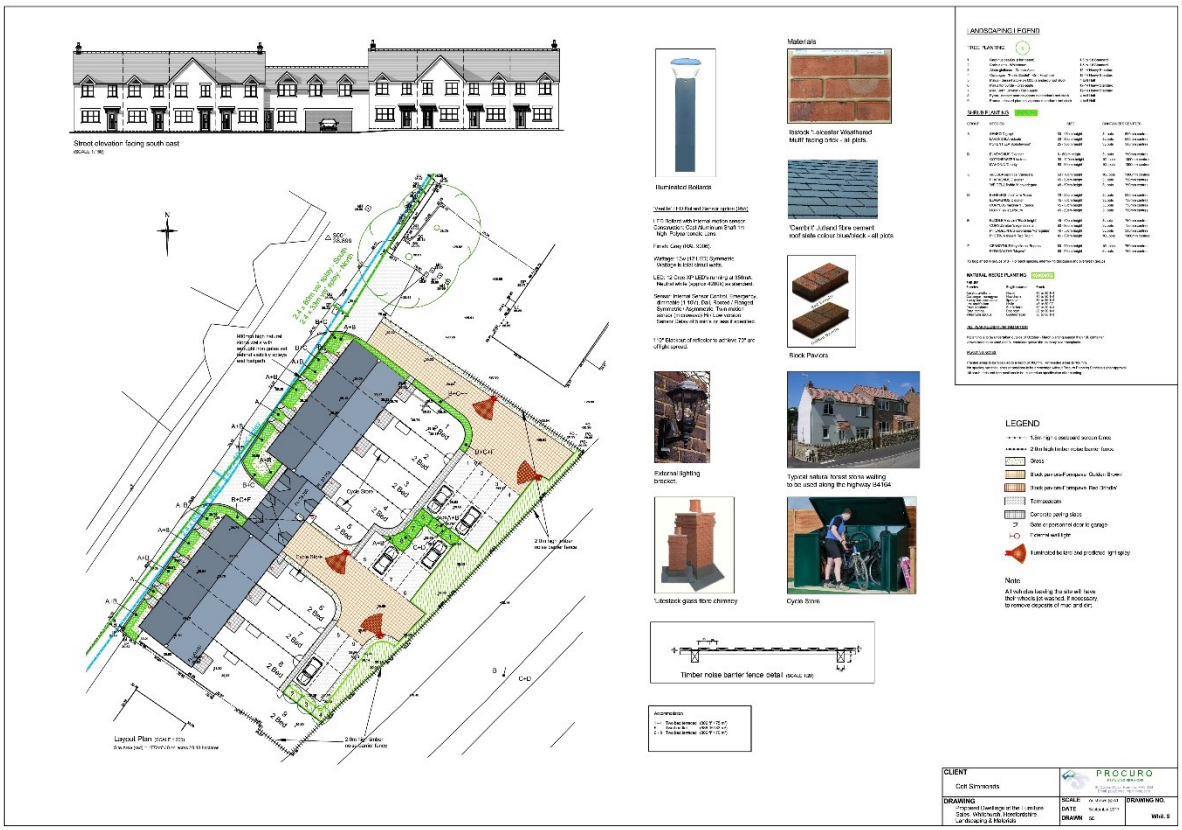
3. Proposed Development

The proposed development site comprises 9 dwellings including the provision of associated site infrastructures including private car parks, concrete paving slabs and access road (Figure 10). The porous block paving of the internal driveway is not included.

A breakdown of the impermeable areas associated with the proposed development site area is shown in Table 4.

