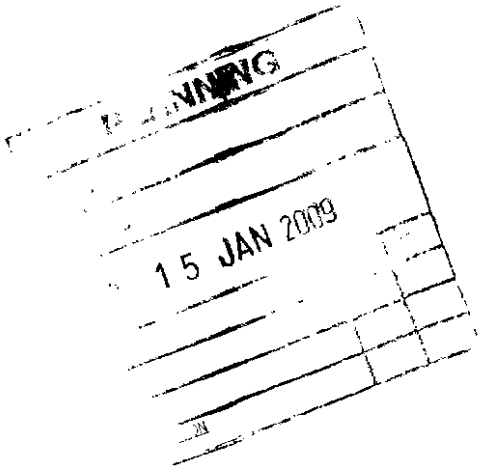

Southside Regeneration Ltd

First Street FRA

Flood Risk Assessment Report

Southside Regeneration Ltd

First Street FRA

Flood Risk Assessment Report

First Street North - Remediation and Utilities Installation

August 2008

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is underteken to any third party

Job number 122007

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Environment Agency Correspondence

Executive Summary

Note: The development site was previously called Central Spine and this was changed to First Street in April 2008.

In December 2006, Arup was commissioned by Southside Regeneration Ltd to undertake a Flood Risk Assessment for the development of a Multi-storey car park on the First Street Site in central Manchester (NGR SJ837974). This report is an update of this initial Flood Risk Assessment (FRA) as the plans for the site have since changed and the multi-storey car park will not be constructed at this time. This FRA is to accompany a planning application for the remediation of the First Street North site and the installation of services and drainage within this site.

Detailed hydrological and hydraulic calculations have been carried out as part of this FRA using FEH methods and ISIS software respectively. These have determined peak flood levels in and around the site for the '1:100 year' (1% annual probability) and '1:100 year with Climate Change' cases.

A new surface water drainage network is proposed for the site which will discharge into the River Medlock Culvert, similar to the existing system but via new outfalls. This will limit the peak flow discharged in the Medlock by attenuation to a value at or below the existing situation for return periods up to and including the 1:100 year return period, including an allowance for climate change. Therefore, the development should provide no increase in the peak River Medlock flows due to the discharge of surface water flows from the site.

The study is intended to identify the extent to which the site is likely to be affected by flooding, whether the surrounding areas would be put at greater risk as a result of the proposed development, and whether further, more detailed, studies are required.

The FRA has been conducted in accordance with the following guidance and legislation:

- Planning Policy Statement 25: Development and Flood Risk, December 2006, and its accompanying Living Draft Practice Guide
- CIRIA C624: Development and Flood Risk – guidance for the construction industry, 2004.

The study has shown that site is not within Flood Zone 3 as the '1:100 year plus Climate Change' flood level of 30.03m AOD is approximately 370mm below the lowest site ground level of 30.4m AOD. A summary of the study findings is tabled below.

	Upstream of Site - East (mAOD)	**Downstream of Site - West (mAOD)**
1:100 yr	29.77	29.27
1:100yr + Climate Change	30.03	29.42
1:100yr + Climate Change + 300mm	30.33	29.72
Typical ground levels	Varies 30.40 to 33.73	-
Proposed Final Levels	Varies 30.88 to 33.64	-

A draft of the FRA along with the supporting hydraulic (ISIS) models has been submitted to the Environment Agency who subsequently accepted a finished floor level of 30.35m AOD for proposed buildings at the development (**Appendix C** - Email dated 21 September 2007).

1 Development description and location

1.1 Location

The site is located approximately 1km to the south of Manchester City Centre, as shown in **Figure 1**, centred at NGR SJ837974.

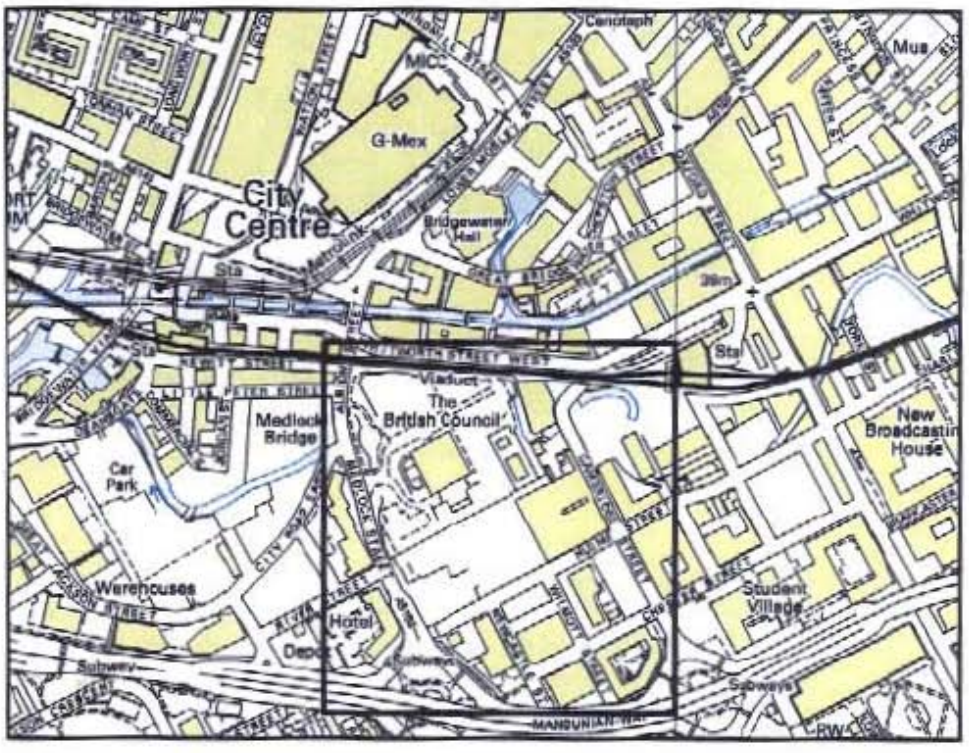


Figure 1 – Site Location Plan extracted from Ordnance Survey map of Manchester

The site occupies an area of 9.2 hectares and is bounded to the north by a railway viaduct between Oxford Road and Deansgate stations and to the east by Great Marlborough Street, Hulme Street and the southern half of Cambridge Street. The A57(M) or Mancunian Way and Medlock Street form the southern and western boundaries of the site.

The technical appraisal of flood risk at the site has been undertaken for the site as a whole however this report accompanies the planning application for the First Street North site only. Report sections relating to the development are specific to the Remediation and Utilities Installation works only as the site is being developed in distinct phases which are still being progressed.

An aerial photograph is shown in **Figure 2**.



Figure 2 – Aerial photograph showing First Street site and the extents of First Street North area

1.2 Existing Site Description

Due to the renovation of the existing office building, located within the remediation area, the site is currently a construction site. The site was previously a brownfield site and the northern part of the site lies within the former Gaythorn Gasworks. The existing building is part of the Grand Island Phase 1 development and was most recently occupied by BT. Previous land use on the site comprises car parking run by NCP and Europarks around Hulme Street and to the south and east of the Grand Island development. There is also grassed open space to the north of the site.

In the southern area of the site, derelict buildings and warehouses are present and previous occupiers of buildings include light industrial and commercial properties. A Salvation Army Hostel and a gas pressure reduction station are also present on the eastern boundary.

The First Street North site was predominantly car parking and open space. The River Medlock bisects the site in a westerly direction flowing in a culvert through the northern section, previously occupied by the Gaythorn Gasworks and in open channel to the east and west of the site. The Medlock is culverted along its entire 240m length within the site. Existing ground levels on the site vary between 30.4mAOD and 35mAOD.

The Rochdale Canal runs in a westerly direction approximately 50m to the north of the site but is not hydraulically linked.

1.3 Existing flood defences and site drainage

The Environment Agency's (EA) Flood Zone Map shows the site is located within Flood Zone 3 (**Figure 3**), due to its proximity to the River Medlock which is culverted through the centre of the site. It is defined as having a high probability of river flooding with annual probability of greater than 1% (also termed 1:100 year return period). However, consultation with the EA has confirmed that the flood map for this location is not well defined and should be considered as approximate as it was developed using the 'JFlow' approach and has not been recently updated.

The study has determined that the site is not within Flood Zone 3 and would not flood in either a '1:100' or '1:100 with climate change' event (refer to **Section 3**).



Figure 3 – Environment Agency Flood Map Extract (dated September 2005)

There are no formal flood defences which protect the site from flooding.

A number of discharge consents for the discharge of storm water overflow, sewerage discharge and surface water to the Rivers Medlock and Tib are recorded in the vicinity of the site. Several historical discharge consents for the discharge of storm sewage overflow in the Medlock are also recorded [4]. The River Tib is no longer present, having being grouted up during the site preparation works for the present day 'Grand Island' development. It is presumed that the storm sewage overflow, sewerage and surface water discharge to the Tib have been diverted to the culverted Medlock [5].

1.4 Planning context (Sequential test)

The risk based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding (Zone 1) – PPS 25 Annex D.

However, there is not a Strategic Flood Risk Assessment (SFRA) currently available for Manchester and it has not been possible to demonstrate that the test has been applied by reference to it.

The proposed development is entirely outside of Flood Zone 3 (as defined in this study) and will not increase the level of flood risk for adjacent sites (either upstream or downstream). It is considered that the Sequential Test has been adequately demonstrated in the site selection.

It is envisaged that this site will be developed as a city centre mixed use development with car parking. It is therefore likely that it would be considered as 'More Vulnerable' or 'Less Vulnerable' development. Such development is acceptable in Flood Zone 2 (see **Table D2**), but subject to the sequential test having been applied first by the LPA. It is likely that all other city centre locations at lower risk of flooding will be already allocated for land use types that are just as, or more, vulnerable to flood impacts.

The current planning application is for the remediation of the site and utilities installation. On completion the site will be left as open space.

Table D.3[22]: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

Table D2 extracted from PPS25

1.4.1 Exception Test

The Exception Test is not required for the proposed development.

1.5 Consultation

A number of external organisations were consulted as listed below:

Organisation	Contact	Purpose	Comment
United Utilities	Brian Morrow	Query on records of sewer flooding in and around the First Street area.	There are no Areas recorded on their DG5 "At Risk" register within the site.
Environment Agency	Sandrine Thomas	A background to the First Street site and flood risk assessment was described and specific data requested.	It was explained that only limited data on 1:100 year river levels and flows, culvert surveys and LIDAR data was available. It was advised data requests should be obtained from the External Relations team although some data would require a fee. This data was obtained as part of the study.

Environment Agency	Sandrine Thomas	Query on River Medlock and Bridgewater Canal interface. Specifically information and engineering plans of the "shaft taking River Medlock underneath Castlefield Canal Basin"	Information on the interaction obtained. See **Section 2.5**. The EA were unaware of any specific plans detailing the Knott Mill Tunnel.
Environment Agency	Paul Eves	The 15 minute stage and flow data for the London Road gauge on the River Medlock was requested for the period 17/01/2007 - 22/01/2007 based on information received from the Manchester Ship Canal Company.	Data was received to enable estimate of Knott Mill Tunnel capacity to be obtained.
Environment Agency	External Relations Departme nt	Information on historic flooding and any background survey or site data requested.	The EA reported they have no records of the site flooding. Cross sectional information for the Medlock surveyed in 1993 was supplied. Culvert inspection report for the Macintosh Mills Culvert was obtained
Environment Agency	Sandrine Thomas, Sylvia Heron, Colin Liptrot	Meeting with Arup, The EA, BDP (Car park Architect) and Fraser Blair Associates (representing Southside Regeneration Ltd) held on 8 Feb 2007 to discuss flood risk at site and FRA methodology proposed.	Methods being applied as part of this FRA study were agreed in principle subject to submission of report to EA for review.
Environment Agency	Sandrine Thomas	Request for confirmation of the Finished Floor Level at the First Street site.	Confirmation received that the EA accept a Finished Floor Level at the First Street site of 30.35mAOD (**Appendix C**).
Environment Agency	Sandrine Thomas	Submission of Microdrainage model for existing and draft version of proposed drainage.	No queries raised. Acceptance that increase in run off coefficient is equivalent to increase in peak rainfall intensity (**Appendix C**).

Environment Agency	Mark Rees	Land Drainage Consent Application for the construction of two new surface water outfalls to the River Medlock culvert.	Application approved. EA reference E/554/MEDL/13053/ST Dated 1st Feb 2008.
British Waterways	John Ackroyd	Query on River Medlock and Bridgewater Canal interface.	It was advised that British Waterways do not operate the Bridgewater Canal although they do operate the Rochdale Canal down to Lock 92 where their responsibility ends.
Manchester Ship Canal Company	Alan Hodkinson	Query on River Medlock and Bridgewater Canal interface.	Information on the interaction obtained. See **Section 2.5.**
Manchester City Council – Manchester Engineering Design Consultancy (MEDC)	Mike Kelly	Query on any known flooding problems in the vicinity or any specific maintenance liabilities resulting from highway drainage or culvert blockages of the Medlock Culvert.	It was advised that no detailed records were kept, however he described he had been specifically involved with the First Street site for the last 3 years and that no problems had been encountered. Furthermore it was noted that gullies in the area were routinely cleaned twice a year.
Manchester City Council Library	N/A	A search for evidence of flooding in and around the site area from the 1950's onwards. Further investigation into the River Medlock and Bridgewater Canal interface.	A search of the Library flooding database and microfiche did not identify any flood history at the site. However "The Lost Rivers of Manchester" by Geoffrey Ashworth (currently out of publication) enabled the tributary rivers of the River Tib and Shooters Brook to the River Medlock to be identified.
World Wide Web	N/A	A search for evidence of flooding in and around the site area from the 1950's onwards. Further investigation into the River Medlock and Bridgewater Canal interface.	No records of historical flooding were available. Confirmation of the River Medlock and Bridgewater Canal interface was confirmed. See **Section 2.5.**

Table 1.1 – Consultation register

2 Definition of Flood Hazard

2.1 Sources of flooding

Fluvial flooding is considered as the only potential source of flooding at the site. Flooding from coastal, drainage, overland flow, infrastructure failure and groundwater sources were considered but discounted during early phases of the study following consultation and library searches which showed no evidence of these other flooding mechanisms.

2.2 Review of historical flood records

During the consultation process, evidence of historical flooding was sought but no records of flooding at the site were found.

During consultation with the EA, it was noted that a flood event occurred in the Castlefield area in 1991; however no record of such an event were available. The EA noted they have no records of flooding at the First Street Site.

2.3 Recorded flows at London Road gauging station

The EA operate 2 river gauging stations on the Medlock which record river flows on a 15-minute basis. These are located at New Viaduct Street (NGR SJ863 987) and London Road (NGR SJ849 975 – approximately 1km upstream of the site).

2.4 Site walkover, river and culvert surveys / topographical survey

A river survey was commissioned as part of this study to enable the River Medlock to be modelled adjacent to the site and the 1 in 100 year (1% chance of occurrence in any 1 year) flood level to be estimated at the site. 23 cross sections through the river and floodplain were surveyed, extending from the Charles Street Bridge (upstream of the site) down to the terminus of the River Medlock with the Bridgewater Canal, on the canal basin side (downstream of the site), a total distance of approximately 1.5km. This included three bridges over the River Medlock, two locations of abandoned structures (weir/flood-gate), sections at culvert faces and five locations of spot height runs to pick up ground/street levels adjacent to the river. Spot levels along the top of both banks were taken along the reach length. This information was used in conjunction with the existing site topographical survey, the site underground culvert survey and the EA cross section survey to construct the hydraulic model (see **Section 3.2**).

