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Document 3.1 – ES Volume 2

Appendix 10.2: WKN Drainage Design Philosophy

Wheelabrator Kemsley (K3 Generating Station) and Wheelabrator Kemsley North (WKN) Waste to Energy Facility DCO

September 2019 -Submission Version

PINS ref: EN010083

RPS

Title: **Drainage Design Philosophy**

Project: WKN Proposed Development

Prepared for: Wheelabrator Technologies

Date: 21/11/2018

Ref: 019593-RPS-SI-XX-RP-D-0030

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CONTENTS

1 INTRODUCTION

1.1 RPS has been commissioned to produce a Drainage Design Philosophy for the WKN Proposed Development, a waste to energy facility on the Swale Estuary at Sittingbourne in Kent. The site is, located adjacent to the existing K3 Site.

1.2 The purpose of the Drainage Design Philosophy report is to outline the design principles for surface and foul water drainage to be adopted in the WKN Site. The report has been produced in conjunction with the Flood Risk Assessment produced for the development, RPS Report JER1519 November 2018.

1.3 The contents of this report are to be read in conjunction with all supporting drawings and/or documents referenced herein, appended to this report or submitted in support of the DCO application for the WKN Proposed Development.

1.4 **Site Description**

1.4.1 The WKN Site is located adjacent to the existing K3, located off Swale Way / Ridham Avenue, approximately 2km to the north-west of Kemsley town centre, approximate National Grid Reference 592169, 166647. The eastern edge of the WKN Site bounds the Swale estuary, a tidal channel which separates the Isle of Sheppey from mainland Kent. The WKN Site has an area of approximately 2.4 Hectares.

1.4.2 The WKN Site currently comprises of temporary hardstanding to facilitate the construction of the neighbouring K3 to the south with no known formal drainage infrastructure. The WKN Site is accessed via an existing private access road from the adjoining Kemsley Paper Mill site.

1.4.3 The WKN Site has a proposed platform level of approximately 6.3m AOD with a retaining structure across a majority of its northern boundary which divides it from the lower lying adjacent salt marsh.

1.4.4 The adjacent K3 Site, which is currently under construction, is permitted to discharge surface water drainage directly to the Swale Estuary, via a tidal outfall, which operates only in periods of low tide. During high tides, the outfall would be 'tide locked' by the means of a non-return flow valve, during which time all surface water runoff would be retained on site.

1.4.5 Foul drainage provision for the WKN Proposed Development is proposed to be drained via a newly constructed on-site gravity sewer system discharging to a new pumping station and rising main. Foul discharge from the WKN site is then pumped back to the privately owned foul drainage system located on the main Kemsley Paper Mill site.

1.5 **Flood Risk Assessment**

1.5.1 A Flood Risk Assessment Report reference JER1519 November 2018 has also been produced by RPS regarding the WKN Proposed Development.

1.5.2 This document identifies the WKN Site to be located with almost wholly within Flood Zone 2, with some localised areas falling within Zones 1 & 3. As such, the finished site level will set to a minimum of 6.3m AOD.

1.6 Ground Conditions

1.6.1 A phase II site investigation undertaken by RPS in July 2009 indicated that the geological strata beneath the adjacent site comprises of the following:

- Cohesive made ground to maximum thickness of 4.5m.
- Cohesive alluvium to maximum thickness of 3.5m
- London clays to maximum thickness of 5m.

These deposits overlay the solid geology associated with the Woolwich and Thanet sands and Cretaceous bedrock Chalk. It is anticipated that the proposed WKN Site will be made up of a similar geological strata and therefore, recommendations of the aforementioned report will be considered during detailed design.

2 PROPOSED SURFACE WATER DRAINAGE

2.1 The proposed new surface water drainage system will be designed using current MicroDrainage analysis software, ensuring all planning requirements, Lead Local Flood Authorities (LLFA) and Environment Agency (EA) guidelines are satisfied to prevent uncontrolled flooding of the WKN Site and surrounding areas.

2.2 The on-site surface water drainage network for the WKN Site will comprise of a single piped system collecting surface water runoff from building roof and hardstanding areas. All runoff will be drained via a Class 1 bypass oil interceptor, sized appropriately to accept the catchment area.

2.3 An external on site plant re-fuelling area and diesel fuel tank is to be provided on the western boundary of the WKN Site. This area will be isolated from the general hardstanding by way of a surface water channel drain surrounding the fuelling area, and then connected via a Class 1 full retention forecourt separator, prior to discharge into the surface water drainage system.

2.4 Surface water runoff from the external hardstanding areas will be collected as follows;

Car parking, HGV parking and site access roads – Linear drainage including combined kerb drainage units and channel drains

Roof areas – The buildings roofs will be drained by a specialist design syphonic roof drainage system with valley and eaves gutters and primary and secondary outlets in accordance with BS EN 12056-3:2000 to accommodate run-off rates in accordance with design rate Category 3.

2.5 The WKN Site drainage has allowed for controlled flooding during storm events above the 1:30 year return period. The difference between the critical 30 year and the 100 year (plus climate change) return period storms have been accommodated within linear drainage devices e.g. combined kerb drainage and site access roads to ensure flood waters are contained within the site demise. No flooding detrimental to buildings shall occur during any modelled storm event. No surface water run-off from paved or other impermeable surfaces shall be permitted to escape onto the surface of adjacent sites for the model scenarios stated.

2.6 Surface water runoff from hardstanding and roofs will discharge directly to a below ground gravity drainage system into an on-site surface water attenuation pond, designed in accordance with the CIRIA C753 SuDS Manual. The attenuation pond will provide detention of flows during low intensity rainfall events and assist with removal of sedimentation from surface water runoff. The pond will also provide surface water attenuation storage during extreme rainfall events to prevent uncontrolled flooding of the WKN Site.

2.7 Surface water will be discharged offsite from the attenuation pond into the Swale Estuary to the east of the WKN Site. The associated Flood Risk Assessment states that there are no EA discharge requirements in terms of runoff quantity for discharge into the Swale Estuary. Surface water will therefore be discharge un-attenuated via a new headwall adjacent to the existing headwall serving the neighbouring site.

2.8 Due to the tidal nature of the Swale Estuary, a tide locked scenario with no discharge will be considered in the event that the outfall is fully submerged. A 1 in 200 year + 2070 Climate change tide level of 5.28mAOD will be considered for the sizing of the attenuation pond as identified in the associated FRA, Document Ref JER1519 October 2018.

