



Flood Risk Assessment

Land East of Lidsey Road, Lidsey

For

Chris Harris

Rev -

Reference C1033

Date 3rd January 2018

Contents

1.	Introduction.....	4
1.1.	Existing Site.....	4
1.2.	Site Location	4
1.3.	Site Topography.....	5
1.4.	Site Geology.....	5
2.	Local Planning Policy	6
2.1.	West Sussex LLFA Policy for the Management of Surface Water	6
2.2.	Lidsey Surface Water Management Plan	6
3.	Flooding Mechanisms.....	6
3.1.	Tidal Flooding	7
3.2.	Fluvial Flooding (Rivers).....	7
3.3.	Pluvial Flooding (Surface Water)	7
3.4.	Foul/Surface Water Sewer Flooding.....	8
3.5.	Groundwater Flooding	8
3.6.	Reservoir Flooding.....	8
4.	Proposed Development.....	9
4.1.	Existing Drainage Regime	9
4.2.	Proposed Surface Water Drainage Regime	9
4.3.	Runoff Rate and Volume	9
4.4.	Allowance for Climate Change	10
4.5.	Urban Creep	10
4.6.	Proposed Foul Water Drainage Regime	10
4.7.	Water Quality	10
4.8.	Maintenance.....	14
4.9.	Residual Risk and Exceedance	16
5.	Summary of WSCC SuDS Policies.....	17
5.1.	SuDS Policy 1 Follow the drainage hierarchy	17
5.2.	SuDS Policy 2 Manage Flood Risk Through Design.....	17
5.3.	SuDS Policy 3 Mimic Natural Flows and Drainage Flow Paths	17
5.4.	SuDS Policy 4 Seek to Reduce Existing Flood Risk	17
5.5.	SuDS Policy 5 Maximise Resilience	17
5.6.	SuDS Policy 6 Design to be Maintainable	17
5.7.	SuDS Policy 7 Safeguard Water Quality.....	17

5.8.	SuDS Policy 8 Design for Amenity and Multi-Functionality	18
5.9.	SuDS Policy 9 Enhance Biodiversity	18
5.10.	SuDS Policy 10 Link to Wider Landscape Objectives	18
6.	Conclusions.....	18

Appendices:

Appendix A – Topographical Survey

Appendix B – Drainage Strategy

Appendix C – Drainage Calculations

Appendix D – Sewer Records

Appendix E - Local Borehole Data

Appendix F – Soakage Test Results

1. Introduction

CGS Civils Ltd have been appointed to provide a Flood Risk Assessment (FRA) for a proposed site of 27 residential units with associated access and parking in Lidsey, West Sussex.

The site is located within a Flood Zone 1 however due to the site being over 1 hectare and with 27 units, is deemed as being a major development therefore triggering a requirement for a FRA.

This Flood Risk Assessment is to be submitted as part of an outline planning application for the development of the site and has been prepared in accordance with the National Planning Policy Framework (NPPF), The associated Technical Guidance document and the 2015 National Planning Practice Guidance (NPPG). The design proposals have been prepared in accordance with Ciria C753 The SuDS Manual and the specific guidance set out in the WSCC LLFA Policy for the Management of Surface Water.

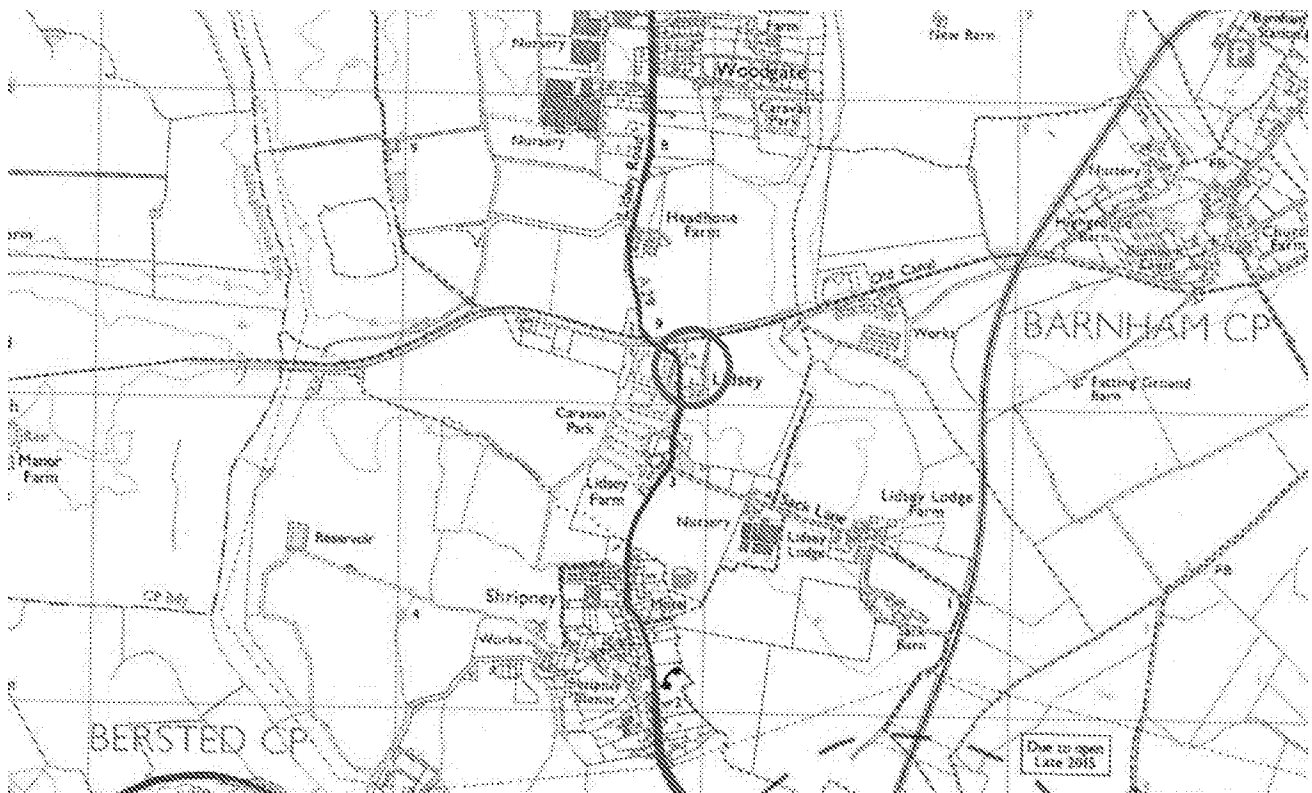
1.1. Existing Site

The current site consists of three properties with associated driveways and gardens.

1.2. Site Location

The site is in Lidsey, West Sussex with a grid reference of 493948E and 103155W.

