Shepherd Gilmour
Consulting Engineers

CANALSIDE DEVELOPMENT
ELLESMERE, SHROPSHIRE

SITE WIDE SUSTAINABLE DRAINAGE STRATEGY

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SECTION 1 INTRODUCTION

INTRODUCTION

1.1. Shepherd Gilmour Infrastructure Ltd (SGi) has been engaged by Burbury Investments (Care of Formal Investments) Ltd (the Client) to prepare a Site Wide Sustainable Drainage Strategy in support of the Canalside Development in Ellesmere, Shropshire.

SITE LOCATION

1.2. The Proposed Development Site (PDS) is located within the town of Ellesmere in Shropshire and is approximately 650m to the southwest of the town centre. The site is currently used as agricultural land and can be found using National Grid Reference SJ535863 or Postcode SY12 0EA (nearest available).

1.3. The site ownership boundary is irregular in shape and is formed by mainly hedgerows and fences. There are several hardboards such as the Shropshire Union Canal to the south and east. Scotland Street to the north and the sewage treatment works to the north.

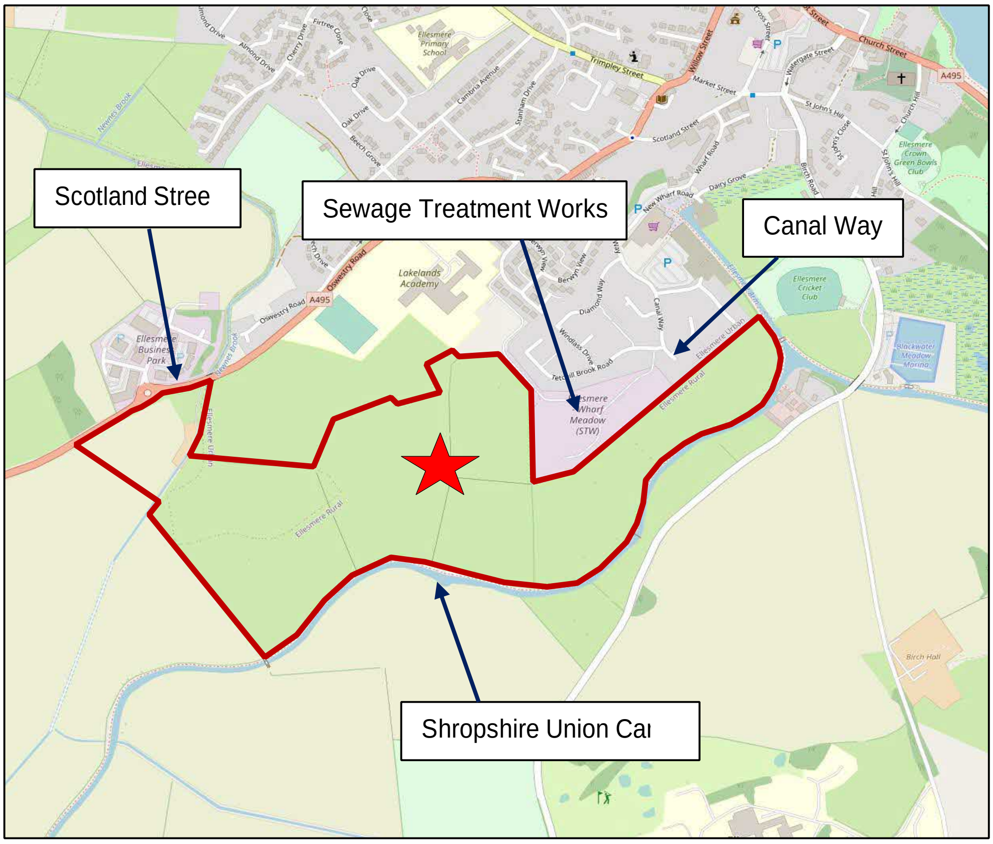

Figure 1.1 Site Location (OpenStreetMap Contributors)

Note. The site ownership boundary is indicative and does not reflect the site boundary produced for planning.

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PROPOSED DEVELOPMENT

1.4. The PDS is a phased development that will be submitted as a detailed application with reserved matters on the individual plots. The number of phases at this stage is an unknown and will be influenced by market conditions, but the initial phase will be the enabling works which consists of:

The proposed flood mitigation works (discussed in detail within the BWB Flood Risk Assessment)

The site wide earthworks and reprofiling to suit the flood mitigation works.

The construction of the main link road through the site.

The construction of the critical foul and surface water infrastructure onsite.

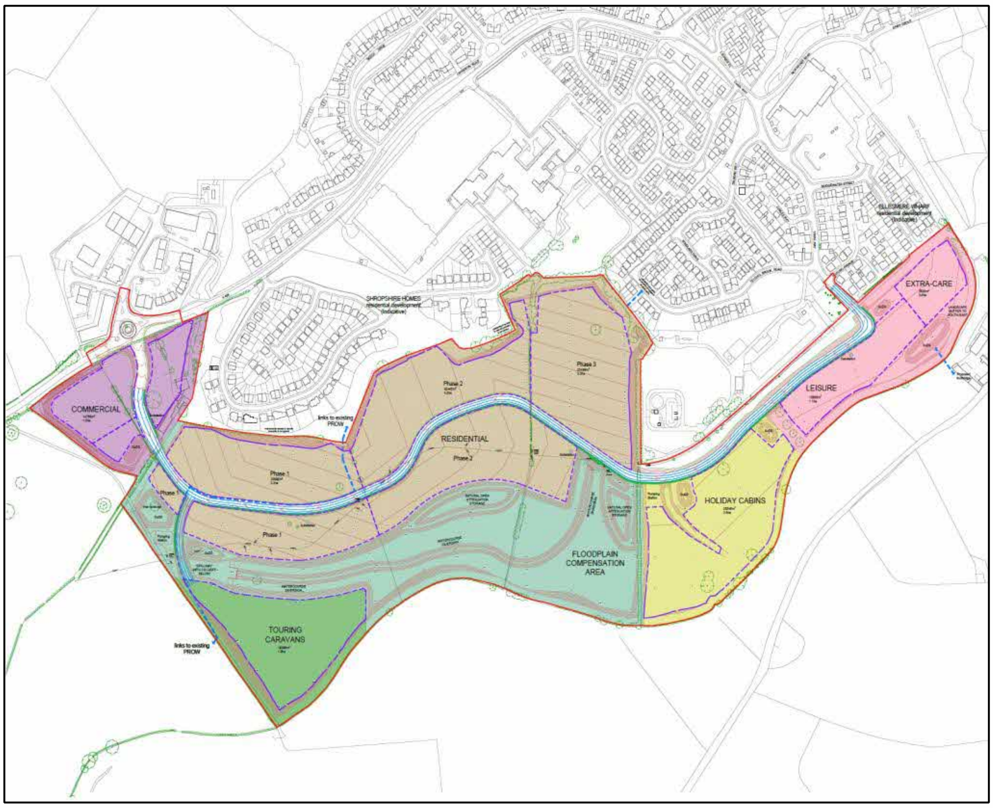

Figure 1.2 Illustrative Masterplan

1.5. A copy of the illustrative masterplan has been included within **Appendix A**.

1.6. This report will focus on the critical surface water infrastructure installed during the enabling works but will also consider the future phases/plots which consist of:

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Land Use	Current Proposal
Retail	Food Store 2000m^2
Commercial / Employment	B2 / B8 11,000m^2
Care Home	100 bed
Residential	400 Dwellings
Leisure	Hotel (80 bed)
	Log Cabins (no.70)
	Touring Caravan Site (no.35)
	Pub / Restaurant 750m^2
	Play Centre 500m^2

Table 1.1 Proposed Development Uses.

1.7. The Clients proposals within **Table 1.1** are subject to change. So future updates and/or addendum reports may be required to support any changes to this original strategy.

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SECTION 2 SUSTAINABLE DRAINAGE STRATEGY

General Requirements

2.1. The general requirement set out in the National/Local Standards is that 'a proposed development must not increase the risk of flooding elsewhere.' In practical terms this means that a development must provide a runoff reduction/overall betterment and/or be equal to the calculated greenfield rate.

Existing Development Review

2.2. Except for several small industrial units adjacent to Scotland Street, the PDS is agricultural land and will therefore be considered as a greenfield site in this report.

Figure 2.1 Existing Buildings (Google Maps)

Shropshire Councils Guidance

2.3. Shropshire Council's guidance/proforma for greenfield sites states the following.

S2. For greenfield developments, the peak runoff rate from the development to any highway drain, sewer, or surface water body for the 100% Annual Exceedance probability rainfall event and the 1% Annual Exceedance probability rainfall event should never exceed the peak greenfield runoff of rate for the same event.

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Greenfield Runoff Rate

2.4. The Institute of Hydrology Report 124 Flood Estimation for Small Catchments has been used to calculate the current greenfield runoff from the catchment.

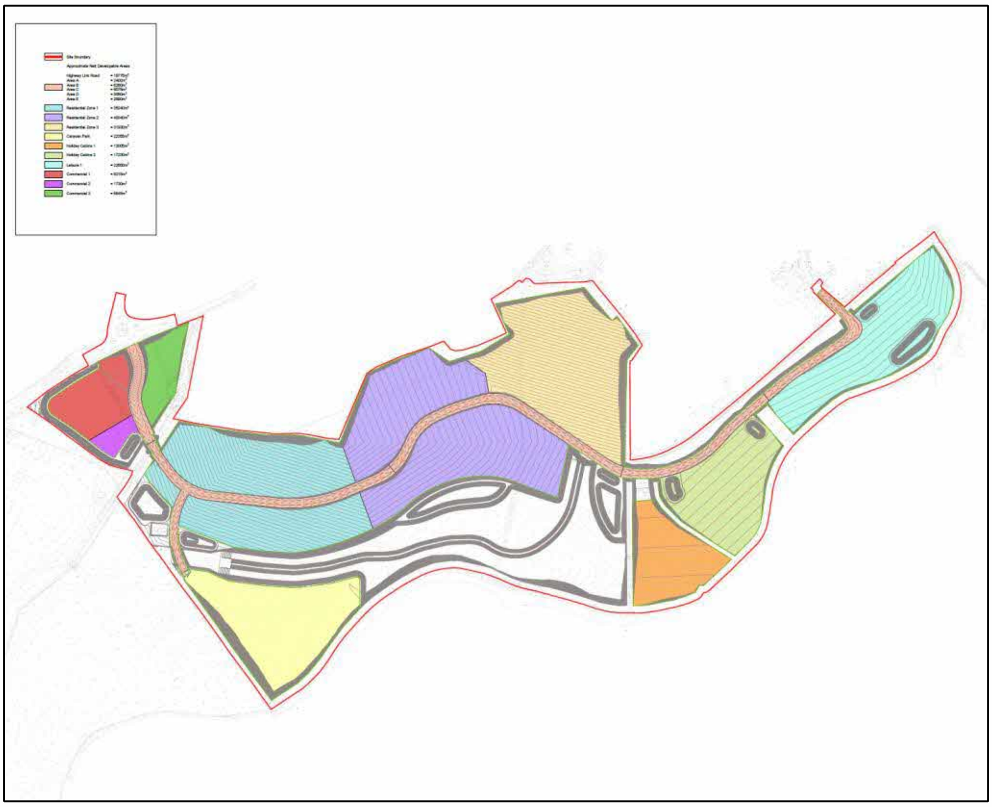

Figure 2.2 Illustrative Catchment Plan

Site Analysis	m^2	ha
Ownership Boundary*	322795	32.28
Nett Developable Area	216703	21.67

Table 2.1 Site Analysis

Note: Greenfield runoff to be adjusted to suit developable area if proposals change.