2.9 Considering a proposed outfall level of 2.650mAOD, the high tide level considered will tide lock the proposed drainage system and prevent discharge for a period of 5.8 hours as per the Spring Tide Cycle drawing within Appendix A.

2.10 The attenuation pond will therefore be sized to accommodate all runoff from the 6 hour (360 minute) 1 in 100 year +20%CC rainfall event with no discharge.

2.11 Using FEH rainfall data for coordinates 592000 166800 the 6 hour 1 in 100 year storm can be generated in MicroDrainage to give an average storm intensity of 12.458mm/hr, see Appendix B. The depth of rainfall in this period can then be calculated as follows.

12.458mm/hr	x	6 hours	=	74.748mm
74.748mm	x	20%cc	=	89.698mm

The total rainfall in this period is therefore considered to be 90mm.

RPS Impermeable areas drawing, contained within Appendix A, indicates a total site area of 2.44ha comprising of permeable and impermeable site catchment areas. A site specific runoff coefficient of 0.79 has been calculated based on the ratio of permeable and impermeable areas. The required attenuation volume is therefore calculated as 1740m^3

2.12 In order to ensure that the attenuation pond will have protection against sea water inundation during extreme tide events, the top of bank level will be set to a minimum level of 5.88 m, which provides 600mm freeboard above the predicted maximum 5.28m AOD 2070 storm tide level.

2.13 An automatic penstock with associated telemetry equipment will be installed into the penultimate chamber before the headwall to ensure the capacity of the attenuation pond is not occupied by any rising tide.

2.14 Calculations indicate that in order to achieve free discharge from the site drainage system to the attenuation pond for all rainfall events, the water level in the pond should not exceed 5.500m AOD, ensuring a minimum of 300mm freeboard is available above the maximum water level to top of pond.

2.15 Any rainwater harvesting storage volume required for re-use in the waste to energy plant will be situated below the outfall level of the pond to ensure the required attenuation volume is maintained.

2.16 The outfall pipe to the pond will be designed so that the pond can fully empty in within the 6.2 hour window when the tide falls below the outfall level in the unlikely event of two successive high tide levels.

2.17 Surface Water Quality and Pollution Control

2.17.1 Proposed run-off quality control for the WKN Site will include proprietary oil/petrol interceptor units supported by an attenuation pond which provides multiple benefits in terms of water quality, quantity and amenity. Additional water quality features including tree-pits, rain gardens and

Permeable pavements were considered in the concept design stage but were discounted due to the poor/aggressive ground conditions which deem these financially unviable.

2.17.2 A water quality risk assessment has been carried out using the SuDS hazard mitigation indices in accordance with Chapter 26, of the CIRIA C753 SuDS Manual. Under this method of assessment the worst case land use classification has been considered for the WKN Proposed Development including industrial roofs, non-residential parking and haulage yards which can be considered as having "high" pollution hazard level.

2.17.3 A combination of SuDS and proprietary treatment systems in the form of oil / petrol interceptor units have been utilised to mitigate the pollution from the identified land use classifications. The following tables demonstrate that the SuDS Mitigation indices provided by the features exceed that of the associated pollution hazard index.

	Pollution Hazard	SuDS Component	TSS	Metals	Hydro-carbons
Pollution Hazard Indices	High		0.8	0.8	0.9
Proposed SuDS Mitigation I_1		Proprietary treatment system (conservative estimate)	0.75	0.75	0.75
Proposed SuDS Mitigation I_2		Pond	0.7	0.7	0.5
Total SuDS Mitigation ($=I_1+0.5xI_2$)			**1.1**	**1.1**	**1.0**

2.17.4 The pollution control features included in the analysis have been incorporated into the WKN Site wide concept drainage strategy the location of which can be seen in the Drainage Layout drawing 019593-RPS-SI-XX-DR-D-0300 contained within Appendix A.

3 SURFACE WATER DESIGN PARAMETERS/CONSTRAINTS

3.1 The new surface water drainage system has been designed using current analysis software, MicroDrainage by XP Solutions, ensuring planning guidelines are satisfied to prevent uncontrolled flooding of the WKN Site and surrounding areas.

3.2 Flooding shall not be permitted in any area for events up to the 1 in 30 year return period storms.

3.3 For storms in excess of 1 in 30 year events, controlled temporary overland flooding is permitted with flood depths restricted accordingly to consider public Health & Safety.

3.4 No flooding detrimental to buildings shall occur during any storm event

3.5 Surface water run-off from paved or other impermeable surfaces shall not be permitted to escape onto the surface of adjacent sites.

3.6 **Design Variables**

- **Rainfall:** FEH Data; FEH CD-R version 3 – Grid Ref E 592000, N 166800.
- **Design Return Period**: 2, 30 and 100 (+20% climate change) years.
- **Climate change:** rainfall profiles increased by 20% for 100 year return period
- **Volumetric Runoff coefficient**: 0.75 Summer, 0.84 Winter
- **Global time of entry:** 4mins to all areas, 15mins to gravel areas
- **Infiltration:** Ignore for peak flow design
- **Backdrops:** Allow in design; maximum depth of 1.5m
- **Velocity:** 0.75 m/s for self-cleansing (private drainage)

3.7 The WKN Site drainage system has been checked against following storm intensities and durations:

Free discharge

- 2 year return period – 15mins to 1440mins storm duration
- 30 year return period – 15mins to 1440mins storm duration
- 100 year return period (+20% climate change) – 15mins to 1440mins storm duration

No discharge

- 2 year return period – 15mins to 360 mins storm duration
- 30 year return period – 15mins to 360 mins storm duration
- 100 year return period (+20% climate change) – 15mins to 360 mins storm duration

3.8 Modelled results have been provided as Appendix B for the worst case no discharge scenario. An orifice plate of 1mm diameter has been incorporated into the last chamber of the network to simulate a closed penstock. These results indicate limited surcharging of the network in the 1 in 2 year storm, No flooding in the 1:30 year storm and controlled surface flooding in the critical 1 in 100 year +CC return period. Temporary surface flooding for site hard standings will be limited to a maximum depth of 125mm.

4 PROPOSED FOUL WATER DRAINAGE

4.1 A new foul water drainage system is required to serve the new site office and mess facility on the WKN Site. It is currently proposed that the foul drainage discharges offsite to the D.S. Smith waste treatment facility to the north of the WKN Site via third party assets. Connection point to be confirmed following discussions with third parties.