Figure 10 Proposed redevelopment site plan



Source: Procuro Planning Services_Proposed Dwellings at Whitchurch (SD, date: Sep 17)

Table 4 Impermeable Surfaces on Site

No	Area Description	Area (m²)	Total Impermeable Area (m²)
8	Two bed terraced dwelling	600	**1,030**
1	Two bed flat	83	
	Concrete paving slabs	90	
	Access road	50	
	Car parks	207	

4. Surface Water Drainage Strategy

4.1 Overview

The proposed development is currently situated on land that is completely developed (i.e. Brownfield). Existing rates are described in Section 2.6 and summarised in Table 3. The proposed development would not increase the area of impermeable surface at the site, however, measures to mitigate rates of runoff from the site are required and avoid increase flood risk elsewhere.

As described in section 2.5 and Appendix B, infiltration tests were undertaken on the site in October 2017 in accordance with BRE365 standard, with observed infiltration rates ranging between 0.0173 m/h and 0.00313 m/h. Therefore, a surface water drainage system that involves infiltration and attenuation procedures will be used for the proposed redevelopment site.

An attenuation / infiltration storage tank design was undertaken using the *Micro Drainage (WinDES)* software. The design assessed would infiltrate and attenuate all runoff with suitable outflow controls. Accordingly, the actual runoff rates from the site as a whole are likely to be no greater than, and possibly lower than, the existing runoff rates.

4.2 Outline Surface Water Drainage Strategy

The recommended surface water drainage strategy has been prepared to intercept, attenuate and infiltrate all runoff generated by the proposed development for rainfall events with Annual Exceedance Probability up to 1.0%, with allowance for climate change. The design ensures that the proposed development would not increase flood risk elsewhere.

NPPF requires a consideration of the impacts of climate change on the flood risk for any proposed development. For this development, it is appropriate to use a climate change increase of 40% for peak rainfall intensities to ensure that the development is fully protected from flood risk over its up to 100-year lifespan (Table 5).

Table 5 Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Source: Environment Agency (2016)

Micro Drainage was used to calculate the dimensions and characteristics of the underground storage tank plus flow control, which are presented in the Source Control outputs (Appendix E). The storage tank will be located beneath the permeable paving internal driveway in two sections. The first storage tank will be located between dwellings 5 and 6, while the second storage tank will be located to the east of dwelling 1. Car parks surface water runoff will be collected into the storage tank via gullies. Whilst surface water runoff from the remainder impermeable areas (e.g. roofs) will be collect via rainwater pipes.

The underground storage tank has been designed in order to infiltrate and attenuate the surface water runoff from the site. A total surface area of 198 m² and a depth of 0.35 m (i.e. 1/2 Stormbloc depth) have been used to design the storage tank. For the purposes of

modelling, Hydro-International's Stormbloc (800 mm x 800 mm x 350 mm deep) has been used to dimension the storage tank (Appendix C).

In relation to infiltration, a conservative value of 0.00313 m/h was adopted, corresponding to the lowest value determined by the percolation test described in Section 2.5. It has been assumed that infiltration will occur through both the sides and base of the Storage Tank.

The total impermeable area of 1,030 m² (Table 4) has been rounded to 1,228 m^2 (0.123 ha), in order to cover the top surface area of the storage tanks.

MicroDrainage modelling (Appendix E) showed that storage tank will reach a maximum water level of 0.333 m with an outflow of 2.4 l/s associated with the critical storm duration of 240 min Winter storm (1:100 year+40%CC rainfall event). The maximum volume will be 62.7 m³. The storage tank will have a freeboard of approx. 17 mm as a safety margin providing 3.37 m³ of storage.

The design utilises a Hydro-Brake vortex flow control, by Hydro International, that is a very robust low maintenance solution as it has no moving parts, nor does it require power – operating solely due to the flow of water through the unit. This flow control is accepted by a number of the UK Water Companies, the Environment Agency and many lead local flood authorities (LLFA) for its accuracy of flow control and low maintenance requirements. To achieve the required outflow rates the unit selected has a 75 mm orifice size, but as it located downstream of the storage tanks plus will be located within a chamber with a sump, this dimension is not likely to give rise to any undue maintenance burden.

