FLOOD RISK ASSESSMENT

FOR THE RESIDENTIAL DEVELOPMENT AT

LAND AT CARCLAZE ROAD
CARCLAZE,
ST AUSTELL

CLIENT

The Trustees Of The Stanley Martin Estate

JRC CONSULTING ENGINEERS LTD

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Contents

REVISION RECORD Report ref: 1005w0002

Rev	Description	Date	Originator	Checked	Approved
A	Issued FOR PLANNING	17.07.16	JRAC	JRAC	JRAC
B	Layout updated & in turn drainage strategy, calculations & drawings	06.12.16	JRAC		JRAC

1. INTRODUCTION

This report was prepared based upon the appointment by PCL Transport Planning Ltd to undertake a Flood Risk Assessment to support an application involving the provision of 99 dwellings at the land adjacent to Kernow Veor, Carclaze At Austell, Cornwall. The FRA has been prepared in line with the relevant legislation and guidance, as detailed below.

Government policy with respect to development in flood risk areas is set out in the Department for Communities and Local Government *National Planning Policy Framework* (NPPF) published in March 2012. The Planning Practice Guidance Suite (PPG) was launched on 6th March 2014 and provides guidance on Flood Risk and Coastal Change. This guidance has superseded the Technical Guidance to the NPPF however it follows similar policies.

Statutory Instrument 2006 No. 2375: *The Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006*, which came into force on 1st October 2006, made the Environment Agency (EA) a statutory consultee for planning applications where flood risk is a key issue. The EA has published a set of advisory comments and guidance notes on the requirements of a site specific FRA for applicants and their agents.

In April 2013 DEFRA published further guidance with respect to flood risk management and the induction of the Lead Local Flood Authority role with respect to managing flood risk at a local level. The EA has a strategic overview role of all sources of flooding and coastal erosion (as defined within the Flood and Water Management Act) including working with others to prepare and carry out sustainable Catchment Flood Management Plans and Shoreline Management Plans, providing evidence and advice to support others and monitoring and reporting roles. This role links into the Lead Local Flood Authority role held under County Councils and unitary authorities. Under the FWMA this role includes:

- prepare and maintain a strategy for local flood risk management in their areas, coordinating views and activity with other local bodies and communities through public consultation and scrutiny, and delivery planning.
- maintain a register of assets – these are physical features that have a significant effect on flooding in their area
- investigate significant local flooding incidents and publish the results of such investigations
- establish approval bodies for design, building and operation of Sustainable Drainage Systems (SuDS)
- issue consents for altering, removing or replacing certain structures or features on ordinary watercourses
- play a lead role in emergency planning and recovery after a flood events

On this basis it is expected that the LLFA, Cornwall County Council will form part of the statutory consultee list in this case.

The objective of this FRA is to assess and substantiate the flood risk to the site in order to show that the proposed development meets the requirements of the NPPF.

Initial review of the parameters associated with this development are such that a site specific Flood Risk Assessment is applicable (as the site is greater than 1 Ha but within Flood Zone 1) and the site does fall within the Critical Drainage Area for St Austell. Therefore, the EA/ LLFA will need to be consulted as part of this planning application.

This report has been developed using latest information from the Environment Agency flood map on their website, liaison with South West Water and procured on the basis of providing a Flood Risk Assessment to support the proposed foul and surface water drainage solution at this development.

2. SITE LOCATION, EXISTING LEVELS AND DRAINAGE

The site is accessed from Carclaze Road which links to the A391 to the North East and is located on the North Eastern extremities of the St Austell District, Cornwall.
The Ordnance Survey grid reference for the site is SX 02582 54277. The site is bounded by the A391 to the North East, to the South and West, residential development some of which is recent.

The site generally falls from North to South with an average gradient of 1 in 10, with localised greater gradients.

An existing location plan, site layout and survey are included within Appendix A.

At present, the site comprises open grassland separated by hedges. The approximate area of the site is 4.1 ha.

As this is a greenfield site, there are no existing surface water drainage provisions and to our knowledge no agricultural drainage facilities to the fields. All rainwater and corresponding run off infiltrates into the ground.

There is an existing 375mm diameter trunk main which crosses the site and has been accommodated within the proposed layout. An extract of the SWW mapping is provided within Appendix B.

Currently, no site investigation is available for the site but a Mining search and desk top contamination report was procured by Mining Searches UK. The BGS Geological Mapping shows the bedrock in the area as being “Meadfoot Group – Hornfelsed Slate and Hornfelsed Sandstone” and is approximately between Emsian/ Pragian in age. In the local area this istypically underlain at depth by granite of the St Austell granite intrusion, outcropping approximately 300 metres to the North of the site. Alluvium and valley gravels lie in the valley bottom and which have been worked over for their tin content.

An aquifer within superficial deposits is recorded approximately 51 metres west of the site and is designated as Secondary A –‘ Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.'

This is considered to be located at such a distance from the subject site so as not to be impacted by the proposed development.

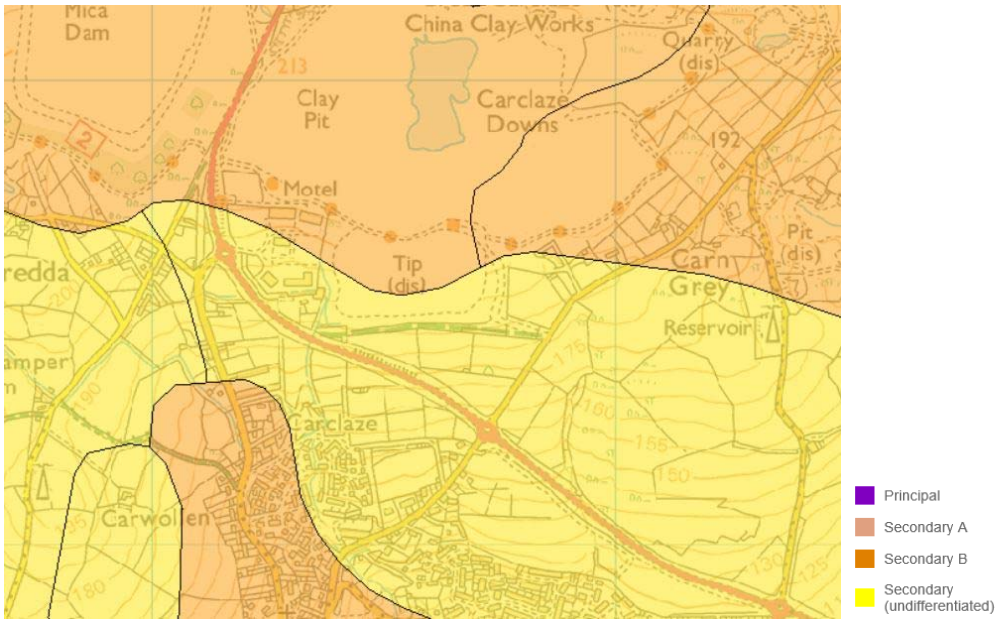

Fig 1
Groundwater Vulnerability Zone Mapping (EA online mapping)

The geological classification for groundwater vulnerability within the bedrock geology on site is designated as a Secondary 'A' aquifer.

There are no river networks recorded on-site. Multiple Tertiary and Secondary river types are recorded within 250 metres of the site and are predominantly located to the North, West and South. The closest of which is located 51 metres to the west of the site

There are multiple surface water features located within 250 metres of the site, the closest of which is located 80 metres to the West.

3. FLOODING HISTORY & SOURCES OF POTENTIAL FLOODING

PPG provides a link to EA climate change guidance (issued in September 2016) 'Adapting to Climate Change'. This gives updated recommended national precautionary sensitivity ranges that can be used to estimate climate change and therefore show how the effect of flooding may alter over the course of the proposed development's design life. The relevant parts of this guidance are reproduced below

Table 4 Change to extreme rainfall intensity compared to a 1961-90 baseline

Applies across all of England	Total potential change anticipated for '2020s' (2015-39)	Total potential change anticipated for '2050s' (2040-2069)	Total potential change anticipated for the '2080s' (2070-2115)
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

The Technical Guidance to the NPPF and the SFRA states that residential development is classed as 'more vulnerable' and should have a design life of 100 years.

Climate change will also increase the risk of surface water flooding, as rainfall intensity is predicted to increase. The key factor is to ensure that there is an adequate freeboard should the flood risk from this source alter as a result of climate change. Furthermore, allowance for climate change should be taken into account in the design of surface water drainage. The management of surface water is dealt with in later sections within this report.

Within the information provided on the Environment Agency online flood map, the locality is not highlighted as subject to flooding from groundwater, surface water or fluvial flooding (Fig 2).

Fig 2
(Environment Agency Online Flood Mapping)

The online Environment Agency information in relation to surface water flooding within the area (Fig 3), does not indicate any on site flooding but does highlight areas downstream which appear susceptible to a minimal elements of flooding.