Figure 1 Site Location



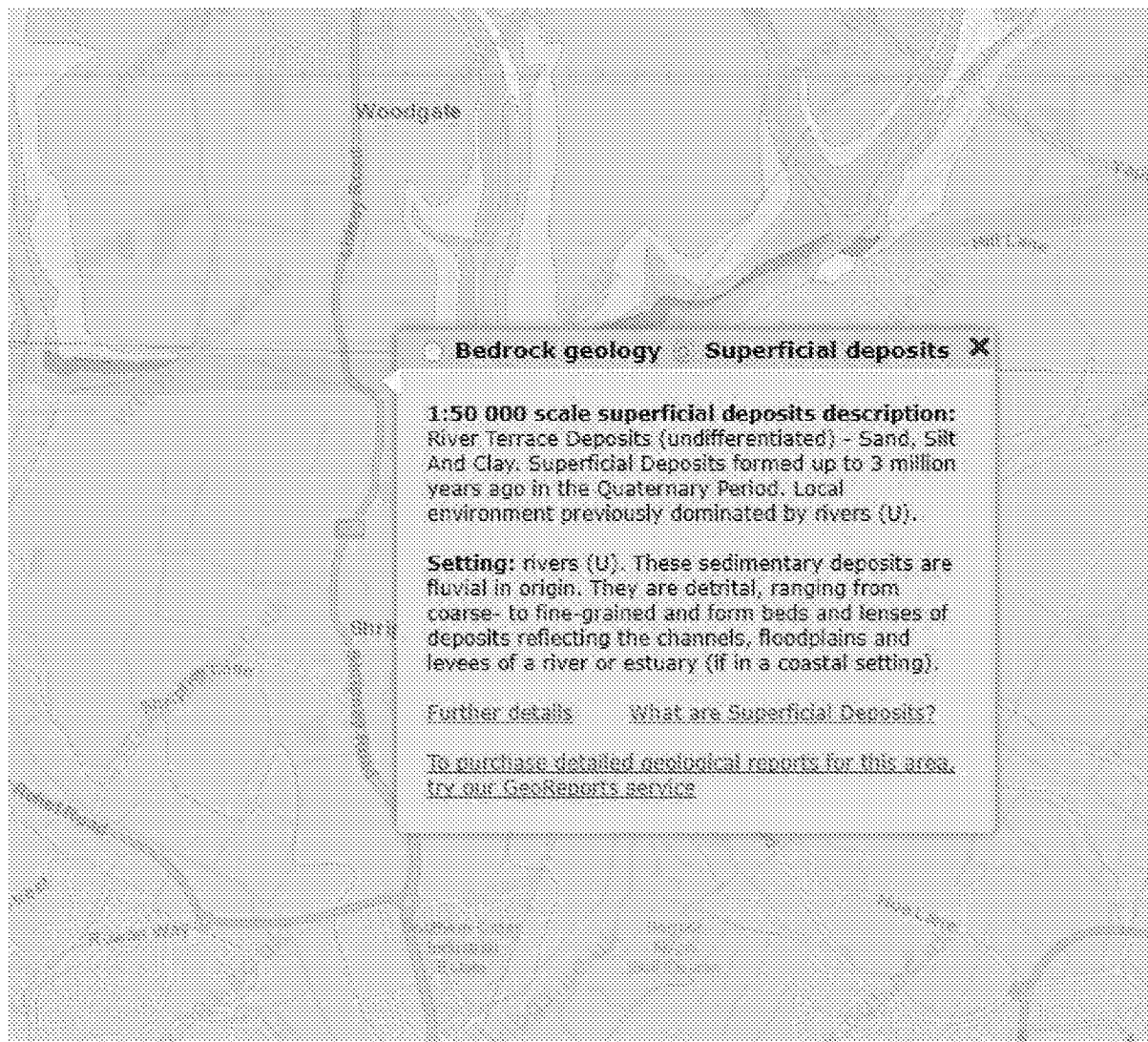
1.3. Site Topography

Levels vary across the site with levels in the north at reaching up to 6.3m AOD and up to 5.3m AOD to the south. Towards the centre of the site the levels fall to approximately 4.8m. Levels along the eastern flank rise from approximately 5.3m AOD to 6.3m AOD.

1.4. Site Geology

The British Geological Survey (BGS) confirms the site to be underlain by the Lambeth Group with clays, silts and sands.

Figure 2 BGS Geology Map



Trial pits dug on site confirmed a sandy clay up to a depth of 1.2m with some chalk elements noted. Local borehole data confirmed predominantly clays over chalk with the chalk noted as being approximately 5m deep. Refer to Appendix E for local borehole data.

2. Local Planning Policy

2.1. West Sussex LLFA Policy for the Management of Surface Water

With West Sussex County Council (WSCC) acting as the Local Lead Flood Authority (LLFA) a specific set of policies have been outlined which are to be adhered to. The following list sets out these policies:

SuDS Policy 1 Follow the drainage hierarchy

SuDS Policy 2 Manage Flood Risk Through Design

SuDS Policy 3 Mimic Natural Flows and Drainage Flow Paths

SuDS Policy 4 Seek to Reduce Existing Flood Risk

SuDS Policy 5 Maximise Resilience

SuDS Policy 6 Design to be Maintainable

SuDS Policy 7 Safeguard Water Quality

SuDS Policy 8 Design for Amenity and Multi-Functionality

SuDS Policy 9 Enhance Biodiversity

SuDS Policy 10 Link to Wider Landscape Objectives

This report will discuss each and demonstrate how the proposed development satisfies them where reasonably practical. In some instances, this will not be possible as this report will accompany an outline submission therefore some of the detail is not available at this stage. It is suggested however that any outstanding data will be issued as part of the full planning submission to fully satisfy the above policies.

2.2. Lidsey Surface Water Management Plan

In 2013, WSCC, being the LLFA commissioned a Surface Water Management Plan (SWMP). The Lidsey SWMP is intended to evaluate flood risk from varying sources of flooding (coastal, fluvial, sewer, groundwater and surface water) and develop an agreed 'action plan' to reduce or mitigate flood risk both now and in the future. The SWMP also provides an evidence base of historical flooding and determines likely current and future flood risk.

