

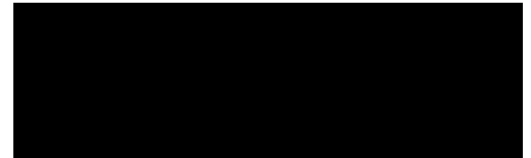
DAPPERS LANE, ANGMERING
DRAINAGE STATEMENT

FRONTIER

23 SEPTEMBER 2021



Abley Letchford Partnership Limited
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Charnham Park
Hungerford
RG17 0YT



Quality Management:

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1.0 Introduction

Context

- 1.1. Abley Letchford Partnership has produced this Drainage Statement with regards to Frontier interests in respect of the development of Dappers Lane, Angmering.
- 1.2. Development will accommodate Demolition & erection of 70 bed care home within Use Class C2, access, parking, landscaping and other associated works (Arun District Council (ADC) planning application reference: A/114/18/PL). This permission was granted in May 2019.
- 1.3. This statement provides written evidence to support the overall site discharge of planning conditions and should be read in conjunction with drawings associated with those packages.
- 1.4. This statement draws upon supporting work undertaken at planning stage on landscape, ecology and drainage design and presents a summary of the overall drainage parameters and design.

Sources of Information

- 1.5. A Flood Risk Assessment (FRA) dated July 2018 has been carried out by ambiental, Ref: 3834/SWDS & FRA Final v1.0, to accompany the planning application for the site, in addition to a Surface and Foul Water Drainage Strategy drawing 3834/01 Rev C. These have been consulted in order to inform the proposed drainage strategy for the site.
- 1.6. A geotechnical investigation was carried out by Southern Testing alongside further investigations on infiltration and ground water. This has been consulted in order to inform the proposed drainage strategy for the site. Furthermore, a drainage survey was undertaken on the existing surface water drainage to establish connections and discharge routes.
- 1.7. In addition to the above approved planning documents, winter infiltration testing and groundwater monitoring was requested by Arun DC, which was carried out in October 2020 to April 2021 by Southern Testing. The results of which are contained within the appendix and have been consulted in order to inform the proposed drainage strategy for the site.
- 1.8. A desktop study of the site was carried out using the sources mentioned previously together with information from the Environment Agency, British Geological Survey, and GOV.uk websites to ascertain local features, geology, hydrology and soil characteristics.
- 1.9. Flood mapping and site characteristics, as published on the Environment Agency's (EA) and the GOV.uk websites, has been used as an information source. Guidance set out within the NPPF, the SFRA, and EA Guidance has also been used as the base for this assessment.

Statement Structure

- 1.10. This statement addresses the requirements of the planning conditions and NPPF and considers the following aspects:



- Section 2: Baseline Environmental Conditions – a description of the site location, its topography and hydrology.
- Section 3: Drainage Strategy – flood risk from the site and appropriate mitigation measures to protect the site post development including surface water and foul water drainage strategies.



2.0 Baseline Environmental Conditions

Introduction

- 2.1. This chapter provides for a description of the site location, its topography and hydrology.

Site Location

- 2.2. The site is located to the east of the village of Angmering, West Sussex. The site is bordered to the north by existing industrial buildings; to the east by open fields; to the south by Water Lane and to the west by Dappers Lane.
- 2.3. Overall the site covers approximately 0.72 hectares (Ha).
- 2.4. The site lies within the administrative area of Arun District Council (Arun DC), with West Sussex County Council (ESCC) being the Lead Local Flood Authority (LLFA).

Existing Site

- 2.5. The site comprises principally scrub land with mature trees, scrub and hedgerows. There is existing impermeable area of hardstanding and a previous building
- 2.6. The topography of the site falls, from a high point of approximately 15.5m AOD on the northern boundary to a low point of approximately 9.00m AOD in the far south west of the site.
- 2.7. A copy of the topographical survey has been included in design packages.

Existing Drainage

- 2.8. The site currently drains mainly by infiltration with some evaporation and greenfield runoff.
- 2.9. Public sewer records obtained from Southern Water confirm there are no public surface water sewers within, or in the vicinity of, the site.
- 2.10. There is a drainage ditch along the southern boundary of the site which takes run off from Water Lane but also from the site. Site investigations have discovered this drainage ditch drains, via a 150mm pipe, into a highway drain and manhole located in the footway adjacent to the south west corner of the site.
- 2.11. The highway drain takes flow from Water Lane and Dappers Lane and discharges west along Water Lane in a 600mm drain before turning south and discharging into the Black Ditch which lies adjacent to the southern side of Water Lane.
- 2.12. However, although there is a positive connection from the site into the highway drain, as stated above the northern part of the site drains by infiltration into the ground. This is reinforced by the geological mapping and surveys, and the infiltration testing that has taken place.
- 2.13. Infiltration testing adjacent to Water Lane suggested infiltration was not viable in the southern portion of the site, therefore to the far south of the site this area drains by run off into the aforementioned drain and Black Ditch.



Flood Risk

- 2.14. The site is located in Flood Zone 1 (Low Probability) - land assessed as having a less than 0.1% (1 in 1000) annual probability of river or sea flooding. There is no flood risk from any other sources.

Geology

- 2.15. The British Geological Survey record plans for the area, indicates superficial Head Deposits (clay, silt, sand and gravel), over Bedrock geology comprises Lambeth Group (clay, silt and sand), and Tarrant Chalk Member (chalk) to the south. The geotechnical assessments and infiltration testing confirm the soil and bedrock properties.

Hydrogeological

- 2.16. The Environment Agency has classified the superficial geology as a Secondary Aquifer with the underlying bedrock classified as a Secondary A Principal Aquifer.
- 2.17. There are no active groundwater abstraction licences or potable water abstraction licenses within 500m of the site. The site is not recorded to be within 500m of a Groundwater Source Protection Zone.

Groundwater

- 2.18. Groundwater monitoring was carried out between October 2020 and April 2021. In the north of the site no groundwater was encountered in three of the wells with one strike at 3.10 m deep in the other. In the south of the site groundwater was encountered at approximately 1.80m deep.
- 2.19. During further monitoring water was encountered in all wells but deeper in the north than the south, although all groundwater in the south was below ground level (810mm or greater) with no water coming to surface.

Infiltration

- 2.20. Infiltration testing was undertaken by Southern Testing, in March 2021. This recent testing was classified as 'winter testing' and was undertaken in dialogue with Arun DC. The full report is within the Appendix.
- 2.21. Due to the groundwater monitoring infiltration testing was undertaken in the north of the site only and not the south due to the high groundwater encountered.
- 2.22. Winter testing to BRE 365 resulted in infiltration rates of between 2.87×10^{-4} m/s to 7.90×10^{-5} m/s again confirming infiltration is very viable on the site. This was undertaken at a greater range of depths and locations across the site, hence the variations in results, and no groundwater was encountered.