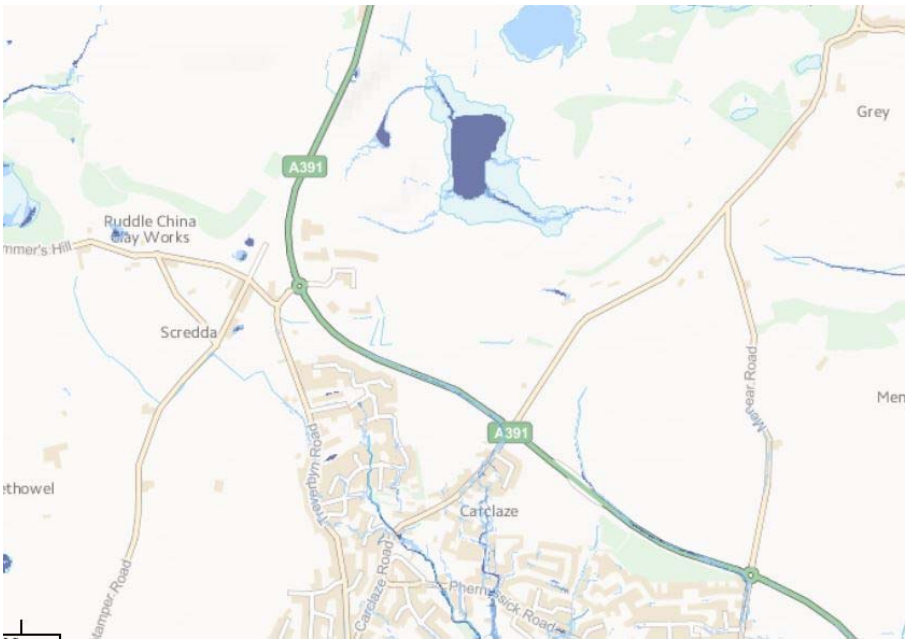

Fig 3

At this stage it is not clear what the specific cause of the surface water flooding is but it is likely, given the proximity of various water features outside of the proposed site, are accommodate via culverts and alike which from time to time become inundated during critical storm events.

4. SEQUENTIAL AND EXCEPTION TEST

The site is a greenfield site and within Flood Zone 1. Therefore, in accordance with NPPF Technical Note on flood risk, the site is deemed appropriate for development with the appropriate surface water design and management measures in place in accordance with best practice and Environment Agency/ Cornwall County Council guidance and CIRIA 753. As this site falls within the Critical Drainage Area the LLFA & Cornwall County Council has the authority to implement further design restrictions and any attenuation facility would need to control peak flows to a 1 in 10 year greenfield run off rate rather than the 1in 100 year rate- offering further protections to downstream infrastructure. Furthermore, the Long Term Storage would also need to be provided on site in addition to the attenuation volumes in order to minimise impact on the watercourse.

Table 2 Flood Risk Vulnerability Classification under clause 25 of the Flood Risk & Coastal Change PPG shows that buildings used for “dwellings” are classified as “more vulnerable”. This is subsequently applied to Table 3 of the same clause to determine whether:

(a) The proposed development is suitable for the flood zone in which it is located and;
(b) Whether an Exception Test is required.

This development satisfies all of the requirements of Table 2 and therefore is deemed appropriate for residential development.

5. PROPOSED DEVELOPMENT & DRAINAGE STRATEGY

The surface water drainage strategy has been procured and informed by the BGS Information available to us at time of writing in terms of assessing the likely use of infiltration to facilitate the most appropriate surface water in terms of following the surface water management train and the importance of water in the environment.

Given planning policy with respect to density of development, as always leads to large areas of impermeable area both in roof and road/ parking areas. It is likely that the natural topography of the site will also dictate the use of split level dwellings and larger areas of road infrastructure in the endeavour to achieve Part M compliance and reduce cut and fill volumes.

The HR Wallingford Suds Tools Website suggests a soil type of 4 at this site. This would indicate that subject to appropriate intrusive site investigation, the site is generally unlikely to be suitable for large scale soakaways. However localised areas of permeable paving may be appropriate given this form of suds offers the best greenfield mimic arrangement.

Given the site gradients and density of development, there would naturally be concerns with respect to the depth of soakaways which would be required to mitigate water exiting through the natural embankments and earthworks features required as part of the cut and fill exercise necessary, whilst also maintaining minimum distances from habitable buildings.

On this basis & in terms of offering a worst case surface water scenario the drainage strategy has been procured on the basis of an attenuated system with localised areas of permeable paving within private areas. The system will need to be designed to a 1 in 100 year event plus 40% for climate change and with the appropriate Long Term Storage volumes. South West Water would only adopt the 1 in 30 year element of any such system and therefore the extra over volume would need to be stored via a private facility.

As the site falls within a Critical Drainage Area and as infiltration is not predominantly offered Long Term Storage must be provided via a complex control ensuring that no more than 2 litres per second per hectare is discharged up to an including the 2 year storm event, after which the 1 in 10 year greenfield run off rate would need to be maintained for all events up to and including the 1 in 100 year plus 40% storm event.

Our calculations would suggest that Long Term Storage (LTS) Volumes of 286cu.m would be necessary on this site in addition to the attenuation volumes associated with achieving the 1 in 10 year greenfield run off rate. Given these large volumes, the approach has been to discharge at Qbar (25 litres per second) for all events thereby avoiding the need for LTS.

The Flow software has been used to assess the natural runoff rates for the existing site. The assessment is based on the IH 124 methodology, which is best practice for greenfield sites such as this.

A copy of this assessment can be seen within Appendix B of this report, with the results summarised in Table 2 below:

QBar	25
Q 1 year (l/s)	19.5
Q 30 year (l/s)	49.4
Q 100 year (l/s)	60.4

To ensure that the flood risk to downstream properties is not increased throughout the design life of the proposed development, the drainage strategy must implement appropriate mitigation measures which are capable of replicating the greenfield surface water runoff rates for all return period storms, with an allowance for climate change.

To enable the peak rate of runoff to be restricted to greenfield rates will require the attenuation of storm water runoff. In addition to this Long Term Storage will be required to address the additional volume of runoff generated by the development.
On this basis the Devon County Council guidance requires an allowance for Long Term Storage where the discharge rate is not controlled to 2 litres per second per hectare (2.1 litres per second in this case).

Therefore, usually a complex flow control would be employed to ensure the LTS is provided before appropriate greenfield run off rates take effect during later critical storm periods. We have undertaken an analysis of the difference in LTS storage and reduction in further storage volumes that would be made with the use of a complex control compared with discharging at 2 litres per second for all events. For this size of development with this gradient we did not determine a significant reduction in attenuation volumes to warrant the use of a complex control. On this basis we have utilised a single control with the following rates of betterment.

Return Period	Greenfield Runoff Rate (l.sec)	Post Development Runoff Rate (l/sec)	Level Betterment
2 year	25	23.8	5%
30 year	49.4	25	49%
100 year	60.4	25	58.6%

Whilst a complex control could be considered at detailed design there would still naturally be elements of betterment in order to ensure that the flow control operated with the correct head at the most critical storm event. It should be noted that the actual level of betterment provided for the 100 year storm events is likely to be in excess of that indicated, as the modelling takes into account the predictions for future climate change.

The intention is that South West Water will adopt all of the drainage including the attenuation facility up to the 1 in 30 year event and the extra over facility would be maintained by a professional maintenance company further ensuring regimes are maintained throughout the life of the facility. An outline testing regime is included within Appendix D.

The drainage strategy drawing is located within Appendix C

6. EXCEEDANCE EVENTS

The requirements of Sewers For Adoption are such that South West Water will only adopt facilities for up to and including the 1 in 30 year storm event whilst the 'storage' facility needs to be designed to 1 in 100 year event plus 30% for climate change. This would appear contrary in its approach given the water needs to travel to its 'storage' facility in order to make use of the additional storage requirements.

In this case, given the gradients of the site and therefore the drainage, the extreme storm events are likely to be naturally accommodated within the network by default and where we do encounter flooding due to blockage or lack of capacity, then care has been taken to ensure that the infrastructure has been designed to inform flood path routes to areas where damage to property & personas is mitigated.

7. SUMMARY & CONCLUSIONS

- The site is designated as being located in Flood Zone 1 and whilst is withhin a Critical Drainage Area, there is no history of surface water flooding

- The site satisfies the Sequential Test in accordance with the appropriate NPPF Technical Note

- The drainage strategy proposes to offer an attenuation facility which has been designed to 1 in 100 years plus 30% for climate change and has been designed in accordance with best practice and the Drainage Guidance for Cornwall Council documentation and CIRIA 753.