A walkover of the site was conducted on the 6th December 2006 to scope the survey described above and to investigate the River Medlock and Bridgewater Canal interface. (See **Section 2.5** for details.)

A topographic survey was also undertaken for the development of the site (See **Figure 4**).

2.5 River Medlock under flood conditions

The River Medlock is approximately 10 miles long and rises in the hills surrounding Oldham before flowing through Ashton-under-Lyne, the suburbs of east Manchester past the City of Manchester Stadium before flowing through Manchester City Centre where it enters the River Irwell. In general, it flows in an east to west direction. The river has been extensively modified in its downstream reach over the years, passing beneath Manchester in a series of culverts before it meets the Bridgewater Canal at Deansgate (Old Chester Road).

At this point, the River and Canal do not converge. The River Medlock drops down a shaft known as the Knott Mill Tunnel, passes in culvert beneath the Castlefield Canal Basin and re-emerges at a lower level on the other side of the Canal Basin from a culvert arch at Potato Wharf . The Medlock then flows in open channel until it joins the River Irwell at Hulme Lock. Historically, the energy generated form the Medlock's waters dropping down

the Knott Mill Tunnel powered an endless rope which lifted coal containers from canal barges to the road level at Castlefield.

At Potato Wharf, there is a separate culvert arch and overflow weir at Giant's Basin. This controls water levels within the Bridgewater Canal and prevents the Canal from overtopping. Here a circular weir drains excess canal water from the Bridgewater Canal with an approximate drop of 4m before flowing into the River Medlock. The original weir constructed in 1770 was of a cloverleaf shape which optimised the hydraulic capacity, as the volume of water which an overflow weir can handle depends upon its length. Using the clover-leaf shape maximized the length of the overflow, but kept the area it occupied to a minimum, however this was replaced for the standard circular weir there today.

The catchment for the River Medlock is steep and as a result the Medlock is a flashy river resulting in quick changes in water level following periods of heavy rainfall. The Knott Mill Tunnel takes all the River Medlock flow under normal conditions. However, after heavy rainfall, the Medlock flows become too great for the capacity of the tunnel which becomes surcharged. The Medlock then begins to back up, raising the water level up to the level of the Bridgewater Canal headwall. Water builds up approximately 1.5m, to a height of 25.4mAOD, overflowing the headwall of the Bridgewater Canal. Flood waters then take the path of the original line of the Medlock for approximately 300m through the Bridgewater Canal towards the Giants Basin and exits via the circular weir back into the River Medlock. (**Photograph 1**)

Consultation with The Manchester Ship Canal Company highlighted that the Bridgewater Canal is all one pound, 60km long and has a normal water level of 25.26mAOD. During extreme rainfall the water level in the Canal fluctuates by ± 75mm, i.e. between a level of 25.185 and 25.335mAOD. The Manchester Ship Canal Company noted the presence a telemetry alarm system which monitors the water level in the Medlock at Knott Mill Tunnel. This alerts their engineering team before the Medlock rises and overflows into the Bridgewater Canal. The alarm is said to trigger 200-300mm before overtopping the headwall into the Canal and this usually gives approximately 30 minutes advance warning before overtopping. Data was provided from the last two alarm occurrences to date:

Date	Time	Occurrence
18/01/2007	6.45am	Alarm raised but the Medlock did not spill into the Bridgewater Canal
21/01/2007	8.50pm	Alarm triggered and shortly after, the Medlock spilled into the Bridgewater Canal

Table 2.1 – Data from Manchester Ship Canal Company's telemetry alarm system

The Manchester Ship Canal Company added that the Knott Mill Tunnel and overflow can take a 1:50 – 1:100 year flow into the Bridgewater Canal before the surrounding streets are flooded but it is believed this is a rough estimate only.

The end of the River Medlock at the Bridgewater Canal junction at Knott Mill Tunnel and the overflow weir at Giants Basin were attributed to the engineer James Brindley and the original pair of culvert arches at Potato Wharf are now Grade II listed structures.

2.6 Surface Water Drainage

First Street North can be divided into two areas by the River Medlock culvert. For the area to the south of the River Medlock culvert, information regarding the existing surface water drainage system was obtained from Building Design Partnership on 02/06/08 (Drawing No. (52)C001 – External Foul and Surface Water Drainage Layout). The existing drainage network for this area is shown in **Figure 4a** and consists of an unattenuated drainage network that discharges to the River Medlock culvert through two outfalls. The upstream

3 Probability

The London Road gauged data of Annual Maximum Flow obtained from the FEH Highflows database was used to calculate a 1:100 year (1% Probability) site flow.

3.1 Hydrological Analysis

3.1.1 Introduction

A hydrological assessment of the River Medlock has been undertaken using methods described within the Flood Estimation Handbook (FEH). The FEH Statistical Method, Rainfall-Runoff Method and Revitalised Rainfall-Runoff Method have been utilised to produce design flow estimates for the River Medlock.

3.1.2 Methodology

A detailed summary of the hydrological analyses undertaken within this study is provided in **Appendix A.** In brief, several flow estimation methods have been employed within this hydrological assessment:

- FEH Statistical Method
- FEH Rainfall-Runoff Method
- Revitalised Flood Hydrograph Method

These methods were used in conjunction with gauged flow data to produce design flow estimates for the River Medlock. The gauged data consisted of an observed QMED (Median annual maximum flood) of 20.2 m^3/s at the London Road gauging station, some 1.5 km upstream of the First Street site. This observed value was adjusted to produce a QMED estimate at the First Street site of 23.7 m^3/s.

3.1.3 Design Flows

The FEH Rainfall Runoff Method (with SPR adjusted to reflect gauged baseflow data), in conjunction with the site QMED estimate of 23.7 m^3/s, was used to produce the design flow estimates shown in **Table 3.1**.

Return Period (years)	Design Flow Estimates Peak Flow (m^3/s)
QMED	**23.7**
5	32.2
10	39.5
25	51.2
50	63.7
100	**79.4**
100 + 20 % increase	**95.3**
200	98.7

Table 3.1 – Design flow estimates.

outfall has a diameter of 375mm and the downstream outfall has a diameter of 300mm both with an invert level of 28.28m AOD. This network has been modelled using MicroDrainage to estimate the peak flow from the site, as discussed in **Section 3.3**.

There is little information regarding the existing drainage network for the area to the north of the River Medlock culvert and an existing drainage survey would be required as part of the development of a drainage strategy for this area. This area is a mix of hard standing and grass and there is no evidence of any drainage infrastructure that would provide any form of flow attenuation to surface water that is discharged off site via either an overland route or into the existing Medlock culvert.

3.2 Hydraulic Modelling

3.2.1 Method

A 1-dimensional hydraulic model of the River Medlock from Charles Street to the Bridgewater Canal was constructed as part of this study using the ISIS software. The model was constructed using surveyed river sections taken as part of this study, spot levels taken along top of banks and using existing EA survey as discussed in **Section 2.4**.

The completed model consists of 30 river sections and all major structures including:-

- Bridges at Oxford road, Cambridge Street and Medlock Street using 2007 cross section survey information and EA survey
- Culvert through the First Street site from line and level survey (Survey Systems 2006)
- Culvert at McIntosh Mills/Foundary Mill using EA inspection survey long section and 2007 cross section survey at upstream and downstream faces
- Abandoned weir structure downstream of Cambridge Street
- Culverts beneath Deansgate and intersection structure at Medlock/Bridgewater Canal beneath Deansgate
- Out of bank area at Peter Street NCP car park using 2007 survey information
- Simplified representation of Bridgewater Canal immediately downstream of Deansgate Culverts

A model cross section location plan is shown in **Figures 5a** and **5b**.

The '100 year' and '100 yr +20% flow' design hydrographs generated using FEH (**Section 3.1**) were run through the model to generate peak water levels at each cross section.

The model is un-calibrated as no existing flood level or extent data is available for comparison.

Parameter	Value
Overall length of model	~1700m
No of river x-sections	30
No of bridges	3
No. of culverts	3
Manning's Roughness: In-bank	0.025
Manning's Roughness: Culverts	0.020 (0.025 at MacIntosh Mills)
Run scenarios	'1:100 year' hydrograph generated from FEH '1:100 + 20 % increase flow' hydrograph generated from FEH

Table 3.2 - Key base model criteria

3.2.2 Hydraulic modelling results

Using the data and method outlined above (**Section 3.2.1**), a hydraulic model has been constructed representing the River Medlock through the larger First Street site area. A model schematic is shown in **Figure 6**.

Detailed modelling results for all cross-sections are shown in **Appendix B**. Predicted maximum water levels in the immediate site vicinity are provided in **Table 3.3** and illustrated

in **Figure 7**. These levels are predicted levels based on the existing condition (February 2007).

Location	Cross-Section	Flood Levels (m AOD)	
		1% (1:100 yr)	1% (1:100 yr) + 20% Climate Change
Open channel downstream of Cambridge St bridge	MED745	29.77	30.04
	MED725	29.83	30.08
Open channel immediately upstream of site	MED703	29.77	30.03
	MED664	29.72	29.98
Culvert sections u/s of BT building	MED652	29.63	29.86
	MED624	29.61	29.84
	MED585	29.51	29.70
Culvert sections in front of BT building	MED552	29.50	29.69
	MED524	29.48	29.68
Culvert sections d/s of BT building	MED493	29.43	29.61
	MED454	29.45	29.63
	MED443	29.41	29.59
D/S Medlock Bridge	MED421	29.27	29.42

Table 3.3 – Predicted maximum water levels in the First Street site vicinity

3.2.3 Model sensitivity

The model was tested to determine its sensitivity against several scenarios in order to give confidence in the predicted flood levels. These included:-

- Changes to Manning's roughness (n): Increase and decrease in culvert and x-section values
- Increase and decrease in Bridgewater Canal levels (downstream model boundary) of ±300mm
- Complete blockage of the Knott Mill Tunnel at Deansgate

For each of these scenarios, the water levels through the site were compared against the base model results and variations noted. The analysis showed that for the 1:100 year flow case, the model results at site were not sensitive and variations were typically low, between +140 mm and -50 mm. Detailed results are shown in **Appendix B**.

3.2.4 Extent of flood risk at site

The predicted maximum flood levels shown in **Table 3.3** have been used to produce **Figure 7** and **Figure 8** (Existing condition Flood Levels through Site and a 2007 Flood Extent Plan respectively).

Ground levels at the site vary from 30.40 to ~33.7mAOD. The lowest bank level adjacent to the site is 30.25m AOD (located just upstream of the site culvert entrance on the eastern edge of the site). This would need to be exceeded before any flood water would enter site.

The modelled peak '1:100 year' (1% annual exceedance probability) flood level ranges from 29.77mAOD just upstream of the site to 29.27mAOD just downstream of the site, approximately 480mm below top of bank level and 630mm below lowest site ground level.

Similarly, the modelled peak '1:100 year + climate change' flood level ranges from 30.03mAOD to 29.42mAOD upstream and downstream of the site, approximately 220mm below top of bank level and 370mm below lowest site ground level.

These show the ground levels at site are above the predicted flood levels for both '1:100yr' and '1:100yr with Climate Change'.

A hydraulic long section showing peak water levels is given in **Figure 9**.

Figure 8 shows the First Street site is outside the predicted extent of the 1:100 year return period flood, and therefore not within Flood Zone 3. It shows the land between the eastern boundary of the site and Cambridge Street to be within the predicted 1:100 year return period flood extent. This area of land is approximately 1 to 1.5 m lower than the eastern boundary of the site and so flood water will not be able to flow in a westerly direction onto the First Street site.

Table 3.4 below summarises site and flood levels.

	Upstream of Site - East (mAOD)	**Downstream of Site - West (mAOD)**
1:100 yr	29.77	29.27
1:100yr + Climate Change	30.03	29.42
1:100yr + Climate Change + 300mm	30.33	29.72
Typical ground levels	Varies 30.40 to 33.73	-
Proposed Final Levels	Varies 30.88 to 33.64	-

Table 3.4 – Summary of site and flood levels

3.2.5 Flood depths and velocities

As discussed above, the study has shown the site does not flood under either '1:100 year' or '1:100 year with climate change' conditions.

3.3 Existing Runoff

The existing drainage network, as shown in **Figure 4a**, has been modelled using Microdrainage software. The peak flows discharged into the Medlock Culvert calculated using the model are shown in **Table 3.5**. These flows are for a 15 minute winter storm. The existing drainage model was sent to the Environment Agency (Sandrine Thomas) and a Drainage Calculation Summary report was submitted with the Land Drainage Consent application for the construction of two new surface water outfalls, discussed in **Section 6.3**, which has received approval.

Return Period (years)	**Peak flow entering the Medlock Culvert from the existing drainage system (l/s)**
1	187
30	414
100	492

Table 3.5 – Existing Drainage Peak Flows

Note: These calculated flows are given for the First Street North area, south of the Medlock Culvert only and do not include for the area north of the culvert for reasons described in **Section 2.6**.

4 Climate Change

4.1 Predicted increased in Flood Risk resulting from Climate Change

Table 3.3 shows the effect of future climate change (i.e. the increase in 100 year flood level that may occur by 2115) has been determined as up to 270mm. This has been derived by increasing the 1:100 year flow by 20% as per **Table B2** in PPS25.

Table B.2 Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Notes

Table B2 extracted from PPS25

5 Detailed Development Proposals

5.1 Description of proposed development

The current planning application is for the remediation and utilities installation in the First Street North site. **Figure 10** shows the site boundary for remediation and the proposed levels at the completion of remediation. These levels include surface finishes and the levels will temporarily be 300mm below these levels. A subsequent planning application will be submitted for the surface finishes.

To the south of the River Medlock culvert there will be some re-grading works of the levels to form proposed Finished Floor Levels for future buildings. To form the Finished Floor Level of 31.5m to the west of First Street No. 1 there will be some local lowering of ground levels adjacent to Medlock Street, with batters to tie in to the existing Medlock Street levels.

To the north of the River Medlock culvert the levels are mainly unaltered from the existing case. To the west of this area the levels will be locally lowered to form a footway, batters will then be used to tie into the existing levels at the boundary with Medlock Street.

The levels will not be altered in the area adjacent to the open channel section of the River Medlock and all proposed levels are above 30.35m AOD, which is the level previously agreed with the EA as a Finished Floor Level for buildings located on this site (**Appendix C**).

5.2 Impact of flood risk on the development

Modelled 1:100 year return period flood levels along the River Medlock do not reach a level high enough to cause flooding of the First Street site. The site is also not considered at risk from other flooding sources.

The potential impact of flood risk on the proposed development is therefore not considered significant. However, if an extremely significant event occurred (in excess of the '1:100 year + Climate change') or the site was to flood as a result of a complete culvert blockage, this would not impact on the site or utilities installed.

6 Flood Risk Management Measures

6.1 Emergency evacuation during an extreme flood

The study has shown the site does not flood under either '1:100 year' or '1:100 year with climate change' conditions. However, in an emergency, egress from the site would be made in a westerly direction (away from river) and the open nature of the site would allow for safe egress.

6.2 Flood water displacement and floodplain loss/gain

In the existing case scenario, there will be no flooding of the First Street site during the 1:100 year return period flood event. A flood water displacement analysis is therefore not necessary.

6.3 Post Development Runoff

As discussed previously in **Section 2.6**, the First Street North site can be divided into two areas separated by the River Medlock culvert. For the area to the south of the River Medlock culvert, the proposed surface water drainage network is shown in **Figure 9a** and **9b**.

