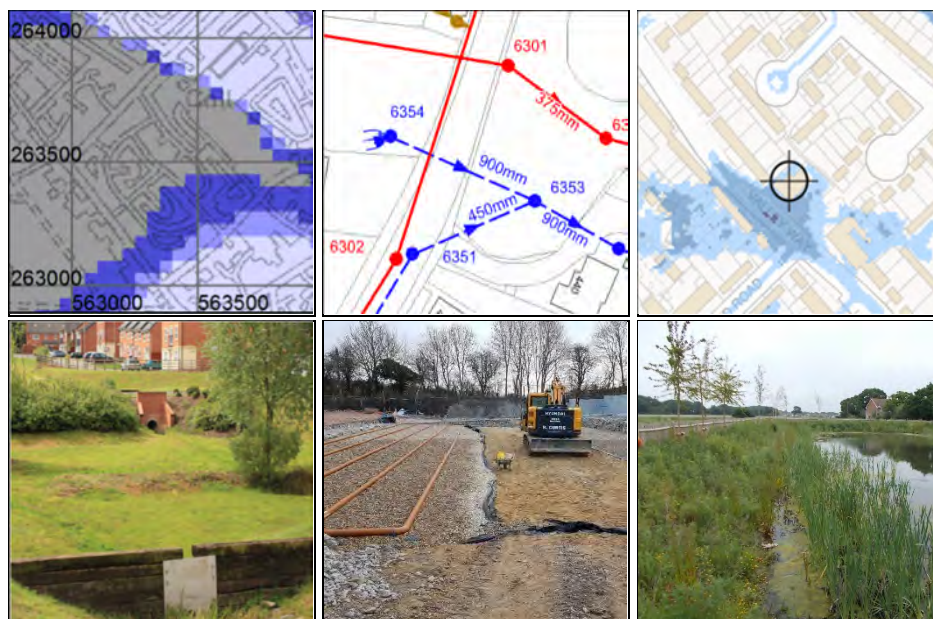




Flood Risk Assessment and Drainage Strategy

**178A West Street
Havant, Hants**

Reference: 1828

Issue: **Date:**

- | | | |
|---|------------|---|
| 1 | 12/12/2019 | |
| 2 | 15/4/2020 | <i>Updated for Winter GWL results.</i> |
| 3 | 15/6/2021 | <i>Updated for revised FFL and storage assessment</i> |

Table of Contents

1	Introduction	3
2	Development Description & Location	3
3	Local Development Documents & Strategic Flood Risk Assessment	3
4	Catchment Flood Management & Shoreline Management Plans	4
5	Catchment Data	4
6	Sewage Authority Data	5
7	Site Particulars	5
8	Source-Pathway-Receptor Assessments	6
9	Flood Probability	7
10	Climate Change	8
11	Detailed Development Proposals & Surface Water Strategy	8
12	Sequential & Exceptions Tests	9
13	Flood Risk Management Measures	10
14	Off Site Impacts	10
15	Residual Risks	10

Appendices

A	Existing Layout & Proposed Site Layout
B	EA Flood Mappings, Local Sewer Plan & Soils Data
C	Flood Storage Compensation & Surface Water Assessment
D	Conditions & Limitations

1. Introduction

- 1.1 Instructions were received from Havant Housing Association to undertake a Flood Risk Assessment (FRA) and set out a Drainage Strategy (DS) for a planning application for the development of 20nr 1-bed 1 person specialist apartments on 'the Coal Yard', 178A West Street, Havant, Hants PO9 1LR.
- 1.2 This assessment has been undertaken by A P Traves BSc CEng MStructE MCIHT.
- 1.3 The client's attention is drawn to the conditions and limitations contained in Appendix D.

2. Development Description & Location

- 2.1 The site comprises approximately 0.29 Ha of land to at 178A West Street, Havant, Hants (grid ref 470950 106550). The site extents are indicated on the annotated aerial photograph in Appendix A. The existing topography is shown on drawing 17853-PD101 contained in Appendix A of this report.
- 2.2 The site comprises an irregular shaped parcel of land at 178A west Street, Havant. The front of the site is impermeably paved and there is a small commercial building on the north side of the pavement. The rear of the site is currently undeveloped.
- 2.3 It is proposed to redevelop the front part of the site for 20 No 1-bed 1 person specialist apartments operated by Havant Housing Association. The proposed layout is shown on PDP Architects drawing 28065-PD110-B contained in Appendix A of this report. The proposed sub floor plan, sections and elevations are shown on PDP Architects drawings 28065-PD102, 28065-PD201-C and 28065-PD202-C also contained in Appendix A of this report.

3. Local Development Documents & Strategic Flood Risk Assessment

- 3.1 The Strategic Flood Risk Assessment (SFRA) for Partnership for Urban South Hampshire (PUSH) has been reviewed and this indicates the following:
- 3.2 SFRA mapping replicates the EA flood mappings and does not indicate any record of sewer flooding at the site..
- 3.3 Hampshire CC Groundwater Management Plan (GWMP) does not identify groundwater issues within Havant.
- 3.4 Flood mapping data has been reviewed from the Environment Agency (EA) website. (refer to Appendix B). This indicates the following:
- 3.5 The EA mapping indicates the front of the site lies in FZ1, the extreme rear of the site lies in FZ3 and FZ2 extends from the rear towards the front of the site and lies partly under the proposed building location. More detailed information regarding flood levels was also obtained from the EA and the particulars of this are discussed in Section 8.
- 3.6 The EA mapping indicates the proposed housing is at low (<1% AEP) risk of surface water flooding. The retained open space area to the rear is at medium to high risk of surface water flooding but no building is proposed in this area. The watercourse forming the western boundary of the site has an inherent surface water flood risk as this contains water throughout the year. It is not proposed to undertake development within the channel.
- 3.7 The EA mapping indicates the site is not in an area of reservoir flood risk.
- 3.8 MAGIC mapping indicates the site lies in a Source Protection Zone 1 (SPZ1) for subsurface activity.

- 3.9 MAGIC mapping indicates the site is not within a drinking water safeguard or protection zone.
- 3.10 The Havant Borough Core Strategy-March 2011 sets out environmental policy with respect to flood risk and climate change in CS15 Flood and Erosion Risk. This is supported by Havant Borough Local Plan 2036 (Draft) policies E12 Managing Flood Risk in New Development and E13 Drainage Infrastructure in New Development.
- 3.11 CS15 requires that unacceptable levels of flood risk are avoided and that surface water is proactively managed through promotion of sustainable drainage techniques.
- 3.12 E12 requires that any new development will be safe over its lifetime, including the access, without increasing flood risk elsewhere.
- 3.13 E13 requires that any new development will have no net increase in surface water run-off compared with the pre-development rate and the drainage system does not increase flood risk elsewhere.
- 3.14 Chapter 9 of this report identifies that the proposed building will be at low risk of flooding CS15, E12 and E13 can therefore be met by:
- Implementing a surface water drainage strategy that manages flood risk from the new development.
 - Provision of a satisfactory sustainable surface water drainage system.
- 3.15 In essence the local policies replicate the requirements of current national policies and practice, and in meeting national policy local policy will also be met.

4. Catchment Flood Management & Shoreline Management Plans

- 4.1 The site is at an elevation of some 7 m AOD and is remote from the influence of tidal flooding. Shoreline Management Plans are not applicable at this location.
- 4.2 The South East Hampshire Catchment Flood Management Plan summary – December 2009 (CFMP) indicates the site falls within sub-area 5 Havant and Denmead. The CFMP states that policy 4 is the preferred policy approach:
- “Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.”*
- 4.3 Overall the CFMP does not present any issues that would prohibit the development of this site with respect to flood issues provided the surface water drainage is based on SuDS principles.

5. Catchment Data

- 5.1 BGS mapping indicates the site geology generically comprises Head deposits and Alluvium over London Clay and Lambeth Group. The site lies on the east bank of Hermitage Stream and is bounded on the northern side by a large historic earthwork railway embankment.
- 5.2 A Geotechnical site investigation was undertaken by Messrs Soils Ltd and the key findings of their report 17902-MIR-927 November 2019 are discussed in the following paragraphs. The soil logs are reproduced in Appendix B.
- 5.3 4No. dynamic sampler boreholes (WS01-WS04) were made to a depth of 4.00m below ground level (bgl). Holes WS01-WS03 were fitted with monitoring wells.
- 5.4 4No. dynamic probe holes (DP01-DP04) were made to a depth of 6.00mbgl.

- 5.5 Made ground and alluvium was encountered within the upper 4m in WS01-WS04. London Clay was inferred to have been encountered in the dynamic probing at some 5.4mbgl. The Lambeth Group was not encountered.
- 5.6 The soils profile is summarised on Table 2.2 of the geotechnical report.
- 5.7 The made ground typically forms the upper 2m of soils and comprises 0.5-0.75m slightly sandy Clay over sandy silty Gravel. Paragraph 2.3.1 of the geotechnical report states *“the stratum is largely out of context with the surrounding area and likely to comprise fill emplaced to level the site following redirection of the stream...during construction of the railway.”* This statement is borne out by examination of old Ordnance Survey maps which suggest the present railway bridge over the stream was built off line of an original stream line through the site and the stream line then diverted along the northern side of the new embankment and through the new bridge and the redundant channel line infilled.
- 5.8 Paragraph 2.3.2 of the geotechnical report identifies the Alluvium to comprise a slightly fine sandy Clay.
- 5.9 Paragraph 2.3.3 of the geotechnical report indicates no sample of London Clay was recovered but the dynamic probe results infer this is located around 6mbgl.
- 5.10 Paragraph 2.5 of the geotechnical report indicates no groundwater was encountered in WS01-WS04 which were made to some 4mbgl. The report does however note that lining of the river channel (ie walls) may affect the results. A programme of GWL monitoring was subsequently undertaken (refer to paragraph 5.11).
- 5.11 In addition to holes WS01-WS03, two additional holes WS101 and WS102 were subsequently made on the land at the rear. The Groundwater Level (GWL) in these was monitored over winter 2019-2020 and is reported on in Soils Ltd report 18075/FLR rev 1.01 of March 2020, relevant information from which is contained in Appendix B. Table 1 of the report indicates that over the front part of the site where the building and car parking are proposed GWL had little variation but peaked slightly in late February early March 2020 at some 1-1.5mbgl. in WS101 and WS102 in the lower rear part of the site to be retained as soft scape GWLs also peaked at this time at close to surface level. Once the difference in AOD surface levels between the front and rear parts of the site is taken into account the results indicate a relatively static and consistent GWL across the site.

6. Sewage Authority Data

- 6.1 There are three public foul water sewers beneath the site; one 300mm DN, one 525mm DN and one 600mm DN. A copy of the local sewer plan is contained in Appendix B. The existing building on site discharges to the 300mm DN sewer.
- 6.2 The proposed development will continue to discharge foul water (FW) to the existing public FW sewer. A sewer capacity check has been undertaken by Southern Water which confirms there is adequate capacity in the local sewerage network to accommodate the foul flow from the development. A copy of this check is contained in Appendix B.
- 6.3 The standing wastewater Infrastructure Charge (IC), which came into force from 1st April 2018, will be paid.

7. Site Particulars

- 7.1 A walkover site reconnaissance was undertaken in July 2019. The site is some 0.29 Ha in area and is located on the north side of West Street. The site comprises an irregular shaped parcel of land at 178A West Street, Havant. The front of the site is impermeably paved and there is a small commercial building on the north side of the pavement. The rear of the site is currently undeveloped.

- 7.2 The rear of the site falls east to west, towards Hermitage Stream from around 7.2m AOD to around 6.2m AOD.
- 7.3 The yard at the front of the site also falls east to west from around 7.2m AOD to around 6.6m AOD.
- 7.4 The front of the site is impermeably paved and there is a small single storey building to the north side of the pavement.
- 7.5 The western edge of the rear of the site is bounded by the channel wall to Hermitage Stream and the front of the site is separated from Hermitage Stream by a paved car sales lot. The adjacent Hermitage Stream channel is of engineering construction with concrete and masonry channel walls and a flat concrete invert.
- 7.6 The land to the north of the site comprises the embankment to the south coast mainline railway and the bridge over Hermitage Stream adjacent the northwest corner of the site.
- 7.7 North of the railway and the site and east and south of the site land use comprises residential dwellings. The immediately west of the site comprises an open car sales yard and the land use to the western side of Hermitage Stream adjacent to the site comprises commercial accommodation.

8. Source-Pathway-Receptor Assessments

- 8.1 The site is at an elevation of some 7m AOD and is not susceptible to tidal flooding.
- 8.2 The EA mapping indicates the front of the site where the access and majority of the building are proposed to be located in FZ1 (low risk) with a significant part of the rear land and small part of the proposed building location in FZ2 (medium risk) and a small part of the rear land in FZ3 (high risk).
- 8.3 More detailed information was obtained from the EA for flood levels and compared to the site specific topographic survey. The flood level data is contained in Appendix B and a copy of the topographical survey is contained in Appendix A. These are discussed in the following paragraphs:
- 8.4 The flow from the two separate bridge spans over hermitage Stream coalesce at node HS1491 adjacent the rear of the site and are indicated to have the following flood levels:
- | | |
|---------------|-----------|
| 1%AEP | 6.34m AOD |
| 1%AEP + 20%CC | 6.58m AOD |
| 0.1%AEP | 6.77m AOD |

Adjacent the site entrance on the northern side of West Street bridge at node HS1404 the flood levels are indicated to be:

1%AEP	6.25m AOD
1%AEP +CC	6.47m AOD
0.1%AEP	6.63m AOD

Messrs Herington consulting made various further consultations with the EA with respect to 1%AEP +105%CC flood level derivation for the site. The outcome from this is set out in the Aqua Callidus Consulting letter of 16 February 2021 a copy of which is contained in Appendix B. This concludes that with a precautionary approach 1%AEP +105%CC of 7.07m AOD is derived which with 0.6m freeboard indicates an FFL of 7.67m AOD.

For simplicity the following conservative values have been used for assessment and mitigation calculation.

FZ3 ₂₀₂₁ rear land and proposed building	6.35m AOD
FZ3 +20%CC rear land and proposed building	6.6m AOD
FZ3 +105%CC rear land and proposed building	7.07m AOD
FZ3 +105%CC access off West Street	6.97m AOD

Pursuant to the Aqua Callidus Consulting letter of 16th February 2021 it was identified to the EA and LPA that flood storage compensation is not achievable on a level for level stage basis without including mobilising storage beneath the ground floor of the building. This is because there is a very limited amount of rear garden area which can be lowered. In providing 0.6m freeboard to the FFL and meeting flush access requirements it is not possible to lower the courtyard around the building main access or the immediately adjacent car park area. It is also not possible to lower the access in to the site.