In accordance with Herefordshire Council Planning Condition 7 (Planning Permission Ref: 170198), no surface water and/or land drainage shall be allowed to connect directly or indirectly with the public sewerage network. Therefore, outfall from the storage tank will discharge into Whitchurch Brook at the northern part of the site.

Runoff from the site has been limited to below the existing runoff rates for all return periods up to the 100-year design rainstorm, plus 40% climate change (Table 6).

Table 6 Outline Geo-cellular Storage Tank Design

Year event	*Impermeable Area to be managed (ha)*	*Max depth (m)*	*Storage Tank Runoff Rates (l/s)*	*Existing Runoff Rates (l/s)*	*Improvement on existing site Runoff Rates (l/s)*
1:2	*0.103*	*0.121*	*1.8*	*1.8*	*0*
1:30		*0.249*	*2.1*	*3.4*	*1.3*
1:100		*0.333*	*2.4*	*4.3*	*1.9*

The Surface Water Drainage Strategy is illustrated in Appendix A.

4.3 Surface Water Runoff Treatment

Due to the nature of land use within the development site, especially in relation to residential car parks, it is a requirement to provide adequate treatment of surface water runoff before entering the underground storage tanks.

Hydro Biofilter™ bioretention system (Figure 11 and Appendix D) captures surface water runoff, even during high flows, and naturally treats an assortment of coarse, fine and dissolved pollutants. It significantly improves upon traditional bioretention and biofilter designs by

combining specialist engineered media with shrubs or trees to provide enhanced bioretention and biofiltration in a kerbside device.

Figure 11 Hydro Biofilter™ bioretention system

Source: Hydro-International

This biofiltration system deals with targeted pollutants such as; very fine particles, trash and floatables, dissolved, liquid and sediment bound hydrocarbons, sediment bound heavy metals, sediment bound nutrients and dissolved pollutants.

The mainly applications of this biofiltration system are SuDS and green infrastructure developments, pollutants hotspots such as maintenance yards, car parks, petrol stations, streets, roads, airports and transportation hubs, new construction or redevelopment of commercial and residential sites, as well as areas requiring removal of coarse, fine or dissolved metals, oils, and nutrients.

According to CIRIA C753 'The SuDS Manual (Chapter 26), to deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for each contaminant type). Pollution hazard indices are represented in Table 7, where values of 0.5 for TSS and 0.4 for both metals and hydrocarbons, are related for residential car parks.

Table 7 Pollution hazard indices for different land use classifications.

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

Notes

1 Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009).

2 These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help determine the most appropriate approach to the development of a design solution.

Where a site land use falls outside the defined categories, the indices should be adapted (and agreed with the drainage approving body) or else the more detailed risk assessment method should be adopted.

Where nutrient or bacteria and pathogen removal is important for a particular receiving water, equivalent indices should be developed for these pollutants (if acceptable to the drainage approving body) or the risk assessment method adopted.

Source: CIRIA C753 The SuDS Manual

Hydro Biofilter™ bioretention system provides a pollution mitigation index (Table 8) of 0.8. To ensure a sensible arrangement of the storage and treatment devices the design utilises two Hydro Biofilters™ of 1.2 m by 1.2 m, which can each treat between 480 and 720m^2 of paved area. These will be located at low points within the paved areas, so that the runoff enters the units before passing to the storage.

Table 8 Hydro Biofilter™ pollution mitigation indices

TSS Mitigation Index	**Metals** Mitigation Index	**Liquid Hydrocarbons** Mitigation Index
0.8	**0.8**	**0.8**

Source: Hydro-International

4.4 Residual Risks

Residual risks include the possibility of a rainstorm of magnitude greater than the 1:100 year+CC event used in this report. Under these circumstances, additional reassurance is provided by the 17 mm freeboard within the storage tank.

It is recommended that a maintenance program should be adopted with regular inspections to ensure that the orifice of the Hydro-Brake vortex flow control remains clear of possible blockage and remove debris and sediments from the catchment surface.