4.2 The foul water drainage system is to be designed in accordance with the frequency factors and discharge units set out in BS EN 12056-2:2000, 'Gravity drainage systems inside buildings – Part 2: Sanitary pipework, layout and calculation'. The network will accommodate foul water discharge from all welfare sanitary ware facilities, hand washing facilities, wash-down, compactor and external plant areas as required.

4.3 The foul water network will typically comprise of gravity sewers, with a package pumping station also included to achieve the high level invert connection required at the existing discharge spur. Pump stations will be provided with 24 hour emergency storage volume capacity in accordance with Building Regulations Document H. Reference should be made to RPS drawing within Appendix A.

4.4 All canteens with hot cooking facilities are to have suitable grease traps or chemical dosing systems designed and installed by the specialist kitchen installation contractor.

5 PROPOSED PROCESS WATER DRAINAGE

5.1 The onsite surface water drainage network for the WKN Site will be split into two separate drainage systems. The first drainage system will collect clean surface water runoff (i.e. from building roof areas) and store it in the lagoon. The second drainage system will collect ‘dirty’ runoff (i.e. from the fuel bunker) and store it in the ‘dirty’ water tank to be constructed in accordance with BS EN 1992-3:2006 ‘Design of Concrete Structures – Part 3: Liquid retaining and containment structures’. This ‘dirty’ water will then be used in the process as required (for example for cooling hot ash).

5.2 Water used in the waste-to-energy process (boiler water) is continually recycle. No boiler water is to be discharged to the surface water system.

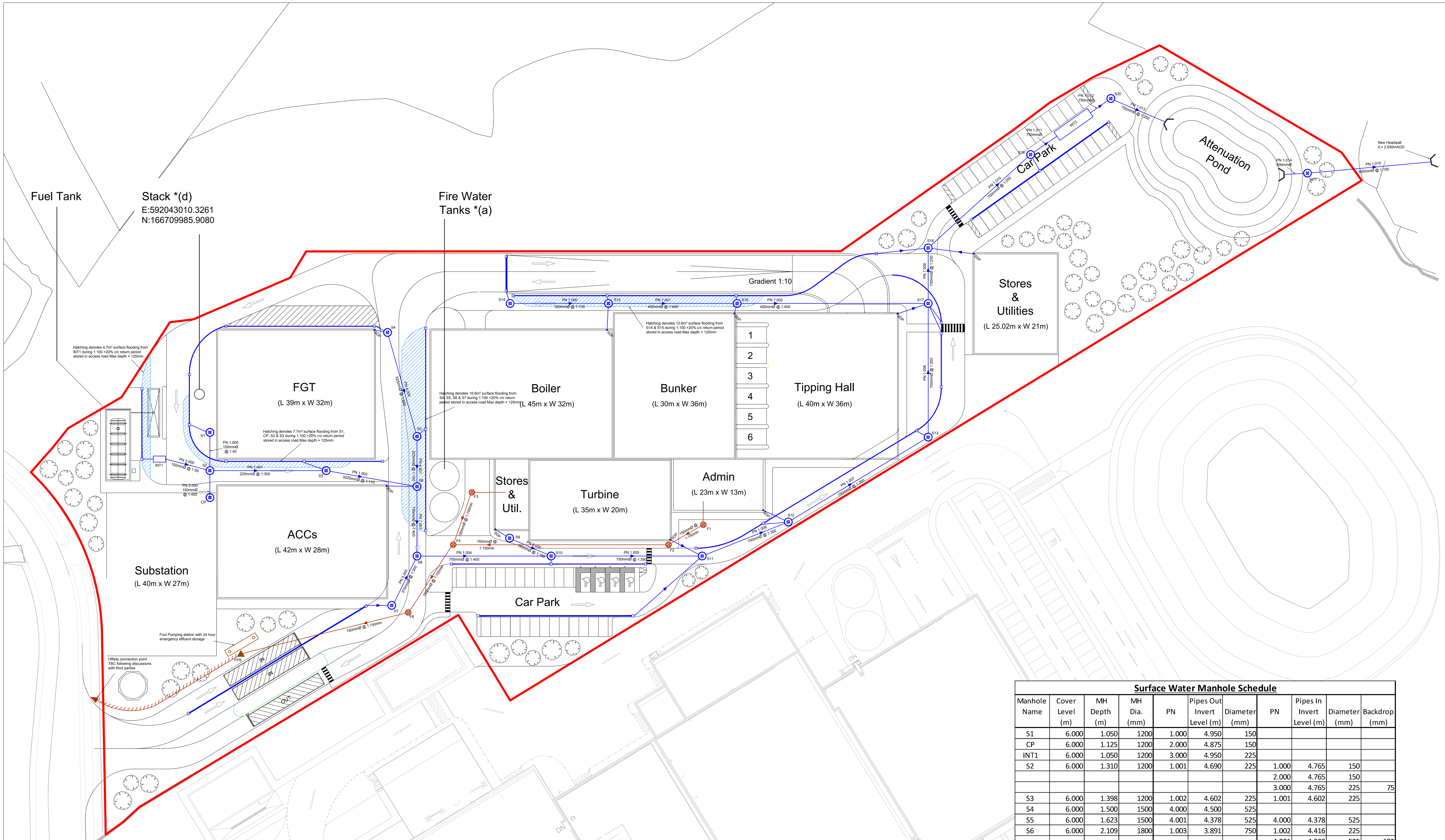
6 ADOPTION & MAINTENANCE

6.1 The maintenance for all plot specific drainage infrastructure will be the responsibility of the owner/occupier of the proposed development. The attenuation pond and associated discharge pipe shall also be the responsibility of the site owner/occupier. Details of the maintenance activities for the constructed drainage infrastructure will be passed to the end user as part of an Operation and Maintenance Manual post completion. Typical maintenance activities may include;