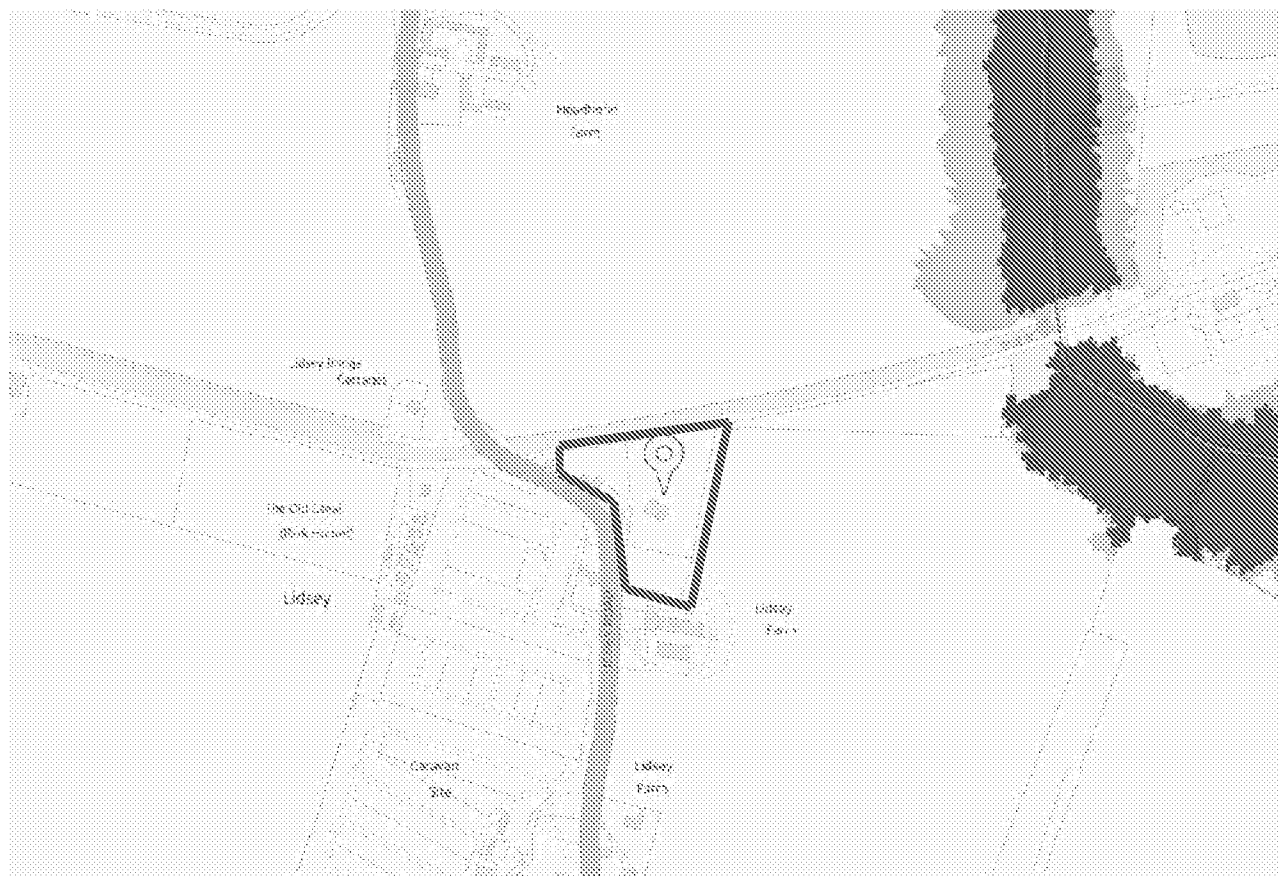
In the preparation of this report the Lidsey SWMP was reviewed to identify if the site was at any additional perceived risk from flooding and to ensure that the content and outcomes of this report are in alignment with the findings of the SWMP.

It was determined that there is negligible risk to the site and that the site would not contribute to any addition flood risk elsewhere.

3. Flooding Mechanisms

The EA Flood Map for Planning confirms that the application site is situated within a Flood Zone 1 (FZ1) which is land assessed as having less than a 1 in 1,000 annual probability of river or sea flooding in any year.

Figure 3 EA Flood Map for Planning Indicating Site Boundary



The list below sets out the potential sources of flood risk to the site and how the site is affected by each.

3.1. Tidal Flooding

The site is located sufficiently inland from the coast and as such is not susceptible to flooding from this source.

3.2. Fluvial Flooding (Rivers)

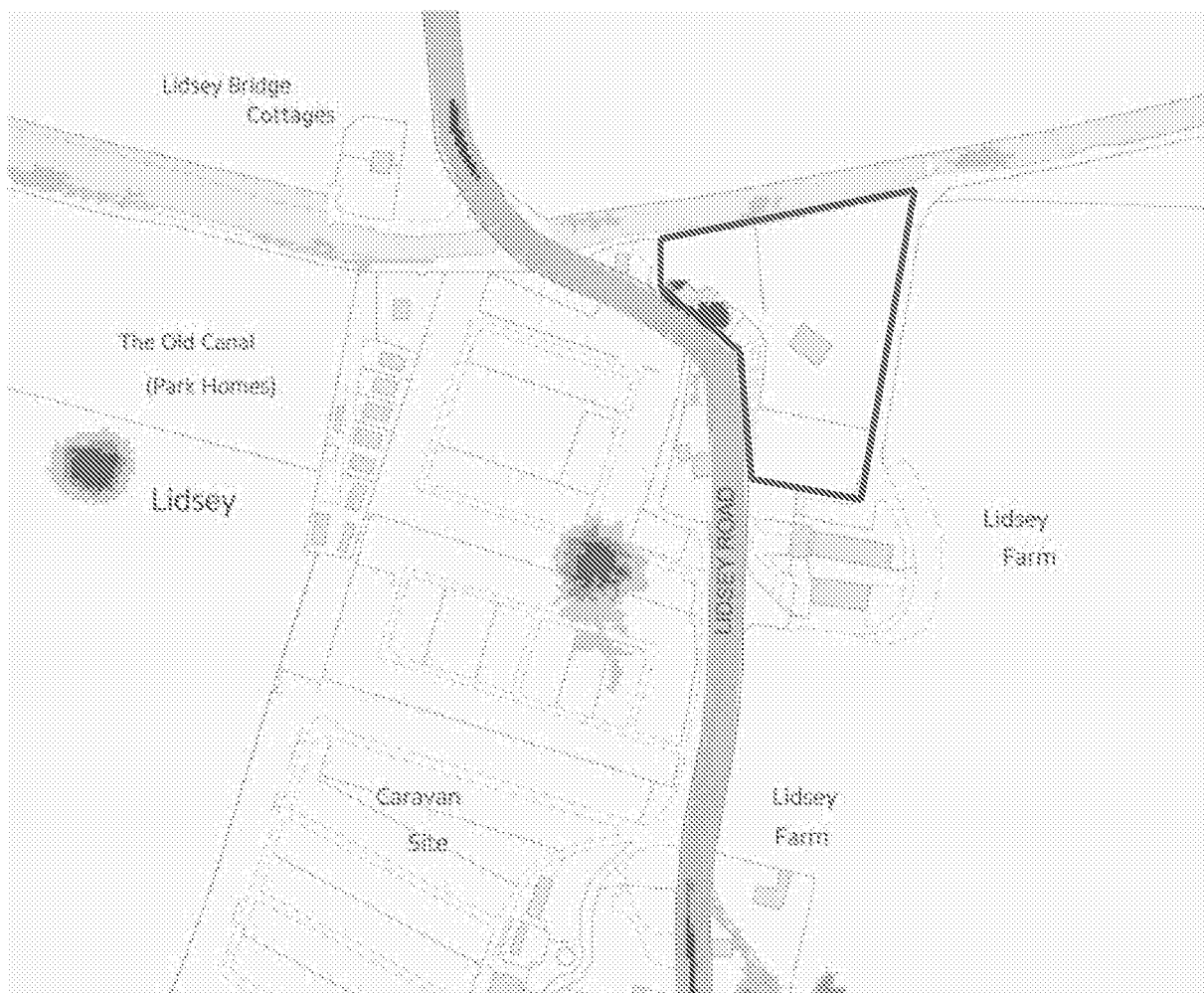
The site is located 375m west from a small watercourse. As per Figure 2 it is outside of its flooding extents.

