URS

Lambeth Highways SuDS

Rain Garden Modelling Report - Final

April 2013

47062094

Prepared for:
Lambeth Council

UNITED KINGDOM & IRELAND

REVISION SCHEDULE

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	December 2012	47062094 Draft Report	Mark Crussell Senior Assistant Hydrologist	Richard Marshall Principal Engineer Sarah Kelly Senior Water Specialist	Jon Robinson Technical Director
02	April 2013	47062094 Final Report (incorporating comments from Lambeth Borough Council and EPG)	Mark Crussell Consultant	Richard Marshall Principal Engineer	Jon Robinson Operations Director

URS
Scott House
Alencon Link
Basingstoke
RG21 7PP

Tel 01256 310 200

www.ursglobal.com

Limitations

URS Infrastructure & Environment UK Limited ("URS") has prepared this Report for the sole use of **Lambeth Council** ("Client") in accordance with the Agreement under which our services were performed. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by URS.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by URS has not been independently verified by URS, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by URS in providing its services are outlined in this Report. The work described in this Report was undertaken between **June 2012 and April 2013** and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

URS disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to URS' attention after the date of the Report.

Certain statements made in the Report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the Report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. URS specifically does not guarantee or warrant any estimate or projections contained in this Report.

Copyright

© This Report is the copyright of URS Infrastructure & Environment UK Limited. Any unauthorised reproduction or usage by any person other than the addressee is strictly prohibited.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

URS was commissioned by Lambeth Council to assess the flood alleviation benefits of 'Rain Gardens' proposed along Chatsworth Way and Ardlui Road in Lambeth.

This package of works forms part of the wider Lambeth Highways SuDS project, being undertaken by a consortium of companies, as outlined below:

- Design of Rain Garden Scheme – undertaken by The Environmental Protection Group Ltd. (EPG);
- Modelling of SuDS Scheme – undertaken by URS;
- Public Engagement / Awareness – undertaken by Sustrans;
- Project Support and production of a Case Study Report for the project - undertaken by URS.

1.2 Rain Gardens

In its simplest form, a Rain Garden is a shallow depression, with absorbent, yet free draining soil and planted with vegetation that can withstand occasional temporary flooding. Rain gardens are designed to mimic the natural water retention of undeveloped land and to reduce the volume of rainwater running off into drains from impervious areas and treat low level pollution.[1]

For the Lambeth Highways SuDS scheme, rain gardens, as kerb build outs (Figure 1.1), are proposed upstream of existing road gullies in Chatsworth Way and Ardlui Road in Lambeth. The Rain Gardens will intercept surface water runoff at or close to source; and allow storage, filtration, infiltration and evapotranspiration (evaporation from soil and from vegetation) so that the amount of runoff discharging to the sewer network is greatly reduced.

Source: Rain Garden Guide[1]

Figure 1.1: Example Highway Rain Garden in Portland Oregon, United States

[1] Bob Bray, Dusty Gedge, Gary Grant & Lani Leuthvilay, 2012, Rain Garden Guide. www.raingardens.info

1.3 Rain Garden Modelling Study

This modelling study assesses the flood alleviation benefits of selected Rain Gardens along Chatsworth Way and Ardlui Road (Figure 1.2) during the 2 year, 30 year and 100 year critical duration storm events. The assessment is based on a comparison of maximum outflow and discharge volume to existing gullies, pre- and post-implementation of the proposed Rain Gardens.

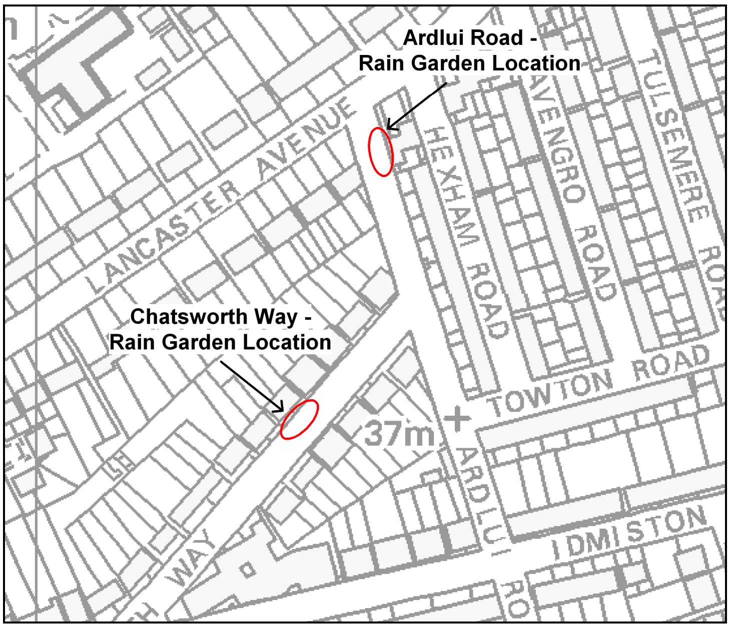


Figure 1.2: Modelled Rain Garden Locations for Lambeth Highways SuDS Scheme

Computer models of two of the proposed Rain Gardens have been built in Micro Drainage WinDes, based on typical layout and section drawings provided by Environmental Protection Group (EPG) (see Appendix A). A topographic survey with all of the potential Rain Garden locations is provided in Appendix B.

The modelling carried out compares the 'worst case' slope gradient (i.e. the steepest) Rain Garden along Ardlui Road with the 'best case' slope gradient (i.e. the most level) Rain Garden with a similar drainage catchment area along Chatsworth Way. This approach has been adopted to assess how Rain Gardens will function in 'best' and 'worst case' scenarios when considering the topography across the study area (see Figure 1.2).

In order to provide an indication of how sensitive the design / model is to different infiltration rates, a range of scenarios, ranging from low infiltration to high infiltration, has been considered.

2 MODELLING APPROACH

2.1 Overview

The WinDes DrawNet and Simulation modules have been used to build the two individual Rain Garden models and assess the impact of the proposed Rain Gardens in terms of rainwater source control and potential flood alleviation.

The existing baseline and Rain Garden scenarios have been tested against a number of different storm durations for the 2 year, 30 year and 100 year storm events. The storm duration results have been analysed to identify the critical 'worst case' storm when considering maximum discharge rate (l/s) and maximum discharge volume (m^3).

2.2 Existing Scenario

To represent the existing baseline (no Rain Garden) scenario, sections of the existing Thames Water sewer network, including road gullies, have been modelled immediately upstream and downstream of the two selected Rain Gardens, one along Chatsworth Way and the other along Ardlui Road.

2.3 Rain Garden Scenario

The key Rain Garden design parameters (see Appendix A for typical layout and sections) represented in the model are:

- Depth of surface storage - 150 mm;
- Depth of Root Zone – 150 mm;
- Depth of Geocellular storage – 150 mm;
- Check dams – ~ 25 mm below existing kerb top level.

The two Rain Gardens have been represented using a series of surface storage units (tank / ponds) and below ground cellular storage, connected by a nominal pipe network (typically 100 mm to 150 mm in diameter), branching off from the existing gully. Upstream pipes represent each Rain Garden kerb inlet and have been assigned an appropriate catchment area within DrawNet, based on review of the topographic survey.

A series of online controls (weirs) have been used to represent check dams, which control surface water levels within the separate compartments. A small orifice (0.02 m diameter) has been used to represent the infiltration rate of surface water from the surface storage sections down into the cellular storage layer.

Once all of the surface storage units have been filled, the weir at the downstream end of the Rain Garden is overtopped and any further surface water finally drains to the Thames Water sewer, via the existing gully pot.

WinDes outputs, including a plan view of the individual Rain Garden pipe network and tabular details of the network, storage structures and online controls, are provided in Appendix C.

A summary of the key model parameters used to represent the individual Rain Gardens along Chatsworth Way and Ardlui Road are provided in the following sub-sections.

2.4 Rain Garden Model Parameters

Tables 2.1 and 2.2 provide the parameters used for the Chatsworth Way and Ardlui Road Rain Garden models.

TABLE 2.1: CHATSWORTH WAY RAIN GARDEN MODEL PARAMETERS

Longitudinal fall (m)	0.1	Number of bays	1
Gully catchment area (m^2)	130	Diameter of outfall pipe to sewer (mm)	150
Below ground storage (m^3) (WinDes cellular storage)		Surface storage volume (m^3) (WinDes tank/pond)	
Structure 1	1.74	Structure 2	1.34
Total	1.74	Total	1.34

TABLE 2.2: ARDLUI ROAD RAIN GARDEN MODEL PARAMETERS

Longitudinal fall (m)	0.48	Number of bays	3
Gully catchment area (m^2)	180	Diameter of outfall pipe to sewer (mm)	150
Below ground storage (m^3) (WinDes cellular storage)		Surface storage volume (m^3) (WinDes pond)	
Structure 1	0.62	Structure 2	0.54
Structure 3	0.86	Structure 4	0.57
Structure 5	0.23	Structure 6	0.23
Total Volume	1.71	Total Volume	1.34

2.5 Model Runs

For both of the selected locations, the following scenarios have been modelled:

- Existing baseline (no Rain Garden);
- Rain Garden (low infiltration – 0.001 m/hr);
- Rain Garden (medium infiltration – 0.01 m/hr);
- Rain Garden (high infiltration – 0.1 m/hr).

2.6 Assumptions and Limitations

The following assumptions and limitations relate to the modelled Rain Gardens:

- A limitation of the study is the selected Rain Gardens (based on 'worst case' and 'best case' slope gradients) have below average[2] gully catchment areas compared to other potential Rain Garden locations within the study area (see Appendix B). Rain Gardens with larger gully catchments receive greater volumes of runoff and therefore the percentage reduction in discharge volume entering the sewer is likely to be less;

- A limitation of modelling each Rain Garden in isolation is that WinDes assumes that when the volume of water exceeds the capacity of the Rain Garden, any flood water is stored locally on the surface and then fed back into the system as soon as capacity becomes available. However, in a 'real life' scenario excess water is likely to continue to flow down the road, entering a downstream Rain Garden or gully;

- The model assumes that all surface water generated within the gully catchment drains to the Rain Garden via the kerb inlets (i.e. no runoff by-passes the Rain Garden). However, in a 'real life' scenario some water is likely to by-pass the Rain Garden inlets, however this loss is unlikely to affect the results significantly;

- A standard gully pipe diameter of 150 mm has been assumed for the existing downstream gully pipe connecting the Rain Garden to the Thames Water sewer.

[2] The average gully catchment area for Rain Gardens within the study area is approximately 250 m^2 (gully catchment areas range from 100 m^2 to 500 m^2)

3 RESULTS

3.1 Overview

The simulated maximum discharge rates and volumes during the 2 year, 30 year and 100 year critical duration storms have been taken at the existing downstream gully pipe, where the Rain Garden connects back into the sewer network. A comparison of results at this downstream location has been used to indicate the benefits provided by the Rain Gardens.

Tabulated results for the Chatsworth Way and the Ardlui Road Rain Garden are provided in Tables 3.1 to 3.3 and Tables 3.4 to 3.6 respectively. The gully pipes status, as indicated in the bullet points below, is also provided:

- ‘ok’ – when the maximum water level is lower than the pipe's soffit;
- ‘surcharged’ – when the maximum water level is above the pipe's soffit;
- ‘flood’ - when the maximum water level is above the upstream manhole cover (i.e. the capacity of the Rain Garden is exceeded).

The storm durations included in the assessment have been limited to the 24 hour storm duration (1440 min). Storm durations greater than this are generally more intermittent and/or less intense in nature, and not suitable for consideration at the gully catchment scale.

Graphs have been produced for the critical storm duration, comparing downstream hydrographs for the existing gully pipe and Rain Garden scenario. The medium infiltration Rain Garden has been selected to illustrate the benefits of the scheme.

3.2 Chatsworth Way

This section presents the results of modelling the Chatsworth Way Rain Garden.

3.2.1 2 Year Critical Storm

Table 3.1 and Figures 3.1(a) and 3.1(b) present the results of modelling the Chatsworth Way Rain Garden for the 2 year critical storm.

Table 3.1 and Figure 3.1 (a) indicate that negligible flow discharges to the sewer via the downstream gully pipe occurs during the maximum outflow 2 year event once the Chatsworth Way Rain Garden is implemented.

Table 3.1 indicates that during the maximum discharge volume 2 year event the Rain Garden scenario reduces the volume discharged to the sewer by a minimum of 61% (low infiltration scenario). During the medium and high infiltration Rain Garden scenario the discharge volume to the sewer is reduced by 75% and 88% respectively with negligible discharge to the downstream sewer network (Figure 3.1 (b)).

TABLE 3.1: CHATSWORTH WAY - 2 YEAR CRITICAL STORM

	Maximum discharge rates				Maximum discharge volumes			
Rain Garden (RG) description	Max rate (l/s)	Critical storm duration (min)	Pipe Status	Discharge rate reduction (%)	Maximum discharge volume (m^3)	Critical storm duration (min)	Pipe Status	Discharge volume reduction (%)
Existing gully	2.6	15 Summer	ok	NA	4.3	1440 Winter	ok	NA
RG - low infiltration (0.001 m/hr)	0.1	1440 Summer	ok	96	1.7	1440 Winter	ok	61
RG - medium infiltration (0.01 m/hr)	0.1	120 Summer	ok	96	1.1	1440 Summer	ok	75
RG - high infiltration (0.1 m/hr)	0.1	120 Summer	ok	96	0.5	1440 Winter	ok	88

Figure 3.1 (a) Chatsworth Way - 2 year (120 min summer storm)

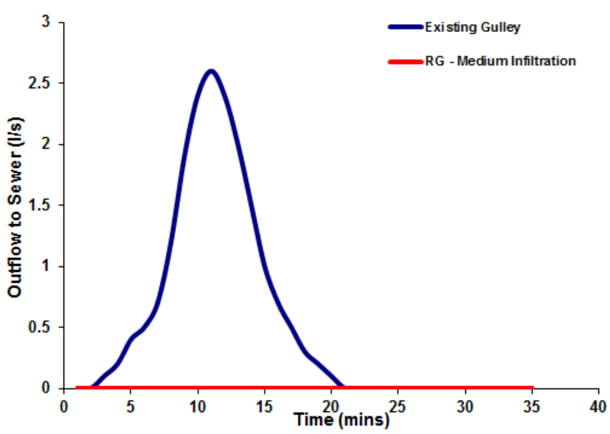
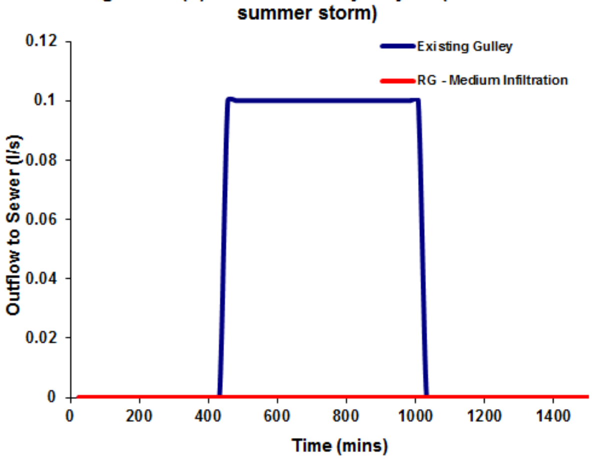


Figure 3.1 (b) Chatsworth Way - 2 year (1440 min summer storm)



3.2.2 30 Year Critical Storm

Table 3.2 and Figures 3.2(a) and 3.2(b) present the results of modelling the Chatsworth Way Rain Garden for the 30 year critical storm.

