of the Site. Comments: It is likely that the underlying geology at the Site is highly permeable and an infiltration SuDS scheme should be possible at the Site. Groundwater levels are expected to be sufficiently deep at the site. Recommendations: A site investigation is recommended to confirm the high infiltration capacity and the depth of the winter water table. Assorted options can be considered for infiltration SuDS and these include infiltration trenches, soakaways, swales, permeable pavements and infiltration basins without outlets.	NO

5.0 Drainage Proposal

5.1 SuDS Hierarchy

5.1.1 Options for the destination for the run-off generated on site have been assessed in line with the prioritisation set out in the Building Regulations Part H document and DEFRA's Draft National Standards for SuDS as follows:

Discharge to Ground	Not viable due to ground conditions
Discharge to Watercourse	No watercourses in the vicinity
Discharge to Surface Water Sewer	Selected option
Discharge to Other Sewer	N/A

5.1.2 The potential for different SuDS devices has been assessed and can be seen in the table below:

SuDS Feature	Environmental benefits	Water quality improvement	Suitability for low permeability soils ($k < 10^{-6}$)	Ground-water recharge	Suitable for small / confined sites?	Site specific restrictions	Appropriate for subject site?
Wetlands	✓	✓	✓	X	X	Site Constraints	No
Retention ponds	✓	✓	✓	X	X	Site Constraints	No
Detention basins	✓	✓	✓	X	X	Site Constraints	No
Infiltration basins	✓	✓	X	✓	X	Site Constraints	No
Soakaways	X	✓	X	✓	✓	Poor Ground	No
Underground storage	X	X	✓	X	✓	None	Yes
Swales	✓	✓	✓	✓	X	Site Constraints	No
Filter strips	✓	✓	✓	✓	X	Poor Ground	No
Rainwater harvesting	X	✓	✓	✓	✓	Site Constraints	No
Permeable paving	X	✓	✓	✓	✓	None	Yes
Green roofs	✓	✓	✓	X	✓	Pitched Roof	No
Rain Garden (external)	✓	✓	✓	X	X	Site Constraints	No
Rain Garden (planter)	✓	✓	✓	X	X	Site Constraints	No

5.2 Surface Water Drainage

- 5.2.1 Surface water drainage at the site will follow the Sustainable Drainage Systems (SuDS) management train. The surface water will discharge into the existing public sewer. A Drainage Plan can be found at **Appendix H**.
- 5.2.2 New climate change allowances have been in force since February 19th 2016. The new allowances take into consideration the design life of the development, flood zone, development type and geographical location.
- 5.2.3 Based on these parameters, the Central value for rainfall intensity should be used. Based on Table 2 (shown below), this is a range between 20% and 40% for the central and upper end values. Therefore, it is appropriate to use 30% on this development for design, with a 40% sensitivity check.

Table 2 peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

- 5.2.4 Any water up to a 1 in 100 year storm event including 40% climate change will be attenuated within the curtilage of the site in the proposed drainage system.
- 5.2.5 National SuDS standards and Sewers for Adoption recommend that the 1 in 30 year storm event is managed below ground with exceedance flows managed above ground.
- 5.2.6 Due to the spatial constraints on site, flows for the 1 in 100 year storm event plus 40% climate change will be contained entirely within the underground drainage system.
- 5.2.7 MicroDrainage calculations have been undertaken, which can be found at **Appendix J**.

5.3 Urban Creep

- 5.3.1 Urban Creep is the conversion of permeable surfaces to impermeable over time. e.g. impermeable surfacing of front gardens to provide additional parking spaces, extensions to existing buildings, creation of large patio areas. The consideration of urban creep (is best) assessed on a site by site basis but is limited to residential development only.

- 5.3.2 It is important that the appropriate allowance for urban creep is included in the design of the drainage system over the lifetime of the proposed development. The allowances set out below are applied to the impermeable area within the property curtilage:

Residential development density Dwellings per hectare	Creep allowance % of impermeable area
≤ 25	10
30	8
35	6
45	4
≥ 50	2
Flats & apartments	0

- 5.3.3 Note where the inclusion of the appropriate allowance would increase the total impermeable area to greater than 100%, 100% should be used as the maximum.
- 5.3.4 The proposed development has the potential for expansion and so an allowance for 10% urban creep has been included in the design.
- 5.3.5 MicroDrainage calculations for the urban creep allowance have also been included at **Appendix J**.