- The drainage strategy recognises the importance of water in the Environment and complies with the NPPF.

- Attenuation discharge rates will need to be further confirmed with South West Water & appropriate capacity checks undertaken by them accordingly in terms of both foul and storm water flows.

This report concludes that the development as proposed is appropriate and meets the requirements of the EA Standing Advice and the NPPF.

John Curtis BSc IEng MICE
On behalf JRC Consulting Engineers Ltd

8. LIMITATIONS

The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the site.

Third party information has been used in the preparation of this report, which JRC Consulting Engineers Ltd, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, JRC Consulting Engineers Ltd accepts no liability for same.

The benefits of this report are provided solely to The Trustees Of The Stanley Martin Estate for the proposed development land at Carclaze only.

JRC Consulting Engineers Ltd excludes third party rights for the information contained in the report.

APPENDIX A

LOCATION PLAN, SITE LAYOUT & SURVEY

Project	CARCLAZE, ST AUSTALL
Title	LOCATION PLAN

General Notes

1. DO NOT SCALE FROM THIS DRAWING. Scaling from this drawing or obtaining dimensions electronically may not provide accurate information and should be avoided, therefore work only from figured dimensions and contact JRC Consulting Engineers.
2. This drawing is to be read in conjunction with all other relevant Architect's, Engineers & Specialist drawings, details, Specification and the relevant Health and Safety Plan (as appropriate to the project).

Rev	Date	Details	Drawn	Checked

Drawing Status: FOR INFORMATION ONLY

Client:

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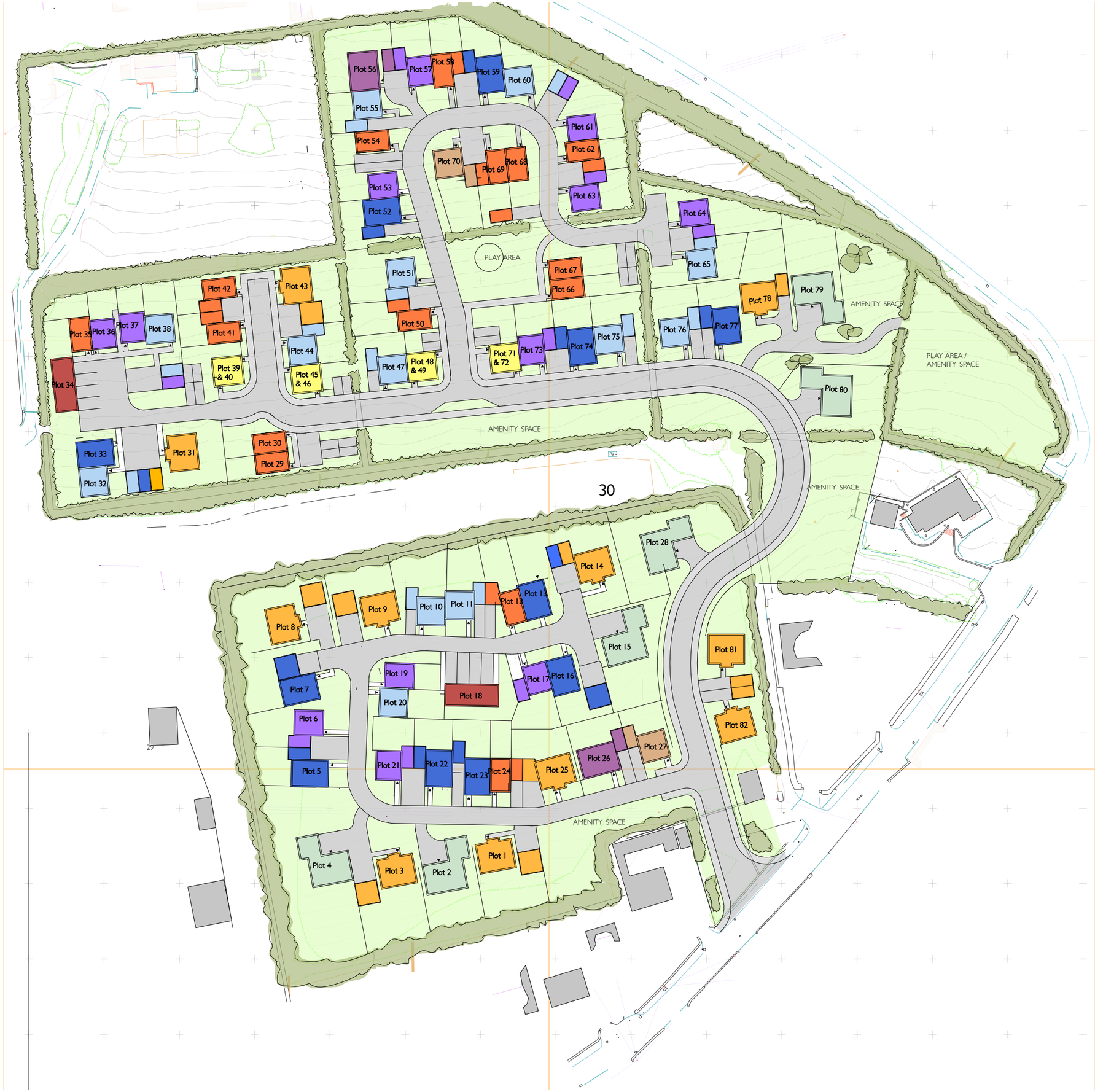
Project no	Drawing no	Revision	Scale (@ A4)	Date
1064	100	P2	0 1:50000 2.5 kilometres	DEC 2016



2 bed 4 Person bungalow 70m2	2 No.
1 bed 2 Person bungalow 49m2	2 No.
1 bed 2 Person flat - 2 storey	8 No.
3 bed 4 Person coachhouse - 72m2	2No.
3 bed 4 Person House 80m2	15 No.
3 bed 5 Person House 90m2	12 No.
3 bed 6 Person House 100m2	13 No.
4 bed 8 Person House 120m2	11No.
4 bed 8 Person House 138m2	11 No.
4 bed 8 Person House 156m2	6No.

TOTAL 82 UNITS

Notes:

Key:

A 29.11.16 Title amended

Revisions:

ala architects

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Job:

PROPOSED DEVELOPMENT OF LAND ADJACENT TO KERNOW VEOR, CARCLAZE
for:
THE TRUSTEES OF THE STANLEY MARTIN ESTATE

PROPOSED SITE PLAN

Date: October 16
Scale: 1: 500 @ A1
Paper size: A1
Drawn By: GD
Drawing Number: DS1604 SL 3

C D M : SIGNIFICANT HAZARDS

THE FOLLOWING HEALTH AND SAFETY HAZARDS ARE IDENTIFIED BY THE DESIGNER AS ABNORMAL IN PURSUANCE OF THE CURRENT CONSTRUCTION DESIGN AND MANAGEMENT REGULATIONS.

RISKS DURING CONSTRUCTION:

- No abnormal risks have been identified relating to this design element.

OPERATION / MAINTENANCE RISKS:

- No abnormal risks have been identified relating to this design element.

RISKS DURING DEMOLITION / DECOMMISSIONING / DISMANTLING / ALTERATIONS:

- No abnormal risks have been identified relating to this design element.

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY COMPETENT & ADEQUATELY RESOURCED CONTRACTOR(S) WORKING TO SAFE SYSTEMS OF WORK.

General Notes

1. DO NOT SCALE FROM THIS DRAWING. Scaling from this drawing or obtaining dimensions electronically may not provide accurate information and should be avoided, therefore work only from figured dimensions and contact JRC Consulting Engineers.
2. This drawing is to be read in conjunction with all other relevant Architect's, Engineers & Specialist drawings, details, Specification and the relevant Health and Safety Plan (as appropriate to the project).