Table 3.2 and Figure 3.2 (a) indicates that maximum discharge to the sewer is limited to 3.9 l/s for the maximum outflow 30 year event Rain Garden scenarios. Figure 3.2 (a) indicates that no discharge to the sewer occurs until 10 minutes.

Table 3.2 indicates that during the maximum discharge volume 30 year event the Rain Garden scenario reduces the volume discharged to the sewer by a minimum of 34% (low infiltration scenario). During the medium to high infiltration Rain Garden scenario the discharge volume to the sewer is reduced by 47% and 85% respectively.

Figure 3.2 (b) indicates how the Rain Garden attenuates runoff for the first 700 minutes of the storm, after which the Rain Garden capacity is exceeded and runoff discharges to the sewer.

TABLE 3.2: CHATSWORTH WAY - 30 YEAR CRITICAL STORM

	Maximum discharge rates				Maximum discharge volumes			
Rain Garden (RG) description	Max rate (l/s)	Critical storm duration (min)	Pipe Status	Discharge rate reduction (%)	Maximum discharge volume (m^3)	Critical storm duration (min)	Pipe Status	Discharge volume reduction (%)
Existing gully	6.4	15 Summer	ok	NA	8.9	1440 Summer	ok	NA
RG - low infiltration (0.001 m/hr)	3.9	15 Summer	ok	39	5.9	1440 Summer	ok	34
RG - medium infiltration (0.01 m/hr)	3.9	15 Summer	ok	39	4.7	1440 Summer	ok	47
RG - high infiltration (0.1 m/hr)	3.9	15 Summer	ok	39	1.3	360 Summer	ok	85

Figure 3.2 (a) Chatsworth Way - 30 year (15 min summer storm)

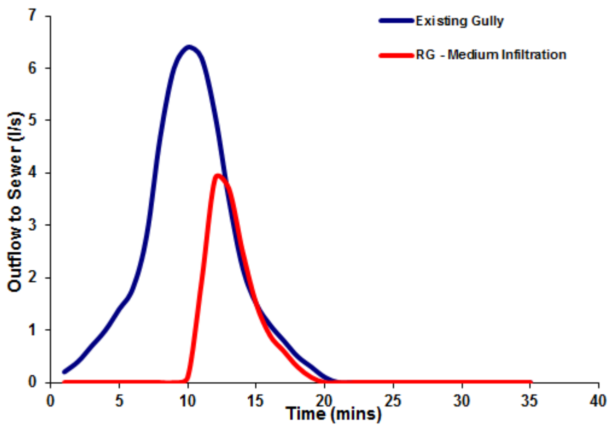
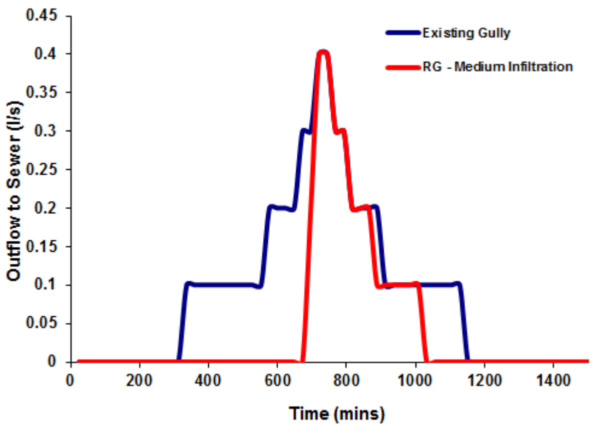


Figure 3.2 (b) Chatsworth Way - 30 year (1440 min summer storm)



3.2.3 100 Year Critical Storm

Table 3.3 and Figures 3.3(a) and 3.3(b) present the results of modelling the Chatsworth Way Rain Garden for the 100 year critical storm.

Table 3.3 indicates that maximum discharge to the sewer is limited to 8.1 l/s for the 100 year event Rain Garden scenarios (16% reduction compared to baseline). Figure 3.3 (a) indicates that no discharge to the sewer occurs until 8 minutes.

Table 3.3 indicates that during the maximum discharge volume 100 year event the Rain Garden scenario reduces the volume discharged to the sewer by a minimum of 26% (low infiltration scenario). During the medium to high infiltration Rain Garden scenario the discharge volume to the sewer is reduced by 36% and 73% respectively. Figure 3.3 (b) indicates how the Rain Garden attenuates runoff until its capacity is reached after approximately 600 minutes.

TABLE 3.3: CHATSWORTH WAY - 100 YEAR CRITICAL STORM

	Maximum discharge rates				Maximum discharge volumes			
Rain Garden (RG) description	Max rate (l/s)	Critical storm duration (min)	Pipe Status	Discharge rate reduction (%)	Maximum discharge volume (m^3)	Critical storm duration (min)	Pipe Status	Discharge volume reduction (%)
Existing gully	9.7	15 Summer	ok	NA	11.9	1440 Summer	ok	NA
RG - low infiltration (0.001 m/hr)	8.1	15 Summer	ok	16	8.8	1440 Summer	ok	26
RG - medium infiltration (0.01 m/hr)	8.1	15 Summer	ok	16	7.6	1440 Summer	ok	36
RG - high infiltration (0.1 m/hr)	8.1	15 Summer	ok	16	3.3	480 Summer	ok	73

Figure 3.3 (a) Chatsworth Way - 100 year (15 min summer storm)

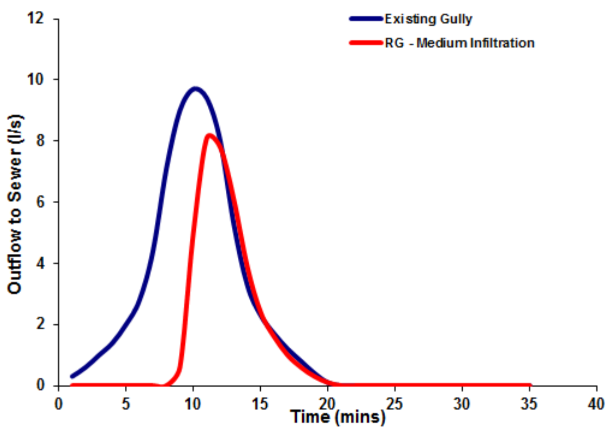
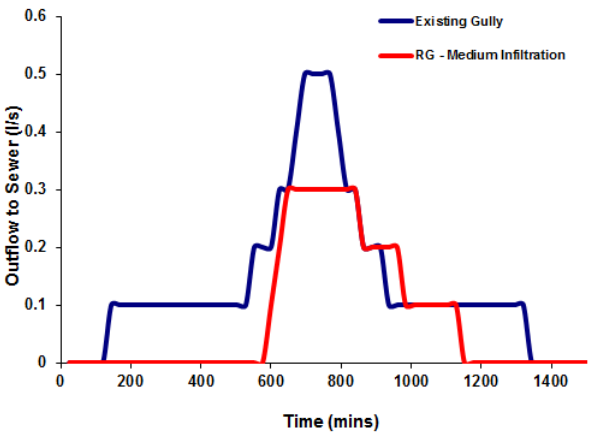


Figure 3.3 (b) Chatsworth Way - 100 year (1440 min summer storm)



3.3 Ardlui Road

This section presents the results of modelling the Ardlui Road Rain Garden.

3.3.1 2 Year Critical Storm

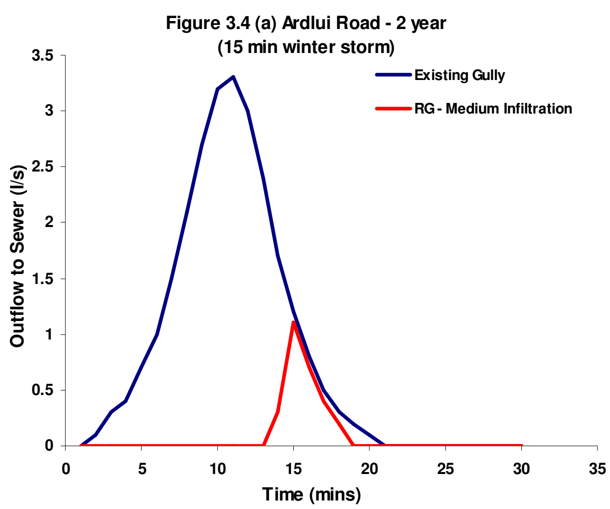
Table 3.4 and Figures 3.4(a) and 3.4(b) present the results of modelling the Ardlui Road Rain Garden for the 2 year critical storm.

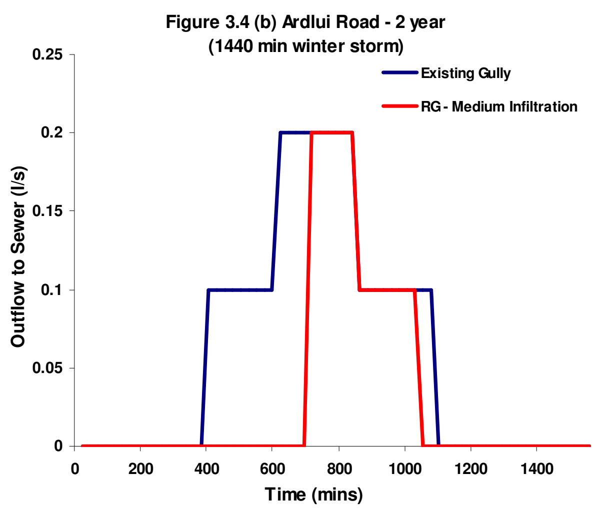
Table 3.4 indicates that maximum discharge to the sewer is limited to 1.0 l/s during the 2 year event Rain Garden scenarios. Figure 3.4 (a) indicates that no discharge to the sewer occurs until 14 minutes.

Table 3.4 indicates that during the maximum discharge volume 2 year event the Rain Garden scenario reduces the volume discharged to the sewer by a minimum of 34% (low infiltration scenario). During the medium to high infiltration Rain Garden scenario the discharge volume to the sewer is reduced by 54% and 100% respectively. Figure 3.4 (b) indicates how the Rain Garden attenuates runoff until its capacity is reached after 700 minutes.

TABLE 3.4: ARDLUI ROAD - 2 YEAR CRITICAL STORM

	Maximum discharge rates				Maximum discharge volumes			
Rain Garden (RG) description	Max rate (l/s)	Critical storm duration (min)	Pipe Status	Discharge rate reduction (%)	Maximum discharge volume (m3)	Critical storm duration (min)	Pipe Status	Discharge volume reduction (%)
Existing gully	3.3	15 Winter	ok	NA	6.1	1440 Winter	ok	NA
RG - low infiltration (0.001 m/hr)	1.0	15 Winter	ok	70	4.0	1440 Winter	ok	34
RG - medium infiltration (0.01 m/hr)	1.0	15 Winter	ok	70	2.8	1440 Winter	ok	54
RG - high infiltration (0.1 m/hr)	1.0	15 Winter	ok	70	0	1440 Winter	ok	100





3.3.2 30 Year Critical Storm

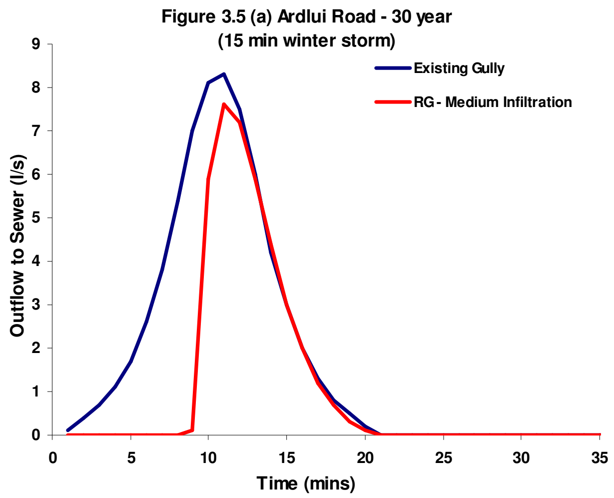
Table 3.5 and Figures 3.5(a) and 3.5(b) present the results of modelling the Ardlui Road Rain Garden for the 30 year critical storm.

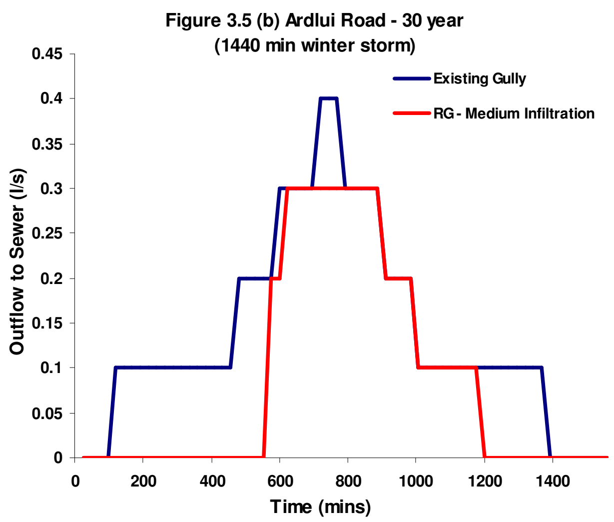
Table 3.5 indicates that maximum discharge to the sewer is limited to 7.6 l/s during the 30 year event Rain Garden scenarios. Figure 3.5 (a) indicates that no discharge to the sewer occurs until 9 minutes.

Table 3.5 indicates that during the maximum discharge volume 30 year event the Rain Garden scenario reduces the volume discharged to the sewer by a minimum of 20% (low infiltration scenario). During the medium to high infiltration Rain Garden scenario the discharge volume to the sewer is reduced by 29% and 89% respectively. Figure 3.5 (b) indicates how the Rain Garden attenuates runoff until its capacity is reached after 570 minutes.

TABLE 3.5: ARDLUI ROAD - 30 YEAR CRITICAL STORM

	Maximum discharge rates				Maximum discharge volumes			
Rain Garden (RG) description	Max rate (l/s)	Critical storm duration (min)	Pipe Status	Discharge rate reduction (%)	Maximum discharge volume (m^3)	Critical storm duration (min)	Pipe Status	Discharge volume reduction (%)
Existing gully	8.3	15 Winter	ok	NA	12.3	1440 Winter	ok	NA
RG - low infiltration (0.001 m/hr)	7.6	15 Winter	Flood	8	9.9	1440 Winter	ok	20
RG - medium infiltration (0.01 m/hr)	7.6	15 Winter	Flood	8	8.7	1440 Winter	ok	29
RG - high infiltration (0.1 m/hr)	7.6	15 Winter	Flood	8	1.4	1440 Winter	ok	89





3.3.3 100 Year Critical Storm

Table 3.6 and Figures 3.6(a) and 3.6(b) present the results of modelling the Ardlui Road Rain Garden for the 100 year critical storm.