5.4 Water Quality

- 5.4.1 A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution. This can be effectively managed by an appropriate “train” or sequence of SuDS components that are connected in series.
- 5.4.2 The frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10 mm of rainfall (first flush) should be adequately treated with SuDS.
- 5.4.3 The minimum number of treatment stages will depend on the sensitivity of the receiving water body and the potential hazard associated with the proposed development SuDS Manual (CIRIA, 2015).
- 5.4.4 The proposed development is a combination of very low (roof water) to low hazard (runoff from small car parking areas), as indicated on the table below:

Hazard	Source of Hazard	Present
Very Low	Residential Roof drainage.	YES
Low	Residential amenity uses including low usage car parking spaces and roads, other roof drainage	YES
Medium	Commercial, industrial uses including car parking spaces and roads (excluding low usage road, trunk roads and motorways)	NO
High	Areas used for handling and storage of chemicals and fuels, handling of storage and waste	NO

5.4.5 The site does not lie within a source protection zone and therefore additional treatment stages are not required.

5.4.6 The extent of treatment depends on land use, level of pollution prevention in the catchment and the natural protection afforded by underlying soil layers. A high hazard site will require more treatment than low hazard.

5.4.7 The treatment processes provided by different SuDS components will have varying capabilities for removal of different types of contaminants as per the table below:

Hazard	Requirements for discharge to surface water and groundwater	Present
Very Low	Removal of gross solids and sediments only.	YES
Low	Simple index approach	YES
Medium	Surface water: Simple index approach Ground water: Simple index approach and risk screening	NO
High	Guidance and risk assessment process in HA (2009). Discharge may require environmental permit or licence. Obtain pre-permitting advice from environmental regulator. Risk assessment likely to be required.	NO

5.4.8 Treatment has been provided in the form of catchpit manholes to remove sediment and contaminated particles and geotextiles where appropriate as a filter medium.

5.5 Construction Phase Drainage

5.5.1 It is an offence to cause or knowingly permit the entry of poisonous, noxious or polluting material into the water environment. Prosecution may ensue if the pollution is serious enough to lower the ecological status of the water body in terms set by the Water Framework Directive (2000/60/EC).

5.5.2 The polluter does not have to be prosecuted first for remediation of damage to be required. If water pollution is serious enough to be classed as environmental damage the damage will

require to be remediated such that the area is returned to the condition it would have been in if the damage had not occurred.

5.5.3 An offence may also be committed if environmental damage or the threat of environmental damage is not reported by the polluter or if no action is taken by the polluter to prevent further damage. Third parties (e.g. private water supply users, landowners, recreational users and the public) who may be affected by possible damage may also report 'risk' of environmental damage to the enforcing authority; in this instance an offence may be committed if action is not taken to prevent the potential environmental damage occurring.

5.5.4 The principles of Sustainable Drainage Systems (SuDS) shall be applied to all components of design and construction regarding surface water management. Any design or site works that may impact on the site drainage or water quality shall:

- Soakaway where soils allow
- Consider and manage erosion
- Retain any silts on site and prevent silts from discharging into watercourses or drains
- Remove pollutants in surface water
- Keep runoff rates at existing greenfield runoff
- Prevent accidental spillages reaching watercourses.

5.5.5 As infiltration is not viable on site, the temporary drainage for the development will be in the form of land drainage with discharge into the public sewer. It is recommended that the surface water connection and flow control devices are installed prior to any other drainage works on site.

5.5.6 Dewatering and drainage for the basement construction will be arranged by the designer of the basement structure.

5.5.7 Pollution will be controlled via the use of catchpit manholes and geotextiles.

5.5.8 Any potentially hazardous substances (i.e. form plant / deliveries) will be within a controlled compound with a separate drainage system that will contain a penstock valve / containment kit in the event of a spillage.

5.6 Foul Water Drainage

5.6.1 The foul water will discharge into the existing foul water chamber within the site boundary.

5.6.2 Foul water flows from the residential portion of the development are 0.138 litres per second based on 4000 litres per dwelling per day in accordance with Sewers for Adoption 7th Edition.

6.0 Flooding Information

6.1.1 As set out in the National Planning Policy Framework (NPPF), inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. For these purposes:

- “areas at risk of flooding” means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems, and which has been notified to the local planning authority by the Environment Agency;
- “flood risk” means risk from all sources of flooding - including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

6.1.2 Flooding information for Planning from the Environment Agency (EA) has shown that the site lies within Flood Zone 1, as found in the map at **Appendix K**.

“Flood Zone 1 - shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area is defined as Land having less than a 1 in 1000 annual probability of river or sea flooding”

6.1.3 As the site is within Flood Zone 1, no further data was requested from the Environment Agency.

6.1.4 As part of the data capture, data and mapping from the Arun Strategic Flood Risk Assessment (SFRA) was sought. This will be included and references in the relevant sections below.