Rev	Date	Details	Drawn	Checked
P1	17.07.16	Issued as part of FRA Appendices	JRC	JRC

Drawing Status

FOR INFORMATION ONLY

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Project

RESIDENTIAL DEVELOPMENT
LAND ADJACENT TO KERNOW VEOR
CARCLAZE, ST AUSTELL, CORNWALL

Client

PCL TRANSPORT PLANNING LTD

Drawing Title

EXISTING
SITE SURVEY
ORIGINAL SURVEY PROVIDED BY SUMO SERVICES LTD

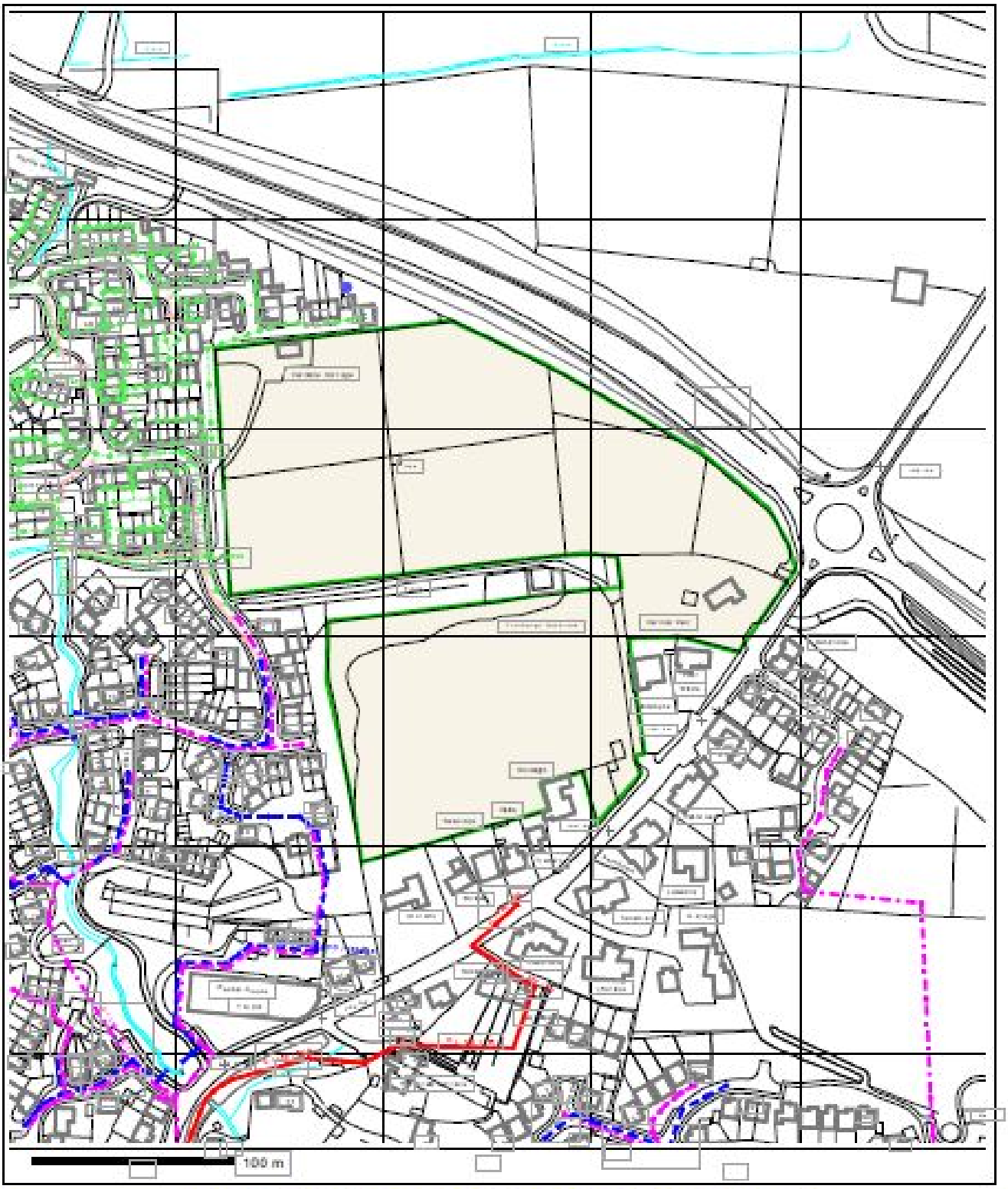
Scale (@ A1) 0 1:500 25 metres

Date JULY 2016

Project no	Drawing no	Revision
1064	0101	P1

APPENDIX B

SOUTH WEST WATER SEWER LOCATION



LOCATION : LAND AT CARCLAZE CARCLAZE ROAD PL25 3TA
Grid Ref : 202555m East, 54221m North

APPENDIX C

JRC CONSULTING ENGINEERS LTD DRAINAGE STRATEGY

General Notes

1. DO NOT SCALE FROM THIS DRAWING. Scaling from this drawing or obtaining dimensions electronically may not provide accurate information and should be avoided, therefore work only from figured dimensions and contact JRC Consulting Engineers.
2. This drawing is to be read in conjunction with all other relevant Architect's, Engineers & Specialist drawings, details, Specification and the relevant Health and Safety Plan (as appropriate to the project).

SURFACE WATER DESIGN STRATEGY

Surface water drainage designed in accordance with the Cornwall County Council Guidance.

The Greenfield run off rates have been assessed in accordance with the ICP SUDS method and are as follows:

Q_{bar} 25 litres per second
Q_{10} 37.25 litres per second
Q_{30} 49.4 litres per second
Q_{100} 60.4 litres per second

In accordance with the Cornwall Councils's 'Drainage Guidance For Cornwall', long term storage must be provided at this site in order to mitigated the volume of run off caused by the development. This storage should be in addition to the attenuation volumes. However in this case given the LTS volume would be 286 cu.m, the Qbar rate has been utilised throughout in order to avoid the need for a complex control and this significant volume.

As a result of this approach a level of betterment has been provided in naturally attenuating to 25 litres per second for the 1 in 100 year event.

Qbar	Pre Development (l/s)	Post Development (l/s)	Betterment (%)
2 year	25.0	23.8	5%
10 year	37.3	25.0	33%
30 year	49.4	25.0	49%
100 year	60.4	25.0	58%

KEY

Existing Public Storm
Existing Public Foul
Proposed Public Storm
Proposed Public Foul
Proposed Private Storm

C D M : SIGNIFICANT HAZARDS

THE FOLLOWING HEALTH AND SAFETY HAZARDS ARE IDENTIFIED BY THE DESIGNER AS ABNORMAL IN PURSUANCE OF THE CURRENT CONSTRUCTION DESIGN AND MANAGEMENT REGULATIONS.

RISKS DURING CONSTRUCTION:
- No abnormal risks have been identified relating to this design element.

OPERATION / MAINTENANCE RISKS:
- No abnormal risks have been identified relating to this design element.

RISKS DURING DEMOLITION / DECOMMISSIONING / DISMANTLING / ALTERATIONS:
- No abnormal risks have been identified relating to this design element.

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY COMPETENT & ADEQUATELY RESOURCED CONTRACTOR(S) WORKING TO SAFE SYSTEMS OF WORK.

Drainage Notes

1. The planning, design and construction of sewers shall be in accordance with Sewers For Adoption 6th edition a design and construction guide for developers and The Civil Engineering Specification for The Water Industry 7th edition.
2. All drainage works are to commence at the outfall and work upstream. Where the proposed site drainage connects to the public sewerage system it will require the submission of an application for sewer connection form to SWW Ltd prior to works commencing.
3. The location and levels of existing manholes and outfalls are to be confirmed on site prior to commencement of works.
4. Levels and locations of all drain and sewer crossings are to be checked on site before construction.
5. The number and site position of all road gullies is to be approved by the engineer.
6. All gully connections to be 150mm Ø design group D4.
7. Proposed adoptable sewers are only permitted to have other sewer/gully connections and other services laid at an angle of between 45 degrees and 90 degrees across the line.
8. Gradients are indicated for hydraulic purposes only and should not be used for setting out.
9. Manhole covers and frames shall as specified in manhole schedules.
10. All sewer pipes to be ULTRA-RIB, unless specified otherwise and conform to 'Sewers for Adoption 7th edition'.
11. Ductile iron sewer pipes to conform to 'Sewers for Adoption 7th edition'. Each joint to be wrapped with three continuous layers of 100mm wide DENSO tape.
12. Class M concrete pipes to BS 5911 may be used on sewers over 300mm min diameter.
13. All concrete used in construction of manholes and pipe protection to be sulphate resisting unless otherwise agreed with the undertaker.
14. Pipe bedding for sewers to be as follows:
    Type SF granular surround shall comply with IGN4-08-01: 14mm to 5mm graded or in accordance with WIS 4-08-02.
    Type Z with concrete surround C20 concrete.
15. Compliance with Health & Safety matters on any trench/ manhole is obligatory and a permit to enter a confined space is required when connecting site drainage to the existing public sewerage system. A permit to enter a confined space will be obtained from SWW LTD prior to the works commencing on any public sewerage system.
16. Red coloured plastic marker tape at least 150mm wide shall be laid at a minimum of 200mm above the soffit of the pipe. The tape shall be printed with the words GRAVITY SEWER in bold capital letters throughout its length and at intervals not exceeding 700mm and shall incorporate a corrosion resistant tracing system for non-metallic pipes.
17. The minimum size of sewer where guide bars, safety chains, or other safety devices are required in Manholes shall be 375mmØ.
18. All type A and B manholes should have concrete surround. Concrete rings should be sealed using "Tokstrip" and lifting eyes pointed with resin modified mortar.
19. The use of ladders or steps in manholes, wet wells and valve chambers shall comply with following: Steel plastic encapsulated MH single steps shall not be used in MHs of a greater depth than 1.0m. Steel plastic encapsulated double steps may be provided in MHs up to 3.0m in depth. Ladders shall be provided in accordance with BS 4211 in MHs between 3.0m and 6.0m deep. MHs greater than 6.0m deep shall be specially designed and have intermediate landings, Access holes in intermediate landings shall be provided with galvanised mild steel gratings to prevent persons falling through. The design of deep MHs shall permit the use of a winch or lifting gear mounted at ground level in case of emergencies.
20. Only low carbon steel or stainless steel ladders for vertical fixing to MHs will be acceptable.
21. Proposed adoptable sewers are only permitted to have other sewer/gully connections and other services laid at an angle of between 45 degrees and 90 degrees across the line with a vertical clearance in excess of 300mm.
22. All ironwork to be kite marked by BSI or certified by equal inspection authority.
23. Minimum backdrop height shall be 1m.