Element	Access Method including specific access equipment	Method of Maintenance	Frequency Required
Roof Gutters	Scaffolding / Cherry pickers to be used where required.	General cleaning of gutters. Jet cleaning where required.	Periodic inspection of gutters to ensure rainwater outlets do not become blocked. Periodic renewal of gutter coatings to prevent corrosion.
Oil / Petrol Separators	In accordance with H&S regulations and confined spaces requirements.	Refer to manufacturer's guidance.	Bi-annual inspection and emptying.
Channel Drains / Kerb Drainage	In accordance with H&S regulations.	Monitor to ensure no blockages develop. Jet cleaning where required.	Bi-annual jet cleaning of channel drains.
Silt-traps and Gullies	In accordance with H&S regulations.	Monitor to ensure no blockages develop.	Bi-annual inspection and emptying of all silt traps and gullies.
Penstock Valves/ Non-Return Flap Valves	In accordance with health and safety regulations and confined spaces requirements.	Monitored to ensure no blockages develop in accordance with the manufacturers recommendations.	Bi-annual inspection or in accordance with the manufacturers recommendations, whichever occurs sooner.
Surface Water Ponds and Swales	In accordance with H&S regulations	General cleaning and monitoring to ensure no blockage. Remove litter and debris. Cut grass and manage vegetation. Inspect inlets and outlets	Bi-annual inspection, cleaning and removal of silt and/or debris
Pumps	In accordance with health and safety regulations and confined spaces requirements.	Monitored via visual and audible alarms in development gatehouse to ensure no blockages develop in accordance with the manufacturers recommendations.	Bi-annual inspection or in accordance with the manufacturers recommendations, whichever occurs sooner.
Headwall	In accordance with health and safety regulations.	Monitored to ensure no blockages develop.	Bi-annual inspection and clearance of any debris

APPENDIX A RPS DRAWINGS

019593-RPS-SI-XX-DR-D-0300	Proposed Drainage Layout
019593-RPS-SI-XX-DR-D-0301	Impermeable Areas
019593-RPS-XX-XX-DR-D-0302	Spring Tide Cycle



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Key:

- ***mmØ @ 1:*** — FW Drain (I/D & Gradient)
- ***mmØ @ 1:*** — SW Drain (I/D & Gradient)
- FW HDPE Rising Main
- F1 — FW Manhole
- S2 — SW Manhole
- FW Pumping Station
- RWP — Rainwater Pipe (c/w RE)
- SDP — Syphonic Primary Downpipe
- Linear Drainage e.g. Kerb/Slot Drain
- Headwall
- INT1 — Proprietary Oil Interceptor Unit

Surface Water Manhole Schedule

Manhole Name	Cover Level (m)	MH Depth (m)	MH Dia. (mm)	PN	Pipes Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	6.000	1.050	1200	1.000	4.950	150				
CP	6.000	1.125	1200	2.000	4.875	150				
INT1	6.000	1.050	1200	3.000	4.950	225				
S2	6.000	1.310	1200	1.001	4.690	225	1.000	4.765	150	
							2.000	4.765	150	
							3.000	4.765	225	75
S3	6.000	1.398	1200	1.002	4.602	225	1.001	4.602	225	
S4	6.000	1.500	1500	4.000	4.500	525				
S5	6.000	1.623	1500	4.001	4.378	525	4.000	4.378	525	
S6	6.000	2.109	1800	1.003	3.891	750	1.002	4.416	225	
							4.001	4.309	525	193
S7	6.000	1.275	1350	5.000	4.725	375				
S8	6.000	2.147	1800	1.004	3.853	750	1.003	3.853	750	
							5.000	4.686	375	458
S9	6.000	1.050	1200	6.000	4.950	150				
S10	6.000	2.224	1800	1.005	3.776	750	1.004	3.776	750	
							6.000	4.859	150	483
S11	6.000	2.324	1800	1.006	3.676	750	1.005	3.676	750	
S12	6.000	2.383	1800	1.007	3.617	750	1.006	3.617	750	
S13	6.000	2.492	1800	1.008	3.508	750	1.007	3.508	750	
S14	6.000	1.200	1200	7.000	4.800	300				
S15	6.000	1.514	1350	7.001	4.486	450	7.000	4.636	300	
S16	6.000	1.588	1350	7.002	4.412	450	7.001	4.412	450	
S17	6.000	2.615	1800	1.009	3.385	750	1.008	3.385	750	
							7.002	4.300	450	616
S18	6.000	2.662	1800	1.010	3.338	750	1.009	3.338	750	
S19	6.000	2.790	1800	1.011	3.210	750	1.010	3.210	750	
INT2	6.000	2.917	1800	1.012	3.083	750	1.011	3.183	750	
S20	6.000	2.938	1800	1.013	3.062	750	1.012	3.062	750	
POND	5.880	2.880	-	1.014	3.000	600	1.013	3.014	750	164
S21	5.880	2.900	1500	1.015	2.980	600	1.014	2.980	600	
	5.000	2.213			OUTFALL		1.015	2.787	600	

Rev	Description	By	Ckd	Date

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Project: WKN Waste to Energy Facility

Title: Proposed Drainage Layout

Status	Scale	Date Created
Preliminary	1:500 @A1	29.10.2018

Project Leader	Drawn By	Checked by
GB	LJS	DW

Document Number: 019593-RPS-SI-XX-DR-D-0300
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Originator - Zone - Level - Type - Role - Drawing Number

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	Impermeable Areas	= 2ha
	Permeable Areas	= 0.44ha

10m SCALE 1:500

Rev	Description	By	Ckd	Date

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Client Wheelabrator Technologies

Project WKN Waste to Energy Facility

Title Impermeable Areas

Status	Scale	Date Created
Preliminary	1:500 @A1	29.10.2018
Project Leader	**Drawn By**	**Checked by**
GB	LJS	DW

