KAVANAGH BURKE
CONSULTING ENGINEERS

Drainage Design Report

for

Warehouse Development

at

Kingswood Road,
Citywest Business Campus,
Dublin 24

Job No:	D1736
Client:	ROCKFACE DEVELOPMENTS LTD
Date:	October 2022
Local Authority:	South Dublin County Council
Revision:	PL2 (Additional Information)

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Contents:

1. INTRODUCTION

This report details the site development works design for a warehouse development at Kingswood Road, Citywest Business Campus, Dublin 24.

The subject site is located on the undeveloped land at Citywest Business Campus, bound by Kingswood Avenue to the south-east and Kingswood Road to the north-east.

The site will be serviced primarily through the connection to the existing services in the area.

The provision of the new on-site surface water, foul sewer and watermain are described as follows with calculations appended.

2. SURFACE WATER

The storm water runoff from the proposed development will be treated and collected in the proposed surface water drainage network. Thereafter, it will be attenuated in the pond/basin and reduced underground StormTech attenuation system (SC-740 or similar approved) before being discharged to the adjacent water channel to the north-western site's corner. The site area is divided to 3 no sub-catchments, with a flow control device proposed on the outlet of the manhole exiting each sub-catchment surface water storage system ensuring that no runoff will leave the site unattenuated. The discharge from site (sum of all 3 no sub-catchments) was set at the rate not exceeding the runoff from the site in its green field state as demonstrated in this report.

Plans, sections and other details of proposed SuDS devices and surface water arrangement on site are shown on the enclosed drawings ref D1736 – D3 - Drainage & Watermain Layout PL2 and D1736 – D4 – SuDS and Drainage Details PL2.

SuDS Management Plan

Due to the industrial nature of the proposed development, the yard surfacing for HGV access and marshalling is concrete. Permeable surfacing is provided to the car park area where traffic loads are light, with addition of Grasscrete surfacing to the car parking spaces (excluding disabled carparking where permeable paving will be used) and fire tender route.

Developments provided for warehousing/distribution facilities require robust industrial structures coupled with hard wearing durable large yard areas. Consideration was given to SuDS devices which incorporate infiltration at source however we have opted for a solution that ensures managed filtration from HGV yards prior to any infiltration to ground or discharge from site. In such an industrial environment, items such as swales & infiltration trenches were deemed unsuitable due to possible pollution risks to the groundwater from constant HGV activity. Permeable and grasscrete surfacing are proposed to the areas with a light traffic load such us carparking bays, fire tender routes while swales will trap any excess of runoff from these areas.

Runoff from the hardstanding areas will be collected by trapped road gullies and rainwater goods throughout the development and directed to an on-site surface water attenuation facility. This facility is designed to attenuate 1 in 30-year storm event of any duration; therefore no flooding will occur on site for any duration events up to 30 year return period as per "Greater Dublin Strategic Drainage Study" (GDSDS) requirements. In addition to providing

attenuation volume, temporary flood storage is check and provided where needed (as an integrated part of the attenuation system) for 100-year return events as per GDSDS requirements. The restricted discharge from site will be limited by a proprietary flow control device. The maximum allowable discharge is limited to calculated flow (see calculations in the succeeding chapters) not exceeding Greenfield runoff rate, Q_{BAR} (as per criterion 4.3 "River Flood Protection" chapter 6.3.4 of GDSDS). All flows and runoffs for storm water network design and attenuation sizing are calculated incorporating 20% climate change factor for all rainfall intensities as per chapter 6.3.2.4 of GDSDS table 6.2 "Climate Change Factors". In addition, a computer analysis in the storm network modelling software was performed to confirm the sizing of the pipe network and underground attenuation storage for 1 in 100-year storms of all durations. This analysis includes a specific model of vortex flow control device with discharge of the calculated QBAR and 20% Climate Change Factor. The analysis indicated no on-site flooding (meaning that both the network and all proposed attenuation storage have sufficient capacities).

SuDS Treatment Train

The treatment train approach was applied to both the storm water network and the attenuation design to ensure that both runoff quality and quantity are appropriately addressed. An array of techniques was used to fulfil requirements of each element of the treatment train:

- Pollution prevention –

To prevent chemicals and other pollutants from contaminating the rainfall runoff, a maintenance regime for the proposed development will be established. A proprietary silt trap and petrol interceptor will be provided on the surface water drainage network to intercept debris, silts and hydrocarbons and prevent them from entering the attenuation systems and from being discharged to the soil or receiving watercourse.

- Source control –

To detain and infiltrate the runoff as close as possible to the point of origin. The infiltration of the surface water, promoting water disposal at source and limiting the discharge to the SW network was proposed throughout the site, with the following measures being proposed in place:

  - Permeable paving / Grasscrete.
  - Swales and tree pits.

Permeable paving with integrated infiltration pit below is proposed to car access road and disabled car parking spaces. Any runoff from the permeable paving area will be discharged to the angular stone filled infiltration pit below the permeable paving blocks. This ensures the runoff water will be allowed to infiltrate to the ground. In case of the rainfall event exceeding the capacity of the infiltration pit, runoff water will be stored at adjacent swale from where it will be allowed to discharge through overflow gully located ar swale to the storm water drain.

- Site control –

to deal with as much of the runoff as possible within the site, interception storage is designed within the proposed attenuation tank. This interception storage is provided to capture first 5mm of any rainfall and store it in the lowered portion of the attenuation system where it will dissipate by infiltration to the soil beneath. This will reduce the quantity of water that discharges from the site.

- Regional control –

to mimic the behaviour of the green field site and protect the receiving watercourse, both underground attenuation storage and pond/basin are designed to cater for all durations of rainfall up to 30 year return period with 20% climate change factor applied. These attenuation systems have also been designed to cater for 1 in 100-year

storms of all durations exceeding the requirements of Greater Dublin Strategic Drainage Study (GDSDS). The proposed discharge from the site will not exceed the green field runoff rate Q_{BAR}.

Storage Systems

Proposed are 2 no attenuation facilities on site – one underground attenuation facility "StormTech" or equivalent and the other one a pond / basin. Both systems were design to collect surface water runoff from dedicated sub-catchments, as shown at enclosed drawing ref D1736 – D3 Drainage and Watermain layout.

"StormTech" or similar approved proprietary system consists of thermoplastic arches backfilled in specified stone and wrapped in a pervious geotextile. Prior to entering the system, the surface water runoff will pass through a proprietary silt trap and petrol interceptor to ensure debris, silt particles and hydrocarbons are removed. Subsequently the surface runoff enters the attenuation facility through an "isolator row" whereby a row of void forming thermoplastic arches are wrapped in a pervious geotextile which provides a second level of suspended solid removal prior to the water entering the greater attenuation area.

These water quality control measures can be cleaned out by suction hose/tanker if required from standard maintenance inspections. In the case of the isolator row, the chamber is backwashed with a proprietary power jet wash and its water removed by suction hose/tanker.

The proposed pond/ basin will cater run-off from 3/4 of the warehouse roof and any overflow runoff from the paved and landscaped surfaces located to the northern side of the building. A Maintenance Plan will be implemented to ensure the proper functioning and will include:

- Cleaning of litter and debris.
- Inlet and outlet structural integrity check.
- Removal of sediment accumulation.
- Re-establish of permanent vegetation on eroded areas.

Water quantity control is provided downstream of the attenuation facility and pond/basin by providing the flow control devices, each set up to limit flow to corresponding sub-catchment Q_{BAR} (sum of sub-catchments discharge rates not exceeding Greenfield runoff rate). The proposed vortex style flow control device of discharge rate will be installed on the outfall of the last surface water manhole prior existing site, shown at accompanying Drainage and Watermain Layout drg. ref. D1736 – D3. The discharge from site, i.e. the restricted flow will discharge to an existing open channel at Kingswood Avenue to the site's western corner and ultimately to Camac River.

Surface Water attenuation including climate change factors, infiltration of the first 5mm of every rainfall event, surface water quantity control through restricted discharge from site and surface water quality control by incorporating trapped gullies, proprietary silt traps, petrol interceptors and a surface water attenuation system that incorporates an "isolator row" which is essentially another form of debris & silt filtration prior to restricted discharge to the nearby stream.

