Herbert Road, Newport

Hydrological Study of the on-site Ordinary Watercourse

FINAL

March 2014

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Hydrological Study of the on-site Ordinary Watercourse

Client Name: Greenhill Construction
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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008 and BS EN ISO 14001: 2004)

Issue	Date	Prepared by	Checked by	Approved by
A	Nov '13	LC	ARW	ARW
B	Dec '13	LC	ARW	ARW
C	Mar '14	LC	ARW	ARW

Comments Revised to incorporate the consented scheme and the enlarged culvert on the proposed scheme

Disclaimer

This report has been prepared for the sole and exclusive use of **Greenhill Construction** from whom it was commissioned and has been prepared in response to their particular requirements and brief.

This report may not be relied upon by any other party.

The Contracts (Rights of Third Parties) Act 1999 shall not apply to this report and the provisions of the said Act are expressly excluded from this report.

This report may not be used for any purpose other than that for which it was commissioned.

The conclusions resulting from this study and contained in this report are not necessarily indicative of future conditions or operating practices at or adjacent to the Site.

Much of the information presented in this report is based on topographical survey information provided by others. That information has neither been checked nor verified by Waterman Transport & Development Ltd.

Content

Appendices

1. INTRODUCTION

Land at Herbert Road, Newport (henceforth referred to as “the Site”) is allocated for residential purposes in the adopted Unitary Development Plan for 153 dwellings.

The Welsh Government’s Planning Policy Wales (PPW) provides the planning policy framework under which Local Planning Authorities (LPAs) must prepare their Local Development Plans (LDPs). The LDP has to encourage developments that are economically, socially and environmentally sustainable. PPW is supplemented by a number of Technical Advice Notes (TANs), including TAN 15: Development and Flood Risk. The Assembly’s TAN 15 Development Advice Map shows that the Site lies entirely within Flood Risk Zone C1. The risk designations indicated in TAN 15 require that a Flood Consequences Assessment (FCA) be carried out in support of a planning application.

In November 2012, Waterman Transport and Development Ltd. (WTD) were commissioned to undertake a study into the hydrological issues affecting the Site, having particular regard to the planning recommendations of TAN 15. Subsequently and in addition to carrying out a detailed FCA to assess the flood risk from the adjacent River Usk, WTD have also carried out a hydrological study on the ordinary watercourse that runs through the proposed Site. This report presents the conclusions of this work.

2. THE SITE

2.1 Site Description

The Site is located in Newport, South Wales at approximate National Grid Reference 331718E 189369N. The Site is located approximately 1km north east of Newport town centre on the east bank of the River Usk between the Newport to Hereford railway line and the River Usk. A location plan is included as Figure 1 below, with the Site boundary indicated by the red dotted line. The Site Plan indicates that the Site is bounded to the north by the new community Glan Usk Primary School; to the east by the railway line; and to the south by a mixed residential and commercial area. The Site is approximately 3.9 hectares (9.7 acres), and includes a narrow strip adjacent to the river which connects the Site to Collier Street which is located to the south. The east bank of the River Usk is located immediately adjacent to the Site and forms the western boundary.

The Site has previously been developed and is now vacant, having been allocated for housing development in the Newport UDP adopted in 2006. It is understood that an extant Planning Permission exists for the Site, which states that '*the site shall be raised to a level of 9.8 metres Above Ordnance Datum with the finished floor levels of all development set 600mm above the 9.8 metres standard…*' (Notice of Decision: Replacement Primary School, All Weather Pitch, Soft and Hard Play Areas and Residential Development; Glebelands, St Julians, Newport; App. No.: 00/0768)

A topographical survey of the Site indicates that the existing ground levels in the north east portion of the Site are at around 6.9m AOD and rise to the east to approx. 7.4m AOD. The Site is located (at least in part) on a former industrial /domestic landfill site. This is reflected in the topography of the main part of the Site which varies between 7.0m AOD and 8.0m AOD. The ground running immediately adjacent to the River Usk along the western boundary of the Site is generally higher, with levels rising from 9.0m AOD in the north to approx. 10.0mAOD halfway along the Site, before dropping to 9.5m AOD at the southern extent. A copy of the topographical survey is included in Appendix A herewith.

An extract from the topographical survey is shown in Figure 2, which depicts the course of the ditch through the Site. The ditch enters the Site from the East via a culvert beneath the railway embankment at NGR: 331812, 189471, and flows in a westerly direction to outfall into the River Usk via a flapped pipe at NGR: 331639, 189414. The invert of the ditch is approx. 1m lower than surrounding ground levels. Reeds grow in the ditch bed, indicating limited flow in the ditch.