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019593-RPS-SI-XX-DR-D-0301	-	S2
	019593	
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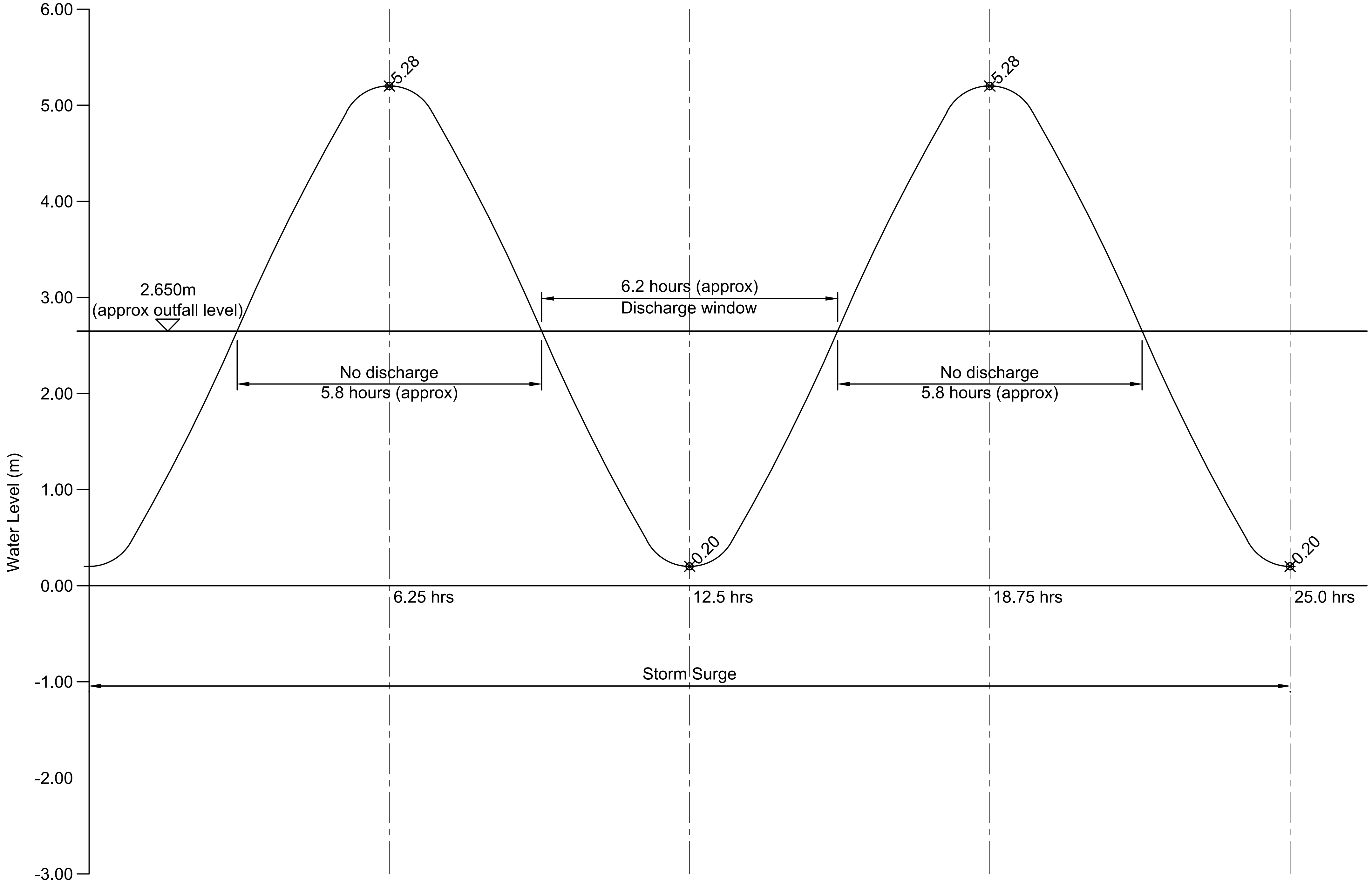

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Project WKN Waste to Energy Facility

Title Spring Tide Cycle

Status	Scale	Date Created
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Project Leader	**Drawn By**	**Checked by**
GB	LJS	DW

Document Number		Revision	Suitability
NK018570	019593-RPS-XX-XX-DR-D-0302	-	S2
Project Number	Originator - Zone - Level - Type - Role - Drawing Number		

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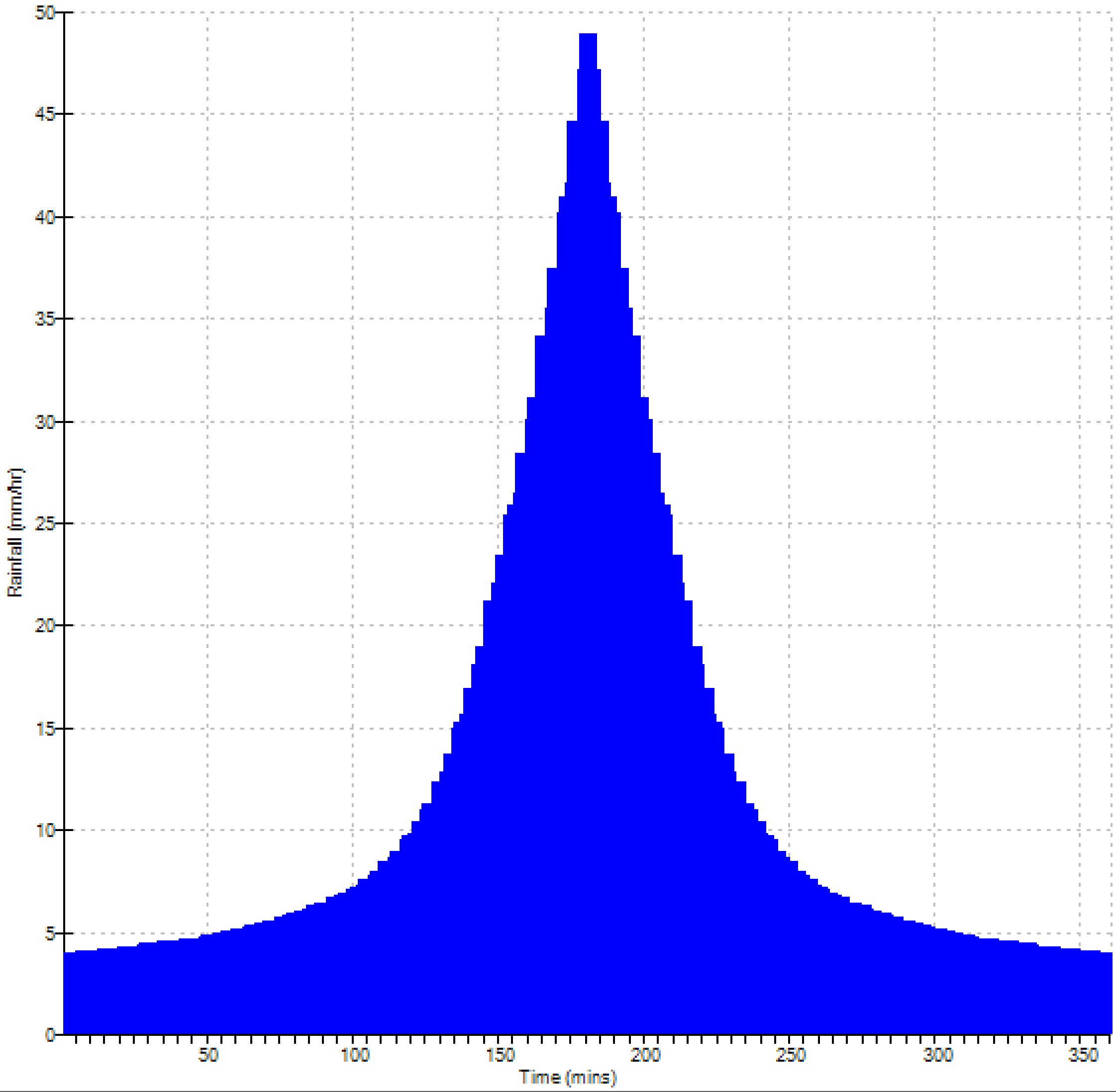
APPENDIX B RPS CALCULATIONS