An assessment of the stage for stage storage impact up to 1%AEP +105%CC is contained in Appendix C. At all stages there is a net cumulative beneficial impact on overall storage volume which ranges between 62m³ and 180m³ of increased storage at any particular stage. In summary the proposals will:

- This will have a beneficial effect to slightly reduce local flood levels.
- The proposed building will be above FZ3 +105%CC flood level

- 8.5 The minor alterations to ground levels set out in paragraph 8.4 will also slightly redistribute the location of the medium and low surface water flood risk areas on the site such that the proposed building and access will be located wholly within the low risk area (0.1-1%AEP). The watercourse (Hermitage Stream) to the west of the site inherently contains water and the channel is defined to be >1% AEP.
- 8.6 The EA mapping indicates the site is not in an area of reservoir flood risk.
- 8.7 The Hampshire CC Groundwater Management Plan (GWMP) does not identify groundwater issues within Havant.
- 8.8 The SFRA does not indicate any sewer flooding at the site.
- 8.9 The critical flood source for the rear of the site is fluvial out of bank flow from the Hermitage stream to the West. The critical flood source for the proposed building and car park to the front of the site is pluvial run-off from within the site. The site surface water drainage system will accord with the principles of CIRIA C753.
- 8.10 The flood receptors of the development would be:
- Residential dwellings
 - Users of the residential dwellings
- 8.11 The proposed development and existing site classifications to Table 2 (Paragraph 066 Reference ID: 7-066-20140306) are as follows:
- Existing commercial Less vulnerable
 - Proposed residential More vulnerable

9. Flood Probability

- 9.1 The EA flood zones shown on the outputs and included in Appendix B represents current best estimates of zone 2 and zone 3 flooding. It does not take account of potential climate change impacts. The flood zone definitions to Table 1 (NPPG Reference ID: 7-065-20140306) are as follows:

Zone 1	Low probability of flooding (<0.1% AEP)
Zone 2	Medium probability of tidal flooding (0.1-0.5% AEP)
	Medium probability of fluvial flooding (0.1-1% AEP)
Zone 3a	High probability of tidal flooding (>0.5% AEP)
	High probability of fluvial flooding (>1% AEP)
Zone 3b	Functional floodplain (>5% AEP probability of flooding)

The flood map does not differentiate between zones 3a and 3b.
Zone 3b is only considered appropriate for water-compatible development.

Zone 3a is additionally considered appropriate for less vulnerable uses.

- 9.2 The proposed dwellings are to be located well above FZ3 +105%CC and will therefore be at low risk of flooding.
- 9.3 The proposed rear open space in FZ2/3 will remain as soft landscaping (water compatible) at medium/high risk.

10. Climate Change

- 10.1 The new climate change allowances for flood risk assessment GOV.UK 22 July 2020 update have been used. Climate change values for the site are:
- Peak river flow: Table 1, South East, third epoch, higher central +45%
 - Peak river flow: Table 1, South East, third epoch, upper end +105%
 - Peak rainfall intensity: Table 2, third epoch, upper end +40%
- 10.2 Surface water drainage strategy is discussed in Chapter 11. The volumes and flows for this strategy have been derived in accordance with CIRIA C753 and include for climate change effects.

11. Detailed Development Proposals & Surface Water Strategy

- 11.1 Surface water drainage must accord with a receptor hierarchy in which Tier 1 (infiltration) must be considered first.
- 11.2 The site soils investigation by Soils Ltd (refer to Section 5) identified around 2m of fill on the site with the fill below 0.5m being of a more gravelly nature. However, given a design flood level of 6.6m AOD and the immediate proximity of Hermitage Stream it is extremely likely that this more gravelly fill would therefore be below GWL as the flood levels in the watercourse rise. Furthermore the infiltration of run-off into made ground is a geohazard as this has potential to induce movement. The results of the Winter GWL monitoring are discussed in Section 5. Considering the GWL monitoring results in conjunction with the soil profile logs from WS03 and WS04 it is apparent that at the level where the soil is of a more gravelly nature it lies below GWL. Therefore attenuated discharge to the watercourse (Tier 2) will be required and the porous pavements would therefore be a class C sealed system.
- 11.3 A UKsuds IOH124 greenfield runoff calculation for the site has been made (Refer to Appendix C). This indicated the following rates:

Q _{bar}	1.46 l/sec
Q ₁	1.24 l/sec
Q ₃₀	3.36 l/sec
Q ₁₀₀	4.66 l/sec

The site is however brownfield and the existing building roof and pavement comprise some 180m² at an existing unattenuated run-off rate of 50 mm/hr. The existing brownfield run-off rate from this is 2.50 l/sec.

There are two approaches to setting post development discharge rates. Either a variable rate discharge and provision of separate long-term storage which itself is limited to a discharge rate of 2 l/sec/Ha; or set a flat discharge of Q_{BAR} or 2 l/sec/Ha and provide adequate storage to facilitate this. In both cases there is a pragmatic lower threshold to mitigate the potential blockage risk associated with small orifices for low flow rates. This is accepted to be 5 l/sec where discharging to open water bodies to allow for vegetation or 2 l/sec where discharging into sewers or piped systems which inherently have no vegetation.

- 11.4 The proposed site characteristics comprise:

Roof & car park	920 m ²
Soft landscape	1,930 m ²

The proposed positively drained site surfaces (roof and driveway) amount to some 920m² (32%). An assessment calculation for the storage required for 920m² drained area attenuated to 2 l/sec for a 1%AEP +40% Climate Change storm is contained in Appendix C. This indicates a storage volume of approximately 55m³ would be required. There are a number of means by which this volume could be provided and 400m² of class C sealed permeable pavement with a 0.40m CGA foundation of 35% void has been used for illustration purposes. Examination of the proposed site layout indicates there would be sufficient space to accommodate the required footprint of 400m². It is concluded that the proposed layout could support the appropriate attenuation storage for 2 l/sec to Hermitage Stream. There would be a net reduction of some 20% (0.50 l/sec)

- 11.5 The UKSUDS surface water storage assessment has been used to confirm the sizings. A copy of this calculation is contained in Appendix C.
- 11.6 The surface water drainage system will be designed to accommodate a 1 in 100 year +50% combined climate change and urban creep rainfall event. With respect to the Non-statutory Technical Standards for Sustainable Drainage Systems (NTS SuDS) the design accords with requirements S3 and S5-9. Design and construction details will accord with Building Regulations, so according with S10-11 and S13-14. The surface water design does not include pumping so S12 is not applicable. The detailed design can be secured by standard planning condition as usual. As set out in paragraph 11.2 if the permeability testing, GWL monitoring and geohazard risks permit it then a Tier 1 infiltration pavement would be provided, however this is considered extremely unlikely in which case a Tier 2 attenuation discharge to watercourse strategy will be provided.
- 11.7 Water butts should be installed to intercept roof water run-off. These will reduce the annual volume of surface water discharge but will not make a material contribution to regulation of critical run-off as these tend to be full during Winter months as there is minimal demand for irrigation in these months.
- 11.8 In summary source control will be provided by:
 - Attenuation storage as outlined in paragraph 11.4
 - Provision of water butts as outlined in paragraph 11.7
- 11.9 The surface water strategy betters the existing run-off regime. There will therefore be no adverse impact on flood flow rates outside the site.
- 11.10 The use comprises generally low and very low pollution hazard levels (C753 Table 26.2) and does not require groundwater risk screening.
- 11.11 Simple index approach calculations are contained in Appendix C. These demonstrate that the proposed SuDS infrastructure can provide the mitigation necessary. It is proposed to provide a porous pavement to treat attenuated run-off prior to discharge into the watercourse.
- 11.12 The existing site falls east to west. The site morphology is not going to be altered so there will be no impact on local flood flow pathways and exceedance flows will continue to discharge west from the site to watercourse, as currently occurs.
- 11.13 A schedule of O&M maintenance requirements for the SuDS infrastructure is also contained in Appendix C. The site SuDS assets will be maintained by the Housing Association.

12. Sequential & Exceptions Tests

- 12.1 The proposed development comprises 20nr 1-bed 1 person specialist apartments dwellings. Havant Housing Association have a number of specific needs and constraints upon providing this specialist housing and have set these out in the Sequential Test in Section 8 of the Design and Access Statement. This demonstrates that there are no other reasonably available sites appropriate to the proposed development in areas with a lower risk of flooding. The proposal therefore meets the Sequential Test.
- 12.2 Application of the Exceptions Test is required.
- 12.3 Paragraph 160(a) of the NPPF requires the development to provide wider sustainability benefits to the community. Havant Housing Association (HHA) provides supported accommodation to tenants with specialist supported living needs across the Borough of Havant for 30 years. HHA's aim is to provide discreet, high quality accommodation within the Havant community. Within this programme, it is necessary for such schemes to be located close to the amenities central Havant has to offer. For tenants to be truly integrated into the community whilst retaining their independence, they require access to shops, transport hubs and leisure/ entertainment amenities, that in the Havant area, only the town centre can fully offer. This provision of specialist supported accommodation is of wider sustainability benefit to the community.
- 12.4 Paragraph 160(b) of the NPPF requires that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible reducing flood risk overall. Paragraph 8.5 demonstrates that the minor adjustment to ground levels will make the development safe, will not increase flood risk elsewhere, and, will have a beneficial effect to slightly reduce local flood levels:
- This will have a beneficial effect to slightly reduce local flood levels.
 - The proposed building will be above FZ3 +105%CC flood level
 - The access to the building will be above FZ3+45%CC and below 0.3m at FZ3 +105%CC
- Paragraph 160(b) of the NPPF is therefore also met.

13. Flood Risk Management Measures

- 13.1 The source pathway receptor assessment is contained in Chapter 8.
- 13.2 Paragraph 8.9 identifies that that fluvial flooding is the governing source at the rear of the site. Paragraph 8.4 demonstrates the 1%AEP +105%CC flood level at the proposed building location is no more than 7.07m AOD. It is proposed to adopt a FFL of at least 7.67m AOD to provide a freeboard of 0.6m.
- 13.3 Paragraph 8.9 also identifies that on site surface run-off is the governing flood source to the car park and access. The management of the storage and conveyance of these volumes and flows is provided for by the surface water strategy set out in Chapter 11. The strategy accords with CIRIA C753 SuDS Manual.
- 13.4 The surface water strategy betters the existing run-off regime. There will therefore be no adverse impact on flood flow rates outside the site.

14. Off Site Impacts

- 14.1 The surface water strategy betters the existing run-off regime. There will therefore be no adverse impact on flood flow rates outside the site .

15. Residual Risks

- 15.1 The proposed surface water strategy for the development provides for flood events up to 1:100 year 2021_{AD} + CC rainfall/fluvial flood events. The residual flood risk is therefore for events in excess of 1:100 year 2021_{AD} + CC rainfall/fluvial flow.
- 15.2 The proposed FFL is located well above 1:100 year 2021_{AD} + CC fluvial flood level from the watercourse. The residual flood risk is therefore fluvial events in excess of 1:100 year 2021_{AD} + CC.

Appendix A



Site location



View on site from West Street



View looking north towards railway bridge spans (site behind wall on RHS)



View from West street bridge towards railway bridge (site beside/behind car lot to RHS)



site layout plan

schedule of accommodation
20nr 1-bed 1 person
12 apartments 43m²
5 apartments 45m²
3 apartments 47m²

**associated cycle
& refuse stores**

7 car parking spaces

**GIA 1130m²
site area 2910m²
area of flood area 1400m²**

notes

this drawing is the copyright of the **pdp architecture llp** and must not be reproduced in whole or part or used for the execution of works without their permission.

all dimensions to be checked on site prior to commencement of construction works and the architect notified of any discrepancy.

figured dimensions are to be used in preference to scaled dimensions.

no deviation from this drawing will be permitted without prior consent of the architect.

all drawings are prepared subject to a full measured and structural survey of the buildings and site.

all structural work is subject to the appointment of a structural engineer to confirm and agree the structural proposals.

os promap licence no. 100020449.

health & safety:
exceptional risks involving specific methods of construction or exceptional maintenance issues:

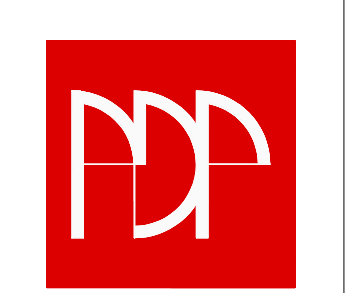
NO SIGNIFICANT RISK

scale width 50 mm @ a1 - 25 mm @ a3

revision	notes	date	drawn	checked
A	Red line amended	25.02.20	MAS	
B	Levels amended	19.02.21	MAS	MBW



PLANNING



pdp architecture llp

chartered architects town planning
interior design consultants

2 beechworth road havant
hampshire po9 1ax
tel 023 9248 1100
fax 023 9247 5050
email pdp@pdp-architects.co.uk

www.pdp-architects.co.uk

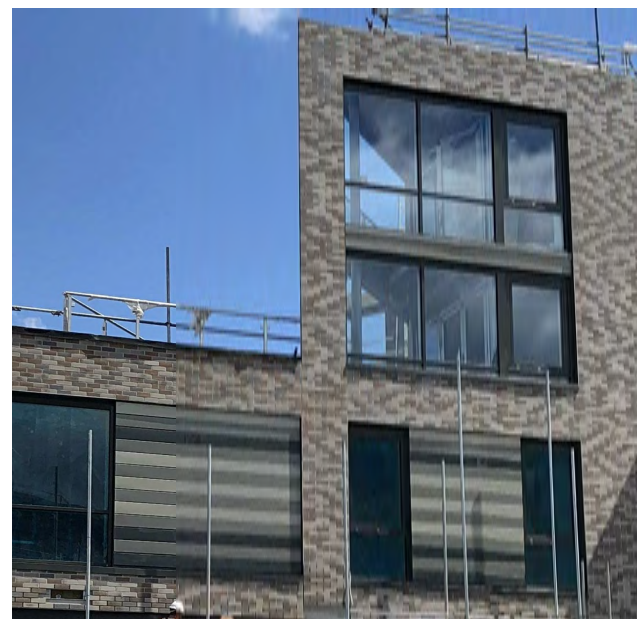
project Proposed Development
The Burrows
West Street Bedhampton

detail Site Layout Plan

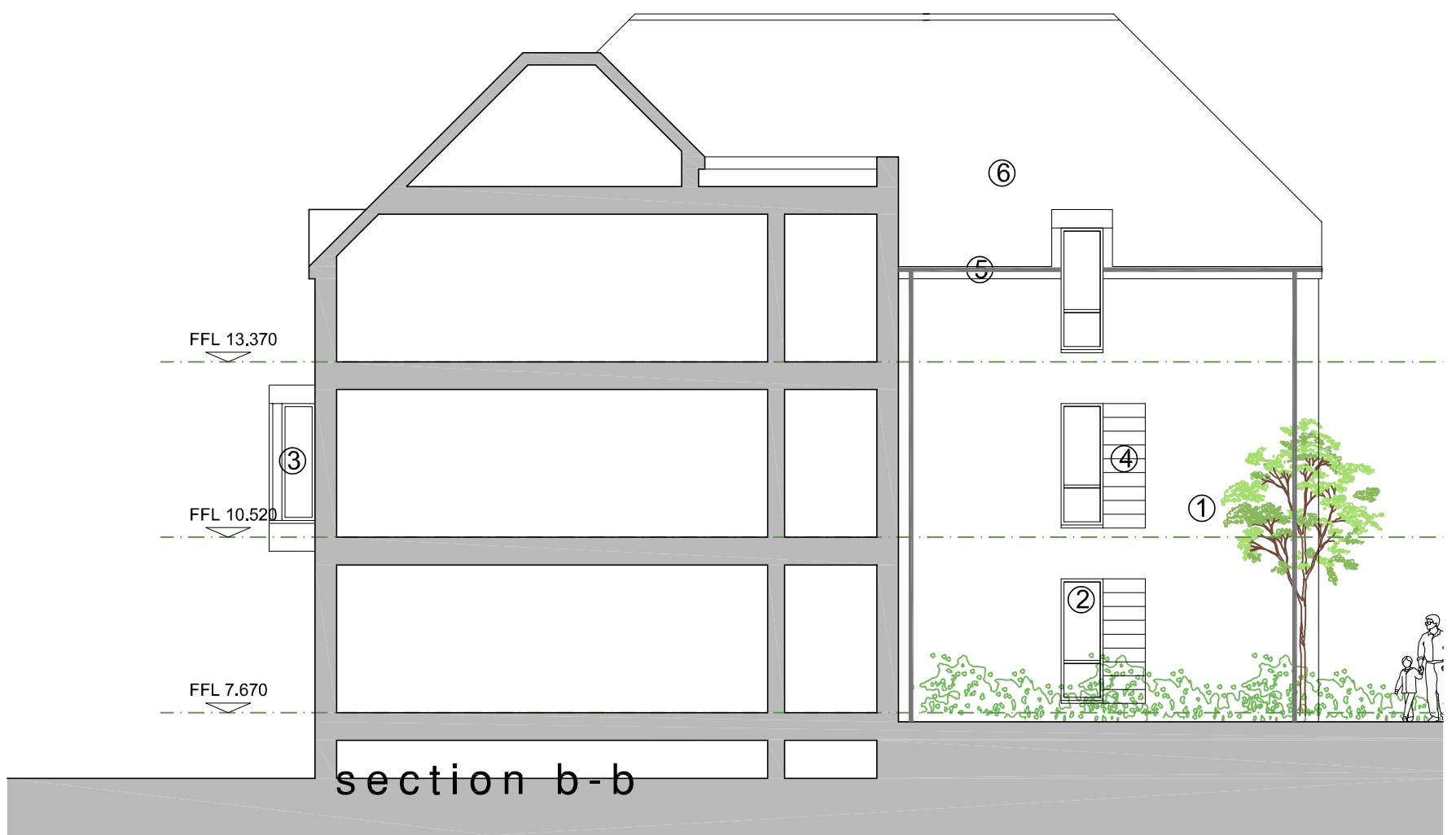
drawn	MAS	checked	
date	Oct 2019	status	Planning
a1 scale	1:250	a3 scale	1:500
		rev	28065-PD110 B