7.0 Flood Risk

7.1 Fluvial Flooding Risk

7.1.1 The Environment Agency flood information indicates no risk from fluvial flooding on site.

7.2 Historic Flood Data

7.2.1 The Environment Agency sources do not indicate any historic fluvial flood events on site.

7.2.2 The Arun Strategic Flood Risk Assessment (Appendix H) gives details of historic flood events in the district. There is a red dot (indicating flood from a failure mechanism) near the site.

7.2.3 Tile 1 of 46 in this Appendix shows in more detail the location of the flood event. It is located to the north east of the site and it can be assumed that the site was not affected.

7.3 Groundwater

7.3.1 Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. A ground water flood event results from a rise in ground water level, sufficient for the water table to intersect the ground surface and inundate low lying land. Groundwater floods may emerge from either a single point or diffuse locations.

7.3.2 The underlying strata throughout the area and investigations into the SFRA geology data suggest that the risk of groundwater emergence should typically be relatively low. However, groundwater flooding risks are often highly localised, and dependent upon geological interfaces between permeable and impermeable subsoils. Therefore, sustainable construction techniques for surfacing will minimise any potential groundwater risk.

7.3.3 The Arun SFRA (Appendix F, Tile 1 of 46) indicates the site is in an area of high susceptibility to groundwater flooding (>75%).

7.3.4 The geotechnical information contained within this report indicates that this is due to the presence of unproductive head in the area, which may lead to a high or perched groundwater table.

7.3.5 Consideration has been given within the drainage design (as shown on the drainage layout) for potential groundwater emergence issues and appropriate mitigation measures have been included.

7.4 Flooding from Sewers

7.4.1 Flooding from sewers can occur because of different reasons; if sewers are blocked during the heavy rainfalls, or if sewer cannot provide adequate capacity, then flooding can cause a large amount of damage.

7.4.2 The Arun SFRA indicates no historic sewer flood incidents have occurred in the area further to the information already assessed.

7.5 Flooding from Reservoirs

7.5.1 Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, we ensure that reservoirs are inspected regularly and essential safety work is carried out.

7.5.2 However, in the unlikely event that a reservoir dam failed, a large volume of water would escape at once and flooding could happen with little or no warning. If the site is within a risk area, plans should be made for safe evacuation and escape. Occupants may need to evacuate immediately, know the safest route to safety, and be ready to follow the advice of emergency services.

7.5.3 The Environment Agency mapping indicates no risk from reservoir flooding.

7.6 Surface Water Flooding

7.6.1 Overland flow / surface water flooding typically arise because of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

7.6.2 The Environment Agency has produced illustrative mapping (Flood Map for Surface Water) relating to flooding risks from surface water. They are classified as Flood Hazard Maps for the purpose of the Flood Risk Regulations 2009. These maps are the next generation on from the previous "Area Susceptible to Surface Water Flooding" maps, which are contained within the SFRA.

7.6.3 The EA maps show high resolution image and indicative flow paths for pluvial events. The maps are based on coarse level data and indicate ridges, valleys and flat spots where water would collect. Typically, the flow paths follow valleys, rivers and watercourses.

7.6.4 The surface water maps and the associated information are intended for guidance only, and cannot provide details for individual properties. They do, however, provide high level information and indicate areas in which surface water flooding issues should be investigated further. The risk categories are classified as follows:

- Very low probability of flooding – This zone is assessed as having less than a 1 in 1000 annual probability of surface water flooding.
- Low probability of flooding – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of surface water flooding.
- Medium probability of flooding - This zone comprises land assessed as having between a 1 in 30 and 1 in 100 annual probability of surface water flooding.

- High probability of flooding – This zone is assessed as having greater than a 1 in 30 annual probability of surface water flooding.

7.6.5 A review of the EA mapping indicates that there is no risk to the site from surface water flooding.

7.6.6 There is a small amount of surface water flooding along The Parade. An assessment of the "medium" risk scenario (1 in 100 year event) indicates that there is no hazard from this flood mechanism and the overall risk from surface water flooding can be stated as low.

8.0 Maintenance

8.1.1 The maintenance regime for the proposed development will be split into two main categories, SuDS drainage and regular private drainage. Both of these elements will be the responsibility of the end user.

8.1.2 Maintenance operations can be divided into the following categories:

- Regular (or routine frequent) - this covers items that are carried out typically with a frequency from monthly to annually. It includes item such as inspection and monitoring, litter removal, grass cutting or other vegetation management, sweeping permeable pavements.
- Infrequent (or routine infrequent) - this covers items that are required typically with a frequency from annually up to 25 years (or possibly greater). It includes items such as wetland vegetation management, silt removal from swales, ponds or wetlands, scarifying and spiking infiltration basins and gravel replacement to filter drains.
- Remedial (or reactive) - this covers maintenance that is not usually required, but may be necessary as a result of vandalism, accidental damage, rainfall that exceeds the design capacity or similar events. Examples include repair of erosion in a swale or repair of permeable surfaces blocked for example by mixing concrete on them.