Southern Testing Infiltration Testing Summary

Location	Average Infiltration Rate	Notes
TP201	1.38×10^{-4}	Three tests carried out
TP202	2.87×10^{-4}	Three tests carried out
TP203	7.90×10^{-5}	Three tests carried out
TP204	2.37×10^{-4}	Three tests carried out



3.0 Drainage Strategy

Introduction

- 3.1. This chapter provides details on an indicative foul and surface water drainage strategy and measures to drain the Development.

Methodology

- 3.2. The drainage strategy has been designed to achieve the requirements of NPPF and utilise a comprehensive Sustainable Drainage System (SuDS).

Management Strategy

- 3.3. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. Changes of land use can have significant downstream impacts where existing drainage systems may not have sufficient capacity for any additional surface water flow.
- 3.4. A surface water management strategy for the development will be required to manage and reduce the flood risk posed by the surface water runoff from the site.
- 3.5. There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations 2010. Rainwater shall discharge to one of the following, listed in order of priority:
- An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
 - a watercourse; or where that is not reasonably practicable,
 - a sewer
- 3.6. Due to the nature of the ground and the existing drainage characteristics of the site it is proposed to discharge surface water runoff from the northern side of the building into the ground via infiltration with the southern side of the building into the watercourse on the southern boundary.
- 3.7. Impermeable areas for the building and associated hardstanding areas such as driveways and roads will be calculated and discharged into the appropriate SuDS feature.

Sustainable Drainage (SuDS)

- 3.8. Sustainable water management measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.
- 3.9. Current guidance, CIRIA (2004) Report C609, provides that a hierarchy of techniques should be identified, namely:



- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a detention pond or wetland.

3.10. In 2015 CIRIA published The SuDS Manual (C753) providing best practice guidance on the planning, design, construction, operation and maintenance of SuDS.

3.11. The SuDS Manual provides guidance to ensure SuDS are planned and designed to maximise the opportunities and benefits of surface water management.

3.12. The four main categories of benefits that can be achieved by SuDS, referred to as the four pillars of SuDS design, are:

- **Water quantity** – control the quantity of runoff to support the management of flood risk, and maintain and protect the natural water cycle
- **Water quality** – manage the quality of the runoff to prevent pollution
- **Amenity** – create and sustain better places for people
- **Biodiversity** – Create and sustain better places for nature

3.13. Given that infiltration type SuDS devices are feasible on the site the following SuDS components applicable to the site could include:

- **Pervious surfacing systems** – structural surfaces that allow water to penetrate thus providing storage and treatment, e.g. pervious paving.
- **Infiltration systems** – components that facilitate the infiltration of water into the ground.
- **Conveyance systems** – components that convey flows to downstream storage systems, e.g. swales, filter drains.
- **Storage systems** – components that control flows, and possibly volumes, by storing water and releasing it slowly, e.g. ponds, wetlands and detention basins.
- **Treatment systems** – components that remove or facilitate the degradation of contaminants present in runoff, e.g. filter strips, proprietary treatment systems.

Pre and Post Development Surface Areas

3.14. The existing site is predominantly Greenfield with areas of impermeable area. However, the quantum of development will increase the impermeable area and surface water runoff.

3.15. Post development impermeable areas have been calculated using the layout masterplan to determine the area of the proposed roads, dwellings and hardstanding.



Greenfield Run Off Rates

- 3.16. In accordance with the approved FRA all surface water run off from the site, where there is a positive offsite discharge, will be limited to the Greenfield mean annual runoff QBAR for all events up to the annual probability 1 in 100 year storm event plus 40% climate change. This provides considerable benefit in overall run off rates both in the short and long term with an allowance made for climate change.
- 3.17. The Greenfield run off rates in accordance with the approved FRA are:
- QBAR – 1.94 l/s/ha
 - 1 in 1 Year – 1.65 l/s/ha
 - 1 in 30 Year – 4.47 l/s/ha
 - 1 in 100 Year – 6.19 l/s/ha
- 3.18. As the impermeable area for the site is small, and the restriction in discharge would not be practical, ADC have confirmed the minimum orifice control size they accept is 50mm diameter. Therefore, any positive discharge rate is set by the minimum orifice size as opposed to Greenfield discharge rates.

Surface Water Treatment Improvements

- 3.19. Notwithstanding the requirement to provide improvements in water quality due to proposed development, the location of the site in respect to the adjacent sensitive receptors, such as the Black Ditch, necessitates additional consideration.
- 3.20. CIRIA report C753 The SuDS Manual outlines the methodology for assessing water quality risks associated with new development. This is a simple index approach which provides a high level scoping analysis of the land usage and gives guidelines for appropriate treatment stages.
- 3.21. This process identifies features necessary to provide adequate substance removal in line with Environment Agency requirements. This is a three step process of Allocation, Mitigation and Review.
- 3.22. Surfaces generating runoff are 'graded' on their potential to contribute to various harmful pollutants and gives each surface a risk of pollution from each element.
- 3.23. Historically, PPG3 documentation would recommend that pollutants were removed utilising oil separators, but since its superseding, more recent guidance has shifted to the use of SuDS features to remove pollutants; thereby providing significant improvements in treatment. The use of non-mechanical features also decrease the requirements for maintenance and increase natural biodiversity.
- 3.24. Without adequate treatment, the pollutants could cause damage if they were to enter the watercourse or water table in large volumes. The use of SuDS features to slow down and degrade these pollutants informs the provision of an acceptable drainage scheme.



SuDS Features

- 3.25. The surface water strategy proposes utilising a number of Sustainable Drainage System techniques (SuDS) to attenuate surface water runoff. The selection of the most appropriate SuDS needs to consider existing constraints, ownership and maintenance issues. To that end, the most suitable SuDS features that could be incorporated into this site are:
- Swales;
 - Permeable paving; and
 - Cellular storage.
- 3.26. The banks of the SuDS features are designed with a maximum gradient of 1 in 4 and an appropriate freeboard above the maximum water level. This allows landscaping of both wetland and wildflower mixes to provide an appropriate landscape context in the vicinity of the features. This provides aesthetic interest to the features as well as assisting in maintenance.
- 3.27. A 3m maintenance area is allowed between the top of water level, plus freeboard, and any external feature, such as hedges, boundaries, etc, to allow for continuing maintenance.
- 3.28. Open SuDS features are designed so as not to compromise the safety of residents, visitors and their property. Generally open boundaries are provided, and perimeter planting could be utilised to define the extents of the features.
- 3.29. All SuDS are sized to accommodate all storms up to and including the 1 in 100 year event with a 40% allowance for climate change with an appropriate freeboard.
- 3.30. The proposals draw reference to the DEFRA document *Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems* March 2015, as well as CIRIA C753 *The SuDS Manual*. In addition, all designs would be in accordance with best practice as stipulated in EA Report SC030219 'Rainfall Runoff Management for Developments'.
- 3.31. The utilisation of Sustainable Drainage Systems (SuDS) provides not only the benefit of controlling waters at source and on-line treatment of collected waters but also allows enhanced aesthetics and biodiversity.