Proposed SuDS elements

In considering the above surface water management solution, we considered all SuDS devices and given the industrial nature of the proposed operations on this site, the above solution of surface water attenuation was decided on with addition of a following range of measures being incorporated into the development, as follows:

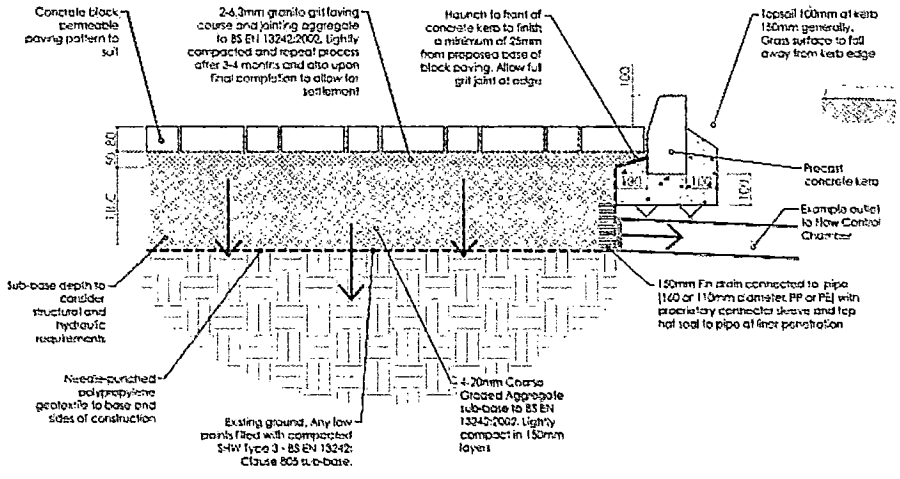
- Permeable paving (to the access road to the carparking);

- Grasscrete paving (to the car parking bays and to the fire tender route).;
- Green walls (to each side of proposed building);
- Tree Pits (at the car parking area for source control as per landscaping details);
- Swales (at the car parking area for source control);
- Pond/basin;
- Trapped Road Gullies (to collect run-off from concrete surfaces);
- Restricted discharge (to the outlets of all attenuation systems for regional control);
- Silt trap and petrol interceptor (to the inlets of all attenuation systems for pollution prevention).
- Underground attenuation system,
- Rainwater harvesting will now be installed within each warehousing unit to provide grey water for use in WC's and possible wash down areas.

Permeable surfacing

Extensive permeable surfacing to the carparking areas promoting infiltration of surface water (permeable surfacing not used to HGV yards as possible hydrocarbon pollutants could exist which should not be allowed infiltrate to the soil below). This system not only reduces the quantity of runoff, but it also has a positive impact on water quality. Due to the shallow nature of the underlying build-up, permeable paving can be utilised even on sites with high ground water levels where other deeper infiltration devices would not work.

Detail 2 - Permeable Paving (System B) with Partial Infiltration



Grasscrete paving

To minimise the storm water runoff and to increase the ratio of the green surfaces on site, Grasscrete type surface is proposed to the carparking spaces (excluding disabled carparking where the permeable paving will be used). Grasscrete surface is not proposed to the circulation roads of the car park to prevent damage to the surfacing and to prevent reduction of the grip between tyres and road surface. However, permeable paving is proposed to the car park roads to assist other permeable hardstanding areas in rainfall runoff reduction. The excess runoff from the proposed pavement will be collected in a swale where an overflow gullies will collect any further excess runoff to the surface water network.

Green Walls

Green Walls have been introduced to the elevations as requested by the Local Authority. These elements of green walls are positioned to face all sides of the proposed building. Green walls will create more visually appealing and dynamic facades that sway in the breeze and change with the seasons. These dense facade coverings will not only help to break the monotony of cladding surfaces but will also help to create efficient building envelope, minimizing heat loss and cooling loads, reducing rainwater runoff and filtering pollutants out of the air.
While warehousing units have extensive roof areas, the use of green roof material on composite insulated cladding panels is not a suitable pairing. Also the aesthetic benefit of these green roofs cannot be realised where a parapet forms part of the building design. Parapets enhance the appearance of large industrial units by providing clean sleek lines to the full building height eliminating the risk of under design where vast areas of roof are visible to the observer.

Tree Pits

Tree pits have been introduced to the carparking areas to promote the infiltration and natural reuse of surface water runoff in these areas. Tree pits will be provided with overflow pipes discharging excess runoff to the proposed on-site storage system from which the storm water will be discharged to the existing storm water network at green field runoff rate.

The nature of the development will not allow for the storm water runoff from the marshalling yard to be discharged directly to swales or tree pits. The runoff from these areas will pass through the aforementioned silt trap, petrol interceptor and isolator row prior to being attenuated. These devices will ensure that the water trapped in the interception storage in the tank is free of pollutants before it is allowed to infiltrate to subsoil.

The following figures synopsise the surface water attenuation calculations:

Site area (red line)	*26,290 m²*
CATCHMENT AREA	21,600 m²
SAAR	779.5
SOIL VALUE	0.3

STRUCTURE TYPE	RUNOFF COEFFICIENTS	AREA (ha)	*AREA – factored (ha)*
Roofs	1.0	1.1203	*1.1203*
Concrete yard & docking area	1.0	0.320	*0.320*
Building perimeter concrete footpath	1.0	0.088	*0.088*
Permeable paving	1.0	0.099	*0.099*
Grasscrete	0.9	0.124	*0.112*
Contributing Landscaping	0.3	0.409	*0.123*
TOTAL	-	**2.160**	***1.858***

Details of the surface water attenuation system including SuDS measures, interceptors, flow restrictions, volume and pipe designs are attached in this Drainage Design Report and on the accompanying Drainage details layout (drawing reference D1736 - D3 - Drainage & Watermain Layout PL2) for review by the Local Authority.

A Flood Impact Assessment compiled by Enviroguide Consulting is enclosed detailing measures proposed for flood mitigation on site.

3. FOUL SEWER

A new foul sewer has been designed to collect sewage from the proposed development and discharge to the existing foul sewer manhole and network at Kingswood Road, Citywest Business Campus.

The peak foul sewer discharge rate is based on the discharge unit method of drainage design for calculating maximum sewage and wastewater flows. The proposed ancillary offices and warehouse toilet facilities are the source of wastewater discharge for the overall development.

As per the requirements of the Irish Water Code of Practice, minimum velocities of 0.75 m/s are met for the proposed gradients and contributing discharge unit numbers (refer to discharge unit calculation sheet for details). The proposed foul sewer including manholes and service connections will be constructed in compliance with design standards set out by Irish Water in the IW Code of Practice for Wastewater Infrastructure and Wastewater Infrastructure Standard Details.

The method of calculating the total discharge units from the development is carried out in accordance with BS EN 752-4:1998 "Drain and sewer systems outside buildings", refer to insert below for the relative tabulated extract.

Table C.1 — Typical frequency factors (k_{DU})

Type of building	k_{DU}
Dwelling, guesthouse, office (intermittent use)	0,5
Hospital, school, restaurant, hotel (frequent use)	0,7
Toilets and/or shower open to the public (congested use)	1,0
Laboratory buildings (special use)	1,2

Table C.2 — Typical values of discharge units (*DU*)

Type of appliance	*DU*
Washbasin, shower	0,3 to 0,6
Urinal	0,3 to 0,8
Bath, kitchen sink	0,8 to 1,3
Dishwasher	0,2 to 0,8
Household washing machine	0,5 to 0,8
Commercial washing machine	1,0 to 1,5
WCs (4,0 l to 9,0 l cistern)	1,2 to 2,5
Floor drains (DN 50 to DN 100)	0,6 to 2,0
The discharge unit will depend on the type of drainage system inside the building and the size of the appliance. Where no specific information is available, the higher value should be used.	

Proposed calculations of discharge units, flows, velocities and pipe designs are included further in this Drainage Design Report for the review of the Local Authority.

4. WATERMAIN

The watermain proposed to serve the development will form 2 no metered connections – portable water and firemain - from the existing main spur at Kingswood Avenue, exact location shown on accompanying drg ref. D1736 – D3.

New looped 150mm dia. HDPE firemain within the site will be provided with adequate sluice valves, water meter & fire hydrants to provide water supply and for firefighting purposes. Hydrants will not be placed within 6m of a building or structure and at a maximum 46m from proposed buildings. All associated details including watermain pipe material will be in accordance with the current Irish Water guidelines. Guidelines set out in the Irish Water Publications IW-CDS_5020-1 & IW-CDS-5030-1 have been consulted and adopted within the design of the proposed drainage & watermain networks.

BCAR system of inspections and certification will be adopted to ensure all fire safety elements are designed and implemented as per Part B of Technical Guidance Documents as well.

Refer to a drawing ref D1736 - D3 - Drainage & Watermain for details of the proposal enclosed for a Local Authority review.

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Surface Water Attenuation Design

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Surface Water Attenuation Calculation

1) Areas for Attenuation Calculation

Site Area (red line) 26,290 m² (2.629 ha)

Catchment area 21,600 m² (2.16ha)

	CATCHMENT AREAS	*Runoff coefficient*	Sub-catchment #1	Sub-catchment #2	Sub-catchment #3
	21,600 m2		11,045 m²	7,470 m²	3,085 m²
Contributing Landscaping:	4,092 m²	*0.3*	1,665 m²	1,287 m²	1,140 m²
Overall landscaping:	*7,741 m²*				
Impermeable Areas:					
1. Roofs	11,203 m²	*1.0*	8,100 m²	2,743 m²	360 m²
2. Concrete yard & docking area	3,200 m²	*1.0*	-	3,200 m²	-
3. Footpaths	875 m²	*1.0*	250 m²	240 m²	385 m²
4. Permeable paving	990 m²	*1.0*	330 m²	-	660 m²
5. Grasscrete	1,240 m²	*0.9*	700 m²	-	540 m²
TOTAL IMPERV. AREAS	17,508 m²		9,380 m²	6,183 m²	1,945 m²

2) Interception Storage

Calculate runoff from 5mm of rainfall on developed area.
For this calculation only hardstanding areas are assumed to provide 80% runoff, and non-hardstanding areas are assumed to provide 0% runoff.