8.2 Riparian Responsibility

8.2.1 If a resident owns land adjoining, above or with a portion of the drainage system running through it, they have certain rights and responsibilities. In legal terms they are a 'riparian owner'. If they rent the land, they should agree with the owner who will manage these rights and responsibilities.

8.2.2 It is recommended that the owner's appointed Management Company handle the maintenance of all underground drainage and all SuDS devices, with the following exceptions:-

- Inspecting and cleaning out any surface mounted hard drainage systems (such as channel drains);
- Inspecting and cleaning out (or reporting) SuDS systems on a small scale (such as garden ditches and swales).

8.3 Allowing for Replacement

8.3.1 The design life of some SuDS elements and drainage elements of the proposed system is shorter than the predicted design life of the development. Therefore, the design and maintenance regime take into account any potential replacement works (such as replacing permeable paving).

8.3.2 Regular inspection of the drainage system should be as per the tables below.

Operation and maintenance requirements for Surface Water Systems		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect for sediment and debris in catchpit manholes and gullies. Clean out as required	Twice Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional Maintenance	Remove sediment and debris from catchpits, gullies, attenuation devices and inside of concrete manhole rings	As required, based on inspections
Remedial Actions	Reconstruct and/or replace components, if performance deteriorates or failure/blockage occurs	As required
	Replacement of clogged components (flow restriction)	As required
Monitoring	Inspect silt traps/gullies/catchpits and note rate of sediment accumulation	Monthly in the first year and then annually
	Check flow control chamber and attenuation devices	Annually

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 glyphosate 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

9.0 Summary and Conclusions

- 9.1.1 Hall Developments Hardwick Road Ltd (Hallson Homes) is planning a proposed development on the site at The Former Kings Beach Hotel, The Parade, Pagham, Bognor Regis PO21 4TW.
- 9.1.2 The Stilwell Partnership has been instructed by Hall Developments Hardwick Road Ltd (Hallson Homes), to produce a Flood Risk Assessment under National Planning Policy Framework (NPPF) to support the Planning Application.
- 9.1.3 The Environment Agency website has confirmed that the site is within Flood Zone 1 for planning.
- 9.1.4 The surface water will discharge into the existing public surface water sewer at a controlled rate.
- 9.1.5 The foul water will discharge into the existing foul water sewer.
- 9.1.6 The report has demonstrated that the proposed drainage measures ensure that no property will be at risk of flooding if the development proceeds and that suitable means of surface water and foul drainage can be achieved for the proposed development.

Appendix A

Site Location Plan

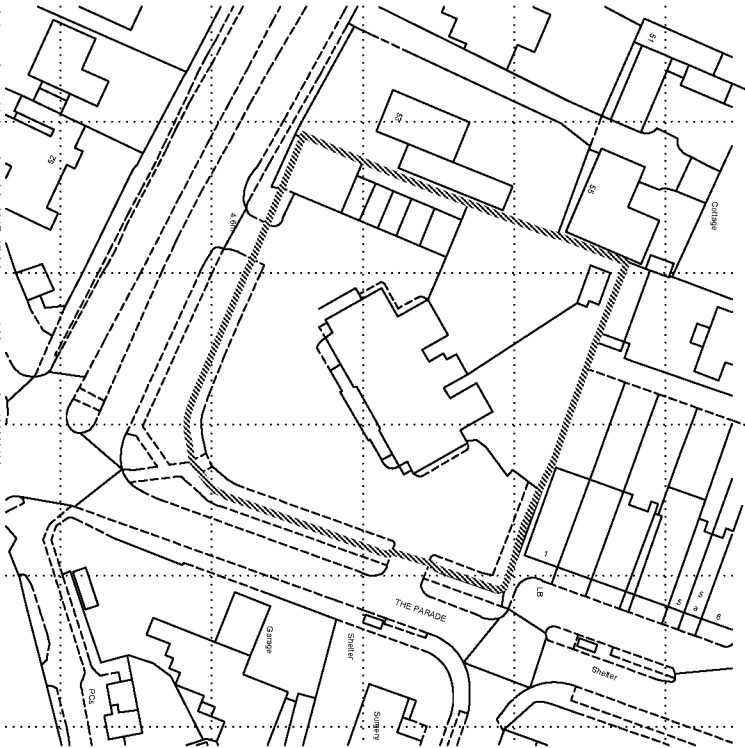
- GENERAL NOTES:
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE OTHER RELEVANT DOCUMENTS.
 2. CONSULTANTS' DRAWINGS.
 3. ALL DIMENSIONS ARE TO FACE UNLESS OTHERWISE SPECIFIED.
 4. ALL WORKS OR MATERIALS INDICATED ON THIS DRAWING ARE TO BE TO THE SATISFACTION OF THE LOCAL AUTHORITY.
 5. LATEST RELEVANT PARTS OF THE BUILDING REGULATIONS AND OTHER RELEVANT LEGISLATION SHALL APPLY.
 6. INSTITUTE OF TRADE ASSOCIATION RECOMMENDATIONS AND PUBLICATIONS.