Within the drainage network, two flow control devices are proposed so that the peak flows discharging into the River Medlock culvert are attenuated so that the proposed flows (including an allowance for climate change) do not exceed existing levels. A 10% increase in peak rainfall intensity has been allowed for due to climate change, in accordance with PPS25 for a building design life of 30 years. This increase in peak flow was included by increasing the runoff coefficient by 10%, which was confirmed by the EA as having the same effect as an increase in peak rainfall intensity (**Appendix C**).

Due to the future construction of buildings on this site, the existing outfalls are to be abandoned and new outfalls constructed. Two new outfalls are to be constructed and the invert of these outfalls is proposed at the 1 in 5 year river level (including for a 20% increase in the peak river flow due to climate change), at a level of 28.66 and 28.62 mAOD for outfall S05 and S11 respectively. An application has been submitted to, and approved by, the Environment Agency for the construction of these new outfalls (EA Ref. E/554/MEDL/13053/ST Dated 1st Feb 2008).

The peak drainage discharge flows are shown in **Table 6.1**. These flows are for a 15 minute winter storm.

Return Period (years)	Peak flow entering the Medlock Culvert from the proposed drainage system (l/s)
1	186
30	320
100	384

Table 6.1 – Proposed Drainage Peak Flows

The drainage of the area to the north of the River Medlock culvert has not yet been progressed but the same principles will be applied as for the drainage of the area to the south of the River Medlock culvert, i.e. the proposed flows will be attenuated to a value at or below the existing condition for return periods up to and including the 1:100 year return period, including an allowance for climate change. No hard surfaces are currently being specified for this area and a drainage strategy would be included as part of a further planning application related to the final finishes on the First Street North site.

7 Residual Risks

The only residual risk identified which could lead to site flooding is the blockage of the Medlock Culvert beneath the site which could lead to the site flooding from the east. This was discussed during consultation with the EA who agreed that due to the size of the culvert and lack of obstructions within its length, blockage is unlikely and any flood washed debris is likely to pass through the culvert completely. Providing a trash screen at the entrance to the culvert was discussed but considered to be a maintenance liability and would only increase flood risk at the site if it became blocked.

8 Conclusions

This Flood Risk Assessment has been prepared, in accordance with PPS25, based upon the available flood zone plans available from the EA. Hydraulic modelling and hydraulic analysis have been conducted to determine '1:100 year' and '1:100 year + climate change' peak water levels adjacent to the site and more accurately define Flood Zone 3 adjacent to the site.

EA records indicate that the existing site is located in Flood Zone 3 as defined within PPS25, however the study has determined this is not the case and the '1:100 year with Climate Change' flood level of 30.03m AOD is approximately 370mm below lowest site ground level of 30.4m AOD.

The proposed development involves the remediation of the First Street North site and the installation of services and drainage within the site.

A new surface water drainage network is proposed for the site which will discharge into the River Medlock Culvert, similar to the existing system but via new outfalls. This will limit the peak flow discharged in the Medlock by attenuation to a value at or below the existing condition for return periods up to and including the 1:100 year return period, including an allowance for climate change. Therefore, the development should provide no increase in the peak River Medlock flows due to the discharge of surface water flows from the site.

The development does not impact on existing floodplain storage or flood flow paths.

The development should have no adverse impacts on the flooding characteristics of the River Medlock.

This Flood Risk Assessment is considered sufficient and no further studies are proposed.

9 References

[1] ODPM (2001). Planning Policy Guidance 25: Development and flood risk

[2] Communities and Local Government (2006). Planning Policy Statement 25: Development and flood risk

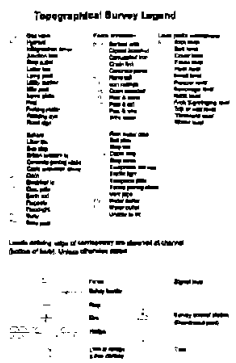
[3] CIRIA (2004). C624 Development and flood risk – guidance for the construction industry

[4] Envirocheck, Reports 72933-1-1 & 75956-1-1, July 2001 & August 2001

[5] Geoffrey Ashworth, The Lost Rivers of Manchester, Willow Publishing, Altrincham, 1987, ISBN 0946361126.

Arup does not accept any liability for the accuracy or otherwise of any information derived from secondary sources within this report, however, reasonable endeavours have been made to verify the information obtained in this way.

FIGURES



Rev Date By Chkd Appd

ARUP

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Client
Southside Regeneration Ltd

Job Title
First Street FRA

Drawing Title
Existing Site Topographical Plan
Recieved from:
Survey Systems Ltd. - Drawing No.
SSL:10111A:200:1:1

Scale at A0 N.T.S

File ID 5301-ARUP-XX-XX-DR-CD-1828-A2D-4188-E314PSZ8XA1

Drawing Status
Information

Job No 122007-00 Drawing No Figure 4 Issue -

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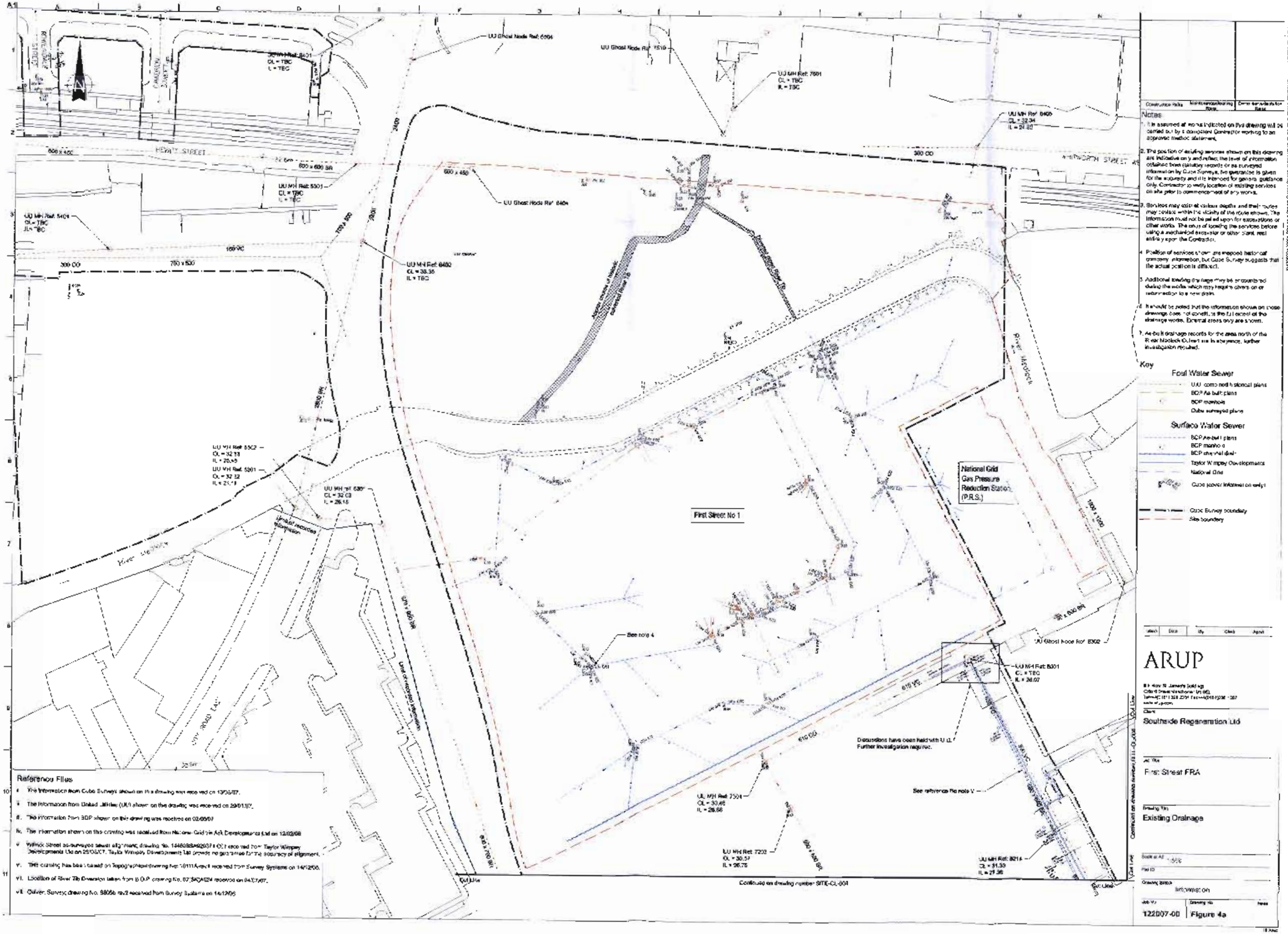
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CL = TBC
IL = TBC
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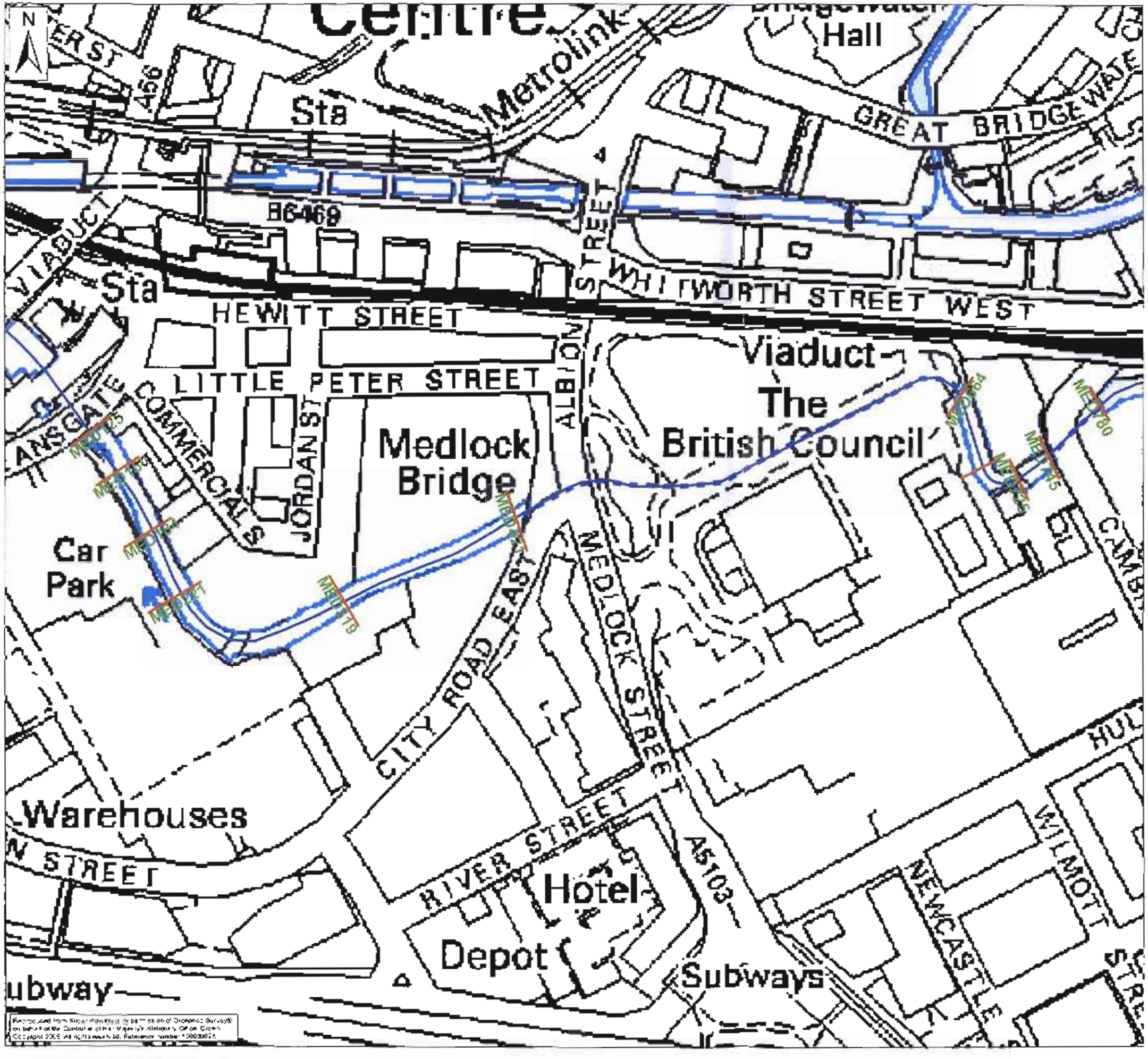
CL = TBC
IL = TBC
UU MH Ref: 8405
CL = 32.34
IL = 24.80
HEWITT STREET
HAYWORTH STREET
600 x 450
600 x 600 BR
UU MH Ref: 5301
CL = TBC
IL = TBC
UU MH Ref: 5401
CL = TBC
IL = TBC
UU Ghost Node Ref: 8404
UU MH Ref: 8402
CL = 38.35
IL = TBC
300 CO
700 x 500
2400
2600 BR
Approx centre of historic Cathedral River St
Historic River St
Approx centre of historic Cathedral River St
UU MH Ref: 8502
CL = 32.33
IL = 25.93
UU MH Ref: 5301
CL = 32.32
IL = 21.19
UU MH Ref: 8501
CL = 32.03
IL = 26.18
Limit of recorded information
River Medlock
First Street No 1
National Grid
Gas Pressure
Reduction Station
(P.R.S.)
1800 x 1200
See note 4
UU Ghost Node Ref: 8502
UU MH Ref: 8301
CL = TBC
IL = 28.07
610 CO
Discussions have been held with U.U. Further investigation required.
See reference file note v
UU MH Ref: 7504
CL = 30.46
IL = 26.66
UU MH Ref: 7203
CL = 30.57
IL = 26.76
UU MH Ref: 8214
CL = 31.59
IL = 27.36
Continues on drawing number SITE-CL-004
Out Line
Out Line
Out Line
Out Line
Reference Files
i. The information from Cube Surveys shown on this drawing was received on 13/06/07.
ii. The information from United Utilities (UU) shown on this drawing was received on 29/01/07.
iii. The information from BDP shown on this drawing was received on 02/05/07
iv. The information shown on this drawing was received from National Grid via Ask Developments Ltd on 12/02/08
v. Wellmok Street as-surveyed sewer alignment, drawing No. 1446/BSAS/2037 II OUT received from Taylor Wimpey Developments Ltd on 25/05/07. Taylor Wimpey Developments Ltd provide no guarantee for the accuracy of alignment.
vi. This drawing has been based on Topographical drawing No 10111A.dwg received from Survey Systems on 14/12/06.
vii. Location of River Tib Diversion taken from B.D.P. drawing No. 07/SK/024 received on 04/07/07.
viii. Cluver Survey drawing No. 98056 rev2 received from Survey Systems on 14/12/06
Construction Notes
Notes
1. It is assumed all works indicated on this drawing will be carried out by a competent Contractor working to an approved method statement.
2. The position of existing services shown on this drawing are indicative only and reflect the level of information obtained from statutory records or as surveyed information by Cube Surveys. No guarantee is given for the accuracy and it is intended for general guidance only. Contractor to verify location of existing services on site prior to commencement of any works.
3. Services may exist at various depths and their routes may deviate within the vicinity of the route shown. The information must not be relied upon for excavations or other works. The onus of locating the services before using a mechanical excavator or other plant rest entirely upon the Contractor.
4. Position of services shown are mapped historical company information, but Cube Survey suggests that the actual position is different.
5. Additional levelling drawings may be encountered during the works which may require drawn on or instruction for a new plan.
6. It should be noted that the information shown on these drawings does not constitute the full extent of the drainage works. External areas only are shown.
7. As-built drainage records for the area north of the River Medlock Culvert are in abeyance, further investigation required.
Key
Foul Water Sewer
UU combined historical plans
BDP As-built plans
BDP manhole
Cube surveyed plans
Surface Water Sewer
BDP As-built plans
BDP manhole
BDP chamber
Taylor Wimpey Developments
National Grid
Cube survey information only
Cube Survey boundary
Site boundary
Issue/Revision
Date
By
Check
Appd
ARUP
Client
Southside Regeneration Ltd
Job Title
First Street FRA
Drawing Title
Existing Drainage
Scale at A1 1:500
File ID
Drawing Status
INFORMATION
Job No
122007-00
Drawing No
Figure 4a
Rev