Rainfall profile

Storm duration (mins) 360

FEH Data

FEH Rainfall Version	1999
Site Location	GB 592000 166800
C (1km)	-0.025
D1 (1km)	0.302
D2 (1km)	0.389
D3 (1km)	0.250
E (1km)	0.312
F (1km)	2.546
Peak Intensity (mm/hr)	48.942
Ave. Intensity (mm/hr)	12.485
Return Period (years)	100.0



STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 592000 166800
C (1km)	-0.025
D1 (1km)	0.302
D2 (1km)	0.389
D3 (1km)	0.250
E (1km)	0.312
F (1km)	2.546
Maximum Rainfall (mm/hr)	100
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	7.400	0.185	40.0	0.031	4.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	5.600	0.110	50.9	0.022	25.00	0.0	0.600	o	150	Pipe/Conduit	
3.000	10.200	0.185	55.1	0.045	4.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	100.00	4.08	4.950	0.031	0.0	0.0	0.0	1.60	28.2	11.2
2.000	72.60	25.07	4.875	0.022	0.0	0.0	0.0	1.41	25.0	5.7
3.000	100.00	4.10	4.950	0.045	0.0	0.0	0.0	1.77	70.2	16.2

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.001	26.500	0.088	300.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	20.600	0.186	111.0	0.047	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.000	24.500	0.123	200.0	0.174	4.00	0.0	0.600	o	525	Pipe/Conduit	
4.001	10.300	0.069	150.0	0.106	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.003	15.100	0.038	400.0	0.118	0.00	0.0	0.600	o	750	Pipe/Conduit	
5.000	11.600	0.039	300.0	0.142	4.00	0.0	0.600	o	375	Pipe/Conduit	
1.004	30.900	0.077	400.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
6.000	9.100	0.091	100.0	0.015	4.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	35.100	0.100	350.0	0.056	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.006	20.700	0.059	350.0	0.160	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.007	38.100	0.109	350.0	0.039	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.008	30.800	0.123	250.0	0.034	0.00	0.0	0.600	o	750	Pipe/Conduit	
7.000	22.100	0.164	135.0	0.123	4.00	0.0	0.600	o	300	Pipe/Conduit	
7.001	29.600	0.074	400.0	0.167	0.00	0.0	0.600	o	450	Pipe/Conduit	
7.002	44.900	0.112	400.0	0.134	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.001	71.29	25.66	4.690	0.098	0.0	0.0	0.0	0.75	29.8	25.1
1.002	70.70	25.93	4.602	0.145	0.0	0.0	0.0	1.24	49.3	36.9
4.000	100.00	4.26	4.500	0.174	0.0	0.0	0.0	1.58	342.1	62.8
4.001	100.00	4.35	4.378	0.280	0.0	0.0	0.0	1.83	395.4	101.1
1.003	70.31	26.11	3.891	0.543	0.0	0.0	0.0	1.39	615.4	137.8
5.000	100.00	4.19	4.725	0.142	0.0	0.0	0.0	1.04	115.0	51.3
1.004	69.54	26.48	3.853	0.685	0.0	0.0	0.0	1.39	615.4	171.9
6.000	100.00	4.15	4.950	0.015	0.0	0.0	0.0	1.00	17.8	5.4
1.005	68.75	26.87	3.776	0.756	0.0	0.0	0.0	1.49	658.3	187.6
1.006	68.29	27.11	3.676	0.916	0.0	0.0	0.0	1.49	658.3	225.8
1.007	67.46	27.53	3.617	0.955	0.0	0.0	0.0	1.49	658.3	232.5
1.008	66.91	27.82	3.508	0.989	0.0	0.0	0.0	1.77	779.9	238.8
7.000	100.00	4.27	4.800	0.123	0.0	0.0	0.0	1.35	95.5	44.4
7.001	100.00	4.76	4.486	0.290	0.0	0.0	0.0	1.01	160.7	104.7
7.002	100.00	5.50	4.412	0.424	0.0	0.0	0.0	1.01	160.7	153.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.009	11.600	0.046	250.0	0.216	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.010	32.000	0.128	250.0	0.053	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.011	6.900	0.028	250.0	0.089	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.012	5.100	0.020	250.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.013	12.000	0.048	250.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.014	3.000	0.020	150.0	0.229	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.015	29.000	0.193	150.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.009	66.70	27.93	3.385	1.629	0.0	0.0	0.0	1.77	779.9	392.3
1.010	66.14	28.23	3.338	1.682	0.0	0.0	0.0	1.77	779.9	401.6
1.011	66.02	28.30	3.210	1.771	0.0	0.0	0.0	1.77	779.9	422.1
1.012	65.94	28.35	3.083	1.771	0.0	0.0	0.0	1.77	779.9	422.1
1.013	65.73	28.46	3.062	1.771	0.0	0.0	0.0	1.77	779.9	422.1
1.014	65.68	28.49	3.000	2.000	0.0	0.0	0.0	1.99	561.6	474.3
1.015	65.25	28.73	2.980	2.000	0.0	0.0	0.0	1.98	561.1	474.3

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.015		5.000	2.787	2.650	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	3.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Region	England and Wales
Return Period (years)	30	M5-60 (mm)	19.200

Synthetic Rainfall Details

Ratio R	0.400	Cv (Winter)	0.840
Profile Type	Summer	Storm Duration (mins)	30
Cv (Summer)	0.750		

Online Controls for Storm

Orifice Manhole: POND, DS/PN: 1.014, Volume (m³): 11.8

Diameter (m) 0.001 Discharge Coefficient 0.600 Invert Level (m) 3.000

Storage Structures for Storm

Tank or Pond Manhole: POND, DS/PN: 1.014

Invert Level (m) 3.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	246.5	2.880	961.9