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Block Plan

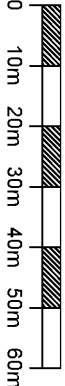
1:500 scale



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Location Plan

1:1250 scale



Revision	Date	Description	Drawn	Checked

Client	Project
ARUN DISTRICT COUNCIL	Proposed Mixed Use Development at The Former King's Beach Hotel, Pagham

Drawn To	Drawn By	Date	Checked By	Date	Approved By	Date
17.3030.110	KW	Dec 17				

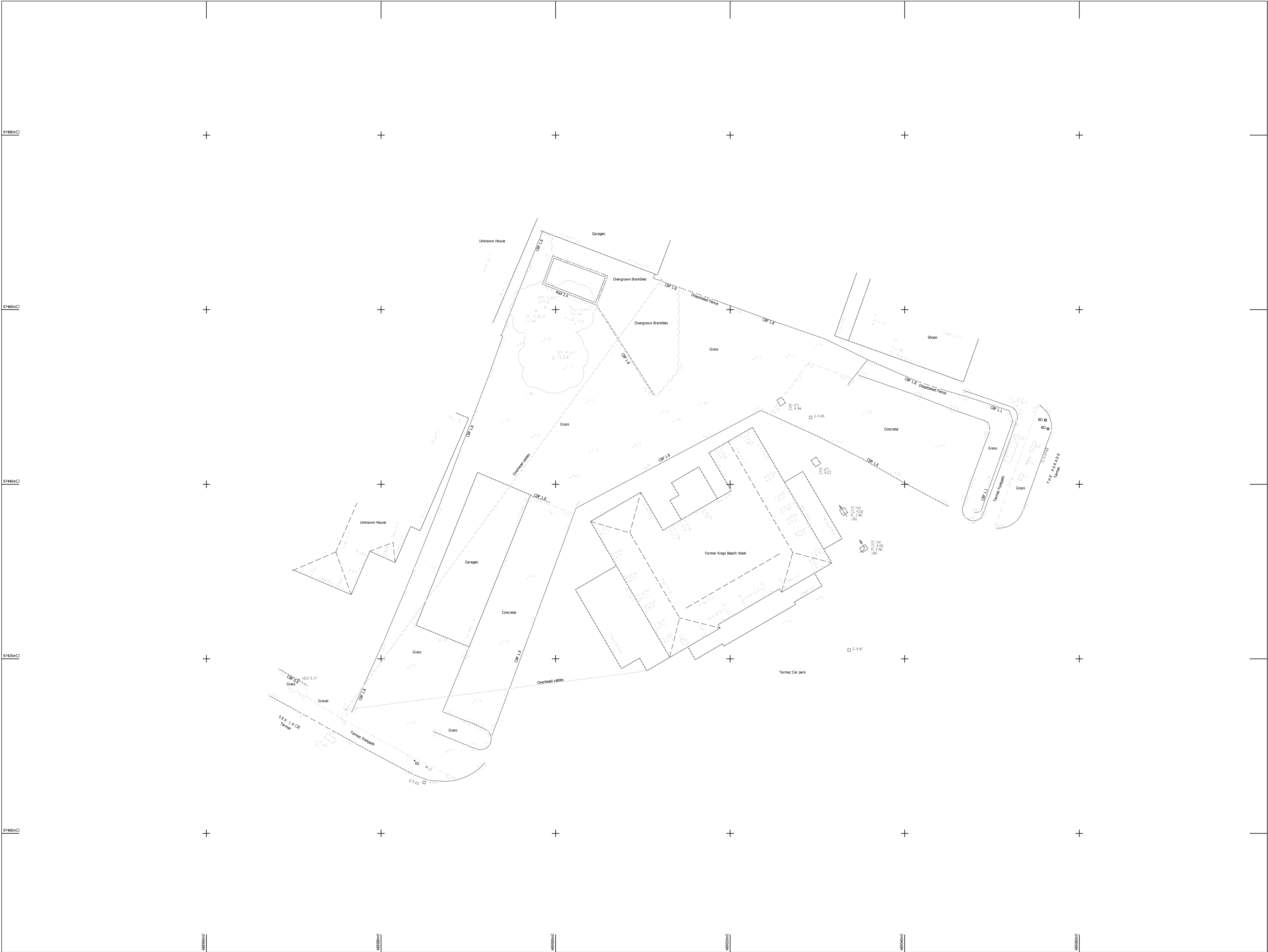
Revision	Scale
P1	As Stated @ A3

PLC ARCHITECTS	© COPYRIGHT RESERVED 2017
NOT TO BE SCALED	DIMENSIONS TO BE CHECKED ON SITE
SCALING ONLY FROM LOCAL AUTHORITY TOWNSHIPS	