3.3. Pluvial Flooding (Surface Water)

The Surface Water Flood Map for the site confirms that there is an isolated pocket of surface water flood risk to the west of the site that surrounds an existing building.

The proposed site plan indicates dwellings being close to, but outside of the area of flood risk. During detailed design phase it is suggested that this area is considered such that levels for the building and external areas are designed so that it protects the buildings and pedestrian routes to allow for safe passage.

Figure 4 Surface Water Flooding Map



3.4. Foul/Surface Water Sewer Flooding

There are no known sewers within the vicinity of the site the risk of flooding from this source is therefore negligible. Refer to Appendix D for sewer record map.

3.5. Groundwater Flooding

Local borehole data confirms that groundwater is located at approximately 5m bgl. Anecdotal data backs this up as recent works on site including the installation of a 4m deep treatment plant on site did not encounter any groundwater. During detailed design it is suggested that detailed winter groundwater monitoring takes places to verify. Refer to Appendix E for local borehole data.

3.6. Reservoir Flooding

The site is not near any reservoirs and is therefore at no risk of flooding from this source.

4. Proposed Development

It is proposed to demolish two existing dwellings on site and to replace them with a residential site of 27 new dwellings with associated access and parking areas.

4.1. Existing Drainage Regime

There are no foul or surface water sewers on site. The foul water from both dwellings currently drain to septic tanks and surface water discharges onto or into the ground. The site is underlain with sandy clay however the infiltrating potential of the soil is moderate.

4.2. Proposed Surface Water Drainage Regime

The surface water management strategy has been developed using best practice Sustainable Drainage Systems (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the EA, WSCC and the SuDS manual (CIRIA C753).

The National Planning Policy Framework (NPPF) recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development.

The overall philosophy of SuDS is to replicate, as closely as possible, the natural drainage process of a site prior to development to mitigate the adverse effect of storm water runoff on the environment. SuDS not only provide the ability to control surface water flows, but also improve water quality, amenity and bio-diversity within the development.

The Building Regulations Requirement H3 and WSCC Planning Policy stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- 1- Discharge into the ground
- 2- Discharge to a surface water body
- 3- Discharge to a surface water sewer

2no. soakage tests to BRE 365 were carried out on site at the end of January 2018 and confirmed a moderate soakage potential of the soil at depths of 0.6m and 1.2m. The rates given were 1.82×10^{-5} m/s and 1.5×10^{-5} m/s respectively. It is recommended at detailed design stage that more tests are carried out throughout the site and at varying depths to see if there is any significant variation.

It is intended to utilise infiltration devices to discharge all the surface water into the ground. The predominant system would be the use of geocellular soakage creates to the rear of each unit with porous paving catering for most of the access road and all parking spaces.

4.3. Runoff Rate and Volume

As surface water is to be discharged into soakaways and permeable paving, there will be no increase in surface water volume that will discharge off the site.

4.4. Allowance for Climate Change

It is important to note that in 2016 the EA revised their advice regarding climate change. The new guidance states that there is a 10% chance the peak rainfall intensity will increase by 40% or more and that there is a 50% chance it will increase by 20% or more, for the years 2070 to 2115. To decide which allowance to use, the vulnerability of the development and the 'built in' resilience measures should be considered. Given the development is a more vulnerable use, a 40% climate change allowance is considered appropriate in this instance.

4.5. Urban Creep

Development results in the conversion of permeable surfaces to impermeable over time (e.g. surfacing of front gardens to provide additional parking spaces, extensions to existing buildings, creation of large patio areas etc.). It is therefore prudent to anticipate these changes and future proofing the system to cater for them at a later date. In accordance with WSCC Policy 5.6.4, an allowance of 10% additional surface area has been added onto the current impermeable areas when sizing the storage features.

4.6. Proposed Foul Water Drainage Regime

There are currently no foul water sewers that serve the site, with the existing dwellings using septic tanks to cater for foul water waste.

The local sewage treatment works are located approximately 500m to the east and it is proposed to construct a new length of sewer from the north of the site to these works under a Section 98 Sewer Requisition agreement. The route of the sewer will follow the existing vehicular track that serves the sewage treatment works.

4.7. Water Quality

New SuDS Manual (Ciria C753, November 2015) introduces slightly different approach compared to the previous version for the water quality management of surface water. The Manual describes risks posed by the surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source).
- The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels.
- The sensitivity of the receiving environment.

The EA website indicates that the site does not lie within a Source Protection Zone.

The recommended approaches for water quality risk management are given in the SuDS Manual Table 26.1.

Figure 5 Approaches to Water Quality Risk Management

TABLE 26.1 Approaches to water quality risk management			
Design method	Hazard characterisation	Risk reduction	
		For surface water	For groundwater
Simple index approach	Simple pollution hazard indices based on land use (eg Table 26.2 or equivalent)	Simple SuDS hazard mitigation indices (eg Table 26.3 or equivalent)	Simple SuDS hazard mitigation indices (eg Table 26.4 or equivalent)
Risk screening ¹	Factors characterising traffic density and extent of infiltration likely to occur (eg Table 26.5 or equivalent)	N/A	Factors characterising unsaturated soil depth and type, and predominant flow type through the soils (eg Table 26.5 or equivalent)
Detailed risk assessment	Site specific information used to define likely pollutants and their significance	More detailed, component specific performance information used to demonstrate that the proposed SuDS components reduce the hazard to acceptable levels	
Process-based treatment modelling	Time series rainfall used with generic pollution characteristics to determine statistical distributions of likely concentrations and loadings in the runoff	Models that represent the treatment processes in the proposed SuDS components give estimates of reductions in event mean discharge concentrations and total annual load reductions delivered by the system	

As per Table 26.1 Simple Index approach will be used as a design method for this site.

Table 26.2 will provide hazard classification of different land uses. The land uses for the surface water drainage for this site are;

- Roof area-impermeable surface
- Private car parking area, footpaths and patios - permeable surface
- Private access road – permeable surface

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index for each contaminant type that equals or exceeds the pollution hazard index for each contaminant type. Therefore, the following must be achieved for the surface running off the site.

Total SuDS mitigation index $\geq$ pollution hazard index

Pollution Hazard Indices are given for different land uses in Table 26.2 of the SuDS manual;

Figure 6 Pollution Hazard Indices for Different Land Use Classifications

TABLE 26.2 Pollution hazard indices for different land use classifications					
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons	
Residential roofs	Very low	0.2	0.2	0.05	
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05	
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4	
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7	
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²	

From Table 26.2 the following information is tabulated in Table 4.

Land Use	Destination of Runoff	Pollution Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Residential roof	Groundwater	Very Low	0.2	0.2	0.05
Private Driveways	Groundwater	Low	0.5	0.4	0.4

Table 4: Pollution hazard index and destination of runoff for the proposed site

The SuDS mitigation index will be obtained from Table 26.3 (for surface water) of the SuDS manual.