Legend

- River Medlock
- MED319 Model Cross-Section Location and Label
- River Medlock (Culvert Sections)

NOTES:

0 35 70 140
Metres

P1	08/07	AM	TWES	MTCW
Issue	Date	By	Chkd	Apprvd

Produced using Geographical Information Systems

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Client
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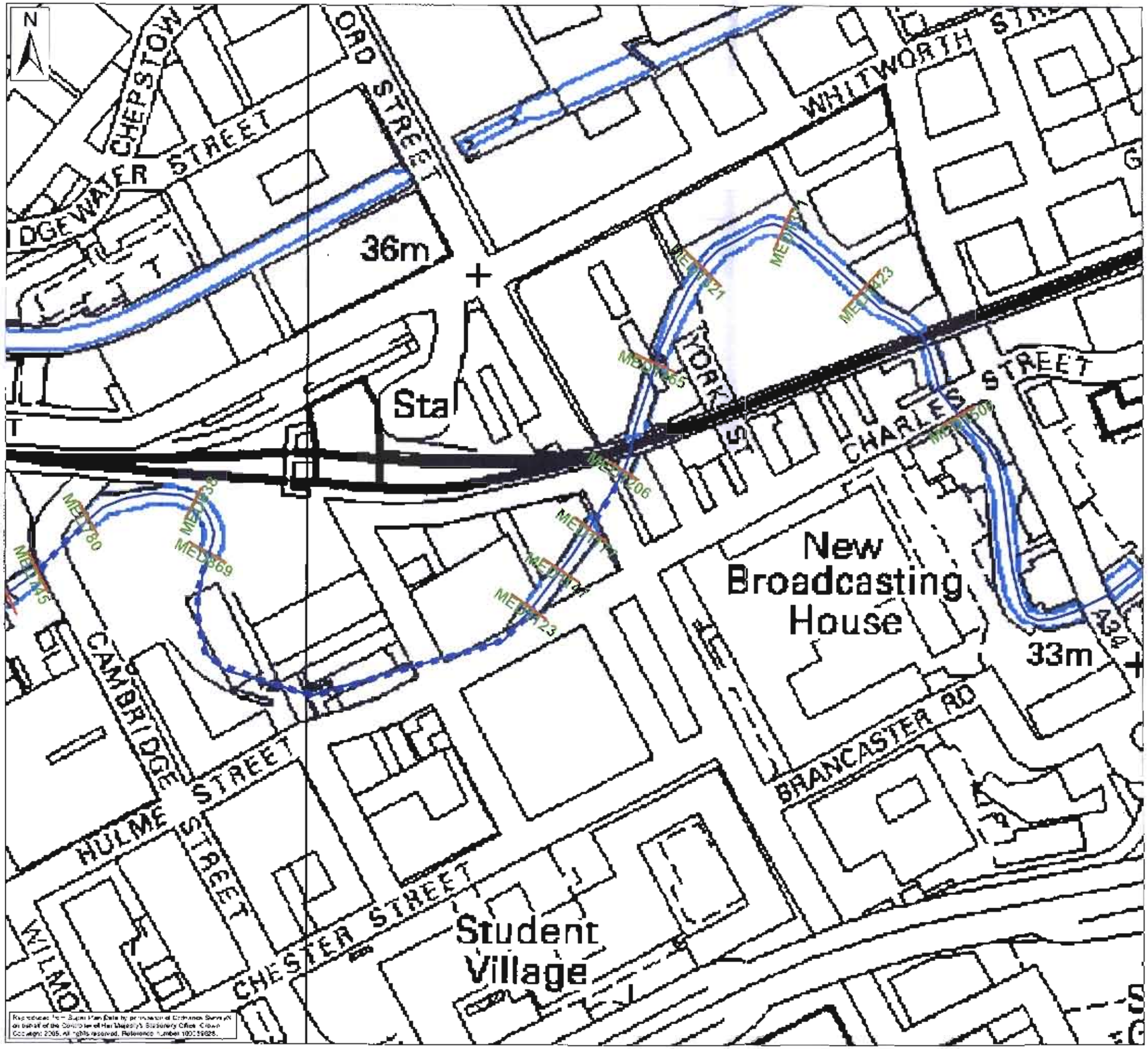
Job Title
First Street FRA

Drawing Title
Model Cross-Section Location Plan (1)

Plot ID J:\122007\4 Arup Project Data\4-03 Drawings\4-03-13 GIS\Cross-Section Locations 1.mxd

Scale at A3	Drawing Status	
1:2,000	Issue	
Job No.	Drawing No.	Issue
122007	Figure 5a	P1



Legend

- River Medlock
- Model Cross-Section Location and Label (MED1321)
- River Medlock (Culvert Sections)

NOTES:

0 25 50 100
Metres

P1	03/07	AM	TWES	MTCW
Issue	Date	By	Chkd	Apprvd

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Client: Southside Regeneration Ltd

Job Title: First Street FRA

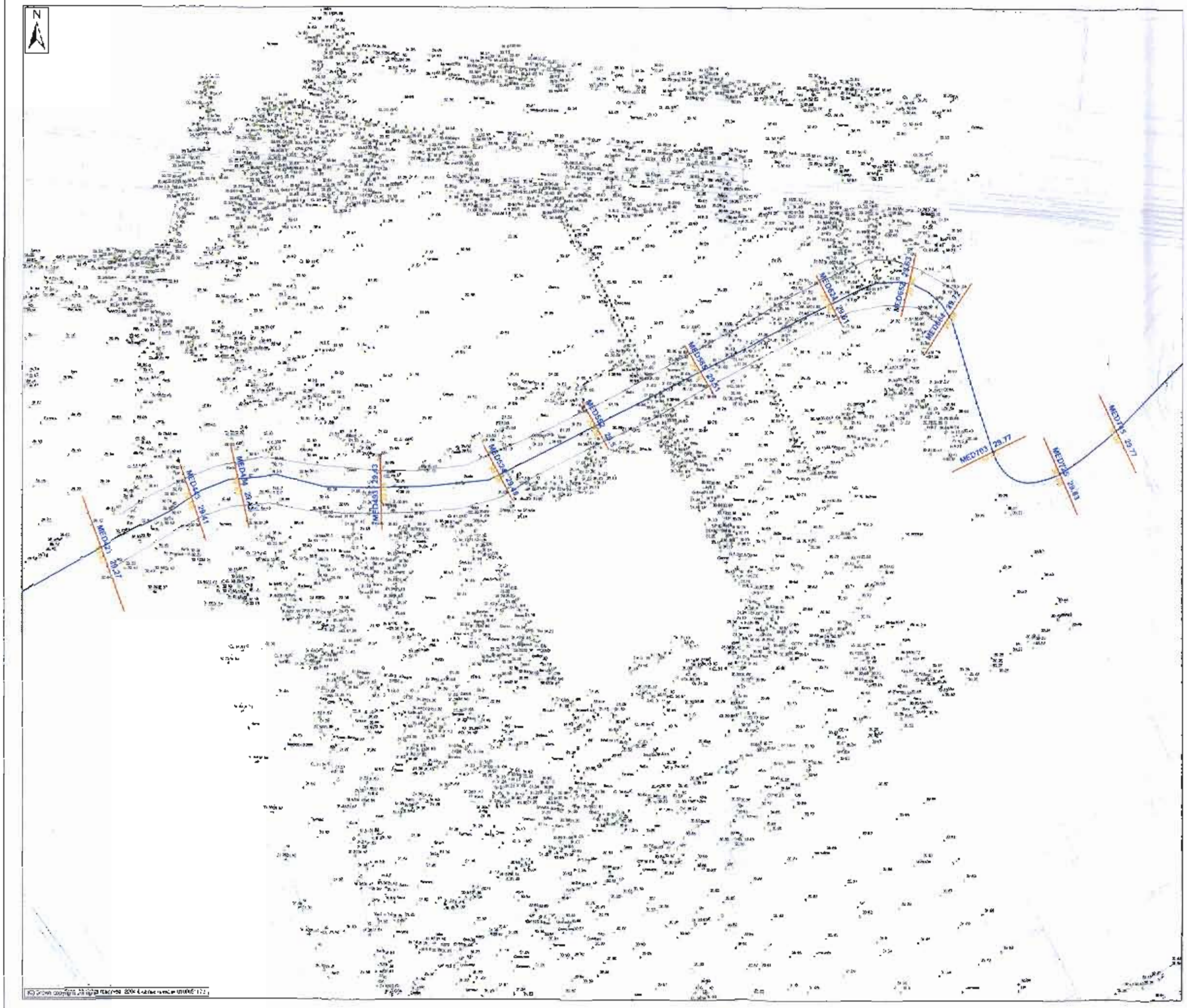
Drawing Title: **Model Cross-Section Location Plan (2)**

Plot ID: J:\122007\4 Arup Project Data\4-05 Drawings\4-09-10 GIS\Cross-Section Locations 2.mxd

Scale at A3	Drawing Status
1:2,000	Issue

Job No.	Figure 5b	Issue
122007	Figure 5b	P1

A1



Legend

- Existing Ground Level
- River Medlock
- Cross Sections

29.27 m AOD = 100 year Flood Level

NOTES:

1) Flood levels quoted are modelled peak water levels and do not include for freeboard.

D1	C3407	AM	TWES	MTDN
Issue	Date	By	Chkd	Appvd

Produced using Geographic Information Systems

ARUP

Client: Southside Regeneration Ltd

Job Title: First Street FRA

Drawing Title: Cross-Section Location and Predicted Flood Levels through Site

Plot ID:

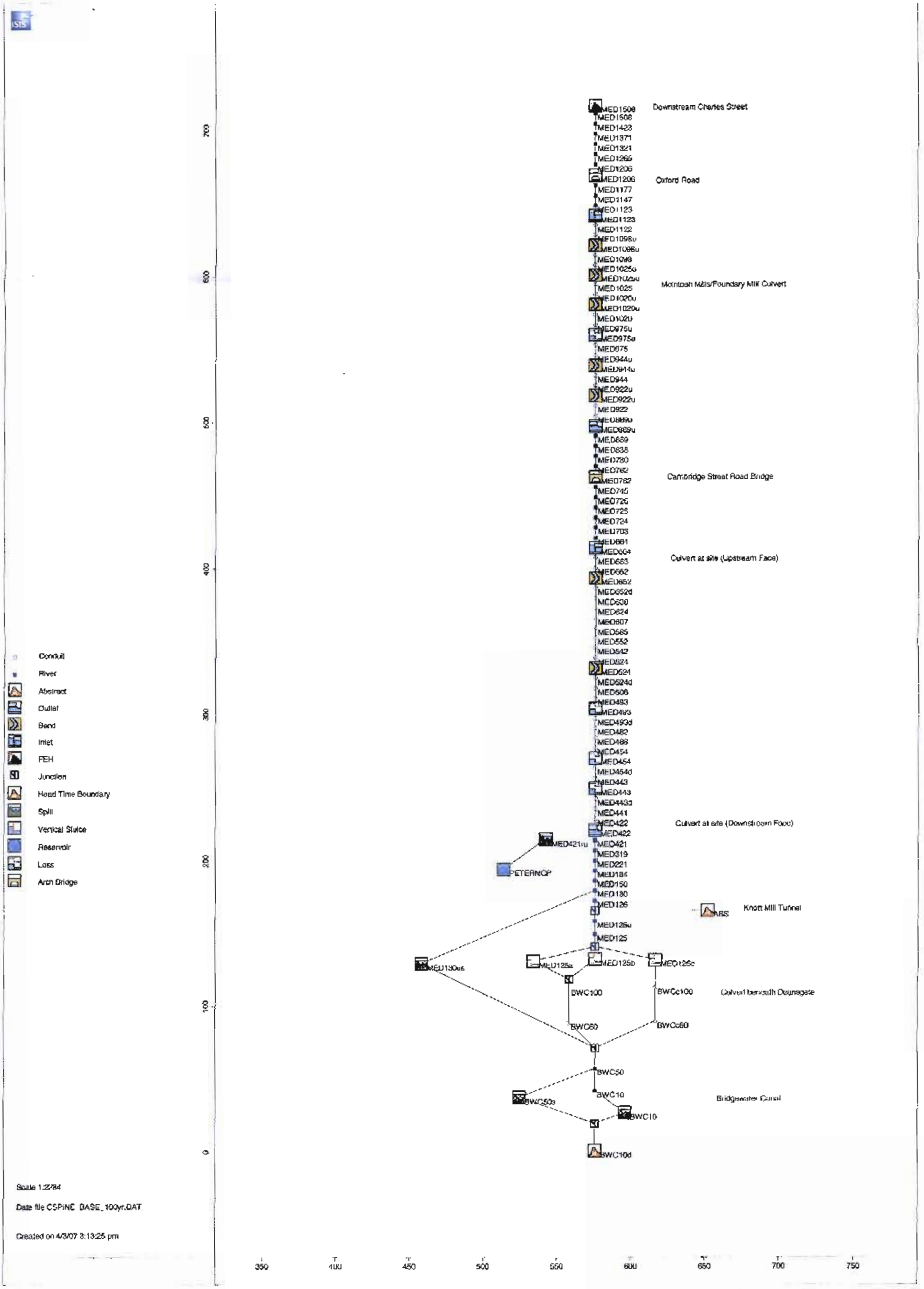
Scale at A1: 1:500

Drawing Status: Issue

Job No	Drawing no.	Issue
122007	Figure 7	P1

First Street FRA Model

Figure 6 - ISIS Schematic Plan



Scale 1:2784

Date file C:\PiNE_BASE_100yr.DAT

Created on 4/3/07 3:13:25 pm



Legend

River Medlock

Phase 1 Site Boundary

Site Boundary

Modelled Existing Condition 100 year (1% AEP) Flood Outline (Zone 3)

NOTES:

1). Flood extent shown represents existing situation as modelled during study.