2.5. A copy of the above site analysis has been included within **Appendix B**.

Volume Wallingford Variables	Value
M5-60 minute rainfall depth	18.0mm
Ratio of M5-60 to M5-2 day rainfalls	0.34mm
Average Annual Rainfall (SAAR)	712mm
SOIL	Soil Type 4
SPR / SPRHO ST	0.47

Table 2.2 Wallingford Procedure Volume 3 Variables

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QBAR rural *= 1.08 (AREA/100)$^{0.89}$ x SAAR$^{1.17}$ x SOIL$^{2.17}$*

Where; AREA = 50 ha (to be scaled to 21.67ha)

SAAR = 712mm

SPR/SPRHOST = 0.47

QBAR rural *= 1.08 (AREA/100)$^{0.89}$ * SAAR$^{1.17}$ * SOIL$^{2.17}$*

*= 1.08 (50/100)$^{0.89}$ * 712$^{1.17}$ * 0.47$^{2.17}$*

= 246.2 (50-hectare site)

*Therefore QBAR = **4.92 l/s/ha***

QBAR Growth Factor

2.6. Growth curve factors have been derived for each of the 10 hydrological regions of the UK. These are based on the work carried out by the Flood Studies research and assists in calculating peak runoff rates for several events using the estimate QBAR value.

Hydrological Region	4			
Estimated QBAR (1 ha)	4.92			
Estimated QBAR (21.67 ha)	106.7			
Return Period	2	5	30	100
Greenfield Peak Runoff (l/s)	95.7	131.3	209.1	274.3

Table 2.3 Peak Greenfield Runoff Rates

Note: Greenfield runoff to be adjusted to suit developable area if proposals change.

2.7. The Microdrainage calculations for the 50-hectare site are shown below in **Figure 2.2**.

Proposed Development Runoff Rate

2.8. The peak runoff for the overall development must be limited to or less than the Greenfield rates shown in **Table 2.3.** This in accordance with the Shropshire Councils current guidance (Para 2.3).

2.9. The distribution of the allowable flow rates throughout the PDS, will be discussed in further detail in **Section 3 & 4.**

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```
                    IH 124 Mean Annual Flood

                             Input

Return Period (years)    100  SAAR (mm)    712        Urban    0.000
            Area (ha)  50.000      Soil  0.470  Region Number  Region 4