Figure 1: Site Location Plan

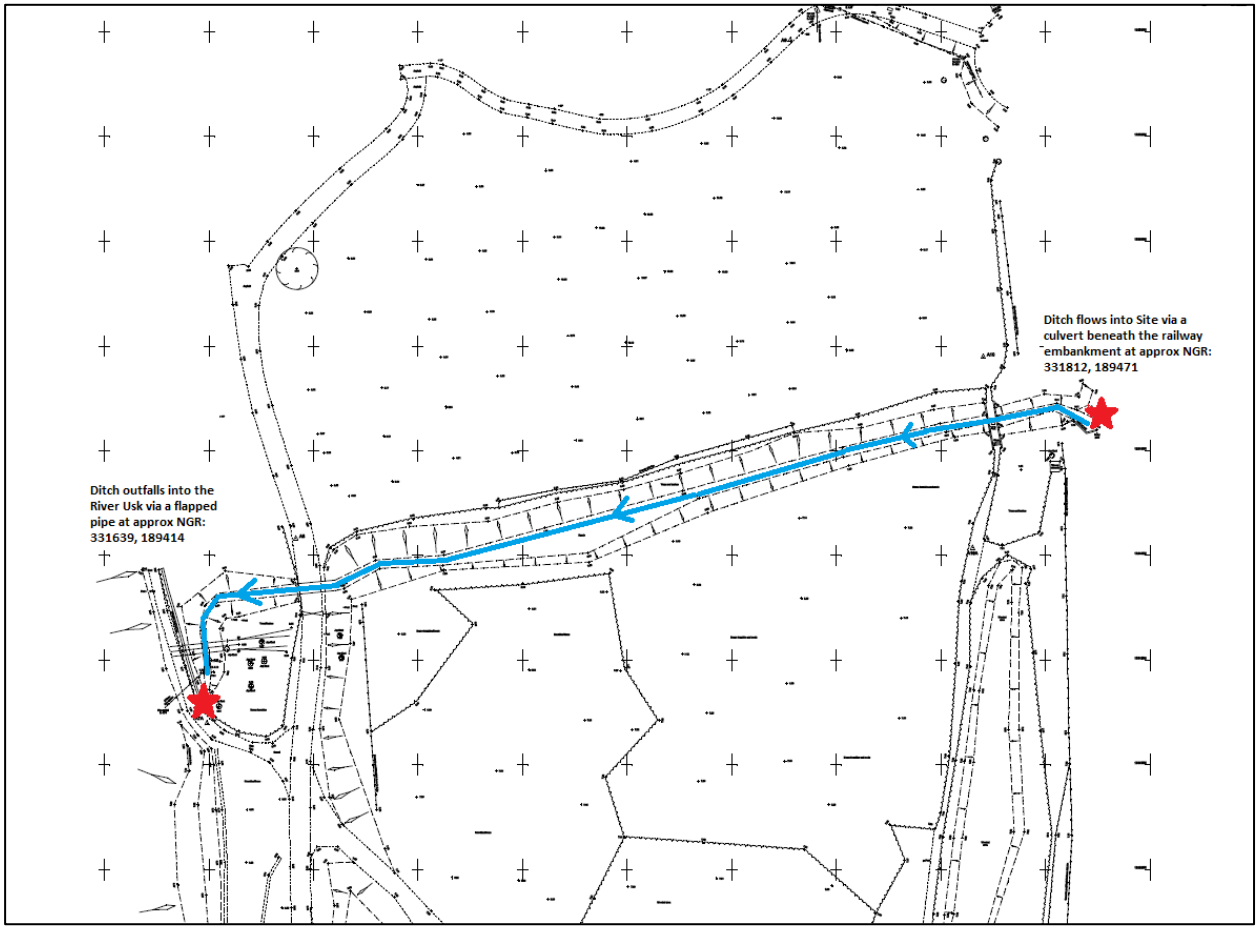

Figure 2: Extract from Topographical Survey

2.2 Proposed Development

It is proposed to construct 242 no. dwellings within the Site. Vehicular access to the Site will be via a new dedicated access route along the narrow strip of land running from the Site to Collier Street. A proposed Site layout plan is included in Appendix B herewith. It is proposed to raise ground levels within the Site in order to mitigate against the predicted flood risk emanating from an extreme tidal event in the adjacent River Usk. The detailed FCA for the Herbert Road Site was based on comprehensive hydraulic modelling of the River Usk. The model outputs were subsequently used to propose that the external levels of the Site will be set at 9.8m AOD, with building slabs set at 9.95m AOD.

The majority of the length of the existing watercourse will be retained as open channel, however a small section of culvert is required in order to provide vehicular access to the northern part of the site. A low lying vegetated area is also proposed to the immediate south of the watercourse, which would provide flood storage in the event of extreme flood flows.