- proposed materials schedule
- ① - facing brickwork newman bricks (grey and brown mix)
 - ② - PVCu windows and doors (grey ral 7000)
 - ③ - powder coated aluminium bays (grey ral 7000)
 - ④ - marley cedral click smooth cladding system (C02, C03 & C15)
 - ⑤ - grey (ral 7000) soffit and fascia and rainwater goods
 - ⑥ - sandtoft double pantile roof (smoothfaced dark grey)
- (all materials to local planning authority approval)



precedent of brick and cladding



notes

this drawing is the copyright of the **pdp architecture llp** and must not be reproduced in whole or part or used for the execution of works without their permission.

all dimensions to be checked on site prior to commencement of construction works and the architect notified of any discrepancy.

figured dimensions are to be used in preference to scaled dimensions.

no deviation from this drawing will be permitted without prior consent of the architect.

all drawings are prepared subject to a full measured and structural survey of the buildings and site.

all structural work is subject to the appointment of a structural engineer to confirm and agree the structural proposals.

os promap licence no. 100020449.

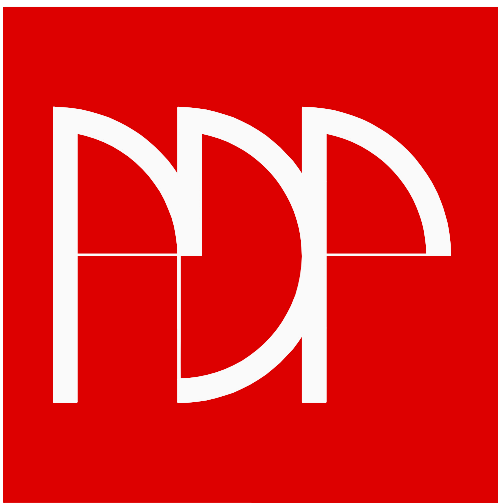
health & safety:
exceptional risks involving specific methods of construction or exceptional maintenance issues:

NO SIGNIFICANT RISK

revision		notes	date	drawn	checked
scale width: 50 mm @ a1 - 25 mm @ a3					
A	Levels amended	19.02.21	MAS	MBW	
B	Windows and roof lines amended	31.03.21	JF	MAS	
C	Ground floor vents added	14.06.21	MAS	MBW	



PLANNING



pdp architecture llp

chartered architects town planning
interior design consultants

2 beechworth road havant
hampshire po9 1ax
tel 023 9248 1100
fax 023 9247 5050
email pdp@pdp-architects.co.uk

www.pdp-architects.co.uk

project Proposed Development
The Burrows
West Street Bedhampton
detail Elevations & Sections

drawn	MAS	checked	MBW
date	Oct 2019	status	Planning
a1 scale	1:100	a3 scale	1:200
		28065-PD201	rev C

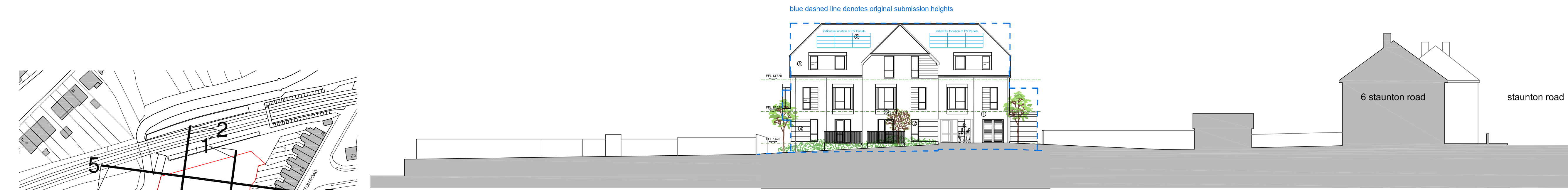
elevations & sections



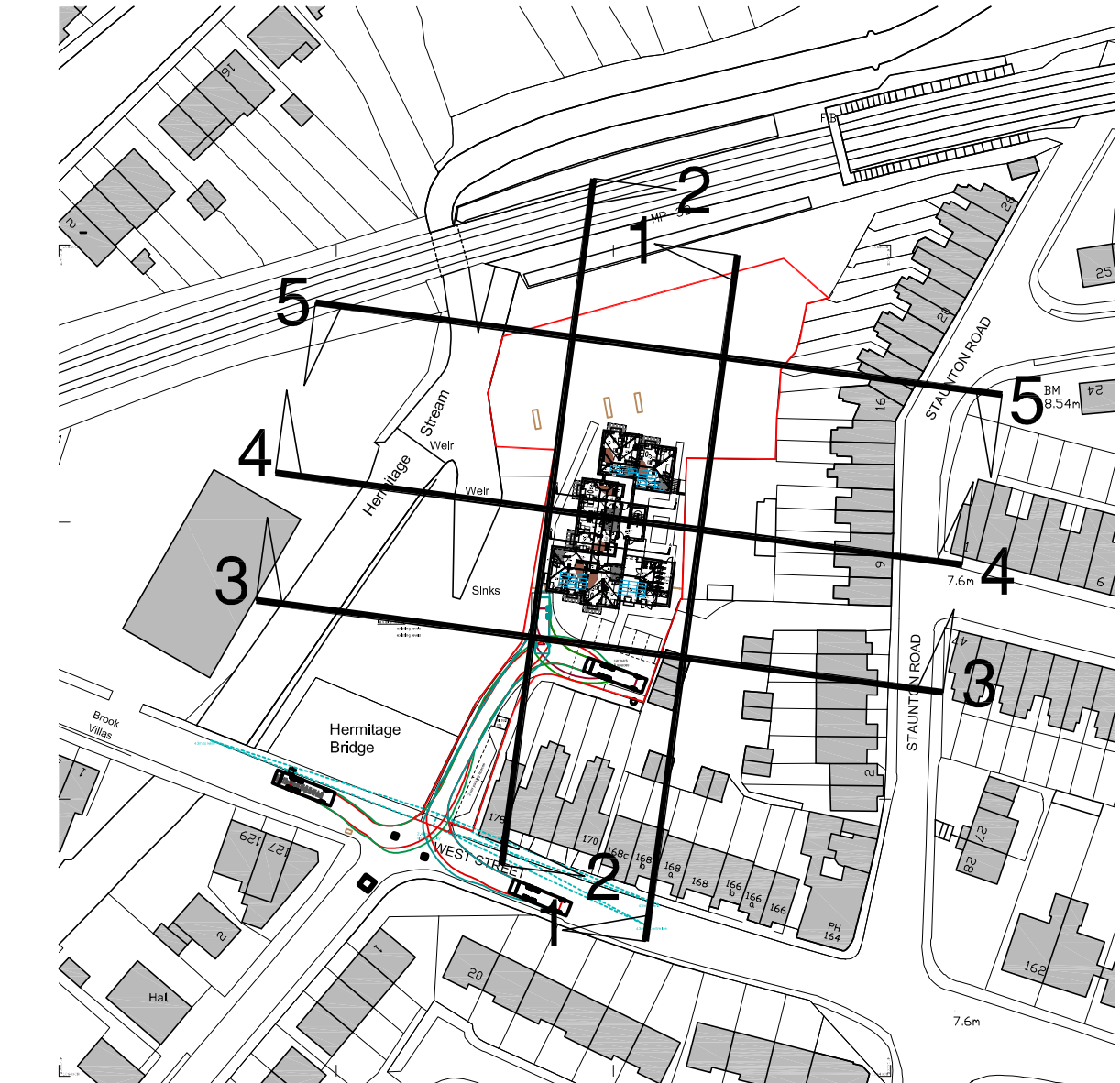
site section 1-1



site section 2-2



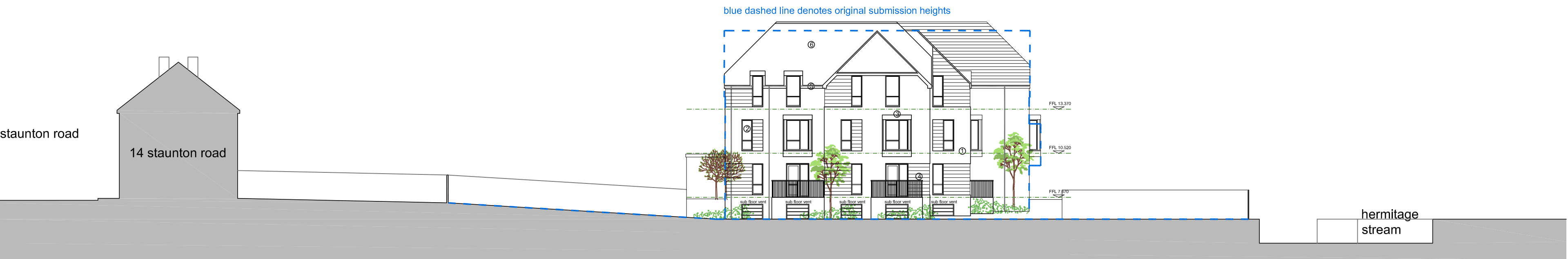
site section 3-3



location plan



site section 4-4



site section 5-5

site sections

notes

this drawing is the copyright of the **pdp architecture llp** and must not be reproduced in whole or part or used for the execution of works without their permission.

all dimensions to be checked on site prior to commencement of construction works and the architect notified of any discrepancy.

figured dimensions are to be used in preference to scaled dimensions.

no deviation from this drawing will be permitted without prior consent of the architect.

all drawings are prepared subject to a full measured and structural survey of the buildings and site.

all structural work is subject to the appointment of a structural engineer to confirm and agree the structural proposals.

os promap licence no. 100020449.

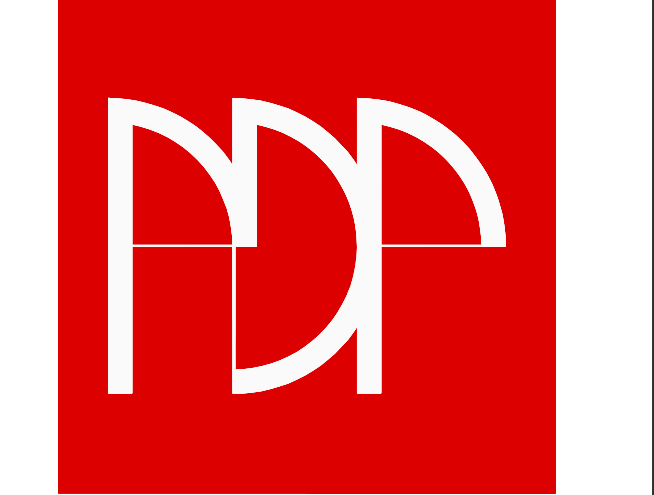
health & safety:
exceptional risks involving specific methods of construction or exceptional maintenance issues:

NO SIGNIFICANT RISK

revision		notes	date	drawn	checked
scale width 50 mm @ a1 - 25 mm @ a3					
A		Building raised to suit EA requirements	19.02.21	MAS	MBW
B		Windows & roof lines amended			
C		Ground floor vents and original outline added	14.06.21	MAS	MBW



PLANNING



pdp architecture llp

chartered architects town planning
interior design consultants

2 beechworth road havant
hampshire po9 1ax
tel 023 9248 1100
fax 023 9247 5050
email pdp@pdp-architects.co.uk

www.pdp-architects.co.uk

project Proposed Development
The Burrows
West Street Bedhampton
Site Sections

drawn	MAS	checked	MBW
date	Oct 2019	status	Planning
a1 scale	1:200	a3 scale	1:400
		rev	C

Appendix B

Flood Map for Planning (Rivers and Sea) - Centred on 178a West Street, Havant - Created on 27 August 2019



Scale 1: 1,193



Flood Map for Planning (Rivers & Sea)

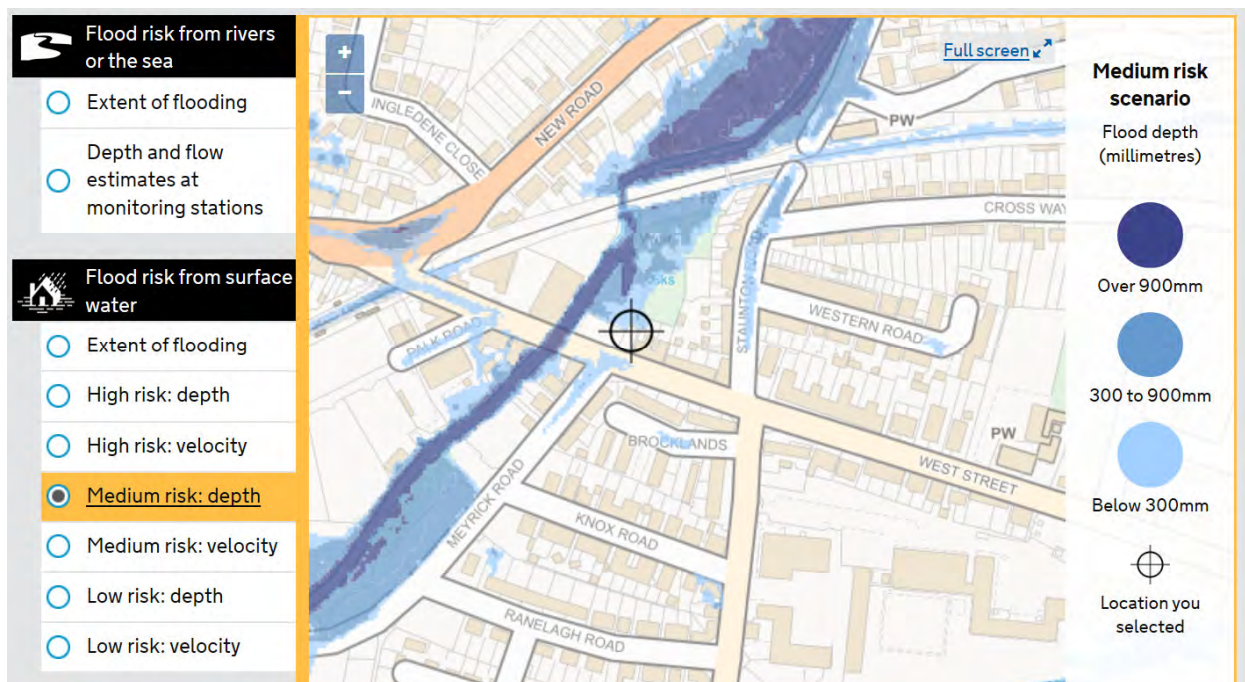
- Defences
- Flood Storage Areas
- Areas benefiting from flood defences
- Flood Zone 3
- Flood Zone 2