Table 3.6 indicates that maximum discharge to the sewer is limited to 12 l/s during the 100 year event Rain Garden scenarios, providing a 4% reduction compared to baseline. Figure 3.6 (a) indicates that no discharge to the sewer occurs until 8 minutes.

Table 3.6 indicates that during the maximum discharge volume 100 year event the Rain Garden scenario reduces the volume discharged to the sewer by a minimum of 13% (low infiltration scenario). During the medium to high infiltration Rain Garden scenario the discharge volume to the sewer is reduced by 22% and 74% respectively. Figure 3.6 (b) indicates how the Rain Garden attenuates runoff until its capacity is reached after 504 minutes.

TABLE 3.6: ARDLUI ROAD - 100 YEAR CRITICAL STORM

	Maximum discharge rates				Maximum discharge volumes			
Rain Garden (RG) description	Max rate (l/s)	Critical storm duration (min)	Pipe Status	Discharge rate reduction (%)	Maximum discharge volume (m^3)	Critical storm duration (min)	Pipe Status	Discharge volume reduction (%)
Existing gully	12.5	15 Winter	ok	NA	16.4	1440 Winter	ok	NA
RG - low infiltration (0.001 m/hr)	12	15 Winter	Flood	4	14.2	1440 Winter	ok	13
RG - medium infiltration (0.01 m/hr)	12	15 Winter	Flood	4	12.8	1440 Winter	ok	22
RG - high infiltration (0.1 m/hr)	12	15 Winter	Flood	4	4.2	1440 Winter	ok	74

Figure 3.6 (a) Ardlui Road - 100 year (15 min winter storm)

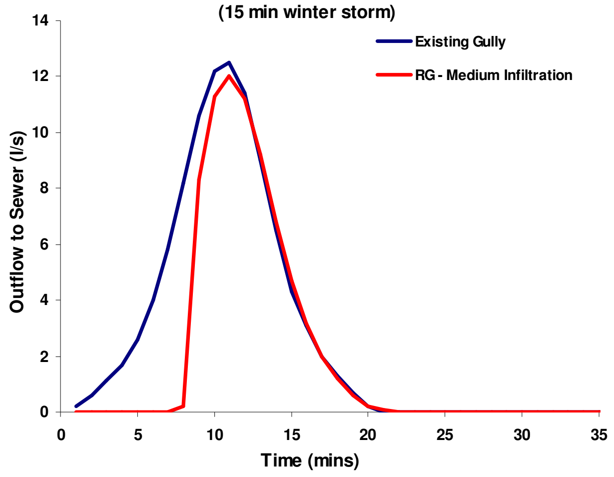
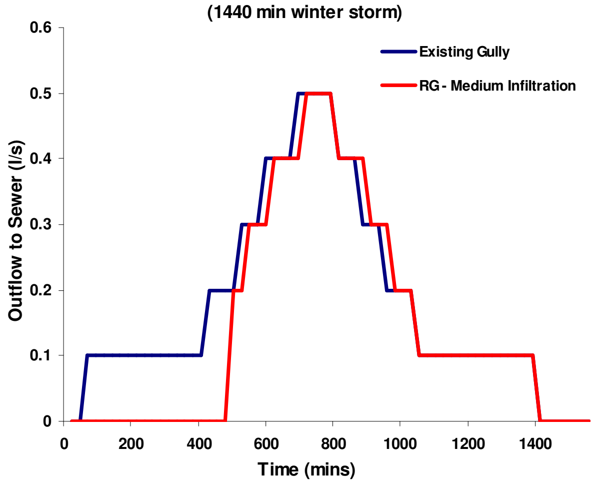


Figure 3.6 (b) Ardlui Road - 100 year (1440 min winter storm)



4 PREDICTOR TOOL

This study considers the performance of selected 'best case' and 'worst case' Rain Gardens where the case is based upon slope gradient alone. In reality, a number of other factors are likely to influence the final positioning of Rain Gardens within the study area.

To provide an indication of how Rain Gardens would perform at various proposed locations within the study area a simple predictor tool has been developed using Microsoft Excel.

The predictor tool is based on Flood Estimation Handbook (FEH) (CD-ROM3) rainfall depth, duration and frequency data extracted for the locality and assesses the performance of Rain Gardens based on the following design criteria input parameters:

- Rain Garden catchment area (m^2);
- Surface storage volume (m^3);
- Cellular storage volume (m^3);
- Average infiltration (l/hr).

For each set of Rain Garden input parameters conditional formatting has been used to turn rainfall depth cells green where no discharge to sewer occurs and pink where some discharge to sewer occurs. The predictor tool also provides the following information for each Rain Garden scenario:

- Volume of runoff (m^3);
- Volume of infiltration during event (m^3);
- Volume of discharge to sewer (m^3);
- Drain down time after event (hrs).

Chatsworth Way Rain Garden model parameters (see Table 2.1) have been used to demonstrate how the predictor tool can be applied. The predictor tool screen dump shown in Appendix D indicates that where considering the 2 year event no discharge to the sewer occurs up to the 315 minute duration storm. Appendix D indicates that the 2 year 315 minute storm requires a drain down time of approximately 43 hours.

It is important to note that this predictor tool only provides an indication of the Rain Garden performance and should only be used within the defined study area (Figure 1.2), as rainfall depth, duration and frequency data varies spatially. The tool should be used as a precursor to detailed modelling, of the type undertaken in WinDes for this study.

The current version of the predictor tool assumes rapid transfer from open storage to cellular storage, however a future version of the tool could be further developed to allow users to specify this parameter.

5 CONCLUSIONS

The conclusions of the Rain Garden modelling study are set out below:

- During more frequent, less severe storms (i.e. 2 year event), both the Ardlui Road (worst case) and Chatsworth Way (best case) gradient Rain Garden locations are shown to provide significant benefits in terms of reducing maximum rates and discharge volumes to the sewer;

- The reduction in maximum discharge rate, post Rain Garden implementation, is less for the Ardlui Road Rain Garden. This is likely due to the larger catchment draining to the Ardlui Road Rain Garden;

- The percentage reduction in maximum discharge volume, post Rain Garden implementation, is less for the Ardlui Road Garden during the low and medium infiltration scenarios when compared to the Chatsworth Way Rain Garden, but similar during the high infiltration scenarios;

- When higher cellular storage infiltration rates are modelled, the maximum discharge volumes at both the 'worst case' and 'best case' Rain Garden locations reduce;

- During less frequent 30 year and 100 year events, the shorter duration, higher intensity storms, associated with the maximum outflow critical storm, exceed the capacity of the 'worst case' Rain Garden. However, the capacity of the 'best case' Rain Garden is not exceeded. Again this is likely due to the smaller catchment draining to the Chatsworth Way Rain Garden;

- During the longer duration 30 year and 100 year events, associated with the maximum discharge critical storm, the capacity of both the 'worst case' and 'best case' Rain Gardens the pipe status remains 'ok';

- In summary, all cases modelled provide a degree of attenuation and storage which, cumulatively, would act to reduce surcharging pressure on the local drainage network.

5.1 Further Work

To further inform and improve the modelling study the following recommendations are made:

- Undertake WinDes modelling at further locations within the study area to assess the flood alleviation benefits of Rain Gardens within larger gully catchments;

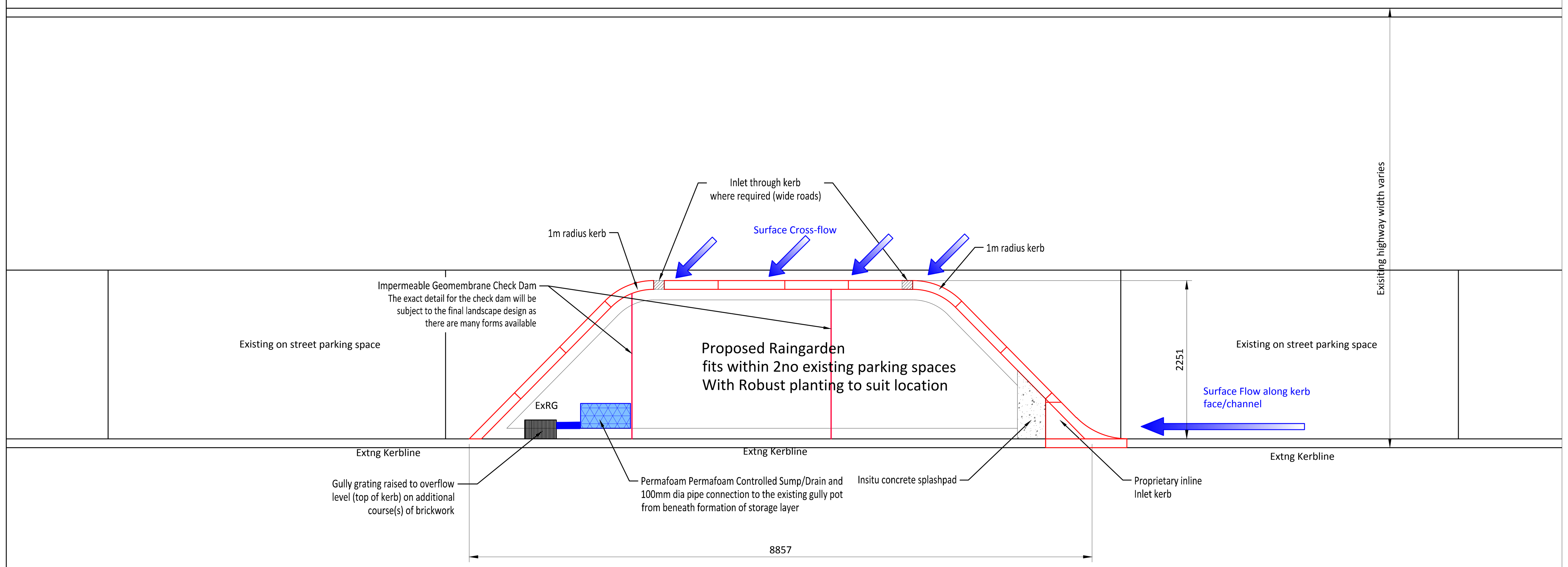
- The interaction between a series of Rain Gardens (including the associated Thames Water sewer network) could be assessed using WinDes FloodFlow. FloodFlow includes the surface terrain allowing excess water exceeding the capacity of the Rain Garden (or bypasses the Rain Garden) to follow existing drainage pathways;

- The FloodFlow approach will allow the flooded volume to feed back into the system at a downstream point, rather than returning back into the system at the same point, as assumed in the current model. This would improve estimates of attenuation performance;

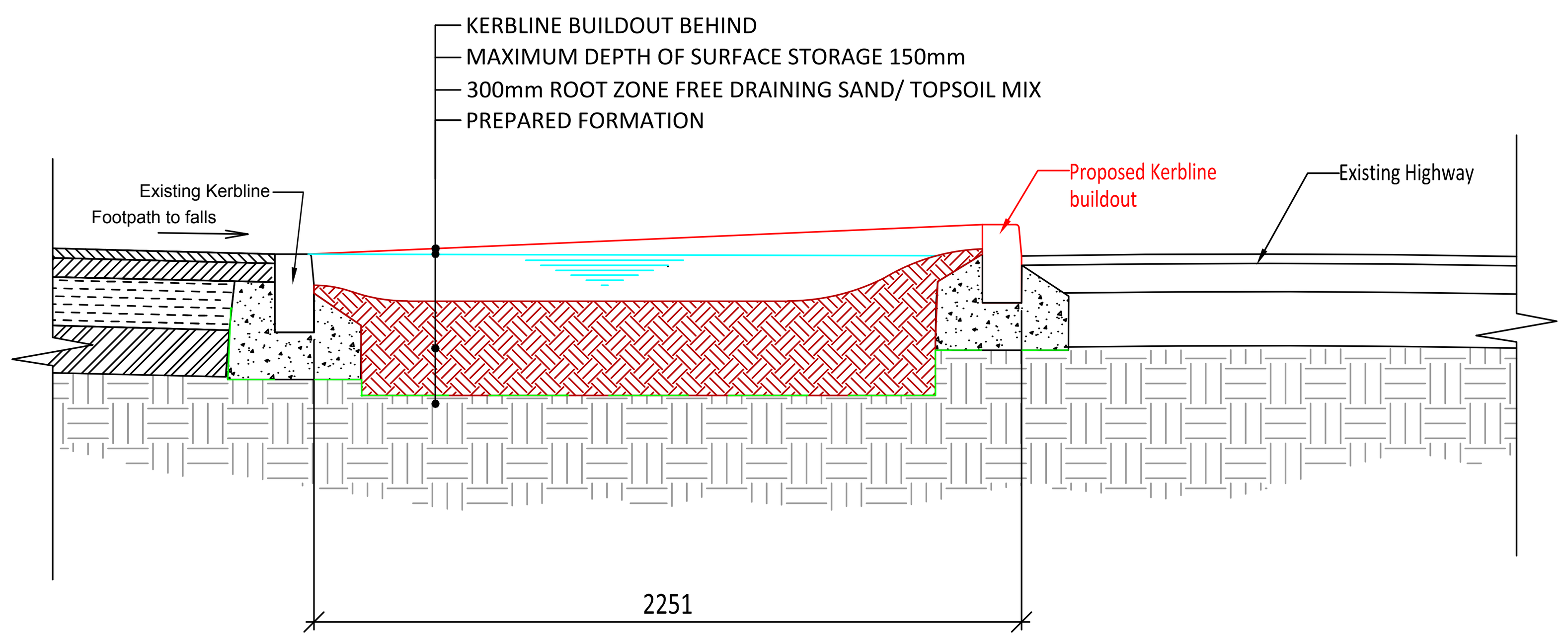
- To improve the understanding of existing flood risk and potentially provide further evidence for the requirement of Rain Gardens in the locality, a baseline model of the existing Thames Water sewer network could be built using WinDes (including FloodFlow). A review of the current Thames Water sewer network dataset held by URS has identified a number of missing pipe invert levels within the study area, this information would be required to inform the baseline model;

- Further development of the predictor tool to allow users to specify rate of transfer from open storage to cellular storage and to benchmark tool performance against model outputs such that in future the tool can be used with confidence to predict Rain Garden performance across larger areas, reducing the immediate need for modelling at the planning stage.