                         Results      l/s

                       QBAR Rural   246.2
                       QBAR Urban   246.2

                       Q100 years   632.8

                          Q1 year   204.4
                         Q2 years   220.7
                         Q5 years   302.9
                        Q10 years   366.9
                        Q20 years   437.7
                        Q25 years   462.4
                        Q30 years   482.5
                        Q50 years   542.2
                       Q100 years   632.8
                       Q200 years   743.6
                       Q250 years   780.6
                      Q1000 years  1024.4
```

Figure 2.3 Microdrainage Calculation 50ha Site

PROPOSED RUNOFF DESTINATION

Surface Water Hierarchy

2.10. Paragraph 080 of the Flood Risk and Coastal Change Guidance within the Planning Practice Guidance sets out the following hierarchy of surface water runoff destinations:

i. Discharge into the ground (infiltration),

ii. Discharge to a surface waterbody,

iii. Discharge to a surface water sewer,

iv. Discharge to a combined sewer.

Discharge into the ground

2.11. There are five bands of soil classes in England which roughly describe the infiltration potential of an area. The bands are derived from factors such as, soil permeability, topography, and the likelihood of impermeable layers.

2.12. The soil classification for the PDS is Type 4. This would generally rule out the use of infiltration as a runoff destination. However, infiltration tests must be carried out accordance with BRE365 on each Phase/Plot to confirm the permeability of the ground.

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Soil	W RAP	Runoff	Soil Value	Soil Characteristics
1	Very High	Very Low	0.15	Sandy, well drained
2	High	Low	0.30	Intermediate soils (sandy)
3	Moderate	Moderate	0.40	Intermediate soils (silty)
4	Low	High	0.45	Clayey, poorly drained
5	Very Low	Very High	0.50	Steep, rocky areas

Table 2.4 Soil Classification

Discharge to a surface water body

2.13. The Tetchill Brook and the Newness Brook, both flow thru the PDS in an east to west direction. These waterbodies are the natural destination for surface water runoff from the current site and this should be maintained.

2.14. The PDS will therefore discharge runoff to these locations at the greenfield rates shown in **Table** 2.2 .

Discharge to a surface water sewer

2.15. Not applicable for this site.

Discharge to a combined sewer

2.16. Not applicable for this site.

SUSTAINABLE DRAINAGE TECHNIQUES

2.17. There are various SuDS techniques which are suitable for high and low-density developments as shown in **Table 2.5**. One or more of these techniques could be incorporated at the detailed design stage to assist with the required reduction and/or betterment in flow rates.

2.18. Most of these techniques can also provide some of/or all the required water quality treatment by capturing silt and breaking down containments such as hydrocarbons to prevent downstream pollution.

SuDS Technique	SuDS Description
Pervious Pavements	Pervious pavements are suitable for pedestrian and/or vehicular trafficked area and allow rainwater to infiltrate through the top surface layer to the underlying structural layers.
Filter Drains	Filter drains are shallow trenches filled with stone/gravel that can convey and temporarily store runoff.
Swales	Swales are relatively shallow flat bottomed, vegetated channels which convey and treat surface water runoff. Swales can also be used to store runoff in the right conditions.
Retention Ponds	Retention ponds are permanent water bodies that are partially filled. During a storm event the remaining void can be used to temporarily used to hold/store runoff.
Detention Basin	Detention basins are landscaped depressions that are normally dry except during and immediately following a storm event. They can be designed as either an online or offline structures and primarily store excess surface water runoff
Soakaways	All the above techniques can be designed to infiltrate runoff into the ground and could be classed as a soakaway. The term soakaway however, usually refers to a underground structure such as perforated tanks/manholes which are installed at greater depths to access better ground conditions.
Green Roofs	Green roofs are areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff.
Underground Storage	Attenuation storage tanks are used to create a below ground void space for the temporary storage of surface water before infiltration, controlled release or reuse onsite.

Table 2.5 SuDS Techniques

CLIMATE CHANGE ALLOWANCE

2.19. An allowance for climate change should be included at the detailed application stage to help minimize vulnerability and provide resilience to flooding. According to the Flood Risk Assessments: Climate Change Allowances **both** the 'Upper End' and 'Central' allowances should be assessed.

2.20. The 'Central' allowance should be applied to the underground surface water drainage network/design to assess its ability to contain critical events. Whilst the 'Upper End' allowance should be applied to evaluate the potential implications and to ensure that the flooding is wholly contained onsite.

2.21. The following climate change allowances should be applied to the proposed rainfall intensities during the detailed application stage.

+40% to +45% Allowance.

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Applies across all of England	Potential Change anticipated for the 2050's	Potential Change anticipated for the 2070's
Upper End	+40%	+45%
Central	+25%	+30%

Table 2.6 Recommend Climate Change Guidance (EA)

WATER QUALITY / CIRIA C753

2.22. CIRIA Report C753 (The SuDS Manual) outlines a simple index approach which is a best practice design standard for managing the quality of runoff. This approach provides the following table which can be used to specify the required type and/or number of SuDS components needed.

No.	Proposed Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydro carbons
1	Residential roofs	Very Low	0.2	0.2	0.05
2	Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2 – 0.8	0.05
3	Individual property driveways, residential car parks, low traffic roads (e.g. cul de sac, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. <300 traffic movements per day	Low	0.5	0.4	0.4
4	Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7

Table 2.7 Pollution Hazard Indices (CIRIA C753)

2.23. Where more than one SuDS component/technique are required to sufficiently cleanse the runoff, then there is a reduced "performance factor" which must be applied to the following component(s).

Total SuDS mitigation index = Mitigation component index + 0.5 x Mitigation index of second component

2.24. The exact runoff treatment will be specified in the following sections of this strategy.

SECTION 3 ENABLING WORKS - SURFACE WATER STRATEGY