Adoption and Ownership

- 3.32. The drainage system is designed to the appropriate standards including Sewers for Adoption, the Building Regulations and the requirement of the National Planning Policy Framework
- 3.33. The intention of adoption and ownership of drainage and SuDS is as follows:
- All Surface water drains to be maintained by a management company associated with the Care Home owners.
 - Foul sewers within development parcels to be offered for adoption to Southern Water under the Section 104 process of the Water Industry Act.
 - Above and below ground attenuation within development parcels (i.e. swales, porous paving and cellular storage) to be maintained by a private maintenance company associated with the Care Home owners.



SuDS Maintenance Strategy

- 3.34. For the water treatment effects of SuDS features to remain effective, a comprehensive maintenance strategy will be implemented.
- 3.35. During construction, maintenance of SuDS features will be undertaken by the Contractor. Upon completion, the assets will be passed over to the Management Company or community group commissioned to maintain the features in perpetuity.
- 3.36. A regular maintenance regime will be created, which consists of several primary measures required to ensure the longevity of the system. These should be undertaken on a regular basis to ensure consistent performance. Typical maintenance activities consist of:
- Inspecting and reporting; relatively regular review of the condition identifying issues and providing resolutions. Periodic review from the maintenance contractor;
 - Litter and debris removal;
 - Grass trimming, overall cutting and localised strimming preventing blockages;
 - Weed and evasive plant control;
 - Shrub management;
 - Aquatic and shoreline vegetation management;
 - Sweeping pervious surfaces; and
 - Oil removal from proprietary systems.
- 3.37. A remedial maintenance schedule will be recommended as part of the handover of the SuDS features. Remedial maintenance is required to provide repairs to the system and monitor long term damage ensuring the system remains consistently productive. The schedule would consist of;
- Structure rehabilitation and repair;
 - Infiltration surface rehabilitation;
 - Scarifying to remove “Thatch”;
 - Spiking or Tining the soil;
 - Air pressure treatment.
- 3.38. The maintenance schedule contents and timing will depend upon multiple factors including usage, contents of water utilising the system, location and biology.

Surface Water Drainage Strategy

- 3.39. A surface water management strategy for the proposed development has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. The drainage system for the proposed development will manage and reduce the flood risk posed by the surface water runoff from the site.



- 3.40. All designs would be in accordance with best practice as stipulated in EA Report SC030219 'Rainfall Runoff Management for Developments'.
- 3.41. In the first instance a traditional network of trapped gullies and pipes collect surface water run-off from roofs. A traditional drainage system for the impermeable areas has been utilised to provide a system that can be checked, cleaned and maintained efficiently.
- 3.42. All roads and car park areas will drain directly to the ground through porous paving.
- 3.43. All surface water drainage pipes have been designed to cater for the 1 in 30 year storm event, in accordance with industry standard, with all attenuation features designed to allow for the 1 in 100 year storm event plus 40% climate change allowance.
- 3.44. The traditional pipe system works in combination with swales, porous paving and cellular storage to provide treatment and attenuation storage, and high water quality benefits, with flow restricted by a proprietary device (e.g. Hydrobrakes) to ensure waters are released at the correct Greenfield rate.
- 3.45. The SuDS features are a mixture of swales, porous paving and cellular storage designed to fill in excess storms.
- 3.46. For the northern side of the building and all the roads and parking areas all surface water will drain into the porous paving and into the ground by infiltration. In agreement with ADC the invert level of the porous paving is above the highest groundwater level recorded through groundwater monitoring, although as confirmed by ADC, the minimum 1m clearance from invert level to groundwater level is not required. However, the drainage scheme has been kept as shallow as possible to provide freeboard to the groundwater.
- 3.47. Furthermore, all incoming pipes, from the building into the porous paving, are above the 1 in 10 year storm event plus 40% climate change allowance.
- 3.48. The southern side of the building will drain into a traditional pipe network with discharge controlled by a Hydrobrake, with a minim 50mm orifice, with excess flows stored in cellular storage.
- 3.49. Surface water discharge will be to a swale prior to discharging into the existing highway ditch on the sites southern boundary and the wider highway drain network which eventually discharges to the Black Ditch. The swale provides further opportunity to filtrate any particulates and discharge into the ground through infiltration, or by evapotranspiration to the surrounding vegetation and trees.
- 3.50. Calculations to show the proposed drainage scheme and SuDS features are able to accommodate excess flows from storm events up to and including the 1 in 100 year event with a 40% allowance for climate change are provided in the appendix. The drainage strategy is shown on ALP drawings A360 – 01 Rev B.
- 3.51. Flows in excess of the above design storms, which may flood from the network, are directed into depressions within the grounds or held in the car park, to ensure that no onsite or offsite residential units are affected by flood waters.

Foul Water Drainage Strategy.

- 3.52. Southern Water (SW) Sewer records indicate that there is a network of foul water sewers within the locality of the Application Site.



- 3.53. A 150mm diameter foul water sewer is located to the south west of the site in Water Lane. The nearest manhole is MH2501.
- 3.54. A foul water Impact study undertaken by Southern Water, at planning stage, identified that capacity is available within the sewer in Water Lane to accommodate the proposed foul water flows.
- 3.55. A new connection will need to be constructed from the site in Dappers Lane and Water Lane to MH2501 to connect the development to the existing Southern Water network. This, alongside the onsite foul water sewers will be offered for adoption to Southern Water.
- 3.56. Section 104 technical approval alongside a Section 106 connection approval will be gained with Southern Water to these connections as detailed above.

Site Drainage Summary

- 3.57. It has been demonstrated that surface water from the site can be managed such that flood risk to and from the site following development is not increased.
- 3.58. It has been demonstrated that foul water from the site can be managed such that it does not have a detrimental effect to the foul sewer network.