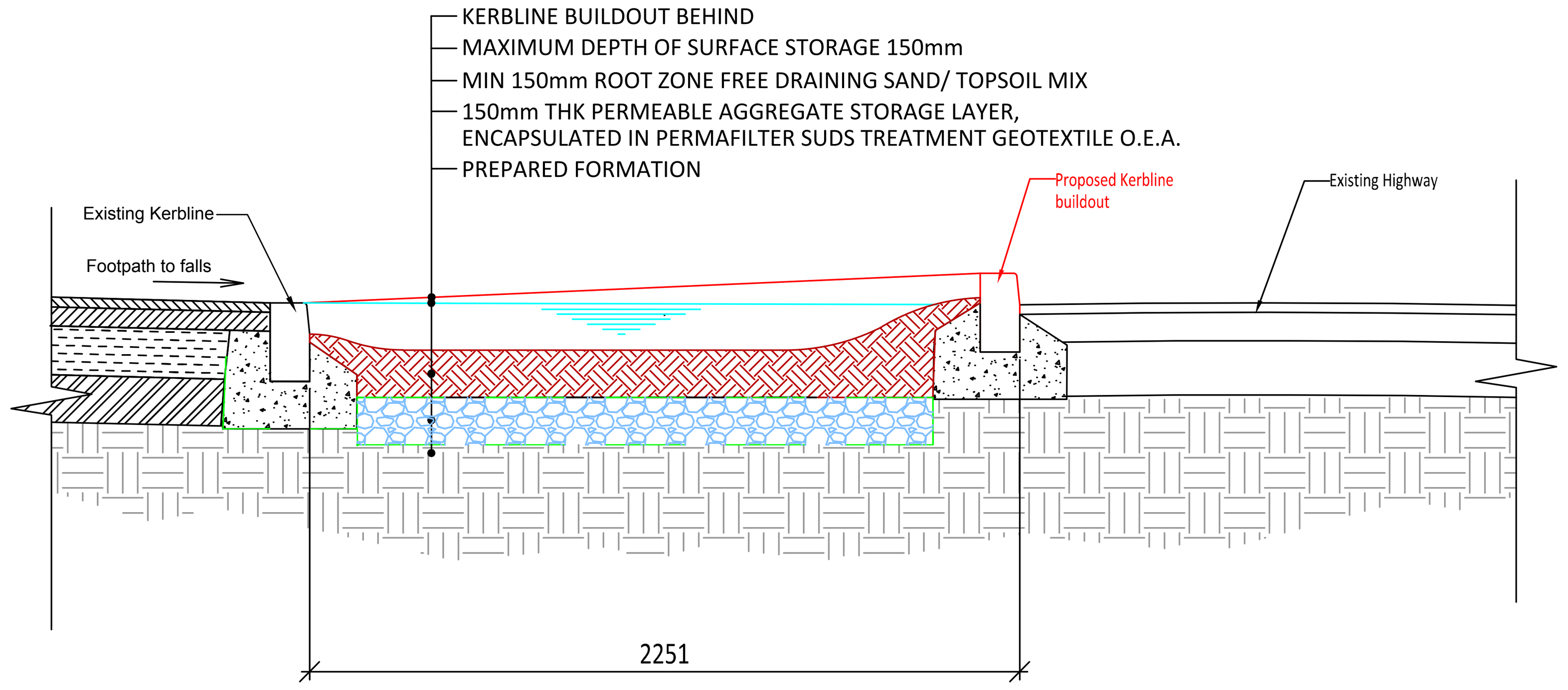
APPENDIX A – TYPICAL LAYOUT & SECTION



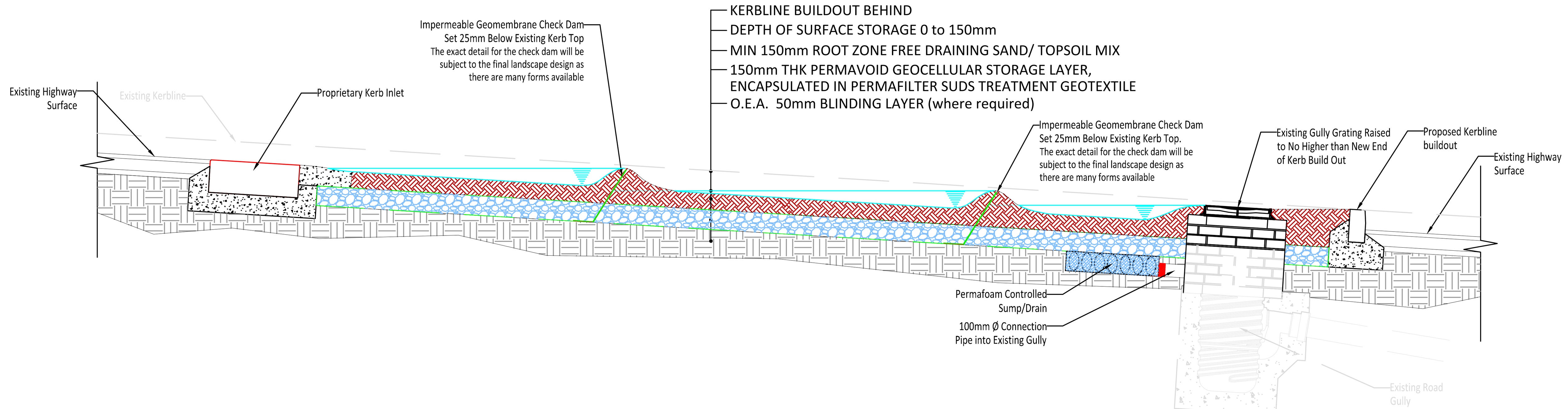
PLAN OF X2 PARKING BAY - KERB BUILDOUT RAINGARDEN
(Scale 1:50)



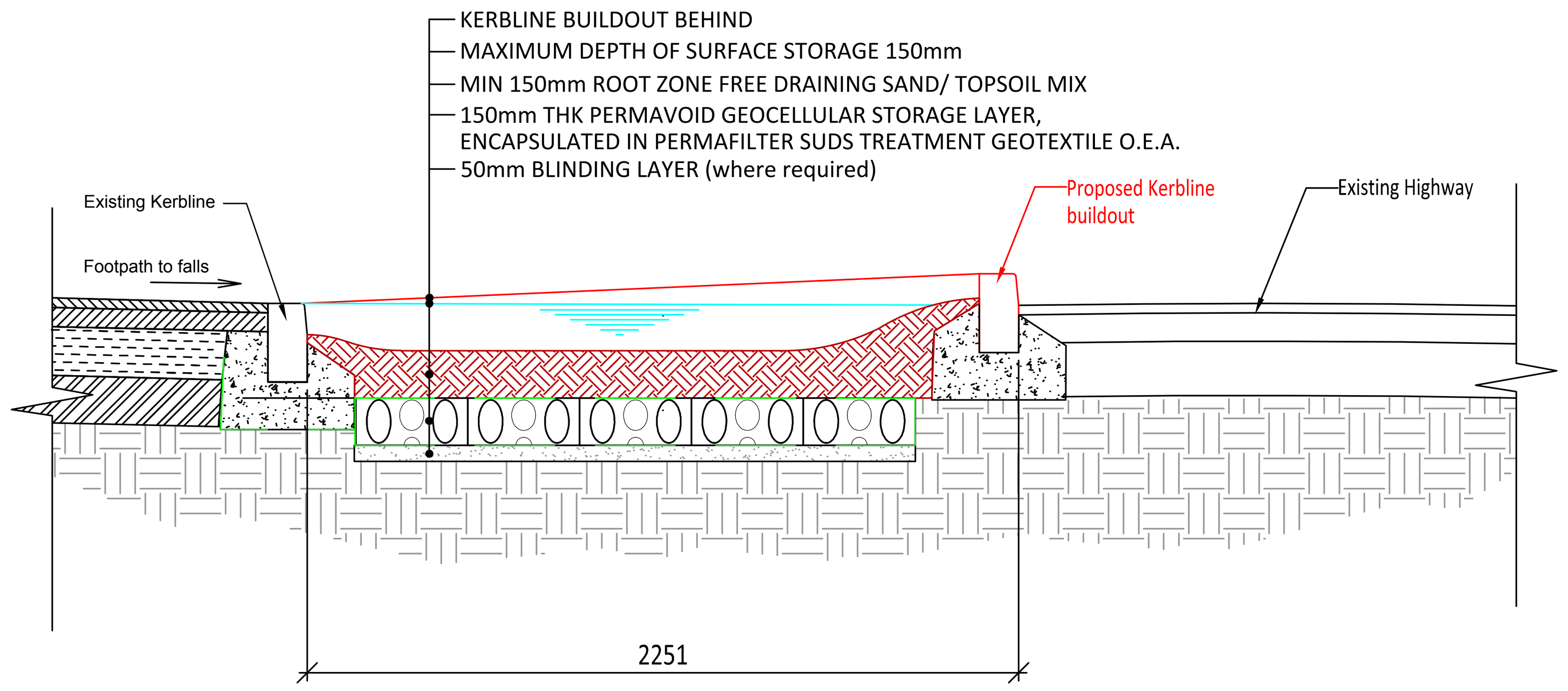
TYPICAL SECTION THROUGH KERB BUILDOUT RAINGARDEN WITH SURFACE STORAGE ONLY
(Scale 1:20)



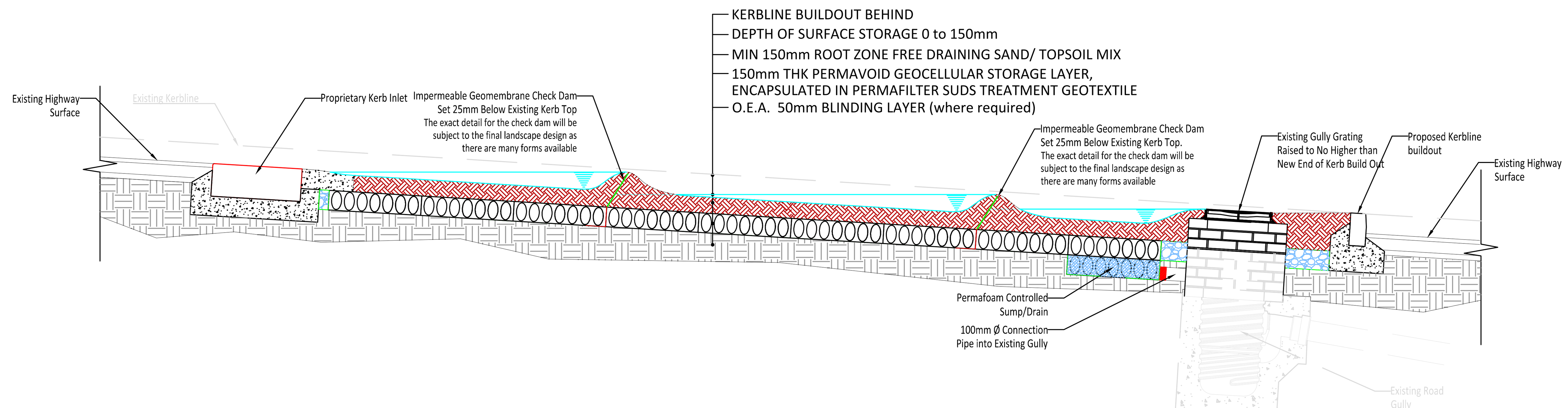
TYPICAL SECTION THROUGH KERB BUILDOUT RAINGARDEN WITH PERMEABLE AGGREGATE STORAGE
(Scale 1:20)



TYPICAL LONG SECTION THROUGH KERB BUILDOUT RAINGARDEN WITH PERMEABLE AGGREGATE STORAGE
(Scale 1:30)



TYPICAL SECTION THROUGH KERB BUILDOUT RAINGARDEN WITH GEOCELLULAR STORAGE
(Scale 1:20)



TYPICAL LONG SECTION THROUGH KERB BUILDOUT RAINGARDEN WITH GEOCELLULAR STORAGE
(Scale 1:30)

Notes

FOR COMMENT

REV	DESCRIPTION	DATE
P2	Checkdams & typical long-sections added	06/08/12
P1	Typical sections added	14/05/12

The Environmental Protection Group Ltd
Warrington Business Park
Long Lane
Warrington
T: 01925 652 980
F: 01925 652 983
W: www.epg-ltd.co.uk
E: conultantrequest@epg-ltd.co.uk
© The Environmental Protection Group Ltd

PROJECT
LAMBETH DIY STREETS

CLIENT
LONDON BOROUGH OF LAMBETH
HIGHWAYS DEPARTMENT

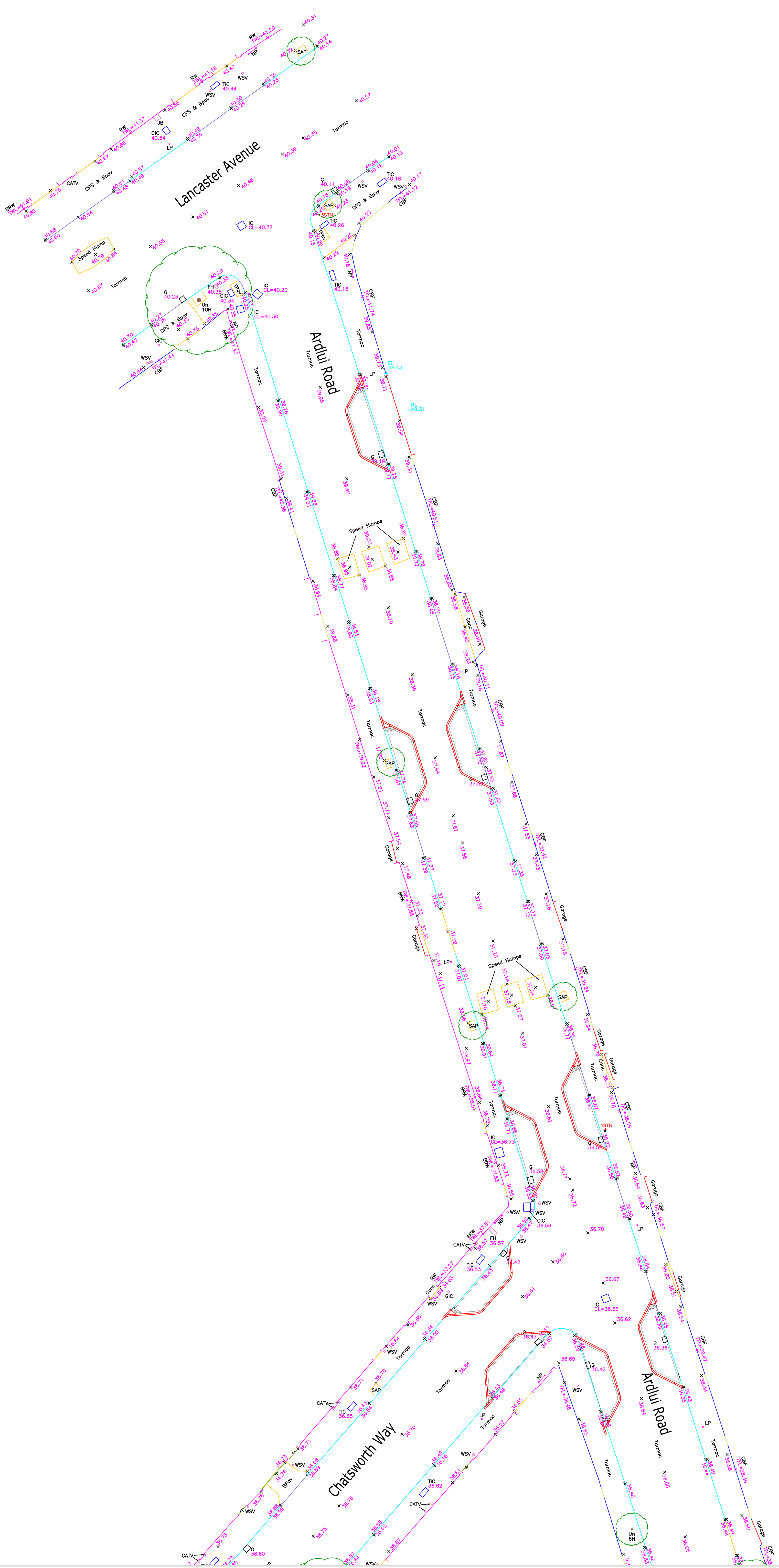
DRAWING TITLE
SURFACE WATER MANAGEMENT
KERB BUILD-OUT RAINGARDEN
LAYOUT & SECTIONS