The equivalent volume of Interception Storage should be provided on site as no discharge from site should occur for this initial 5mm depth of rainfall. The Interception Storage on this subject site will be provided through the base of attenuation tank.

Design Impermeable Areas: 17,508 m² x 0.80 = 14,006.4 m²

Total volume for 5mm rainfall: 5mm x 14,006.4 m² = **70 m³**

Therefore, a minimum Interception Storage volume of 70 m³ should be provided for corresponding sub-catchments. This will prevent discharge from the site during rainfall events of up to 5mm rainfall. For the basis of this calculation infiltration will be provided through the base of the attenuation system. The soft landscaping on site will also be a source of rainfall infiltration.

3) Greenfield Runoff Rate – QBAR, (mean annual flood flow):

$Q_{BARrural}$ (m^3/sec) = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$

SAAR (E 305400, N 228350): 779.5 mm (*as per Met Eireann data*)

Soil Index:
S1 (very low runoff)
S2
S3 (moderate runoff)
S4
S5 (very high runoff)

Soil = 0.1($Soil_1$) + 0.3($Soil_2$) + 0.37($Soil_3$) + 0.47($Soil_4$) + 0.53($Soil_5$)

As the site is relatively small in catchment terms the soil class will be 100% Soil2 as per online Wallingford Procedure Greenfield runoff estimation tool on www.uksuds.com (*refer to chapter: Surface Water Design for the HR Wallingford Greenfield runoff rate estimation report and details*).

Soil Class: $Soil_2$
Runoff Potential: Low
Soil Value: 0.3

Q_{BAR}:
As the site area is less than 50 hectares, QBAR for 50 hectares is firstly calculated:

Q_{BAR} (m^3/sec) = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$ =
0.00108 x $(0.5)^{0.89}$ x $(779.5)^{1.17}$ x $(0.3)^{2.17}$ =
103.34 l/sec =
2.07 l/sec/ha

Q_{BAR} for the subject site area (overall catchment area):

2.07 l/sec/ha x 2.16ha =
Q_{BAR} = 4.46 l/sec

According to GDSDS chapter 6.3.1.4 if the separate long-term storage cannot be provided and temporary flood storage forms part of the single attenuation system, all the runoff from the site should be discharged at either a rate of 2.0 l/s/ha or the average annual peak flow rate Q_{BAR}, whichever is greater.

Subject site catchment area is divided to 3no sub-catchment areas; therefore, each sub catchment will be provided with flow control device. The sum of 3 no sub-catchments runoff rate will be equal to greenfield runoff rate i.e. max Q_{BAR} will be set out at 4.46 l/sec, as shown below:

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Sub-catchment #1 Q_{BAR}:

Total sub-catchment area = 11,045 m²

2.07 l/sec/ha x 1.1045ha =

C#1 Q_{BAR} = 2.28 l/sec

→ *Flow control device to be placed on outlet of C#1 SW MH 17 to limit flow to 2.28 l/sec.*

Sub-catchment #3 Q_{BAR}

Total sub-catchment area = 3,085 m²

2.07 l/sec/ha x 0.3085ha =

C#3 Q_{BAR} = 0.64 l/sec

→ *Flow control device to be placed on outlet of C#3 SW MH 12 to limit flow to 0.9 l/sec.*

Sub-catchment #2 Q_{BAR}

Total sub-catchment area = 7,470 m²

2.07 l/sec/ha x 0.747ha =

C#2 Q_{BAR} = 1.54 l/sec

→ *Flow control device to be placed on outlet of C#2 SW MH 14 to limit flow to 2.18 l/sec (i.e. sum of sub-catchment C#2 & C#3, Q_{BAR} = 0.64 +1.54 = 2.18 l/s).*

→ **Therefore,** $\sum Q_{BAR}$ (C#1, C#2, C#3) ≤ Q_{BAR}

2.28 l/s + 1.54 l/s + 0.64 l/s ≤ 4.46 l/s *(greenfield runoff rate)*

4) Attenuation Storage Volume

Refer to enclosed Surface Water Network Design chapter in this Design Report for detailed storm water network modelling and attenuation storages volumes check with a specific Hydrobrake flow control devices included in the analysis. Storages were checked for storm durations up to 3 days for 1 year, 2 years, 30 years and 100 years return period including 20% CCF.

In summary:

INTERCEPTION STORAGE:

70m³ to be provided by a lowered base to the attenuation system.
Attenuation System Area: 830m². Therefore, the Interception Storage Depth will equal 200mm. A lowered base level to the attenuation facility allowing base infiltration will facilitate on site discharge of this interception volume. This storage volume being lower than the system outlet cannot discharge from site.

ATTENUATION VOLUME REQUIRED:

- **Sub-catchment C#1:** **695m³** to be provided within pond/basin on site.
- **Sub-catchment C#2 & C#3:** **686m³** to be provided within the underground attenuation system on site.

TEMPORARY FLOOD STORAGE:

The proposed attenuation storage will accommodate all rainfall events of all durations up to 1 in 100 years return. Therefore no separate flood storage is needed.

TOTAL ATTENUATION VOLUME PROVIDED: 1,425 m³

- Sub-catchment #1: **735m³** (pond/basin)
- Sub-catchment #2 & #3: **690m³** (underground attenuation system)

Storm Water Network analysis and Attenuation Tank Size checks were performed using a computer hydraulic analysis software. The analysis did not highlight any ponding for any storm durations up to 1:100y return therefore the network and attenuation capacity calculated above are satisfactory.
The results of the analysis are included in this report.

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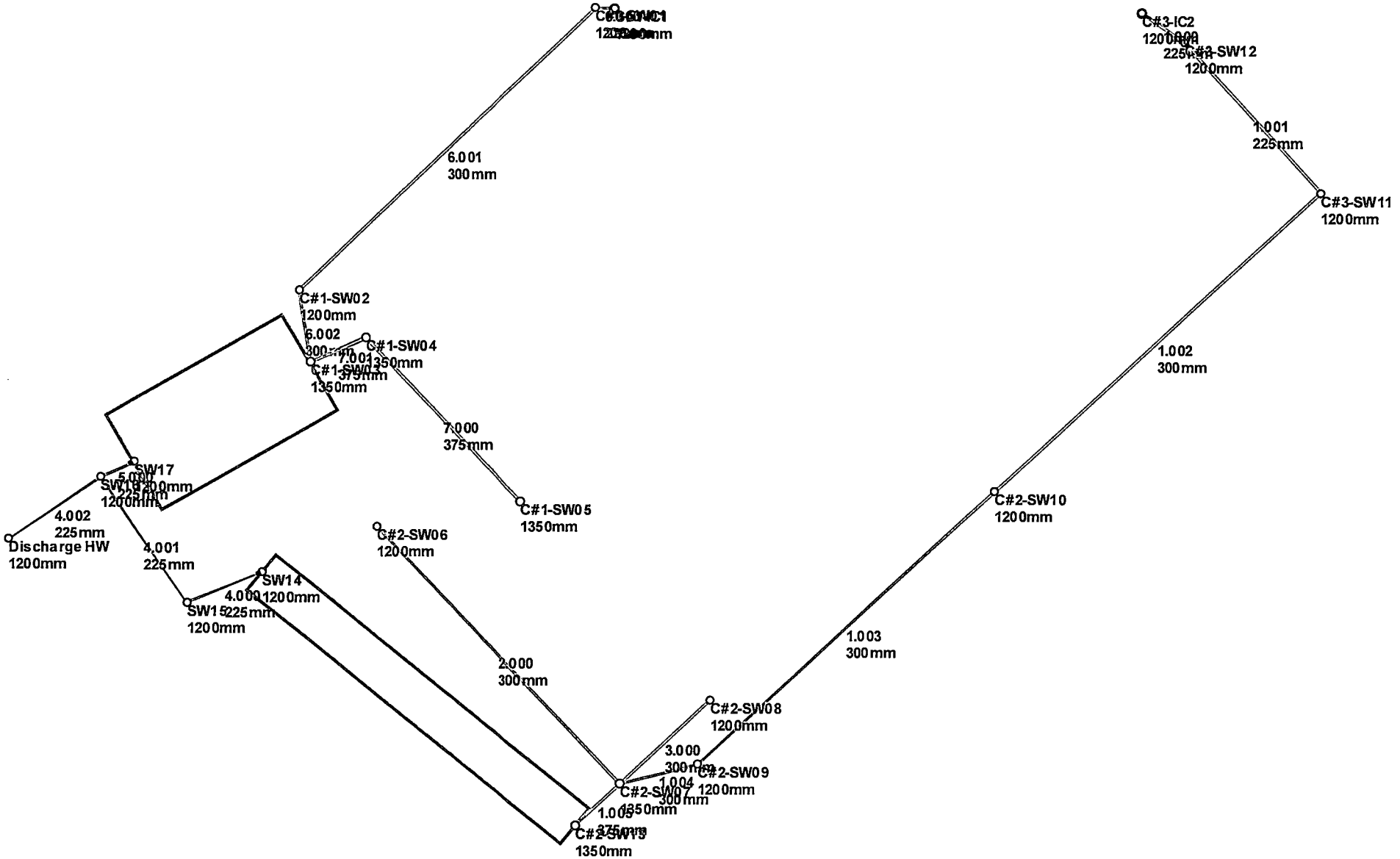
Surface Water Network Design

KAVANAGH BURKE CONSULTING ENGINEERS	Kavanagh Burke Ltd Unit F3 Calmount Park, Ballymount, Dublin 12	File: D1736 - SW Network PL2 AI.pfd Network: Storm Network Elena Dragoje 14/10/2022	Page 1 Surface Water Network rev.PL2 A.I.



Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	18.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.271	Preferred Cover Depth (m)	0.750
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	Tof E (mins)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Easting (m)	Northing (m)
C#1-IC1	0.033	5.00	98.075	Manhole	SW MH	1200	705331.008	728430.223
C#1-SW01	0.025	5.00	98.075	Manhole	SW MH	1200	705327.815	728430.372
C#1-SW02	0.095	5.00	98.125	Manhole	SW MH	1200	705279.364	728384.095
C#1-SW03			98.100	Manhole	SW MH	1350	705281.166	728372.231
C#1-SW04	0.270	5.00	98.500	Sealed Manhole	SW MH	1350	705290.331	728376.231
C#1-SW05	0.540	5.00	98.500	Sealed Manhole	SW MH	1350	705315.646	728349.247
C#2-SW06	0.170	5.00	97.815	Manhole	SW MH	1200	705292.169	728345.130
C#2-SW07	0.155	5.00	98.075	Manhole	SW MH	1350	705331.906	728302.881
C#2-SW08	0.270	5.00	98.500	Sealed Manhole	SW MH	1200	705346.533	728316.520
C#2-SW09	0.039	5.00	98.300	Manhole	SW MH	1200	705344.514	728306.046
C#2-SW10	0.024	5.00	98.325	Manhole	SW MH	1200	705392.462	728350.812
C#3-SW11	0.053	5.00	98.325	Manhole	SW MH	1200	705445.131	728399.903
C#3-SW12	0.104	5.00	98.325	Manhole	SW MH	1200	705423.225	728424.583
C#3-IC2	0.048	5.00	98.175	Manhole	SW MH	1200	705416.229	728429.417
C#2-SW13			97.975	Manhole	SW MH	1350	705324.603	728296.006
SW14		5.00	98.060	Manhole	SW MH	1200	705273.426	728337.647
SW15			98.000	Manhole	SW MH	1200	705261.432	728332.631
SW16			98.000	Manhole	SW MH	1200	705247.533	728353.411
SW17	0.018	5.00	99.350	Manhole	SW MH	1200	705252.994	728355.897
Discharge HW			97.000	Manhole	SW MH	1200	705232.701	728343.213

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Tof C (mins)	Rain (mm/hr)
1.000	C#3-IC2	C#3-SW12	8.504	0.600	97.050	97.000	0.050	170.1	225	5.14	50.0
1.001	C#3-SW12	C#3-SW11	33.000	0.600	97.000	96.850	0.150	220.0	225	5.77	50.0
1.002	C#3-SW11	C#2-SW10	72.000	0.600	96.775	96.500	0.275	261.8	300	7.01	47.0
1.003	C#2-SW10	C#2-SW09	65.597	0.600	96.500	96.250	0.250	262.4	300	8.14	44.1

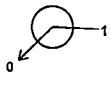
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)
1.000	0.999	39.7	6.5	0.900	1.100	0.900	1.100	0.048	0.0	61
1.001	0.877	34.9	20.6	1.100	1.250	1.100	1.250	0.152	0.0	124
1.002	0.967	68.3	26.1	1.250	1.525	1.250	1.525	0.205	0.0	129
1.003	0.966	68.3	27.4	1.525	1.750	1.525	1.750	0.229	0.0	132

Links

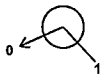
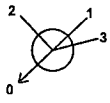
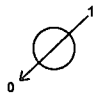
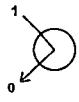
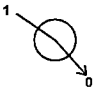
Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Tof C (mins)	Rain (mm/hr)
1.004	C#2-SW09	C#2-SW07	12.999	0.600	96.250	96.200	0.050	260.0	300	8.37	43.6
2.000	C#2-SW06	C#2-SW07	58.000	0.600	96.700	96.400	0.300	193.3	300	5.86	50.0
3.000	C#2-SW08	C#2-SW07	19.999	0.600	97.000	96.800	0.200	100.0	300	5.21	50.0
1.005	C#2-SW07	C#2-SW13	10.030	0.600	96.125	96.075	0.050	200.6	375	8.50	43.3
4.000	SW14	SW15	13.001	0.600	95.800	95.700	0.100	130.0	225	5.19	50.0
4.001	SW15	SW16	25.000	0.600	95.700	95.540	0.160	156.2	225	5.59	50.0
6.000	C#1-IC1	C#1-SW01	3.196	0.600	97.075	97.050	0.025	127.9	225	5.05	50.0
6.001	C#1-SW01	C#1-SW02	67.000	0.600	96.975	96.750	0.225	297.8	300	6.28	49.2
6.002	C#1-SW02	C#1-SW03	12.000	0.600	96.750	96.700	0.050	240.0	300	6.48	48.6
7.000	C#1-SW05	C#1-SW04	37.000	0.600	97.000	96.775	0.225	164.4	375	5.44	50.0
7.001	C#1-SW04	C#1-SW03	10.000	0.600	96.775	96.700	0.075	133.3	375	5.54	50.0
5.000	SW17	SW16	6.000	0.600	95.760	95.730	0.030	200.0	225	5.11	50.0
4.002	SW16	Discharge HW	18.000	0.600	95.540	95.460	0.080	225.0	225	5.93	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)
1.004	0.970	68.6	31.6	1.750	1.575	1.575	1.750	0.268	0.0	143
2.000	1.127	79.7	23.0	0.815	1.375	0.815	1.375	0.170	0.0	110
3.000	1.572	111.1	36.6	1.200	0.975	0.975	1.200	0.270	0.0	118
1.005	1.275	140.9	101.2	1.575	1.525	1.525	1.575	0.863	0.0	236
4.000	1.145	45.5	0.0	2.035	2.075	2.035	2.075	0.000	0.0	0
4.001	1.043	41.5	0.0	2.075	2.235	2.075	2.235	0.000	0.0	0
6.000	1.155	45.9	4.5	0.775	0.800	0.775	0.800	0.033	0.0	47
6.001	0.906	64.0	7.7	0.800	1.075	0.800	1.075	0.058	0.0	70
6.002	1.010	71.4	20.2	1.075	1.100	1.075	1.100	0.153	0.0	109
7.000	1.410	155.7	73.2	1.125	1.350	1.125	1.350	0.540	0.0	181
7.001	1.567	173.1	109.8	1.350	1.025	1.025	1.350	0.810	0.0	217
5.000	0.921	36.6	2.4	3.365	2.045	2.045	3.365	0.018	0.0	39
4.002	0.867	34.5	2.4	2.235	1.315	1.315	2.235	0.018	0.0	40

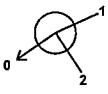
Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
C#1-IC1	98.075	1.000	1200				
				0	6.000	97.075	225
C#1-SW01	98.075	1.100	1200	1	6.000	97.050	225
							
				0	6.001	96.975	300
C#1-SW02	98.125	1.375	1200	1	6.001	96.750	300
							
				0	6.002	96.750	300

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
C#1-SW03	98.100	2.200	1350		1	7.001	96.700	375
					2	6.002	96.700	300
C#1-SW04	98.500	1.725	1350		1	7.000	96.775	375
					0	7.001	96.775	375
C#1-SW05	98.500	1.500	1350		0	7.000	97.000	375
C#2-SW06	97.815	1.115	1200		0	2.000	96.700	300
C#2-SW07	98.075	1.950	1350		1	3.000	96.800	300
					2	2.000	96.400	300
					3	1.004	96.200	300
					0	1.005	96.125	375
C#2-SW08	98.500	1.500	1200		0	3.000	97.000	300
C#2-SW09	98.300	2.050	1200		1	1.003	96.250	300
					0	1.004	96.250	300
C#2-SW10	98.325	1.825	1200		1	1.002	96.500	300
					0	1.003	96.500	300
C#3-SW11	98.325	1.550	1200		1	1.001	96.850	225
					0	1.002	96.775	300
C#3-SW12	98.325	1.325	1200		1	1.000	97.000	225
					0	1.001	97.000	225
C#3-IC2	98.175	1.125	1200		0	1.000	97.050	225
C#2-SW13	97.975	2.142	1350		1	1.005	96.075	375

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SW14	98.060	2.260	1200				
				0	4.000	95.800	225
SW15	98.000	2.300	1200		1	4.000	95.700	225
				0	4.001	95.700	225
SW16	98.000	2.460	1200		1	5.000	95.730	225
					2	4.001	95.540	225
				0	4.002	95.540	225
SW17	99.350	3.590	1200				
				0	5.000	95.760	225
Discharge HW	97.000	1.540	1200		1	4.002	95.460	225

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	Scotland and Ireland	Skip Steady State	x
M5-60 (mm)	18.000	Drain Down Time (mins)	240
Ratio-R	0.271	Additional Storage (m³/ha)	25.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	0	0
2	20	0	0
10	20	0	0
30	20	0	0
100	20	0	0

Node C#3-SW12 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	97.000	Product Number	CTL-SHE-0046-9000-0850-9000
Design Depth (m)	0.850	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	0.9	Min Node Diameter (mm)	1200

Node SW14 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	96.000	Product Number	CTL-SHE-0068-2200-1200-2200
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.2	Min Node Diameter (mm)	1200

Flow control device to be set to limit flow to 4.46 l/s flow rate not exceeding Greenfield runoff rate for subject catchment) at the outlet of the manhole SW MH 16 prior entering adjacent water course.