Flood Map Areas (assuming no defences)

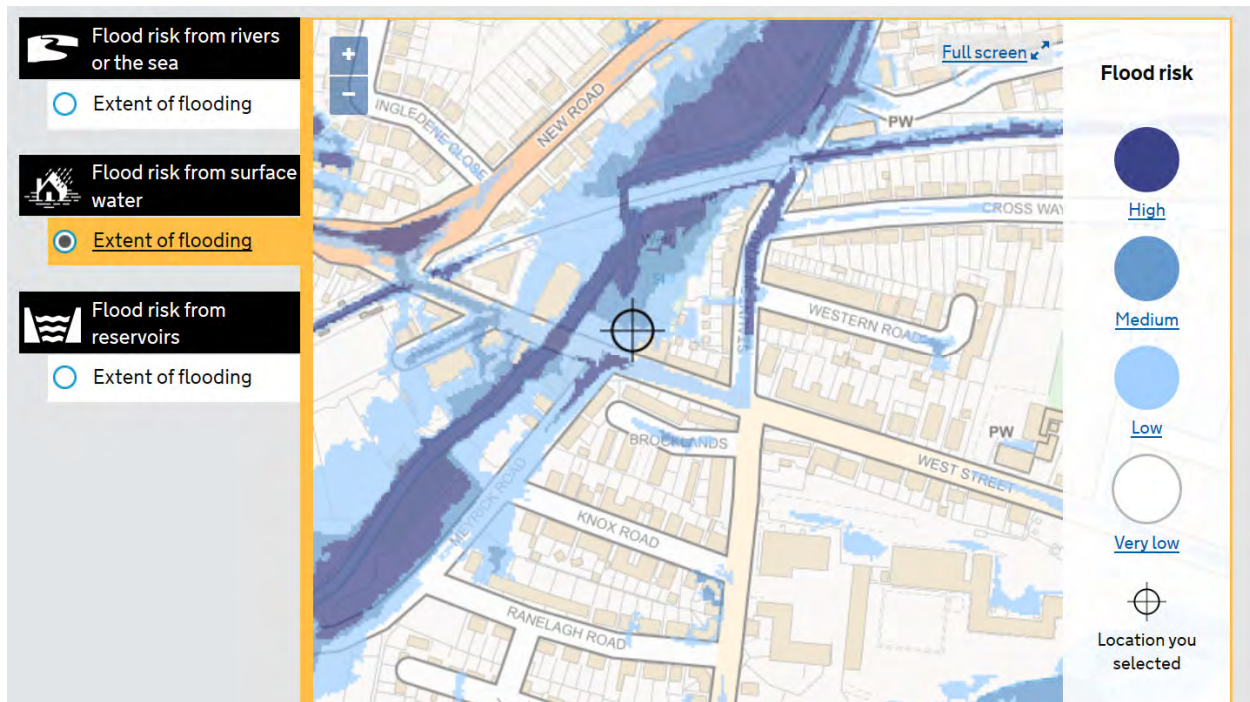
Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

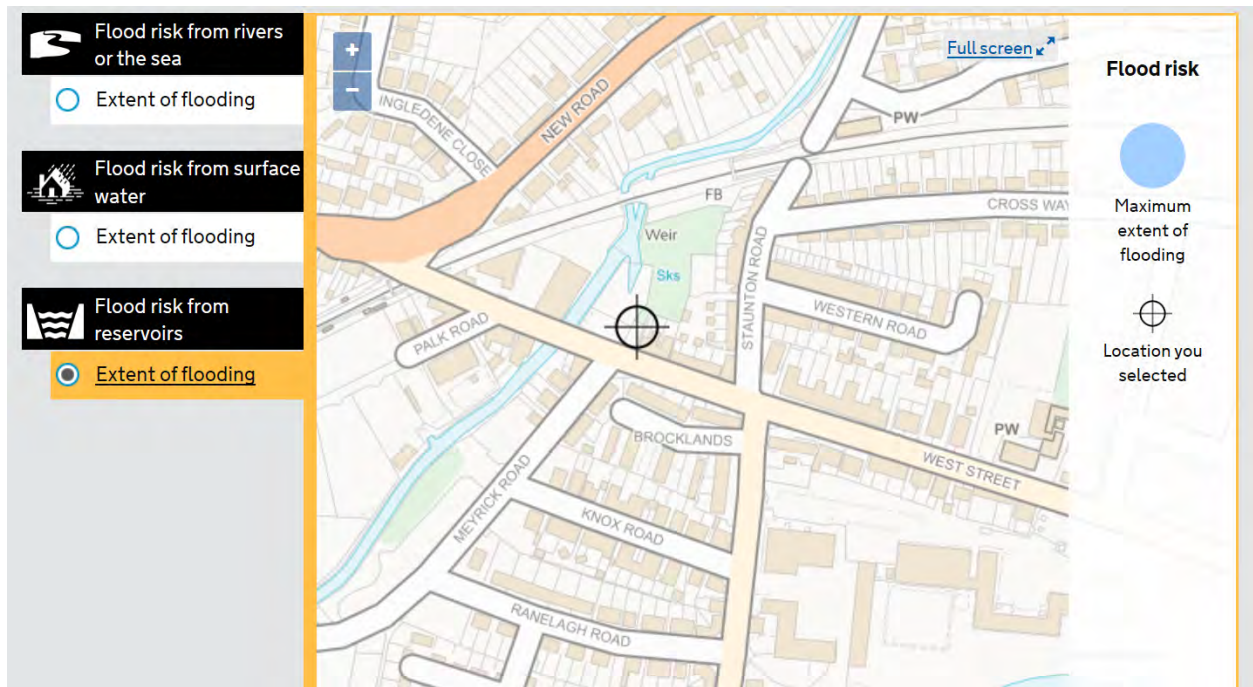
Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.



Surface water 1.0% AEP flood risk

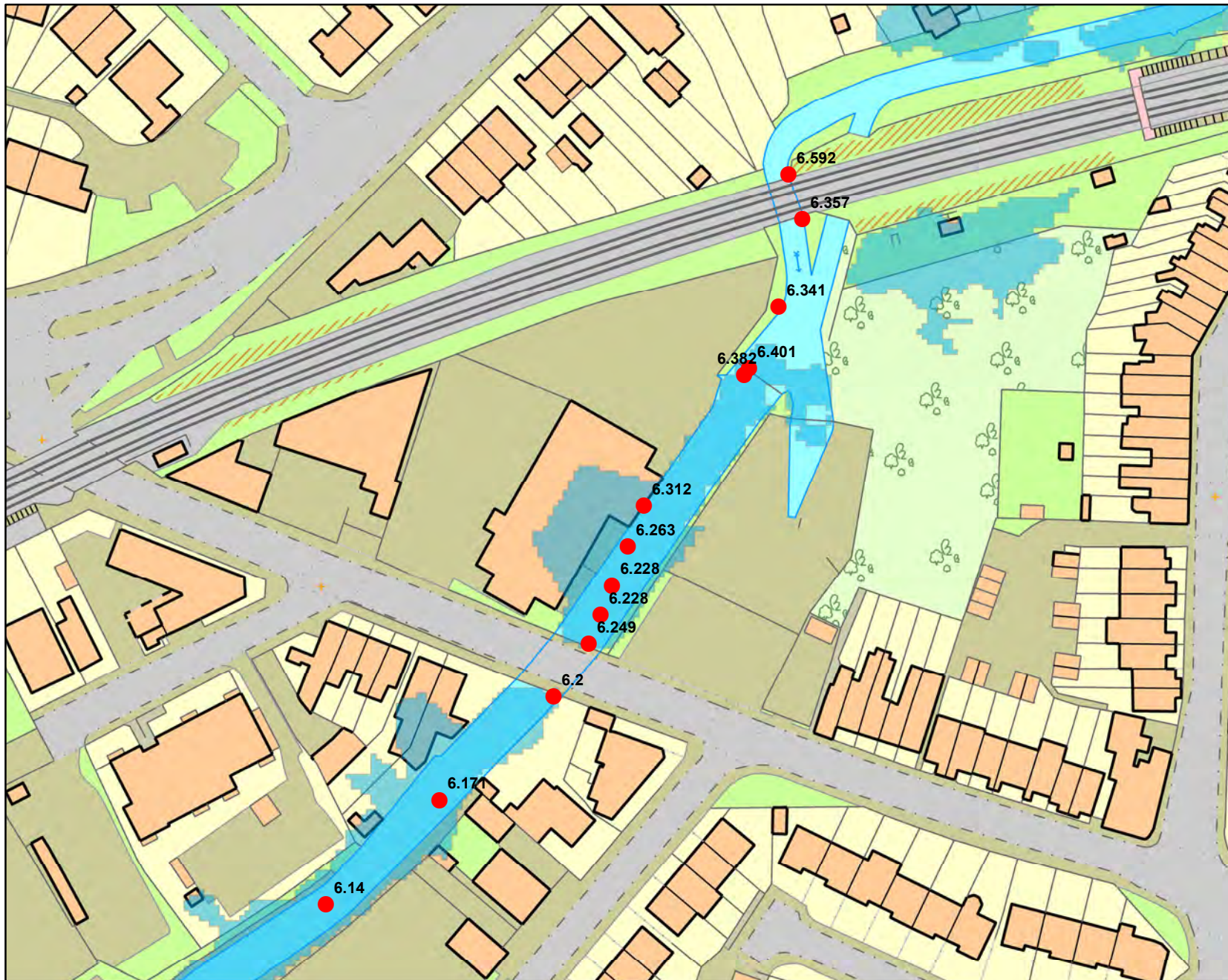


Low Surface water flood risk to front of site



Reservoir flood risk

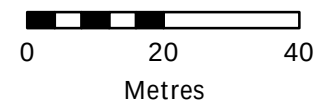
100 Year Flood Levels Map Centred on 178A West Street, Havant - Created on 27 August 2019



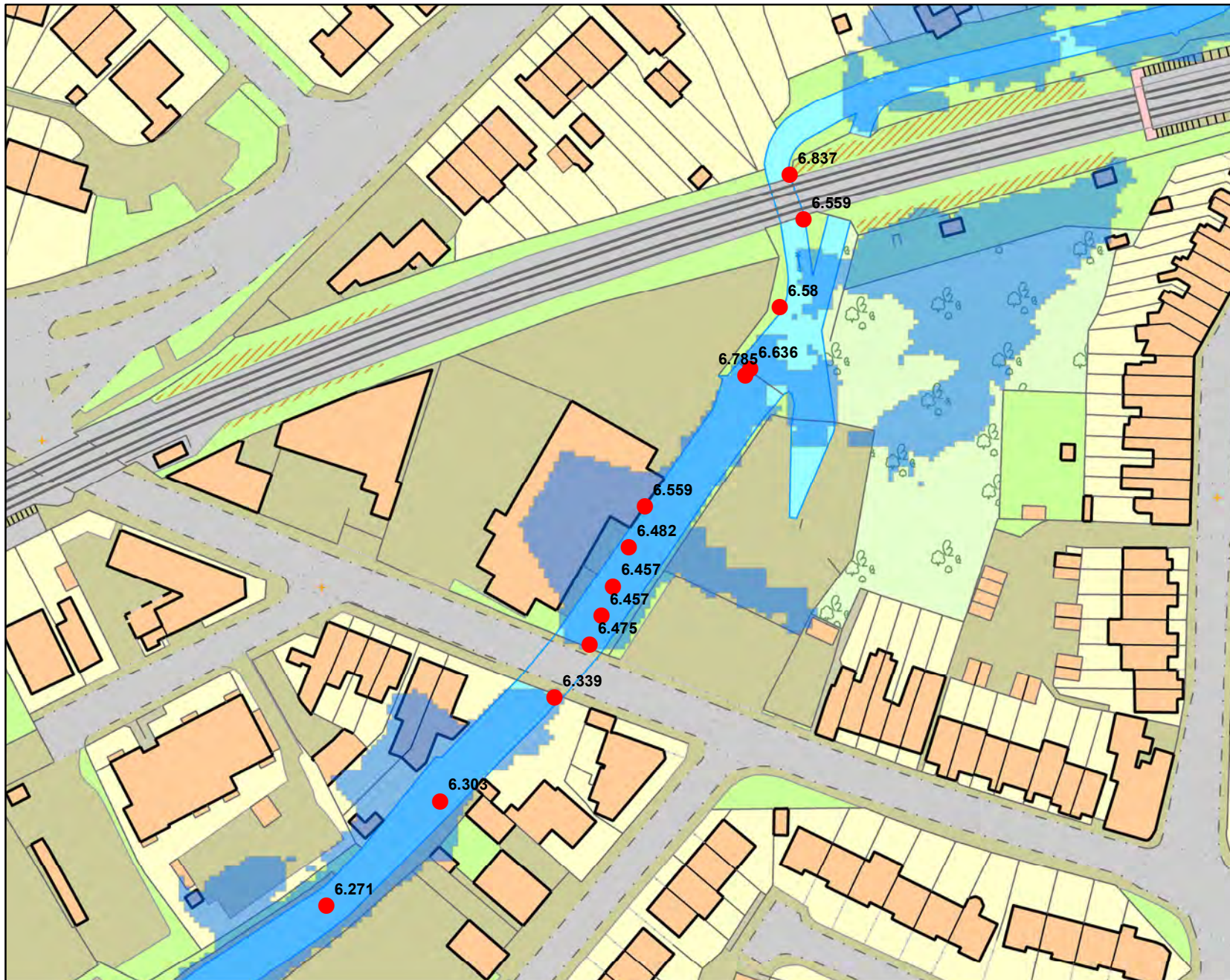
Legend

- Lavant & Hermitage 1D Levels
- Lavant & Hermitage 100Yr (Flood Zone 3)

1:1,111 *
*when printed at A4.