Appendices



Appendix 1 – Calculations

Drainage Simulation Calculations

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	9.999
CV	0.750	Preferred Cover Depth (m)	0.600
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1A		5.00	14.550	600	507344.197	104704.518	0.750
1B			14.120	600	507355.308	104699.444	0.750
1C			11.500	600	507361.350	104688.675	0.750
1	0.083	5.00	11.510	600	507356.284	104683.424	1.010
2	0.017	5.00	11.160	1200	507314.142	104657.839	1.200
2A			11.160	1200	507304.142	104657.839	1.220
-TANK IN			11.160		507313.142	104657.839	1.210
-TANK OUT			11.160		507305.142	104657.839	1.210
5	0.011	5.00	11.640	600	507279.300	104679.978	0.750
6			11.940	600	507279.300	104657.839	1.940
8	0.015	5.00	11.230	1200	507295.430	104657.839	1.390
11			10.050		507295.430	104643.728	0.500
4			14.640	600	507279.896	104688.958	0.743
3	0.019	5.00	14.910	600	507279.896	104707.571	0.700

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000_1	1A	1B	12.215	0.600	12.800	13.370	0.570	28.4	150	5.11	50.0
1.001_1	1B	1C	12.348	0.600	13.370	10.750	2.620	4.7	150	5.15	50.0
1.002_1	1C	1	7.296	0.600	10.750	10.540	0.250	29.2	150	5.22	50.0
3.000	1	2	49.301	0.600	10.500	9.960	0.540	61.3	150	6.00	50.0
1.004_1	2	-TANK IN	1.000	0.600	9.960	9.950	0.010	100.0	150	6.01	50.0
1.004	8	11	14.111	0.600	9.840	9.550	0.290	48.7	150	6.34	50.0
2.000	2A	8	8.712	0.600	9.940	9.840	0.100	87.1	150	6.18	50.0
1.003	6	8	16.130	0.600	10.000	9.840	0.160	100.8	150	5.79	50.0
1.002	5	6	22.139	0.600	10.890	10.000	0.890	24.9	150	5.53	50.0
1.001	4	5	9.000	0.600	13.897	10.940	2.957	3.0	100	5.34	50.0
1.000	3	4	18.013	0.600	14.210	13.897	0.313	59.5	100	5.31	50.0
1.006	-TANK OUT	2A	1.000	0.600	9.950	9.940	0.010	100.0	150	6.05	50.0
4.000	-TANK IN	-TANK OUT	1.000	0.600	9.950	9.950	0.000	0.0	150	6.03	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000_1	1.896	33.5	0.0	0.600	0.600	0.000	0.0	0	0.000
1.001_1	4.074	82.6	0.0	0.600	0.600	0.000	0.0	0	0.000
1.002_1	1.870	33.1	0.0	0.600	0.860	0.000	0.0	0	0.000
3.000	1.052	18.6	6.2	0.860	1.050	0.033	0.0	60	0.951
1.004_1	1.005	17.8	9.4	1.050	1.060	0.050	0.0	78	1.019
1.004	1.446	25.5	18.0	1.240	0.390	0.095	0.0	93	1.563
2.000	1.077	19.0	9.4	1.070	1.240	0.050	0.0	75	1.075
1.003	1.000	17.7	5.7	1.240	1.240	0.030	0.0	58	0.891
1.002	2.027	35.8	5.7	0.600	1.780	0.030	0.0	40	1.483
1.001	4.460	35.1	3.7	0.643	0.600	0.019	0.0	22	2.927
1.000	1.000	7.9	3.7	0.600	0.643	0.019	0.0	48	0.983
1.006	1.005	17.8	9.4	1.060	1.070	0.050	0.0	78	1.019
4.000	1.000	17.7	9.4	1.060	1.060	0.050	0.0	0	∞



Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000_1	12.214	28.4	150	PH1	14.550	13.800	0.600	14.120	13.370	0.600
1.001_1	12.948	4.7	150	PH1	14.120	13.370	0.600	11.500	10.750	0.600
1.002_1	7.298	29.2	150	PH1	11.500	10.750	0.600	11.510	10.500	0.860
3.000	49.901	91.3	150	PH1	11.510	10.500	0.860	11.160	9.960	1.050
1.004_1	1.000	100.0	150	PH1	11.160	9.950	1.050	11.160	9.950	1.060
1.004	14.111	48.7	150	PH1	11.230	9.840	1.240	10.050	9.550	0.950
2.000	8.712	87.1	150	PH1	11.160	9.940	1.070	11.230	9.840	1.240
1.003	18.130	100.9	150	PH1	11.940	10.000	1.790	11.230	9.840	1.240
1.002	22.139	24.9	150	PH1	11.640	10.899	0.600	11.940	10.000	1.790
1.001	9.600	3.0	100	PH1	14.640	13.897	0.643	11.640	10.940	0.600
1.000	18.610	59.5	100	PH1	14.910	14.210	0.600	14.640	13.897	0.643
1.006	1.000	100.0	150	PH1	11.160	9.950	1.060	11.160	9.940	1.070
4.000	1.000	0.0	150	DUMMY	11.160	9.950	1.060	11.160	9.950	1.060

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000_1	1A	600	Manhole	Adoptable	1B	600	Manhole	Adoptable
1.001_1	1B	600	Manhole	Adoptable	1C	600	Manhole	Adoptable
1.002_1	1C	600	Manhole	Adoptable	1	600	Manhole	Adoptable
3.000	1	600	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.004_1	2	1200	Manhole	Adoptable	-TANK IN		Junction	
1.004	8	1200	Manhole	Adoptable	11		Junction	
2.000	2A	1200	Manhole	Adoptable	8	1200	Manhole	Adoptable
1.003	6	600	Manhole	Adoptable	8	1200	Manhole	Adoptable
1.002	9	600	Manhole	Adoptable	6	600	Manhole	Adoptable
1.001	4	600	Manhole	Adoptable	5	600	Manhole	Adoptable
1.000	3	600	Manhole	Adoptable	4	600	Manhole	Adoptable
1.006	-TANK OUT		Junction		2A	1200	Manhole	Adoptable
4.000	-TANK IN		Junction		-TANK OUT		Junction	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
1A	507344.197	104704.518	14.550	0.750	600		0 1.000_1	13.800	150
1B	507355.308	104699.444	14.120	0.750	600		1 1.001_1	13.370	150
1C	507361.350	104688.675	11.500	0.750	600		0 1.002_1	10.750	150
1	507356.284	104683.424	11.510	1.010	600		1 1.002_1	10.500	150
2	507314.142	104657.839	11.160	1.200	1200		0 3.000	10.500	150
2A	507304.142	104657.839	11.160	1.220	1200		1 3.000	9.960	150
-TANK IN	507313.142	104657.839	11.160	1.210			0 1.004_1	9.940	150
-TANK OUT	507305.142	104657.839	11.160	1.210			1 1.004_1	9.950	150
5	507279.300	104679.978	11.640	0.750	600		0 4.000	9.950	150
							1 4.000	9.950	150
							0 1.006	9.950	150
							1 1.001	10.940	100
							0 1.002	10.899	150



Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
8	507279.300	104657.839	11.940	1.940	600		1 1.002	10.000	150
							0 1.003	10.000	150
8	507295.430	104657.839	11.230	1.390	1200		1 1.003 2 2.000	9.840 9.840	150 150
							0 1.004	9.840	150
11	507295.430	104643.728	10.050	0.500			1 1.004	9.550	150
4	507279.896	104688.958	14.640	0.743	600		1 1.000	13.897	100
							0 1.001	13.897	100
3	507279.896	104707.571	14.910	0.700	600		0 1.000	14.210	100

Simulation Settings

Rainfall Methodology	FEH-13	Drain Down Time (mins)	240
Summer CV	0.750	Additional Storage (m³/ha)	20.0
Winter CV	0.840	Check Discharge Rate(s)	x
Analysis Speed	Detailed	Check Discharge Volume	x
Skip Steady State	✓		

Storm Durations

30	120	240	480	720	1440	2880	5760	8640
60	180	360	600	960	2160	4320	7200	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
10	40	0	0
100	40	0	0

Node 8 Online Hydro-Brake® Control

Flap Valve	x
Replaces Downstream Link	✓
Invert Level (m)	9.840
Design Depth (m)	1.420
Design Flow (l/s)	1.4
Objective	(HE) Minimise upstream storage
Sump Available	✓
Product Number	CTL-SHE-0051-1400-1420-1400
Min Outlet Diameter (m)	0.075
Min Node Diameter (mm)	1200

Node -TANK OUT Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.950
Safety Factor	5.0	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	56.0	0.0	0.800	56.0	0.0	0.801	0.0	0.0

Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 96.66%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	1A	1	13.800	0.000	0.0	0.0000	0.0000	OK
30 minute summer	1B	1	13.370	0.000	0.0	0.0000	0.0000	OK
30 minute summer	1C	1	10.750	0.000	0.0	0.0000	0.0000	OK
30 minute summer	1	18	10.585	0.085	11.6	0.0797	0.0000	OK
180 minute winter	2	176	10.446	0.486	5.0	0.6854	0.0000	SURCHARGED
180 minute winter	2A	176	10.446	0.506	3.1	0.5724	0.0000	SURCHARGED
180 minute winter	-TANK IN	176	10.446	0.496	4.6	0.0000	0.0000	SURCHARGED
180 minute winter	-TANK OUT	176	10.446	0.496	7.4	26.3923	0.0000	SURCHARGED
30 minute summer	5	18	10.946	0.056	10.7	0.0319	0.0000	OK
180 minute winter	6	176	10.446	0.446	3.0	0.1262	0.0000	SURCHARGED
180 minute winter	8	176	10.446	0.606	4.3	0.8162	0.0000	SURCHARGED
30 minute summer	11	1	9.550	0.000	1.0	0.0000	0.0000	OK
30 minute summer	4	18	13.928	0.031	6.9	0.0089	0.0000	OK
30 minute summer	3	18	14.299	0.089	6.9	0.0744	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	1A	1.000_1	1B	0.0	0.000	0.000	0.0000	
30 minute summer	1B	1.001_1	1C	0.0	0.000	0.000	0.0000	
30 minute summer	1C	1.002_1	1	0.0	0.000	0.000	0.0378	
30 minute summer	1	3.000	2	11.6	0.751	0.623	0.6893	
180 minute winter	2	1.004_1	-TANK IN	4.6	0.408	0.257	0.0176	
180 minute winter	2A	2.000	8	-0.1	-0.175	-0.188	0.1534	
180 minute winter	-TANK IN	4.000	-TANK OUT	4.4	0.698	0.251	0.0176	
180 minute winter	-TANK OUT	1.006	2A	-0.3	0.440	-0.185	0.0176	
30 minute summer	5	1.002	6	10.7	1.152	0.298	0.2614	
180 minute winter	6	1.003	8	2.8	0.185	0.156	0.2840	
180 minute winter	8	Hydro-Brake®	11	1.0				22.3
30 minute summer	4	1.001	5	6.9	3.404	0.196	0.0182	
30 minute summer	3	1.000	4	6.9	1.420	0.875	0.0879	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 96.66%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	1A	1	13.800	0.000	0.0	0.0000	0.0000	OK
30 minute summer	1B	1	13.370	0.000	0.0	0.0000	0.0000	OK
180 minute winter	1C	180	11.024	0.274	0.4	0.0774	0.0000	SURCHARGED
180 minute winter	1	180	11.024	0.524	5.2	0.4886	0.0000	SURCHARGED
180 minute winter	2	180	11.024	1.064	7.8	1.4996	0.0000	FLOOD RISK
180 minute winter	2A	180	11.023	1.083	5.6	1.2254	0.0000	FLOOD RISK
180 minute winter	-TANK IN	180	11.024	1.074	7.1	0.0000	0.0000	FLOOD RISK
180 minute winter	-TANK OUT	180	11.024	1.074	12.2	42.5866	0.0000	FLOOD RISK
180 minute winter	5	180	11.023	0.133	4.8	0.0757	0.0000	OK
180 minute winter	6	180	11.023	1.023	4.8	0.2896	0.0000	SURCHARGED
180 minute winter	8	180	11.023	1.183	6.8	1.5938	0.0000	FLOOD RISK
30 minute summer	11	1	9.550	0.000	1.0	0.0000	0.0000	OK
30 minute summer	4	19	13.935	0.038	9.9	0.0108	0.0000	OK
30 minute summer	3	19	14.700	0.490	11.6	0.4099	0.0000	FLOOD RISK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	1A	1.000_1	1B	0.0	0.000	0.000	0.0000	
30 minute summer	1B	1.001_1	1C	0.0	0.000	0.000	0.0304	
180 minute winter	1C	1.002_1	1	-0.4	-0.005	-0.002	0.1284	
180 minute winter	1	3.000	2	5.2	0.401	0.280	0.8679	
180 minute winter	2	1.004_1	-TANK IN	7.1	0.427	0.400	0.0176	
180 minute winter	2A	2.000	8	-5.6	-0.015	-0.002	0.1534	
180 minute winter	-TANK IN	4.000	-TANK OUT	6.9	0.900	0.389	0.0176	
180 minute winter	-TANK OUT	1.006	2A	-5.6	0.346	-0.002	0.0176	
180 minute winter	5	1.002	6	4.8	0.755	0.134	0.3779	
180 minute winter	6	1.003	8	4.4	0.250	0.249	0.2840	
180 minute winter	8	Hydro-Brake®	11	1.3				26.7