Node SW17 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	95.760	Product Number	CTL-SHE-0085-4500-2140-4500
Design Depth (m)	2.140	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	4.5	Min Node Diameter (mm)	1200

Permeable paving storage - to the front (east) of the warehouse/office (A=480m2)

Node C#3-IC2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	97.250	Slope (1:X)	2000.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.600
Safety Factor	2.0	Width (m)	6.000	Inf Depth (m)	
Porosity	0.30	Length (m)	79.000		

Node SW14 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	66.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	95.800	Main Channel Slope (1:X)	2000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.015

Sub-catchemnt #2 Underground Attenuation Tank volume = 686m3 See drawing ref. D1736-D3 & D4 for details including volume, base and high water level.

Inlets
C#2-SW13

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	490.0	0.0	1.400	490.0	0.0	1.410	5.0	0.0

Permeable paving storage - to the northern side of the warehouse (A=330m2)

Node C#1-IC1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	97.575	Slope (1:X)	2000.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	240	Depth (m)	0.300
Safety Factor	2.0	Width (m)	6.000	Inf Depth (m)	
Porosity	0.30	Length (m)	55.000		

Node SW17 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	17.500
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	95.800	Main Channel Slope (1:X)	175.0
Safety Factor	2.0	Time to half empty (mins)	0	Main Channel n	0.015

Inlets
C#1-SW03

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	201.0	0.0	1.200	396.0	0.0	2.100	587.0	0.0
0.700	305.0	0.0	1.700	495.0	0.0			

Sub-catchemnt #1 Detention basin volume = 735m3
See drawing ref. D1736-D3 & D4 for detention basin details including volume, dimensions, base and high water level.

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year +20% CC 15 minute summer	115.481	32.677
1 year +20% CC 15 minute winter	81.039	32.677
1 year +20% CC 30 minute summer	79.567	22.515
1 year +20% CC 30 minute winter	55.837	22.515
1 year +20% CC 60 minute summer	56.887	15.034
1 year +20% CC 60 minute winter	37.794	15.034
1 year +20% CC 120 minute summer	37.363	9.874
1 year +20% CC 120 minute winter	24.823	9.874
1 year +20% CC 180 minute summer	29.896	7.693
1 year +20% CC 180 minute winter	19.433	7.693
1 year +20% CC 240 minute summer	24.370	6.440
1 year +20% CC 240 minute winter	16.191	6.440
1 year +20% CC 360 minute summer	19.417	4.997
1 year +20% CC 360 minute winter	12.622	4.997
1 year +20% CC 480 minute summer	15.790	4.173
1 year +20% CC 480 minute winter	10.491	4.173
1 year +20% CC 600 minute summer	13.349	3.651
1 year +20% CC 600 minute winter	9.121	3.651
1 year +20% CC 720 minute summer	12.135	3.252
1 year +20% CC 720 minute winter	8.155	3.252
1 year +20% CC 960 minute summer	10.292	2.710
1 year +20% CC 960 minute winter	6.817	2.710
1 year +20% CC 1440 minute summer	7.813	2.094
1 year +20% CC 1440 minute winter	5.251	2.094
1 year +20% CC 2160 minute summer	5.856	1.618
1 year +20% CC 2160 minute winter	4.035	1.618
1 year +20% CC 2880 minute summer	5.033	1.349
1 year +20% CC 2880 minute winter	3.382	1.349
1 year +20% CC 4320 minute summer	3.983	1.041
1 year +20% CC 4320 minute winter	2.623	1.041
1 year +20% CC 5760 minute summer	3.381	0.865
1 year +20% CC 5760 minute winter	2.188	0.865
1 year +20% CC 7200 minute summer	2.940	0.750
1 year +20% CC 7200 minute winter	1.897	0.750
1 year +20% CC 8640 minute summer	2.614	0.667
1 year +20% CC 8640 minute winter	1.687	0.667
1 year +20% CC 10080 minute summer	2.365	0.603
1 year +20% CC 10080 minute winter	1.527	0.603
2 year +20% CC 15 minute summer	139.256	39.405
2 year +20% CC 15 minute winter	97.723	39.405
2 year +20% CC 30 minute summer	95.775	27.101
2 year +20% CC 30 minute winter	67.210	27.101
2 year +20% CC 60 minute summer	68.330	18.058
2 year +20% CC 60 minute winter	45.397	18.058

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +20% CC 120 minute summer	44.418	11.738
2 year +20% CC 120 minute winter	29.510	11.738
2 year +20% CC 180 minute summer	35.340	9.094
2 year +20% CC 180 minute winter	22.972	9.094
2 year +20% CC 240 minute summer	28.772	7.604
2 year +20% CC 240 minute winter	19.115	7.604
2 year +20% CC 360 minute summer	22.833	5.876
2 year +20% CC 360 minute winter	14.842	5.876
2 year +20% CC 480 minute summer	18.508	4.891
2 year +20% CC 480 minute winter	12.296	4.891
2 year +20% CC 600 minute summer	15.511	4.242
2 year +20% CC 600 minute winter	10.598	4.242
2 year +20% CC 720 minute summer	14.093	3.777
2 year +20% CC 720 minute winter	9.471	3.777
2 year +20% CC 960 minute summer	11.942	3.145
2 year +20% CC 960 minute winter	7.911	3.145
2 year +20% CC 1440 minute summer	9.033	2.421
2 year +20% CC 1440 minute winter	6.071	2.421
2 year +20% CC 2160 minute summer	6.737	1.862
2 year +20% CC 2160 minute winter	4.642	1.862
2 year +20% CC 2880 minute summer	5.767	1.546
2 year +20% CC 2880 minute winter	3.876	1.546
2 year +20% CC 4320 minute summer	4.538	1.186
2 year +20% CC 4320 minute winter	2.988	1.186
2 year +20% CC 5760 minute summer	3.835	0.982
2 year +20% CC 5760 minute winter	2.482	0.982
2 year +20% CC 7200 minute summer	3.323	0.848
2 year +20% CC 7200 minute winter	2.145	0.848
2 year +20% CC 8640 minute summer	2.949	0.752
2 year +20% CC 8640 minute winter	1.903	0.752
2 year +20% CC 10080 minute summer	2.668	0.681
2 year +20% CC 10080 minute winter	1.722	0.681
10 year +20% CC 15 minute summer	202.234	57.225
10 year +20% CC 15 minute winter	141.918	57.225
10 year +20% CC 30 minute summer	138.254	39.121
10 year +20% CC 30 minute winter	97.020	39.121
10 year +20% CC 60 minute summer	97.162	25.677
10 year +20% CC 60 minute winter	64.552	25.677
10 year +20% CC 120 minute summer	62.465	16.508
10 year +20% CC 120 minute winter	41.500	16.508
10 year +20% CC 180 minute summer	49.255	12.675
10 year +20% CC 180 minute winter	32.017	12.675
10 year +20% CC 240 minute summer	39.698	10.491
10 year +20% CC 240 minute winter	26.374	10.491
10 year +20% CC 360 minute summer	31.177	8.023
10 year +20% CC 360 minute winter	20.266	8.023
10 year +20% CC 480 minute summer	25.076	6.627
10 year +20% CC 480 minute winter	16.660	6.627
10 year +20% CC 600 minute summer	20.881	5.711