25-26 Hampshire Terrace	25-26 Hampshire Terrace
100022432	100022432
Hampshire England	Hampshire England
Tel: (023) 92 755 333	Tel: (023) 92 755 333
E-Mail: admin@plcarchitects.com	E-Mail: admin@plcarchitects.com
Web: www.plcarchitects.com	Web: www.plcarchitects.com

Appendix B

Topographical Survey



Drainage
All drainage invert information has been obtained through visual inspection only with no entry into manholes. Therefore the complete accuracy cannot be guaranteed. Where drainage is of critical importance we suggest the services of a specialist drainage engineer be used.

Trees
Every effort has been made to identify and detail all trees on site but where trees are of critical importance we suggest the use of a specialist such as an arborist. Tree spread and heights are indicative.

GPS
GPS levels and grid are obtained using industry standard guidelines and can vary according to the quality of the GPS network at the time of survey. Therefore all GPS detail is relative to the time and date of the survey.

Copyright
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Level Datum
Levels are related to OS datum derived from GPS

Grid
Grid is related to OSGB36/05 derived from the GPS network.

Northpoint



Encompass Surveys Ltd
Unit 28
Deer Park Farm Industrial Estate
Knowle Lane
Fair Oak, Easington
Hampshire SO50 7P
Tel: 023 80692002 Email: info@encompasssurveys.co.uk
Fax: 023 80697125 Website: encompasssurveys.co.uk

Client	Punch Partnerships (BML) Ltd		
Survey	Former Kings Beach Hotel		
Location	The Parade Pagham PO21 4TW		
Survey Type	Topographical	Scale	1:200 @ A1
Drawing ref	ET/101117/SA06	Date	Nov 17
Drawn/Checked	CH/GD	Revision	

Appendix C

Southern Water Sewer Records



Drawn by: **chakrkr**

Scale: 1:1250

Date: 19/01/2018

Z

A diagram of a Z-shaped molecule. It consists of a central circle with a horizontal line passing through its center. To the right of the circle, the line extends and then turns upwards and to the right, ending in a triangle pointing to the right.