5. Foul Drainage

Foul flows from the properties will be collected by dedicated and separate foul sewers. The sewers will be connected into public foul sewers off site.

6. Water Efficiency Measures

Planning Condition 18 requires that certification is provided to demonstrate that the site has achieved certain water efficiency measures. To assist in achieving these efficiency targets low water usage fittings should be utilised throughout the development.

7. Operation & Maintenance of Surface Water Systems

The responsibility for maintaining any surface water features would be with the property owners and occupiers. Alternatively, a management company could be employed.

Table 9 – Typical SuDS Operation & Maintenance Activities (Source: *SuDS Manual*)

Operation & Maintenance Activity	Storage Tank
Regular Maintenance	
Inspection	●
Litter and debris removal	○
Grass cutting	○
Occasional Maintenance	
Sediment management	●
Remedial Maintenance	
Structure rehabilitation / repair	○

Key: ● will be required ○ may be required

8. Conclusion

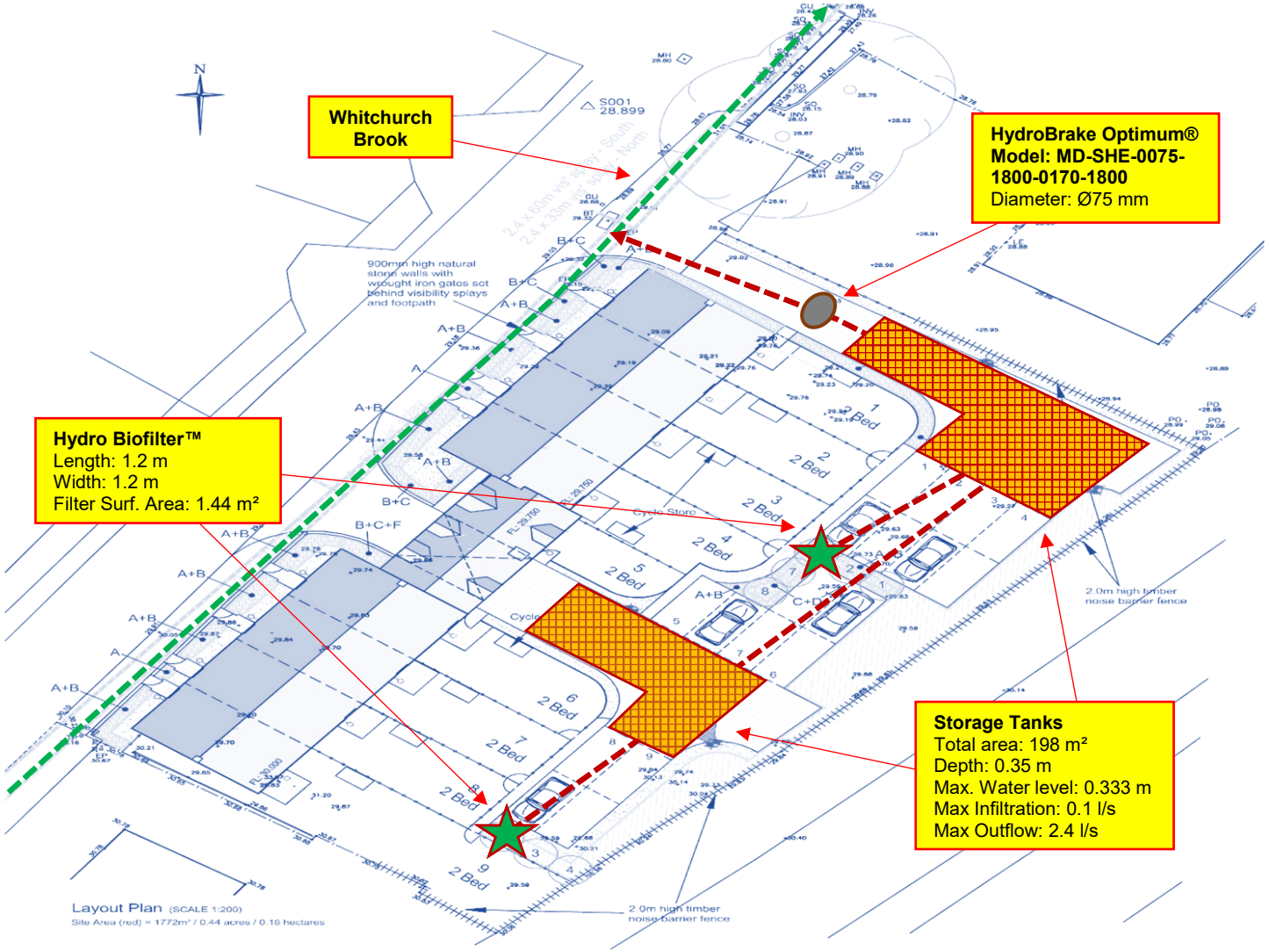
This Surface Water and Foul Water Management Plan assessment has determined that:

- The proposed development site comprises 9 dwellings including the provision of associated site infrastructures including private car parks, concrete paving slabs and access road;
- Foul flows from the properties will be collected within dedicated and separate foul sewers for disposal off site into the public network;

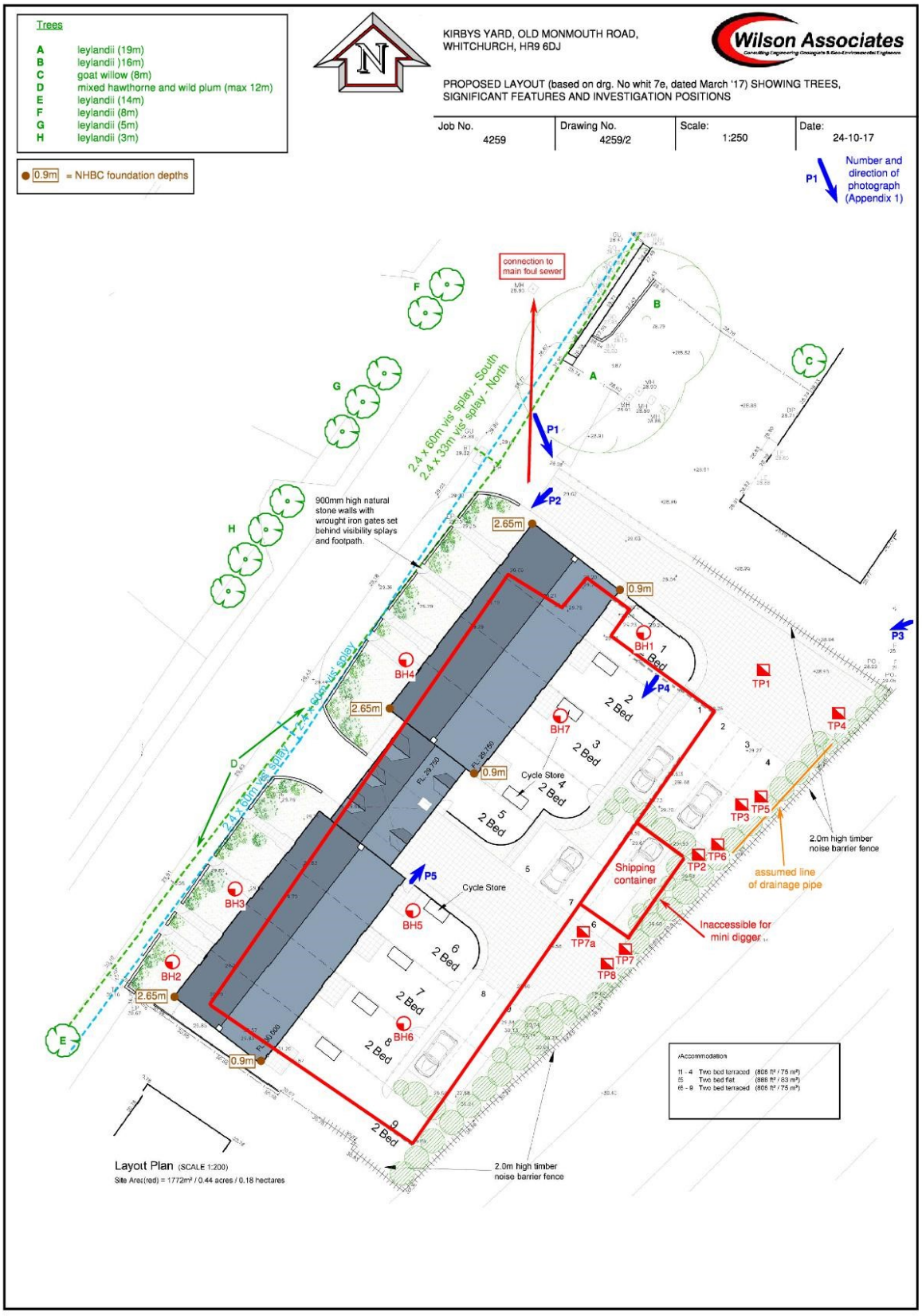
- The site is currently developed, and it is likely that runoff rates are close to existing Brownfield rates;
- The site is shown to be located in Flood Zone 3, with a 1 in 100 or greater annual probability of river flooding, however, a Flood Risk Assessment for the proposed development site has been developed by KRS Environmental in June 2017;
- The risk of surface water flooding is generally Low at the site, which means that each year this site has a chance of flooding between 0.1% and 1%. According to the EA map, this low-risk surface water runoff comes from both the Old Monmouth road and A40, whereby runoff will flow through the natural slope of the ground to the north-east. However, these surface water floods will have a maximum water depth below 0.3 m and they will flow through the front part of the buildings and rear car parks, outside the main buildings;
- The site of the proposed development falls on HOST soil class 6, which is described as “Freely draining slightly acid loamy soils”. Infiltration tests were undertaken on the site in October 2017 by Wilson Associates in accordance with BRE365 standard, with observed infiltration rates ranging between 0.0173 m/h and 0.00313 m/h. Therefore, the soils underlying the site are shown to be insufficiently permeable to allow surface water management using infiltration;
- The proposed surface water drainage system will collect all runoff from the impermeable surfaces for infiltration and attenuation, thus reducing to nil surface water runoff for rainfall events with Annual Exceedance Probability of 1.0% or higher, including the latest climate change allowance recommended by the EA;