Rev	Date	Details	Drawn	Checked
P2	6.12.16	Updated to latest layout	JLD	JRC
P1	16.07.16	Issued as part of FRA	JRC	JRC

Drawing Status
PLANNING APPLICATION

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Project
RESIDENTIAL DEVELOPMENT
LAND ADJACENT TO KERNOW VEOR
CARCLAZE, ST AUSTELL, CORNWALL

Client
PCL TRANSPORT PLANNING LTD

Drawing Title
PROPOSED DRAINAGE STRATEGY

Scale (@ A1) 1:500 (0 – 25 metres)
Date DEC 2016

Project no	Drawing no	Revision
1064	0500	P2

Drainage Design Report

Flow

V3.0

Network	Storm Network 1
Filename	D:\Dropbox (JRC CONSULTING)\JRC CONSULTING Team Folder\PROJECTS\1064 Carclaze Road, St Austell\Drainage\1064_DRAINAGE.PFD
Username	JRC_CONSULTING\JOHN
Last analysed	06/12/2016 16:13:55
Report produced on	06/12/2016 16:15:07

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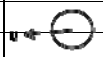
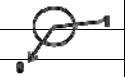
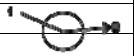
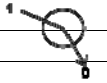
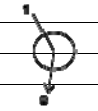
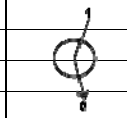
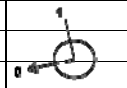
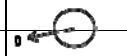
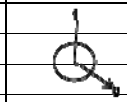
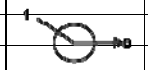
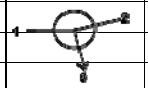
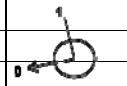
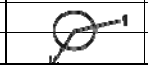
Rainfall Methodology	FSR
Return Period (years)	1
Additional Flow (%)	0
FSR Region	England and Wales
M5-60 (mm)	17.000
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Type (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	✓

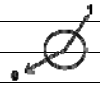
	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
	1	0.088	5.00		168.473	Manhole	Adoptable	1200		202554.960	54318.972	1.350	
	2	0.088	5.00		168.067	Manhole	Adoptable	1200		202481.231	54309.508	1.681	
	3	0.088	5.00		167.423	Manhole	Adoptable	1200		202477.711	54304.235	2.260	
	4	0.088	5.00		160.820	Manhole	Adoptable	1200		202484.392	54246.737	1.350	
	5				160.166	Manhole	Adoptable	1200		202493.453	54242.439	1.549	
	6	0.088	5.00		160.370	Manhole	Adoptable	1200		202539.115	54247.455	2.024	
	7				159.511	Manhole	Adoptable	1200		202601.755	54254.335	1.536	
	8	0.088	5.00		158.156	Manhole	Adoptable	1200		202616.673	54247.469	1.487	
	9	0.088	5.00		156.229	Manhole	Adoptable	1200		202623.152	54234.785	1.873	
	10	0.088	5.00		154.816	Manhole	Adoptable	1200		202621.131	54219.460	1.954	
	11	0.088	5.00		153.766	Manhole	Adoptable	1200		202597.573	54198.618	1.425	
	12	0.088	5.00		151.879	Manhole	Adoptable	1200		202591.893	54180.704	1.511	
	13	0.088	5.00		148.628	Manhole	Adoptable	1350		202598.303	54150.335	1.648	
	19	0.088	5.00		153.594	Manhole	Adoptable	1200		202560.666	54186.746	1.350	
	20	0.088	5.00		153.523	Manhole	Adoptable	1200		202543.819	54182.453	1.527	
	21				154.289	Manhole	Adoptable	1200		202511.921	54182.179	2.481	
	22				150.238	Manhole	Adoptable	1200		202509.212	54144.690	1.438	
	23				149.546	Manhole	Adoptable	1200		202516.155	54139.487	1.425	
	14				148.498	Manhole	Adoptable	1350		202558.240	54139.848	1.693	
	15				146.348	Manhole	Adoptable	2900		202562.655	54119.556	3.374	
	16				146.250	Manhole	Adoptable	2900		202493.886	54102.584	3.347	
	17				145.500	Manhole	Adoptable	1350		202490.589	54096.938	2.618	
	18				145.500	Manhole	Adoptable	1350		202473.636	54086.492	2.680	

Name	US Node	DS Node	Length (m)	k (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	C.Offset (m)	Min DS IL (m)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
1.000	1	2	74.334	0.600	Colebrook-White	167.123	166.386	0.737	100.9	150	Circular	6.24	36.9			1.000	17.7	8.8	1.200	1.531	0.088	0.0			
1.001	2	3	6.340	0.600	Colebrook-White	166.386	165.163	1.223	5.2	150	Circular	6.26	36.8			4.456	78.7	17.6	1.531	2.110	0.176	0.0			
1.002	3	4	57.885	0.600	Colebrook-White	165.163	159.470	5.693	10.2	150	Circular	6.57	36.0			3.178	56.2	25.8	2.110	1.200	0.264	0.0			
1.003	4	5	10.029	0.600	Colebrook-White	159.470	158.692	0.778	12.9	225	Circular	6.61	35.9			3.664	145.7	34.3	1.125	1.249	0.352	0.0			
1.004	5	6	45.937	0.600	Colebrook-White	158.617	158.346	0.271	169.5	375	Circular	7.16	34.7			1.388	153.4	33.1	1.174	1.649	0.352	0.0			
1.005	6	7	63.017	0.600	Colebrook-White	158.346	157.975	0.371	169.9	225	Circular	8.21	32.5			1.000	39.8	38.8	1.799	1.311	0.440	0.0			
1.006	7	8	16.422	0.600	Colebrook-White	157.975	156.669	1.306	12.6	225	Circular	8.29	32.4			3.710	147.5	38.7	1.311	1.262	0.440	0.0			
1.007	8	9	14.243	0.600	Colebrook-White	156.669	154.356	2.313	6.2	225	Circular	8.33	32.3			5.307	211.0	46.3	1.262	1.648	0.528	0.0			
1.008	9	10	15.458	0.600	Colebrook-White	154.356	152.862	1.494	10.3	225	Circular	8.39	32.2			4.091	162.7	53.8	1.648	1.729	0.616	0.0			
1.009	10	11	31.454	0.600	Colebrook-White	152.862	152.341	0.521	60.4	225	Circular	8.71	31.7			1.686	67.0	60.4	1.729	1.200	0.704	0.0			
1.010	11	12	18.793	0.600	Colebrook-White	152.341	150.368	1.973	9.5	225	Circular	8.78	31.5			4.264	169.6	67.7	1.200	1.286	0.792	0.0			
1.011	12	13	31.038	0.600	Colebrook-White	150.368	147.130	3.237	9.6	225	Circular	8.90	31.3			4.250	169.0	74.7	1.286	1.273	0.880	0.0			
1.012	13	14	41.413	0.600	Colebrook-White	146.980	146.805	0.175	236.6	375	Circular	9.49	30.3			1.173	129.6	79.6	1.273	1.318	0.968	0.0			
2.000	19	20	17.385	0.600	Colebrook-White	152.244	152.071	0.173	100.5	150	Circular	5.29	39.5			1.002	17.7	9.4	1.200	1.302	0.088	0.0			
2.001	20	21	31.899	0.600	Colebrook-White	151.996	151.808	0.188	169.7	225	Circular	5.82	38.0			1.001	39.8	18.1	1.302	2.256	0.176	0.0			
2.002	21	22	37.587	0.600	Colebrook-White	151.808	148.800	3.008	12.5	225	Circular	5.99	37.5			3.721	148.0	17.9	2.256	1.213	0.176	0.0			
2.003	22	23	8.676	0.600	Colebrook-White	148.800	148.121	0.679	12.8	225	Circular	6.03	37.4			3.680	146.3	17.8	1.213	1.200	0.176	0.0			
2.004	23	14	42.087	0.600	Colebrook-White	148.121	146.955	1.166	36.1	225	Circular	6.35	36.6			2.184	86.8	17.4	1.200	1.318	0.176	0.0			
1.013	14	15	20.767	0.600	Colebrook-White	146.805	144.599	2.206	9.4	375	Circular	9.55	30.3			5.934	655.4	93.8	1.318	1.374	1.144	0.0			
1.014	15	16	70.832	0.600	Colebrook-White	142.974	142.903	0.071	997.6	1800	Circular	10.33	29.1			1.509	3840.0	90.2	1.574	1.547	1.144	0.0			
1.015	16	17	6.538	0.600	Colebrook-White	142.903	142.882	0.021	311.3	375	Circular	10.44	28.9			1.021	112.8	89.7	2.972	2.243	1.144	0.0			
1.016	17	18	19.913	0.600	Colebrook-White	142.882	142.820	0.062	321.2	375	Circular	10.77	28.5			1.005	111.0	88.3	2.243	2.305	1.144	0.0			