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 3.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH D3 (1km) 0.250
FEH Rainfall Version 1999 E (1km) 0.312
Site Location GB 592000 166800 F (1km) 2.546
C (1km) -0.025 Cv (Summer) 0.750
D1 (1km) 0.302 Cv (Winter) 0.840
D2 (1km) 0.389

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	S1	15 Summer	2	+0%	30/15 Summer	100/15 Summer		
2.000	CP	30 Winter	2	+0%	30/15 Summer	100/15 Summer		
3.000	INT1	15 Summer	2	+0%	100/15 Summer	100/15 Summer		
1.001	S2	15 Winter	2	+0%	30/15 Summer	100/15 Summer		
1.002	S3	15 Winter	2	+0%	30/15 Summer	100/15 Summer		
4.000	S4	15 Winter	2	+0%	100/15 Summer	100/15 Winter		
4.001	S5	15 Winter	2	+0%	100/15 Summer	100/15 Winter		
1.003	S6	15 Winter	2	+0%	30/15 Winter	100/15 Winter		
5.000	S7	15 Summer	2	+0%	100/15 Summer	100/15 Winter		
1.004	S8	15 Winter	2	+0%	30/15 Winter			
6.000	S9	15 Summer	2	+0%	100/15 Summer	100/15 Winter		
1.005	S10	15 Winter	2	+0%	30/15 Winter			
1.006	S11	360 Winter	2	+0%	30/15 Winter			
1.007	S12	360 Winter	2	+0%	30/60 Winter			
1.008	S13	360 Winter	2	+0%	30/15 Summer			
7.000	S14	15 Winter	2	+0%	30/15 Summer	100/15 Summer		
7.001	S15	15 Winter	2	+0%	30/15 Summer	100/15 Winter		
7.002	S16	15 Winter	2	+0%	30/15 Summer			

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	5.002	-0.098	0.000	0.26		6.4	OK	2
2.000	CP	4.902	-0.123	0.000	0.07		1.5	OK	2
3.000	INT1	5.009	-0.166	0.000	0.16		9.3	OK	2
1.001	S2	4.816	-0.099	0.000	0.59		16.2	OK	2
1.002	S3	4.718	-0.108	0.000	0.53		23.8	OK	2
4.000	S4	4.627	-0.398	0.000	0.13		35.6	OK	1
4.001	S5	4.541	-0.361	0.000	0.21		51.9	OK	1
1.003	S6	4.166	-0.475	0.000	0.27		94.5	OK	1
5.000	S7	4.874	-0.226	0.000	0.33		29.2	OK	1
1.004	S8	4.124	-0.479	0.000	0.25		118.4	OK	
6.000	S9	4.995	-0.105	0.000	0.20		3.1	OK	
1.005	S10	4.047	-0.479	0.000	0.24		126.0	OK	
1.006	S11	4.043	-0.383	0.000	0.05		23.2	OK	
1.007	S12	4.045	-0.322	0.000	0.04		23.7	OK	
1.008	S13	4.047	-0.210	0.000	0.04		22.9	OK	
7.000	S14	4.912	-0.188	0.000	0.30		25.2	OK	2
7.001	S15	4.699	-0.237	0.000	0.37		50.9	OK	1
7.002	S16	4.636	-0.226	0.000	0.50		71.7	OK	

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.009	S17	360 Winter	2	+0%	30/15 Summer				4.048
1.010	S18	360 Winter	2	+0%	30/15 Summer				4.048
1.011	S19	360 Winter	2	+0%	2/240 Winter				4.043
1.012	INT2	360 Winter	2	+0%	2/120 Winter				4.043
1.013	S20	360 Winter	2	+0%	2/120 Winter				4.043
1.014	POND	360 Winter	2	+0%	2/30 Winter				4.043
1.015	S21	60 Winter	2	+0%					2.980

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.009	S17	-0.086	0.000	0.08		36.2	OK	
1.010	S18	-0.040	0.000	0.06		36.2	OK	
1.011	S19	0.083	0.000	0.09		35.5	SURCHARGED	
1.012	INT2	0.210	0.000	0.10		34.8	SURCHARGED	
1.013	S20	0.231	0.000	0.07		34.1	SURCHARGED	
1.014	POND	0.443	0.000	0.00		0.0	SURCHARGED	
1.015	S21	-0.600	0.000	0.00		0.0	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	3.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.250
FEH Rainfall Version	1999	E (1km)	0.312
Site Location	GB 592000 166800	F (1km)	2.546
C (1km)	-0.025	Cv (Summer)	0.750
D1 (1km)	0.302	Cv (Winter)	0.840
D2 (1km)	0.389		

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	S1	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
2.000	CP	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.000	INT1	15 Winter	30	+0%	100/15 Summer	100/15 Summer		
1.001	S2	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
1.002	S3	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
4.000	S4	360 Winter	30	+0%	100/15 Summer	100/15 Winter		
4.001	S5	360 Winter	30	+0%	100/15 Summer	100/15 Winter		
1.003	S6	360 Winter	30	+0%	30/15 Winter	100/15 Winter		
5.000	S7	15 Summer	30	+0%	100/15 Summer	100/15 Winter		
1.004	S8	360 Winter	30	+0%	30/15 Winter			
6.000	S9	15 Summer	30	+0%	100/15 Summer	100/15 Winter		
1.005	S10	360 Winter	30	+0%	30/15 Winter			
1.006	S11	360 Winter	30	+0%	30/15 Winter			
1.007	S12	360 Winter	30	+0%	30/60 Winter			
1.008	S13	360 Winter	30	+0%	30/15 Summer			
7.000	S14	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
7.001	S15	15 Winter	30	+0%	30/15 Summer	100/15 Winter		
7.002	S16	15 Winter	30	+0%	30/15 Summer			

