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Objection Rebuttal

Technical Note

Date: 16/12/2022

Client Name: London Square Developments Ltd

Document Reference: WIE12357-100-TN-5-2-1

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS EN ISO 45001:2018)

Issue	Prepared by	Checked & Approved by
	Sean Whelan	Brendan McCarthy
	Senior Engineer	Technical Director
First		

Introduction

1.1. Waterman has been commissioned by London Square Developments Ltd to provide a rebuttal to the objections raised by London Borough of Richmond upon Thames (LBRuT) with respect to the outline planning application (22/2556/FUL) for the proposed development located at the former Greggs Bakery Site, located at Gould Road, Twickenham TW2 6RT.

1.2. Four objections have been raised and there has already been some discussion between the project team and LBRuT, as detailed below; the original objections are in black, initial responses from the project team in blue, and the subsequent responses from LBRuT in red.

Drainage hierarchy:

- *PASS – the application proposes to manage rainwater via rainwater harvesting, infiltration through permeable paving, and green infrastructure via green/brown roofs. Infiltration tests demonstrate a suitable rate of 4.47 to 4.62 x 10^{-6} m/s with suitable ground conditions described as Kempton Park Gravel. The SuDS features discharge into a watercourse named the River Crane. There will be 1 discharge point restricted using a pump.*
- *MORE INFORMATION REQUIRED – consent for the proposed discharge point connection has not been provided and this is required. The proposed development would discharge primarily to ground, via infiltration through the sub-base layer of the proposed permeable paving. For any surface water unable to discharge via infiltration, a pumped outfall would discharge to the River Crane at a rate of 8.7 l/s for the residential scheme and 8.9 l/s for the commercial scheme. There were no objections to this discharge point from the EA as part of the 2019 application, which discharged at a very similar rate, therefore, it can be safely assumed that this would still be acceptable.*
- *As you are still discharging to the river crane, even if it is a small amount, consent is still required and has not yet been given.*

Runoff rate:

- *MORE INFORMATION REQUIRED – The greenfield runoff rate does not match the greenfield runoff proposed for the same site through planning application reference 22/2556/FUL as it only accounts for the impermeable area on site. The greenfield runoff rate should be calculated for the whole site area.*
  We have taken a conservative approach in using the impermeable area to calculate both the greenfield runoff rate and the proposed attenuation volume. To use the entire site area to calculate the runoff rate and the impermeable area to calculate the attenuation volume would result in a larger rate and a smaller resulting attenuation volume, so would be a less conservative approach. Additionally, as we are proposing to utilise infiltration to partially dispose of surface water runoff, it has been assumed that the permeable areas of the site would discharge to ground and runoff would enter the proposed drainage system.
- *This is not sufficient justification by not using the whole site area. The calculations must be amended.*

Attenuation volume:

- *FAIL – the application does not conform to Defra's Non-Statutory Technical Standards for Sustainable Drainage. It must be demonstrated that the site will not flood as a result of the 1 in 30 year rainfall event, that there will be no flooding of buildings as a result of events up to and including the 1 in 100 year rainfall event, and on-site flow as a result of the 1 in 100 year event with a climate change consideration must be suitably managed. Calculations should include the whole site area.*
  The proposed drainage strategy has been designed to accommodate all surface water runoff from the 1 in 100 year +40% event with no flooding occurring during the 1 in 30 year event. Detailed calculations would be provided at the detailed design stage.
- *We are unable to pass this section without the detailed calculations.*

Maintenance:

- *MORE INFORMATION REQUIRED - the drainage strategy includes the maintenance tasks and frequencies for each drainage component proposed. Information on who will own the maintenance tasks is required.*
  Due to the early stage of design for the scheme, a maintenance company has not yet been secured to carry out the management and maintenance of the drainage system. This information would be submitted at the detailed design stage.
- *We are unable to pass this section without the maintenance schedule and company information.*

1.3. It is intended that this technical note will, where possible, provide the additional detail required by LBRuT such that the objections can be removed.