0 25 50 100
Metres

Issue	Date	By	Chkd	Apprvd
P1	03/07	AM	TWES	MTCW

Produced using Geographical Information Systems

ARUP

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Client
Southside Regeneration Ltd

Job Title
First Street FRA

Drawing Title
2007 Flood Extent Plan (Flood Zone 3)

Plot ID J:\122007\4 Arup Project Data\4-03 Drawings\4-03-10 GIS\ Provided Site Flood Extent.mxd

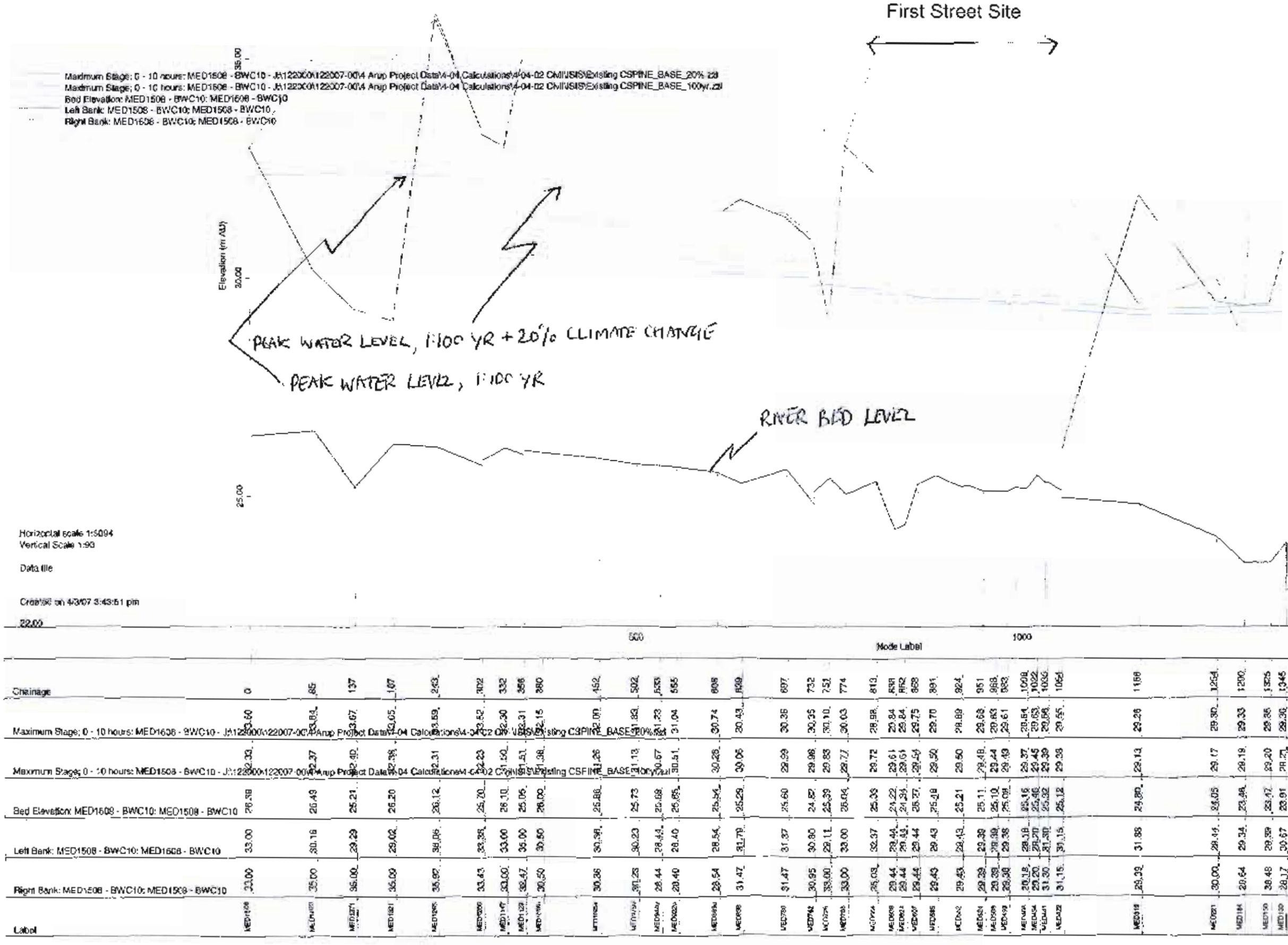
Scale at A3	Drawing Status
1:1,500	Issue

Job No.	Drawing No.	Issue
122007	Figure 8	P1

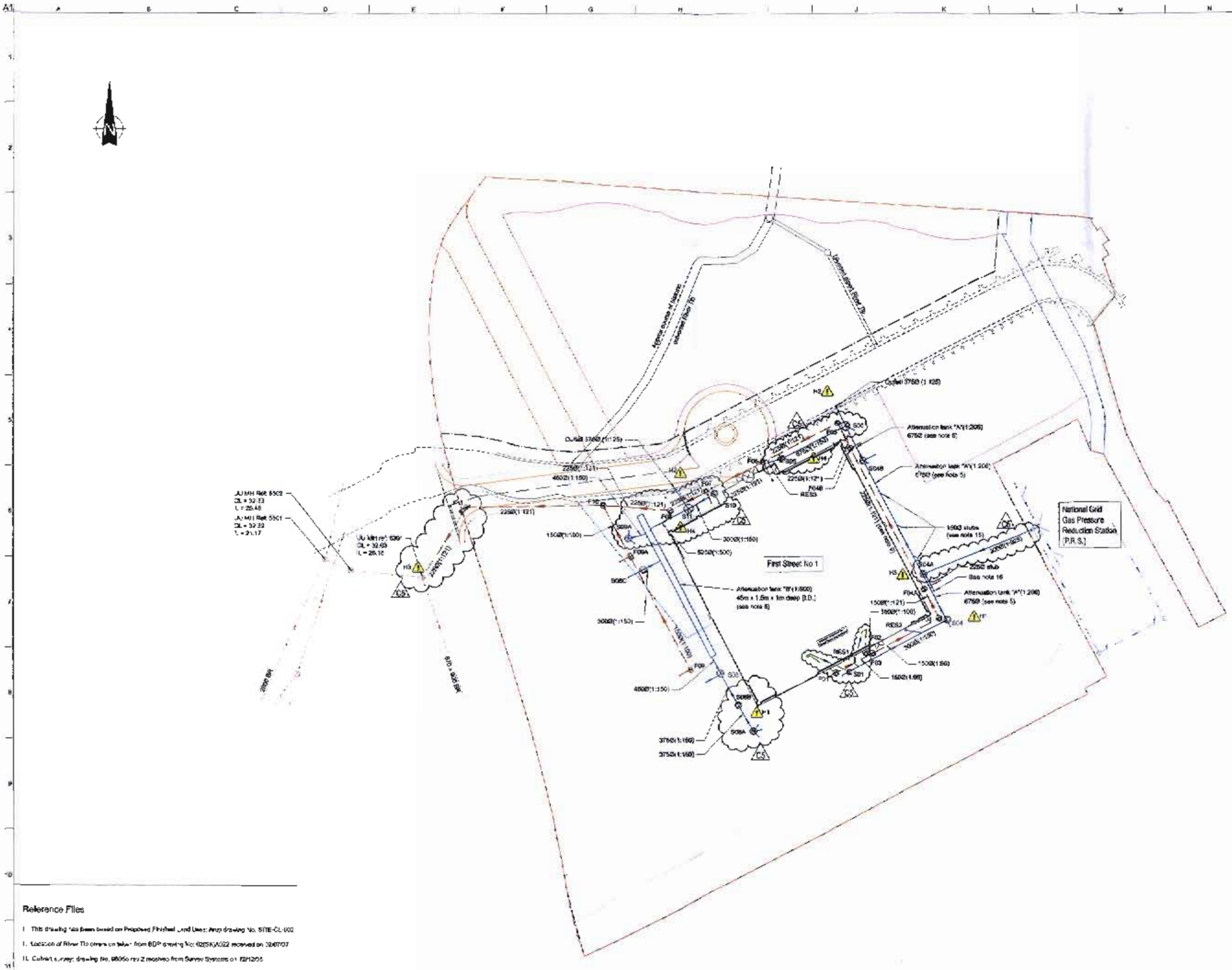
First Street FRA Model

Figure 8: Long Section showing Maximum Stage

Node: MED1508



Chainage	0	85	137	187	263	302	332	356	380	452	502	553	585	608	639	697	732	751	774	813	838	852	868	891	924	951	968	983	1008	1022	1036	1061	1166	1254	1290	1325	1345	1396	1686
Maximum Stage; 0 - 10 hours: MED1508 - BWC10 - J:\122000\122007-00\4 Arup Project Data\4-04 Calculations\4-04-02 Civil\ISIS\Existing CSPINE_BASE_20%.zsl	33.60	33.84	33.67	33.65	33.59	33.52	33.30	33.31	33.15	32.00	31.83	31.73	31.04	30.74	30.43	30.36	30.35	30.10	30.03	29.98	29.84	29.84	29.75	29.70	29.69	29.68	29.63	29.61	29.54	29.53	29.56	29.55	29.29	29.30	29.33	29.35	29.30	25.82	25.99
Maximum Stage; 0 - 10 hours: MED1508 - BWC10 - J:\122000\122007-00\4 Arup Project Data\4-04 Calculations\4-04-02 Civil\ISIS\Existing CSPINE_BASE_100yr.zsl	32.33	32.37	32.40	32.38	32.31	32.23	32.02	31.91	31.86	31.26	31.13	30.97	30.81	30.26	30.06	29.99	29.98	29.83	29.72	29.72	29.61	29.61	29.49	29.50	29.50	29.48	29.44	29.49	29.37	29.45	29.39	29.38	29.13	29.17	29.19	29.20	28.72	25.82	25.95
Bed Elevation: MED1508 - BWC10; MED1508 - BWC10	26.38	26.49	25.21	26.20	26.12	25.20	26.10	25.05	26.00	25.86	25.73	25.68	25.65	25.54	25.29	25.60	24.87	25.39	26.04	25.33	24.22	24.33	25.77	25.48	25.21	25.11	25.10	25.09	25.16	25.46	25.02	25.12	29.80	24.05	23.84	23.47	23.91	22.85	22.95
Left Bank: MED1508 - BWC10; MED1508 - BWC10	33.00	30.16	29.29	29.02	30.06	33.35	33.00	35.00	30.50	30.36	30.23	28.43	28.40	28.54	31.79	31.97	30.80	28.11	33.00	32.37	29.44	29.43	29.44	29.43	29.43	29.39	29.39	29.38	29.18	29.20	31.30	31.15	31.88	29.44	29.34	28.39	30.67	28.61	29.44
Right Bank: MED1508 - BWC10; MED1508 - BWC10	33.00	35.00	35.00	35.00	35.00	33.43	33.00	38.47	30.50	30.36	30.23	28.44	28.40	28.54	31.47	31.47	30.95	33.00	33.00	25.03	29.44	29.44	29.44	29.43	29.43	29.39	29.39	29.38	29.18	29.20	31.30	31.15	25.39	30.00	29.64	28.48	28.17	28.61	25.56
Label	MED1508	MED1507	MED1506	MED1505	MED1504	MED1503	MED1502	MED1501	MED1500	MED1499	MED1498	MED1497	MED1496	MED1495	MED1494	MED1493	MED1492	MED1491	MED1490	MED1489	MED1488	MED1487	MED1486	MED1485	MED1484	MED1483	MED1482	MED1481	MED1480	MED1479	MED1478	MED1477	MED1476	MED1475	MED1474	MED1473	MED1472	BWC10	BWC10


Health and Safety Information -
Hazards -
H1 - Contaminated ground. See remediation strategy report document No. REP/ 220654/EB/001 & 002
H2 - New outfall construction through culvert wall.
H3 - Work in highway and connection to existing UU manhole.
H4 - Large diameter pipe construction within 3m of glass building facade. Contractor to specify plant and costs accordingly.
H5 - Construction within 2m of glass building facade. Contractor to specify plant and costs accordingly.
Notes
1. For all sewer notes refer to drawing SITE-CN-W7.
Key
Site Boundary
Phase 1 Boundary
Existing
UU combined sewer
PRS storm water sewer
Proposed
Storm Water Sewer
Storm Water Sewer, Works being done by Carillion
Foul Water Sewer
Foul Water Sewer, Works being done by Carillion
Foul Water Manhole, Works being done by Carillion
Outfall 3750 (1:25)
Attenuation tank "A"(1:200) 6752 (see note 6)
Attenuation tank "A"(1:200) 6750 (see note 5)
Attenuation tank "B"(1:500) 45m x 1.5m x 1m deep (I.D.) (see note 5)
UU MH ref: 5302 CL = 32.23 I = 25.48
UU MH ref: 5301 CL = 32.23 I = 21.17
UU MH ref: 5300 CL = 32.03 I = 25.16
First Street No 1
National Grid Gas Pressure Reduction Station (P.R.S.)
See note 16
Reference Files
1 This drawing has been based on Proposed Finished Land Uses Arup drawing No. SITE-CL-002
2. Location of River Tib centre line taken from BDP drawing No: 62(SK)022 received on 20/07/07
3. Culvert survey drawing No. 98056 rev 2 received from Survey Systems on 12/12/05
4. First Street No 1 outline drawing No 01(SK)A126 received from BDP on 03/05/08
ARUP
Client
Southside Regeneration Ltd
Job Title
First Street, Manchester.
Drawing Title
Proposed Services - Sewers
Scale @ A1 1:500
Plot ID
Drawing Status
Information
Job No 122907-00
Drawing No Figure 9a
Issue

Notes:-

1. Existing manhole and pipe locations are based on Building Design Partnership Drawing No. (02)C001.

2. Information about underneath connections for Building Number 1 received from Building Design Partnership Drawing No. (9-)C202 Rev C received on 12/10/07 and Carillion Plc sketch No. Drainage GL S-13 South received 27/11/07.

3. Drawing shows proposed drainage only. See drawings No. SITE-CL-003 and SITE-CL-004 for existing drainage network.

4. To be read in conjunction with other proposed service drawings (see drawings No. SITE-CL-101 to SITE-CL-113) and services record information (see drawing No. SITE-CL-113). The drainage layout shown has been coordinated with the site utilities information that is currently available, any changes to the drainage layout may impact on the services.

5. Refer to document SPG-C001 for the interception tank performance specification.

6. Refer to document SPG-C004 for the external works drainage specification.

7. Foul water drainage construction close to basement piled foundations of Building No. 1. Contractor to provide temporary works to ensure no soil falls away from basement slab.

8. All stub connections are to be capped.

9. All stub connections are to be surveyed immediately after installation and as-built locations and levels provided to the main contractor as soon after the pipe line completion as is possible.

10. For the public realm areas petrol interceptors will be provided in accordance with the Environment Agency PPG03 and will be located as close to the source of pollution as possible. No road drainage will pass through the petrol interceptors and no parallel drainage systems will be installed. Location of petrol interceptors will be specified after confirmation of the traffic strategy. Gully locations to be specified after final finished levels are confirmed by the 1st Couture Architects.

11. For assumed surface water gully locations, refer to sketch MS0072.

12. 100Ø stub pipes on to the main drainage pipe, to be connected at 45° in line with main drainage run in direction of flow.

13. Stub for gully connection and to enable rodding of the drainage connection for Building Number 5.

14. Manhole chamber size and cover size as required by BS EN 752-3:1997.

15. Manhole cover type to be specified after the confirmation of the traffic strategy and finish of the external areas.

16. Cover levels are indicative only and subject to change. To be confirmed with Townsend Landscape Architects. Current cover levels extracted from TOWNSEND(04)0004 Rev P02 and TOWN3760DA2006 Rev P03. Alterations to cover level will affect depth to soffit and therefore may affect the pipe bedding information and the manhole cover size.

17. Backdrop required for stub connections into manholes FO5, F07, F08 and F09A. Backdrop height to be determined to connect with building outlet level).

18. The temporary connection pipe to the PRS and the 2 inlets to the north of Building No 1 with connections to the Hydro SDS and S111 are surcharged in the 1 in 1 year storm event, they are not surcharged in the 1 in 2 year storm event. This is due to the localised outfall level to the River Medlock Culvert. Greater levels of surcharging may occur in these manholes.

19. Invert levels shown are based on previous manhole invert levels. Flow pipe connections from Building No.1 to proposed manholes should have a shallow gradient, but no flatter than 1:150 such that the manhole invert is as high as practically possible.

20. In addition to the hazardous normally associated with the types of work detailed on the layout take note of the Health and Safety Warning box shown on the layout.