Figure 7 Indicative SuDS Mitigation Indices for discharges to groundwater

TABLE 26.4	Indicative SuDS mitigation indices for discharges to groundwater			
	Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates ¹	TSS	Metals	Hydrocarbons
	A layer of dense vegetation underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.6 ⁴	0.5	0.6
	A soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.4 ⁴	0.3	0.3
	Infiltration trench (where a suitable depth of filtration material is included that provides treatment, ie graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20 mm gravel) underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.4 ⁴	0.4	0.4
	Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.7	0.6	0.7
	Bioretention underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.8 ⁴	0.8	0.8
	Proprietary treatment systems ^{5, 6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

SuDS mitigation index are tabulated in Table 5 as followed;

Runoff Source	Destination of Runoff	Mitigation Index Source	Mitigation Indices			
			Characteristics of the material overlying the proposed infiltration surface	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential roof	Ground water	Table 26.4 (for groundwater)	A soil with good containment attenuation potential	0.4	0.3	0.3
Individual driveways, car parks and shared surface	Ground water	Table 26.4 (for groundwater)	Permeable Paving	0.7	0.6	0.7

Table 5: SuDS mitigation index

In summary, the SuDS component mitigation indices are greater than pollution hazard indices and therefore provides the required level of treatment.

4.8. Maintenance

A full SuDS maintenance and management plan will be submitted as part of the full planning submission. In short however, the pipework, manholes, gullies, and catch pits and will be maintained regularly to ensure effective operation. It is recommended that they are inspected every 3 months and after every severe storm event. The maintenance will include the clearing and cleansing of gully pots and catch pits. Any blockages are to be rodded through and removed from the following downstream manhole. The following maintenance requirements for the SuDS features are extracts from Ciria C573 and are to be adhered to. A private management company is to be employed to undertake these tasks.

Permeable Paving is to be maintained in accordance with Table 20.15 from the SuDS manual which is shown below:

Figure 8 Operation and maintenance requirements for pervious pavements

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 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

Geocellular soakaways are to be maintained in accordance with Table 21.3 from the SuDS manual which is shown below:

Figure 9 Operation and Maintenance requirements for Attenuation Storage Tanks (Soakaways)

TABLE 21.3	Operation and maintenance requirements for attenuation storage tanks		
	Maintenance schedule	Required action	Typical frequency
Regular maintenance		Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
		Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
		For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
		Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions		Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring		Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
		Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

4.9. Residual Risk and Exceedance

It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible, however, it is practicable to minimise the risk by careful design of the layout of the development such that internal flooding is avoided. Areas of hard standing can be laid to falls away from buildings to provide a significant volume of surface storage during extreme events with flows directed to areas where damage and disruption to operations will be minimised such as onto the access road then carriageway.

The building levels themselves are to be elevated a minimum of 150mm above surrounding levels to prevent flooding of the buildings. It is suggested that these requirements are considered at detailed design stage.

5. Summary of WSCC SuDS Policies

The following list will summarise the main points of the report whilst also demonstrating how each of the policies has been addressed:

5.1. SuDS Policy 1 Follow the drainage hierarchy

Due to the favourable soakage potential of the sub soils, all surface water will be discharged into the ground via soakaways or permeable paving.

5.2. SuDS Policy 2 Manage Flood Risk Through Design

As this is only an outline application, full external levels details are not available. It is however suggested at detailed design phase that all buildings will be projected a minimum of 150mm above proposed ground levels. Levels should also be designed so that exceedance routes fall toward the access road which will flow out to the carriageway.

Consideration should also be given to ensuring that people can safely evacuate the buildings and emergency access maintained.

5.3. SuDS Policy 3 Mimic Natural Flows and Drainage Flow Paths

All surface water is to be discharged to ground therefore natural drainage routes are mimicked as best as possible.

5.4. SuDS Policy 4 Seek to Reduce Existing Flood Risk

The existing site has been identified as having no risk of flooding except for an isolated pocket of flood risk from surface water to the far west of the site. During detailed design phase it is suggested that this is investigated further.

5.5. SuDS Policy 5 Maximise Resilience

All SuDS infiltration devices have been designed to accommodate the 1 in 100 year + 40% critical storm event. All surface water will be discharged into the ground as close to source as possible. To provide additional resilience and future proofing an additional 10% impermeable area increase has been applied to the overall site impermeable area.

5.6. SuDS Policy 6 Design to be Maintainable

The drainage systems on site shall be easily accessible and maintainable. During detailed design phase an agreed drainage management and maintenance plan will be provided that will detail a schedule of maintenance activities and an agreed timeframe for undertaking them. Section 4.8 indicates a typical SuDS maintenance plan taken from Ciria C753. Any proposed plan should also reference this guidance.

5.7. SuDS Policy 7 Safeguard Water Quality

The surface water system has been designed in accordance with Ciria C753 and passes the water quality criteria as set out in the document. This is demonstrated in Section 4.7. As the site will drain via infiltration, the first 5mm of rainfall will be intercepted and disposed of on site with the remaining volume following the same route.

5.8. SuDS Policy 8 Design for Amenity and Multi-Functionality

Due to space and level constraints the utilisation of the open space area may not be suitable for a SuDS system. All the infiltration devices will store up to the 1 in 100 years+ 40% storm thereby negating the requirement for any above ground storage. During detailed design phase however, it is recommended that the utilisation of the open space is explored to determine if it can be used for SuDS.

5.9. SuDS Policy 9 Enhance Biodiversity

As discussed in section 5.8, due to constraints, the use of above ground SuDS features may not be feasible. Green roofs will also be unsuitable for the individual dwellings due to the roof pitches. During detailed design phase however, it is recommended that the utilisation of the open space is explored to determine if it can be used for SuDS.

5.10. SuDS Policy 10 Link to Wider Landscape Objectives

Again, this is covered in sections 5.8 and 5.9 with the site being potentially unsuitable for above ground SuDS features. The open space however should be designed that it promotes amenity and bio-diversity.

6. Conclusions

The Environment Agency Flood Map for Planning confirms that the site is in a Flood Zone 1 i.e. having less than a 1 in 1000 chance of flooding in a year.

There is a small risk of surface water flooding to the west of the site however with sensible planning, this can be mitigated with the external levels design.

Geocellular Soakaways and Permeable paving has been selected for the storage which has been designed for the 1 in 100-year + 40% storm to protect the dwellings and any adjacent property.

The removal of the existing septic tanks and connection onto the main sewer will provide improvement to the current groundwater quality.

An assessment of the water quality has confirmed that there will be suitable SuDS methods to control any small amount of pollution that the site may generate.

All WSCC SuDS policies have been appropriately addressed for the level of detail available for this outline submission.

Based on the above, the proposals to construct 27no. new dwellings on the site is appropriate for the location.