30 minute summer	4	1.001	5	9.9	3.750	0.283	0.0238
30 minute summer	3	1.000	4	9.9	1.597	1.264	0.0984

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	x
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
2		5.00	14.750	507322.067	104713.560	0.500
1	0.047		14.750	507324.030	104713.560	0.600

Links

Name	US Node	DS Node	Length (m)	ks (mm)	/ n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	2	1	1.983	0.400		14.250	14.150	0.100	19.5	50	5.00	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	E Area (ha)	E Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.100	2.2	0.0	0.450	0.550	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	1.983	19.5	50	DUMMY	14.750	14.250	0.450	14.750	14.150	0.550

Link	US Node	Node Type	DS Node	Node Type
1.000	2	Junction	1	Junction

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Connections	Link	IL (m)	Dia (mm)
2	507322.067	104713.560	14.750	0.500				
					→			
						0	1.000	14.250 50
1	507324.030	104713.560	14.750	0.600		1	1.000	14.150 50
					←			

Simulation Settings

Rainfall Methodology	FEH-13	Drain Down Time (mins)	240
Summer CV	0.750	Additional Storage (m³/ha)	20.0
Winter CV	0.840	Check Discharge Rate(s)	x
Analysis Speed	Detailed	Check Discharge Volume	x
Skip Steady State	✓		

Storm Durations

30	120	240	480	720	1440	2880	5760	8640
60	180	360	600	960	2160	4320	7200	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
10	40	0	0
100	40	0	0

Node 1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	1.03320	Width (m)	4.560
Side Inf Coefficient (m/hr)	0.00000	Length (m)	53.600
Safety Factor	5.0	Slope (1:X)	58.2
Porosity	0.30	Depth (m)	0.440
Invert Level (m)	14.150	Inf Depth (m)	
Time to half empty (mins)	6		



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Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 96.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	2	23	14.616	0.366	0.6	0.0000	0.0000	FLOOD RISK
30 minute winter	1	23	14.616	0.466	14.9	4.8867	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
30 minute winter	2	1.000	1	-0.6	-0.016	-0.287	0.0038
30 minute winter	1	Infiltration		7.1			



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Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 96.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	2	23	14.750	0.500	1.0	0.0000	0.0000	FLOOD RESE
30 minute winter	1	20	14.750	0.600	25.2	7.8204	1.8616	FLOOD

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
30 minute summer	2	1.000	1	-1.0	-0.513	-0.493	0.0038
30 minute winter	1	Infiltration		9.1			

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	x
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
3		5.00	14.220	507328.488	104704.529	1.250
2	0.156		14.220	507330.451	104704.529	1.283

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	3	2	1.963	0.600	12.970	12.937	0.633	59.5	50	5.00	50.0

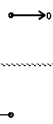
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	E Area (ha)	E Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.626	1.2	0.0	1.200	1.233	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	1.963	59.5	50	DUMMY	14.220	12.970	1.200	14.220	12.937	1.233

Link	US Node	Node Type	DS Node	Node Type
1.000	3	Junction	2	Junction

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Connections	Link	IL (m)	Dia (mm)	
3	507328.488	104704.529	14.220	1.250					
2	507330.451	104704.529	14.220	1.283		0	1.000	12.976	50
						1	1.000	12.937	50

Simulation Settings

Rainfall Methodology	FEH-13	Drain Down Time (mins)	240
Summer CV	0.750	Additional Storage (m³/ha)	20.0
Winter CV	0.840	Check Discharge Rate(s)	x
Analysis Speed	Detailed	Check Discharge Volume	x
Skip Steady State	✓		

Storm Durations

30	120	240	480	720	1440	2880	5760	8640
60	180	360	600	960	2160	4320	7200	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
10	40	0	0
100	40	0	0
200	40	0	0
1000	100	0	0



Node 2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Width (m)	127.300
Side Inf Coefficient (m/hr)	0.00000	Length (m)	10.000
Safety Factor	6.5	Slope (1:X)	20.0
Porosity	0.30	Depth (m)	0.410
Invert Level (m)	13.650	Inf Depth (m)	
Time to half empty (mins)			

Node 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	1.03320	Porosity	0.30
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	13.500
Safety Factor	6.5	Time to half empty (mins)	5

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	456.0	456.0	0.150	456.0	456.0	0.151	0.0	456.0



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Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 98.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	3	24	13.623	0.653	2.2	0.0000	0.0000	SURCHARGED
30 minute winter	2	24	13.623	0.686	49.9	18.5150	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
30 minute winter	3	1.000	2	-1.1	-1.167	-1.887	0.0038
30 minute winter	2	Infiltration		20.1			



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Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 98.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
30 minute winter	3	26	13.879	0.909	2.8	0.0000	0.0000	SURCHARGED
30 minute winter	2	26	13.879	0.942	84.4	39.4405	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)
30 minute winter	3	1.000	2	-2.8	-1.410	-1.259	0.0038
30 minute winter	2	Infiltration		20.1			



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Results for 200 year +40% CC Critical Storm Duration. Lowest mass balance: 98.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
30 minute winter	3	28	13.927	0.957	2.8	0.0000	0.0000	FLOOD RISE
30 minute winter	2	27	13.927	0.990	95.9	47.0943	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)
30 minute winter	3	1.000	2	-2.8	-1.412	-1.246	0.0038
30 minute winter	2	Infiltration		20.1			



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Results for 1000 year +100% CC Critical Storm Duration. Lowest mass balance: 98.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute winter	3	58	14.209	1.239	2.8	0.0000	0.0000	FLOOD RISE
60 minute winter	2	58	14.209	1.272	125.1	120.5877	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
60 minute winter	3	1.000	2	2.8	0.000	0.000	0.0038
60 minute winter	2	Infiltration		20.1			

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Easting (m)	Northing (m)	Depth (m)
4		5.00	14.030	507365.325	104725.204	0.430
3	0.032		14.030	507367.288	104725.204	0.600

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	4	3	1.963	0.400	13.600	13.430	0.170	11.5	50	5.92	50.0

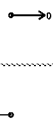
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	E Area (ha)	E Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.438	2.8	0.0	0.380	0.550	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	1.963	11.5	50	DUMMY	14.030	13.600	0.380	14.030	13.430	0.550

Link	US Node	Node Type	DS Node	Node Type
1.000	4	Junction	3	Junction

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Connections	Link	IL (m)	Dia (mm)
4	507365.325	104725.204	14.030	0.430				
						0	1.000	13.600
3	507367.288	104725.204	14.030	0.600		1	1.000	13.430