It is proposed to install a flap-valve on the culvert that conveys the watercourse beneath the riverside walkway, as well as upsize the existing culvert to a 2.5m diameter. This will prevent tidal waters backing up the watercourse during extreme tidal events.

2.2.1 Consented Scheme

The Herbert Road Site benefits from an extant planning permission. The proposed development is located within the 'Glebelands' site H(5), which is designated as a main source of housing land within the Newport Deposit Plan 2011-2026. It is detailed in the Deposit Plan that the Glebelands Site has 'existing commitments for residential development'.

In October 2000 outline planning permission was granted for the construction of a replacement primary school with ancillary play areas, together with the proposed residential development on the site located at the 'Glebelands'. The Newport Deposit Plan recognises that the Site is at risk of flooding during an extreme flood event and highlights that the Site will need to be raised so as to 'ensure adequate flood risk management levels are achieved'. The Extant Planning Permission permits the Site to be raised to 9.8m AOD with building slabs set at 10.4m AOD. The replacement primary school has now been constructed. This planning consent has been implemented by virtue of the construction of the primary school.

Newport City Council have provided their initial comments regarding the proposals as part of a screening opinion for residential development. They highlight that '*a large part of the site lies within a defended floodplain (C1) as identified in the Welsh Government's Development Advice Maps. It will be necessary to show that the effects of tidal flooding can be acceptably managed on the site. If land raising is proposed the impact of flood water displacement and run-off effects should be taken into account.'*

With consideration of the extant planning permission the detailed Flood Risk Assessment, which was carried out to assess the flood risk from the River Usk, used the consented scheme for the 'baseline' scenario. The proposed scenario was then compared to the consented scenario when assessing the impact of water displacement and third party effects. The principle of this development has already been accepted and the details under consideration have been the subject of extensive consultations and discussion. This separate study of the ordinary watercourse will take the same approach, and use the consented scheme to form the 'baseline' scenario.

The Planning Permission Notice of Decision (31/10/2000) does not include any details pertaining to the proposed arrangement of the ordinary watercourse and or the drainage of surface water. Drawing No. TP-01 Rev A, included in Appendix C herewith, was submitted with Application No. 03/1531 for the 'Erection of a replacement Primary School, all weather pitch, soft and hard play areas and residential development' and which was granted permission in May 2004. It can be seen that the proposed layout does not include the ordinary watercourse, and it is assumed that it would have been culverted as part of the proposals.

In light of the lack of detail, some assumptions have been made to allow for a comparison between the proposed and the consented schemes. It is assumed that the consented scheme will have inserted a culvert between the existing 2m diameter pipe culvert and the eastern boundary of the Site to convey the watercourse beneath the development.

It is currently general policy that no watercourse should be culverted unless there is an overriding need to do so due to the implications of a potential blockage; maintenance and ecological degradation. It is clear therefore that the current proposals to retain this watercourse in open channel will create additional storage capacity when compared to the consented scheme. It will also ensure that the development can be completed in line with the current watercourse culverting policy.

Notwithstanding this, the controlling influence on flood levels for both the consented and the proposed scenario will be the restriction posed by the 2m diameter culvert, regardless of whether the inlet is located at its present location or at the eastern boundary of the Site. For the purposes of this study, the consented scenario retains the ordinary watercourse in open channel. Therefore, the ordinary watercourse is represented within the consented model using a z-shape based on the topographic survey data. The same z-shape is also used to represent the ordinary watercourse for the proposed and the existing scenarios.

3. Hydrological Regime

3.1 Ordinary Watercourse

In order to better understand the flow regime for the ordinary watercourse, a flow monitoring survey was carried out. Trueflow Surveys Ltd was subsequently instructed to carry out a flow survey with the aim of providing information regarding flow rates in the culverted watercourse. The monitoring location selected was the junction of Archer Street and Margaret Street. The general objective of the study was to record flow rates arriving at the point to establish the response to rainfall events at the selected measurement point.

A total of 45 days survey work was carried out from 4th July to 18th August 2013. During this time a number of rainfall events occurred resulting in increased flow rates in the culverted system.

The survey work was carried out using 1 sewer flow monitor and 1 rain gauge.

The flow data indicated that during dry weather the flow rate in the culvert is generally less than 5 l/s. In storm conditions the flow rates reached a maximum of 225 l/s. The results of the Survey are included in Appendix D herewith.