Drainage hierarchy

1.4. We have received feedback from the EA (see Appendix A) and they have not objected to the proposed discharge to the River Crane.

1.5. The EA have issued a holding objection based on the proposed development being a "*missed opportunity for restoring the River Crane"* however this is a separate issue that we are working to resolve. We have responded to the EA's objection and are currently awaiting feedback.

Runoff rate

1.6. The Greenfield Runoff Rate of 9.1 l/s/ha has not changed between the schemes. The total runoff from the Site will be restricted to 10.3 l/s based on the total site area of 1.130 ha.

1.7. As only impermeable surfaces will be positively drained, runoff from these areas will be restricted to 8.7 l/s, in line with the greenfield runoff rate of 9.1 l/s/ha. Permeable surfaces will drain naturally via infiltration or runoff directly to the River Crane. Discharge from the impermeable and permeable surfaces will therefore be restricted to the total site greenfield runoff rate of 10.3 l/s.

Attenuation volume

1.8. Detailed calculations for the 1 in 30, 1 in 100, and 1 in 100 year plus climate change events are provided in Appendix B.

Maintenance

1.9. A management agent appointed by London Square will be responsible for maintenance of the SuDS and will carry out the tasks set out within the drainage strategy.

A. EA Objection

creating a better place
for people and wildlife

Environment Agency

Thomas Faherty
London Borough of Richmond upon Thames
Planning Department
Civic Centre (44) York Street
Twickenham
Middlesex
TW1 3BZ

Our ref: SL/2022/122209/01-L01
Your ref: 22/2556/FUL

Date: 6 October 2022

Dear Thomas,

Demolition of existing buildings (with retention of a single dwelling) and redevelopment of the site to provide up to 116 residential units and 175 sqm commercial floorspace (use class E) with associated hard and soft landscaping, car parking and highways works and other associated works.

Greggs Bakery, Gould Road, Twickenham, TW2 6RT.

Thank you for consulting us on the above application on 30 August 2022.

Environment Agency Position

Objection: missed opportunity for restoring the River Crane and impact on Water Framework Directive requirements
We **object** to this development as submitted and recommend planning permission is refused, in line with local and national planning policy, and Water Framework Directive (WFD) requirements.

Reasons
Based on the information submitted, there is a significant risk that the proposed development may prevent the River Crane achieving good ecological potential by preventing future improvement under the WFD. The development will permanently redevelop a 300m section of the River Crane's riparian edge, retaining the concrete bank, leaving no opportunity for future naturalisation.

There are several benefits provided by naturalised, undeveloped river corridors including:

- A filtering effect on runoff to 'clean' surface water before it enters the watercourse.
- Providing a habitat for many aquatic species including fish, invertebrates and macrophytes through the provision of refuge areas and a more diverse range of habitats for foraging and breeding.
- The provision of a wildlife corridor which improves the resilience of species to climate change and urban fragmentation.

Recent pilot projects on the Crane have demonstrated it is possible to remove the hard engineered riverbanks and bed along this stretch of the river and "soften" to provide a naturalised riverbank with a more diverse range of habitats.

Water Framework Directive
Not providing an adequate naturalised, undeveloped river corridor here may prevent the improvement in status of the biological element of the current WFD classification (currently at moderate for fish, invertebrates and macrophytes). Urban development is listed as a reason why the Crane is not achieving good ecological potential (Catchment data explorer- River Crane).

The Thames River Basin Management Plan (RBMP) sets out the environmental objectives for the river basin district, including statutory objectives for water bodies and protected areas. It also includes a summary programme of measures required to achieve these objectives.

Under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD Regulations), public bodies must have regard to the relevant RBMP in exercising their functions which affect a river basin district.

The WFD Regulations also require that all water bodies are protected from deterioration and pollution. If a significant risk of water pollution from a development cannot be avoided or adequately mitigated, planning permission should be refused.

Local Planning Policy
This objection is supported by Policy LP 18- River Corridors of the Richmond Local Plan (2018), which states "Development adjacent to the river corridors will be expected to contribute to improvements and enhancements to the river environment."