- A 95% void ratio geo-cellular (i.e. Stormbloc) storage tank design was undertaken using the *Micro Drainage (WinDES)* software. The design assessed would infiltrate and attenuate all runoff with suitable outflow controls. Accordingly, the actual runoff rates from the site as a whole are lower than the existing brownfield rates;
- The storage tank will be located beneath the permeable paving internal driveway in two sections. The first storage tank will be located between dwellings 5 and 6, while the second storage tank will be located to the east of dwelling 1;
- The underground storage tank has been designed in order to infiltrate and attenuate the surface water runoff from the site. A total surface area of 198 m² and a depth of 0.35 m (i.e. 1/2 Stormbloc depth) have been used to design the storage tank. For the purposes of modelling, Hydro-International’s Stormbloc (800 mm x 800 mm x 350 mm deep) has been used to dimension the storage tank;
- In relation to infiltration, a conservative value of 0.00313 m/h was adopted, corresponding to the lowest value determined by the percolation test described in Section 2.5. It has been assumed that infiltration will occur through both the sides and base of the Storage Tank;
- Results showed that storage tank will reach a maximum water level of 0.333 m with an outflow of 2.4 l/s associated with the critical storm duration of 240 min Winter storm (1:100 year+40%CC rainfall event). The maximum volume will be 62.7 m³. The storage tank will have a freeboard of approx. 17 mm as a safety margin providing 3.37 m³ of storage;
- The design utilises a Hydro-Brake vortex flow control, by Hydro International. To achieve the required outflow rates the unit selected has a 75 mm orifice size, but as it located downstream of the storage tanks plus will be located within a chamber with a sump, this dimension is not likely to give rise to any undue maintenance burden;
- In accordance with Herefordshire Council Planning Condition 7 (Planning Permission Ref: 170198), no surface water and/or land drainage shall be allowed to connect directly or indirectly with the public sewerage network. Therefore, outfall from the storage tank will discharge into Whitchurch Brook to the north of the site;