Name	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node	Dia (mm)	Width (mm)	Node Type	MH Type
1.000	74.334	100.9	150	Circular	168.473	167.123	1.200	168.067	166.386	1.531	1	1200		Manhole	Adoptable	2	1200		Manhole	Adoptable
1.001	6.340	5.2	150	Circular	168.067	166.386	1.531	167.423	165.163	2.110	2	1200		Manhole	Adoptable	3	1200		Manhole	Adoptable
1.002	57.885	10.2	150	Circular	167.423	165.163	2.110	160.820	159.470	1.200	3	1200		Manhole	Adoptable	4	1200		Manhole	Adoptable
1.003	10.029	12.9	225	Circular	160.820	159.470	1.125	160.166	158.692	1.249	4	1200		Manhole	Adoptable	5	1200		Manhole	Adoptable
1.004	45.937	169.5	375	Circular	160.166	158.617	1.174	160.370	158.346	1.649	5	1200		Manhole	Adoptable	6	1200		Manhole	Adoptable
1.005	63.017	169.9	225	Circular	160.370	158.346	1.799	159.511	157.975	1.311	6	1200		Manhole	Adoptable	7	1200		Manhole	Adoptable
1.006	16.422	12.6	225	Circular	159.511	157.975	1.311	158.156	156.669	1.262	7	1200		Manhole	Adoptable	8	1200		Manhole	Adoptable
1.007	14.243	6.2	225	Circular	158.156	156.669	1.262	156.229	154.356	1.648	8	1200		Manhole	Adoptable	9	1200		Manhole	Adoptable
1.008	15.458	10.3	225	Circular	156.229	154.356	1.648	154.816	152.862	1.729	9	1200		Manhole	Adoptable	10	1200		Manhole	Adoptable
1.009	31.454	60.4	225	Circular	154.816	152.862	1.729	153.766	152.341	1.200	10	1200		Manhole	Adoptable	11	1200		Manhole	Adoptable
1.010	18.793	9.5	225	Circular	153.766	152.341	1.200	151.879	150.368	1.286	11	1200		Manhole	Adoptable	12	1200		Manhole	Adoptable
1.011	31.038	9.6	225	Circular	151.879	150.368	1.286	148.628	147.130	1.273	12	1200		Manhole	Adoptable	13	1350		Manhole	Adoptable
1.012	41.413	236.6	375	Circular	148.628	146.980	1.273	148.498	146.805	1.318	13	1350		Manhole	Adoptable	14	1350		Manhole	Adoptable
2.000	17.385	100.5	150	Circular	153.594	152.244	1.200	153.523	152.071	1.302	19	1200		Manhole	Adoptable	20	1200		Manhole	Adoptable
2.001	31.899	169.7	225	Circular	153.523	151.996	1.302	154.289	151.808	2.256	20	1200		Manhole	Adoptable	21	1200		Manhole	Adoptable
2.002	37.587	12.5	225	Circular	154.289	151.808	2.256	150.238	148.800	1.213	21	1200		Manhole	Adoptable	22	1200		Manhole	Adoptable
2.003	8.676	12.8	225	Circular	150.238	148.800	1.213	149.546	148.121	1.200	22	1200		Manhole	Adoptable	23	1200		Manhole	Adoptable
2.004	42.087	36.1	225	Circular	149.546	148.121	1.200	148.498	146.956	1.318	23	1200		Manhole	Adoptable	14	1350		Manhole	Adoptable
1.013	20.767	9.4	375	Circular	148.498	146.805	1.318	146.348	144.599	1.374	14	1350		Manhole	Adoptable	15	2900		Manhole	Adoptable
1.014	70.832	997.6	1800	Circular	146.348	142.974	1.574	146.250	142.903	1.547	15	2900		Manhole	Adoptable	16	2900		Manhole	Adoptable
1.015	6.538	311.3	375	Circular	146.250	142.903	2.972	145.500	142.882	2.243	16	2900		Manhole	Adoptable	17	1350		Manhole	Adoptable
1.016	19.913	321.2	375	Circular	145.500	142.882	2.243	145.500	142.820	2.305	17	1350		Manhole	Adoptable	18	1350		Manhole	Adoptable

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Node Type	MH Type	Connections		Link Name	IL (m)	Dia (mm)	Link Type
1	202554.960	54318.972	168.473	1.350	1200		Manhole	Adoptable						
														
										0	1.000	167.123	150	Circular
2	202481.231	54309.508	168.067	1.681	1200		Manhole	Adoptable		1	1.000	166.386	150	Circular
														
										0	1.001	166.386	150	Circular
3	202477.711	54304.235	167.423	2.260	1200		Manhole	Adoptable		1	1.001	165.163	150	Circular
														
										0	1.002	165.163	150	Circular
4	202484.392	54246.737	160.820	1.350	1200		Manhole	Adoptable		1	1.002	159.470	150	Circular
														
										0	1.003	159.470	225	Circular
5	202493.453	54242.439	160.166	1.549	1200		Manhole	Adoptable		1	1.003	158.692	225	Circular
														
										0	1.004	158.617	375	Circular
6	202539.115	54247.455	160.370	2.024	1200		Manhole	Adoptable		1	1.004	158.346	375	Circular
														
										0	1.005	158.346	225	Circular
7	202601.755	54254.335	159.511	1.536	1200		Manhole	Adoptable		1	1.005	157.975	225	Circular
														
										0	1.006	157.975	225	Circular
8	202616.673	54247.469	158.156	1.487	1200		Manhole	Adoptable		1	1.006	156.669	225	Circular
														
										0	1.007	156.669	225	Circular
9	202623.152	54234.785	156.229	1.873	1200		Manhole	Adoptable		1	1.007	154.356	225	Circular
														
										0	1.008	154.356	225	Circular
10	202621.131	54219.460	154.816	1.954	1200		Manhole	Adoptable		1	1.008	152.862	225	Circular
														
										0	1.009	152.862	225	Circular
11	202597.573	54198.618	153.766	1.425	1200		Manhole	Adoptable		1	1.009	152.341	225	Circular

														
										0	1.010	152.341	225	Circular
12	202591.893	54180.704	151.879	1.511	1200		Manhole	Adoptable		1	1.010	150.368	225	Circular
										0	1.011	150.368	225	Circular
13	202598.303	54150.335	148.628	1.648	1350		Manhole	Adoptable		1	1.011	147.130	225	Circular
										0	1.012	146.980	375	Circular
19	202560.666	54186.746	153.594	1.350	1200		Manhole	Adoptable						
														
										0	2.000	152.244	150	Circular
20	202543.819	54182.453	153.523	1.527	1200		Manhole	Adoptable		1	2.000	152.071	150	Circular
														
										0	2.001	151.996	225	Circular
21	202511.921	54182.179	154.289	2.481	1200		Manhole	Adoptable		1	2.001	151.808	225	Circular
														
										0	2.002	151.808	225	Circular
22	202509.212	54144.690	150.238	1.438	1200		Manhole	Adoptable		1	2.002	148.800	225	Circular
										0	2.003	148.800	225	Circular
23	202516.155	54139.487	149.546	1.425	1200		Manhole	Adoptable		1	2.003	148.121	225	Circular
										0	2.004	148.121	225	Circular
14	202558.240	54139.848	148.498	1.693	1350		Manhole	Adoptable		1	2.004	146.955	225	Circular
										2	1.012	146.805	375	Circular
										0	1.013	146.805	375	Circular
15	202562.655	54119.556	146.348	3.374	2900		Manhole	Adoptable		1	1.013	144.599	375	Circular
										0	1.014	142.974	1800	Circular
16	202493.886	54102.584	146.250	3.347	2900		Manhole	Adoptable		1	1.014	142.903	1800	Circular
														