100 Year Flood Levels Map Centred on 178A West Street, Havant - Created on 27 August 2019

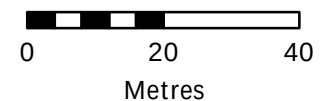


Legend

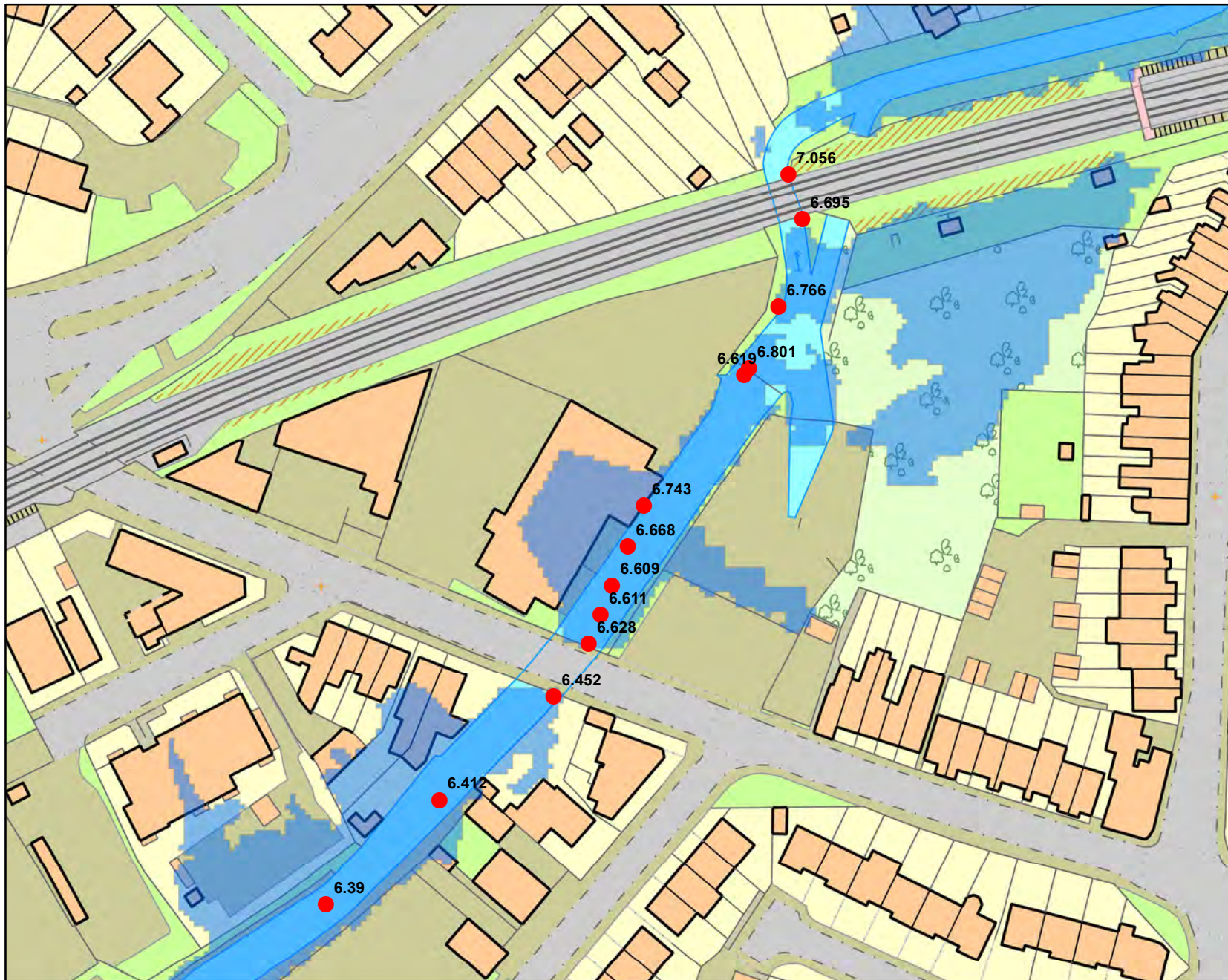
- Lavant & Hermitage 1D Levels
- Lavant & Hermitage 100Yr + Climate Change

1:1,111 *

*when printed at A4.



100 Year Flood Levels Map Centred on 178A West Street, Havant - Created on 27 August 2019

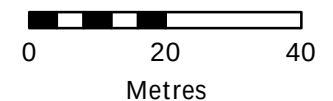


Legend

- Lavant & Hermitage 1D Levels
- Lavant & Hermitage 1000Yr (Flood Zone 2)

1:1,111 *

*when printed at A4.



18 February 2021

PDP Architecture LLP
2 Beechworth Road
Havant
Hants
PO9 1AX

✉ 52 Common Lane
Titchfield, Hants,
PO14 4BU

☎ 07717 759149
🌐 www.aquacallidus.co.uk

FAO: Michael Saunders

Ref: 1828

Re: 178 West Street, Bedhampton, Hants APP/20/00363

Dear Sirs

The Environment Agency (EA) in their consultation response HA/2020/122284/01-L01 of 16th June 2020 requested:

- i. that climate change consideration be extended up to the +105% scenario
- ii. that flood plain compensation is assessed against the +105% scenario and in their associated informative that where level for level flood plain compensation is not possible then other forms of mitigation may be agreed with the LPA. If floodable voids are proposed then the void soffit should be located above 1%AEP +105% CC flood level.

A copy of their consultation response is appended.

Herrington Consulting have liaised extensively with the EA in order to agree the 1%AEP+105%CC flood levels for the site. Herrington Consulting sought model details from the EA to progress this and in their initial response (November 2020) the EA responded:

"Ideally, working to best practice we would indeed expect to see the 'intermediate approach' adopted for the assessment of climate change at this site. Unfortunately however, we do not hold flood levels or flow data for modelled return periods less than 1:100years or for return period events up to 1:1000 years. Therefore, extrapolation using a stage-discharge graph for a 105% flow rate of the 1:100year return period flow would not be possible.

We accept that given the nature of the proposed development, a detailed modelling approach would be disproportionate to the scale of the development. Therefore, in this instance, in the absence of data for modelled return periods up to 1:100years we would accept a 'basic' assessment of climate change. In this assessment, using 'Flood risk assessments: climate change allowances' we would expect to see a range of allowances considered as a minimum design standard on top of the 1:100 year flood level. These allowances can be basically assessed by using the climate change allowances in combination with 1 in 100 years flood depths to produce the design flood depth and thus flood levels for the lifetime of the development.

As standard, on top of this design flood level with climate change adjustments applied we would expect to see 600mm of freeboard added to the finished floor levels where possible, and 300mm as a minimum."

Herington Consulting therefore requested the EA basic assessment data table for the site location. The EA however then confirmed that whilst in some of their regions such as Thames they had produced a table to support this approach they had not done so and were not intending to do so for the Solent and South Downs region and therefore conceded that it was therefore not possible to use this approach. The EA at that stage suggested that the depth of flood at any point for the 1%AEP +105%CC could be calculated by prorated adjustment from known 1%AEP and 0.1%AEP depths. There is however a fundamental problem in such an approach in that any location outside the current 0.1%AEP (FZ2) extents would be dry (zero depth) and no matter what the pro rate scalar this would always factor zero up or down to still be zero (dry) but within the channel forming FZ2 extents it would over report depth by 'mounding' the water up in the channel without any lateral spread. This is clearly absurd as at any one section moving down the channel model there would be a singular level ie lateral spread would occur. To overcome this flood levels have therefore been determined from the known outputs for 1%AEP, 1%AEP+20%CC and 0.1%AEP scenarios with respect to the known rate of flood level increase for the known rate of flow increase. Whilst this will still give conservative results these will be more realistic as the level rise per cumec of flow increase will diminish as the flood laterally spreads giving not just a greater depth of flow but also a greater width of flow. The infoworks model layout and data output for nodes HS1491 and HS1404 are attached. This output and 1%AEP +105%CC level determination are discussed in the following paragraphs.

There are two spans over the river to the railway bridge immediately north of the site. The channel flows split and recombine at section HS1491 which lies adjacent the northern end of the proposed building. Hydraulic Section HS1491 contains the whole of the flow without subdivision.

The channel bifurcates at HS1468 just downstream of this point and one arm entering a culvert having a finite 'enclosed' flow capacity that is relatively constant but does increase slightly as the head of floodwater at the entrance to the culvert increases. Having taken off this relatively constant culvert flow the larger remaining flow continues down the large open concrete channel to the West Street bridge. The whole of the remaining flow passes through hydraulic section HS1404 which lies adjacent the southern edge of the site.

For all the model scenarios the flood level at HS1404 is around 0.1m lower than that at HS1491, which is logical as the flow is moving down hill and a substantial offtake has been made at HS1468.

For HS1491:

1%AEP to 1%AEP+20% CC level increase 0.24m for 4.68m³/sec flow increase = 0.051m per m³/s

1%AEP +20%CC to 0.1%AEP level increase 0.19m for 4.09m³/sec flow increase = 0.046m per m³/s

For HS1404:

1%AEP to 1%AEP+20% CC level increase 0.22m for 4.19m³/sec flow increase = 0.052m per m³/s

1%AEP +20%CC to 0.1%AEP level increase 0.16m for 3.76m³/sec flow increase = 0.043m per m³/s

There are two conclusions from this:

The level increase for the two flood stage changes are very similar at both hydraulic sections as would be expected with a consistent engineered concrete channel between the two sections. Secondly the rate of level increase per additional cumec decreases as the flow rate and flood level increase and the flood begins to laterally spread.

Pro rate projections:

The prorated +105%CC flow at HS1491 = 24.64m³/sec + [(105%/20%)*(29.32-24.62m³/sec)] = 49.21 m³/sec

The prorated +105%CC flow at HS1404 = 15.65m³/sec + [(105%/20%)*(19.84-15.65m³/sec)] = 37.65 m³/sec

The increase in flow rates above 0.1%AEP modelled flood levels are:

HS1491 (49.21-33.41) = 15.80 m³/sec

HA1404 (37.65-23.60) = 14.05 m³/sec

From the known scenario data as the flow increases and flood levels increase the flood laterally expands and with increased flow rates there is a diminishing rate of rise on flood level.

From 1%AEP to 1%AEP+20% CC this is some 0.051 m per m³/sec and from 1%AEP +20%CC to 0.1%AEP this is some 0.045 m per m³/sec. It is readily evident from visual reconnaissance of the immediate channel side topography on this section that for a further increase of some 14-15m³/sec the flow would spread much further and produce a much greater reduction in the associated rate of rise quite possibly to below 0.02 m per m³/sec or less. It is also inherent that it would diminish to a rate significantly below the 0.045 m per m³/sec leading up to the 0.1%AEP levels. Two different rates have therefore been considered for sensitivity and are considered in context with freeboard provision, an upper 0.04 m per m³/sec and a conservative lower 0.02 m per m³/sec.

Upper bound 0.04 m per m³/sec:

HS1491 uplift on 0.1%AEP (15.80 m ³ /sec * 0.04 m per m ³ /sec)	= +0.63m
HS1404 uplift on 0.1%AEP (14.05 m ³ /sec * 0.04 m per m ³ /sec)	= +0.56m

Lower 0.02 m per m³/sec:

HS1491 uplift on 0.1%AEP (15.80 m ³ /sec * 0.02 m per m ³ /sec)	= +0.31m
HS1404 uplift on 0.1%AEP (14.05 m ³ /sec * 0.02 m per m ³ /sec)	= +0.28m

At an upper bound value of 0.04 m per m³/sec a further 0.6m freeboard would represent a further flow of some 15m³/sec or effectively +170%CC and a net level increase of around 1.2m over 0.1%AEP level. The 0.02 m per m³/sec would with such freeboard be inappropriately conservative at 0.9m over 0.1%AEP level the flood extents would be an order of magnitude wider than the 0.1%AEP flood extents.

The upper bound 0.04 m per m³/sec in conjunction with a 0.3m freeboard would provide a total uplift on 0.1%AEP of some 0.9m. The lower 0.02 m per m³/sec in conjunction with a 0.6m freeboard would also provide a total uplift on 0.1%AEP of some 0.9m.

It is therefore proposed that the FFL should be set no lower than HS1491 0.1%AEP (of 6.77m AOD) + 0.9m ie a minimum FFL of 7.67m AOD will be provided.

It is readily apparent that a stage for stage flood compensation for a +105% scenario is not deliverable as the surrounding land is already urbanised and is all of much the same level. As the EA set out in their informative that where level for level flood plain compensation is not possible then other forms of mitigation may be agreed with the LPA, and if floodable voids are proposed then the void soffit should be located above 1%AEP +105% CC flood level. For HS1491 0.1%AEP (of 6.77m AOD) +0.31m the void soffit would therefore need to be at least 7.08m AOD (1%AEP +105%CC) and given a typical floor construction of 155mm beams, 150mm insulation and 75mm screed (380mm typical overall) this can be delivered with a 7.67m AOD minimum FFL.

Provided an FFL of 7.67m AOD is otherwise acceptable to the LPA and that they agree that floodable voids below the building can be provided subject to appropriate planning condition then the proposal can be modified in those respects to address the EA consultation points. The elevated FFL would avoid the risk to the building and occupants and flood storage volume would be maintained so not having adverse effects elsewhere.

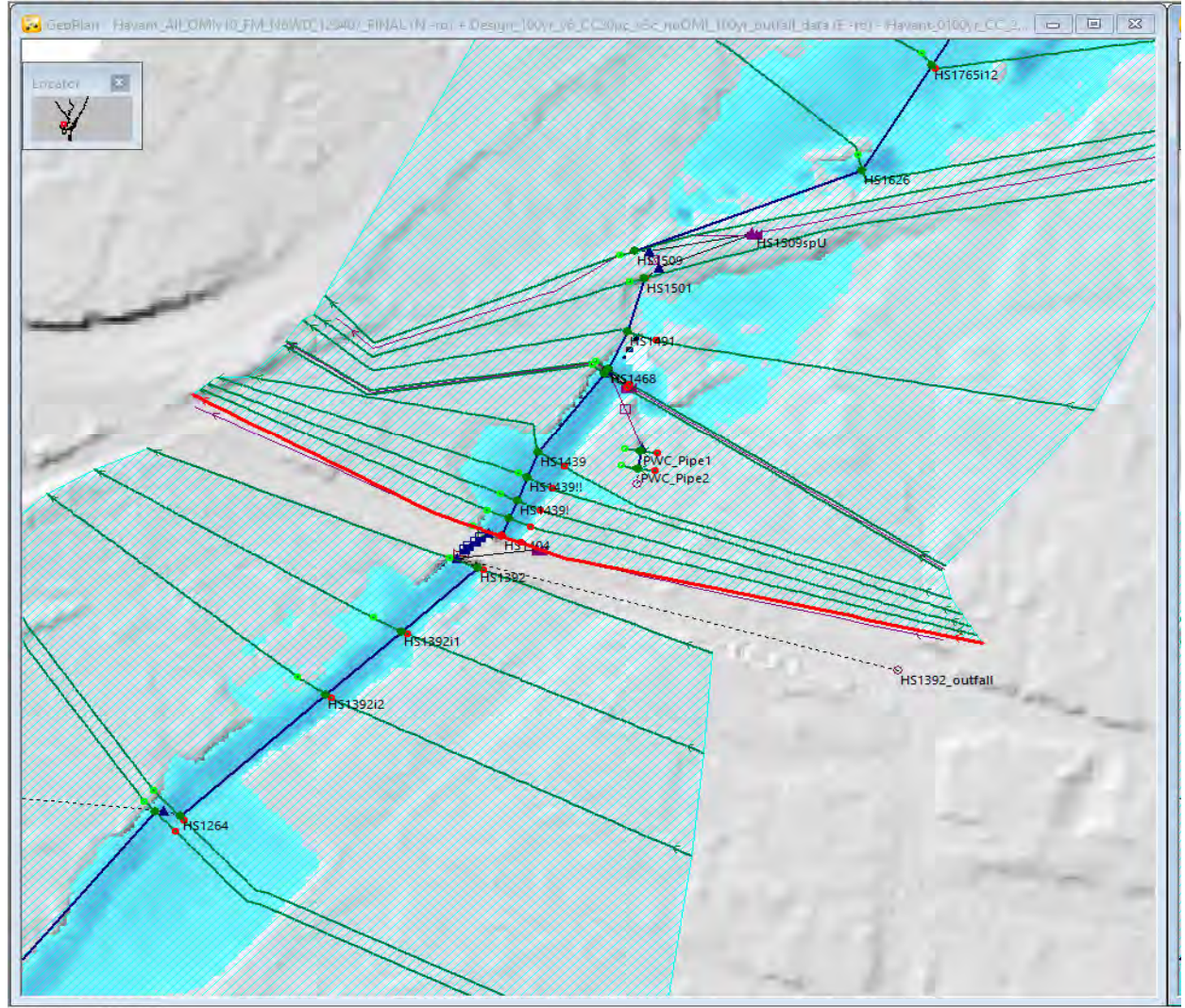
The LPA will undoubtedly want to reconsult the EA and a virtual round table session would be essential prior to production of specific new material in order to avoid any abortive work by anyone.