SEWER RECORDS PAGE 2 OF 2

Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape
0303XX				BRC	CIRC	2503XX	4.95	3.14	150	PF	CIRC												
0307XX				BRC	CIRC	2507XX	4.74	3.25	150	PF	CIRC												
0310XX				BRC	CIRC	2501XX	4.42	3.61	150	PF	CIRC												
0320XX				BRC	CIRC	2502XX	4.74	3.61	150	PF	CIRC												
0351XX	4.33	3.13		CP	RECT	2555XX	5.03	4.25	150	CP	CIRC												
0401XX	4.87	3.72		VC	CIRC	2556XX	4.86	3.98	225	VC	CIRC												
0402XX	4.83	3.68		BAC	CIRC	2557XX	4.89	4.23	150	CP	CIRC												
0403XX	4.95	3.16		BAC	CIRC	2558XX	4.86	3.76	375	CP	CIRC												
0404XX	4.88	2.94		BAC	CIRC	2559XX	4.86	3.76	375	CP	CIRC												
0405XX	4.88	3.26		BAC	CIRC	7301XX	4.33	2.63	150	PF	CIRC												
0406XX	4.87	3.28		VC	CIRC	7304XX	4.42	2.53	150	PF	CIRC												
0407XX	4.75	3.18		VC	CIRC	7351XX	4.47	3.08	300	CP	CIRC												
0408XX	4.87	3.18		CP	CIRC	7352XX	4.44	3.44	225	CP	CIRC												
0453XX	4.83	3.23		CP	CIRC	7402XX	4.58	2.63	200	PF	CIRC												
0454XX	4.87	3.37		CP	CIRC	8208XX	4.58		200	OTHER	BRC												
0455XX	4.87	3.48		150	CP	8301XX	4.44	3.53	150	PF	CIRC												
0501XX	1.8	2.62		150	CP	8302XX	4.53	3.23	150	PF	CIRC												
0502XX	4.8			150	CP	8303XX	4.46	2.98	150	PF	CIRC												
0510XX				150	CP	8304XX	4.52	3.07	150	PF	CIRC												
0511XX				150	CP	8305XX	4.52	3.07	150	PF	CIRC												
0512XX				150	CP	8306XX	4.54	3.46	150	PF	CIRC												
0513XX				150	CP	8307XX	4.55	3.2	150	PF	CIRC												
0514XX				150	CP	8308XX	4.44	3.19	150	PF	CIRC												
0515XX				150	CP	8309XX	4.51	3.43	150	PF	CIRC												
0516XX				150	CP	8310XX	4.57	3.45	150	PF	CIRC												
0517XX				150	CP	8311XX	4.57	3.45	150	PF	CIRC												
0518XX				150	CP	8312XX	4.57	3.45	150	PF	CIRC												
0519XX				150	CP	8313XX	4.57	3.45	150	PF	CIRC												
0520XX				150	CP	8314XX	4.57	3.45	150	PF	CIRC												
0521XX				150	CP	8315XX	4.57	3.45	150	PF	CIRC												
0522XX				150	CP	8316XX	4.57	3.45	150	PF	CIRC												
0523XX				150	CP	8317XX	4.57	3.45	150	PF	CIRC												
0524XX				150	CP	8318XX	4.57	3.45	150	PF	CIRC												
0525XX				150	CP	8319XX	4.57	3.45	150	PF	CIRC												
0526XX				150	CP	8320XX	4.57	3.45	150	PF	CIRC												
0527XX				150	CP	8321XX	4.57	3.45	150	PF	CIRC												
0528XX				150	CP	8322XX	4.57	3.45	150	PF	CIRC												
0529XX				150	CP	8323XX	4.57	3.45	150	PF	CIRC												
0530XX				150	CP	8324XX	4.57	3.45	150	PF	CIRC												
0531XX				150	CP	8325XX	4.57	3.45	150	PF	CIRC												
0532XX				150	CP	8326XX	4.57	3.45	150	PF	CIRC												
0533XX				150	CP	8327XX	4.57	3.45	150	PF	CIRC												
0534XX				150	CP	8328XX	4.57	3.45	150	PF	CIRC												
0535XX				150	CP	8329XX	4.57	3.45	150	PF	CIRC												
0536XX				150	CP	8330XX	4.57	3.45	150	PF	CIRC												
0537XX				150	CP	8331XX	4.57	3.45	150	PF	CIRC												
0538XX				150	CP	8332XX	4.57	3.45	150	PF	CIRC												
0539XX				150	CP	8333XX	4.57	3.45	150	PF	CIRC												
0540XX				150	CP	8334XX	4.57	3.45	150	PF	CIRC												
0541XX				150	CP	8335XX	4.57	3.45	150	PF	CIRC												
0542XX				150	CP	8336XX	4.57	3.45	150	PF	CIRC												
0543XX				150	CP	8337XX	4.57	3.45	150	PF	CIRC												
0544XX				150	CP	8338XX	4.57	3.45	150	PF	CIRC												
0545XX				150	CP	8339XX	4.57	3.45	150	PF	CIRC												
0546XX				150	CP	8340XX	4.57	3.45	150	PF	CIRC												
0547XX				150	CP	8341XX	4.57	3.45	150	PF	CIRC												
0548XX				150	CP	8342XX	4.57	3.45	150	PF	CIRC												
0549XX				150	CP	8343XX	4.57	3.45	150	PF	CIRC												
0550XX				150	CP	8344XX	4.57	3.45	150	PF	CIRC												
0551XX				150	CP	8345XX	4.57	3.45	150	PF	CIRC												
0552XX				150	CP	8346XX	4.57	3.45	150	PF	CIRC												
0553XX				150	CP	8347XX	4.57	3.45	150	PF	CIRC												
0554XX				150	CP	8348XX	4.57	3.45	150	PF	CIRC												
0555XX				150	CP	8349XX	4.57	3.45	150	PF	CIRC												
0556XX				150	CP	8350XX	4.57	3.45	150	PF	CIRC												
0557XX				150	CP	8351XX	4.57	3.45	150	PF	CIRC												
0558XX				150	CP	8352XX	4.57	3.45	150	PF	CIRC												
0559XX				150	CP	8353XX	4.57	3.45	150	PF	CIRC												
0560XX				150	CP	8354XX	4.57	3.45	150	PF	CIRC												
0561XX				150	CP	8355XX	4.57	3.45	150	PF	CIRC												
0562XX				150	CP	8356XX	4.57	3.45	150	PF	CIRC												
0563XX				150	CP	8357XX	4.57	3.45	150	PF	CIRC												
0564XX				150	CP	8358XX	4.57	3.45	150	PF	CIRC												
0565XX				150	CP	8359XX	4.57	3.45	150	PF	CIRC												
0566XX				150	CP	8360XX	4.57	3.45	150	PF	CIRC												
0567XX				150	CP	8361XX	4.57	3.45	150	PF	CIRC												
0568XX				150	CP	8362XX	4.57	3.45	150	PF	CIRC												
0569XX				150	CP	8363XX	4.57	3.45	150	PF	CIRC												
0570XX				150	CP	8364XX	4.57	3.45	150	PF	CIRC												
0571XX				150	CP	8365XX	4.57	3.45	150	PF	CIRC												
0572XX				150	CP	8366XX	4.57	3.45	150	PF	CIRC												
0573XX				150	CP	8367XX	4.57	3.45	150	PF	CIRC												
0574XX				150	CP	8368XX	4.57	3.45	150	PF	CIRC												
0575XX				150	CP	8369XX	4.57	3.45	150	PF	CIRC												
0576XX				150	CP	8370XX	4.57	3.45	150	PF	CIRC												
0577XX				150	CP	8371XX	4.57	3.45	150	PF	CIRC												
0578XX				150	CP	8372XX	4.57	3.45	150	PF	CIRC												
0579XX				150	CP	8373XX	4																