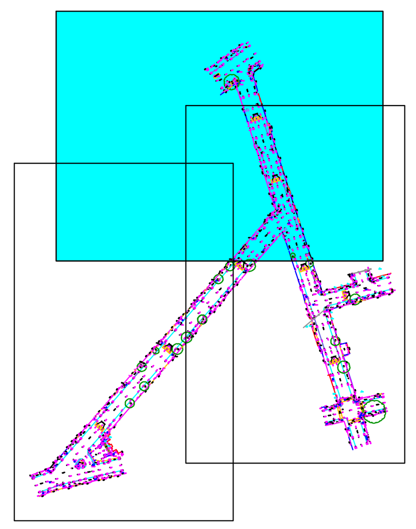
SCALE	DATE
As Shown @ A1	10/02/2012

DRAWN BY	CHECKED BY	REVISION
PP	SW	P2

DRAWING No
EPG/7754/SD/01

APPENDIX B – TOPOPGRAPHIC SURVEY





SURVEY STATIONS			
Name	Easting	Northing	Height
1STN	532052.036	172472.001	38.828
2STN	532100.602	172545.832	37.532
3STN	532139.976	172574.516	36.914
4STN	532186.823	172641.741	36.659
5STN	532160.646	172725.354	40.266
6STN	532201.059	172570.348	36.662
7STN	532235.803	172500.711	37.559
8STN	532229.416	172585.389	36.690

Notes

1. The survey grid is a local grid, coincident with Ordnance Survey National Grid at 1STN.
2. Surveyed boundary features are not necessarily legal boundaries.
3. Dimensions should not be scaled. All dimensions should be checked on site before any fabrication / construction.
4. Copyright of all data produced by Technics Group shall remain with Technics Group unless otherwise specifically agreed.
5. Information provided should not be altered or modified in any way. It should not be used for any purpose other than for which it was intended and should not be issued to other parties without prior agreement of Technics Group.
6. Technics Group cannot accept responsibility for any damage to computer systems which may result from viruses which may be contained in the data provided.
7. If the AutoCAD drawing is being read by any system other than AutoCAD it should be checked against a hard copy. Technics Group cannot accept liability for omissions.
8. All drainage connections shown are sounded only. They have not been water tested. Services may be obscured by parked cars, leaf litter or building materials etc.
9. External eaves levels are surveyed to lowest tile position.

© TECHNICSGROUP

Level Datum

ALL LEVELS ARE ORTHOMETRIC HEIGHTS RELATED TO OSGM02 GPS DATUM, COMPUTED USING LEICA SMARTNET RTK NETWORK.

Topo Key

STREET FURNITURE

BB	Belisha Beacon
BL	Basement Light
Bin	Litter Bin
BO	Bollard
BS	Bus Stop
CPO	Concrete Post
EC	Electric Cupboard
EP	Electric Pole
FB	Flower Bed
FHM	Fire Hydrant Marker
FL	Flood Light
FP	Flag Pole
FPO	Fence Post
JB	Junction Box
GB	Grit Box
GMK	Gas Marker Post
GPO	Gate Post
IBO	Illuminating Bollard
LH	Lamp Hole
LP	Lamp Post
LPO	Lockable Post
MK	Marker
MPO	Metal Post
NP	Name Plate
PB	Post Box
PM	Parking Meter
RPO	Reflector Post
RS	Road Sign
SI	Sign
STN	Survey Station
Tap	Water Tap
TCB	Telephone Call Box
TL	Traffic Light
TLCB	Traffic Light Control Box
TP	Telegraph Post
TPO	Timber Post

PIPES & CABLES

DBC	Directly Buried Cable
DP	Down Pipe
FWP	Foul Water Pipe
GP	Gas Pipe
RWP	Rain Water Pipe
SP	Stand Pipe
SVP	Soil Vent Pipe
UTT	Unable to Trace
VP	Vent Pipe
WP	Waste Pipe

LEVELS & DEPTHS

A	Approximate
BD	Back Drop Depth
BDL	Back Drop Level
CD	Chamber Depth
CL	Cover Level
DHL	Door Head Level
DSL	Door Sill Level
DPC	Damp Proof Course
EL	Eaves Level
FFL	Finished Floor Level
FRL	Flat Roof Level
ID	Invert Depth
IL	Invert Level
OD	Outlet Depth
OL	Outlet Level
PWL	Parapet Wall Level
RL	Ridge Level
SD	Sump Depth
SFD	Soffit Depth
SFL	Soffit Level
SiltL	Silt Level
SL	Sump Level
SSL	Structural Slab Level
TFL	Top of Fence Level
THL	Threshold Level
TWL	Top of Wall Level
USL	Underside Level
WL	Water Level
WHL	Window Head Level
WSL	Window Sill Level

FENCES & WALLS

BW	Block Wall
BRP	Brick Pier
BRTW	Brick Retaining Wall
BRW	Brick Wall
BWF	Barbed Wire Fence
CBF	Close Board Fence
CIF	Corrugated Iron Fence
CLF	Chain Link Fence
CPF	Chestnut Pailing Fence
CRW	Concrete Retaining Wall
CW	Concrete Wall
CWF	Chicken Wire Fence
Dil	Dilapidated
HR	Handrail
IWF	Interwoven Fence
LF	Lattice Fence
MF	Miscellaneous Fence
MRF	Metal Railing Fence
OBF	Open Board Fence
PCF	Post & Chain Fence
PNF	Panel Fence
PRF	Post & Rail Fence
PWF	Post & Wire Fence
RTW	Retaining Wall
STW	Stone Wall
SRTW	Stone Retaining Wall
WMF	Wire Mesh Fence

INSPECTION CHAMBERS

AC	Access Cover
BH	Borehole
CDC	Concrete Drainage Channel
EIC	Electric Inspection Cover
ER	Earth Rod
FH	Fire Hydrant
FWIC	Foul Water Inspection Cover
GIC	Gas Inspection Cover
GM	Gas Meter
GV	Gas Valve
G	Gully
IC	Inspection Cover
KI	Kerb Inlet
LHP	London Hydraulic Power
MDC	Metal Drainage Channel
MW	Monitoring Well
NFI	No Further Information
RE	Rodding Eye
SDIC	Service Duct Inspection Cover
SV	Stop Valve
SWCP	Storm Water Catch Pit
SWIC	Storm Water Inspection Cover
TCIC	Traffic Control Inspection Cover
TIC	Telecom Inspection Cover
UIC	Unidentified Inspectional Cover
UTR	Unable to Raise
WIC	Water Inspection Cover
WM	Water Meter
WWO	Water Wash Out
WSV	Water Stop Valve

SURFACES

BPav	Brick Paving
Conc	Concrete
CPav	Crazy Paving
CPS	Concrete Paving Slabs
FB	Flower\Shrub Border
KFC	Kidney Flint Cobbles
SPS	Stone Paving Slabs
T	Tiles
Tmac	Tarmac
TPav	Tactile Paving
TS	Trench Scar

MEASUREMENTS

d	Depth(m)
Ø	Diameter (mm)
Ext. Ø	External Diameter (mm)
H	Object Height (m)

Symbology

Banking
Step Up
Ø Diameter shown in mm
Survey Station

Linetypes

Telecom Overhead
Power Overhead
Gates & Doors
Change of Surface
Drop Kerb
Fence
Wall
Kerb
Building Face
Overhead Feature
Trench Scar
Tree Canopy
Bushes\Foliage\Overgrowth
Tree Canopy Extents

Trees

SPECIES ABBREVIATION

AL	Alder	HO	Holly	PL	Plane
BE	Beech	HZ	Hazel	RH	Rhododendron
CE	Cedar	LA	Larch	RO	Rowan
CH	Cherry	LB	Laburnum	SAP	Sapling
CY	Cypress	LM	Lime	SB	Silver Birch
DE	Dead	LO	Locust	SCN	Sweet Chestnut
ED	Elder	LPN	London Plane	ST	Stump
EU	Eucalyptus	LU	Laurel	SY	Sycamore
FR	Fruit	MA	Maple	Un	Unknown
HA	Hawthorn	MG	Magnolia	WB	Whitebeam
HB	Hornbeam	NS	Norway Spruce	WG	Wellingtonia
HC	Horse Chestnut	PI	Pine	WI	Willow
HL	Hemlock	PO	Poplar	WN	Walnut

NOTES:
1. The tree species have been identified to the best of the Surveyors knowledge. They have not been verified by an Arborist and are not guaranteed. If they are important they should be verified.
2. Tree heights are estimated.
3. A CAD layer exists with the full tree canopies intact which is turned off.
4. Trees with bole diameters below the specified minimum size may not have been surveyed.
5. Multibole sizes are indicative.

Revision

Rev	Date	Notes	By

CLIENT

Environmental Services

SITE
Chatsworth Way, Ardlui Rd and Towton Rd
Lambeth
London SE27 9HN

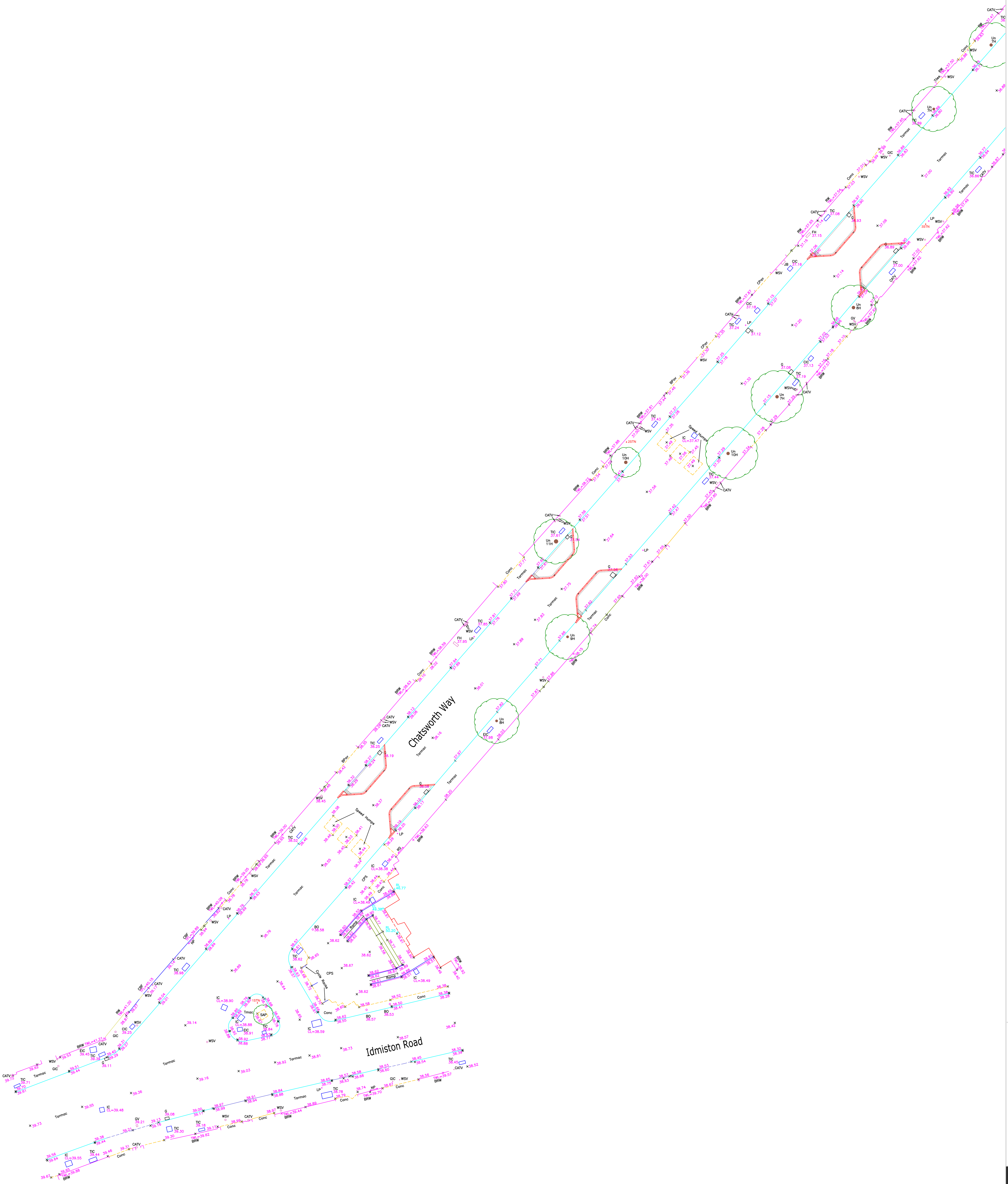
DRAWING TITLE
Topographical Survey

PROJECT NUMBER	DRAWING NUMBER	DATE
SP12089	SD12089-01	Feb 2012
SURVEYED BY	DRAWN BY	CHECKED BY
LW	LW	AJH
SCALE	SHEET SIZE	SHEET
1:200	A0	1 OF 3

TECHNICS GROUP
Geospatial Consultant Surveyors

TECHNICS GROUP
TECHNICS HOUSE
MERROW BUSINESS PARK
GUILDFORD
SURREY, GU4 7WA
T: 01483 230 080
E: mail@technicsgroup.com
W: technicsgroup.com

Regulated by RICS



Notes

1. The survey grid is a local grid, coincident with Ordnance Survey National Grid at 1STN.
2. Surveyed boundary features are not necessarily legal boundaries.
3. Dimensions should not be scaled. All dimensions should be checked on site before any fabrication / construction.
4. Copyright of all data produced by Technics Group shall remain with Technics Group unless otherwise specifically agreed.
5. Information provided should not be altered or modified in any way. It should not be used for any purpose other than for which it was intended and should not be issued to other parties without prior agreement of Technics Group.
6. Technics Group cannot accept responsibility for any damage to computer systems which may result from viruses which may be contained in the data provided.
7. If the AutoCAD drawing is being read by any system other than AutoCAD it should be checked against a hard copy. Technics Group cannot accept liability for omissions.
8. All drainage connections shown are sounded only. They have not been water tested. Services may be obscured by parked cars, leaf litter or building materials etc.
9. External eaves levels are surveyed to lowest tile position.