3.1. The PDS has been split into several indicative drainage catchments based on the proposed topography and future land uses. **Figure 3.1** provides an overview of these catchments, and a large-scale plan has been included within **Appendix B**.

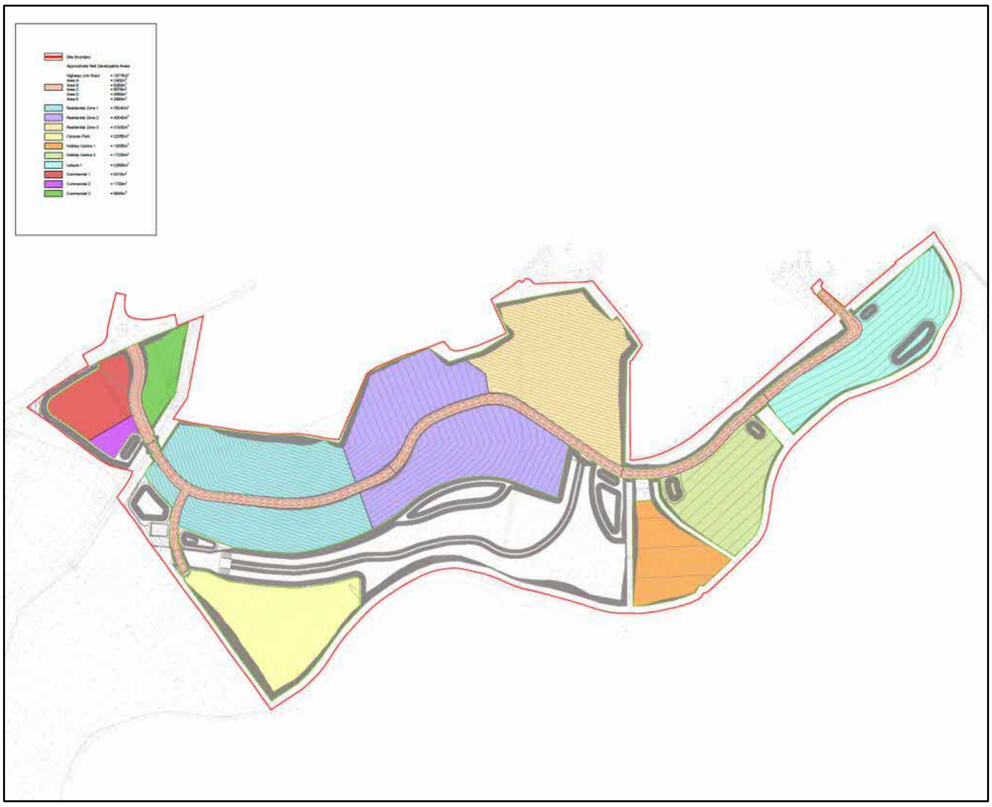

Figure 3.1 Illustrative Catchment Plan

Catchment Reference	Catchment Area
Enabling Works	**19775m^2**
Highway A	2400m^2
Highway B	6260m^2
Highway C	5075m^2
Highway D	3050m^2
Highway E	2990m^2
Future Phases	**196930m^2**
Residential Zone 1	35240m^2
Residential Zone 2	40040m^2
Residential Zone 3	31920m^2
Caravan Park	22355m^2

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Holiday Cabins 1	12005m^2
Holiday Cabins 2	17230m^2
Leisure 1	22550m^2
Commercial 1	8215m^2
Commercial 2	1730m^2
Commercial 3	5645m^2

Table 3.1 Surface Water Catchments

HIGHWAY A

Highway A – Proposed Drainage

3.2. Highway A is the start of the new link road that will connect the PDS to the upgraded Scotland Street roundabout (S278 works). This link road extends through the PDS to Canal Way and has been split into five separate catchments.

3.3. The runoff generated by the hardstanding highway, will be directed to/collected by kerb drains on either side of the carriageway. From there is will discharge to an underground carrier drain that connects to a sealed filter drain/trench.

3.4. The filter trench will contain two perforated pipes; The first will be a 150mm pipe positioned at high level and will the connection point for all incoming pipes. This 150mm pipe will allow the incoming connections to be fully maintained whilst permitting runoff to infiltrate through the filter media to the secondary pipe at low level.

3.5. The low-level pipe will act as the main carrier within the filter trench and will allow runoff to convey through each section of the network before discharging into the downstream attenuation basin/pond (**Figure 3.2 & 3.3**). Flows from this attenuation basin/pond will then be discharged to the Newness Brook at a restricted rate via the newly diverted ordinary watercourse.

3.6. A copy of the full-size drainage plan has been included within **Appendix C1**.

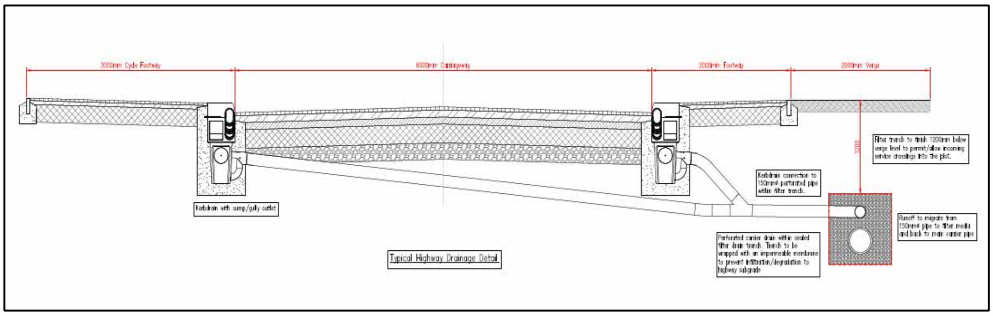

Figure 3.2 Typical Kerb Drain Arrangement

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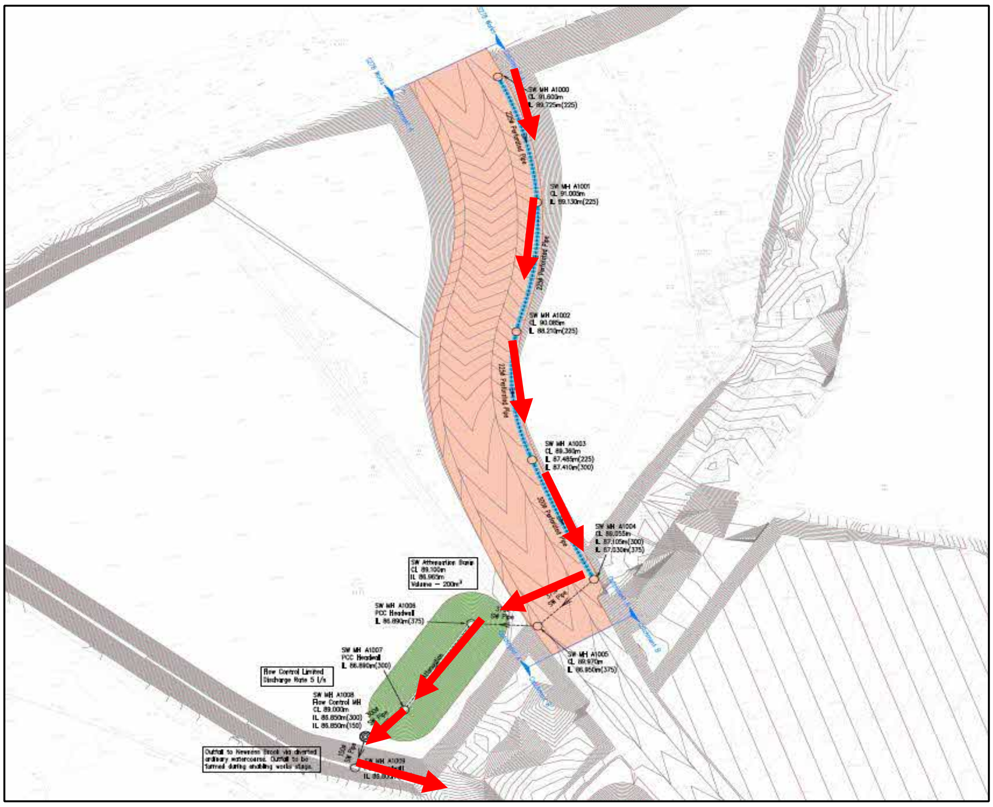

Figure 3.3 Highway A - SW Drainage

Highway A - Limited Discharge Rate

3.7. Flows into the ordinary watercourse will be limited to a maximum flow rate of 5 l/s via a vortex flow control. The 5 l/s will apply to all return periods including the 100-year event including climate change (45%)

Highway A - Water Quality

3.8. Whilst Ciria C753's simple index approach will be used within the PDS, it will primarily be for the future plots/phases. Shropshire's Manual for Adoptable Roads and Transport (SMART) document requests that runoff from the adoptable highway must pass through a minimum of two treatment stages prior to discharging offsite.

3.9. Highway A runoff will therefore be cleansed/treated by connecting the kerb drains and gullies directly to a filter trench (first stage) and then passing runoff to pass through an online attenuation basin/pond (second stage).

3.10. The runoff will also flow along a new swale to the outfall destination, and this could provide a third stage of treatment. However, this does depend on the water level at the outfall which fluctuates.

Highway A - Microdrainage Simulation

3.11. The proposed network for Highway A has been modelled within Microdrainage to check its suitability. The Microdrainage simulations indicate that the proposed network and downstream attenuation is adequate and can be improved upon at the detailed design stage.

3.12. We would also note that an additional 500m^2 has been modelled within this system to allow for any additional runoff generated by adoptable bellmouth(s) and S278 works (if needed).

3.13. Once these elements are finalised/included the runoff rate at the flow control could increase, but will ultimately remain at or below the permitted 5 l/s.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s)	5				
Simulated Peak Runoff (l/s)	N/A	4.9	4.9	4.9	4.9

Table 3.2 Highway A - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

3.14. A copy of the Microdrainage files have been included within **Appendix C2**.

Highway A - Sensitivity Check

3.15. During the most extreme storm events, the water level within the adjacent Newness Brook will increase and could submerged the surface water outfall. We have therefore used a 590mm surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Newness (87.390m Node 11 BWB Flood Risk Assessment).

3.16. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

3.17. A copy of the Microdrainage files have been included within **Appendix C3**.

HIGHWAY B

Highway B – Proposed Drainage

3.18. Highway B will follow the same strategy/design principals as per Highway A. The only difference is that the flows from the proposed attenuation basin/pond discharge to a culverted section of Tetchill Brook rather than the Newness (as shown in **Figure 3.6**).

3.19. A copy of the full-size drainage plan has been included within **Appendix D1**.

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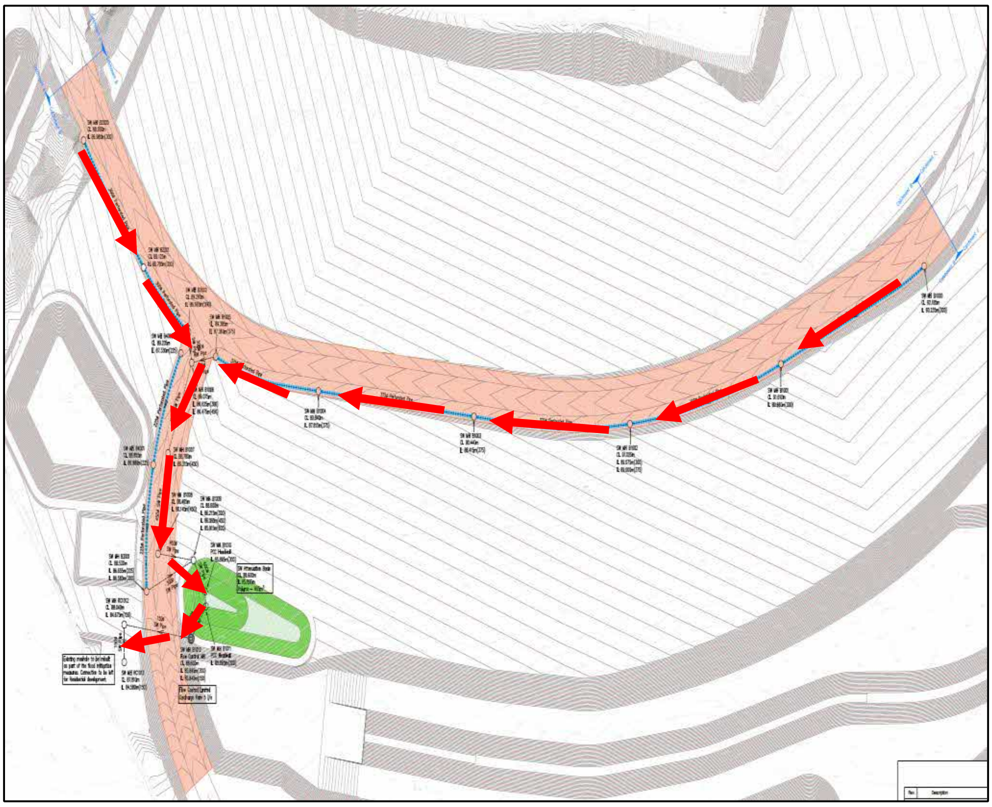

Figure 3.6 Highway B - SW Drainage

Highway B - Limited Discharge Rate

3.20. Flows into the Tetchill Brook will be limited to a maximum flow rate of 5 l/s via a vortex flow control. The 5 l/s will also apply to all return periods including the 100-year event including climate change (45%).

Highway B - Water Quality

3.21. As per Highway A. Runoff from Highway B will be cleansed/treated by connecting the kerb drains and gullies directly to a filter trench (first stage) and then passing runoff to pass through an online attenuation basin/pond (second stage).

Highway B - Microdrainage Simulation

3.22. The proposed network for Highway B has been modelled within Microdrainage to check its suitability. The Microdrainage simulations show that the proposed network and downstream attenuations are adequate and can be improved upon at the detailed design stage.

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Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s)	5				
Peak Runoff (l/s)	N/A	3.5	3.7	4.2	4.9

Table 3.3 Highway B - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

3.23. A copy of the Microdrainage files have been included within **Appendix D2**.

Highway B – Sensitivity Check

3.24. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 2.42m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.000m Node 16 BWB Flood Risk Assessment).

3.25. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

3.26. A copy of the Microdrainage files have been included within **Appendix D3**.

HIGHWAY C

Highway C – Proposed Drainage

3.27. Highway C will follow the same strategy/design principals as per Highway A & B. The only difference is that the flows from the proposed attenuation basin/pond discharge to a section of the diverted Tetchill Brook (as shown in **Figure 3.7**).