This objection is also supported by the following policies in the Richmond Local Plan:

- Policy LP 23 – Water resources and infrastructure.
- Policy LP 15 – Biodiversity
- Policy LP 30 – Health and Wellbeing

National Planning Policy
This objection is supported by Paragraph 174 of the National Planning Policy Franework (NPPF) which states that planning policies and decisions should contribute to and enhance the natural and local environment by:

"*minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures".*

Overcoming our objection
The applicant should provide an alternative scheme, which meets the requirements of the Water Framework (WFD), and local and national planning policy as outlined above.

To achieve this, the applicant should refer to the Lower Crane Vision which sets out a plan for this section of the Crane, and can be used to produce detailed designs for the reach through the development.

To support any revised scheme, the applicant should provide detailed designs for restoration of the River Crane through the development, including cross sections and plan view drawings produced by a specialist geomorphology consultant. The applicant should also provide a construction method statement, to demonstrate that the Crane will be protected during the construction phase.

Please note, as submitted, it is unlikely we would grant a Floor Risk Activity Permit (FRAP) for these works.

Informative

Flood Risk Activity Permit
The Environmental Permitting (England and Wales) Regulations 2016 require a permit to be obtained for any activities which will take place:

- on or within 8 metres of a main river (16 metres if tidal)
- on or within 8 metres of a flood defence structure or culvert (16 metres if tidal)
- on or within 16 metres of a sea defence
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert
- in a floodplain more than 8 metres from the river bank, culvert or flood defence structure (16 metres if it's a tidal main river) and you don't already have planning permission.

For further guidance please visit https://www.gov.uk/guidance/flood-risk-activities-environmental-permits or contact our National Customer Contact Centre on 03702 422 549 or by emailing enquiries@environment-agency.gov.uk. The applicant should not assume that a permit will automatically be forthcoming once planning permission has been granted, and we advise them to consult with us at the earliest opportunity.

Advice to Applicant

Biodiversity Net Gain
The biodiversity net gain report submitted (Richard Graves Associates, 5 August 2022) excludes the "rivers" element of the metric from calculations. We recommend that the biodiversity net gain report is revised to re-calculate the change in biodiversity units between the baseline state and the proposed development.

Note to Applicant

Planning advice service
Should you wish us to review any technical documents or want further advice regarding ecological enhancements to the River Crane, we can do this as part of our charged for planning advice service.

Further engagement will provide you with the opportunity to discuss and gain our views on potential options to overcome our objection with us, before formally submitting further information as part of your planning application. It should also result in a better quality and more environmentally sensitive development.

As part of our charged for service we will provide a dedicated project manager to act as a single point of contact to help resolve any problems. We currently charge £100 per hour, plus VAT. We will provide you with an estimated cost for any further discussions or review of documents. The standard terms of our charged for service are available here.

If you would like more information on our planning advice service, including a cost estimate, please contact us at kslplanning@environment-agency.gov.uk.

Note to Local Planning Authority

Closing comments
Thank you for contacting us regarding the above application. Our comments are based on our available records and the information submitted to us. Please quote our reference number in any future correspondence. Please provide us with a copy of the decision notice for our records. This would be greatly appreciated

If you are minded to approve the application contrary to our objection, I would be grateful if you could re-notify us to explain why, and to give us the opportunity to make further representations.

Should you have any queries regarding this response, please contact me.