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
10 year +20% CC 600 minute winter	14.267	5.711
10 year +20% CC 720 minute summer	18.870	5.057
10 year +20% CC 720 minute winter	12.682	5.057
10 year +20% CC 960 minute summer	15.848	4.173
10 year +20% CC 960 minute winter	10.498	4.173
10 year +20% CC 1440 minute summer	11.873	3.182
10 year +20% CC 1440 minute winter	7.979	3.182
10 year +20% CC 2160 minute summer	8.773	2.425
10 year +20% CC 2160 minute winter	6.045	2.425
10 year +20% CC 2880 minute summer	7.457	1.999
10 year +20% CC 2880 minute winter	5.012	1.999
10 year +20% CC 4320 minute summer	5.820	1.522
10 year +20% CC 4320 minute winter	3.832	1.522
10 year +20% CC 5760 minute summer	4.897	1.254
10 year +20% CC 5760 minute winter	3.170	1.254
10 year +20% CC 7200 minute summer	4.228	1.079
10 year +20% CC 7200 minute winter	2.729	1.079
10 year +20% CC 8640 minute summer	3.740	0.954
10 year +20% CC 8640 minute winter	2.414	0.954
10 year +20% CC 10080 minute summer	3.371	0.860
10 year +20% CC 10080 minute winter	2.176	0.860
30 year +20% CC 15 minute summer	256.863	72.683
30 year +20% CC 15 minute winter	180.255	72.683
30 year +20% CC 30 minute summer	176.278	49.881
30 year +20% CC 30 minute winter	123.704	49.881
30 year +20% CC 60 minute summer	123.107	32.534
30 year +20% CC 60 minute winter	81.790	32.534
30 year +20% CC 120 minute summer	78.466	20.736
30 year +20% CC 120 minute winter	52.131	20.736
30 year +20% CC 180 minute summer	61.506	15.828
30 year +20% CC 180 minute winter	39.981	15.828
30 year +20% CC 240 minute summer	49.349	13.041
30 year +20% CC 240 minute winter	32.786	13.041
30 year +20% CC 360 minute summer	38.499	9.907
30 year +20% CC 360 minute winter	25.025	9.907
30 year +20% CC 480 minute summer	30.814	8.143
30 year +20% CC 480 minute winter	20.472	8.143
30 year +20% CC 600 minute summer	25.560	6.991
30 year +20% CC 600 minute winter	17.464	6.991
30 year +20% CC 720 minute summer	23.025	6.171
30 year +20% CC 720 minute winter	15.475	6.171
30 year +20% CC 960 minute summer	19.243	5.067
30 year +20% CC 960 minute winter	12.747	5.067
30 year +20% CC 1440 minute summer	14.315	3.837
30 year +20% CC 1440 minute winter	9.621	3.837
30 year +20% CC 2160 minute summer	10.499	2.902
30 year +20% CC 2160 minute winter	7.234	2.902
30 year +20% CC 2880 minute summer	8.874	2.378
30 year +20% CC 2880 minute winter	5.964	2.378

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +20% CC 4320 minute summer	6.868	1.796
30 year +20% CC 4320 minute winter	4.523	1.796
30 year +20% CC 5760 minute summer	5.744	1.470
30 year +20% CC 5760 minute winter	3.718	1.470
30 year +20% CC 7200 minute summer	4.936	1.259
30 year +20% CC 7200 minute winter	3.186	1.259
30 year +20% CC 8640 minute summer	4.349	1.109
30 year +20% CC 8640 minute winter	2.807	1.109
30 year +20% CC 10080 minute summer	3.908	0.997
30 year +20% CC 10080 minute winter	2.522	0.997
100 year +20% CC 15 minute summer	333.817	94.459
100 year +20% CC 15 minute winter	234.257	94.459
100 year +20% CC 30 minute summer	230.059	65.099
100 year +20% CC 30 minute winter	161.445	65.099
100 year +20% CC 60 minute summer	159.562	42.167
100 year +20% CC 60 minute winter	106.009	42.167
100 year +20% CC 120 minute summer	100.744	26.624
100 year +20% CC 120 minute winter	66.932	26.624
100 year +20% CC 180 minute summer	78.458	20.190
100 year +20% CC 180 minute winter	51.000	20.190
100 year +20% CC 240 minute summer	62.640	16.554
100 year +20% CC 240 minute winter	41.616	16.554
100 year +20% CC 360 minute summer	48.513	12.484
100 year +20% CC 360 minute winter	31.535	12.484
100 year +20% CC 480 minute summer	38.621	10.206
100 year +20% CC 480 minute winter	25.659	10.206
100 year +20% CC 600 minute summer	31.901	8.726
100 year +20% CC 600 minute winter	21.797	8.726
100 year +20% CC 720 minute summer	28.638	7.675
100 year +20% CC 720 minute winter	19.246	7.675
100 year +20% CC 960 minute summer	23.803	6.268
100 year +20% CC 960 minute winter	15.767	6.268
100 year +20% CC 1440 minute summer	17.572	4.709
100 year +20% CC 1440 minute winter	11.809	4.709
100 year +20% CC 2160 minute summer	12.782	3.533
100 year +20% CC 2160 minute winter	8.807	3.533
100 year +20% CC 2880 minute summer	10.737	2.878
100 year +20% CC 2880 minute winter	7.216	2.878
100 year +20% CC 4320 minute summer	8.235	2.153
100 year +20% CC 4320 minute winter	5.423	2.153
100 year +20% CC 5760 minute summer	6.842	1.751
100 year +20% CC 5760 minute winter	4.428	1.751
100 year +20% CC 7200 minute summer	5.849	1.492
100 year +20% CC 7200 minute winter	3.775	1.492
100 year +20% CC 8640 minute summer	5.131	1.309
100 year +20% CC 8640 minute winter	3.312	1.309
100 year +20% CC 10080 minute summer	4.594	1.172
100 year +20% CC 10080 minute winter	2.965	1.172

Results for 1 year +20% CC Critical Storm Duration. Lowest mass balance: 94.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	C#1-IC1	10	97.129	0.054	4.9	0.1058	0.0000	OK
15 minute winter	C#1-SW01	11	97.047	0.072	8.5	0.1218	0.0000	OK
15 minute winter	C#1-SW02	11	96.870	0.120	21.9	0.3422	0.0000	OK
960 minute winter	C#1-SW03	780	96.658	0.758	15.3	1.0848	0.0000	OK
15 minute winter	C#1-SW04	11	97.033	0.258	118.3	1.3782	0.0000	OK
15 minute winter	C#1-SW05	10	97.196	0.196	80.2	2.0461	0.0000	OK
15 minute winter	C#2-SW06	11	96.815	0.115	25.3	0.5676	0.0000	OK
4320 minute winter	C#2-SW07	3060	96.418	0.293	5.0	1.0007	0.0000	OK
15 minute winter	C#2-SW08	10	97.131	0.131	40.1	0.7398	0.0000	OK
4320 minute winter	C#2-SW09	3060	96.418	0.168	1.4	0.2695	0.0000	OK
15 minute winter	C#2-SW10	12	96.580	0.080	11.9	0.1174	0.0000	OK
15 minute winter	C#3-SW11	11	96.845	0.070	8.7	0.1392	0.0000	OK
600 minute winter	C#3-SW12	465	97.423	0.423	2.2	1.3074	0.0000	SURCHARGED
600 minute winter	C#3-IC2	465	97.423	0.373	2.4	22.5363	0.0000	SURCHARGED
4320 minute winter	C#2-SW13	3060	96.418	0.585	4.9	0.8367	0.0000	OK
4320 minute winter	SW14	3060	96.418	0.618	3.5	0.6986	0.0000	SURCHARGED
960 minute winter	SW15	915	95.733	0.033	2.0	0.0377	0.0000	OK
2880 minute summer	SW16	2760	95.602	0.062	5.5	0.0703	0.0000	OK
960 minute winter	SW17	780	96.658	0.898	9.3	1.1280	0.0000	SURCHARGED
2880 minute summer	Discharge HW	2760	95.520	0.060	5.5	0.0000	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)
15 minute winter	C#1-IC1	6.000	C#1-SW01	4.8	0.706	0.105	0.0218	
15 minute winter	C#1-SW01	6.001	C#1-SW02	8.2	0.425	0.128	1.3103	
15 minute winter	C#1-SW02	6.002	C#1-SW03	21.2	0.852	0.297	0.2988	
960 minute winter	C#1-SW03	Flow through pond	SW17	9.0	0.041	0.000	211.5721	
15 minute winter	C#1-SW04	7.001	C#1-SW03	117.4	1.577	0.678	0.7438	
15 minute winter	C#1-SW05	7.000	C#1-SW04	78.3	1.129	0.503	2.5580	
15 minute winter	C#2-SW06	2.000	C#2-SW07	24.2	0.992	0.304	1.4141	
4320 minute winter	C#2-SW07	1.005	C#2-SW13	4.9	0.565	0.035	0.9926	
15 minute winter	C#2-SW08	3.000	C#2-SW07	39.2	1.392	0.353	0.5648	
4320 minute winter	C#2-SW09	1.004	C#2-SW07	1.4	0.403	0.020	0.6191	
15 minute winter	C#2-SW10	1.003	C#2-SW09	11.0	0.517	0.161	1.5835	
15 minute winter	C#3-SW11	1.002	C#2-SW10	8.4	0.635	0.122	0.9886	
600 minute winter	C#3-SW12	Hydro-Brake®	C#3-SW11	0.8				
600 minute winter	C#3-IC2	1.000	C#3-SW12	-1.4	0.072	-0.035	0.3382	
4320 minute winter	C#2-SW13	Flow through pond	SW14	3.5	0.017	0.000	294.5602	
4320 minute winter	SW14	Hydro-Brake®	SW15	2.0				
960 minute winter	SW15	4.001	SW16	2.0	0.345	0.048	0.1499	
2880 minute summer	SW16	4.002	Discharge HW	5.5	0.630	0.159	0.1562	682.2
960 minute winter	SW17	Hydro-Brake®	SW16	3.5				