Appendix A

Topographical Survey

Appendix B

Drainage Strategy

DESIGN SUBJECT TO THE APPROVAL OF:
PLANNING AUTHORITY

TRENCH SOAKAWAYS BASED ON RECORDED INFILTRATION RATE OF $1.5 \times 10^{-7} \text{m/s}$. FURTHER INFILTRATION TESTS TO BE CARRIED OUT DURING DETAILED DESIGN STAGE

New foul sewer to connect onto existing Southern Water network under a Section 98 Agreement

INFILTRATING POROUS PAVING BASED ON RECORDED INFILTRATION RATE OF $1.82 \times 10^{-7} \text{m/s}$. FURTHER INFILTRATION TESTS TO BE CARRIED OUT DURING DETAILED DESIGN STAGE

LEGEND

- PROPOSED SURFACE WATER DRAIN (SWD)
PROPOSED FOUL WATER DRAIN (FWD)
SURFACE WATER INSPECTION CHAMBER 475 ϕ PPIC
FOUL WATER INSPECTION CHAMBER 475 ϕ PPIC
FOUL WATER MANHOLE 1200 ϕ PCC
GEOCELLULAR SOAKAWAY DESIGNED TO CATER FOR THE 1 IN 100 YEAR + 40% STORM
TYPE 1 = 4.8m³ STORAGE REQUIRED
TYPE 2 = 10m³ STORAGE REQUIRED
TYPE 3 = 5.6m³ STORAGE REQUIRED
INFILTRATING POROUS PAVING DESIGNED TO CATER FOR THE 1 IN 100 YEAR + 40% STORM
MIN 300mm OPEN GRADED SUB BASE FOR SHARED AREAS
MIN 250mm OPEN GRADED SUB BASE FOR PRIVATE DRIVEWAYS

STANDARD NOTES

- DO NOT SCALE FROM THIS DRAWING. REFER TO FIGURED DIMENSIONS ONLY. THE CONTRACTOR SHOULD CHECK ALL DIMENSIONS ON SITE.
- ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS ARE IN METERS UNLESS NOTED OTHERWISE.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ARCHITECT AND ENGINEERING DETAILS, DRAWINGS AND SPECIFICATIONS.
- ANY DISCREPANCIES SHOULD BE REPORTED TO THE ARCHITECT AND/OR ENGINEER IMMEDIATELY, SO THAT CLARIFICATION CAN BE SOUGHT PRIOR TO THE COMMENCEMENT OF WORK.
- COVER LEVELS SHOWN ARE APPROXIMATE. COVERS AND FRAMES SHALL BE SET TO FINISHED GROUND LEVELS AND FALLS.
- THE CONTRACTOR IS TO KEEP A RECORD OF ANY VARIATIONS MADE ON SITE, INCLUDING THE RELOCATION OF SEWERS OR DRAINS, SO THAT AN AS CONSTRUCTED DRAWING CAN BE PREPARED UPON COMPLETION OF THE PROJECT.
- IF ANY SUB SOIL DRAINAGE SYSTEMS ARE UNCOVERED DURING THE WORKS CONTACT THE ENGINEER FOR INSTRUCTIONS. SUB SOIL DRAINS ARE TO BE DIVERTED AROUND NEW WORKS AND CONNECTED INTO THE SURFACE WATER.
- NO PRIVATE AREAS ARE TO DRAIN ONTO ADAPTABLE AREAS AND VICE VERSA.

P-	05.02.18	PRELIMINARY ISSUE FOR COMMENT/APPROVAL	C.S.	S.S.	C.S.
REV	DATE	DESCRIPTION	BY	CHK	APP
 Consulting Civil Engineers					
CLIENT MR CHRIS HARRIS					
ARCHITECT STUDIO LACK ARCHITECTS					
JOB TITLE THE OLD COTTAGE AND BRIDGE COTTAGE, LIDSEY					
DRAWING TITLE DRAINAGE STRATEGY					
DRAWN	CS	ENGINEER	C.SLADE	CHECKED	APPROVED
DATE	JANUARY 2018	SCALE	# AT	SS	CS
JOB No.	C1033	STATUS	P	DRAWING No.	100
REV.	P-				

PRELIMINARY – NOT
FOR CONSTRUCTION

Appendix C

Drainage Calculations

Drainage Design Report

Flow+

v6.0

Copyright © 1988-2018 Causeway Software Solutions Limited

Network	Storm Network
Filename	C:\Users\chris\Dropbox\CGS Civils\01 - Projects\C1033 Land East of Lidsey Road\02 - Calculations\Plots 1-17 Soakaways.pfd
Username	Chris Stade (chris@cgscivils.co.uk)
Last analysed	
Report produced	
Causeway Sales	
Tel:	
Fax:	
Email:	
Web:	
Technical support	
http://support.causeway.co.uk	

Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	10
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Depth (m)
	SA	0.005		5.500	1.200

Rainfall Methodology	FSR	Return Period (years)	Climate Change (%)
FSR Region	England and Wales	100	40
M5-60 (mm)	20.000		
Ratio-R	0.400		
Summer CV	0.750		
Winter CV	0.840		
Analysis Speed	Normal		
Drain Down Time (mins)	240		
Additional Storage (m³/ha)	20.0		
Storm Durations (mins)	15		
	30		
	60		
	120		
	180		
	240		
	360		
	480		
	600		
	720		
	960		
	1440		
Check Discharge Rate(s)	x		
1 year (l/s)			
30 year (l/s)			
100 year (l/s)			
Check Discharge Volume	x		
100 year 360 minute (m³)			

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m ²)	Inf. Area (m ²)
SA	0.05400	0.05400	2.0	0.95	4.300		0.000	6.0	0.0
							0.800	6.0	0.0
							0.801	0.0	0.0

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 100.00%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
600 minute winter	SA	570	5.047	0.747	0.3	4.3200	0.0000	OK	Infiltration		0.0				

Drainage Design Report

Flow+

v6.0

Copyright © 1988-2018 Causeway Software Solutions Limited

Network	Storm Network
Filename	C:\Users\chris\Dropbox\CGS Civils\01 - Projects\C1033 Land East of Lidsey Road\02 - Calculations\Plots 18-22 Soakaways.pfd
Username	Chris Slade (chris@cgscivils.co.uk)
Last analysed	05/02/2018 19:29:49
Report produced on	05/02/2018 19:30:10

Causeway Sales

Tel:

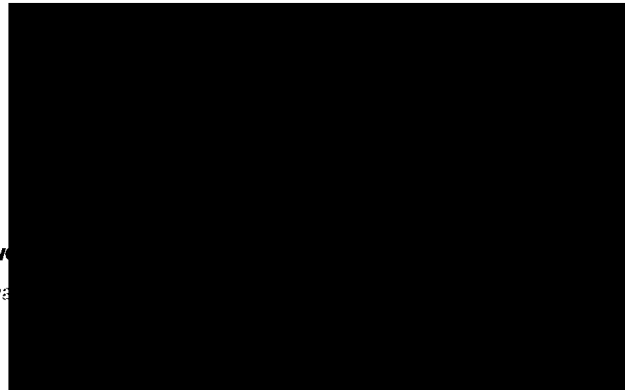
Fax:

Email:

Web:

Technical support website

<http://support.causeway.co.uk>



Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	10
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Depth (m)
	SA	0.010		5.500	1.600