										0	1.015	142.903	375	Circular
17	202490.589	54096.938	145.500	2.618	1350		Manhole	Adoptable		1	1.015	142.882	375	Circular
										0	1.016	142.882	375	Circular
18	202473.636	54086.492	145.500	2.680	1350		Manhole	Adoptable		1	1.016	142.820	375	Circular

Rainfall Methodology	FSR		**Return Period (years)**	**Climate Change (%)**
FSR Region	England and Wales		2	0
M5-60 (mm)	17.000		10	0
Ratio-R	0.300		30	0
Summer CV	0.750		100	40
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)	✓			
1 year (l/s)	19.5			
30 year (l/s)	49.4			
100 year (l/s)	60.4			
Check Discharge Volume	✓			
100 year 360 minute (m³)				

Methodology	IH124
Positively Drained Area (ha)	3.750
SAAR (mm)	1242
Soil Index	3
SPR	0.40
Region	8
Growth Factor 1 year	0.78
Growth Factor 30 years	1.98
Growth Factor 100 years	2.42
QBar	25.0
Q 1 year (l/s)	19.5
Q 30 year (l/s)	49.4
Q 100 year (l/s)	60.4

Head/Flow							
Node	**Flap Valve**	**Online / Offline**	**Replaces Downstream Link**	**Loop to Node**	**Invert Level (m)**	**Head (m)**	**Flow (l/s)**
16	x	Online	✓		142.903	0.037	1.089
						0.073	4.062
						0.110	8.394
						0.147	13.403
						0.184	18.155
						0.220	22.075
						0.257	22.913
						0.294	23.558
						0.331	24.048
						0.367	24.411
						0.404	24.670
						0.441	24.843
						0.478	24.946
						0.514	24.992
						0.551	24.992
						0.588	24.956
						0.624	24.891
						0.661	24.803
						0.698	24.696
						0.735	24.571
						0.771	24.429
						0.808	24.267
						0.845	24.080
						0.882	23.863
						0.918	23.606
						0.955	23.300
						0.992	22.933
						1.029	22.491
						1.065	21.960
						1.102	21.328

						1.139	20.579
						1.176	20.382
						1.212	20.683
						1.249	20.978
						1.286	21.270
						1.322	21.557
						1.359	21.840
						1.396	22.119
						1.433	22.394
						1.469	22.666
						1.506	22.934
						1.543	23.199
						1.580	23.461
						1.616	23.720
						1.653	23.976
						1.690	24.228
						1.727	24.479
						1.763	24.726
						1.800	24.971
						1.980	26.135
						2.160	27.246

Depth/Area/Inf Area

Node	Base Infiltration Coefficient (m/hr)	Side Infiltration Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
16	0.00000	0.00000	2.0	1.00	142.903	188	0.000	140.0	0.0
							1.800	140.0	0.0

Default Values			**Overrides**					
Entry Loss (manhole)	0.250		**Link**	**Entry Loss**	**Exit Loss**		**Node**	**Flood Risk (m)**
Exit Loss (manhole)	0.250							
Entry Loss (junction)	0.000							
Exit Loss (junction)	0.000							
Flood Risk (m)	0.300							

Results for 2 year Critical Storm Duration. Largest routing error: 0.78%															
Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Name**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	1	11	167.221	0.098	12.4	0.2397	0.0000	OK	1.000	2	11.9	1.294	0.672	0.6814	
15 minute winter	2	10	166.443	0.057	24.0	0.1234	0.0000	OK	1.001	3	23.7	2.853	0.300	0.0527	
15 minute winter	3	10	165.250	0.087	36.0	0.1655	0.0000	OK	1.002	4	35.5	3.126	0.633	0.6574	
15 minute winter	4	11	159.568	0.098	47.9	0.2386	0.0000	OK	1.003	5	47.5	3.071	0.326	0.1552	
15 minute winter	5	13	158.776	0.159	47.5	0.1800	0.0000	OK	1.004	6	47.8	0.849	0.312	3.5556	
15 minute winter	6	12	158.769	0.423	59.4	0.8455	0.0000	SURCHARGED	1.005	7	45.9	1.462	1.155	1.7426	
15 minute winter	7	13	158.068	0.093	45.9	0.1055	0.0000	OK	1.006	8	45.7	3.320	0.310	0.2296	
15 minute winter	8	12	156.749	0.080	55.2	0.1844	0.0000	OK	1.007	9	55.1	3.787	0.261	0.2080	
15 minute winter	9	11	154.455	0.099	65.4	0.2043	0.0000	OK	1.008	10	65.3	2.074	0.402	0.4367	
15 minute winter	10	12	153.349	0.487	76.9	0.9896	0.0000	SURCHARGED	1.009	11	73.7	2.206	1.099	0.9534	
15 minute winter	11	12	152.458	0.117	83.4	0.2769	0.0000	OK	1.010	12	83.5	3.825	0.492	0.4102	
15 minute winter	12	11	150.494	0.126	94.5	0.2899	0.0000	OK	1.011	13	94.1	4.251	0.557	0.6869	
15 minute winter	13	11	147.239	0.259	105.7	0.6467	0.0000	OK	1.012	14	105.2	1.890	0.812	2.3111	
15 minute winter	19	10	152.340	0.096	12.4	0.2335	0.0000	OK	2.000	20	12.0	1.050	0.678	0.1995	
15 minute winter	20	10	152.132	0.136	24.4	0.3095	0.0000	OK	2.001	21	24.0	1.438	0.603	0.5379	
15 minute winter	21	11	151.870	0.062	24.0	0.0702	0.0000	OK	2.002	22	24.2	2.681	0.163	0.3386	
15 minute winter	22	11	148.863	0.063	24.2	0.0715	0.0000	OK	2.003	23	24.3	2.178	0.166	0.0970	
15 minute winter	23	11	148.204	0.083	24.3	0.0936	0.0000	OK	2.004	14	24.1	1.856	0.278	0.5473	
15 minute winter	14	11	146.925	0.120	129.3	0.1723	0.0000	OK	1.013	15	128.7	4.459	0.196	0.6004	
120 minute winter	15	88	143.316	0.342	58.1	2.2584	0.0000	OK	1.014	16	50.8	0.723	0.013	27.3676	
120 minute winter	16	88	143.316	0.413	50.8	60.5525	0.0000	SURCHARGED	Head/Flow		23.8				
120 minute winter	17	88	143.004	0.122	23.8	0.1746	0.0000	OK	1.016	18	23.8	0.821	0.214	0.5774	166.1
120 minute winter	18	88	142.930	0.110	23.8	0.0000	0.0000	OK							

Results for 10 year Critical Storm Duration. Largest routing error: 0.78%															
Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Name**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	1	11	167.266	0.143	18.5	0.3480	0.0000	OK	1.000	2	17.2	1.360	0.971	0.9466	
15 minute winter	2	10	166.457	0.071	35.3	0.1555	0.0000	OK	1.001	3	35.0	3.025	0.444	0.0731	
15 minute winter	3	11	165.281	0.118	53.5	0.2245	0.0000	OK	1.002	4	53.1	3.485	0.946	0.8895	
15 minute winter	4	12	159.615	0.145	70.7	0.3528	0.0000	OK	1.003	5	73.1	3.247	0.502	0.3349	
15 minute winter	5	13	159.384	0.767	73.1	0.8679	0.0000	SURCHARGED	1.004	6	59.6	0.877	0.389	5.0667	
15 minute winter	6	13	159.351	1.005	77.0	2.0117	0.0000	SURCHARGED	1.005	7	64.1	1.868	1.611	1.8936	
15 minute winter	7	13	158.090	0.115	64.1	0.1297	0.0000	OK	1.006	8	63.9	3.623	0.433	0.2917	
15 minute winter	8	12	156.761	0.092	75.6	0.2137	0.0000	OK	1.007	9	75.5	3.854	0.358	0.3437	
15 minute winter	9	12	154.530	0.174	89.9	0.3602	0.0000	OK	1.008	10	88.6	2.313	0.545	0.5620	
15 minute winter	10	13	153.974	1.112	103.2	2.2603	0.0000	SURCHARGED	1.009	11	98.8	2.704	1.474	1.0458	
15 minute winter	11	12	152.485	0.144	112.2	0.3396	0.0000	OK	1.010	12	112.1	4.100	0.661	0.5139	
15 minute winter	12	12	150.517	0.149	127.2	0.3428	0.0000	OK	1.011	13	126.8	4.391	0.750	0.9400	
15 minute winter	13	11	147.302	0.322	144.2	0.8052	0.0000	OK	1.012	14	142.8	1.995	1.102	2.8993	
15 minute winter	19	11	152.383	0.139	18.5	0.3373	0.0000	OK	2.000	20	17.8	1.111	1.005	0.2820	
15 minute winter	20	10	152.172	0.176	36.0	0.4009	0.0000	OK	2.001	21	35.6	1.562	0.895	0.7178	
15 minute winter	21	11	151.884	0.076	35.6	0.0861	0.0000	OK	2.002	22	35.7	2.954	0.242	0.4549	
15 minute winter	22	11	148.879	0.079	35.7	0.0893	0.0000	OK	2.003	23	35.8	2.382	0.245	0.1309	
15 minute winter	23	11	148.224	0.103	35.8	0.1168	0.0000	OK	2.004	14	35.7	2.054	0.411	0.7320	
15 minute winter	14	12	146.950	0.145	178.5	0.2073	0.0000	OK	1.013	15	178.3	4.834	0.272	0.7663	
120 minute winter	15	94	143.532	0.558	85.3	3.6834	0.0000	OK	1.014	16	71.9	0.784	0.019	51.5807	
120 minute winter	16	94	143.532	0.629	71.9	92.1814	0.0000	SURCHARGED	Head/Flow		25.0				
120 minute winter	17	88	143.007	0.125	25.0	0.1793	0.0000	OK	1.016	18	25.0	0.832	0.225	0.5988	244.4
120 minute winter	18	88	142.933	0.113	25.0	0.0000	0.0000	OK							