Results for 2 year +20% CC Critical Storm Duration. Lowest mass balance: 94.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	C#1-IC1	10	97.135	0.060	5.9	0.1170	0.0000	OK
15 minute winter	C#1-SW01	11	97.054	0.079	10.3	0.1343	0.0000	OK
15 minute winter	C#1-SW02	11	96.884	0.134	26.5	0.3823	0.0000	OK
960 minute winter	C#1-SW03	885	96.813	0.913	17.9	1.3071	0.0000	OK
15 minute winter	C#1-SW04	11	97.070	0.295	142.6	1.5782	0.0000	OK
15 minute winter	C#1-SW05	10	97.222	0.222	96.7	2.3204	0.0000	OK
15 minute winter	C#2-SW06	11	96.828	0.128	30.5	0.6313	0.0000	OK
4320 minute winter	C#2-SW07	3240	96.531	0.406	5.9	1.3895	0.0000	SURCHARGED
15 minute winter	C#2-SW08	10	97.147	0.147	48.4	0.8283	0.0000	OK
4320 minute winter	C#2-SW09	3240	96.531	0.281	1.7	0.4522	0.0000	OK
15 minute winter	C#2-SW10	12	96.588	0.088	14.1	0.1285	0.0000	OK
15 minute winter	C#3-SW11	11	96.851	0.076	10.3	0.1515	0.0000	OK
720 minute winter	C#3-SW12	570	97.468	0.468	2.3	1.4464	0.0000	SURCHARGED
720 minute winter	C#3-IC2	570	97.468	0.418	2.6	29.0229	0.0000	SURCHARGED
4320 minute winter	C#2-SW13	3240	96.531	0.698	5.8	0.9994	0.0000	OK
4320 minute winter	SW14	3240	96.531	0.731	3.9	0.8272	0.0000	SURCHARGED
600 minute winter	SW15	540	95.733	0.033	2.0	0.0377	0.0000	OK
10080 minute summer	SW16	5160	95.602	0.062	5.5	0.0703	0.0000	OK
960 minute winter	SW17	885	96.813	1.053	10.4	1.3231	0.0000	SURCHARGED
10080 minute summer	Discharge HW	5160	95.520	0.060	5.5	0.0000	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)
15 minute winter	C#1-IC1	6.000	C#1-SW01	5.8	0.743	0.127	0.0251	
15 minute winter	C#1-SW01	6.001	C#1-SW02	10.0	0.445	0.156	1.5129	
15 minute winter	C#1-SW02	6.002	C#1-SW03	25.8	0.898	0.361	0.3447	
960 minute winter	C#1-SW03	Flow through pond	SW17	10.1	0.039	0.000	264.0989	
15 minute winter	C#1-SW04	7.001	C#1-SW03	141.4	1.641	0.817	0.8594	
15 minute winter	C#1-SW05	7.000	C#1-SW04	94.2	1.169	0.605	2.9635	
15 minute winter	C#2-SW06	2.000	C#2-SW07	29.3	1.043	0.368	1.6279	
4320 minute winter	C#2-SW07	1.005	C#2-SW13	5.8	0.565	0.041	1.1063	
15 minute winter	C#2-SW08	3.000	C#2-SW07	47.4	1.457	0.426	0.6516	
4320 minute winter	C#2-SW09	1.004	C#2-SW07	1.7	0.427	0.024	0.9038	
15 minute winter	C#2-SW10	1.003	C#2-SW09	13.1	0.518	0.192	2.0403	
15 minute winter	C#3-SW11	1.002	C#2-SW10	9.9	0.662	0.145	1.1221	
720 minute winter	C#3-SW12	Hydro-Brake®	C#3-SW11	0.8				
720 minute winter	C#3-IC2	1.000	C#3-SW12	-1.5	0.065	-0.038	0.3382	
4320 minute winter	C#2-SW13	Flow through pond	SW14	3.9	0.017	0.000	350.2792	
4320 minute winter	SW14	Hydro-Brake®	SW15	2.0				
600 minute winter	SW15	4.001	SW16	2.0	0.339	0.048	0.1528	
10080 minute summer	SW16	4.002	Discharge HW	5.5	0.630	0.159	0.1562	1486.8
960 minute winter	SW17	Hydro-Brake®	SW16	3.5				

Results for 10 year +20% CC Critical Storm Duration. Lowest mass balance: 94.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	C#1-IC1	10	97.148	0.073	8.6	0.1435	0.0000	OK
1440 minute winter	C#1-SW01	1140	97.133	0.158	1.1	0.2679	0.0000	OK
1440 minute winter	C#1-SW02	1140	97.133	0.383	2.9	1.0938	0.0000	SURCHARGED
1440 minute winter	C#1-SW03	1140	97.133	1.233	18.0	1.7640	0.0000	OK
15 minute winter	C#1-SW04	11	97.213	0.438	195.6	2.3406	0.0000	SURCHARGED
15 minute winter	C#1-SW05	11	97.408	0.408	140.6	4.2588	0.0000	SURCHARGED
15 minute winter	C#2-SW06	11	96.860	0.160	44.3	0.7886	0.0000	OK
5760 minute winter	C#2-SW07	4500	96.797	0.672	6.0	2.2989	0.0000	SURCHARGED
15 minute winter	C#2-SW08	10	97.187	0.187	70.3	1.0530	0.0000	OK
5760 minute winter	C#2-SW09	4500	96.797	0.547	1.7	0.8797	0.0000	SURCHARGED
5760 minute winter	C#2-SW10	4500	96.797	0.297	1.4	0.4343	0.0000	OK
15 minute winter	C#3-SW11	10	96.866	0.091	14.5	0.1816	0.0000	OK
720 minute winter	C#3-SW12	645	97.582	0.582	3.1	1.7994	0.0000	SURCHARGED
720 minute winter	C#3-IC2	645	97.582	0.532	3.8	45.5052	0.0000	SURCHARGED
5760 minute winter	C#2-SW13	4500	96.797	0.964	5.9	1.3800	0.0000	OK
5760 minute winter	SW14	4500	96.797	0.997	3.9	1.1280	0.0000	SURCHARGED
240 minute winter	SW15	212	95.733	0.033	2.0	0.0377	0.0000	OK
600 minute winter	SW16	555	95.602	0.062	5.5	0.0706	0.0000	OK
1440 minute winter	SW17	1140	97.133	1.373	10.1	1.7241	0.0000	SURCHARGED
600 minute winter	Discharge HW	555	95.520	0.060	5.5	0.0000	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)
15 minute winter	C#1-IC1	6.000	C#1-SW01	8.5	0.821	0.185	0.0331	
1440 minute winter	C#1-SW01	6.001	C#1-SW02	1.1	0.244	0.017	3.6158	
1440 minute winter	C#1-SW02	6.002	C#1-SW03	2.9	0.500	0.041	0.8450	
1440 minute winter	C#1-SW03	Flow through pond	SW17	9.8	0.040	0.000	386.2755	
15 minute winter	C#1-SW04	7.001	C#1-SW03	194.9	1.778	1.126	1.0539	
15 minute winter	C#1-SW05	7.000	C#1-SW04	129.4	1.197	0.831	4.0810	
15 minute winter	C#2-SW06	2.000	C#2-SW07	42.7	1.147	0.537	2.1624	
5760 minute winter	C#2-SW07	1.005	C#2-SW13	5.9	0.537	0.042	1.1063	
15 minute winter	C#2-SW08	3.000	C#2-SW07	68.9	1.587	0.620	0.8698	
5760 minute winter	C#2-SW09	1.004	C#2-SW07	1.6	0.403	0.023	0.9154	
5760 minute winter	C#2-SW10	1.003	C#2-SW09	1.4	0.355	0.020	4.6163	
15 minute winter	C#3-SW11	1.002	C#2-SW10	14.1	0.724	0.206	1.4594	
720 minute winter	C#3-SW12	Hydro-Brake®	C#3-SW11	0.8				
720 minute winter	C#3-IC2	1.000	C#3-SW12	-2.4	-0.059	-0.059	0.3382	
5760 minute winter	C#2-SW13	Flow through pond	SW14	3.9	0.017	0.000	480.5978	
5760 minute winter	SW14	Hydro-Brake®	SW15	2.0				
240 minute winter	SW15	4.001	SW16	2.0	0.331	0.048	0.1562	
600 minute winter	SW16	4.002	Discharge HW	5.5	0.632	0.160	0.1574	229.5
1440 minute winter	SW17	Hydro-Brake®	SW16	3.7				