3.28. A copy of the full-size drainage plan has been included within **Appendix E1**.

Highway C - Limited Discharge Rate

3.29. Flows into the Tetchill Brook will be limited to a maximum flow rate of 5 l/s via a vortex flow control. The 5 l/s will also apply to all return periods including the 100-year event including climate change (45%).

Highway C - Water Quality

3.30. As per Highway A. Runoff from Highway C will be cleansed/treated by connecting the kerb drains and gullies directly to a filter trench (first stage) and then passing runoff to pass through an online attenuation basin/pond (second stage).

3.31. The runoff will also flow along a new swale to the main channel, and this could provide a third stage of treatment. However, this does depend on the water level at the outfall which fluctuates.

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Highway C - Microdrainage Simulation

3.32. The proposed network for Highway C has been modelled within Microdrainage to check its suitability. The Microdrainage simulations show that the proposed network and downstream attenuations are adequate and can be improved upon at the detailed design stage.

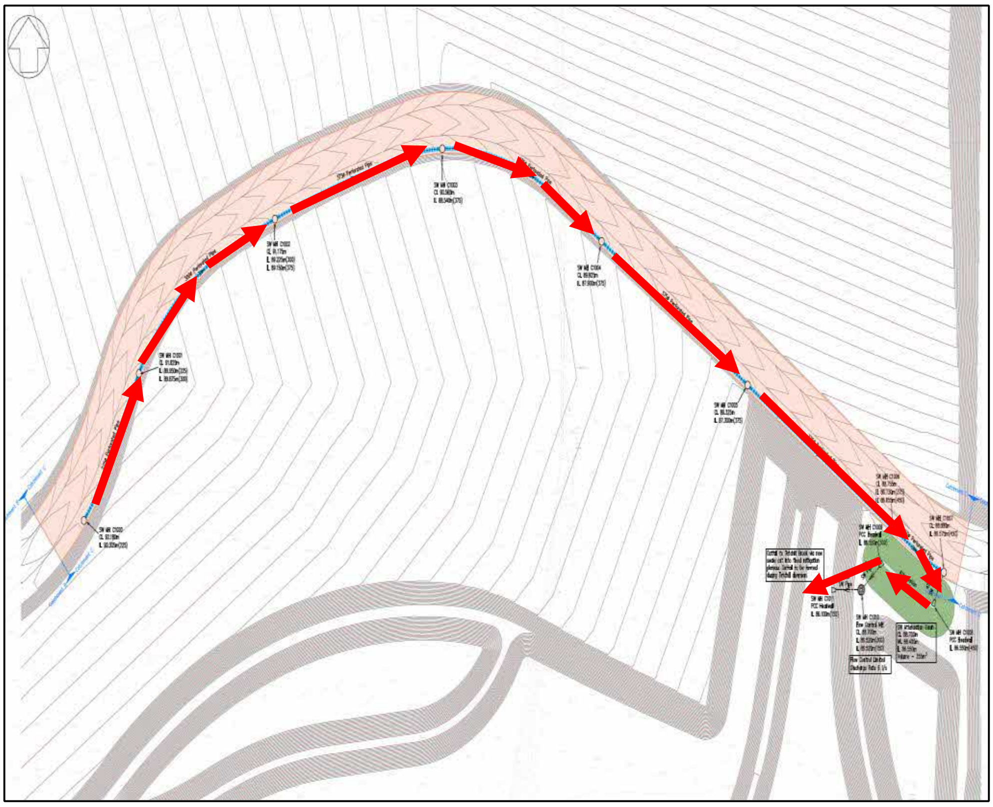

Figure 3.7 Highway C - SW Drainage

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s)	5				
Peak Runoff (l/s)	N/A	3.1	3.4	4.0	4.9

Table 3.4 Highway C - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

3.33. A copy of the Microdrainage files have been included within **Appendix** E2 .

Highway C – Sensitivity Check

3.34. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 900mm surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.000m Node 19 BWB Flood Risk Assessment).

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3.35. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

3.36. A copy of the Microdrainage files have been included within **Appendix E3**.

HIGHWAY D

Highway D – Proposed Drainage

3.37. Highway D will follow the same strategy/design principals as per Highway A, B & C. The only difference is that the flows from the proposed attenuation basin/pond discharge to an upstream section of the Tetchill Brook (as shown in **Figure 3.8**).

3.38. A copy of the full-size drainage plan has been included within **Appendix F1**.

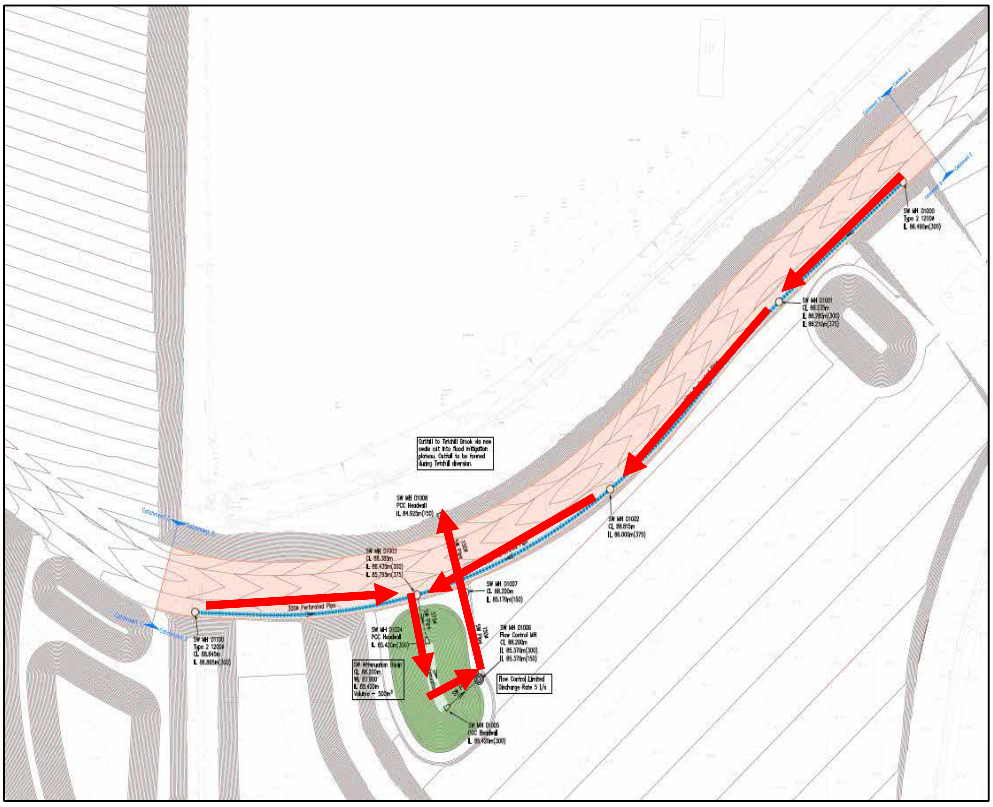

Figure 3.8 Highway D - SW Drainage

Highway D - Limited Discharge Rate

3.39. Flows into the Tetchill Brook will be limited to a maximum flow rate of 5 l/s via a vortex flow control. The 5 l/s will also apply to all return periods including the 100-year event including climate change (45%).

Highway D - Water Quality

3.40. As per Highway A. Runoff from Highway D will be cleansed/treated by connecting the kerb drains and gullies directly to a filter trench (first stage) and then passing runoff to pass through an online attenuation basin/pond (second stage).

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3.41. The runoff will also flow along a new swale to the main channel, and this could provide a third stage of treatment. However, this does depend on the water level at the outfall which fluctuates.

Highway D - Microdrainage Simulation

3.42. The proposed network for Highway D has been modelled within Microdrainage to check its suitability. The Microdrainage simulations show that the proposed network and down stream attenuations are adequate and can be improved upon at the detailed design stage.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s)			5		
Peak Runoff (l/s)	N/A	2.3	2.5	3.0	3.6

Table 3.5 Highway D - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

3.43. A copy of the Microdrainage files have been included within **Appendix F2**.

Highway D – Sensitivity Check

3.44. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 900mm surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.030m Node 21 BWB Flood Risk Assessment).

3.45. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

3.46. A copy of the Microdrainage files have been included within **Appendix F3**.

HIGHWAY E

Highway E – Proposed Drainage

3.47. Highway E will follow the same strategy/design principals as per Highway D and will discharge to the Tetchill Brook (as shown in **Figure 3.9**).

3.48. A copy of the full-size drainage plan has been included within **Appendix G1**.

Highway E - Limited Discharge Rate

3.49. Flows into the Tetchill Brook will be limited to a maximum flow rate of 5 l/s via a vortex flow control. The 5 l/s will also apply to all return periods including the 100-year event including climate change (45%).

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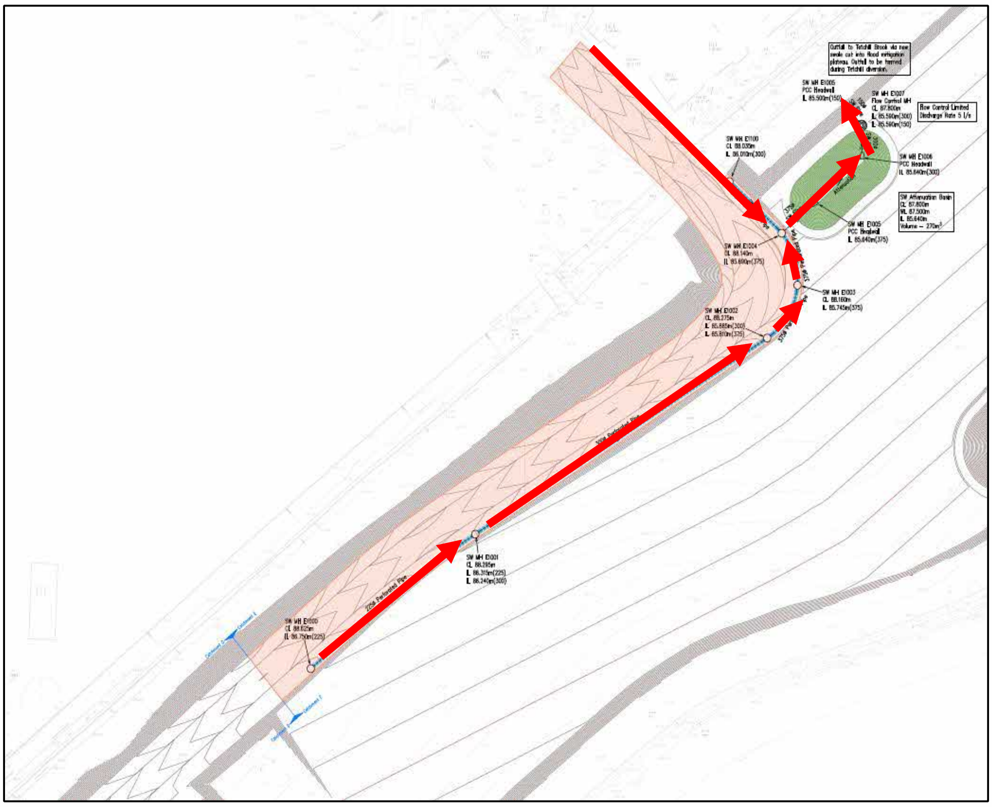

Figure 3.9 Highway E - SW Drainage

Highway E - Water Quality

3.50. As per Highway D. Runoff from Highway E will be cleansed/treated by connecting the kerb drains and gullies directly to a filter trench (first stage) and then passing runoff to pass through an online attenuation basin/pond (second stage).

3.51. The runoff will also flow along a new swale to the main channel, and this could provide a third stage of treatment. However, this does depend on the water level at the outfall which fluctuates.

Highway E - Microdrainage Simulation

3.52. The proposed network for Highway E has been modelled within Microdrainage to check its suitability. The Microdrainage simulations show that the proposed network and downstream attenuations are adequate and can be improved upon at the detailed design stage.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s)	5				
Peak Runoff (l/s)	N/A	2.8	3.0	3.6	4.4

Table 3.5 Highway D - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

3.53. A copy of the Microdrainage files have been included within **Appendix G2**.

Highway E – Sensitivity Check

3.54. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 1.54 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.030m Node 25 BWB Flood Risk Assessment).

3.55. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

3.56. A copy of the Microdrainage files have been included within **Appendix G3**.

ENABLING WORKS SUMMARY

3.57. The highway areas that form part of the enabling works have all been provided a limited discharge rate of 5 l/s for all events. The current Microdrainage simulations indicate that these areas are discharging at a lower rate, but this deficit provides an element of flexibility for future bellmouths etc.

<table>
<tr><th>Return Period</th><th>1</th><th>2</th><th>5</th><th>30</th><th>100</th></tr>
<tr><td>Highway A</td><td rowspan="5">N/A</td><td colspan="4">5</td></tr>
<tr><td>Highway B</td><td colspan="4">5</td></tr>
<tr><td>Highway C</td><td colspan="4">5</td></tr>
<tr><td>Highway D</td><td colspan="4">5</td></tr>