Simulation Settings

Rainfall Methodology	FEH-13	Drain Down Time (mins)	240
Summer CV	0.750	Additional Storage (m³/ha)	20.0
Winter CV	0.840	Check Discharge Rate(s)	x
Analysis Speed	Detailed	Check Discharge Volume	x
Skip Steady State	✓		

Storm Durations

30	120	240	480	720	1440	2880	5760	8640
60	180	360	600	960	2160	4320	7200	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
10	40	0	0
100	40	0	0

Node 3 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.28440	Width (m)	14.400
Side Inf Coefficient (m/hr)	0.00000	Length (m)	15.000
Safety Factor	5.0	Slope (1:X)	20.5
Porosity	0.30	Depth (m)	0.440
Invert Level (m)	13.430	Inf Depth (m)	
Time to half empty (mins)	29		



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PARTNERSHIP
Consulting Engineers

Abley Letchford Partnership
3 Tealgate, Charnham Park
Hungerford
RG17 0YT

File: A360-Preliminary Design
Network: CAR PARK 3
Jonathan Shuttleworth
10/09/2021

Page 2

Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 96.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
60 minute winter	4	46	13.878	0.278	0.3	0.0000	0.0000	FLOOD RISE
60 minute winter	3	46	13.878	0.448	7.0	5.8468	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)
60 minute winter	4	1.000	3	-0.3	-0.152	-0.009	0.0038
60 minute winter	3	Infiltration		2.1			



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File: A360-Preliminary Design
Network: CAR PARK 3
Jonathan Shuttleworth
10/09/2021

Page 3

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 96.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute winter	4	43	14.030	0.430	0.4	0.0000	0.0000	FLOOD RISE
60 minute winter	3	42	14.030	0.600	12.0	10.2690	0.9826	FLOOD

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
60 minute winter	4	1.000	3	-0.4	-0.131	-0.131	0.0038
60 minute winter	3	Infiltration		2.8			

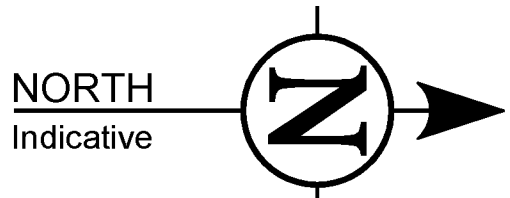


Appendix 2 – Site Investigations

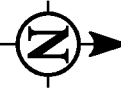
Infiltration Report

Groundwater Monitoring

Drainage Survey



UTILITIES & UNDERGROUND INVESTIGATIONS

[illegible][illegible]

DRAWING NOTES

At below grid stations shown have been identified from above ground without excavation. Survey Station use electronic-magnetic and/or ground penetrating radar (GPR) methods to investigate for underground utilities, services and depths. Excavations are carried out to confirm any identifications, positions and depths.

Survey Solutions has used all reasonable care to research available service records but the completeness or use of the service records supplied to or by Survey Solutions cannot be guaranteed. Therefore Survey Solutions cannot be held responsible for any features annotated as 'taken from records' (TFR).

Depths obtained using electro-magnetic or GPR are effected by ground conditions and should be treated as indicative only. Electro-magnetic depths to utilities and services are generally taken to the centre of a feature, GPR depths to the top of a feature and drainage depth shown to inverts, unless otherwise indicated.

Discharge and/or times will be obtained without delaying the chapter and therefore should be entered as appropriate. Page dimensions which have not been obtained visually will be taken from records when available.

All services, discharge and utilities routes are assumed straight between access points, unless otherwise stated. The numbers of cables in runs will not be shown unless specifically requested. All services are below ground unless indicated.

Services, utilities and features may not have been surveyed if obstructed or not reasonably visible or accessible at the time of survey.

Survey Solutions accept no responsibility for the completeness or accuracy of either the topographical survey or base mapping on this project.

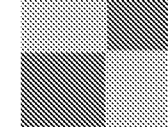
All critical dimensions and measurements should be checked and verified with any errors or discrepancies notified to Survey Solutions immediately. The accuracy of the digital data is the same as the plotting scale implies. All dimensions are in metres unless otherwise stated.

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work.

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Do not scale from this drawing.

AVAILABILITY OF UTILITY RECORD DRAWINGS		
UTILITY	AVAILABILITY	UTILITY COMPANY PROVIDER
SEWER	NO	NA
WATER MAIN	NO	NA
STORM SEWER	NO	NA
TELECOM	NO	NA
CABLE TV	NO	NA
ELECTRICITY	NO	NA
OIL PIPES	NO	NA
OTHER	NO	NA

[illegible]

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PROJECT TITLE		DAPPER LINE, ANGERING, WEST SUSSEX, BN16 4EN.	
DRAWING DETAIL		DRAWING NUMBER	
SPECIFIC COTV DRAINAGE SURVEY,		DRAWING NUMBER	
SHEET 1 OF 1		39429BWSW-01	
CLIENT		FLEBY PROJECTS LTD	
SURVEYOR		LIT	
SURVEY DATE		23/03/2021	
CHECKED BY		JMB	
APPROVED BY		GSR	
DWG STATUS		ISSUE DATE	
FINAL		23/03/2021	
REVISION			
SCALE		1:200	



Appendix 3 – Local Authority Correspondence

ADC Checklist



Surface Water Drainage Proposal Checklist

This 'Surface Water Drainage Proposals Checklist' has been designed to clearly define Arun District Council's and Chichester District Council's expectations and requirements for any surface water drainage proposals, submitted for appraisal by the council's Engineers, during the planning process.

Please be aware that it is in your interest to provide all of the requested information, as this will allow the council's Engineers to quickly and efficiently review your proposals. The omission of any requested information may lead to delays in the planning process.

This document will be of help to any applicant, or drainage consultant, preparing to submit a 'Discharge of Conditions Application' relating to surface water drainage conditions. Alternatively, it can also be used earlier in the planning process, if the applicant wishes to avoid pre-commencement conditions relating to surface water drainage. The Town and Country Planning Regulations now require pre-commencement conditions to have the prior agreement of the applicant regarding their wording and use. Therefore, if you wish to avoid pre-commencement conditions, in relation to surface water drainage, you will need to submit proposals that provide the information requested in this checklist and also align with the requirements of the following documents:

West Sussex Policy for the Management of Surface Water (WSSC)

'Supplementary Requirements for Surface Water Drainage Proposals'. (Arun DC)

'Supplementary Requirements for Surface Water Drainage Proposals'. (Chichester DC)

By submitting all of the information requested by this checklist you will enable the council's Engineers to determine whether your proposals follow the hierarchy for sustainable drainage and will adequately drain the site.

Please be aware that it will be difficult for the council's Engineers to undertake a timely assessment of your application if you fail to provide any of the information requested.