Yours sincerely,

George Goodby
Sustainable Places Planning Advisor

Mobile +447879802840
E-mail kslplanning@environment-agency.gov.uk

B. Detailed Surface Water Calculations

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 507 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.642	0.252	2.1	8.7	10.8	270.7	O K
30 min Summer	9.712	0.322	2.1	8.7	10.8	346.2	Flood Risk
60 min Summer	9.777	0.387	2.1	8.7	10.8	416.2	Flood Risk
120 min Summer	9.859	0.469	2.1	8.7	10.8	504.0	Flood Risk
180 min Summer	9.896	0.506	2.1	8.7	10.8	543.8	Flood Risk
240 min Summer	9.912	0.522	2.1	8.7	10.8	561.2	Flood Risk
360 min Summer	9.913	0.523	2.1	8.7	10.8	562.1	Flood Risk
480 min Summer	9.897	0.507	2.1	8.7	10.8	544.9	Flood Risk
600 min Summer	9.879	0.489	2.1	8.7	10.8	525.3	Flood Risk
720 min Summer	9.860	0.470	2.1	8.7	10.8	504.9	Flood Risk
960 min Summer	9.822	0.432	2.1	8.7	10.8	464.7	Flood Risk
1440 min Summer	9.755	0.365	2.1	8.7	10.8	392.5	Flood Risk
2160 min Summer	9.673	0.283	2.1	8.7	10.8	303.9	O K
2880 min Summer	9.609	0.219	2.1	8.7	10.8	235.4	O K
4320 min Summer	9.525	0.135	2.1	8.7	10.8	145.6	O K
5760 min Summer	9.487	0.097	2.1	8.4	10.5	104.0	O K
7200 min Summer	9.471	0.081	2.1	7.0	9.1	86.8	O K
8640 min Summer	9.459	0.069	2.1	6.0	8.1	74.5	O K
10080 min Summer	9.451	0.061	2.1	5.3	7.4	65.8	O K
15 min Winter	9.673	0.283	2.1	8.7	10.8	303.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	155.890	0.0	278.3	19
30 min Summer	101.072	0.0	361.1	33
60 min Summer	62.436	0.0	446.2	62
120 min Summer	39.506	0.0	564.8	122
180 min Summer	29.656	0.0	636.0	182
240 min Summer	23.946	0.0	684.8	242
360 min Summer	17.419	0.0	747.3	360
480 min Summer	13.748	0.0	786.4	416
600 min Summer	11.382	0.0	813.9	474
720 min Summer	9.727	0.0	834.6	534
960 min Summer	7.552	0.0	864.1	662
1440 min Summer	5.259	0.0	902.5	924
2160 min Summer	3.651	0.0	939.8	1316
2880 min Summer	2.824	0.0	969.3	1676
4320 min Summer	1.985	0.0	1022.0	2376
5760 min Summer	1.559	0.0	1070.0	3000
7200 min Summer	1.303	0.0	1118.1	3744
8640 min Summer	1.132	0.0	1166.0	4416
10080 min Summer	1.010	0.0	1214.1	5152
15 min Winter	155.890	0.0	311.8	18

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.752	0.362	2.1	8.7	10.8	389.4	Flood Risk
60 min Winter	9.827	0.437	2.1	8.7	10.8	469.6	Flood Risk
120 min Winter	9.921	0.531	2.1	8.7	10.8	571.2	Flood Risk
180 min Winter	9.966	0.576	2.1	8.7	10.8	619.6	Flood Risk
240 min Winter	9.988	0.598	2.1	8.7	10.8	642.8	Flood Risk
360 min Winter	9.996	0.606	2.1	8.7	10.8	651.1	Flood Risk
480 min Winter	9.981	0.591	2.1	8.7	10.8	635.2	Flood Risk
600 min Winter	9.956	0.566	2.1	8.7	10.8	608.7	Flood Risk
720 min Winter	9.932	0.542	2.1	8.7	10.8	582.6	Flood Risk
960 min Winter	9.884	0.494	2.1	8.7	10.8	530.8	Flood Risk
1440 min Winter	9.790	0.400	2.1	8.7	10.8	430.6	Flood Risk
2160 min Winter	9.672	0.282	2.1	8.7	10.8	302.7	O K
2880 min Winter	9.581	0.191	2.1	8.7	10.8	205.2	O K
4320 min Winter	9.487	0.097	2.1	8.4	10.5	103.9	O K
5760 min Winter	9.463	0.073	2.1	6.4	8.4	78.6	O K
7200 min Winter	9.448	0.058	2.1	5.1	7.1	62.8	O K
8640 min Winter	9.439	0.049	2.0	4.3	6.3	52.8	O K
10080 min Winter	9.434	0.044	1.8	3.8	5.7	47.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	101.072	0.0	404.4	33
60 min Winter	62.436	0.0	499.8	62
120 min Winter	39.506	0.0	632.6	120
180 min Winter	29.656	0.0	712.4	178
240 min Winter	23.946	0.0	767.1	236
360 min Winter	17.419	0.0	837.0	348
480 min Winter	13.748	0.0	880.8	458
600 min Winter	11.382	0.0	911.6	554
720 min Winter	9.727	0.0	934.8	572
960 min Winter	7.552	0.0	967.8	720
1440 min Winter	5.259	0.0	1010.9	1010
2160 min Winter	3.651	0.0	1052.6	1408
2880 min Winter	2.824	0.0	1085.6	1760
4320 min Winter	1.985	0.0	1144.7	2332
5760 min Winter	1.559	0.0	1198.4	3056
7200 min Winter	1.303	0.0	1252.4	3752
8640 min Winter	1.132	0.0	1306.0	4416
10080 min Winter	1.010	0.0	1359.9	5144