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 94.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	C#1-IC1	1380	97.426	0.351	0.7	0.6857	0.0000	SURCHARGED
1440 minute winter	C#1-SW01	1380	97.426	0.451	1.3	0.7655	0.0000	SURCHARGED
1440 minute winter	C#1-SW02	1380	97.426	0.676	3.4	1.9307	0.0000	SURCHARGED
1440 minute winter	C#1-SW03	1380	97.426	1.526	21.6	2.1830	0.0000	OK
1440 minute winter	C#1-SW04	1380	97.426	0.651	18.2	3.4766	0.0000	SURCHARGED
15 minute winter	C#1-SW05	11	97.674	0.674	178.6	7.0255	0.0000	SURCHARGED
5760 minute winter	C#2-SW06	4440	96.963	0.263	1.5	1.3003	0.0000	OK
5760 minute winter	C#2-SW07	4440	96.963	0.838	6.7	2.8653	0.0000	SURCHARGED
15 minute winter	C#2-SW08	10	97.223	0.223	89.3	1.2537	0.0000	OK
5760 minute winter	C#2-SW09	4440	96.963	0.713	1.7	1.1459	0.0000	SURCHARGED
5760 minute winter	C#2-SW10	4440	96.963	0.463	1.4	0.6761	0.0000	SURCHARGED
5760 minute winter	C#3-SW11	4440	96.963	0.188	1.2	0.3736	0.0000	OK
720 minute winter	C#3-SW12	675	97.686	0.686	3.8	2.1228	0.0000	SURCHARGED
720 minute winter	C#3-IC2	675	97.686	0.636	4.7	60.6041	0.0000	SURCHARGED
5760 minute winter	C#2-SW13	4440	96.963	1.130	6.6	1.6171	0.0000	OK
5760 minute winter	SW14	4440	96.963	1.163	4.3	1.3154	0.0000	SURCHARGED
5760 minute winter	SW15	4440	95.733	0.033	2.0	0.0378	0.0000	OK
2160 minute winter	SW16	2040	95.605	0.065	5.9	0.0730	0.0000	OK
1440 minute winter	SW17	1380	97.426	1.666	11.7	2.0919	0.0000	SURCHARGED
2160 minute winter	Discharge HW	2040	95.522	0.062	5.9	0.0000	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)
1440 minute winter	C#1-IC1	6.000	C#1-SW01	0.7	0.414	0.015	0.1271	
1440 minute winter	C#1-SW01	6.001	C#1-SW02	1.3	0.264	0.020	4.7181	
1440 minute winter	C#1-SW02	6.002	C#1-SW03	3.4	0.520	0.048	0.8450	
1440 minute winter	C#1-SW03	Flow through pond	SW17	11.3	0.035	0.000	515.4413	
1440 minute winter	C#1-SW04	7.001	C#1-SW03	18.2	0.984	0.105	1.1030	
15 minute winter	C#1-SW05	7.000	C#1-SW04	167.0	1.515	1.073	4.0810	
5760 minute winter	C#2-SW06	2.000	C#2-SW07	1.5	0.435	0.019	3.9410	
5760 minute winter	C#2-SW07	1.005	C#2-SW13	6.6	0.537	0.047	1.1063	
15 minute winter	C#2-SW08	3.000	C#2-SW07	87.4	1.663	0.786	1.0525	
5760 minute winter	C#2-SW09	1.004	C#2-SW07	1.7	0.403	0.024	0.9154	
5760 minute winter	C#2-SW10	1.003	C#2-SW09	1.4	0.364	0.021	4.6193	
5760 minute winter	C#3-SW11	1.002	C#2-SW10	1.2	0.359	0.018	4.2089	
720 minute winter	C#3-SW12	Hydro-Brake®	C#3-SW11	0.8				
720 minute winter	C#3-IC2	1.000	C#3-SW12	-3.0	-0.076	-0.076	0.3382	
5760 minute winter	C#2-SW13	Flow through pond	SW14	4.3	0.017	0.000	561.7689	
5760 minute winter	SW14	Hydro-Brake®	SW15	2.0				
5760 minute winter	SW15	4.001	SW16	2.0	0.337	0.048	0.1597	
2160 minute winter	SW16	4.002	Discharge HW	5.9	0.644	0.171	0.1645	663.6
1440 minute winter	SW17	Hydro-Brake®	SW16	4.0				

Max water level in the underground attenuation and sub-catchemnts #2 & #3 network for storms up to 1:30y return. Critical event duration 4440min. Maximum achieved water level during this event does not exceed the high water level in the proposed attenuation tank (97.20m) therefore proposed attenuation has sufficient capacity to accommodate storms up to 1in30 years return. See drawing ref. D1736-D3 & D4 for attenuation base and high water level.

Max water level in the detention basin and sub-catchemnt #1 network for storms up to 1:30y return. Critical event duration 1380min. Maximum achieved water level during this event does not exceed the high water level in the proposed attenuation tank (97.90m) therefore proposed basin has sufficient capacity to accommodate storms up to 1in30 years return. See drawing ref. D1736-D3 & D4 for detention basin details including base and high water level.

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 94.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	C#1-IC1	1380	97.754	0.679	1.9	17.5408	0.0000	SURCHARGED
1440 minute winter	C#1-SW01	1380	97.754	0.779	1.6	1.3243	0.0000	SURCHARGED
1440 minute winter	C#1-SW02	1380	97.754	1.004	4.2	2.8708	0.0000	SURCHARGED
1440 minute winter	C#1-SW03	1380	97.754	1.854	24.8	2.6537	0.0000	OK
1440 minute winter	C#1-SW04	1380	97.755	0.980	22.3	5.2346	0.0000	SURCHARGED
15 minute winter	C#1-SW05	11	98.073	1.073	232.1	11.1890	0.0000	SURCHARGED
4320 minute winter	C#2-SW06	4020	97.207	0.507	2.2	2.5037	0.0000	SURCHARGED
4320 minute winter	C#2-SW07	4020	97.207	1.082	9.4	3.6977	0.0000	SURCHARGED
15 minute winter	C#2-SW08	11	97.315	0.315	116.0	1.7739	0.0000	SURCHARGED
4320 minute winter	C#2-SW09	4020	97.207	0.957	2.1	1.5371	0.0000	SURCHARGED
4320 minute winter	C#2-SW10	4020	97.207	0.707	1.7	1.0316	0.0000	SURCHARGED
4320 minute winter	C#3-SW11	4020	97.207	0.432	1.4	0.8572	0.0000	SURCHARGED
960 minute winter	C#3-SW12	915	97.832	0.832	3.8	2.5746	0.0000	SURCHARGED
960 minute winter	C#3-IC2	915	97.832	0.782	4.8	81.6947	0.0000	SURCHARGED
4320 minute winter	C#2-SW13	4020	97.206	1.373	9.3	1.9655	0.0000	OK
4320 minute winter	SW14	4020	97.206	1.406	5.5	1.5907	0.0000	SURCHARGED
4320 minute winter	SW15	4020	95.735	0.035	2.2	0.0397	0.0000	OK
2880 minute winter	SW16	2640	95.608	0.068	6.5	0.0767	0.0000	OK
1440 minute winter	SW17	1380	97.754	1.994	13.0	2.5051	0.0000	SURCHARGED
2880 minute winter	Discharge HW	2640	95.525	0.065	6.5	0.0000	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)
1440 minute winter	C#1-IC1	6.000	C#1-SW01	-1.4	0.443	-0.031	0.1271	
1440 minute winter	C#1-SW01	6.001	C#1-SW02	1.6	0.264	0.025	4.7181	
1440 minute winter	C#1-SW02	6.002	C#1-SW03	3.8	0.533	0.054	0.8450	
1440 minute winter	C#1-SW03	Flow through pond	SW17	12.5	0.030	0.000	681.5618	
1440 minute winter	C#1-SW04	7.001	C#1-SW03	21.4	1.010	0.124	1.1030	
15 minute winter	C#1-SW05	7.000	C#1-SW04	213.7	1.937	1.372	4.0810	
4320 minute winter	C#2-SW06	2.000	C#2-SW07	2.2	0.477	0.028	4.0843	
4320 minute winter	C#2-SW07	1.005	C#2-SW13	9.3	0.572	0.066	1.1063	
15 minute winter	C#2-SW08	3.000	C#2-SW07	110.7	1.726	0.996	1.3445	
4320 minute winter	C#2-SW09	1.004	C#2-SW07	1.9	0.428	0.028	0.9154	
4320 minute winter	C#2-SW10	1.003	C#2-SW09	1.6	0.366	0.024	4.6193	
4320 minute winter	C#3-SW11	1.002	C#2-SW10	1.4	0.362	0.021	5.0702	
960 minute winter	C#3-SW12	Hydro-Brake®	C#3-SW11	0.9				
960 minute winter	C#3-IC2	1.000	C#3-SW12	-3.0	-0.074	-0.074	0.3382	
4320 minute winter	C#2-SW13	Flow through pond	SW14	5.5	0.019	0.001	676.0886	
4320 minute winter	SW14	Hydro-Brake®	SW15	2.2				
4320 minute winter	SW15	4.001	SW16	2.2	0.342	0.053	0.1742	
2880 minute winter	SW16	4.002	Discharge HW	6.5	0.660	0.187	0.1761	933.0
1440 minute winter	SW17	Hydro-Brake®	SW16	4.4				

Max water level in the underground attenuation and sub-catchemnts #2 & #3 network for storms up to 1:100y return. Critical event duration 4020min. Maximum achieved water level during this event does not exceed the high water level in the proposed attenuation tank (97.20m) therefore proposed attenuation has sufficient capacity to accommodate storms up to 1in100 years return. See drawing ref. D1736-D3 & D4 for attenuation base and high water level.

Max water level in the detention basin and sub-catchemnt #1 network for storms up to 1:100y return. Critical event duration 1380min. Maximum achieved water level during this event does not exceed the high water level in the proposed attenuation tank (97.90m) therefore proposed basin has sufficient capacity to accommodate storms up to 1in100 years return. See drawing ref. D1736-D3 & D4 for detention basin details including base and high water level.