- Two Hydro Biofilter™ bioretention systems of 1.2 m by 1.2 m, and a filter surface area of 1.44 m², are recommended for the site in order to provide a suitable surface water runoff treatment for the car parks. Both Hydro Biofilters™ will be located immediately upstream from the respective SuDSs, close to the car parks.
- The responsibility for maintaining any surface water features would be with the property owners and occupiers.

Appendix A Outline Surface Water Drainage Strategy *(Source: Procuro Planning Services, Ref: SD, date: Sep 2017)*



Appendix B Geotechnical Assessment *(Source: Wilson Associates)*



Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Kirbys Yard, Old Monmouth Road, Whitchurch HR9 6DJ				BH1
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4259	08-12-17	29.20	E 354,800 N 217,300	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
							MADE GROUND: probable loose, pinkish brown, slightly sandy, clayey GRAVEL (gravel is fine to coarse, angular limestone); gravel car park		
0.70	D						0.50 - becoming firm, dark brown CLAY with fine to medium gravel of angular limestone and brick		
1.00		N9				(1.80)			
							1.40 - firm black to dark brown, gravelly CLAY (gravel is angular slag)		
						1.80	1.60 - firm dark brown CLAY		
2.00		N12					SAND: probable loose, reddish brown, slightly clayey SAND		
							2.10 - rare medium to coarse rounded gravel of quartz and lithorelicts of sandstone		
2.50-3.80	D								
						(2.20)		BRs	
3.00		N8					2.90 - probable loose, clayey SAND, with occasional rounded coarse gravel to cobble sized sandstone		
							3.70 - slightly clayey, gravelly SAND (gravel is subrounded, medium to coarse sandstone)		
						4.00			
4.00		N33					Borehole terminated at 4.0m depth		
							Gas/groundwater monitoring well installed to 4.0m; fitted with gas valve and lockable cover at surface		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	Position scanned using Cable Avoidance Tool (CAT); no services detected BRs = Brownstones Formation

All dimensions in metres Scale 1:50	Client Mr C Simmonds	Method/ Plant Used Rotary Coring / Comacchio MC300 (R02)	Logged By CM

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Kirbys Yard, Old Monmouth Road, Whitchurch HR9 6DJ				BH2
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4259	08-12-17	30.10	E 354,762 N 217,281	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
						(1.00)	MADE GROUND: probable dense, black GRAVEL (TARMAC) 0.10 - probable dense, dark brown to pinkish clayey GRAVEL (gravel is coarse angular limestone) 0.30 -probable firm, reddish brown, sandy CLAY; rare medium rounded gravel of sandstone		
0.80	D					1.00	0.60 - becoming gravelly and mottled reddish orange (gravel is fine to coarse, angular sandstone and slag)		
1.00	D					(1.00)	SAND: probable loose, reddish brown, medium to coarse SAND; occasional fine to medium gravel of rounded quartz 1.50 - becoming clayey with rare gravel of sandstone	AL	
1.80	D					2.00	1.70 - becoming gravelly with organic fragments (gravel is fine to medium rounded sandstone)		
							Borehole terminated at 2.0m depth		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	Position scanned using Cable Avoidance Tool (CAT); no services detected AL = Alluvium