21. It is assumed that all works indicated on layout will be carried out by a competent Contractor working to an approved method statement.

22. The positions of existing services shown on the layout are indicative only and reflect the level of information available from statutory records. No guarantee is given for the accuracy and it is intended for general guidance only. Contractor to verify location of existing services on site prior to commencement of works.

23. Services may run at an unknown depths and their routes may overlap within the vicinity of the route shown. The information must not be relied upon for excavations or other works. The onus of locating the services before using mechanical excavator or other plant rest entirely upon the Contractor.

Outstanding Issues

1. The Environment Agency approval for construction of the two new outfalls into the River Medlock current is conditional on details and drawings of temporary works, and completion of a bat survey in the culvert.

2. Awaiting confirmation from the Environment Agency regarding whether the 'green wall' drainage can enter the surface water drainage system.

FOUL WATER

REF No	POSITION EASTING	POSITION NORTHING	INCOMING PIPE DIA. (mm)	INCOMING PIPE I.L. (mAOD)	OUTGOING PIPE DIA. (mm)	OUTGOING PIPE I.L. (mAOD)	LAYOUT	CHAMBER DIAMETER (mm)	COVER LEVEL (mAOD) (SEE NOTE 16)	MANHOLE DEPTH TO SOFFIT (m)	COVER SIZE (mm) COVER TYPE	COMMENTS
F01	-	-	a: 150	29.500	c=150	29.050	b a	1200	31.18	1.930	600 x 600	Stub for possible connection to Cafe
			b: 150	29.050							-	1 No inlet from Building Number 1
F02	-	-	a: 150	28.862	b: 150	28.662	a b	1200	31.46	2.118	600 x 600	1 No inlet from Building Number 1
											-	
F03	-	-	a: 150	28.871	c=150	28.871	b a	1200	31.13	2.109	600 x 600	-
			b, 150	28.871							-	-
F04	-	-	a: 150	28.548	b: 150	28.548	b a	1200	31.14	2.442	600 x 600	-
											-	
F04A	-	-	a: 225	28.397	c=225	28.397	a b	1200	31.16	2.636	600 x 600	Stub connection from Building Number 5
			b: 150	28.472							-	-
F04B	-	-	a: 150	28.099	c=225	28.034	a b	1200	31.16	2.911	600 x 600	Stub connection from Building Number 4
			b: 225	28.034							-	-
F05	-	-	a 225	27.958	b=225	27.958	b a	1200	31.06	2.867	600 x 600	-
											-	
F06	-	-	a 225	27.754	c=225	27.754	a b	1200	31.03	3.041	600 x 600	-
			c 150	-							-	1 No inlet from Building Number 1 Backdrop into manhole (see note 17)
F07	-	-	a 225	27.614	c=225	27.614	a b	1200	31.09	3.251	600 x 600	-
			b 150	-							-	1 No inlet from Building Number 1 Backdrop into manhole (see note 17)
F08	-	-	a=225	27.515	b:225	27.518	b a	1200	31.06	3.317	600 x 600	-
											-	
F09	-	-	a:150	-	b: 150	28.700	b a	1243 x 792	31.01	2.160	600 x 600	Stub for connection from Building Number 3 Backdrop into manhole (see note 17)
											-	
F09A	-	-	a: 150	28.309	c=150	28.309	c a b	1243 x 792	31.06	2.571	600 x 600	-
			b: 150	-							-	Stub for connection to Building Number 2 Backdrop into manhole (see note 17)
F10	-	-	a: 225	27.363	c: 225	27.363	c a b	1200	31.06	3.467	600 x 600	-
			b: 150	28.173							-	Backdrop into manhole of 0.736m
F11	-	-	a: 225	27.044	b:225	27.044	b a	1200	31.88	4.559	600 x 600	-
											-	
UU 5304 Existing S.W.M.H.	-	-	a: 225	26.850	c:675 +900	26.180	b a	-	32.09	4.95	-	-
			b: 450 x 900	26.180							-	-

SURFACE WATER

REF No	POSITION EASTING	POSITION NORTHING	INCOMING PIPE DIA. (mm)	INCOMING PIPE I.L. (mAOD)	OUTGOING PIPE DIA. (mm)	OUTGOING PIPE I.L. (mAOD)	LAYOUT	CHAMBER DIAMETER (mm)	COVER LEVEL (mAOD) (SEE NOTE 16)	MANHOLE DEPTH TO SOFFIT (m)	COVER SIZE (mm) COVER TYPE	COMMENTS
S01 As-Built	383044.090	397352.486	a: 100	29.809	c: 300	29.500	b c a	1200	31.09	1.190	600 x 600	Stub for connection to Green Wall
			b: 225	29.675							-	1 No inlet from Building No 1
RES1	-	-	a: 150	-	b: 100	-	b a	-	31.14	1.2 min	-	1 No inlet from Building No 1
											-	
RES2	-	-	a: 100	-	b: 100	-	a b	-	31.33	1.2 min	-	Stub for connection to Green Wall
											-	
S04	-	-	a: 150	29.041	c:675	28.016	c b a	1600	31.13	1.429	1200 x 600	Stub for Street drainage
			b: 300	29.391							-	-
S04A	-	-	a 225	-	a: 675	28.046	a c b d	1500	31.13	1.509	600 x 600	Stub for connection to Building No 6
			b: 150	29.471							-	Stub for gully connection for Street Drainage, See note 13)
			c: 300	28.996							-	Connection for PRS drainage
			d: 675	28.946							-	-
S04B	-	-	a: 300	29.146	a: 675	28.770	d a c b	1500	31.13	1.685	600 x 600	Stub for connection to Building No 4,
			b: 150	29.295							-	Stub for gully connection for Street Drainage
			c: 675	28.770							-	-
S05	-	-	a: 150	29.247	d: 975	28.722	d a c b	2100	31.15	2.019	600 x 600	Stub for gully connection for Street drainage
			b: 675	28.722							-	Manhole with flow control device and connection to outfall to River Medlock culvert
			c: 675	28.722								
RES3	-	-	-	-	a: 225	-	a	-	31.15	-	-	To allow making of connection to building No 1
											-	
S06	-	-	a 225	28.980	c: 675	28.857	b a	1500	31.15	1.618	600 x 600	1 No inlet from Building No 8 (see note 13)
			b 150	29.302							-	Stub for Road drainage
S06A	-	-	a: 225	-	d: 375	29.566	d a b c	1600	31.04	1.099	1200 x 675	Stub for Southern Square drainage Backdrop into manhole
			b: 100	-							-	Connection for site drain Backdrop into manhole
			c: 225	-								Stub for Southern Square drainage Backdrop into manhole
S06B	-	-	a: 375	29.500	c: 375	29.500	c a	1600	30.99	1.108	1200 x 675	-
											-	-
S09	-	-	a: 375	29.425	c: 450	29.367	c a b	1600	30.99	1.173	1200 x 675	-
			b: 300	29.517							-	Stub for connection to Building Number 3
S09C	-	-	a: 300	29.455	c: 300	29.455	a c	1600	31.20	1.462	1200 x 675	Stub for connection to Building Number 2
											-	
S09A	-	-	a: 300	29.440	c=450	29.280	b a c	1500	31.24	1.600	1200 x 675	Stub for Southern drainage
			b: 300	29.440							-	Stub for Road drainage
S10	-	-	a: 225	28.133	c: 525	27.905	b a c	1500	31.16	1.520	600 x 600	1 No inlet from Building Number 1 (see note 13)
			b: 150	28.480							-	Stub for Road drainage
S11	-	-	a: 525	28.047	c: 375	28.681	b a c	2100	31.13	2.014	600 x 600	Backdrop of 0.366m into manhole
			b: 525	28.681								Manhole with flow control device and connection to outfall to River Medlock culvert

Distribution Route | Maintenance/Cleaning Plans | Demolition/Adaptation Plans

Notes

1. For Drainage Layout refer to drawing SITE-CL-107

Issue	Date	By	Chkd	Appd

ARUP

13 Fitzroy St Fitzroy Buildings
Oxford Street Manchester M1 6EL
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Client
Southside Regeneration Ltd

Job Title
First Street, Manchester.

Drawing Title
Proposed Services - Sewers
Drainage Notes and Manhole Schedule

Scale at A1 1:500

Key ID

Drawing Status
Construction

Job No	Drawing No	Issue
122007-00	Figure 9b	

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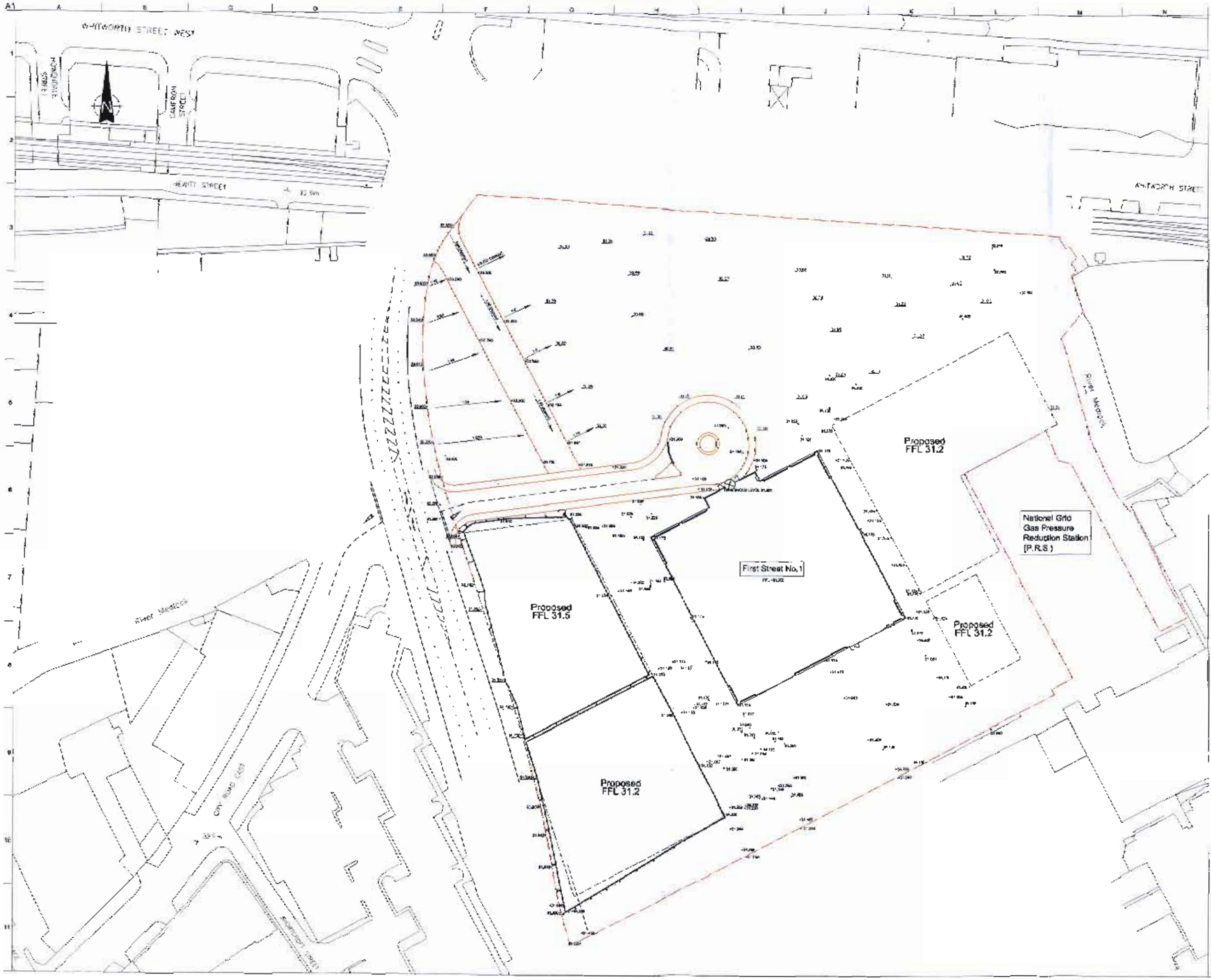


Notes

1. Drawing to be read in conjunction with Drawing Number SITE-CL-602
2. Drawing reflects Employer's request for Proposed Temporary levels. This Drawing has been approved by the Project Manager and Employer.
3. Where no level information is given, final levels are to be as existing.
4. Tender sum includes for cover system formed on level plus 300mm 'clean' cover as defined in the Remediation Specification. Additional work includes a minimum of a further 300mm cover consisting of Soft Landscaped areas/Car Parking as shown on Drawing Number SITE-CL-602

Key

- Existing Levels at Back of Medlock Street Footway to be Retained
- Proposed Levels to be as High lighted Existing Levels
- Proposed Levels taken from Townshend Stage D Information
- 1:2 Batter Slope
- Proposed Gradient
- Extent of 1:2 Battered Slope
- Proposed Future Building Plot Outline
- Site Boundary

Reference Files

1. This drawing has been based on Topographical Drawing No. 10111A rev1 received from Survey Systems on 14/12/06
2. This drawing has been based on Drawing No. TOWN570(04)0004 - Phase 1 North Park Drainage and Levels Plan received from Townshend Landscape Architects on 13/02/08
3. This drawing has been based on the highway layout Drawing No. CS001455-H-SK-24 received from Capita Symonds on 24/04/08.
4. First Street No 1 outline drawing No 01(SK) A126 received from B.D.P. on 03/03/06
5. Plot outlines and finished floor levels have been based on drawing No. 070803_Ra received from B.D.P. on 03/08/07

Issue	Date	By	Chkd	Appd

ARUP

Client
Southside Regeneration Ltd.

Job Title
First Street, Manchester.