<tr><td>Highway E</td><td colspan="4">5</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>**Enabling Works Runoff (l/s)**</td><td>**N/A**</td><td colspan="4">**25**</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Greenfield Peak Runoff (l/s)</td><td>N/A</td><td>95.7</td><td>131.3</td><td>209.1</td><td>274.3</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>**Remaining Peak Runoff (l/s)**</td><td>**N/A**</td><td>**70.7**</td><td>**106.3**</td><td>**184.1**</td><td>**249.3**</td></tr>
</table>

Table 3.6 Remaining SW Allowance

3.58. **Table 3.6** provided the remaining allowance for the future phases/plots. This will be allocated across the development once the client's proposals have been firmed up.

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SECTION 4 FUTURE WORKS - SURFACE WATER STRATEGY

4.1. To safeguard the PDS, SGi have carried out an indicative drainage design for the future plots/phases. These designs will not be built, but some of the associated attenuation features i.e., ponds/basin will be formed as part of the enabling works contract.

Indicative SW Flow Distribution

4.2. The remaining surface water allowance (**Table 3.6**) have been distributed across the PDS based on their catchment areas and has been shown in **Table 4.1**.

Catchment Reference	Catchment Area (m^2)	Area Percentage	2 Year (l/s)	5 Year (l/s)	30 Year (l/s)	100 Year (l/s)
	196930	**100%**	**70.7**	**106.3**	**184.1**	**249.3**
Residential 1	35240	17.89%	12.65	19.02	32.94	44.61
Residential 2	40040	20.33%	14.37	21.61	37.43	50.69
Residential 3	31920	16.21%	11.46	17.23	29.84	40.41
Caravan Park	22355	11.35%	8.03	12.07	20.90	28.30
Holiday Cabins 1	12005	6.10%	4.31	6.48	11.22	15.20
Holiday Cabins 2	17230	8.75%	6.19	9.30	16.11	21.81
Commercial 1	5645	2.87%	2.03	3.05	5.28	7.15
Commercial 2	22550	11.45%	8.10	12.17	21.08	28.55
Retail 1	8215	4.17%	2.95	4.43	7.68	10.40
Retail 2	1730m^2	0.88%	0.62	0.93	1.62	2.19

Table 4.1 SW Flow Distribution

4.3. Whilst the Retail 2 plot is a small development the flow rate allowance is a concern due to the risk of blockages and maintenance. A 5 l/s restriction will therefore be applied to this plot for all events. The adjusted flow distribution is now shown in **Table 4.2**.

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Catchment Reference	Catchment Area (m²)	Area Percentage	2 Year (l/s)	5 Year (l/s)	30 Year (l/s)	100 Year (l/s)
	195200	100%	70.7	106.3	184.1	249.3
Residential 1	35240	18.05%	11.86	18.29	32.33	44.10
Residential 2	40040	20.51%	13.48	20.78	36.74	50.11
Residential 3	31920	16.35%	10.74	16.57	29.29	39.95
Caravan Park	22355	11.45%	7.52	11.60	20.51	27.98
Holiday Cabins 1	12005	6.15%	4.04	6.23	11.01	15.02
Holiday Cabins 2	17230	8.83%	5.80	8.94	15.81	21.56
Commercial 1	5645	2.89%	1.90	2.93	5.18	7.06
Commercial 2	22550	11.55%	7.59	11.70	20.69	28.22
Retail 1	8215	4.21%	2.76	4.26	7.54	10.28
Retail 2	N/A	N//A	5			

Table 4.2 SW Flow Distribution - Adjusted

RESIDENTIAL ZONE 1

Residential Zone 1- Indicative Network

4.4. This area consists of three parcels which will drain surface water runoff to the same location. We have assumed that up to 65% of this catchment could be hardstanding and have included a 10% allowance for urban creep (75% total).

Residential Area 1 = 35240m² @ 75% PIMP = 26430m² Hardstanding Area.

Residential Zone 1- Indicative Route

4.5. Runoff generated by the area will be collected and conveyed by an underground network to a new attenuation pond/basin on the western boundary. Flows from this attenuation structure will then discharge to the brook at the agreed rate. The indicative route has been shown in **Figure 4.2** and a full-size plan has been included within **Appendix H1** .

Residential Zone 1- Flow Rate

4.6. SW flows has been restricted to the rates shown in **Table 4.2.**

Residential Zone 1- Microdrainage Simulation

4.7. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

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Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	11.86	18.29	32.33	44.10
Peak Runoff (l/s)	N/A	11.00	12.20	14.80	18.90

Table 4.3 Residential Zone 1 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.8. A copy of the Microdrainage files have been included within **Appendix H2**.

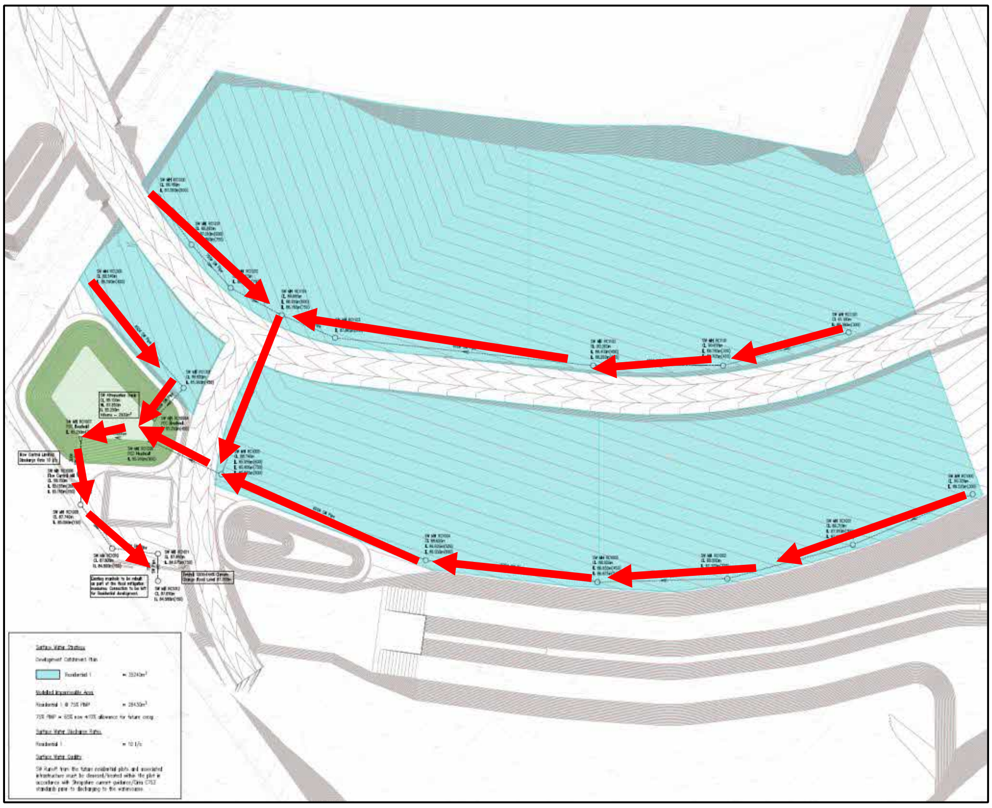

Figure 4.2 Residential Zone 1 Drainage

Residential Zone 1 – Sensitivity Check

4.9. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 2.42 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.000 m Node 16 BWB Flood Risk Assessment).

4.10. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.11. A copy of the Microdrainage files have been included within **Appendix H3**.

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RESIDENTIAL ZONE 2

Residential Zone 2- Indicative Network

4.12. This area consists of two parcels which will drain surface water runoff to the same location. We have assumed that up to 65% of this catchment could be hardstanding and have included a 10% allowance for urban creep (75% total).

Residential Area 2 = 40040m² @ 75% PIMP = 30030m² Hardstanding Area.

Residential Zone 2- Indicative Route

4.13. Runoff generated by the area will be collected and conveyed by an underground network to a new attenuation pond/basin on the new Tetchill boundary. Flows from this attenuation structure will then discharge to the brook at the agreed rate. The indicative route has been shown in **Figure 4.3** and a full-size plan has been included within **Appendix I1**.

Residential Zone 2- Flow Rate

4.14. SW flows has been restricted to the rates shown in **Table 4.2**.

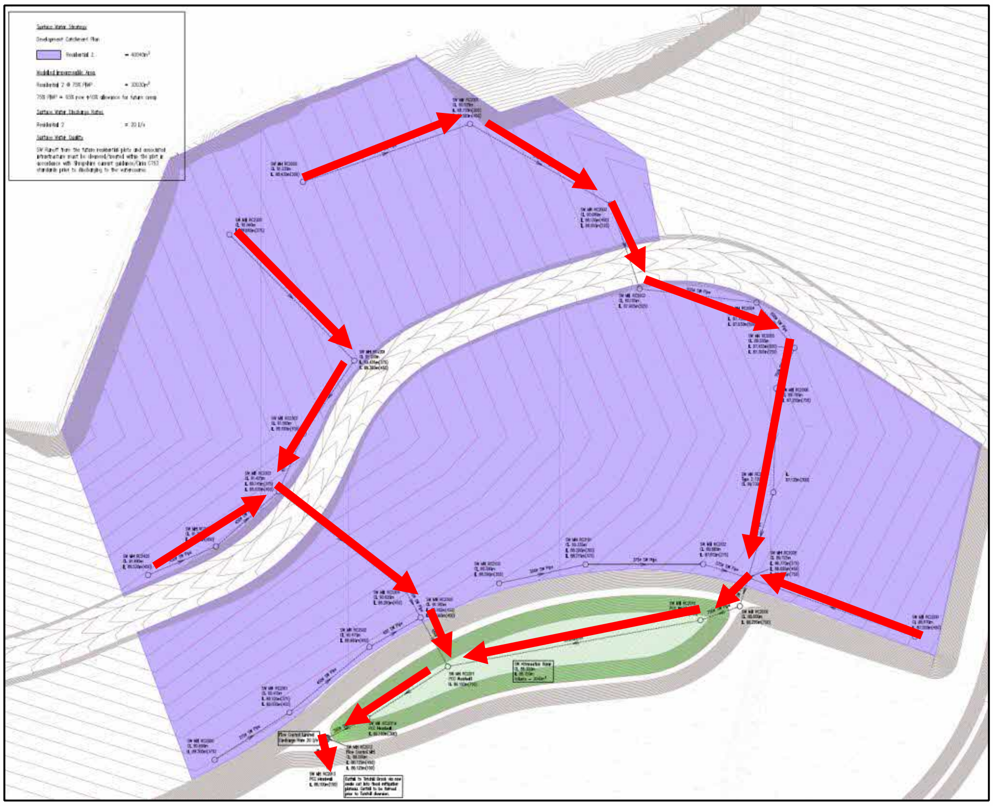

Figure 4.3 Residential Zone 2 Drainage

Residential Zone 2- Microdrainage Simulation

4.15. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

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Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	13.48	20.78	36.74	50.11
Peak Runoff (l/s)	N/A	13.20	14.40	17.60	22.50

Table 4.4 Residential Zone 2 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.16. A copy of the Microdrainage files have been included within **Appendix I2**.

Residential Zone 2 – Sensitivity Check

4.17. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 1.01 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.000m Node 17 BWB Flood Risk Assessment).

4.18. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.19. A copy of the Microdrainage files have been included within **Appendix I3**.

RESIDENTIAL ZONE 3 & HOLIDAY CABINS 1

Residential Zone 3 & Holiday Cabins 1- Network

4.20. This network services two catchments which drain to the same location: Residential Zone 3 and Holiday Cabins 1. This is primarily due to the onsite constraints and the existing gas main which will drain surface water runoff.

4.21. As per the previous residential areas, we have assumed that up to 75% of the residential catchment (65% plus a 10% urban creep allowance) and up to 30% of the holiday cabins could be hard standing.

Residential Area 2 = 31920m² @ 75% PIMP = 23940m² Hardstanding Area.

Holiday Cabin 1 = 12005m² @ 30% PIMP = 3600m² Hardstanding Area.

Residential Zone 3 & Holiday Cabins 1- Indicative Route