Yours Sincerely,

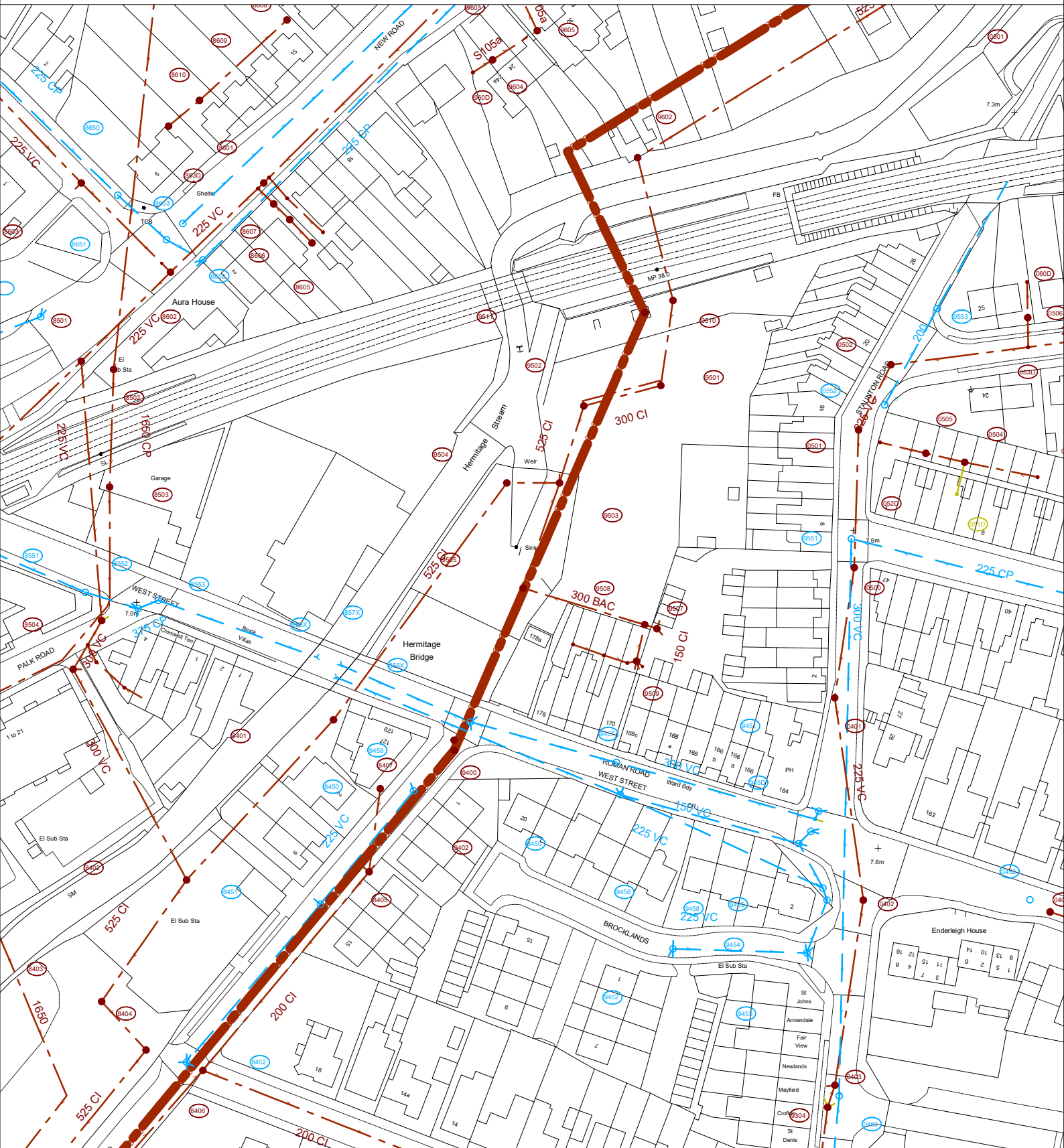
Aqua Callidus Consulting Ltd

Andy Traves

	HS1491		HS1404	
	Max. Stage (mAOD)	Max. Flow (m/s)	Max. Stage (mAOD)	Max. Flow (m/s)
100 year	6.34	24.64	6.25	15.65
100 year +20%	6.58	29.32	6.47	19.84
1000 year	6.77	33.41	6.63	23.60



SOUTHERN WATER



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.

Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530

O.S. REF: SU7006NE

Scale: 1:1250

Sewer Plot

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement



Printed By: Mercy

Date: 26-9-2019

Site Plan

Requested By:





Andy Traves
Aqua Callidus Consulting
52 Common Lane
Titchfield
Fareham
Portsmouth
Hampshire
PO14 4BU

Your ref

Our ref
DS_CC_PDE-112927

Date
09 October 2019

Contact

Tel 0330 303 0119

Dear Mr Traves,

Site: 178 West Street, Havant, Hampshire, PO9 1LR.

We have completed the capacity check for the above development site and the results are as follows:

Foul Water

Following initial investigations, there is currently adequate capacity in the local sewerage network to accommodate a foul flow for the above development at/downstream of manhole reference SU70068405. Please note that no surface water flows (existing or proposed) can be accommodated within the existing foul sewerage system.

It should be noted that this information is only a hydraulic assessment of the existing sewerage network and does not grant approval for a connection to the public sewerage system. A formal S106 connection application is required to be completed and approved by Southern Water Services. Please see the link below:

<https://developerservices.southernwater.co.uk/ConnectiontoPublicSewer/ApplicationForm>

Should you require any further information, please contact us at the above mentioned phone number or address shown in the footer.

Yours sincerely,

Tim Peacock-Bjurström
Technical Delivery Lead
Business Channels

Please note: - The information provided above does not grant approval for any designs/drawings submitted for the capacity analysis. The results quoted above are only valid for 12 months from the date of issue of this letter.



Figure 3 – Trial Hole Plan

Project

The Burrows, West Street,
Bedhampton, Havant, Hampshire
PO9 1LR

Client

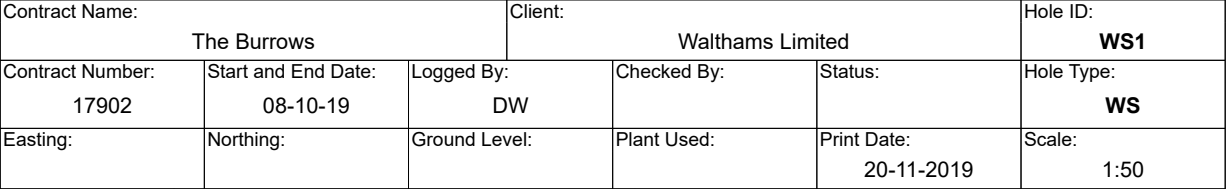
Walthams Ltd.

Date

November 2019

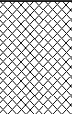
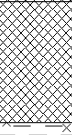
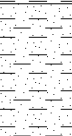
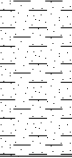
Job Number

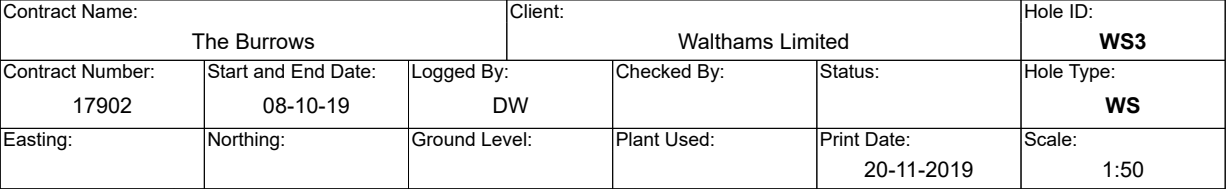
17902



Samples & In Situ Testing	Strata Details	Groundwater
---------------------------	----------------	-------------

Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)						
									Rootlets observed to 1.4m bgl					
									Water Strikes					
Chiselling					Installation				Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)						
					0.00	1.00	PLAIN	33						
					1.00	4.00	SLOTTED	33						
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

	Contract Name: The Burrows				Client: Walthams Limited				Hole ID: WS2						
	Contract Number: 17902		Start and End Date: 08-10-19		Logged By: DW		Checked By:		Status:		Hole Type: WS				
	Easting:		Northing:		Ground Level:		Plant Used:		Print Date: 20-11-2019		Scale: 1:50				
Weather:			Termination:					Sheet 1 of 1							
Samples & In Situ Testing				Strata Details								Groundwater			
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation		
0.50	ES D			(0.75)		Dark brown, slightly sandy CLAY. Frequent roots becoming occasional with depth. Occasional angular to sub-angular, fine to coarse flint, brick, chalk, and clinker gravel. MADE GROUND. No sample in WS from 0.0 - 0.5m bgl.						1			
0.80	ES D			0.75		Brown, slightly sandy, gravelly CLAY. Gravel is angular to sub-angular, fine to coarse flint and rare chalk. Very gravelly from 1.0 - 1.2m bgl. MADE GROUND									
1.00	D			(0.45)		Slightly white mottled, light brown, slightly silty, slightly sandy GRAVEL. Gravel is sub-angular to sub-rounded, fine to coarse chalk and flint. MADE GROUND									
1.40	D			1.20											
1.90	D			(0.80)		Greyish brown, slightly silty CLAY. Occasional orangish brown oxide staining in partings. ALLUVIUM						2			
2.00	D			2.00		Dark grey mottled black slightly fine sandy CLAY. ALLUVIUM									
2.20	D			2.10											
2.70	D														
3.20	D			(1.90)								3			
3.70	D			4.00		End of Borehole at 4.00m									
														4	
												5			
												6			
												7			
												8			
												9			
												10			
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:						
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 1.2m bgl						
Chiselling					Installation				Water Strikes						
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	
					0.00	1.00	PLAIN	33							
					2.00	4.00	SLOTTED	33							
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.															



Samples & In Situ Testing	Strata Details	Groundwater
---------------------------	----------------	-------------

Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks: Rootlets observed to 1.4m bgl					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)						
Chiselling					Installation				Water Strikes					
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
					0.00	1.00	PLAIN	33						
					1.00	4.00	SLOTTED	33						
									Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.					

			Contract Name: The Burrows				Client: Walthams Limited				Hole ID: WS4			
			Contract Number: 17902		Start and End Date: 08-10-19		Logged By: DW		Checked By:		Status:		Hole Type: WS	
			Easting:		Northing:		Ground Level:		Plant Used:		Print Date: 20-11-2019		Scale: 1:50	
Weather:				Termination:						Sheet 1 of 1				
Samples & In Situ Testing					Strata Details								Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/ Installation	
0.20	ES			(0.50)		Dark brown, slightly sandy, silty CLAY. Frequent rootlets. Occasional angular to rounded, fine to coarse flint, brick, and clinker gravel. MADE GROUND.						1		
0.60	ES			0.50			Black speckled and dark brown mottled, brown to light brown, slightly clayey, slightly sandy GRAVEL. Gravel is sub-angular to sub-rounded, fine to coarse chalk and flint. Occasional sub-rounded coarse sand to fine gravel sized carbonised organics. Occasional sub-rounded fine gravel sized carbonised organics. Occasional coarse gravel sized pockets of clay above 1.0m bgl. Rare rootlets.. MADE GROUND <i>Becomes light brown at 1.0m bgl, becomes silty below 1.0m bgl.</i>							
0.90	ES D			(1.15)										
1.50	D			1.65		Light brown, slightly sandy, silty GRAVEL. Gravel is angular to sub-angular, fine to coarse flint and chalk. MADE GROUND						2		
1.80	D			(0.70)										
2.40	D			2.35		<i>Backfill material from 3.0 - 3.85m bgl.</i>						3		
2.90	D			(1.65)		Dark grey mottled black slightly fine sandy CLAY. ALLUVIUM								
3.90	D					4.00	End of Borehole at 4.00m							
												4		
												5		
												6		
												7		
												8		
												9		
												10		
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 1.0m bgl					
Chiselling					Installation				Water Strikes					
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

Waltham Contracting Ltd.

Via email only: pam@walthamltd.co.uk

March 2020

Our Ref.: 18075/FLR Rev 1.01

Thomas Telford House, Sun Valley Business Park
Winnall Close
Winchester
SO23 0LB

01962 673 330
soilslimited.co.uk

Dear Maurice

Re: The Burrows, West Street, Bedhampton, Havant, Hampshire PO9 1LG

We are writing regarding the supplementary intrusive investigation undertaken at the above-named site.

This letter report must be read in conjunction with Soils Limited report ref.: 17902/MIR_R27, dated November 2019.

Brief

Soils Limited quotation (Q22283, dated 5th December 2019) set the scope of the investigation. The investigation was to comprise installation additional groundwater monitoring wells onsite and groundwater monitoring over the winter period (2020). In addition, laboratory contamination testing was to be undertaken on near surface soil samples to delineate potential contamination identified during the previous intrusive investigation undertaken onsite.

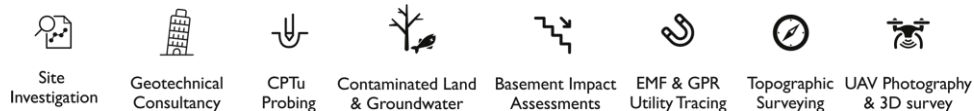
Site Works

On 6th January 2020, two windowless sampler boreholes (WS101 – WS102) were drilled to depths between 2.80m bgl and 4.00m bgl at locations selected by the client. Monitoring standpipes were installed in each windowless sampler borehole to allow for continued monitoring of both groundwater and soil gas, where present. Details of the installations are shown in the Field Logs presented in Appendix A.

Four trial pits (HDP1 – HDP4) were hand excavated each to a depth of 0.80m bgl around WS3 location (from main investigation) to delineate a potential lead hot-spot contamination.

All trial holes were scanned with a Cable Avoidance Tool (C.A.T.) and signal generator (Genny) prior to excavation to ensure the health and safety of the operatives.

Approximate locations of the trial holes have been included as Figure 1.



Soils Limited is a limited company registered in England and Wales number 1612073. VAT number 318273558

Registered Office: Newton House, Cross Road, Tadworth, Surrey KT20 5SR

Ground Conditions

Full details of the ground conditions encountered are presented within Field Logs in Appendix A.

Groundwater

Groundwater “strikes” were recorded within WS101 and WS102 and was struck at depths of 1.00m bgl and 1.10m bgl respectively.

Further groundwater monitoring was conducted within the standpipes installed onsite and commenced in December 2019 and concluded March 2020. The results have been presented in Table 1.

Table 1. Groundwater Monitoring

Trial Hole	Depth to Water (m bgl)						Base of Well (m bgl)
	16/12/19	31/12/19	18/01/20	27/01/20	02/03/20	19/03/20	
WS1	1.13	1.12	1.13	1.16	1.02	1.10	4.00
WS2	1.21	1.31	1.30	1.35	1.30	1.35	4.00
WS3	1.51	1.54	1.55	1.57	1.54	1.55	4.00
WS101	Well installed		0.31	0.42	0.00	0.05	3.30
WS102	06/01/2020		0.42	0.50	0.42	0.57	1.90

Note: 0.00 – water level recorded at surface

Chemical Analysis Summary

Samples were selected for contamination testing as instructed by the client.