Drawing Title
Proposed Temporary Levels

Scale at A1 1:500

Plot ID

Drawing Status
Information

Job No	Drawing No	Issue
122007-00	Figure 10	

PHOTOGRAPHS



Photograph 1 The Giants Basin, Castlefield. Excess canal flows enter the Medlock through arch culvert



Photograph 2 River Medlock entering the Knott Mill Tunnel



Photograph 3 River Medlock entering the Knott Mill Tunnel



Photograph 4 Looking upstream from the Knott Mill Tunnel



Photograph 5 Looking downstream from the Medlock Road Bridge



Photograph 6 Downstream face of the Medlock Road Bridge



Photograph 7 Looking upstream from the Site at the entrance point of the Medlock Culvert



Photograph 8 Looking downstream from Gloucester Street Road Bridge - (concrete panel fence is eastern/upstream boundary of site)



Photograph 9 Road Bridge at Cambridge Street



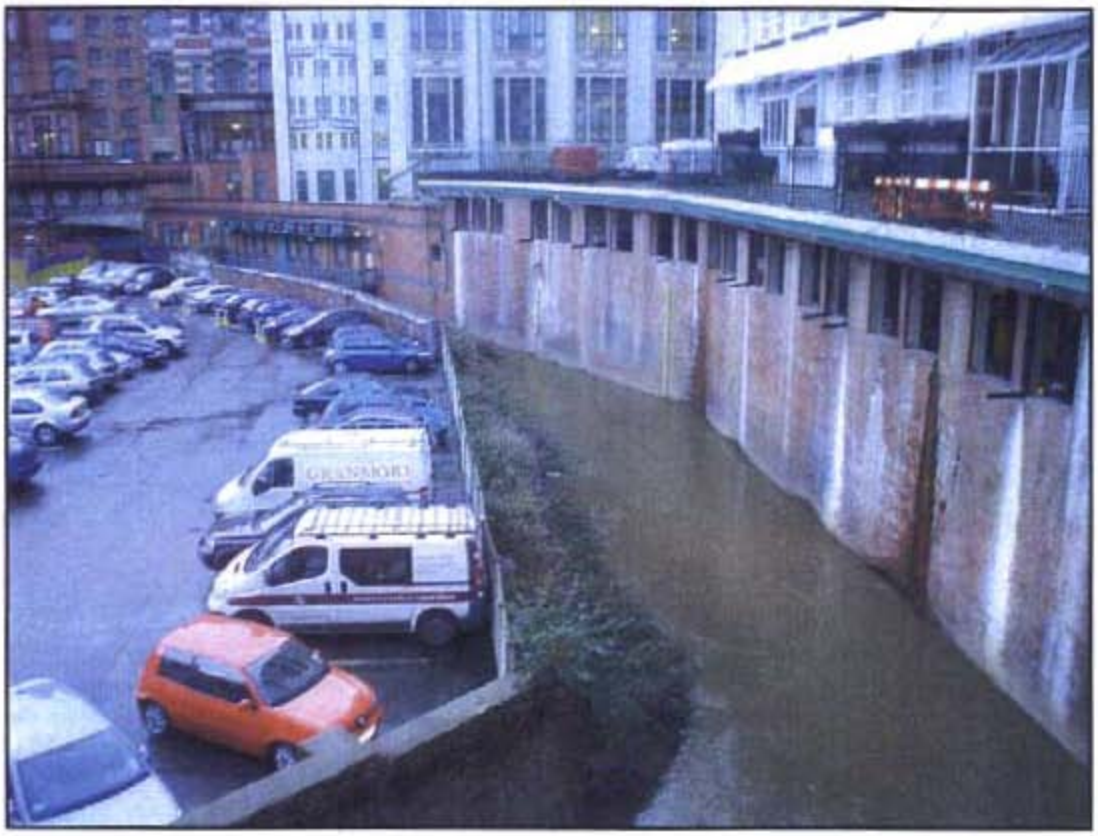
Photograph 10 Medlock culverted beneath derelict site of former foundry works



Photograph 11 Looking downstream from Oxford Road Bridge



Photograph 12 Looking upstream from Oxford Road Bridge



Photograph 13 Looking downstream from the rear of Asia /Lancaster House



Photograph 14 Looking downstream from Charles Street Road Bridge – upstream extent of hydraulic model

Appendix A

Hydrology

A1 Hydrological Assessment

A1.1 Introduction

A hydrological assessment of the River Medlock has been undertaken using methods described within the Flood Estimation Handbook (FEH). The FEH Statistical Method, Rainfall-Runoff Method and Revitalised Rainfall Runoff Method have been utilised to produce design flow estimates for the River Medlock.

A1.2 Flow Assessment Location

For the purposes of this hydrological assessment design flows for the site have been estimated to a point immediately downstream of the First Street site in Manchester (NGR 383594 397391).

Catchment descriptors for this location have been derived from the FEH CD-ROM (Version 1.0) and are displayed in Table A1.

Table A1. Selected catchment descriptors to downstream of First Street site, Manchester (FEH CD-ROM Version 1.0).

Variable	Value
AREA (km²)	63.9
FARL	0.994
PROPWET	0.54
ALTBAR	137
ASPBAR	238
ASPVAR	0.45
BFIHOST	0.375
DPLBAR (km)	12.33
DPSBAR (m/km)	54.2
LDP (km)	23.13
SAAR (mm)	1011
SAAR4170	1022
SPRHOST	36.1
URBCONC	0.837
URBEXT1990	0.309
URBLOC1990	0.791

A1.3 FEH Statistical Method

The Environment Agency released the HiFlows-UK dataset in 2005 (www.environment-agency.gov.uk/hiflowsuk). This contains updated flood peak data up to 2003 for use with the FEH methods.

One of the gauging stations within this dataset is River Medlock at London Road. General information about this gauging station is included in Table A2.

Table A2. River Medlock at London Road Gauging Station Information.

Station Description	
Station Name	London Road
NRFA Reference	69020
NGR	SJ 84909752
Suitability for QMED	Yes – only gauged to 34% of QMED, however the structure does not drown and flows are contained by walls
Suitability for Pooling	No – insufficient gaugings to confirm rating extrapolation
Data Start	1969
FEH Catchment Descriptors	
AREA	52.7 km²
BFIHOST	0.388
FARL	0.993
SAAR	1036 mm
PROPWET	0.55
URBEXT	0.252

The QMED for this station of 20.2 m³/s has been provided on the HiFlows-UK website, based on 32 years of annual maximum flow gaugings. The information contained in Table A2 states that gauge readings for this station are deemed acceptable in terms of accuracy up to and including the QMED value.

A1.3.1 QMED at Development Site

A QMED value of 42.4 m³/s has been calculated for the point downstream of the First Street site using the catchment descriptors in Table A1.

The observed QMED value from the gauging station at London Road has been used to refine the catchment descriptors QMED value for the site. This has been achieved by calculating the ratio of the observed QMED to the catchment descriptors QMED at the gauging station, and then multiplying this factor by the catchment descriptors QMED at the site. This produces a corrected QMED value at the site of 23.7 m³/s (Table A3).

Table A3. QMED Derivation

Flow Assessment Location	FEH Catchment Descriptors QMED (m³/s)	Observed QMED (m³/s)	Corrected QMED (m³/s)
London Road	36.2	20.2	20.2
First Street Site	42.4	-	23.7

A1.3.2 Single Site Analysis

The FEH states that single site analysis can be used when there is a reliable and long record at the site of interest. There are 32 years of data record from the London Road gauge. This can be used to produce a return period estimate for half the record length. Single site analysis can be used to produce flow estimates up to the 16 year return period

event. These flows are displayed in Table A4 along with higher return period flows for comparison purposes.

Table A4. Single site analysis flows.

Return Period (years)	Predicted Flow (m^3/s)
2	23.7
5	33.6
10	41.5
25	53.6
50	64.7
100	78.0
200	93.9

A1.3.3 Pooling Group Analysis

The techniques described above have led to the estimation of a QMED value for the River Medlock catchment to downstream of the development site. A pooling group technique has then been applied to produce a growth curve for this catchment.

It is generally recommended to use 5T gauging station years of data within the pooled analysis, where T is the target return period. In this study this equates to 500 years of pooled data. WINFAP-FEH software was used to create the initial pooling group which was then tested for discordancy and heterogeneity.

In brief, one gauging station was removed from the original pooling group due to a relatively high FARL value which was greater than the recommended FARL range of 0.05 either side of the site value. This station was:

- 23002 Derwent @ Eddy's Bridge

Initially this gauging station was replaced by:

- 28061 Churnet @ Basford Bridge

However, there is also significant attenuation within this catchment as indicated by the FARL value of 0.931. This station was also removed from the pooling group. It was not replaced as the pooling group contained 496 years of station data, deemed sufficiently close to the required 500 years of station data.

The final pooling group, after amendments, is displayed in Table A5.

Table A5. Final Pooling Group.

Rank	Station Number	Station Name	Distance
1	205008	Lagan @ Drumiller	0.239
2	203042	Crumlin @ Cidercourt Bridge	0.266
3	203043	Oonawater @ Sharmoy	0.268
4	24004	Bedburn Beck @ Bedburn	0.344
5	205005	Ravarnet @ Ravarnet	0.365
6	27059	Laver @ Ripon	0.418
7	47010	Tamar @ Crowford Bridge	0.428
8	203049	Clady @ Clady Bridge	0.447
9	47018	Thrushel @ Hayne Bridge	0.475
10	41020	Bevern Stream@ Clappers Bridge	0.487
11	84009	Nethan @ Kirkmuirhill	0.497
12	42003	Lymington @ Brockenhurst	0.506
13	23010	Tarset Burn @ Greenhaugh	0.516
14	203024	Cusher @ Gamble's Bridge	0.525
15	47008	Thrushel @ Tinhay	0.542
16	27086	Skell @ Alma Weir	0.55
17	8011	Livet @ Minmore	0.561
18	21025	Ale Water @ Ancrum	0.586
19	28041	Hamps @ Waterhouses	0.602

A growth curve was created for the River Medlock using the generalised logistic distribution (Table A6). Using these growth curve multipliers in combination with the adjusted QMED value of 23.7 m³/s produces the various return period peak flows in Table A6.

Table A6. Growth curve multipliers and flood frequency curve from original pooling group.

Return Period (years)	Growth Curve Multiplier	Predicted Flow (m³/s)
2	1	23.7
5	1.213	28.7
10	1.34	31.7
25	1.498	35.5
50	1.619	38.3
100	1.744	41.3
200	1.876	44.4
500	2.06	48.8

A1.3.4 Updated Catchment Descriptors

An updated FEH CD-ROM (Version 2.0) was released by CEH Wallingford in January 2007. This provides updated catchment descriptors for the First Street site which are displayed in Table A7 along with the FEH CD-ROM Version 1.0 catchment descriptors.

Table A7. Comparison of catchment descriptors (FEH CD-ROM Versions 1.0 and 2.0).

Variable	Catchment Descriptor Values	
	FEH CD-ROM Version 1.0	FEH CD-ROM Version 2.0
AREA (km²)	63.9	63.9
FARL	0.994	0 975
PROPWET	0.54	0.54
ALTBAR	137	137
ASPBAR	238	238
ASPVAR	0.45	0.45
BFIHOST	0.375	0.375
DPLBAR (km)	12.33	13.4
DPSBAR (m/km)	54.2	53.6
LDP (km)	23.13	25.3
SAAR (mm)	1011	1011
SAAR4170	1022	1022
SPRHOST	36.1	36.05
URBCONC	0.837	0.838
URBEXT1990	0.309	0.3083
URBLOC1990	0.791	0.784
URBEXT2000	-	0.4058
URBLOC2000	-	0.811

Utilisation of updated catchment descriptors for both the First Street site and the London Road gauge produces the QMED estimates displayed in Table A8.

Table A8. QMED derivation using FEH CD-ROM Version 2.0 catchment descriptors.

Flow Assessment Location	FEH Catchment Descriptors QMED (m³/s)	Observed QMED (m³/s)	Corrected QMED (m³/s)
London Road	39.8	20.2	20.2
First Street Site	43.4	-	23.3

Analysis of Table A7 shows that the URBEXT value for the First Street site has increased with the updated catchment descriptors. The QMED estimate for the site however, has reduced from 23.7 to 23.3 m³/s. The reason for the reduction in QMED estimate may be explained by the fact that the URBEXT values have increased by a larger margin at the London Road gauge than at the First Street site. When the observed QMED at the gauge is

factored by the catchment descriptor QMED estimates a slightly lower site QMED estimate is produced.

Given the relatively small reduction in QMED estimate between the two versions of the FEH CD-ROM it is proposed to retain the value of 23.7 m^3/s produced by Version 1.0 FEH CD-ROM catchment descriptors as this is the more conservative estimate.

A1.4 FEH Rainfall-Runoff Method

The FEH Rainfall-Runoff Method uses the catchment descriptors derived in Section A1.2[1] above to produce a flood hydrograph for differing return period events. The descriptors are used to calculate parameters such as the time to peak, critical storm duration and rainfall depth for the subject catchment.

The FEH boundary unit in the ISIS hydraulic modelling package has been used to calculate flood hydrographs, and the peak flows from these hydrographs are shown in Table A9.

Using an equation described in the FEH, observed BFI data from the River Medlock at London Road gauging station has been used to amend the SPR parameter within the rainfall-runoff method. Peak flows calculated using this amended parameter are also displayed in Table A9.

A1.4.1 Revitalised Rainfall-Runoff Flood Hydrograph Method

The revitalised flood hydrograph (ReFH) method was also utilised to calculate flood hydrographs. The peak flows from these hydrographs are also shown in Table A9.

Table A9. Comparison of Uncalibrated Rainfall-Runoff peak flows (using a 50% summer profile).

Return Period	Rainfall Runoff Method Flows (m3/s)		ReFH Method Flows
(years)	(catchment descriptors)	(SPR adjusted)	(m3/s)
2	56.2	57.6	20.8
5	76.4	78.3	29.6
10	93.8	96.1	36.3
25	121.6	124.7	44.7
50	151.2	154.9	53.3
100	188.5	193.1	65.1
200	234.5	240.1	81.5

The ReFH method has been introduced as it is considered that the Rainfall-Runoff method produces growth curves which over-predict higher return period flows. The ReFH method growth curve is similar to that of the statistical single site analysis method (Figure A2), however the ReFH method flows in Table A8 do not utilise locally observed data such as a QMED value. The QMED value calculated in the ReFH method, using catchment descriptors, is lower than the observed value. As yet, there is also no available guidance on the detailed application of the ReFH method.

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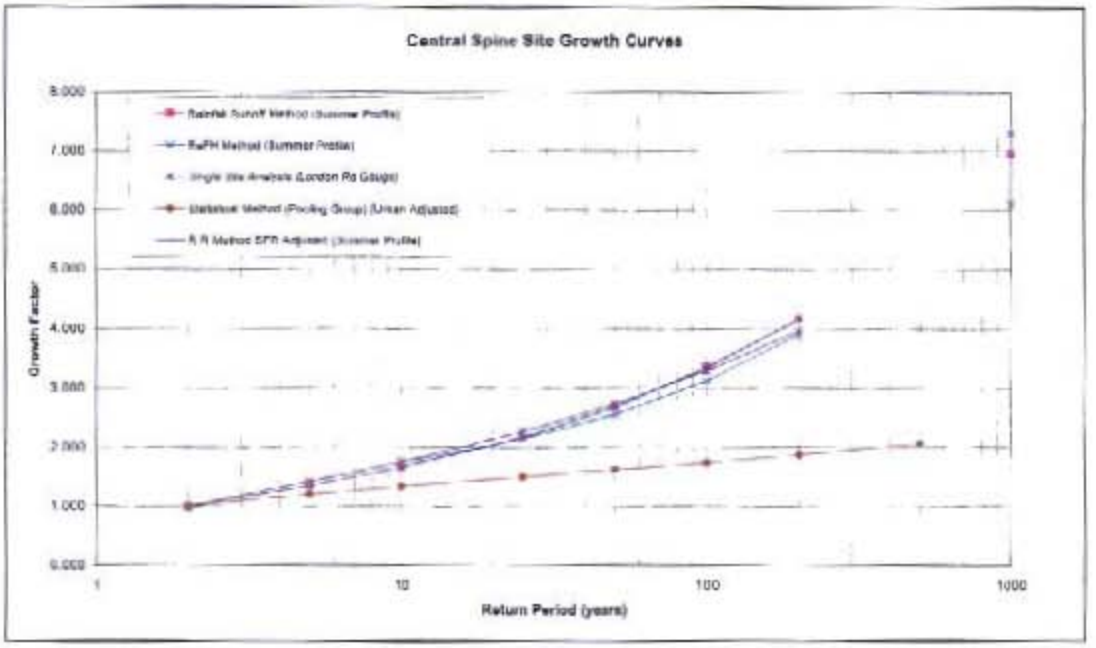
[1] The analysis described in Section A1.3.3. shows that FEH CD-ROM Version 2.0 catchment descriptors produce a slightly lower QMED estimate than that produced by Version 1.0 catchment descriptors. It is proposed to retain usage of the Version 1.0 QMED estimate as this is the more conservative value. For this reason the Version 1.0 catchment descriptors have also been utilised within the Rainfall-Runoff Method analysis.

Figure A2. Growth curves for differing flow estimation techniques.



A1.5 Design Flows

The QMED estimate at the First Street site produced using the gauged data from the London Road gauge is considered the most accurate as it utilises locally observed data.