4.22. Runoff generated by the residential area will be collected and conveyed by an underground network to a new attenuation pond/basin to the east of the new Tetchill boundary. Runoff from Holiday Cabins will also be brought to the same attenuation point via an underground network.

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4.23. Flows from this attenuation structure will then discharge to the brook at the agreed rate. The indicative route has been shown in **Figure 4.4** and a full-size plan has been included within **Appendix J1**.

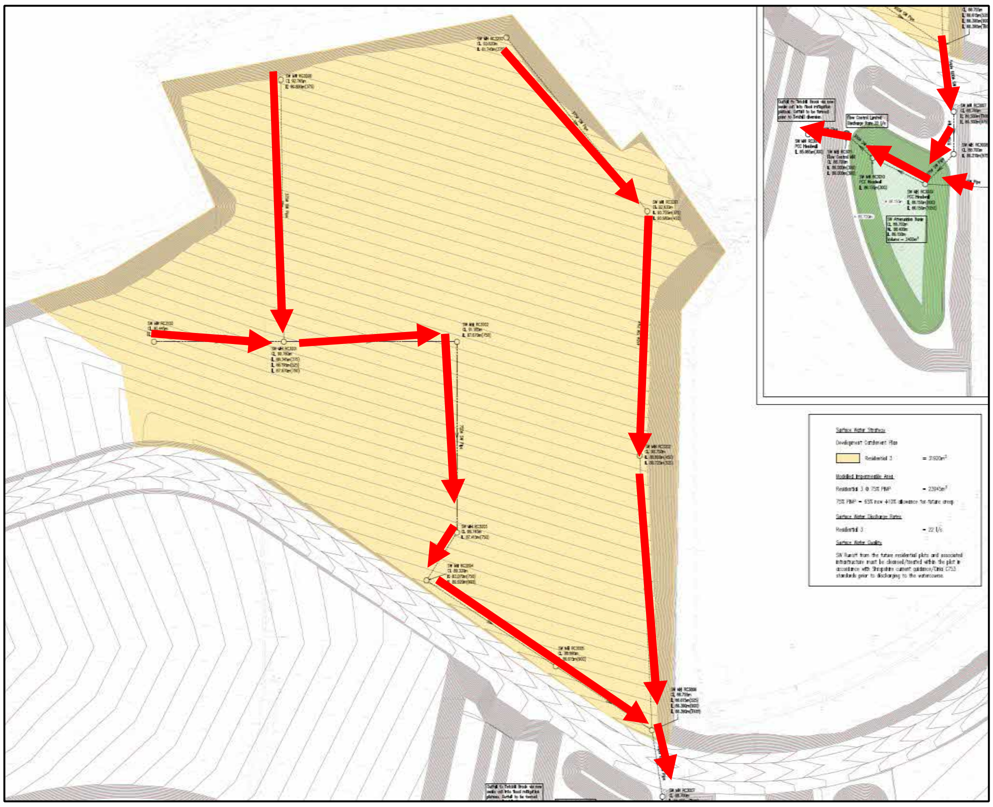

Figure 4.4 Residential Zone 3 Drainage

Residential Zone 3 & Holiday Cabins 1- Flow Rate

4.24. SW flows has been restricted to the rates shown in **Table 4.5.**

Return Period	2	5	30	100
Residential 3 Flow Rates (l/s) (Table 4.2)	10.74	16.57	29.29	39.95
Holiday Cabin 1 Flow Rates (l/s) (Table 4.2)	4.04	6.23	11.01	15.02
Allowable Discharge Rate (l/s)	14.78	22.80	40.30	54.97

Table 4.5 Residential Zone 3 & Holiday Cabins 1 – Flow Rate

Residential Zone 3 & Holiday Cabins 1- Microdrainage Simulation

4.25. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

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Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.5)	N/A	14.78	22.80	40.30	54.97
Peak Runoff (l/s)	N/A	12.90	15.60	33.90	53.30

Table 4.6 Residential Zone 3 & Holiday Cabins 1 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.26. A copy of the Microdrainage files have been included within **Appendix J2**.

Residential Zone 3 – Sensitivity Check

4.27. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 1.035m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.000m Node 19 BWB Flood Risk Assessment).

4.28. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.29. A copy of the Microdrainage files have been included within **Appendix J3**.

CARAVAN PARK

Caravan Park - Network

4.30. We have assumed that up to 30% of the caravan park catchment could be hard standing.

Caravan Park = 22355m² @ 30% PIMP = 6706m² Hardstanding Area.

Caravan Park - Indicative Route

4.31. Runoff generated by this area will be collected and conveyed by an underground network to a new outfall at Tetchill Brook. An underground cellular tank will provide the required attenuation on this plot and the indicative drainage route has been shown in **Figure 4.5.** A full-size plan has been included within **Appendix K1**.

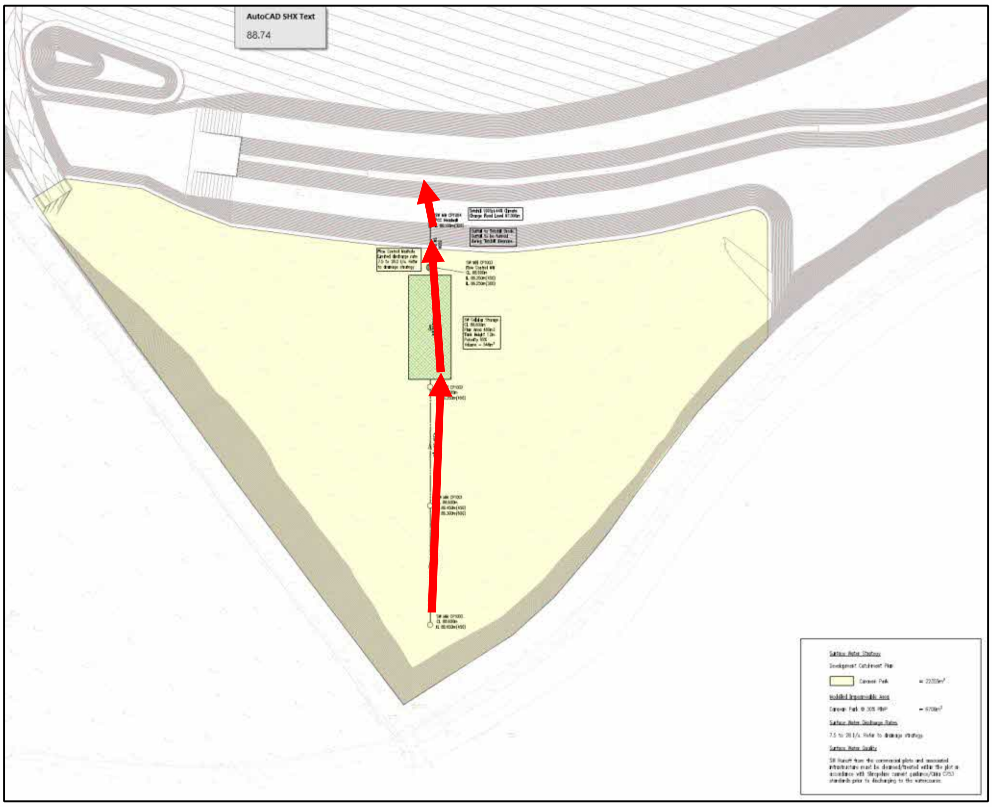

Figure 4.5 Caravan Park Drainage

Caravan Park - Flow Rate

4.32. SW flows has been restricted to the rates shown in **Table 4.2**.

Caravan Park - Microdrainage Simulation

4.33. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	7.52	11.60	20.51	27.98
Peak Runoff (l/s)	N/A	6.7	7.6	9.8	14.0

Table 4.7 Residential 3 & Holiday Cabins 1 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.34. A copy of the Microdrainage files have been included within **Appendix K2**.

Caravan Park - Sensitivity Check

4.35. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 900mm surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.000m Node 16 BWB Flood Risk Assessment).

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4.36. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.37. A copy of the Microdrainage files have been included within **Appendix K3**.

HOLIDAY CABINS 2

Holiday Cabins 2 - Network

4.38. This network services the eastern half of the Holiday Cabins area and we have assumed that up to 30% of this area could be hard standing.

Holiday Cabin 2 = 17230m² @ 30% PIMP = 5170m² Hardstanding Area.

Holiday Cabins 2 - Indicative Route

4.39. Runoff generated by this area will be collected and conveyed by an underground network to a new attenuation pond/basin to the eastern edge of this plot. Flows from this attenuation structure will then discharge to the brook at the agreed rate. The indicative route has been shown in **Figure 4.6** and a full-size plan has been included within **Appendix L1**.

Holiday Cabins 2 - Flow Rate

4.40. SW flows has been restricted to the rates shown in **Table 4.2**.

Holiday Cabins 2 - Microdrainage Simulation

4.41. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	5.80	8.94	15.81	21.56
Peak Runoff (l/s)	N/A	4.00	4.00	4.20	6.10

Table 4.8 Holiday Cabins 2 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.42. A copy of the Microdrainage files have been included within **Appendix L2**.

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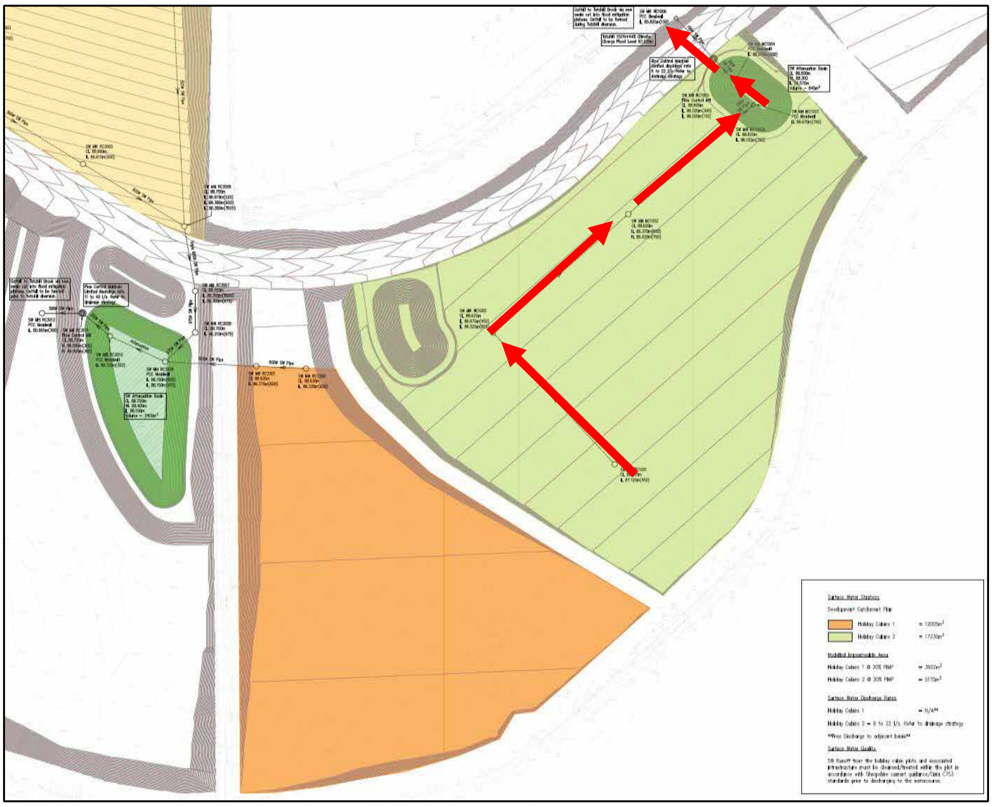

Figure 4.6 Holiday Cabin 2 Drainage

Holiday Cabins 2 - Sensitivity Check

4.43. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 1.210 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.030m Node 21 BWB Flood Risk Assessment).

4.44. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.45. A copy of the Microdrainage files have been included within **Appendix L3.**

COMMERCIAL 3

Commercial 3 - Network

4.46. This network services the commercial area on the northern boundary just off Scotland Street. We have assumed that up to 65% of this area could be hard standing.

Commercial 1 = 5645m² @ 65% PIMP = 4235m² Hardstanding Area.

Commercial 3 - Indicative Route

4.47. Runoff generated by this area will be collected and conveyed by an underground network to a new outfall to Newness Brook. An underground cellular tank would provide the required attenuation on this plot and the indicative drainage route has been shown in **Figure 4.7.** A full-size plan has been included within **Appendix M1.**

Commercial 3 - Flow Rate

4.48. SW flows has been restricted to the rates shown in **Table 4.2.**

Commercial 3 - Microdrainage Simulation

4.49. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	1.90	2.93	5.18	7.06
Peak Runoff (l/s)	N/A	1.90	2.20	2.70	3.70

Table 4.9 Commercial 3 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.50. A copy of the Microdrainage files have been included within **Appendix M2.**

Figure 4.7 Commercial 3 Drainage

Commercial 3 - Sensitivity Check

4.51. During the most extreme storm events, the water level within the adjacent Newness Brook will increase and could submerged the surface water outfall. We have therefore used a 0.370 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.870 m Node 9 BWB Flood Risk Assessment).

4.52. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.53. A copy of the Microdrainage files have been included within **Appendix M3.**

LEISURE 1

Commercial 1 - Network

4.54. This network services the Leisure area on the eastern boundary of the PDS. We have assumed that up to 65 % of this area could be hard standing.

Commercial 2 = 22550m² @ 65% PIMP = 14660m² Hardstanding Area.

Leisure 1 - Indicative Route

4.55. Runoff generated by this area will be collected and conveyed to a new outfall on the Tetchill Brook. Due to the constraints on this plot a new attenuation pond/basin will be positioned close to the head of the network and will enable restricted flows to back up into it. The indicative route has been shown in **Figure 4.8** and a full-size plan has been included within **Appendix N1**.