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 515318 173345 TQ 15318 73345
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.954

Time (mins) From:	To:	Area (ha)
0	4	0.954

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.390 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01600 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	3584.0	925.0	0.600	3584.0	925.0

Pump Outflow Control

Invert Level (m) 9.390

Depth (m)	Flow (l/s)
0.100	8.7000

Summary of Results for 100 year Return Period

Half Drain Time : 340 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.568	0.178	2.1	8.7	10.8	191.5	O K
30 min Summer	9.617	0.227	2.1	8.7	10.8	244.0	O K
60 min Summer	9.660	0.270	2.1	8.7	10.8	290.8	O K
120 min Summer	9.712	0.322	2.1	8.7	10.8	346.5	Flood Risk
180 min Summer	9.732	0.342	2.1	8.7	10.8	368.0	Flood Risk
240 min Summer	9.738	0.348	2.1	8.7	10.8	373.7	Flood Risk
360 min Summer	9.731	0.341	2.1	8.7	10.8	366.9	Flood Risk
480 min Summer	9.719	0.329	2.1	8.7	10.8	353.5	Flood Risk
600 min Summer	9.704	0.314	2.1	8.7	10.8	337.9	Flood Risk
720 min Summer	9.689	0.299	2.1	8.7	10.8	321.4	O K
960 min Summer	9.659	0.269	2.1	8.7	10.8	288.8	O K
1440 min Summer	9.605	0.215	2.1	8.7	10.8	231.5	O K
2160 min Summer	9.544	0.154	2.1	8.7	10.8	166.1	O K
2880 min Summer	9.505	0.115	2.1	8.7	10.8	123.3	O K
4320 min Summer	9.471	0.081	2.1	7.1	9.1	87.2	O K
5760 min Summer	9.454	0.064	2.1	5.5	7.6	68.7	O K
7200 min Summer	9.443	0.053	2.1	4.6	6.6	57.0	O K
8640 min Summer	9.437	0.047	1.9	4.1	6.0	50.2	O K
10080 min Summer	9.432	0.042	1.7	3.7	5.4	45.4	O K
15 min Winter	9.590	0.200	2.1	8.7	10.8	215.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	111.350	0.0	198.6	18
30 min Summer	72.194	0.0	257.7	33
60 min Summer	44.597	0.0	318.6	62
120 min Summer	28.219	0.0	403.3	122
180 min Summer	21.183	0.0	454.2	180
240 min Summer	17.105	0.0	489.0	240
360 min Summer	12.442	0.0	533.6	298
480 min Summer	9.820	0.0	561.6	356
600 min Summer	8.130	0.0	581.2	422
720 min Summer	6.948	0.0	596.0	488
960 min Summer	5.395	0.0	617.0	618
1440 min Summer	3.756	0.0	644.5	880
2160 min Summer	2.608	0.0	671.1	1252
2880 min Summer	2.017	0.0	692.2	1584
4320 min Summer	1.418	0.0	729.8	2288
5760 min Summer	1.113	0.0	764.1	3000
7200 min Summer	0.931	0.0	798.5	3680
8640 min Summer	0.809	0.0	832.7	4408
10080 min Summer	0.722	0.0	867.1	5144
15 min Winter	111.350	0.0	222.5	18