© TECHNICSGROUP

Level Datum

ALL LEVELS ARE ORTHOMETRIC HEIGHTS RELATED TO OSGM02 GPS DATUM, COMPUTED USING LEICA SMARTNET RTK NETWORK.

Topo Key

STREET FURNITURE

BB	Belisha Beacon
BL	Basement Light
Bin	Litter Bin
BO	Bollard
BS	Bus Stop
CPO	Concrete Post
EC	Electric Cupboard
EP	Electric Pole
FB	Flower Bed
FHM	Fire Hydrant Marker
FL	Flood Light
FP	Flag Pole
FPO	Fence Post
JB	Junction Box
GB	Grit Box
GMK	Gas Marker Post
GPO	Gate Post
IBO	Illuminating Bollard
LH	Lamp Hole
LP	Lamp Post
LPO	Lockable Post
MK	Marker
MPO	Metal Post
NP	Name Plate
PB	Post Box
PM	Parking Meter
RPO	Reflector Post
RS	Road Sign
SI	Sign
STN	Survey Station
Tap	Water Tap
TCB	Telephone Call Box
TL	Traffic Light
TLCB	Traffic Light Control Box
TP	Telegraph Post
TPO	Timber Post

PIPES & CABLES

DBC	Directly Buried Cable
DP	Down Pipe
FWP	Foul Water Pipe
GP	Gas Pipe
RWP	Rain Water Pipe
SP	Stand Pipe
SVP	Soil Vent Pipe
UTT	Unable to Trace
VP	Vent Pipe
WP	Waste Pipe

LEVELS & DEPTHS

A	Approximate
BD	Back Drop Depth
BDL	Back Drop Level
CD	Chamber Depth
CL	Cover Level
DHL	Door Head Level
DSL	Door Sill Level
DPC	Damp Proof Course
EL	Eaves Level
FFL	Finished Floor Level
FRL	Flat Roof Level
ID	Invert Depth
IL	Invert Level
OD	Outlet Depth
OL	Outlet Level
PWL	Parapet Wall Level
RL	Ridge Level
SD	Sump Depth
SFD	Soffit Depth
SFL	Soffit Level
SiltL	Silt Level
SL	Sump Level
SSL	Structural Slab Level
TFL	Top of Fence Level
THL	Threshold Level
TWL	Top of Wall Level
USL	Underside Level
WL	Water Level
WHL	Window Head Level
WSL	Window Sill Level

FENCES & WALLS

BW	Block Wall
BRP	Brick Pier
BRTW	Brick Retaining Wall
BRW	Brick Wall
BWF	Barbed Wire Fence
CBF	Close Board Fence
CIF	Corrugated Iron Fence
CLF	Chain Link Fence
CPF	Chestnut Pailing Fence
CRW	Concrete Retaining Wall
CW	Concrete Wall
CWF	Chicken Wire Fence
Dil	Dilapidated
HR	Handrail
IWF	Interwoven Fence
LF	Lattice Fence
MF	Miscellaneous Fence
MRF	Metal Railing Fence
OBF	Open Board Fence
PCF	Post & Chain Fence
PNF	Panel Fence
PRF	Post & Rail Fence
PWF	Post & Wire Fence
RTW	Retaining Wall
STW	Stone Wall
SRTW	Stone Retaining Wall
WMF	Wire Mesh Fence

INSPECTION CHAMBERS

AC	Access Cover
BH	Borehole
CDC	Concrete Drainage Channel
EIC	Electric Inspection Cover
ER	Earth Rod
FH	Fire Hydrant
FWIC	Foul Water Inspection Cover
GIC	Gas Inspection Cover
GM	Gas Meter
GV	Gas Valve
G	Gully
IC	Inspection Cover
KI	Kerb Inlet
LHP	London Hydraulic Power
MDC	Metal Drainage Channel
MW	Monitoring Well
NFI	No Further Information
RE	Rodding Eye
SDIC	Service Duct Inspection Cover
SV	Stop Valve
SWCP	Storm Water Catch Pit
SWIC	Storm Water Inspection Cover
TCIC	Traffic Control Inspection Cover
TIC	Telecom Inspection Cover
UIC	Unidentified Inspectional Cover
UTR	Unable to Raise
WIC	Water Inspection Cover
WM	Water Meter
WWO	Water Wash Out
WSV	Water Stop Valve

SURFACES

BPav	Brick Paving
Conc	Concrete
CPav	Crazy Paving
CPS	Concrete Paving Slabs
FB	Flower\Shrub Border
KFC	Kidney Flint Cobbles
SPS	Stone Paving Slabs
T	Tiles
Tmac	Tarmac
TPav	Tactile Paving
TS	Trench Scar

MEASUREMENTS

d	Depth(m)
Ø	Diameter (mm)
Ext. Ø	External Diameter (mm)
H	Object Height (m)

Symbology

Banking
Step Up
Ø Diameter shown in mm
Survey Station

Linetypes

Telecom Overhead
Power Overhead
Gates & Doors
Change of Surface
Drop Kerb
Fence
Wall
Kerb
Building Face
Overhead Feature
Trench Scar
Tree Canopy
Bushes\Foliage\Overgrowth
Tree Canopy Extents

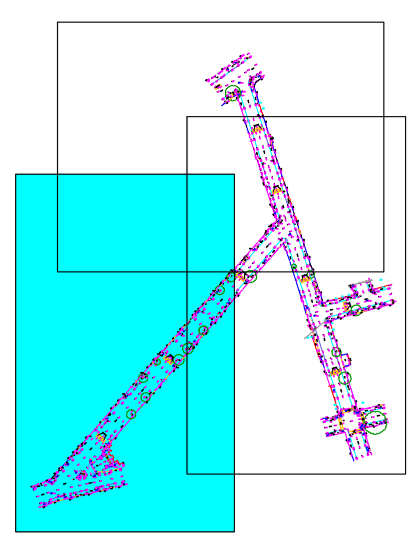
Trees

SPECIES ABBREVIATION

AL	Alder	HO	Holly	PL	Plane
BE	Beech	HZ	Hazel	RH	Rhododendron
CE	Cedar	LA	Larch	RO	Rowan
CH	Cherry	LB	Laburnum	SAP	Sapling
CY	Cypress	LM	Lime	SB	Silver Birch
DE	Dead	LO	Locust	SCN	Sweet Chestnut
ED	Elder	LPN	London Plane	ST	Stump
EU	Eucalyptus	LU	Laurel	SY	Sycamore
FR	Fruit	MA	Maple	Un	Unknown
HA	Hawthorn	MG	Magnolia	WB	Whitebeam
HB	Hornbeam	NS	Norway Spruce	WG	Wellingtonia
HC	Horse Chestnut	PI	Pine	WI	Willow
HL	Hemlock	PO	Poplar	WN	Walnut

NOTES:
1.The tree species have been identified to the best of the Surveyors knowledge. They have not been verified by an Arborist and are not guaranteed. If they are important they should be verified.
2.Tree heights are estimated.
3.A CAD layer exists with the full tree canopies intact which is turned off.
4.Trees with bole diameters below the specified minimum size may not have been surveyed.
5.Multibole sizes are indicative.

N



SURVEY STATIONS			
Name	Easting	Northing	Height
1STN	532052.036	172472.001	38.828
2STN	532100.602	172545.832	37.532
3STN	532139.976	172574.516	36.914
4STN	532186.823	172641.741	36.659
5STN	532160.646	172725.354	40.266
6STN	532201.059	172570.348	36.662
7STN	532235.803	172500.711	37.559
8STN	532229.416	172585.389	36.690

Revision

Rev	Date	Notes	By
Rev	Date	Notes	By

CLIENT
Environmental Services

SITE
Chatsworth Way, Ardlui Rd and Towton Rd
Lambeth
London SE27 9HN

DRAWING TITLE
Topographical Survey

PROJECT NUMBER	DRAWING NUMBER	DATE
SP12089	SD12089-01	Feb 2012
SURVEYED BY	DRAWN BY	CHECKED BY
LW	LW	AJH
SCALE	SHEET SIZE	SHEET
1:200	A0	2 OF 3

TECHNICS GROUP
Geospatial Consultant Surveyors

TECHNICS GROUP
TECHNICS HOUSE
MERROW BUSINESS PARK
GUILDFORD
SURREY, GU4 7WA
T: 01483 230 080
E: mail@technicsgroup.com
W: technicsgroup.com

Regulated by RICS
chartered ices
THE SURVEY ASSOCIATION
EUROPEAN GPR ASSOCIATION
CHAS Accredited Contractor
constructionline

© TECHNICSGROUP

Notes

1. The survey grid is a local grid, coincident with Ordnance Survey National Grid at 1STN.
2. Surveyed boundary features are not necessarily legal boundaries.
3. Dimensions should not be scaled. All dimensions should be checked on site before any fabrication / construction.
4. Copyright of all data produced by Technics Group shall remain with Technics Group unless otherwise specifically agreed.
5. Information provided should not be altered or modified in any way. It should not be used for any purpose other than for which it was intended and should not be issued to other parties without prior agreement of Technics Group.
6. Technics Group cannot accept responsibility for any damage to computer systems which may result from viruses which may be contained in the data provided.
7. If the AutoCAD drawing is being read by any system other than AutoCAD it should be checked against a hard copy. Technics Group cannot accept liability for omissions.
8. All drainage connections shown are sounded only. They have not been water tested. Services may be obscured by parked cars, leaf litter or building materials etc.
9. External eaves levels are surveyed to lowest tile position.

Level Datum

ALL LEVELS ARE ORTHOMETRIC HEIGHTS RELATED TO OSGM02 GPS DATUM, COMPUTED USING LEICA SMARTNET RTK NETWORK.

Topo Key

STREET FURNITURE

BB Belisha Beacon
BL Basement Light
Bin Litter Bin
BO Bollard
BS Bus Stop
CPO Concrete Post
EC Electric Cupboard
EP Electric Pole
FB Flower Bed
FHM Fire Hydrant Marker
FL Flood Light
FP Flag Pole
FPO Fence Post
JB Junction Box
GB Grit Box
GMK Gas Marker Post
GPO Gate Post
IBO Illuminating Bollard
LH Lamp Hole
LP Lamp Post
LPO Lockable Post
MK Marker
MPO Metal Post
NP Name Plate
PB Post Box
PM Parking Meter
RPO Reflector Post
RS Road Sign
SI Sign
STN Survey Station
Tap Water Tap
TCB Telephone Call Box
TL Traffic Light
TLCB Traffic Light Control Box
TP Telegraph Post
TPO Timber Post

PIPES & CABLES

DBC Directly Buried Cable
DP Down Pipe
FWP Foul Water Pipe
GP Gas Pipe
RWP Rain Water Pipe
SP Stand Pipe
SVP Soil Vent Pipe
UTT Unable to Trace
VP Vent Pipe
WP Waste Pipe

LEVELS & DEPTHS

A Approximate
BD Back Drop Depth
BDL Back Drop Level
CD Chamber Depth
CL Cover Level
DHL Door Head Level
DSL Door Sill Level
DPC Damp Proof Course
EL Eaves Level
FFL Finished Floor Level
FRL Flat Roof Level
ID Invert Depth
IL Invert Level
OD Outlet Depth
OL Outlet Level
PWL Parapet Wall Level
RL Ridge Level
SD Sump Depth
SFD Soffit Depth
SFL Soffit Level
SiltL Silt Level
SL Sump Level
SSL Structural Slab Level
TFL Top of Fence Level
THL Threshold Level
TWL Top of Wall Level
USL Underside Level
WL Water Level
WHL Window Head Level
WSL Window Sill Level

FENCES & WALLS

BW Block Wall
BRP Brick Pier
BRTW Brick Retaining Wall
BRW Brick Wall
BWF Barbed Wire Fence
CBF Close Board Fence
CIF Corrugated Iron Fence
CLF Chain Link Fence
CPF Chestnut Pailing Fence
CRW Concrete Retaining Wall
CW Concrete Wall
CWF Chicken Wire Fence
Dil Dilapidated
HR Handrail
IWF Interwoven Fence
LF Lattice Fence
MF Miscellaneous Fence
MRF Metal Railing Fence
OBF Open Board Fence
PCF Post & Chain Fence
PNF Panel Fence
PRF Post & Rail Fence
PWF Post & Wire Fence
RTW Retaining Wall
STW Stone Wall
SRTW Stone Retaining Wall
WMF Wire Mesh Fence

INSPECTION CHAMBERS

AC Access Cover
BH Borehole
CDC Concrete Drainage Channel
EIC Electric Inspection Cover
ER Earth Rod
FH Fire Hydrant
FWIC Foul Water Inspection Cover
GIC Gas Inspection Cover
GM Gas Meter
GV Gas Valve
G Gully
IC Inspection Cover
KI Kerb Inlet
LHP London Hydraulic Power
MDC Metal Drainage Channel
MW Monitoring Well
NFI No Further Information
RE Rodding Eye
SDIC Service Duct Inspection Cover
SV Stop Valve
SWCP Storm Water Catch Pit
SWIC Storm Water Inspection Cover
TCIC Traffic Control Inspection Cover
TIC Telecom Inspection Cover
UIC Unidentified Inspectional Cover
UTR Unable to Raise
WIC Water Inspection Cover
WM Water Meter
WWO Water Wash Out
WSV Water Stop Valve

SURFACES

BPav Brick Paving
Conc Concrete
CPav Crazy Paving
CPS Concrete Paving Slabs
FB Flower\Shrub Border
KFC Kidney Flint Cobbles
SPS Stone Paving Slabs
T Tiles
Tmac Tarmac
TPav Tactile Paving
TS Trench Scar

MEASUREMENTS

d Depth(m)
Ø Diameter (mm)
Ext. Ø External Diameter (mm)
H Object Height (m)

Symbology

Banking
Step Up
Ø Diameter shown in mm
Survey Station

Linetypes

Telecom Overhead
Power Overhead
Gates & Doors
Change of Surface
Drop Kerb
Fence
Wall
Kerb
Building Face
Overhead Feature
Trench Scar
Tree Canopy
Bushes\Foliage\Overgrowth
Tree Canopy Extents

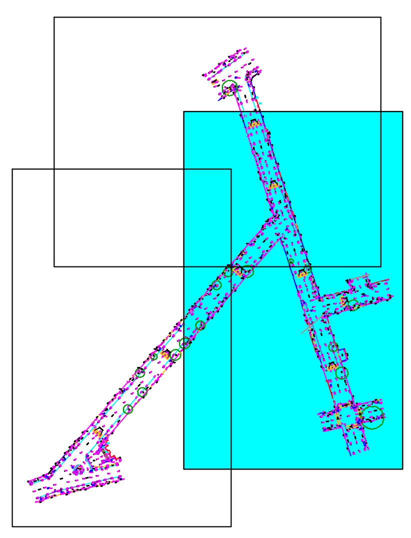
Trees

SPECIES ABBREVIATION

AL	Alder	HO	Holly	PL	Plane
BE	Beech	HZ	Hazel	RH	Rhododendron
CE	Cedar	LA	Larch	RO	Rowan
CH	Cherry	LB	Laburnum	SAP	Sapling
CY	Cypress	LM	Lime	SB	Silver Birch
DE	Dead	LO	Locust	SCN	Sweet Chestnut
ED	Elder	LPN	London Plane	ST	Stump
EU	Eucalyptus	LU	Laurel	SY	Sycamore
FR	Fruit	MA	Maple	Un	Unknown
HA	Hawthorn	MG	Magnolia	WB	Whitebeam
HB	Hornbeam	NS	Norway Spruce	WG	Wellingtonia
HC	Horse Chestnut	PI	Pine	WI	Willow
HL	Hemlock	PO	Poplar	WN	Walnut

NOTES:
1.The tree species have been identified to the best of the Surveyors knowledge. They have not been verified by an Arborist and are not guaranteed. If they are important they should be verified.
2.Tree heights are estimated.
3.A CAD layer exists with the full tree canopies intact which is turned off.
4.Trees with bole diameters below the specified minimum size may not have been surveyed.
5.Multibole sizes are indicative.