An assessment of the catchment area of the ordinary watercourse indicates that it drains an area of circa 4.865 hectares. The catchment area is heavily urbanised and drains the residential area of St Julians to the east of the Herbert Road Site. The watercourse is culverted for a length of some 500m between St Julians Avenue and the Site. The watercourse then enters the Site via a culvert beneath the railway embankment. It was noted during the monitor installation that the cross section of the culvert changed to rectangular downstream of the chamber and that the height of the culvert changed from 1050 mm circular to approximately 350 by 1050 mm rectangular, as shown in Figure 3 below.

Figure 3: Sewer Cross-section at monitoring location; (1) Looking upstream from monitoring location; (2) Looking downstream from monitoring location

The watercourse flows through the Herbert Road Site in open channel for a length of approx. 180m before discharging into the River Usk via a flapped pipe of 0.575m diameter. Along the open channel section, the ordinary watercourse is conveyed beneath the newly constructed pedestrian access route into the Glan Usk School Site via a circular culvert of 2m diameter. It has also been assumed that the area to the north of the Site encompassing the 'Glebelands' and the new Glan Usk School site drains into this watercourse, although the exact location of the connection cannot be established.

3.2 Flow Data

The data collected from the monitoring survey was used to estimate the return periods for the two storm events that occurred during the monitoring period. The results are presented in Table 1 below;

	Storm Event 1	Storm Event 2
Measured average rainfall intensity	5.1mm/hr	13.6mm/hr
Equivalent storm approx.; Return Period	0.5 year	1 year
Storm Duration	120 mins	60 mins
Summer Average rainfall intensity	6.5mm/hr	12.8mm/hr
Modelled catchment area*	4.78ha	4.38ha
* Matching the hydrographs of measured and predicted flows (concentrating on peak flows rather than average flows)		
NB. Using FSR Parameters; M5-60 = 20.000mm; Ratio R = 0.318		

Table 1: Summary of the results derived from the flow monitoring survey data

Using the results presented above, and the relevant FEH catchment descriptors for the estimated catchment extent, peak flow estimates for the 1.0% annual probability storm event were calculated using Windes. An increase of 30% was then added to the peak flow estimates to account for climate change.

Furthermore, peak flow estimates have also been generated for the Glan Usk School Site. Unfortunately the drainage layout drawing was unavailable for the school development and as such we have no evidence of connectivity to the open channel/culvert. However, connectivity has been assumed in order to provide a conservative estimate of the watercourse's capacity. An assessment of the as-built external works drawing for the Glan Usk School indicates that the Site comprises an impermeable area of 1.85ha.

The results are presented in Table 2 below;

	Peak flow estimates for the 1.0% probability storm + 30%		Peak flow estimates for the 0.1% probability storm	
	Summer	**Winter**	**Summer**	**Winter**
Drainage Channel	0.9 cumecs	0.99 cumecs	1.17 cumecs	1.29 cumecs
Glan Usk School Site*	0.69 cumecs	0.56 cumecs	0.88 cumecs	0.72 cumecs
* The hydrographs for the 60min storm have been used so as to coincide with the peak baseflow				

Table 2: Peak flow estimates for the drainage channel

Peak flows from the school site are between 0.56-0.69 cumecs during a 1.0% probability storm + 30%. Combined with the baseflow in the open channel this corresponds with the flat 2m diameter culvert used to convey the watercourse beneath the newly constructed pedestrian access route into the Glan Usk School Site, which is likely to have been designed to accommodate these two flows plus an allowance for appropriate freeboard.

4. Hydraulic Modelling

In order to assess the flood risk associated with the drainage ditch for the proposed development, a small hydraulic model was constructed for the watercourse using ESTRY-TUFLOW.

The model was based on the larger River Usk model, which was supplied to WTD to assess the flood risk to the Herbert Road Site from extreme tidal events in the adjacent River Usk. The model was trimmed to encompass the Herbert Road Site and the ordinary watercourse. The channel was then modelled in the 2d domain, with the pedestrian access culvert and the outfall pipe modelled using the 1d element. The topographical survey data was used to specify the culvert dimensions, and a z shape was used to define the channel invert and the top of bank.

The proposed layout drawings for the consented and the proposed schemes were used to generate a DTM for each scenario using the PDS ground modelling software. The resultant grids were then read into the model via the tgc file for the relevant model simulations. An additional z-shape layer was used to represent the building slab levels for the proposed scenario to ensure that the model represented FFLs at 9.95m AOD.

A 2d grid size of 1m was utilised; it is considered that this resolution provides a good representation of the ditch and topographical features, which are typically 5-20m wide.