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.645	0.255	2.1	8.7	10.8	274.7	O K
60 min Winter	9.696	0.306	2.1	8.7	10.8	328.6	O K
120 min Winter	9.756	0.366	2.1	8.7	10.8	394.0	Flood Risk
180 min Winter	9.782	0.392	2.1	8.7	10.8	421.4	Flood Risk
240 min Winter	9.791	0.401	2.1	8.7	10.8	431.1	Flood Risk
360 min Winter	9.785	0.395	2.1	8.7	10.8	424.3	Flood Risk
480 min Winter	9.767	0.377	2.1	8.7	10.8	405.2	Flood Risk
600 min Winter	9.748	0.358	2.1	8.7	10.8	384.9	Flood Risk
720 min Winter	9.727	0.337	2.1	8.7	10.8	362.7	Flood Risk
960 min Winter	9.685	0.295	2.1	8.7	10.8	317.1	O K
1440 min Winter	9.608	0.218	2.1	8.7	10.8	234.7	O K
2160 min Winter	9.524	0.134	2.1	8.7	10.8	143.6	O K
2880 min Winter	9.483	0.093	2.1	8.1	10.2	100.1	O K
4320 min Winter	9.453	0.063	2.1	5.5	7.5	67.7	O K
5760 min Winter	9.438	0.048	2.0	4.2	6.1	51.3	O K
7200 min Winter	9.430	0.040	1.7	3.5	5.2	43.2	O K
8640 min Winter	9.425	0.035	1.4	3.1	4.5	37.7	O K
10080 min Winter	9.421	0.031	1.3	2.7	4.0	33.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	72.194	0.0	288.7	33
60 min Winter	44.597	0.0	356.8	62
120 min Winter	28.219	0.0	451.7	120
180 min Winter	21.183	0.0	508.7	176
240 min Winter	17.105	0.0	547.7	232
360 min Winter	12.442	0.0	597.7	340
480 min Winter	9.820	0.0	629.0	382
600 min Winter	8.130	0.0	651.0	458
720 min Winter	6.948	0.0	667.6	532
960 min Winter	5.395	0.0	691.1	676
1440 min Winter	3.756	0.0	721.9	950
2160 min Winter	2.608	0.0	751.7	1296
2880 min Winter	2.017	0.0	775.3	1588
4320 min Winter	1.418	0.0	817.5	2332
5760 min Winter	1.113	0.0	855.9	3000
7200 min Winter	0.931	0.0	894.4	3744
8640 min Winter	0.809	0.0	932.7	4408
10080 min Winter	0.722	0.0	971.2	5240