N



SURVEY STATIONS			
Name	Easting	Northing	Height
1STN	532052.036	172472.001	38.828
2STN	532100.602	172545.832	37.532
3STN	532139.976	172574.516	36.914
4STN	532186.823	172641.741	36.659
5STN	532160.646	172725.354	40.266
6STN	532201.059	172570.348	36.662
7STN	532235.803	172500.711	37.559
8STN	532229.416	172585.389	36.690

Revision

Rev	Date	Notes	By
Rev	Date	Notes	By

CLIENT

Environmental Services

SITE
Chatsworth Way, Ardlui Rd and Towton Rd
Lambeth
London SE27 9HN

DRAWING TITLE
Topographical Survey

PROJECT NUMBER	DRAWING NUMBER	DATE
SP12089	SD12089-01	Feb 2012
SURVEYED BY	DRAWN BY	CHECKED BY
LW	LW	AJH
SCALE	SHEET SIZE	SHEET
1:200	A0	3 OF 3

TECHNICS GROUP

Geospatial Consultant Surveyors

TECHNICS GROUP
TECHNICS HOUSE
MERROW BUSINESS PARK
GUILDFORD
SURREY, GU4 7WA
T: 01483 230 080
E: mail@technicsgroup.com
W: technicsgroup.com

Regulated by RICS

APPENDIX C – WINDES OUTPUTS

Existing Network Details for SW.txt

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
	1.000	24.812	1.306	19.0	0.000	5.00	0.600	o	300
*	2.000	1.000	0.005	200.0	0.000	5.00	0.600	o	100
*	2.001	1.093	0.006	182.2	0.000	0.00	0.600	o	100
	3.000	3.413	0.200	17.1	0.013	5.00	0.600	o	150
	4.000	2.046	0.300	6.8	0.001	5.00	0.600	o	150
*	2.002	2.802	0.150	18.7	0.002	0.00	0.600	o	150
*	5.000	1.204	0.005	240.8	0.000	5.00	0.600	o	100
*	5.001	1.499	0.006	249.8	0.000	0.00	0.600	o	100
	6.000	1.830	0.150	12.2	0.000	5.00	0.600	o	150
*	2.003	1.000	0.060	16.7	0.002	0.00	0.600	o	150
*	7.000	1.000	0.005	200.0	0.000	5.00	0.600	o	100
*	7.001	1.000	0.006	166.7	0.000	0.00	0.600	o	100
	2.004	3.567	4.985	0.7	0.000	0.00	0.600	o	150

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
	1.000	1	40.370	35.210	4.860	39.400	33.904	5.196		1200
*	2.000	2	40.000	39.260	0.640	40.000	39.255	0.645		1
*	2.001	3	40.000	39.255	0.645	39.420	39.249	0.071	Orifice	1
	3.000	2	39.600	39.449	0.001	39.420	39.249	0.021		1
	4.000	3	39.700	39.549	0.001	39.420	39.249	0.021		1
*	2.002	4	39.420	39.249	0.021	39.270	39.099	0.021	Weir	1 x 2100
*	5.000	7	40.000	39.110	0.790	40.000	39.105	0.795		1
*	5.001	8	40.000	39.105	0.795	39.270	39.099	0.071	Orifice	1
	6.000	5	39.400	39.249	0.001	39.270	39.099	0.021		1
*	2.003	6	39.270	39.099	0.021	39.190	39.039	0.001	Weir	1 x 2100
*	7.000	11	40.000	39.050	0.850	40.000	39.045	0.855		1
*	7.001	12	40.000	39.045	0.855	39.190	39.039	0.051	Orifice	1
	2.004	7	39.190	39.039	0.001	39.400	34.054	5.196	Weir	1 x 1000

©1982-2011 Micro Drainage Ltd

Existing Network Details for SW.txt

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
1.001	32.322	1.701	19.0	0.000	0.00	0.600	o	300
8.000	4.219	5.088	0.8	0.000	5.00	0.600	o	150
9.000	3.806	5.085	0.7	0.000	5.00	0.600	o	150
1.002	34.883	1.836	19.0	0.000	0.00	0.600	o	300

PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
1.001	8	39.400	33.904	5.196	37.673	32.203	5.170		1
8.000	9	37.592	37.441	0.001	37.673	32.353	5.170		1
9.000	10	37.589	37.438	0.001	37.673	32.353	5.170		1
1.002	11	37.673	32.203	5.170	36.714	30.367	6.047		1

©1982-2011 Micro Drainage Ltd

Online Controls for SW.txt

Orifice Manhole: 3, DS/PN: 2.001, Volume (m^3): 0.0

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 39.255

Weir Manhole: 4, DS/PN: 2.002, Volume (m^3): 0.1

Discharge Coef 0.544 Width (m) 2.100 Invert Level (m) 39.395

Orifice Manhole: 8, DS/PN: 5.001, Volume (m^3): 0.0

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 39.105

Weir Manhole: 6, DS/PN: 2.003, Volume (m^3): 0.1

Discharge Coef 0.544 Width (m) 2.100 Invert Level (m) 39.245

Orifice Manhole: 12, DS/PN: 7.001, Volume (m^3): 0.0

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 39.045

Weir Manhole: 7, DS/PN: 2.004, Volume (m^3): 0.0

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 39.150

©1982-2011 Micro Drainage Ltd

Storage Structures for SW.txt

Cellular Storage Manhole: 3, DS/PN: 2.001

Invert Level (m) 38.955 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.10000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.10000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	4.1	4.1	0.151	0.0	5.3
0.150	4.1	5.3			

Tank or Pond Manhole: 4, DS/PN: 2.002

Invert Level (m) 39.249

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.100	3.3	0.150	4.1

Cellular Storage Manhole: 8, DS/PN: 5.001

Invert Level (m) 38.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.10000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.10000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	5.7	5.7	0.151	0.0	7.1
0.150	5.7	7.1			

Tank or Pond Manhole: 6, DS/PN: 2.003

Invert Level (m) 39.099

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.050	1.9	0.100	3.8	0.150	5.7

Cellular Storage Manhole: 12, DS/PN: 7.001

Invert Level (m) 38.745 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.10000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.10000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1.5	1.5	0.151	0.0	2.2
0.150	1.5	2.2			

©1982-2011 Micro Drainage Ltd

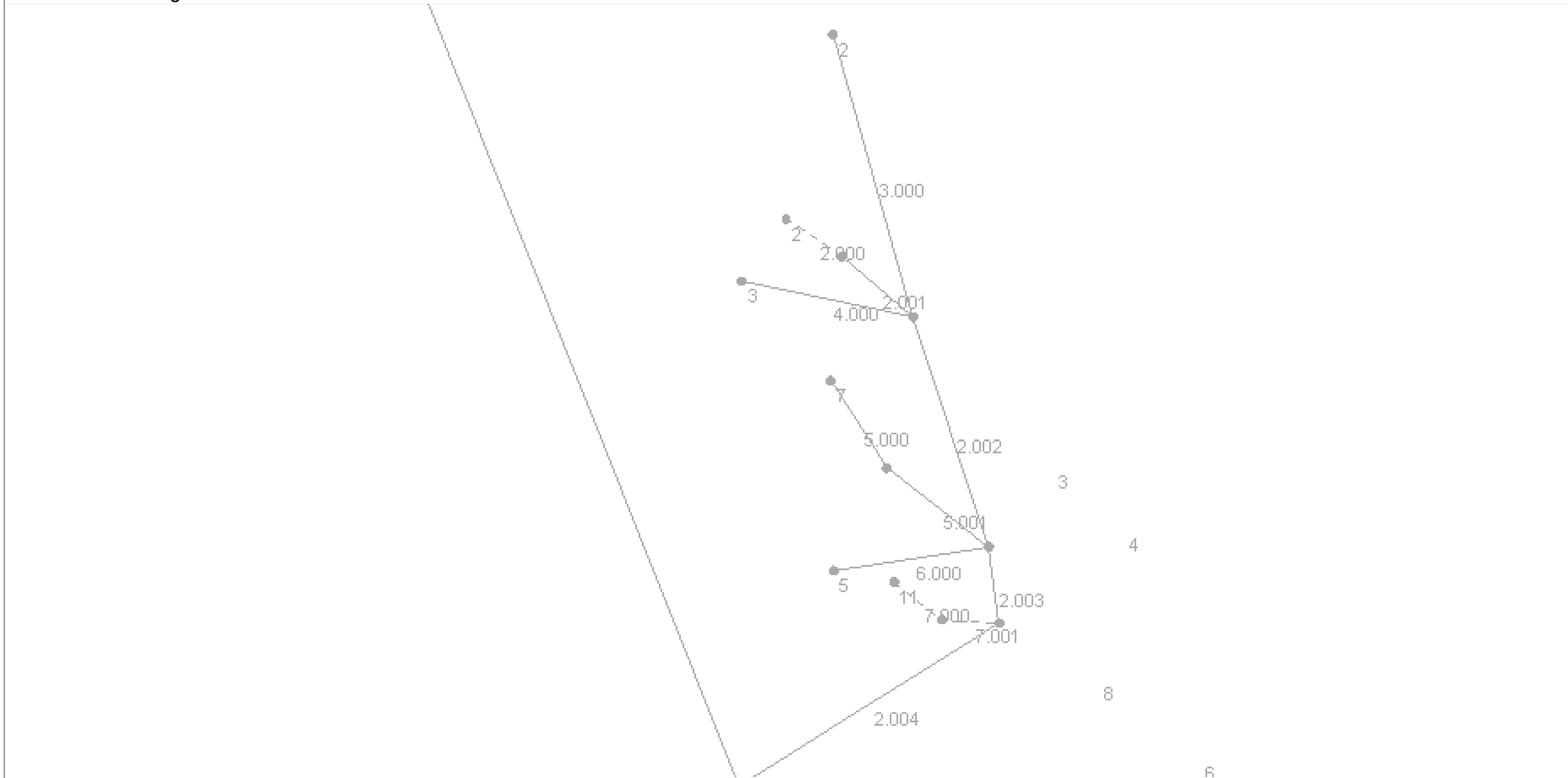
Tank or Pond Manhole: 7, DS/PN: 2.004

Invert Level (m) 39.039

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	0.0	0.150	1.5

©1982-2011 Micro Drainage Ltd

URS Infrastructure & Environment UK Ltd		Page 1
Scott House Alencon Link Basingstoke RG21 7PP		
Date 15/10/2012 09:38 File SW_high_Infiltration.mdx	Designed by 34299mc Checked by	
Micro Drainage	Network W.12.6	



©1982-2011 Micro Drainage Ltd

Existing Network Details for Storm

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
	S1.000	16.566	0.240	69.0	0.000	5.00	0.600	o	300
	S2.000	4.168	0.100	41.7	0.000	5.00	0.600	o	150
	S3.000	4.041	0.140	28.9	0.000	5.00	0.600	o	150
	S1.001	19.775	0.160	123.6	0.000	0.00	0.600	o	300
	S4.000	7.144	0.100	71.4	0.009	5.00	0.600	o	150
*	S5.000	5.432	0.180	30.2	0.004	5.00	0.600	o	150
	S6.000	1.746	0.005	349.2	0.000	5.00	0.600	o	100
	S6.001	2.511	0.006	418.5	0.000	0.00	0.600	o	100
	S4.001	3.753	4.840	0.8	0.000	5.00	0.600	o	150
*	S7.000	4.019	4.710	0.9	0.000	5.00	0.600	o	150
*	S1.002	36.721	0.300	122.4	0.000	0.00	0.600	o	300
*	S8.000	3.798	4.690	0.8	0.000	5.00	0.600	o	150

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
	S1.000	1	37.470	32.470	4.700	37.220	32.230	4.690		1200
	S2.000	2	37.220	32.220	4.850	37.220	32.120	4.950		1
	S3.000	3	37.220	32.220	4.850	37.220	32.080	4.990		1
	S1.001	2	37.220	32.220	4.700	37.060	32.060	4.700		1
	S4.000	5	37.220	37.000	0.070	37.220	36.900	0.170		1
*	S5.000	6	37.320	37.080	0.090	37.220	36.900	0.170		1
	S6.000	7	37.220	36.911	0.209	37.220	36.906	0.214		1
	S6.001	8	37.220	36.906	0.214	37.220	36.900	0.220	Orifice	1
	S4.001	5	37.220	36.900	0.170	37.060	32.060	4.850	Weir	1 x 1000
*	S7.000	13	36.920	36.770	0.000	37.060	32.060	4.850		1
*	S1.002	3	37.060	32.060	4.700	36.760	31.760	4.700		1
*	S8.000	11	36.600	36.450	0.000	36.760	31.760	4.850		1

©1982-2011 Micro Drainage Ltd

Existing Network Details for Storm

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	S9.000	3.765	4.690	0.8	0.000	5.00	0.600	o	150
*	S1.003	3.434	0.020	171.7	0.000	0.00	0.600	o	300

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	S9.000	12	36.600	36.450	0.000	36.760	31.760	4.850		1
*	S1.003	4	36.760	31.760	4.700	36.740	31.740	4.700		1

©1982-2011 Micro Drainage Ltd

Online Controls for Storm

Orifice Manhole: S8, DS/PN: S6.001, Volume (m³): 0.0

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 36.906

Weir Manhole: S5, DS/PN: S4.001, Volume (m³): 0.2

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 37.000

©1982-2011 Micro Drainage Ltd

Storage Structures for Storm

Cellular Storage Manhole: S8, DS/PN: S6.001

Invert Level (m) 36.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.01000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	11.6	11.6	0.151	0.0	15.0
0.150	11.6	15.0			