The single site analysis produces a 10 year return period flow of 41.5 m³/s which equates to a growth factor of 1.75. The statistical pooling group analysis produces a 10 year return period growth factor of 1.34 which is deemed too low, and has been discarded from further evaluation.

Applying the growth curves from the remaining flow estimation techniques to the observed QMED value 23.7 m³/s produces the following flow estimates:

- Rainfall-Runoff (SPR adjusted) = 79.4 m³/s
- ReFH = 78.7 m³/s
- Single Site = 78.0 m³/s

These flow estimates are all relatively similar and no particular estimate has a clear priority over another. The precautionary principle has therefore been applied and the Rainfall-Runoff Method (with SPR adjusted) has been applied to the QMED value of 23.7 m³/s. This produces the flood frequency curve in Table A10.

Table A10. Final flood frequency curve.

Return Period (years)	Growth Factor	Peak Flow (m³/s)
QMED	1.000	23.7
5	1.360	32.2
10	1.669	39.5
25	2.165	51.2
50	2.690	63.7
100	3.352	79.4
200	4.168	98.7

Appendix B

Hydraulic Model Results

RIVER MEDLOCK MAXIMUM STAGE RESULTS (m AOD)			RIVER MEDLOCK MAXIMUM STAGE RESULTS (m AOD)		
Cross-Section	100 year	100 year +20% CC	Cross-Section	100 year	100 year +20% CC
MED1508	32.33	33.60	MED542	29.49	29.68
MED1423	32.37	33.64	MED524	29.48	29.68
MED1371	32.40	33.67	MED524d	29.46	29.65
MED1321	32.38	33.65	MED508	29.44	29.63
MED1265	32.31	33.59	MED493	29.43	29.61
MED1206	32.23	33.52	MED493d	29.35	29.51
MED1177	31.54	32.35	MED482	29.41	29.59
MED1147	31.50	32.30	MED468	29.37	29.54
MED1123	31.51	32.31	MED454	29.45	29.63
MED1122	31.40	32.18	MED454d	29.40	29.57
MED1098u	31.38	32.15	MED443	29.41	29.59
MED1098	31.34	32.10	MED443d	29.36	29.52
MED1025u	31.26	32.00	MED441	29.39	29.56
MED1025	31.22	31.95	MED422	29.38	29.55
MED1020u	31.22	31.94	MED421	29.27	29.42
MED1020	31.18	31.90	MED421ru	25.26	25.26
MED975u	31.13	31.83	MED319	29.13	29.26
MED975	30.81	31.41	MED221	29.17	29.30
MED944u	30.67	31.23	MED184	29.19	29.33
MED944	30.62	31.17	MED150	29.20	29.35
MED922u	30.52	31.04	MED130	29.21	29.36
MED922	30.43	30.93	MED130d1	25.82	25.82
MED869u	30.29	30.74	MED126	29.27	29.43
MED869	30.10	30.47	MED125u	29.27	29.43
MED838	30.06	30.43	MED125	29.27	29.43
MED780	29.99	30.36	MED125a	29.27	29.43
MED762	29.98	30.35	MED125b	29.27	29.43
MED745	29.77	30.04	MED125c	29.27	29.43
MED726	29.83	30.11	ABS	29.27	29.43
MED725	29.81	30.08	BWCa100	25.83	25.83
MED724	29.83	30.10	BWCb100	25.83	25.83
MED703	29.77	30.03	BWCc100	25.79	25.79
MED664	29.72	29.98	BWC100	25.83	25.83
MED663	29.60	29.82	BWC60	25.82	25.82
MED652	29.63	29.86	BWCc60	25.82	25.82
MED652d	29.60	29.83	BWC50	25.82	25.82
MED638	29.61	29.84	BWC50sd	25.26	25.26
MED624	29.61	29.84	BWC50s	25.65	25.65
MED607	29.54	29.75	BWC10	25.95	25.99
MED585	29.51	29.70	BWC10d	25.26	25.26
MED552	29.50	29.69	BWC10sd	25.26	25.26
			PETERNCP	29.25	29.39

Table B1 – Base Model Peak Water Levels

			MAXIMUM STAGE DIFFERENCE COMPARED TO BASE MODEL (m)							
Location	Cross-Section	100 Year Base Model (m AOD)	Culvert Manning's - 0.015	Culvert Manning's - 0.030	Channel Manning's - 0.020	Channel Manning's = 0.030	Channel Manning's = 0.035	Knob Mill Tunnel Blockage	D/S Weir Level + 300 mm	D/S Weir Level - 300 mm
	MED1508	32.33	-0.31	0.34	-0.12	0.13	0.29	0.10	0.00	-0.01
	MED1423	32.37	-0.33	0.34	-0.12	0.13	0.27	0.10	0.00	-0.01
	MED1371	32.40	-0.32	0.33	-0.11	0.13	0.26	0.10	0.00	-0.01
	MED1321	32.39	-0.32	0.33	-0.11	0.13	0.26	0.10	0.00	-0.01
	MED1268	32.31	-0.33	0.34	-0.11	0.13	0.26	0.10	0.00	-0.01
	MED1208	32.23	-0.35	0.36	-0.11	0.12	0.25	0.11	0.00	-0.01
	MED1177	31.94	-0.35	0.35	-0.10	0.11	0.20	0.10	0.00	-0.01
	MED1147	31.50	-0.35	0.35	-0.10	0.11	0.20	0.10	0.00	-0.01
	MED1123	31.01	-0.38	0.38	-0.09	0.10	0.19	0.10	0.00	-0.01
	MED1127	31.40	-0.35	0.35	-0.10	0.10	0.19	0.10	0.00	-0.01
	MED1080u	31.38	-0.35	0.36	-0.10	0.10	0.19	0.10	0.00	-0.01
	MED1098	31.34	-0.35	0.35	-0.10	0.10	0.19	0.10	0.00	-0.01
	MED1025u	31.28	-0.33	0.37	-0.10	0.10	0.19	0.11	0.00	-0.01
	MED1038	31.22	-0.35	0.37	-0.10	0.10	0.19	0.11	0.00	-0.01
	MED1025u	31.22	-0.33	0.37	-0.10	0.10	0.19	0.11	0.00	-0.01
	MED1025	31.16	-0.33	0.37	-0.10	0.10	0.20	0.11	0.00	-0.01
	MED975u	31.13	-0.27	0.26	-0.10	0.11	0.20	0.11	0.00	-0.01
	MED975	30.81	-0.28	0.27	-0.10	0.11	0.20	0.11	0.00	-0.01
	MED944u	30.67	-0.20	0.22	-0.10	0.11	0.21	0.11	0.00	-0.01
	MED944	30.62	-0.20	0.23	-0.10	0.11	0.21	0.11	0.00	-0.01
	MED922u	30.57	-0.14	0.15	-0.10	0.11	0.21	0.11	0.00	-0.01
	MED922	30.43	-0.14	0.20	-0.10	0.11	0.22	0.11	0.00	-0.01
	MED888u	30.35	-0.51	0.11	-0.10	0.11	0.22	0.11	0.00	-0.01
	MED868	30.10	-0.09	0.12	-0.10	0.11	0.21	0.11	0.00	-0.01
	MED838	30.06	-0.02	0.12	-0.09	0.10	0.20	0.11	0.00	-0.01
	MED780	29.99	-0.02	0.13	-0.08	0.09	0.17	0.12	0.00	-0.01
	MED760	29.98	-0.02	0.14	-0.07	0.07	0.14	0.14	0.00	-0.01
Open channel downstream of Cambridge Str bridge	MED747	29.77	-0.03	0.13	-0.06	0.06	0.13	0.10	0.00	-0.01
	MED726	29.83	-0.02	0.13	-0.06	0.06	0.12	0.10	0.00	0.00
	MED725	29.81	-0.03	0.13	-0.05	0.06	0.12	0.10	0.00	-0.01
	MED724	29.80	-0.02	0.13	-0.05	0.06	0.11	0.10	0.00	-0.01
Open channel immediately upstream of silo	MED703	29.77	-0.03	0.13	-0.05	0.05	0.11	0.10	0.00	-0.01
	MED664	29.72	-0.03	0.13	-0.04	0.05	0.09	0.11	0.00	-0.01
Culvert sections u/s of BT building	MED663	29.80	-0.04	0.14	-0.04	0.05	0.09	0.11	0.00	-0.01
	MED662	29.63	-0.03	0.13	-0.04	0.05	0.09	0.11	0.00	-0.01
	MED628	29.60	-0.03	0.13	-0.04	0.05	0.09	0.11	0.00	0.00
	MED638	29.61	-0.03	0.13	-0.04	0.05	0.09	0.11	0.00	-0.01
	MED624	29.61	-0.03	0.11	-0.04	0.05	0.09	0.11	0.00	-0.01
	MED607	29.54	-0.02	0.10	-0.04	0.05	0.09	0.11	0.00	-0.01
	MED585	29.51	-0.02	0.08	-0.04	0.05	0.10	0.11	0.00	-0.01
Culvert sections in front of BT building	MED552	29.50	0.03	0.05	-0.04	0.05	0.10	0.11	0.00	0.00
	MED542	29.49	0.00	0.04	-0.04	0.05	0.10	0.11	0.00	0.00
	MED524	29.48	0.00	0.02	-0.04	0.05	0.10	0.11	0.00	-0.01
	MED524d	29.46	0.00	0.01	-0.04	0.05	0.10	0.11	0.00	-0.01
Culvert sections d/s of BT building	MED508	29.44	0.01	0.01	-0.04	0.05	0.10	0.11	0.00	-0.01
	MED493	29.43	0.01	0.00	-0.04	0.05	0.10	0.11	0.00	0.00
	MED453d	29.35	0.01	0.00	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED482	29.41	0.02	-0.01	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED468	29.37	0.02	-0.02	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED454	29.40	0.03	-0.03	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED454d	29.40	0.03	-0.03	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED443	29.41	0.03	-0.04	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED432	29.38	0.03	-0.03	-0.05	0.05	0.10	0.11	0.00	-0.01
	MED441	29.39	0.03	-0.04	-0.05	0.05	0.11	0.12	0.00	-0.01
	MED422	29.38	0.03	-0.04	-0.05	0.05	0.11	0.12	0.00	-0.01
Downstream Medlock Bridge	MED421	29.37	0.03	-0.04	-0.05	0.05	0.11	0.12	0.00	-0.01
	MED379u	28.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MED319	29.13	0.02	-0.04	-0.03	0.03	0.08	0.13	0.00	-0.01
	MED331	29.17	0.02	-0.04	-0.01	0.00	0.00	0.13	0.00	-0.01
	MED184	29.19	0.03	-0.04	0.00	0.00	-0.01	0.13	0.00	-0.01
	MED150	29.20	0.03	-0.04	0.00	0.00	-0.02	0.13	0.00	-0.01
	MED130	29.21	0.03	-0.04	0.00	0.00	-0.02	0.13	0.00	-0.01
	MED130us	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MED130d1	25.82	0.00	0.00	-0.02	0.02	0.05	0.00	0.31	-0.16
	MED128	29.27	0.03	-0.04	0.00	0.01	-0.02	0.13	0.00	-0.01
	MED128u	29.27	0.03	-0.04	0.00	-0.01	0.02	0.13	0.00	-0.01
	MED125	29.27	0.03	-0.04	0.00	-0.01	-0.02	0.13	0.00	-0.01
	MED120a	29.27	0.03	-0.04	0.00	-0.01	-0.02	0.13	0.00	-0.01
	MED125b	29.27	0.03	-0.04	0.00	-0.01	-0.02	0.13	0.00	-0.01
	MED125c	29.27	0.03	-0.04	0.00	-0.01	-0.02	0.13	0.00	-0.01
	A55	29.27	0.03	-0.04	0.00	-0.01	-0.02	-3.44	0.00	-0.01
	BWCa100	25.83	0.00	0.01	-0.02	0.02	0.05	0.00	0.30	-0.30
	BWCb100	25.85	0.00	0.01	-0.02	0.02	0.05	0.00	0.30	-0.30
	BWCc100	28.79	-0.03	0.09	0.02	0.03	0.06	0.04	0.34	-0.37
	BWC100	25.83	0.00	0.01	-0.02	0.02	0.05	-0.01	0.30	0.30
	BWC90	25.82	0.00	0.00	-0.02	0.02	0.05	0.00	0.31	-0.30
	BWCa80	25.82	0.00	0.00	-0.02	0.02	0.05	0.00	0.31	-0.30
	BWC80	25.82	0.00	0.00	-0.02	0.02	0.05	-3.56	0.31	-0.30
	BWCb80	25.26	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00
	BWC50a	25.85	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00
	BWC10	25.95	0.01	-0.01	0.01	-0.02	-0.04	-3.69	0.30	-0.30
	BWC10d	25.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PETERNCP	29.25	0.02	-0.04	-0.05	0.05	0.13	0.00	0.00	-0.01
	Variation through silo	Maximum:	0.03	0.14	0.04	0.06	0.11	0.12	0.00	0.00
		Minimum:	-0.04	-0.04	-0.05	0.05	0.09	0.11	0.00	-0.01
		Average:	0.00	0.03	-0.04	0.05	0.10	0.11	0.00	-0.01

Table B2 – Model Sensitivity Results

Appendix C

Environment Agency Correspondence

RE: Central Spine FRA

From: Thomas, Sandrine [sandrine.thomas@environment-agency.gov.uk]
Sent: 21 September 2007 13:43
To: Tom Saville
Cc: Barrett, Helen; Gordon Blair (FBA)
Subject: RE: Central Spine FRA

Tom

I can confirm that the Environment Agency would exceptionally accept a 320 mm freeboard in lieu of the usual 600 mm freeboard given the modelling work you have conducted and the estimated flow used for the study. Therefore, the proposed Finished Floor Level at the Central Spine site of 30.35mAOD is accepted.

As discussed in our phone conversations the Flood Risk Assessment that you have prepared will have to be completed with the study on surface water runoff and submitted to Manchester City Council with any subsequent planning applications for the site.
Regards
Sandrine

Sandrine Thomas
Development Control Engineer (East Manchester Area)
Environment Agency
Appleton House
430 Birchwood Boulevard
Birchwood
WARRINGTON WA3 7WD
Tel: 01925 543 405
Fax: 01925 852 260

Clare Leech

From: Thomas, Sandrine [sandrine.thomas@environment-agency.gov.uk]
Sent: 10 December 2007 15:21
To: Clare Leech
Subject: RE: Central Spine Existing and Proposed Drainage Model
Attachments: FD1Form.doc; Fact Sheet No 4 Drawings.tif; Explanatory notes.doc; Fact Sheet No 4.doc

Clare,

I would rather increase the rainfall depth parameter by 10% which is what I did it actually result in the same flows therefore I accept the increase on the volumetric runoff coefficient.
Please find enclosed our consent forms.
Regards
Sandrine

From: Clare Leech [mailto:Clare.Leech@arup.com]
Sent: 10 December 2007 14:23
To: Thomas, Sandrine
Subject: RE: Central Spine Existing and Proposed Drainage Model

Sandrine,

The current design life of the building is 30 years, therefore I allowed for a 10% increase in peak rainfall intensity. Unfortunately the version of microdrainage we have does not have the option to allow for climate change, therefore I allowed for this increase in the peak rainfall intensity by increasing the volumetric runoff coefficient by 10%. Could you please confirm this is acceptable.

I will send you an updated drainage model tomorrow. Could you please e-mail me the required form for application for the new outfalls.

Thanks.

Regards,

Clare Leech
Graduate Engineer

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