Summary of Results for 30 year Return Period

Half Drain Time : 245 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.526	0.136	2.1	8.7	10.8	146.4	O K
30 min Summer	9.561	0.171	2.1	8.7	10.8	184.0	O K
60 min Summer	9.591	0.201	2.1	8.7	10.8	216.0	O K
120 min Summer	9.628	0.238	2.1	8.7	10.8	255.5	O K
180 min Summer	9.638	0.248	2.1	8.7	10.8	266.6	O K
240 min Summer	9.639	0.249	2.1	8.7	10.8	267.8	O K
360 min Summer	9.632	0.242	2.1	8.7	10.8	260.6	O K
480 min Summer	9.621	0.231	2.1	8.7	10.8	248.4	O K
600 min Summer	9.608	0.218	2.1	8.7	10.8	234.7	O K
720 min Summer	9.595	0.205	2.1	8.7	10.8	220.8	O K
960 min Summer	9.571	0.181	2.1	8.7	10.8	194.3	O K
1440 min Summer	9.530	0.140	2.1	8.7	10.8	151.0	O K
2160 min Summer	9.492	0.102	2.1	8.7	10.8	109.3	O K
2880 min Summer	9.474	0.084	2.1	7.3	9.3	89.9	O K
4320 min Summer	9.452	0.062	2.1	5.4	7.5	66.9	O K
5760 min Summer	9.440	0.050	2.1	4.4	6.4	54.1	O K
7200 min Summer	9.434	0.044	1.8	3.8	5.6	47.2	O K
8640 min Summer	9.429	0.039	1.6	3.4	5.0	42.3	O K
10080 min Summer	9.426	0.036	1.5	3.1	4.6	38.6	O K
15 min Winter	9.543	0.153	2.1	8.7	10.8	164.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.786	0.0	152.9	18
30 min Summer	55.190	0.0	196.9	33
60 min Summer	33.902	0.0	242.0	62
120 min Summer	21.638	0.0	309.1	120
180 min Summer	16.227	0.0	347.8	178
240 min Summer	13.077	0.0	373.7	204
360 min Summer	9.483	0.0	406.6	264
480 min Summer	7.471	0.0	427.1	330
600 min Summer	6.183	0.0	441.9	398
720 min Summer	5.285	0.0	453.3	464
960 min Summer	4.112	0.0	470.2	596
1440 min Summer	2.884	0.0	494.7	848
2160 min Summer	2.028	0.0	521.9	1188
2880 min Summer	1.587	0.0	544.7	1556
4320 min Summer	1.140	0.0	586.8	2252
5760 min Summer	0.912	0.0	625.8	2992
7200 min Summer	0.774	0.0	663.7	3680
8640 min Summer	0.681	0.0	700.8	4408
10080 min Summer	0.614	0.0	737.6	5144
15 min Winter	85.786	0.0	171.3	18

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.583	0.193	2.1	8.7	10.8	207.4	O K
60 min Winter	9.617	0.227	2.1	8.7	10.8	244.4	O K
120 min Winter	9.661	0.271	2.1	8.7	10.8	291.7	O K
180 min Winter	9.676	0.286	2.1	8.7	10.8	307.0	O K
240 min Winter	9.677	0.287	2.1	8.7	10.8	308.8	O K
360 min Winter	9.666	0.276	2.1	8.7	10.8	297.0	O K
480 min Winter	9.651	0.261	2.1	8.7	10.8	280.4	O K
600 min Winter	9.633	0.243	2.1	8.7	10.8	261.1	O K
720 min Winter	9.614	0.224	2.1	8.7	10.8	241.2	O K
960 min Winter	9.579	0.189	2.1	8.7	10.8	202.9	O K
1440 min Winter	9.521	0.131	2.1	8.7	10.8	141.3	O K
2160 min Winter	9.479	0.089	2.1	7.7	9.8	95.3	O K
2880 min Winter	9.459	0.069	2.1	6.0	8.1	74.3	O K
4320 min Winter	9.438	0.048	2.0	4.2	6.2	51.8	O K
5760 min Winter	9.429	0.039	1.6	3.4	5.0	42.0	O K
7200 min Winter	9.424	0.034	1.4	2.9	4.3	36.0	O K
8640 min Winter	9.420	0.030	1.2	2.6	3.8	31.7	O K
10080 min Winter	9.417	0.027	1.1	2.3	3.4	28.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	55.190	0.0	220.6	32
60 min Winter	33.902	0.0	271.1	62
120 min Winter	21.638	0.0	346.3	118
180 min Winter	16.227	0.0	389.6	174
240 min Winter	13.077	0.0	419.2	228
360 min Winter	9.483	0.0	455.4	284
480 min Winter	7.471	0.0	478.4	360
600 min Winter	6.183	0.0	495.0	434
720 min Winter	5.285	0.0	507.7	506
960 min Winter	4.112	0.0	526.7	644
1440 min Winter	2.884	0.0	554.2	892
2160 min Winter	2.028	0.0	584.6	1216
2880 min Winter	1.587	0.0	610.1	1584
4320 min Winter	1.140	0.0	657.3	2288
5760 min Winter	0.912	0.0	701.0	3000
7200 min Winter	0.774	0.0	743.4	3744
8640 min Winter	0.681	0.0	785.0	4408
10080 min Winter	0.614	0.0	826.1	5144