4.1.1 Ordinary Watercourse 1d_Nwke

As described in Section 2.2.1, it has been assumed that the ordinary watercourse channel for the existing, proposed and consented scenarios is the same. The ditch enters the Site via a 350 by 1050 mm rectangular culvert and then flows in open channel for approx. 180m where it outfalls into the River Usk via a length of culvert of 0.575m diameter. Along the open channel reach, a small pedestrian footbridge spans the ditch at NGR 331789, 189466. The ditch is also conveyed beneath the pedestrian walkway at the north western boundary of the Site via a 2m diameter pipe culvert. A Site walkover by WTD staff confirmed that this pipe culvert is not flap-valved, and survey data indicates that the upstream invert level is 6.03m AOD. It is clear therefore, that with a peak MHWS Tide Level of 6.45m AOD for the present-day, and 7.5m AOD for 2114, water levels in the River Usk will back up this watercourse and the ditch is considered to be tidally influenced. For the existing and the consented scenarios, this culvert has been modelled as Type 'C' to represent the fact that water can flow both upstream and downstream through the structure. However, for the proposed scenario, it is modelled as Type 'CU', to represent the proposals to flap-valve this structure to protect against extreme tide levels in the River Usk.

For the proposed scenario, the culvert has also been upsized from 2m diameter to 2.5m diameter. A Manning's Value of 0.015 is assigned to the culvert, which is an appropriate value for clear straight concrete pipe culverts.

4.2 Model Inflows

The model inflow data was applied directly to the 2d domain using a 2d_bc layer. In order to represent the flow within the watercourse, an inflow point was applied immediately downstream of the railway culvert. A second inflow point was also applied to the 2d domain immediately upstream of the pedestrian access culvert to represent the flow input from the Glan Usk Schol Site, which is assumed to flow into the ditch before it outfalls into the River Usk. Both inflows were assigned Type 'QT'. The hydrographs calculated using Windes were used to model the inflows.

The model's downstream boundary has assumed a tide level within the River Usk channel corresponding to Mean High Water Spring Tide levels. A tidal curve was derived by extracting the time-series data generated by the NRW River Usk model for the MHWS Tide event in the River Usk (MHWST2011_002F_580_TS). The nearest 1d node to the watercourse's outfall location is USK08125.1;

the results data for this node was subsequently used to provide the downstream model boundary. An additional 1.05m was added to the tide profile to account for climate change up to 2114 for the 1.0% APE model simulations.

The inflow hydrographs were specified so that the peak flows coincided with the peak levels within the River Usk. This provides a conservative assessment of flood risk for the watercourse.

4.3 Model Results

Modelling has shown that the capacity of the watercourse is sufficient to convey flow for the predicted 1.0% probability storm, with 30% applied to account for climate change. Drawing Nos. CIV13980-C-SA-90-2001-A02 and CIV13980-C-SA-90-2002-A02, which are included in Appendix E herewith, illustrate the maximum flood depths before and after development respectively for the 1.0%+CC APE.

Model outputs confirm that the capacity of the watercourse is also sufficient to convey flow for the 0.1% probability storm. Drawing No. CIV13980-C-SA-90-2004-A02, which is included in Appendix E herewith, illustrates the maximum flood depths for the proposed scenario during the 0.1% APE. It can be seen that the floodwaters are retained in-channel, and do not encroach onto the proposed development plateau. It is intended to enhance the watercourse to provide a wildlife/ecology buffer zone and activity walks, which will link in with some green open space. The conveyance capacity of this channel is sufficient to accommodate any waters backing up as a result of tide-lock. Model results indicate that the culvert structures are appropriately sized to allow water to discharge into the River Usk without causing water to back-up and spill into the Herbert Road Site.

Drawing No. CIV13980-C-SA-90-2007-A01, which is included in Appendix E herewith, shows that when the proposed scenario is compared to the consented scenario for the 1.0%+CC APE, a general betterment is observed with peak flood levels some 30-80mm lower for the proposed scenario.

Drawing No. CIV13980-C-SA-90-2005-A02, which is included in Appendix E herewith, illustrates that there is some impact on flood levels in the watercourse during the 1.0%+CC APE as a result of the development proposals, when compared to the existing scenario. The maximum flood extent from the ordinary watercourse is retained within the channel, and floodwaters are not diverted off site. It is noted that peak flood levels are raised locally within the Herbert Road Site, however, due to the restricted capacity of the upstream culvert and the elevated ground levels the other side of the railway it is considered that the increased water surface elevations at this location will not impact on flood levels upstream. Survey data shows that the invert level of the culvert outlet is circa 6.6m AOD. Upstream of this, the culvert extends for a length of 1243m to the inlet at St Julian's Avenue. LiDAR data indicates that ground levels at the culvert inlet are circa 15.9m AOD.

4.4 Disposal of Surface Water

TAN 15 requires that consideration be given to the disposal of surface water emanating from the proposed development site to ensure the development does not increase the risk or magnitude of flooding to other parties.

It is understood that the site's existing land drainage system currently drains to the aforementioned watercourse which subsequently discharges into the River Usk.