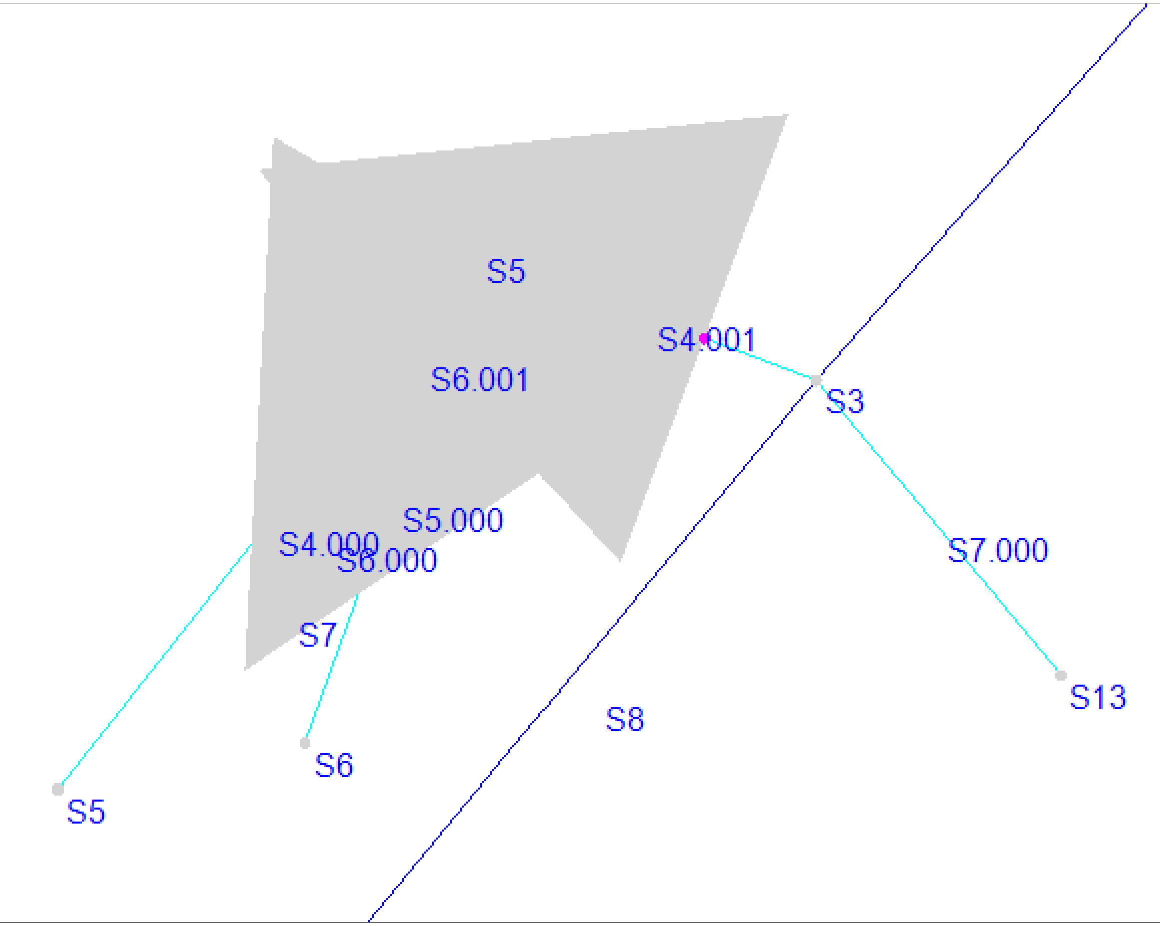
Tank or Pond Manhole: S5, DS/PN: S4.001

Invert Level (m) 36.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	11.6	0.113	11.6

©1982-2011 Micro Drainage Ltd

URS Infrastructure & Environment UK Ltd		Page 1
Scott House Alencon Link Basingstoke RG21 7PP		
Date 08/03/2013 09:39 File SW_F_Med_Infiltration_75%_TEST...	Designed by 34299mc Checked by	
Micro Drainage	Network W.12.6	



©1982-2011 Micro Drainage Ltd

APPENDIX D – LAMBETH RAIN GARDEN PREDICTOR TOOL

Predictor Tool example, based on the Chatsworth Way Rain Garden. The URS Lambeth Rain Garden Predictor Tool v2.0 (47062094 - URS Lambeth Rain Garden Predictor Tool_v2.0.xls) has been provided electronically alongside this report.

URS

Lambeth Council — Rain Garden Predictor Tool **PLEASE SEE NOTES TAB**

Spreadsheet version 2.0

Only valid for use within the Ardlui Road / Chatsworth Way area of the London Borough of Lambeth (should not be used to inform detailed design)

Rain Garden total impermeable catchment area (m²) 130 | surface storage volume (m³) 1.34 | cellular storage volume (m³) 1.74 | average infiltration (litres / hour) 72

Selected depth (mm) 26.49 | Volume of runoff (m³) 3.4437 | Volume of discharge to sewer (m³) 0

elected duration (hr) 5.25 | 'olume of infiltration during event (m³) 0.378 | Drain down time after event (hours) 42.6

Duration hours	Duration minutes	0.08 year rainfal 1 month	0.17 year rainf 2 months	0.25 year rainf 3 months	0.33 year rainf 4 months	0.42 year rainf 5 months	0.5 year rainf 6 months	0.58 year rainf 7 months	0.67 year rainf 8 months	0.75 year rainf 9 months	0.83 year rainf 10 months	0.92 year rainf 11 months	1 year rainf 12 months	1.5 year rainf 18 months	2 year rainf 2 years	5 year rainf 5years	10 year rainf 10 years	20 year rainf 20 years	50 year rainf 50 years	100 year rainf 100 years	200 year rainf 200 years	500 year rainfall 500 years
0.25	15	3.46	4.39	5.04	5.56	6	6.39	6.73	7.04	7.33	7.6	7.85	8.09	9.29	10.24	14	17.73	22.45	30.69	38.87	49.23	67.27
0.5	30	4.52	5.68	6.47	7.1	7.64	8.1	8.52	8.9	9.25	9.57	9.87	10.15	11.58	12.72	17.13	21.45	26.87	36.19	45.33	56.79	76.48
0.75	45	5.29	6.59	7.49	8.2	8.8	9.32	9.78	10.2	10.59	10.95	11.28	11.6	13.18	14.43	19.27	23.98	29.85	39.86	49.61	61.74	82.44
1	60	5.91	7.33	8.3	9.07	9.73	10.29	10.79	11.24	11.66	12.04	12.41	12.74	14.44	15.79	20.95	25.96	32.16	42.68	52.88	65.51	86.95
1.25	75	6.44	7.96	9	9.82	10.51	11.11	11.64	12.12	12.56	12.97	13.35	13.71	15.51	16.93	22.36	27.6	34.07	45.01	55.57	68.59	90.61
1.5	90	6.9	8.51	9.61	10.47	11.2	11.83	12.38	12.89	13.35	13.78	14.18	14.56	16.44	17.92	23.58	29.02	35.72	47.01	57.86	71.22	93.72
1.75	105	7.33	9.01	10.16	11.06	11.82	12.47	13.05	13.58	14.06	14.5	14.92	15.31	17.26	18.8	24.66	30.28	37.18	48.77	59.88	73.52	96.44
2	120	7.71	9.47	10.66	11.59	12.38	13.06	13.66	14.21	14.7	15.16	15.6	16	18.01	19.6	25.64	31.41	38.49	50.34	61.68	75.57	98.85
2.25	135	8.07	9.89	11.12	12.08	12.9	13.6	14.22	14.78	15.29	15.77	16.21	16.63	18.7	20.33	26.53	32.44	39.68	51.77	63.31	77.43	101.03
2.5	150	8.41	10.28	11.55	12.54	13.38	14.1	14.73	15.32	15.84	16.33	16.79	17.21	19.34	21.01	27.36	33.4	40.78	53.09	64.81	79.13	103.02
2.75	165	8.72	10.65	11.95	12.97	13.83	14.57	15.22	15.82	16.36	16.85	17.32	17.76	19.94	21.65	28.13	34.29	41.8	54.3	66.2	80.7	104.85
3	180	9.02	11	12.33	13.37	14.26	15.01	15.68	16.29	16.84	17.35	17.83	18.27	20.5	22.24	28.85	35.12	42.75	55.44	67.49	82.16	106.55
3.25	195	9.3	11.33	12.69	13.76	14.66	15.43	16.11	16.73	17.3	17.82	18.3	18.76	21.03	22.81	29.53	35.9	43.64	56.51	68.7	83.53	108.14
3.5	210	9.57	11.64	13.03	14.12	15.04	15.83	16.52	17.16	17.73	18.26	18.76	19.22	21.53	23.34	30.17	36.64	44.49	57.51	69.84	84.81	109.63
3.75	225	9.83	11.94	13.36	14.47	15.41	16.21	16.92	17.56	18.14	18.68	19.19	19.66	22.01	23.85	30.78	37.34	45.29	58.46	70.92	86.03	111.04
4	240	10.07	12.23	13.67	14.81	15.76	16.57	17.29	17.95	18.54	19.09	19.6	20.08	22.47	24.33	31.37	38.01	46.06	59.37	71.94	87.18	112.38
4.25	255	10.31	12.5	13.98	15.13	16.09	16.92	17.65	18.32	18.92	19.48	20	20.48	22.91	24.8	31.92	38.65	46.79	60.23	72.92	88.27	113.65
4.5	270	10.54	12.77	14.27	15.43	16.42	17.26	18	18.68	19.29	19.85	20.38	20.87	23.33	25.24	32.46	39.26	47.48	61.06	73.85	89.32	114.85
4.75	285	10.76	13.03	14.55	15.73	16.73	17.58	18.33	19.02	19.64	20.21	20.75	21.24	23.73	25.67	32.97	39.85	48.15	61.85	74.74	90.32	116.01
5	300	10.98	13.28	14.82	16.02	17.03	17.89	18.66	19.35	19.98	20.56	21.1	21.6	24.12	26.09	33.47	40.41	48.8	62.61	75.6	91.28	117.12
5.25	315	11.19	13.52	15.08	16.3	17.32	18.2	18.97	19.67	20.31	20.89	21.44	21.95	24.5	26.49	33.95	40.96	49.42	63.34	76.42	92.2	118.18
5.5	330	11.39	13.75	15.34	16.57	17.6	18.49	19.27	19.98	20.63	21.22	21.78	22.29	24.87	26.87	34.41	41.49	50.02	64.04	77.21	93.09	119.2
5.75	345	11.59	13.98	15.58	16.83	17.88	18.77	19.56	20.29	20.93	21.53	22.1	22.62	25.22	27.25	34.86	42	50.6	64.73	77.98	93.95	120.18
6	360	11.78	14.2	15.82	17.09	18.15	19.05	19.85	20.58	21.24	21.84	22.41	22.94	25.57	27.61	35.29	42.49	51.16	65.39	78.72	94.78	121.13
6.25	375	11.96	14.42	16.06	17.33	18.41	19.32	20.13	20.86	21.53	22.14	22.71	23.24	25.9	27.97	35.71	42.97	51.7	66.02	79.44	95.58	122.05
6.5	390	12.15	14.63	16.29	17.58	18.66	19.58	20.4	21.14	21.81	22.43	23.01	23.55	26.23	28.31	36.12	43.44	52.23	66.64	80.13	96.35	122.94
6.75	405	12.32	14.83	16.51	17.81	18.91	19.84	20.66	21.41	22.09	22.71	23.3	23.84	26.54	28.65	36.52	43.89	52.74	67.24	80.81	97.11	123.8
7	420	12.5	15.03	16.73	18.04	19.15	20.09	20.92	21.68	22.36	22.99	23.58	24.13	26.85	28.97	36.91	44.33	53.24	67.83	81.46	97.84	124.64
7.25	435	12.67	15.23	16.94	18.27	19.38	20.33	21.17	21.94	22.62	23.26	23.85	24.4	27.16	29.29	37.29	44.76	53.73	68.4	82.1	98.55	125.45
7.5	450	12.83	15.42	17.15	18.49	19.61	20.57	21.42	22.19	22.88	23.52	24.12	24.68	27.45	29.61	37.66	45.18	54.2	68.95	82.72	99.24	126.24
7.75	465	13	15.61	17.35	18.7	19.84	20.8	21.66	22.43	23.13	23.78	24.38	24.94	27.74	29.91	38.02	45.59	54.67	69.49	83.33	99.91	127.01
8	480	13.16	15.79	17.55	18.91	20.06	21.03	21.89	22.68	23.38	24.03	24.64	25.21	28.02	30.21	38.37	45.99	55.12	70.02	83.91	100.57	127.76
8.25	495	13.31	15.97	17.74	19.12	20.27	21.26	22.12	22.91	23.62	24.28	24.89	25.46	28.3	30.5	38.72	46.38	55.56	70.53	84.49	101.21	128.49
8.5	510	13.47	16.15	17.94	19.32	20.49	21.47	22.35	23.14	23.86	24.52	25.14	25.71	28.57	30.78	39.06	46.76	55.99	71.04	85.05	101.83	129.2
8.75	525	13.62	16.33	18.12	19.52	20.69	21.69	22.57	23.37	24.09	24.76	25.38	25.96	28.83	31.06	39.39	47.14	56.41	71.53	85.6	102.44	129.9
9	540	13.77	16.5	18.31	19.72	20.9	21.9	22.79	23.59	24.32	24.99	25.62	26.2	29.09	31.34	39.71	47.5	56.83	72.01	86.14	103.04	130.57
9.25	555	13.91	16.66	18.49	19.91	21.1	22.11	23	23.81	24.54	25.22	25.85	26.43	29.35	31.61	40.03	47.86	57.23	72.48	86.66	103.62	131.24
9.5	570	14.06	16.83	18.67	20.1	21.29	22.31	23.21	24.03	24.76	25.44	26.08	26.67	29.6	31.87	40.34	48.22	57.63	72.94	87.18	104.19	131.89
9.75	585	14.2	16.99	18.84	20.28	21.49	22.51	23.42	24.24	24.98	25.66	26.3	26.9	29.84	32.13	40.65	48.56	58.02	73.4	87.68	104.75	132.52
10	600	14.34	17.15	19.02	20.46	21.68	22.71	23.62	24.45	25.19	25.88	26.52	27.12	30.09	32.39	40.95	48.9	58.4	73.84	88.18	105.3	133.15
10.25	615	14.48	17.31	19.19	20.64	21.87	22.9	23.82	24.65	25.4	26.09	26.74	27.34	30.32	32.64	41.24	49.23	58.77	74.27	88.66	105.84	133.75

DISCLAIMER | README NOTES | PREDICTOR TOOL | DDF Graph

ady