Rainfall Methodology	FSR	Return Period (years)	Climate Change (%)
FSR Region	England and Wales	100	40
M5-60 (mm)	20.000		
Ratio-R	0.400		
Summer CV	0.750		
Winter CV	0.840		
Analysis Speed	Normal		
Drain Down Time (mins)	240		
Additional Storage (m³/ha)	20.0		
Storm Durations (mins)	15		
	30		
	60		
	120		
	180		
	240		
	360		
	480		
	600		
	720		
	960		
	1440		
Check Discharge Rate(s)	x		
1 year (l/s)			
30 year (l/s)			
100 year (l/s)			
Check Discharge Volume	x		
100 year 360 minute (m³)			

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
SA	0.05400	0.05400	2.0	0.95	3.900		0.000	12.5	0.0
							0.800	12.5	0.0
							0.801	0.0	0.0

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 63.29%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	SA	1320	5.550	1.600	0.3	9.7058	0.0000	OK	Infiltration		0.0				

Drainage Design Report

Flow+

v6.0

Copyright © 1988-2018 Causeway Software Solutions Limited

Network	Storm Network
Filename	C:\Users\chris\Dropbox\CGS Civils\01 - Projects\C1033 Land East of Lidsey Road\02 - Calculations\Plots 22-27 Soakaways.pfd
Username	Chris Slade (chris@cgscivils.co.uk)
Last analysed	05/02/2018 19:25:21
Report produced on	05/02/2018 19:29:08

Causeway Sales

Tel:

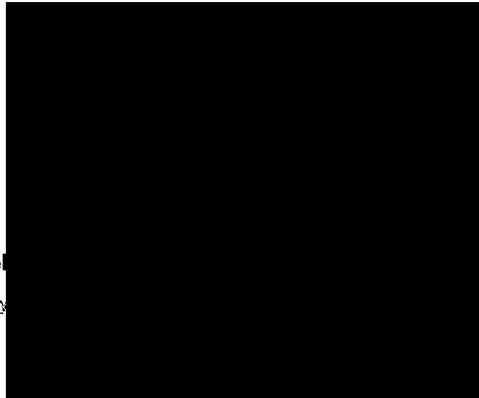
Fax:

Email:

Web:

Technical support web

<http://support.causeway>



Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	10
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Depth (m)
	SA	0.006		5.500	1.300

Rainfall Methodology	FSR	Return Period (years)	Climate Change (%)
FSR Region	England and Wales	100	40
M5-60 (mm)	20.000		
Ratio-R	0.400		
Summer CV	0.750		
Winter CV	0.840		
Analysis Speed	Detailed		
Drain Down Time (mins)	240		
Additional Storage (m³/ha)	20.0		
Storm Durations (mins)	15		
	30		
	60		
	120		
	180		
	240		
	360		
	480		
	600		
	720		
	960		
	1440		
Check Discharge Rate(s)	x		
1 year (l/s)			
30 year (l/s)			
100 year (l/s)			
Check Discharge Volume	x		
100 year 360 minute (m³)			

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m ²)	Inf. Area (m ²)
SA	0.05400	0.05400	2.0	0.95	4.200		0.000	7.0	0.0
							0.800	7.0	0.0
							0.801	0.0	0.0

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 99.34%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
720 minute winter	SA	675	5.057	0.857	0.3	5.5383	0.0000	OK	Infiltration		0.0				

Drainage Design Report

Flow+

v6.0

Copyright © 1988-2018 Causeway Software Solutions Limited

Network	Storm Network
Filename	C:\Users\chris\Dropbox\CGS Civils\01 - Projects\C1033 Land East of Lidsey Road\02 - Calculations\Typical Porous Paving.pfd
Username	Chris Slade (chris@cgscivils.co.uk)
Last analysed	06/02/2018 08:27:01
Report produced on	06/02/2018 08:27:18

Causeway Sales

Tel:

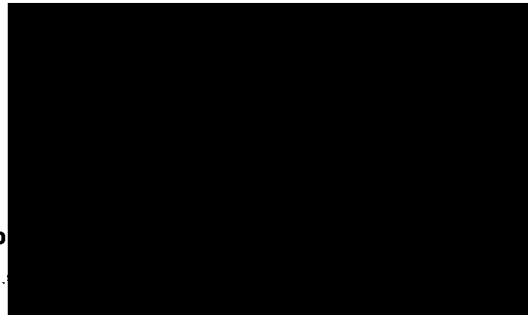
Fax:

Email:

Web:

Technical support web

<http://support.causeway.com>



Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	10
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Depth (m)
	SA	0.005		5.500	0.500

Rainfall Methodology	FSR	Return Period (years)	Climate Change (%)
FSR Region	England and Wales	100	40
M5-60 (mm)	20.000		
Ratio-R	0.400		
Summer CV	0.750		
Winter CV	0.840		
Analysis Speed	Normal		
Drain Down Time (mins)	240		
Additional Storage (m³/ha)	20.0		
Storm Durations (mins)	15		
	30		
	60		
	120		
	180		
	240		
	360		
	480		
	600		
	720		
	960		
	1440		
Check Discharge Rate(s)	x		
1 year (l/s)			
30 year (l/s)			
100 year (l/s)			
Check Discharge Volume	x		
100 year 360 minute (m³)			

Carpark											
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Width (m)	Length (m)	Slope (1:X)	Depth (m)	Inf Depth (m)
SA	0.06552	0.06552	2.0	0.30	5.000	54	10.000	10.000	60.0	0.300	

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 100.00%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute winter	SA	26	5.115	0.115	2.4	1.2128	0.0000	OK	Infiltration		0.5				

Appendix D

Sewer Records

103440

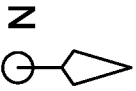


102862

O.S. REF. SU9303SE		Drawn by: chowdha		The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. <i>WATERWORKS, 8245, 1999 are contributors of British Waterways Company WATERWORKS, 1999 are contributors of British Waterways Company</i>		
Scale: 1:2500						
Title: 276218_The Old Cottage, Lidsey	Date: 12/01/2018	Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.				

493477

494422



SEWER RECORDS PAGE 2 OF 2

[illegible][illegible]

LEGEND - SEWERS

Wastwater (F&C) [Symbol: Circle with 'W']
 Rooding Eye (SW) [Symbol: Circle with 'R']
 Rooding Eye (NW) [Symbol: Circle with 'R']
 Gauging point (SW) [Symbol: Circle with 'G']
 Gauging point (NW) [Symbol: Circle with 'G']
 Intercept chamber (SW) [Symbol: Circle with 'I']
 Intercept chamber (F&C) [Symbol: Circle with 'I']
 Storm tank (SW) [Symbol: Circle with 'S']
 Storm tank (F&C) [Symbol: Circle with 'S']
 Venturi diameter (SW) [Symbol: Circle with 'V']
 Venturi diameter (F&C) [Symbol: Circle with 'V']
 Label ellipse [Symbol: Ellipse with 'L']
 Dumfries/SS4 manhole [Symbol: Circle with 'D']
 Dumfries/SS4 manhole [Symbol: Circle with 'D']
 Dumfries [Symbol: Circle with 'D']
 Dumfries chamber [Symbol: Circle with 'D']
 Purbeck chamber [Symbol: Circle with 'P']
 Storm Overflow [Symbol: Circle with 'S']
 Boulding manhole [Symbol: Circle with 'B']