TAN 15 requires all new developments to consider, and where possible incorporate, the use of Sustainable Urban Drainage Systems (SuDS) to effectively dispose of surface water emanating from the Site. Due to the nature of the ground beneath the existing Site, it is unlikely that the use of soakaways will be appropriate for the development proposals, and therefore other SuDS options should be considered.

The next most desired method of surface water disposal is by means of a discharge to the watercourse.

The levels of the on-site watercourse and its outfall into the River Usk means that they are tidally influenced, and in this respect an increase in the rate of surface water runoff/discharge from the site into the watercourse should have negligible impact on third parties.

It should be noted that the hydraulic modelling carried out for the ordinary watercourse uses a conservative approach, which assumes that the peak of the summer storm hydrograph for the Glan Usk School Site occurs simultaneously with the peak of the winter storm hydrograph for the entire catchment of the ordinary watercourse. An additional 30% has been added to both hydrographs to account for climate change. Furthermore, these occur simultaneously with the peak of a mean high water spring tide event, which has also been adjusted to account for sea level rise for 100 years (i.e 1.05m is added to the present-day value). In reality, it is extremely unlikely that this will happen. The storm hydrograph for the Glan Usk School Site has a total duration of less than 1 hour, compared to just over 1 hour for the entire catchment of the ordinary watercourse.

Figure 4 illustrates the modelled water level at three of the 1d nodes for the proposed (blue line) and the existing (red line) scenarios. It can be seen that for a period of circa 1 hour, peak water levels are raised locally within the watercourse during the proposed scenario compared to the existing scenario. However, modelling has shown that this difference is accommodated within the channel and does not affect third party land/property off-site. Furthermore, it can be seen that the peak water level in the watercourse is circa 8m AOD. It is proposed to set the development plateau at 9.8m AOD which leaves a considerable degree of freeboard and/or additional capacity. It is therefore proposed that surface water will have free discharge into the ordinary watercourse.