Table 2 outlines the specification for each sample tested.

Table 2. Chemical Analysis Specification

Substance	Locations: Depths (m bgl)					
	HDP1:0.50 ^S	HDP2:0.50 ^S	HDP3:0.50 ^S	HDP4:0.50 ^S	WS101:0.20 ^S	WS102:0.50 ^S
Asbestos Screen					✓	✓
Total Phenols					✓	✓
Organic Matter					✓	✓
pH					✓	✓
Metals	✓	✓	✓	✓	✓	✓
Metalloids	✓	✓	✓	✓	✓	✓
Organics					✓	✓

Notes: **Metals:** Cd, Cr, Pb, Hg, Ni, Se, Cu, Zn, Bo, V. **metalloids:** As. **organics:** USEPA 16 speciated PAH, TPH Texas, **Asbestos screening** was undertaken in accordance with HSG 248. ^S = Soil sample.

The results from the chemical analysis are presented in Appendix B.

The following attachments make up the remainder of this letter report.

Figure 1. Trial Hole Location Plan

Appendix A. Field Logs

Appendix B. Chemical Laboratory Results

Should you have any queries, please do not hesitate to contact the undersigned.

Yours sincerely

A handwritten signature in black ink, appearing to read 'TRudkin', with a long horizontal stroke extending to the right.

Tim Rudkin BSc. (Hons.), MSc., FGS.

Geo-Environmental Engineer

tr@soilslimited.co.uk

For and on behalf of Soils Limited.

Enc.



Figure number

1

Title

Trial Hole Location Plan

Project

The Burrows

Date

February 2020

Client

Waltham Contraction Ltd.

Reference

I8075/FLR

Appendix A – Field Logs

				Contract Name: The Burrows				Client: Walthams Limited				Hole ID: WS101										
				Contract Number: 18075		Start and End Date: 06-01-20		Logged By: DW		Checked By:		Status:		Hole Type: WS								
				Easting:		Northing:		Ground Level:		Plant Used: Premier compact 110		Print Date: 08-01-2020		Scale: 1:50								
Weather:				Termination: Hole collapse						Sheet 1 of 1												
Samples & In Situ Testing					Strata Details										Groundwater							
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description							Water Strike	Backfill/Installation								
0.20	ES			0.20		From driller's logs: Soft dark brown slightly sandy, slightly gravelly SILT. Gravel is angular to rounded fine to medium flint and brick. Frequent roots and rootlets. Occasional slate pieces. MADE GROUND.							1									
0.50	B ES			(0.40) 0.60												From driller's logs: Soft brown slightly gravelly slightly sandy silty CLAY. Gravel is angular flint, brick, and concrete. Frequent roots and rootlets. MADE GROUND.						
				(0.40)																		
1.00	ES			1.00		Firm dark brown mottled, greyish brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to sub-angular, fine to coarse flint, brick, clinker, chalk and concrete. Occasional black staining. MADE GROUND.																
1.10	D			(0.30)																		
1.35	ES D ES			1.30		Firm, purplish brown and grey mottled, greyish brown to light greyish brown with depth, slightly silty, slightly sandy CLAY. Sand is fine. Occasional rootlets. Occasional black staining from 1.3 - 1.45m bgl.							2									
				(0.45)																		
1.80	D			1.75		Soft, grey and yellowish brown mottled, slightly silty, slightly sandy CLAY. Sand is fine. Occasional rootlets.																
				(0.35)																		
				2.10		Very soft, slightly black mottled, grey, slightly silty, slightly sandy CLAY. Sand is fine. Occasional rootlets and decomposing woody roots.																
				(0.60)																		
2.50	D			2.70		Grey, slightly silty, sandy GRAVEL. Gravel is angular to well-rounded, fine to coarse flint.							3									
2.80	D			(0.50)																		
				3.20		Very soft, black stained dark grey, slightly sandy, slightly gravelly, silty CLAY. Gravel is angular to well rounded, fine to medium flint. Occasional decomposing wood fragments.																
				(0.50)																		
3.60	D			3.70		Stiff, dark grey mottled, grey, slightly silty CLAY. Occasional fine sand sized selenite crystals visible.																
3.80	D			(0.30)																		
				4.00		End of Borehole at 4.00m							4									
													5									
													6									
													7									
													8									
													9									
													10									
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:													
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 2.7m bgl.													
Chiselling					Installation				Water Strikes													
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks								
					0.00	1.00	PLAIN	19	1.00			30	0.00									
					1.00	3.30	SLOTTED	19														
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.																						

				Contract Name: The Burrows				Client: Walthams Limited				Hole ID: WS102				
				Contract Number: 18075		Start and End Date: 06-01-20		Logged By: DW		Checked By:		Status:		Hole Type: WS		
				Easting:		Northing:		Ground Level:		Plant Used: Premier compact 111		Print Date: 08-01-2020		Scale: 1:50		
Weather:				Termination: Hole collapse						Sheet 1 of 1						
Samples & In Situ Testing					Strata Details										Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation			
0.20	ES			(0.30)		From driller's logs: Soft dark brown slightly sandy, slightly gravelly SILT. Gravel is angular to rounded, fine to medium flint and brick. Frequent roots and rootlets. Occasional slate pieces. MADE GROUND.										
0.50	B ES			0.30								From driller's logs: Soft brown slightly gravelly slightly sandy silty CLAY. Gravel is flint brick and concrete. Frequent roots and rootlets. MADE GROUND.				
1.00	ES			(0.70)		From driller's logs: Very soft, light grey gravelly CLAY. Gravel is fine to coarse flint. Rare rootlets.						1				
1.20 - 1.50	D			1.00								Very soft dark grey and dark brown mottled, slightly sandy, silty GRAVEL. Gravel is angular to sub-angular, fine to coarse flint. Frequent rootlets.				
1.60	D			1.20		White to light brown with depth, slightly sandy, silty GRAVEL. Gravel is angular to well rounded, fine to coarse flint and chalk. Silt is carbonate rich/chalky. Occasional fine orange staining in silt. Rare rootlets. Clay band at base of stratum grading into subsequent stratum.										
1.90	D			(0.30)								Firm dark grey mottled, grey, slightly silty CLAY. Decomposing woody root 1.5cm diameter at 2.6m bgl. Top 5 cm light grey, grading from previous stratum.				
2.20	D			1.50		End of Borehole at 2.80m										
2.40	D			(0.80)												
2.90	D			2.30												
				(0.50)												
				2.80												
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:							
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Rootlets observed to 1.7m bgl.							
Chiselling					Installation				Water Strikes							
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks		
					0.00	1.00	PLAIN	19	1.10			30	0.00			
					1.00	1.90	SLOTTED	19								
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.																

Appendix C



STAGE 6-25-6.40 m AOD

STORAGE GAIN

$$\begin{aligned}
 +100 \text{ mm} & \times 245 \text{ m}^2 = +24.5 \text{ m}^3 \\
 +125 \text{ mm} & \times 289 \text{ m}^2 = +2.9 \text{ m}^3 \\
 +125 \text{ mm} & \times 49 = +6.1 \\
 +125 \text{ mm} & \times 37 = +4.6 \\
 +250 \text{ mm} & \times 195 = +48.7 \\
 +250 \text{ mm} & \times 88 = +22.0
 \end{aligned}$$

STORAGE LOSS

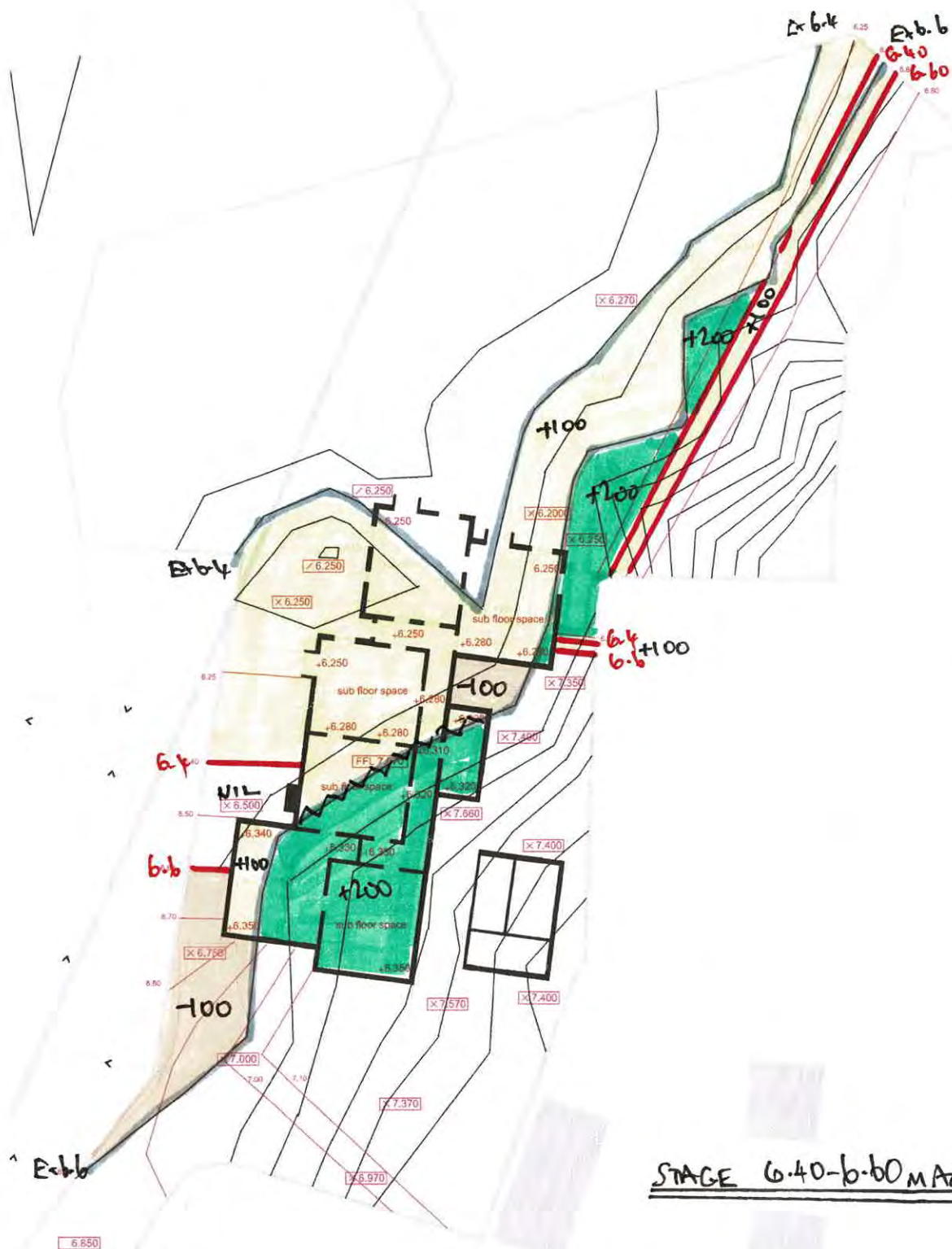
$$-250 \text{ mm} \times 10\% \text{ water footprint} = 59.3 \text{ m}^2 = -1.5 \text{ m}^3$$

STAGE IMPACT

$$+112.3 \text{ m}^3$$

CUMULATIVE FROM 6.25 m AOD

$$+112.3 \text{ m}^3$$



STAGE 6.40-b.b.0 m AOD

STORAGE GAIN

$$\begin{aligned}
 +200 \times 18 \text{ m}^2 &= +3.6 \text{ m}^3 \\
 +200 \times 53 &= +10.6 \\
 +200 \times 112 &= +22.4 \\
 +100 \times 15 &= +1.5 \\
 +100 \times 442 &= +44.2
 \end{aligned}$$

STORAGE LOSS

$$\begin{aligned}
 -200 \text{ mm} \times 50\% \times 59.3 &= -5.9 \text{ m}^3 \\
 -100 &\times 18 &= -1.8 \\
 -100 &\times 74 &= -7.4
 \end{aligned}$$

STAGE IMPACT

$$+67.2 \text{ m}^3$$

CUMULATIVE FROM 6.25 m AOD

$$+179.9 \text{ m}^3$$



STAGE 7.0-7.1m ADD

STORAGE LAID
N/A.

STAGE IMPACT
-31.7m³.

CUMULATIVE IMPACT FROM 6.25m ADD
+62.6m³.

STORAGE LAID
 $-100 \times 100\% \times 59.3 = -5.9m^3.$
 $-50 \times 93m^2 = -4.7$
 $-50 \times 35 = -1.7$
 $-100 \times 194 = -19.4.$

Calculated by:	Andy Traves
Site name:	West Street
Site location:	Havant

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	50.85370° N
Longitude:	0.99376° W
Reference:	2520726619
Date:	Oct 16 2019 11:16

Runoff estimation approach

IH124

Site characteristics

Total site area (ha):	0.2875
-----------------------	--------

Methodology

Q _{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	731	731
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is $Q_{\text{BAR}} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $\text{SPR/SPRHOST} \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q _{BAR} (l/s):	1.46	1.46
1 in 1 year (l/s):	1.24	1.24
1 in 30 years (l/s):	3.36	3.36
1 in 100 year (l/s):	4.66	4.66
1 in 200 years (l/s):	5.46	5.46

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Project No.: 1828
Project Title: 187A West Street

Rectangular Detention Tank Assessment to CIRIA C753

No infiltration

Site Location: Havant
r = 0.36 (range 0.12 to 0.45)
Drained Area = 920 m²
Design storm 1 in = 100 year
Runoff volume uplift = 40 % for climate change
10 % for urban creep

Catchment ID: gross impermeable
C_v = 1.00

Technical Assessment

Base axis Length L_x = 5.00 m
Base axis Length L_y = 80.00 m
Discharge rate = 2.0 l/s
Tank depth = 0.40 m
tank porosity = 35 %

Base area = 400.0 m²

Tank volume = 56.0 m³
Design volume = 56.0 m³
M5-60 Rainfall = 20 mm

Storm Duration	5 min	10 min	15 min	30 min	1 hr	2 hr	4 hr	6 hr	10 hr	24 hr
(secs)	300	600	900	1800	3600	7200	14400	21600	36000	86400
r= 0.36 Value Z1	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.90	2.42
Rainfall M5 (mm)	7.2	10.2	12.4	15.8	20.0	24.4	29.6	33.4	38.0	48.4
M100/M5 gf Value Z2	1.84	1.91	1.95	2.00	2.03	2.01	1.97	1.94	1.91	1.82
Rainfall M100 (mm)	13.3	19.5	24.2	31.5	40.6	49.1	58.4	64.9	72.4	88.2
With climate uplift (mm)	18.6	27.3	33.8	44.2	56.8	68.7	81.8	90.8	101.4	123.5
With urban creep (mm)	20.4	30.1	37.2	48.6	62.5	75.6	89.9	99.9	111.5	135.9
RUNOFF (m³)	18.8	27.6	34.2	44.7	57.5	69.6	82.8	91.9	102.6	125.0
inflow rate (l/s)	62.7	46.1	38.0	24.8	16.0	9.7	5.7	4.3	2.9	1.4
storage rate (l/s)	60.7	44.1	36.0	22.8	14.0	7.7	3.7	2.3	0.9	0.0
Discharge (m³)	0.6	1.2	1.8	3.6	7.2	14.4	28.8	43.2	72.0	125.0
Req'd STORAGE (m³)	18.2	26.4	32.4	41.1	50.3	55.2	54.0	48.7	30.6	0.0
Residual drain time (h)	2.5	3.7	4.5	5.7	7.0	7.7	7.5	6.8	4.3	0.0

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site characteristics

Total site area (ha):

Significant public open space (ha):

Area positively drained (ha):

Impermeable area (ha):

Percentage of drained area that is impermeable (%):

Impervious area drained via infiltration (ha):

Return period for infiltration system design (year):

Impervious area drained to rainwater harvesting (ha):

Return period for rainwater harvesting system (year):

Compliance factor for rainwater harvesting system (%):

Net site area for storage volume design (ha):

Net impermeable area for storage volume design (ha):

Pervious area contribution to runoff (%):

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:

Urban creep allowance factor:

Volume control approach:

Interception rainfall depth (mm):

Minimum flow rate (l/s):

Methodology

esti

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	91.63
FEH / FSR conversion factor:	1.19	1.19
SAAR (mm):	731	731
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	1.45	1.45
Q_{BAR} for net site area (l/s):	0.93	0.93

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	2	2
1 in 30 years (l/s):	2	2
1 in 100 year (l/s):	2	2

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m³):	54	54
Long term storage 1/100 years (m³):	0	0
Total storage 1/100 years (m³):	54	54

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at <http://uksuds.com/terms-and-conditions.htm>. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

Date: 15/12/2019

Site Ref

178A West Street

SuDS Water Quality Management CIRIA C753 Ch26

Simple Index Approach

Catchment

roof

Is discharge to: SPZ1? ☐ N Drinking Water Protection Area? ☐ N

Is site in close proximity to an area with sensitive environmental designation?