Results for 30 year Critical Storm Duration. Largest routing error: 0.78%															
Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Name**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	1	12	167.441	0.318	23.2	0.7736	0.0000	SURCHARGED	1.000	2	18.3	1.440	1.034	1.0469	
15 minute winter	2	12	166.473	0.087	40.2	0.1891	0.0000	OK	1.001	3	39.1	2.978	0.496	0.0893	
15 minute winter	3	12	165.784	0.621	62.3	1.1857	0.0000	SURCHARGED	1.002	4	57.5	3.472	1.024	1.0191	
15 minute winter	4	13	160.004	0.534	79.4	1.3010	0.0000	SURCHARGED	1.003	5	79.8	3.233	0.548	0.3989	
15 minute winter	5	14	159.784	1.167	79.8	1.3197	0.0000	SURCHARGED	1.004	6	63.9	0.887	0.417	5.0667	
15 minute winter	6	14	159.730	1.384	84.6	2.7692	0.0000	SURCHARGED	1.005	7	74.0	2.096	1.862	1.9774	
15 minute winter	7	14	158.102	0.127	74.0	0.1431	0.0000	OK	1.006	8	73.9	3.770	0.501	0.3270	
15 minute winter	8	13	156.770	0.101	88.3	0.2340	0.0000	OK	1.007	9	88.1	3.833	0.418	0.4062	
15 minute winter	9	13	155.149	0.793	108.4	1.6413	0.0000	SURCHARGED	1.008	10	100.2	2.520	0.616	0.6148	
15 minute winter	10	13	154.385	1.523	117.3	3.0950	0.0000	SURCHARGED	1.009	11	113.2	2.994	1.689	1.1035	
15 minute winter	11	12	152.502	0.161	129.5	0.3808	0.0000	OK	1.010	12	129.3	4.276	0.763	0.5748	
15 minute winter	12	11	150.532	0.164	149.2	0.3762	0.0000	OK	1.011	13	148.6	4.428	0.879	1.0980	
15 minute winter	13	12	147.432	0.452	170.4	1.1292	0.0000	SURCHARGED	1.012	14	168.4	2.040	1.300	3.2168	
15 minute winter	19	11	152.508	0.264	23.2	0.6422	0.0000	SURCHARGED	2.000	20	21.4	1.215	1.208	0.3019	
15 minute winter	20	11	152.211	0.215	43.9	0.4916	0.0000	OK	2.001	21	43.2	1.588	1.087	0.8404	
15 minute winter	21	11	151.892	0.084	43.2	0.0953	0.0000	OK	2.002	22	43.2	3.090	0.292	0.5258	
15 minute winter	22	11	148.888	0.088	43.2	0.0998	0.0000	OK	2.003	23	43.2	2.479	0.295	0.1514	
15 minute winter	23	11	148.236	0.115	43.2	0.1304	0.0000	OK	2.004	14	43.0	2.153	0.495	0.8413	
15 minute winter	14	12	146.966	0.161	211.4	0.2299	0.0000	OK	1.013	15	211.8	5.032	0.323	0.8745	
120 minute winter	15	98	143.739	0.765	106.7	5.0553	0.0000	OK	1.014	16	88.0	0.826	0.023	77.1907	
120 minute winter	16	98	143.739	0.836	88.0	122.5330	0.0000	SURCHARGED	Head/Flow		25.0				
120 minute winter	17	70	143.007	0.125	25.0	0.1793	0.0000	OK	1.016	18	25.0	0.832	0.225	0.5988	312.7
60 minute winter	18	41	142.933	0.113	25.0	0.0000	0.0000	OK							

Results for 100 year +40% Critical Storm Duration. Largest routing error: 0.78%															
Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Name**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	1	11	168.473	1.350	41.8	3.2873	3.4048	FLOOD	1.000	2	19.3	1.263	1.091	1.3086	
15 minute winter	2	12	168.063	1.677	60.1	3.6529	0.0000	FLOOD RISK	1.001	3	46.4	2.951	0.589	0.1116	
15 minute winter	3	11	167.423	2.260	82.3	4.3166	3.3347	FLOOD	1.002	4	58.2	3.432	1.037	1.0191	
15 minute winter	4	11	160.671	1.200	98.4	2.9231	0.0000	FLOOD RISK	1.003	5	95.6	3.399	0.656	0.3989	
30 minute winter	5	17	160.166	1.549	90.3	1.7519	11.2520	FLOOD	1.004	6	69.5	0.790	0.453	5.0667	
30 minute summer	6	18	160.183	1.837	106.2	3.6759	0.0000	FLOOD RISK	1.005	7	82.8	2.386	2.082	2.0132	
15 minute summer	7	17	158.107	0.132	82.6	0.1493	0.0000	OK	1.006	8	83.2	3.845	0.564	0.5138	
15 minute winter	8	12	157.197	0.528	121.1	1.2217	0.0000	SURCHARGED	1.007	9	116.5	3.903	0.552	0.5665	
15 minute winter	9	11	156.229	1.873	152.8	3.8790	1.7913	FLOOD	1.008	10	136.3	3.427	0.838	0.6148	
30 minute winter	10	17	154.816	1.954	170.4	3.9705	20.8753	FLOOD	1.009	11	125.3	3.216	1.870	1.2510	
15 minute winter	11	12	153.366	1.025	159.4	2.4252	0.0000	SURCHARGED	1.010	12	146.0	4.189	0.861	0.7474	
15 minute winter	12	12	151.692	1.324	185.3	3.0403	0.0000	FLOOD RISK	1.011	13	172.0	4.468	1.018	1.2344	
15 minute winter	13	11	147.667	0.687	210.0	1.7167	0.0000	SURCHARGED	1.012	14	208.4	2.200	1.608	3.4429	
15 minute winter	19	12	153.497	1.253	41.8	3.0511	0.0000	FLOOD RISK	2.000	20	33.9	1.927	1.916	0.3061	
15 minute winter	20	12	152.720	0.724	72.1	1.6541	0.0000	SURCHARGED	2.001	21	68.7	2.033	1.728	0.9390	
15 minute winter	21	12	151.917	0.109	68.7	0.1235	0.0000	OK	2.002	22	68.9	3.415	0.466	0.7582	
15 minute winter	22	12	148.919	0.119	68.9	0.1343	0.0000	OK	2.003	23	69.0	2.694	0.471	0.2218	
15 minute winter	23	12	148.279	0.158	69.0	0.1792	0.0000	OK	2.004	14	68.7	2.372	0.791	1.2189	
15 minute winter	14	12	146.995	0.190	276.3	0.2718	0.0000	OK	1.013	15	276.6	5.341	0.422	1.0757	
180 minute winter	15	172	144.786	1.812	150.4	11.9659	0.0000	SURCHARGED	1.014	16	119.0	0.846	0.031	179.5350	
180 minute winter	16	172	144.785	1.882	119.0	275.9656	0.0000	SURCHARGED	Head/Flow		25.0				
15 minute winter	17	17	143.007	0.125	25.0	0.1793	0.0000	OK	1.016	18	25.0	0.832	0.225	0.5989	208.3
15 minute winter	18	17	142.933	0.113	25.0	0.0000	0.0000	OK							

APPENDIX D

MAINTENANCE REGIME

SURFACE WATER ATTENUATION STORAGE

The attenuation will be adopted by South West Water under Section 104 Agreement subject to South West Waters protocol the following maintenance plan is to be put forward for the attenuation system.

Maintenance schedule	Required action	Recommended Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Remove sediment from pre-treatment structures	Annually, or as required
Remedial actions	Repair/rehabilitation of 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 and after large storms