Leisure 1 - Flow Rate

4.56. SW flows has been restricted to the rates shown in **Table 4.2**.

Leisure 1 - Microdrainage Simulation

4.57. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	7.59	11.70	20.69	28.22
Peak Runoff (l/s)	N/A	6.7	6.7	6.7	23.0

Table 4.10 Leisure 1 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.58. A copy of the Microdrainage files have been included within **Appendix N2.**

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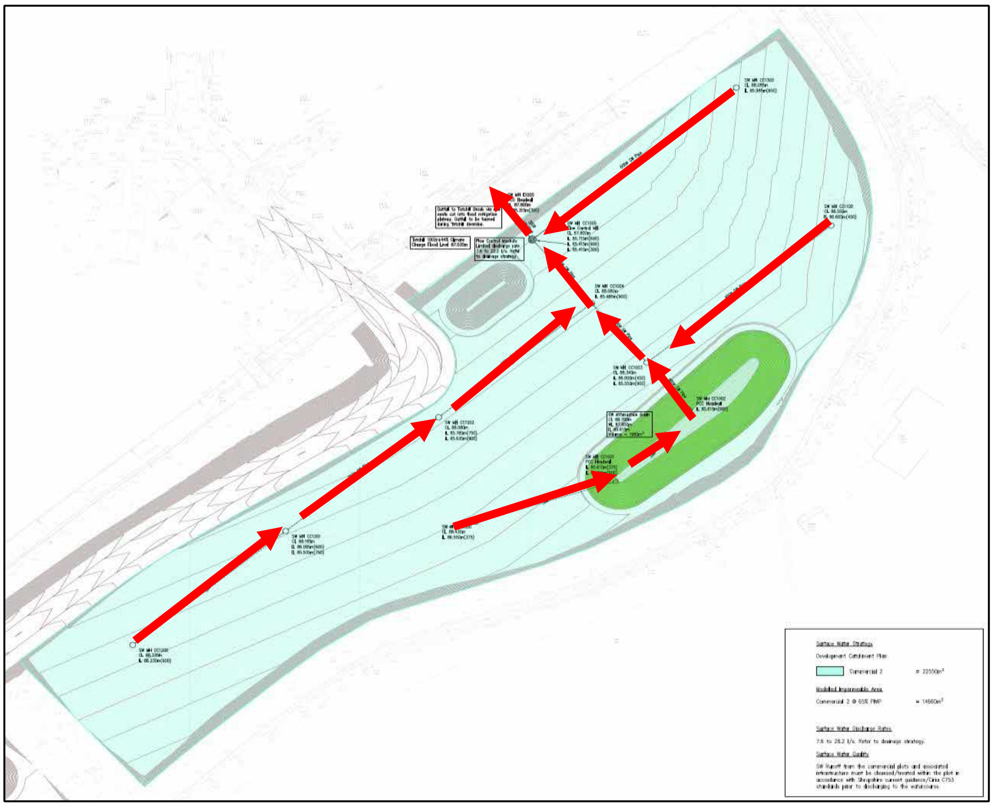

Figure 4.8 Leisure 1 Drainage

Leisure 1 - Sensitivity Check

4.59. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 1.715 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Tetchill (87.030 m Node 19 BWB Flood Risk Assessment).

4.60. During the surcharged conditions the network shows minor flooding at the flow control chamber (0.82 m^3). This levelling of flood can be accommodated within the development does not pose a pose a potential flood risk to this plot or downstream.

4.61. A copy of the Microdrainage files have been included within **Appendix N3.**

COMMERCIAL 1

Commercial 1 - Network

4.62. This network services the plot referenced as Commercial 1 and will most likely be a food store. We have assumed that up to 75% of this area could be hard standing.

Retail 1 = 8215m² @ 30% PIMP = 6160m² Hardstanding Area.

Commercial 1 - Indicative Route

4.63. Runoff generated by this area will be collected and conveyed by an underground network to a new outfall formed on the diverted ordinary watercourse. An underground cellular tank would provide the required attenuation on this plot and the indicative drainage route has been shown in **Figure 4.9.** A full-size plan has been included within **Appendix O1**.

Commercial 1 - Flow Rate

4.64. SW flows has been restricted to the rates shown in **Table 4.2**.

Commercial 1 - Microdrainage Simulation

4.65. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	2.76	4.26	7.54	10.28
Peak Runoff (l/s)	N/A	2.70	3.0	3.8	5.3

Table 4.11 Commercial 1 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.66. A copy of the Microdrainage files have been included within **Appendix O2**.

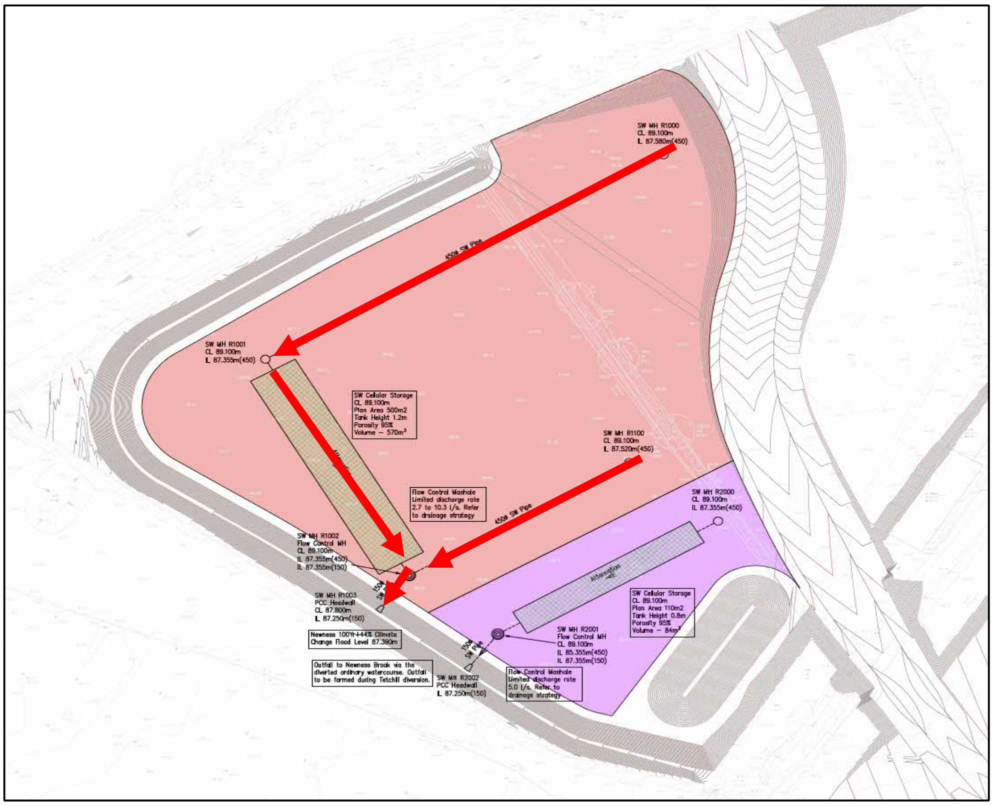

Figure 4.9 Commercial 1 Drainage

Retail 1 - Sensitivity Check

4.67. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 0.140 m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Newness Brook (87.390 m Node 11 BWB Flood Risk Assessment).

4.68. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.69. A copy of the Microdrainage files have been included within **Appendix O3.**

COMMERCIAL 2

Commercial 2 - Network

4.70. This network services the plot referenced as Commercial 2. Potential uses for this plot are unknown so we have assumed that up to 75% of the area could be hard standing.

Retail 2 = 1730m² @ 30% PIMP = 1300m² Hardstanding Area.

Commercial 2 - Indicative Route

4.71. Runoff generated by this area will be collected and conveyed by an underground network to a new outfall formed on the diverted ordinary watercourse. An underground cellular tank would provide the required attenuation on this plot and the indicative drainage route has been shown in **Figure 4.10.** A full-size plan has been included within **Appendix P1**.

Commercial 2 - Flow Rate

4.72. SW flows has been restricted to the rates shown in **Table 4.2**.

Commercial 2 - Microdrainage Simulation

4.73. The indicative network has been modelled within Microdrainage to check its suitability. and show that the proposed network and downstream attenuations are adequate.

Return Period	1	2	5	30	100
Permitted Peak Runoff (l/s) (Table 4.2)	N/A	5			
Peak Runoff (l/s)	N/A	3.6	4.0	4.4	4.5

Table 4.12 Residential 3 & Holiday Cabins 1 - Simulation Results

Note: FEH 2013 Data is unavailable for 1 year return periods.

4.74. A copy of the Microdrainage files have been included within **Appendix P2**.

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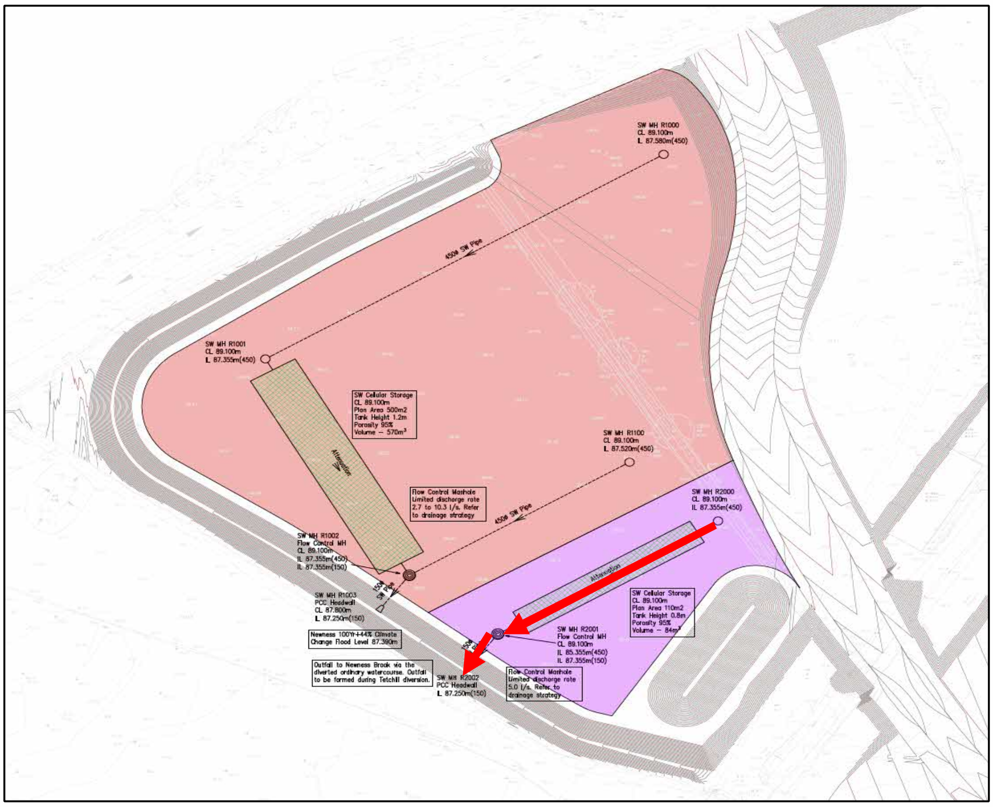

Figure 4.10 Commercial 2 Drainage

Commercial 2 - Sensitivity Check

4.75. During the most extreme storm events, the water level within the adjacent Tetchill Brook will increase and could submerged the surface water outfall. We have therefore used a 0.140m surcharge on the outfall which is equivalent to the 100-year plus 44% flood level in the Newness Brook (87.390m Node 11 BWB Flood Risk Assessment).

4.76. During the surcharged conditions the network is shown to operate as normal and does not pose a potential flood risk to the adjacent developments and/or downstream.

4.77. A copy of the Microdrainage files have been included within **Appendix P3.**

SECTION 5 CONCLUSION

Enabling Works Strategy

5.1. This Drainage Strategy for the Canalside Development, Ellesmere, provides evidence that the proposed enabling works i.e., the site wide earthworks, main spline road and the major infrastructure can be undertaken/carried out without having an adverse effect on the future plots/phases or downstream developments.

5.2. The main spline road will be limited to a total discharge rate of 25 l/s which will be distributed across the required catchments. This restriction applies to all return as shown in **Table 3.6 & 5.1** and is not a linear discharge rate.

Return Period	1	2	5	30	100
Highway A	N/A	5			
Highway B		5			
Highway C		5			
Highway D		5			
Highway E		5			
Enabling Works Runoff (l/s)	**N/A**	**25**			
Greenfield Peak Runoff (l/s)	N/A	95.7	131.3	209.1	274.3
Remaining Peak Runoff (l/s)	**N/A**	70.7	106.3	184.1	249.3

Table 5.1 Highway Surface Water Restrictions

5.3. Runoff from the main spline road will receive at least two forms of treatment as per Shropshire Guidelines. The current proposals include carrier filter drains within a verge and downstream attenuation basin/ponds. Should the proposals differ during the detailed design stage then an appropriate alternative must be used.

Future Plot/Phase Strategy

5.4. The future plots/phases will be provided the remaining greenfield allowance (shown in **Table 5.1**) will be redistributed once the proposals are firmed up. However, to safeguard the site, SGi have created/developed a series of indicative drainage proposals to provide evidence that the future works can function adequately.

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Future Plot/Phase Water Quality

5.5. The onsite infrastructure/onsite waterbodies will only receive clean/treaded runoff. This treatment will be in accordance with Ciria C753 as discussed in **Section 2**. The future Plots/Phases will provide/develop their own treatment proposals during the detail design stage.

Climate Change

As per the latest Environment Agency guidelines. An additional climate change allowance of 45% has been included on all drainage proposals presented in this report and will be apply to both the enabling works and the future plots/phases.

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