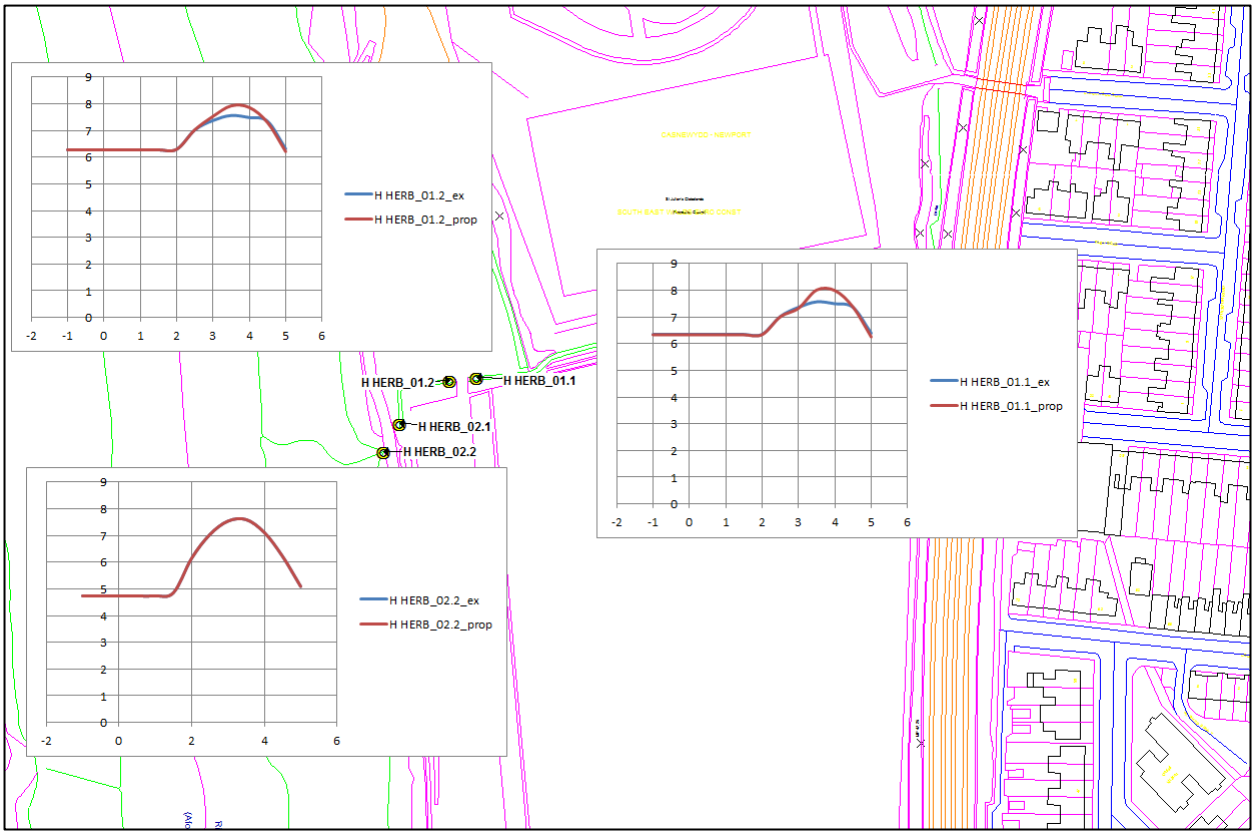

Figure 4: Modelled water surface elevation for the proposed and the existing scenario.

5. SUMMARY ASSESSMENT

- It is proposed to increase the existing 2m culvert beneath the river walkway to 2.5m diameter, as well as insert a flap valve at the pipe outlet.
- Modelling has shown that the proposed Site layout does not affect the conveyance capacity of the existing drainage ditch that runs through the Site.
- Floodwaters are retained within channel and do not encroach onto the proposed development plateau, which is to be raised to 9.8m AOD.
- Hydraulic modelling has shown that the proposed scenario provides betterment in terms of peak flood levels when compared to the consented scheme.
- The development proposals will increase the coverage of impermeable surfaces with a resultant increase in surface water runoff. As the use of soakaways is not likely to be feasible then surface water emanating from the proposed development should discharge to the watercourse in the northern half of the site.

APPENDICES

A. TOPOGRAPHIC SURVEY

Key to Abbreviations

Asp.	Asphalt
B	Bollard
BB	Bellshe Beacon
BH	Bush
Bk.	Brick wall
Br.	Brick wall
BT	British Telecom Cover
BW	Barbed Wire
CB	Telephone Control Cabinet
CB	Cave Boarded
CCTV	Closed Circuit Television
COP	Cable Diver Pit
CI	Corrugated Iron
CL	Cover Level
CL	Chain Link
CP	Chestnut Paling
Conc.	Concrete
Elec.	Electricity Inspection Cover
El Sub Stn	Electricity Sub Station
EP	Electricity Pole
ER	Earth Rod
FH	Fire Hydrant
FW	Foul Water
G	Gully
Gab.	Gabion Wall
GV	Gas Valve
IC	Inspection Chamber
IL	Invert Level
IR	Iron Railings
LB	Litter Bin
LL	Lamb Lap
LP	Lamp Post
MH	Manhole
Mtr	Meter
PR	Post and Rail
RE	Rodding Eye
RS	Road Sign
RWP	Rain Water Pipe
SL	Sump Level
SL	Stone Wall
SV	Stop Valve
SW	Surface Water
TL	Traffic Light
TOW	Top of Wall
TP	Telegraph Pole
TV	Cable Television Cover
UTL	Unable to Lift
VP	Vent Pipe
WL	Water Level
WM	Water Meter

LINE TYPES

- Building
- Canopy
- Edge of Surfaces
- Embankments and ditches
- Fences
- Overhead cables
- Vegetation
- Walls, Kerbs etc.
- Hedges

Kerb levels are channel levels unless otherwise stated.

Notes

Sheet Layout

North Point

All levels related to-
Ordnance Survey Datum derived by GPS.

Title
HERBERT ROAD,
NEWPORT.

Client
GREEN HILL

Scales- H.T.S.@A0	Dates- October 2012
Surveyed by-D Michell-Jones	Checked by- A H Davies
Drawing Number- 2396	Rev.

DAVIES
SURVEYS LIMITED
2 Ynys Bridge Court, CARDIFF, CF15 9SS
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Email: info@daviessurveys.co.uk
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B. PROPOSED SITE LAYOUT

EXISTING RAILWAY LINE

R I V E R U S K
(A F O N W Y S G)

Works

Works

MORGAN STREET

TS Resolute
(Newport Sea Cadet Corps)

PLOT SCHEDULE

	799 HOUSE TYPE _ 5 PERSON 3 BEDROOM	-	30
	910 HOUSE TYPE _ 5 PERSON 3 BEDROOM	-	28
	877 HOUSE TYPE _ 5 PERSON 3 BEDROOM	-	28
	666 HOUSE TYPE_4 PERSON 2 BEDROOM	-	30
	TRYFAN HOUSE TYPE _ 5 PERSON 3 BEDROOM	-	14
	PRESELI HOUSE TYPE _ 4 PERSON 2 BEDROOM	-	8
	BRECON HOUSE TYPE _ 4 PERSON 2 BEDROOM	-	2
	FLATS_2 PERSON 1 BEDROOM FLAT TYPE	-	7
	FLATS_3 PERSON 2 BEDROOM FLAT TYPE	-	51
	FLATS_3 PERSON 2 BEDROOM ELDERLY FLAT TYPE	-	6
	FLATS_2 PERSON 1 BEDROOM FLAT TYPE	-	6
	FLATS_3 PERSON 2 BEDROOM FLAT TYPE	-	6
	FLATS_3 PERSON 2 BEDROOM ELDERLY FLAT TYPE	-	12
	FLATS_3 PERSON 2 BEDROOM FLAT TYPE	-	20
	TOTAL	-	248