☐ N

if so how close?

m

Is an additional treatment component required due to sensitivity?

☐ Y

Land Use

roofs-non-residential

Hazard

low

TSS index	Metals index	HydroCar index
0.3	0.2	0.05

Treatments

To surface water discharge ☐ Y

Component

1 Permeable pavement

2 N/A

3 N/A

mitigation index

X1 N/A

Enhanced mitigation index

Residual pollution index

TSS MIndex	Metals MIndex	HydroCa MIndex	factor
0.7	0.6	0.7	1.00
0	0	0	0.50
0	0	0	0.50
0.7	0.6	0.7	
0	0	0	1.00
0.7	0.6	0.7	
0	0	0	

Land Use

roofs-non-residential

Hazard

low

TSS index	Metals index	HydroCar index	residual
0	0	0	

Treatments

To groundwater discharge ☐ N

Infiltration surface

1 N/A

2 N/A

Final residual pollution index

TSS MIndex	Metals MIndex	HydroCa MIndex	factor
0	0	0	1.00
0	0	0	0.50
0	0	0	

Is a groundwater risk screening required?

☐ N

Notes:

SPZ1 applies to infiltration to the Chalk bedrock at depth below the site. This is separated from the surface by an intermediate stratum of clay which is an aquaclude so SPZ1 will not be impacted.

Date: 15/12/2019

Site Ref 178A West Street

SuDS Water Quality Management CIRIA C753 Ch26

Simple Index Approach

Catchment

car park

Is discharge to: SPZ1? **N** Drinking Water Protection Area ?

N

Is site in close proximity to an area with sensitive environmental designation?

N

if so how close?

m

Is an additional treatment component required due to sensitivity?

Y

Land Use

car parks-residential

Hazard

low

TSS index	Metals index	HydroCar index
0.5	0.4	0.4

Treatments

To surface water discharge **Y**

Component

1 Permeable pavement

2 N/A

3 N/A

mitigation index

X1 N/A

Enhanced mitigation index

Residual pollution index

TSS MIndex	Metals MIndex	HydroCa MIndex	factor
0.7	0.6	0.7	1.00
0	0	0	0.50
0	0	0	0.50
0.7	0.6	0.7	
0	0	0	1.00
0.7	0.6	0.7	
0	0	0	

Land Use

car parks-residential

Hazard

low

TSS index	Metals index	HydroCar index	residual
0	0	0	

Treatments

To groundwater discharge **N**

Infiltration surface

1 N/A

2 N/A

Final residual pollution index

TSS MIndex	Metals MIndex	HydroCa MIndex	factor
0	0	0	1.00
0	0	0	0.50
0	0	0	

Is a groundwater risk screening required?

N

Notes:

SPZ1 applies to infiltration to the Chalk bedrock at depth below the site. This is separated from the surface by an intermediate stratum of clay which is an aquaclude so SPZ1 will not be impacted.

SUDS operation and maintenance - general

There are three categories on maintenance activities:

Regular maintenance consists of basic tasks done on a frequent and predictable schedule, including vegetation management, litter and debris removal, and inspections.

Occasional maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (sediment removal is an example). The table below summarises the likely maintenance activities required for each SUDS component and specific maintenance activities is given in the following sections.

Remedial maintenance comprises intermittent tasks that may be required to rectify faults associated with the system. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and as such timings are difficult to predict. Remedial maintenance items can comprise items such as:

- inlet/outlet repairs
- erosion repairs
- reinstatement or realignment of edgings, barriers, rip-rap or other erosion control
- infiltration surface rehabilitation
- replacement of blocked filter fabrics
- construction stage sediment removal (although this activity should have been undertaken before the maintenance contract)
- system rehabilitation immediately following a pollution event.

O&M activity	SUDS component												
	Pond	Wetland	Detention basin	Infiltration basin	Soakaway	Infiltration trench	Filter trench	Modular storage	Pervious pavements	Swale/bioretention/greenroofs	Filter strip	Sand filter	Pre-treatment systems
Regular maintenance													
Inspection	■	■	■	■	■	■	■	■	■	■	■	■	■
Litter/debris removal	■	■	■	■	□	■	■	□	■	■	■	■	■
Grass cutting	■	■	■	■	□	■	■	□	□	■	■	□	□
Wee/invasive plant control	□	□	□	□		□	□		□	□	□	□	□
Shrub management	□	□	□	□					□	□	□		□
Shoreline vegetation management	■	■	□										□
Aquatic vegetation management	■	■	□										□
Occasional maintenance													
Sediment management *	■	■	■	■	■	■	■	■	■	■	■	■	■
Vegetation/plant replacement	□	□	□	□						□	□		□
Vacuum sweeping and brushing									■				
Remedial maintenance													
Structure rehabilitation/repair	□	□	□	□	□	□	□	□	□	□	□	□	□
Infiltration surface reconditioning				□	□	□	□		□	□	□	□	

■ will be required

□ may be required

* sediment to be collected upstream of the main device

GENERAL MAINTENANCE

Litter/debris removal

This is an integral part of SUDS maintenance and reduces the risks of inlet and outlet blockages, retains amenity value and minimises pollution risks. High litter removal frequencies may be required at high profile commercial/retail parks where aesthetics are a major driver.

Grass cutting

It is recommended that grass cutting be minimised around SUDS facilities, apart from swales and filter strips and structural embankments where a height of 100–150 mm is recommended to prevent the plants falling over, or “lodging”, when water flows across the surface. In general, allowing grass to grow tends to enhance water quality performance. Short grass around a wet system such as pond or wetland provides an ideal habitat for nuisance species such as geese; allowing the grass to grow is an effective means of discouraging them. Grass around wet pond or wetland systems should not be cut to the edge of the permanent water. Grass cutting is an activity undertaken primarily to enhance the perceived aesthetics of the facility. The frequency of cutting will tend to depend on surrounding land uses, and public requirements. Therefore, grass cutting should be done as infrequently as possible, recognising the aesthetic concerns of local residents. However, grass around inlet and outlet infrastructure should be trimmed closely to reduce risks to system performance. If a manicured, parkland effect is required, then cutting will need to be undertaken more regularly than for meadow type grass areas, which aim to maximise habitat and biodiversity potential.

Weed/invasive plant control

Weeds are generally defined as vegetation types that are unwanted in a particular area. For SUDS, weeds are often alien or invasive species, which do not enhance the technical performance or aesthetic value of the system, or non-native species and the spread of which is undesirable. In some places, weeding has to be done by hand to prevent the destruction of surrounding vegetation (hand weeding should generally be required only during the first year, ie during plant establishment). However, over grassed surfaces, mowing can be an effective management measure. The use of herbicides and pesticides should be prohibited since they cause water quality deterioration. The use of fertilisers should also be limited or prohibited to minimise nutrient loadings which are damaging to water bodies.

Shrub management

Shrubs tend to be densely planted and are likely to require weeding at the base, especially during the first year to ensure that they get enough water. Shrubs should be selected so they can grow to their maximum natural height without pruning.

Aquatic/shoreline vegetation management

Aquatic plant aftercare in the first 1–3 years may be required to ensure establishment of planted vegetation and control nuisance weeds/invasive plants. Once established, the build-up of dead vegetation from previous seasons should be removed at convenient intervals to reduce organic silt accumulation (eg every three years and at the end of landscape contract periods).

Emergent vegetation may need to be harvested every 5–10 years to maintain flood attenuation volumes, optimise water quality treatment potential and ensure fresh growth, although this is often not required. Care should be taken to avoid nesting birds during the breeding season and to avoid great crested newt and water vole habitats. The typical window for this activity is towards the end of the growing season (September and October). As vegetation matures, plant height may also become a safety issue in residential areas.

Where emergent vegetation is managed, up to 25 per cent can be removed by cutting at 100 mm above soil level using shearing action machinery. Up to 25 per cent of submerged vegetation can be cut and raked out at any one time, using approved rakes, grabs or other techniques, depending on whether clay or waterproof membranes are present. Aquatic vegetation arisings should be stacked close to the water's edge for 48 hours to de-water and allow wildlife to return to the SUDS feature. They should then be removed to wildlife piles, compost heaps or off site before decomposition, rotting or damage to existing vegetation can occur.

Algae removal may be undertaken for aesthetic purposes during the first 3–5 years of a pond/wetland's life. The growth of algae, which is considered by some to be visually intrusive, is encouraged by nutrients introduced into the water body. This situation should settle down once upstream construction activities are complete.

Management of green waste

Appropriate methods should be implemented to dispose of green waste, including

- The development of wildlife piles
- On- or off-site composting
- Disposal to landfill

REMEDIAL MAINTENANCE

Structure rehabilitation/repair

There will come a time with most SUDS techniques when a major overhaul of the system is required to remove clogged filters, geotextiles, gravel etc. This will typically be between 10 and 25 years, depending on the technique and factors such as the type of catchment and sediment load. For example the use of geotextiles close to the surface in pervious surfaces traps the majority of sediment in a relatively easily accessible location. Reconstruction of the surface layer and bedding layer is all that is required, rather than reconstruction of the whole pavement depth.

Major overhaul is most likely to be required on techniques that rely on filtration through soils or aggregates, such as sand filters and infiltration devices. Other SUDS techniques are unlikely to need major overhaul if routine maintenance is undertaken as required (for example ponds and wetlands).

Rehabilitation activities for each SUDS component are described on the following tables.

Infiltration surface rehabilitation

In the event that grassed surface permeability has reduced, there are a number of landscape techniques that can be used to open the surface to encourage infiltration. Such activities are not commonplace and are likely to be required only in circumstances where silt has not been effectively managed upstream.

1. Scarifying to remove “thatch”. Thatch is a tightly intermingled organic layer of dead and living shoots, stems and roots, developing between the zone of green vegetation and the soil surface. Scarifying with tractor-drawn or self-propelled equipment to a depth of at least 50 mm breaks up silt deposits, removes dead grass and other organic matter and relieves compaction of the soil surface.
2. Spiking or tining the soil, using aerating equipment to encourage water percolation. This is particularly effective if followed by top dressing with a medium to fine sand, and is best undertaken when the soil is moist. Spiking or tining with tractor drawn or self-propelled equipment penetrates and perforates soil layers to a depth of at least 100 mm (at 100 mm centres) and allows the entry of air, water, nutrients and top dressing materials.
3. As a last resort, it may be necessary to remove and replace the grass and topsoil by:
 - removing accumulated silt and (subject to a toxicity test) applying to land or dispose of to landfill
 - removing damaged turf which should be composted
 - cultivating remaining topsoil to required levels
 - re turfing (using turf of a quality and appearance to match existing) or reseeded (to BS 7370: Part 3, Clause 12.6 (BSI, 1991) using seed to match existing turf) area to required levels. It may be necessary to supply and fix fully biodegradable coir blanket to protect seeded soil. Turf and seeded areas should be top dressed with fine sieved topsoil to BS 3882 (BSI, 1994) to achieve final design levels. Watering will be required to promote successful germination and/or establishment.

Water butts operation and maintenance

Maintenance schedule	Required action	Frequency
Regular maintenance	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris..	Annually (or following poor performance).
Occasional maintenance	Replacement of any filters.	As required
Remedial actions	Repair of erosion damage, or damage to tank.	As required
Monitoring	Inspection of the tank for debris and sediment build up.	Annually (or following poor performance).
	Inspection of inlets, outlets and withdrawal devices.	Annually (or following poor performance).
	Inspection of areas receiving overflow, for evidence of erosion.	After extreme storms.
	Inspection of roof drain filters	Annually (or following poor performance).

Pervious pavement operation and maintenance

Maintenance schedule	Required action	Frequency
Regular maintenance	Brushing and vacuuming.	Three times/year at end of winter, mid-summer, after autumn leaf fall, or as required based on site-specific observations of clogging or manufacturers' recommendations.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required
	Removal of weed.	As required
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.	As required
	Rehabilitation of surface and upper sub-structure.	As required (if infiltration performance is reduced as a result of significant clogging).
Monitoring	Initial inspection.	Monthly for 3 months after installation.
	Inspect for evidence of poor operation and/or weed growth. If required take remedial action.	3-monthly, 48 h after large storms.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually
	Monitor inspection chambers.	Annually

Modular systems operation and maintenance

Maintenance schedule	Required action	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
	Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly (and after large storms)
	Remove sediment from pre-treatment structures	Annually, or as required
Occasional maintenance	-	-
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

Appendix D

CONDITIONS AND LIMITATIONS OF FLOOD RISK ASSESSMENT & DRAINAGE STRATEGIES

October 2020

Aqua Callidus Consulting Ltd is constituted as a limited liability company in accordance with the Companies Act 1989 (with registered number 11390910 and with its registered office at Kintyre House, 70 High Street, Fareham, Hants, PO16 7BB).



1. The report is confidential to the clients stated in the report and has been prepared to their instructions for their own purposes and it is not permitted to disclose this report to other parties (except NHBC, Local Authority, the Client's own Solicitors and Professional Advisers) without the prior consent of Aqua Callidus Consulting Ltd.
2. This report has been prepared by Aqua Callidus Consulting Ltd, with all reasonable skill, care and diligence within the terms of contract with the Client incorporated in our Standard Terms of Business.
3. The copyright of this report remains the property of Aqua Callidus Consulting Ltd.
4. Aqua Callidus Consulting Ltd disclaims any responsibility to the Client and others in the respect of any matters outside the scope of this report.
5. No liability for the contents of this report is accepted to any parties other than the client stated in the report.
6. Where reference is made to third party information (for example topographic surveys, sewer plans, Environment Agency information, geotechnical investigations and reports, and proposed development layouts and drawings etc) the responsibility for the rights to use this information rests with the client where such information has been provided to us by the client or on behalf of the client by parties acting as their agent. No liability is accepted for the accuracy of third party information.
7. Unless stated otherwise reports are prepared as a desktop assessment and no site visit has been made.
8. Unless specifically stated otherwise in the report, any proposed strategies are in principle and sizings are illustrative only and are to be confirmed or modified as a appropriate at detailed design stage.