Surface Water Drainage Proposal Checklist

Ground Investigation Results				
Results Required	Results Provided?			
Winter groundwater monitoring results (Please refer to guidance note 1 below)	Yes	X	No	
Period of winter groundwater monitoring Note 1	From	21/10/2020		
	To	13/04/2021		
Maximum recorded groundwater level	mAOD 0.81 mBGL			
Winter infiltration test results Note 2	Yes	X	No	
Date of winter infiltration testing	29/03/2021			
Details of the location and depth of the infiltration testing Note 3	Yes	X	No	
Minimum infiltration rate Note 4	Various 7.90 x 10-5 m/s			

Guidance Notes

1. A full winters groundwater monitoring should be undertaken, (October to March inclusive) to enable the peak annual groundwater levels to be established. The extent of winter monitoring for developments of less than 5 properties should be discussed with the council's Engineers.
2. Infiltration testing should be undertaken during the wet winter months (typically January) and in line with BRE365, or a similar approved method. Tests should be repeated 3x, to replicate saturated ground conditions. Please note that infiltration testing is to be carried out at a time and depth agreed with the Councils engineers.
3. Infiltration testing should be undertaken at the location and depth of any proposed infiltration structures. This must be above the maximum recorded groundwater level in that vicinity.
4. The minimum infiltration rate obtained at the location and depth of the proposed infiltration structures should be used to inform the design of the structures.

Proposed Method of Surface Water Disposal				
Infiltration	Yes	X	No	
On-site, via soak-away structures				
If on-site infiltration is not to be used, has justification for this been provided? Note 5	Yes	X	No	
Attenuation (on-site) with a restricted discharge to a watercourse on, or adjacent to, the site	Yes	X	No	
Attenuation (on-site) with a restricted discharge to a surface water sewer on, or adjacent to, the site	Yes		No	
Attenuation (on-site) with a restricted discharge to a foul water sewer on, or adjacent to, the site	Yes		No	

Guidance Notes

5. If on-site infiltration is not being used to drain the site you will need to provide evidence that demonstrates on-site infiltration is unviable.

Drainage Design: Supporting Calculations				
Calculations Required		Calculations Provided?		
Infiltration Structures	Half-drain time for 10 year event (plus climate change allowance)	Yes	X	No
		Hours		
	Half-drain time for 100 year event (plus climate change allowance)	Yes	X	No
		Hours		
	Calculations demonstrating that the 1 in 100 year event, plus climate change allowance can be accommodated on-site. Note 7	Yes	X	No
Attenuation and Subsequent Restricted Discharge	Lowest base level of infiltration structure	Various mAOD mBGL		
	Has the design sought to provide treatment of potential contaminants? E.g. hydrocarbons.	Yes	X	No
	Pre-development run-off rate calculations	Yes	X	No
		l/s		
Attenuation and Subsequent Restricted Discharge	Proposed discharge rate Note 6	1.4 l/s		
	Calculations demonstrating that the 1 in 100 year event, plus climate change allowance can be accommodated on-site. Note 7	Yes	X	No
	Has the design sought to provide treatment of potential contaminants? E.g. hydrocarbons.	Yes	X	No
	If your proposed scheme incorporates any impermeable lined attenuation features we require calculations to demonstrate that appropriate resistance to floatation (due to groundwater levels) is catered for in the design	Yes		No X
	If you propose discharging into or altering an ordinary watercourse; have you sought Ordinary Watercourse/Land Drainage Consent? Note 8	Yes		No X
	If discharging to a watercourse, piped system or the sea, has the proposed drainage network been modelled against predicted top water levels for the 1 in 100 year storm event plus climate change allowance, within the existing system? Note 9	Yes		No X

Guidance Notes

- Any proposed discharge rate must be less than, or equal to, the pre-development rate. Greenfield sites must use the mean flow rate (Qbar) and be based upon the area occupied by the development, ignoring significant open spaces. Please note that the minimum acceptable discharge rate is 2l/s when using formal flow control devices, unless otherwise agreed. Additionally, if you are developing a brownfield site, we expect you to provide fully detailed plans of the existing surface water drainage arrangements on site, including impermeable areas, gullies, outfalls, pipes & diameters, manholes, etc. We generally seek 50% betterment in terms of run off from brownfield sites.
- The appropriate factor of safety from the table below must be applied to your calculations to ensure your design is fully in accordance with CIRIA R156/ CIRIA C753.



Factor of Safety Table						
Size of Area to be Drained	Consequences of failure					
	No damage or inconvenience		Minor inconvenience, e.g. surface water on car park		Damage to buildings or structures or roads.	
	Cv=1.0	Cv=0.75	Cv=1.0	Cv=0.75	Cv=1.0	Cv=0.75
<100 m ²	1.5	2	2	3	10	13
100m ² to 1000m ²	1.5	2	3	4	10	13
>1000m ²	1.5	2	5	6.5	10	13

8. Ordinary Watercourse/Land Drainage Consent will need to be sought, ideally in parallel with planning permission, if you propose discharging into, culverting or altering a watercourse.
9. Modelling is required to ensure that problems, such as surcharged outfalls, are addressed.

Plans/Drawings/Diagrams				
Required	Provided?			
Plan detailing the location of groundwater monitoring and infiltration testing	Yes	X	No	
Detailed drainage layout plan ^{Note 10}	Yes	X	No	
Construction detail plans ^{Note 11}	Yes	X	No	
Exceedance flow route plans ^{Note 12}	Yes		No	X
Impermeable area plan	Yes	X	No	
If ground levels are being raised $\geq$ 300mm above existing levels and is unavoidable, have fully detailed plans been provided, together with drainage proposals, to address any potential drainage related issues.	Yes		No	NA

Guidance Notes

10. Drainage layout plans should include:
 - All surface water drainage pipes labelled with; diameters, pipe materials, falls and invert levels.
 - All infiltrating and attenuating structures (including permeable paving) labelled with; dimensions, invert and cover levels.
 - All manholes labelled with; cover levels, invert levels, cover types detailed.
 - All silt traps clearly labelled with sump depths.
 - Control structures with outflow rates and invert levels.
 - Proposed/existing levels of any areas subject to ground raising, together with suitable measures/detailed drawings for the associated management of surface water runoff. Please note that ground raising should be avoided unless there are exceptional circumstances.
11. Site specific construction detail plans should be supplied if your proposed drainage scheme includes any of the following elements: pipe bed and surround; infiltrating structures; attenuating structures; manholes; catch-pits/silt traps; control devices; permeable paving; headwalls.



12. Unless specifically requested by the council's drainage engineers 'Exceedance Flow Route Plans' are only required for developments of more than 5 residential properties or more than 0.5ha of commercial development .

development planning
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