SHAPES (S)

Arched [Symbol: Circle with 'A']
 Rectangular [Symbol: Circle with 'R']
 Elliptical [Symbol: Circle with 'E']
 Circular [Symbol: Circle with 'C']
 V [Symbol: Circle with 'V']
 S [Symbol: Circle with 'S']
 T [Symbol: Circle with 'T']
 S [Symbol: Circle with 'S']
 S [Symbol: Circle with 'S']

NODE REFERENCING SYSTEM

1st digit - horizontal man working identifier
 2nd digit - horizontal man working identifier
 3rd digit - sewer type identifier
 4th digit - sewer type identifier
 5-9 = Surface Water
 10 = man required node

Other (s) [Symbol: Circle with 'O']
 Other [Symbol: Circle with 'O']
 Changing in sewer (s) [Symbol: Circle with 'C']
 Change in sewer [Symbol: Circle with 'C']
 Reduce valve [Symbol: Circle with 'R']
 Ring valve [Symbol: Circle with 'R']
 Flap valve [Symbol: Circle with 'F']
 Valve [Symbol: Circle with 'V']
 Arched [Symbol: Circle with 'A']
 Closed Valve [Symbol: Circle with 'C']
 Air Valve [Symbol: Circle with 'A']
 Hatch box (SW) [Symbol: Circle with 'H']
 Hatch box (F&C) [Symbol: Circle with 'H']
 Direction arrow [Symbol: Circle with 'D']
 Emptying valve [Symbol: Circle with 'E']
 Cuckpig [Symbol: Circle with 'C']
 Sewerway [Symbol: Circle with 'S']
 Inlet [Symbol: Circle with 'I']
 Boulding Pan [Symbol: Circle with 'B']

Wastewater treatment works [Symbol: Circle with 'W']
 Wastewater treatment works [Symbol: Circle with 'W']
 Odour treatment works [Symbol: Circle with 'O']
 Odour treatment works [Symbol: Circle with 'O']
 Vent [Symbol: Circle with 'V']
 Vent down drain bank [Symbol: Circle with 'V']
 Storm tank [Symbol: Circle with 'S']
 Storm tank [Symbol: Circle with 'S']
 Interceptor [Symbol: Circle with 'I']
 Interceptor [Symbol: Circle with 'I']
 Head of Public Sewer [Symbol: Circle with 'H']
 Head of Public Sewer [Symbol: Circle with 'H']
 Micro Pumping Station [Symbol: Circle with 'M']
 Micro Pumping Station [Symbol: Circle with 'M']

Drawn by:	chowdha
Title:	276218_The Old Cottage, Lidsey
Date:	12/01/2018
	

Appendix E

Local Borehole Data

BGS Borehole Data Map



The following borehole logs are in order:

- BH1
- BH2
- BH3

SU 90 SW 49

9372 0369

Headbone Farm

Block G

Surface level +8.0 m
Water struck at +6.0 m
September 1981

Overburden 2.0 m
Mineral 1.5 m
Waste 0.1 m
Mineral 0.8 m
Bedrock 1.0 m*

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Brickearth	Clay, brown, silty, with a few pebbles near base	1.5	2.0
Raised Beach Deposits (younger)	a 'Very clayey' pebbly sand Gravel: fine with coarse; flint (some white and porous), sandstone and ironstone with some chalk Sand: fine with medium and some coarse Fines: silt	1.5	3.5
	Clay, grey, silty	0.1	3.6
	b 'Clayey' sandy gravel Gravel: coarse with fine; flint (some white and porous) with limestone, sandstone and some chalk Sand: fine with medium and some coarse Fines: silt	0.8	4.4
London Clay	Clay, grey	1.0+	5.4

GRADING

	Mean for deposit percentages			Depth below surface (m)	Percentages								
	Fines	Sand	Gravel		Fines			Sand			Gravel		
					-4	+4 -4	+4 -1	+1 -4	+4 -16	+16 -64	+64 mm		
a	20	69	11	2.0-3.0	23	49	13	5	8	2	0		
				3.0-3.5	12	55	6	5	10	2	0		
				Mean	20	53	11	5	9	2	0		
b	16	51	33	3.6-4.4	16	35	9	7	12	21	0		
a+b	18	64	18	Mean	18	48	10	6	10	8	0		

SU 90 SW 53

0456 0287

Lickey Lodge

Surface level +3.4 m
Water not struck
September 1981

Block B

Overburden 2.0 m
Mineral 1.5 m
Waste 0.6 m
Bedrock 2.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Brickearth	Clay, brown, silty; abundant chalk pellets below 1.1 m; pebbly and more sandy near base	1.7	2.0
Raised Beach Deposits (younger)	'Very clayey' sandy gravel Gravel: coarse and fine; flint and chalk Sand: fine with some coarse and medium Fines: silt and clay, light brown	1.5	3.5
	Silt, sandy, pebbly, very chalky, with a few flint pebbles	0.6	4.1
Upper Chalk	Chalk, weathered, pale brown, sandy near top, cleaner and with nodular flints below 6.0 m	2.2+	6.3

GRADING

Mean for deposit percentages			Depth below surface (m)	Percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				-#	+# -1	+1 -1	+1 -4	+4 -16	+16 -64	+64 mm
36	42	22	2.0-3.0	35	33	3	5	7	13	4
			3.0-4.5	38	35	4	5	7	7	4
			Mean	36	33	4	5	7	11	4

TERRAMECH INVESTIGATIONS LIMITED

REMARKS:

[illegible]

Appendix F

Soakage Test Results



Job: Land East of Lidsey Road, Lidesy 0.5m Deep Test (Porous Paving)

Infiltration Calculator

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

V_{p75-25} = Effective storage volume between 75% and 25% effective depth

a_{p50} = Internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} = The time for the water level to fall from 75% to 25% effective depth

f = Infiltration rate

Trial pit width	=	0.4
Trial pit depth	=	0.5
Trial pit length	=	0.45

a_{p50} = 0.515 m/squared

t_{p75-25} = 4800 seconds

V_{p75-25} = 0.045 m/cubed

F = 1.82E-05



Job: Land East of Lidsey Road, Lidsey - 1.2m Deep Test (Soakaways)

Infiltration Calculator

$$f = \frac{V_{p75-25}}{ap_{50} \times tp_{75-25}}$$

V_{p75-25} = Effective storage volume between 75% and 25% effective depth

ap_{50} = Internal surface area of the trial pit up to 50% effective depth and including the base area

tp_{75-25} = The time for the water level to fall from 75% to 25% effective depth

f = Infiltration rate

Trial pit width	=	0.45
Trial pit depth	=	1.2
Trial pit length	=	0.5

ap_{50} = 1.2525 m/squared

tp_{75-25} = 7200 seconds

V_{p75-25} = 0.135 m/cubed

F = 1.5E-05

Trial Pits 1 and 2



Trial Pit 1