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	5.133	0.033	0.000	0.62		14.9	SURCHARGED	2
2.000	CP	5.081	0.056	0.000	0.27		5.5	SURCHARGED	2
3.000	INT1	5.102	-0.073	0.000	0.39		22.6	OK	2
1.001	S2	5.076	0.161	0.000	1.30		35.8	SURCHARGED	2
1.002	S3	4.934	0.107	0.000	1.26		56.2	SURCHARGED	2
4.000	S4	4.745	-0.280	0.000	0.03		9.2	OK	1
4.001	S5	4.746	-0.157	0.000	0.06		14.8	OK	1
1.003	S6	4.750	0.109	0.000	0.08		26.6	SURCHARGED	1
5.000	S7	4.992	-0.108	0.000	0.85		74.3	OK	1
1.004	S8	4.753	0.150	0.000	0.07		32.4	SURCHARGED	
6.000	S9	5.025	-0.075	0.000	0.50		7.8	OK	
1.005	S10	4.754	0.228	0.000	0.07		35.8	SURCHARGED	
1.006	S11	4.752	0.327	0.000	0.09		43.4	SURCHARGED	
1.007	S12	4.750	0.383	0.000	0.09		45.3	SURCHARGED	
1.008	S13	4.750	0.492	0.000	0.08		46.6	SURCHARGED	
7.000	S14	5.145	0.045	0.000	0.68		57.6	SURCHARGED	2
7.001	S15	5.031	0.095	0.000	0.99		136.9	SURCHARGED	1
7.002	S16	4.953	0.091	0.000	1.38		199.2	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.009	S17	360 Winter	30	+0%	30/15 Summer				4.750
1.010	S18	360 Winter	30	+0%	30/15 Summer				4.746
1.011	S19	360 Winter	30	+0%	2/240 Winter				4.750
1.012	INT2	360 Winter	30	+0%	2/120 Winter				4.746
1.013	S20	360 Winter	30	+0%	2/120 Winter				4.748
1.014	POND	360 Winter	30	+0%	2/30 Winter				4.746
1.015	S21	60 Winter	30	+0%					2.980

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.009	S17	0.616	0.000	0.16		75.2	SURCHARGED	
1.010	S18	0.658	0.000	0.13		76.8	SURCHARGED	
1.011	S19	0.790	0.000	0.20		79.7	SURCHARGED	
1.012	INT2	0.914	0.000	0.23		79.2	SURCHARGED	
1.013	S20	0.936	0.000	0.16		77.5	SURCHARGED	
1.014	POND	1.146	0.000	0.00		0.0	SURCHARGED	
1.015	S21	-0.600	0.000	0.00		0.0	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 3.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH D3 (1km) 0.250
FEH Rainfall Version 1999 E (1km) 0.312
Site Location GB 592000 166800 F (1km) 2.546
C (1km) -0.025 Cv (Summer) 0.750
D1 (1km) 0.302 Cv (Winter) 0.840
D2 (1km) 0.389

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	S1	15 Winter	100	+20%	30/15 Summer	100/15 Summer		
2.000	CP	15 Winter	100	+20%	30/15 Summer	100/15 Summer		
3.000	INT1	15 Winter	100	+20%	100/15 Summer	100/15 Summer		
1.001	S2	15 Winter	100	+20%	30/15 Summer	100/15 Summer		
1.002	S3	15 Winter	100	+20%	30/15 Summer	100/15 Summer		
4.000	S4	15 Winter	100	+20%	100/15 Summer	100/15 Winter		
4.001	S5	15 Winter	100	+20%	100/15 Summer	100/15 Winter		
1.003	S6	15 Winter	100	+20%	30/15 Winter	100/15 Winter		
5.000	S7	15 Winter	100	+20%	100/15 Summer	100/15 Winter		
1.004	S8	15 Winter	100	+20%	30/15 Winter			
6.000	S9	15 Winter	100	+20%	100/15 Summer	100/15 Winter		
1.005	S10	15 Winter	100	+20%	30/15 Winter			
1.006	S11	15 Winter	100	+20%	30/15 Winter			
1.007	S12	15 Winter	100	+20%	30/60 Winter			
1.008	S13	15 Winter	100	+20%	30/15 Summer			
7.000	S14	15 Winter	100	+20%	30/15 Summer	100/15 Summer		
7.001	S15	15 Winter	100	+20%	30/15 Summer	100/15 Winter		
7.002	S16	15 Winter	100	+20%	30/15 Summer			

<u>100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm</u>

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	6.003	0.903	3.476	0.99		24.0	FLOOD	2
2.000	CP	6.001	0.976	1.265	0.77		15.8	FLOOD	2
3.000	INT1	6.005	0.830	4.724	0.53		31.0	FLOOD	2
1.001	S2	6.001	1.086	0.696	2.31		63.7	FLOOD	2
1.002	S3	6.002	1.176	2.257	1.55		69.5	FLOOD	2
4.000	S4	6.011	0.986	11.240	0.48		129.0	FLOOD	1
4.001	S5	6.003	1.101	3.114	0.81		201.6	FLOOD	1
1.003	S6	6.000	1.359	0.897	0.91		318.4	FLOOD	1
5.000	S7	6.001	0.901	1.334	1.49		130.8	FLOOD	1
1.004	S8	5.990	1.387	0.000	0.81		390.0	FLOOD RISK	
6.000	S9	5.960	0.860	0.018	0.88		13.7	FLOOD	
1.005	S10	5.947	1.421	0.000	0.74		390.9	FLOOD RISK	
1.006	S11	5.896	1.471	0.000	1.03		484.8	FLOOD RISK	
1.007	S12	5.831	1.465	0.000	0.93		495.4	FLOOD RISK	
1.008	S13	5.736	1.478	0.000	0.84		506.5	FLOOD RISK	
7.000	S14	6.010	0.910	10.100	1.18		99.6	FLOOD	2
7.001	S15	6.002	1.066	2.526	1.66		229.1	FLOOD	1
7.002	S16	5.995	1.132	0.000	2.19		317.2	FLOOD RISK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.009	S17	15 Winter	100	+20%	30/15 Summer				5.650
1.010	S18	360 Winter	100	+20%	30/15 Summer				5.479
1.011	S19	360 Winter	100	+20%	2/240 Winter				5.479
1.012	INT2	360 Winter	100	+20%	2/120 Winter				5.479
1.013	S20	360 Winter	100	+20%	2/120 Winter				5.479
1.014	POND	360 Winter	100	+20%	2/30 Winter				5.479
1.015	S21	60 Winter	100	+20%					2.980

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.009	S17	1.515	0.000	1.92		903.1	SURCHARGED	
1.010	S18	1.391	0.000	0.22		133.2	SURCHARGED	
1.011	S19	1.519	0.000	0.35		139.5	SURCHARGED	
1.012	INT2	1.647	0.000	0.40		138.7	SURCHARGED	
1.013	S20	1.667	0.000	0.29		137.4	SURCHARGED	
1.014	POND	1.879	0.000	0.00		0.0	SURCHARGED	
1.015	S21	-0.600	0.000	0.00		0.0	OK	