Appendix D

Opus International Report



13 April 2018

Opus International Consultants (UK) Ltd

Cordage Asset Management Ltd.
Unit 3 Broadbridge Business Centre
Delling Lane
Bosham
West Sussex
PO18 8NF
Ref: E-F2278.00/DRC

Fareham Office
Modulus House, Salferns Lane
Fareham, PO16 0QS
United Kingdom

Dear Sirs

RE: FORMER KINGS BEACH HOTEL, PAGHAM

I write following the undertaking of the geotechnical investigation, soil infiltration testing and ground water monitoring at the above site. This letter provides a summary with conclusions of the findings with respect to the proposed development at the property.

Your attention is drawn to the enclosed copy of the Conditions and Limitations for Site Investigations.

Investigation Methodology

The investigation was undertaken on the 20th of March 2018 with the completion of machine excavated trial pits (TP1 to TP3).

Prior to commencing ground investigations copies of the available statutory utility plans retrieved by Opus were reviewed to maintain clearance from potential public buried utilities on or in proximity to the boundary of the property. A site walk over assessment was also carried and finally the exploratory holes were checked with Cable Avoidance Tool and signal generator. Where underground services were suspected, exploratory positions were relocated in the interests of health and safety.

The locations of the trial pits are shown on the enclosed hole location plan. Detailed soil logs, soil infiltration test results and photographs of the trial pits are also enclosed. A bespoke groundwater monitoring well was installed in TP2 to allow subsequent groundwater monitoring to be carried out. Two subsequent monitoring visits was carried out on the 29th March and 12th April 2018.

Results

The soil encountered in TP1 was described as an upper veneer of Made Ground comprising silty gravelly Sand from ground level to 0.70m begl (metres below ground level). From 0.70 to 2.00m begl the underlying soil was described as silty clayey Sand.

Within TP2 and TP3 the upper soil an upper veneer of Made Ground comprising silty sandy Clay from ground level to 0.20m begl. From 0.20m begl the underlying soil was described as soft consistency gravelly silty sandy Clay to the base of the trial holes (2.25m and 2.50m respectively). Groundwater seepage was noted in the base of TP3. Stability in all trial pits was generally good during the opening up works.

In situ Testing

A single infiltration test was carried out in the three trial pits with the water falling only to 83% of the fill depth in TP1, 78.2% in TP2 and 91.6% in TP3 over the monitoring period (see enclosed results).

Monitoring of the groundwater level within the bespoke monitoring well installed in TP2 recorded a level of 2.18m begl on the 29th of March and 1.35m begl on the 12th of April.

Conclusions

Soil infiltration tests were undertaken once within each of the three trial pits with the permeability readily apparent as very low with insufficient amount of draw down to properly calculate a soil infiltration. None the less from the limited data available rates of the order of 1.7 to 4.5×10^{-9} m/s have been computed. However this was with the hole full of maximum head of pressure and would expect actual rates for completed tests (25% fill depth achieved) to be less (slower) than this.

Some illustrative calculations were subsequently undertaken by Opus civils team for the order of infiltration calculated. These results have however indicated a half drain time of the order of 200hrs (hours) compared to the required half drain time in 24hrs. Subsequently therefore soakaways and permeable pavement are not considered a viable option at this site.

Please do not hesitate to contact the undersigned if you require any further information regarding the above.

Best regards,

David Crellin MSc BSc FGS

Enc.

Opus International Consultants UK Limited Exploratory Hole Location Plan (Drawing no E-F2278.00 101 P1)
Exploratory Hole Logs (TP1, TP2 and TP3)
Soil Infiltration Result
Photographs
Conditions and Limitations for Site Investigations