All dimensions in metres Scale 1:50	Client Mr C Simmonds	Method/ Plant Used Rotary Coring / Comacchio MC300 (R02)	Logged By CM

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Kirbys Yard, Old Monmouth Road, Whitchurch HR9 6DJ				BH3
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4259	08-12-17	29.80	E 217,286 N 354,765	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
							MADE GROUND: very dense black GRAVEL (TARMAC)		
							0.20 - becomes probable dense, pinkish brown, sandy GRAVEL; gravel is coarse limestone (SUB-BASE)		
0.50							0.35 - becomes probably stiff, reddish brown, slightly sandy CLAY; rare medium gravel of rounded quartz (FILL?)		
1.00		N8				(2.10)	0.70 - becoming slightly gravelly (gravel is medium to coarse, subrounded sandstone and slag)		
							1.30 - becoming very gravelly CLAY (gravel is fine to coarse slag and sandstone		
1.80									
2.00		N10				2.10	SAND: probable dense, reddish brown, slightly clayey SAND (occasional gravel of rounded fine to medium quartz)		
							2.90 - cobbles of probable strong sandstone and quartz		
3.00		N6				(1.90)	3.00 - fewer cobbles of bedrock	BRs	
						4.00	3.90 - 100mm cobbles of bedrock recovered		
4.00		N27					Borehole terminated at 4.0m depth		
							Gas/groundwater monitoring well installed to 4.0m; fitted with gas valve and lockable cover at surface		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	Position scanned using Cable Avoidance Tool (CAT); no services detected

All dimensions in metres Scale 1:50	Client Mr C Simmonds	Method/ Plant Used Rotary Coring / Comacchio MC300 (R02)	Logged By CM

Wilson Associates
Consulting Engineering Geologists & Geo-Environmental Engineers

BOREHOLE LOG

Project				BOREHOLE No
Kirbys Yard, Old Monmouth Road, Whitchurch HR9 6DJ				BH4
Job No	Date	Ground Level (c.m, AOD)	Co-Ordinates (c.)	
4259	08-12-17	29.30	E 354,778 N 217,306	
Contractor				Sheet
CC Ground Investigations Limited				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Type No	Test Result	Water	Undrained Shear Strength	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
0.50						(1.70)	MADE GROUND: probable very dense, black GRAVEL (TARMAC) 0.20 - pinkish brown, coarse angular GRAVEL (SUB-BASE) 0.40 - black GRAVEL with coarse angular brick and coal and rare cobbles of coal 0.50 - stiff, dark brown, slightly sandy, gravelly CLAY (gravel is fine to medium, angular slag and brick)		
1.00		N7					1.00 - probable dense, clayey GRAVEL (gravel is medium to coarse slag)		
						1.70			
						2.00	CLAY: probable firm, dark brown to reddish brown, sandy, slightly gravelly CLAY (gravel is black, medium root fragments fragments); roots fragments throughout (ALLUVIUM?)	AL	
2.00		N10					SAND: probable loose, reddish brown, slightly clayey, fine to medium sand		
2.70							2.70 - occasional coarse gravel of sandstone and rare medium gravel of quartz		
3.00		N20							
						(3.90)		BRs	
4.00		N25					4.00 - becoming probable dense, slightly clayey, fine to medium SAND		
5.00		N38					5.00 - becoming probable very dense, slightly clayey, fine to medium SAND		
						5.90			
6.00		N75/ 80 mm					Borehole terminated at 4.5m depth Gas/groundwater monitoring well installed to 4.5m; fitted with gas valve and lockable cover at surface - becoming probably strong, reddish brown, mottled pale brown sandstone		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Hole Dia. mm	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	Position scanned using Cable Avoidance Tool (CAT); no services detected BRs = Brownstones Formation AL = Alluvium

All dimensions in metres Scale 1:50	Client Mr C Simmonds	Method/ Plant Used Rotary Coring / Comacchio MC300 (R02)	Logged By CM