0M 10M 50M

PRELIMINARY

Client

Contract
Development at Herbert Road
NEWPORT

Description
PROPOSED SITE LAYOUT

Scale	Date
1:500 @ A0	Nov '12
Dwg No.	Revision
sw49 (04) 01	

Greenhill
BUILDING AN AFFORDABLE FUTURE
The Greenhouse,
Esperanto Way,
Newport. NP19 0RD
Telephone (01633) 290159
Fax (01633) 508835

C. DRAWING NO TP-01 REV A

VIEW POINT
Primary node marking transition from more open greenspace of the boulevard between the school and motorway and the housing to the south. To include seating, cycle racks and interpretation point. Area to have protective railings.

RIVERSIDE WALK
Bound gravel footpath and cycle way continues along the riverside flanked with grassed spaces and swathes of native tree and shrub planting. Providing a visually enhanced outlook for residents in the adjoining development and walkers/cyclists alike.

REEN & POND
Reen widened to form shallow pond with gentle side batters (or protected timber retaining to footpaths) and firm base. Potential for ecological value to be developed.

MAINTENANCE ACCESS
Access gates to provide for ping-pong access to playing field.

INFANT YARD PLAY AREA
Indigenous planting within boundary fence as education resource. Also to screen play area from public riverside zone. Bound gravel quiet teaching spaces with living willow screens to provide shade.

New housing access road with integrated pavement/cycle route provides for drop off facility in inclement weather.

NURSERY PLAYGROUND
Separate free formed play by gated 'fun' screen, with coloured rubberised surfacing.

PLAYING FIELD
70x40m with perimeter zone

MOUNDED AMPHITHEATRE
Mounding to create viewing area for sports events/ informal recreation space. Area forms impectant visual setting to school.

Footpath and cycle-way link through space to riverside

VILLAGE GREEN
Shared school and housing use, providing part of the development greenspace and enhancing community links. Access gates in school fencing to allow space to be used as infant play area. All access points to the green to have self-closing gates.

Reen diverted and culverted

SCHOOL ENTRANCE
To incorporate steel pergola, block paving and amenity planting. School alignment to emphasise entrance and links with community. Provision for schools 'Knowledge is Power' placard.

EMERGENCY VEHICLE ACCESS ROUTE
Mesh reinforced grass roadway allows for discrete provision of an emergency vehicle link via the new access road to the housing through to the hard stand and school access road.

JUNIOR SOFT PLAY AREA
Planting and mounding to separate play area from service road and create outdoor class space

Turning head for emergency vehicles and deliveries to kitchens etc

ACCESS ROAD
Flanked with 69 designated school parking spaces including 7 disabled parking bays

STORAGE BUILDING
To provide secure containment for kitchen and school waste bins, and separate storage for school outdoor activity equipment.

Maintenance works and new woodland planting to be undertaken to existing embankment to allotments to improve quality of environment, enhance ecological and wildlife value and provide safe, secure, sustainable boundary to the school.

Security fence set within new indigenous tree and shrub planting

Overflow car park

COVERED COLLECTION POINT
For Parents after school

SITE BOUNDARY BUFFER
Indigenous and native tree and shrub planting to be integrated to adjoining industrial and railway boundaries with new housing development, providing a dual noise and visual buffer to the site.

'PERCENT FOR ART' FEATURE
To include pedestrian access and incorporate School signage and community notice board

PEDESTRIAN UNDERPASS
Underpass to be upgraded to enhance pedestrian security.

To housing end, the existing planting to be removed and a raised block paved table to be formed. Security of 'blind wings' to be improved for those accessing from the school by railings to either side.

To school side, pedestrian safety to be enhanced by providing railings to prevent access to railway line. Formed circular green with circle of trees adjoined by surfaced art feature area provides for a school and community meeting place.

WESTBURY

SCHEDULE OF ACCOMMODATION

WESTBURY HOMES LIMITED

Apartments,

1 Bedroom apartment		36
2 Bedroom apartment		12
AN	ANVIL	4
BL	BLACKSMITH	1
FO	FORGE	6
BT	BICESTER	4
HO	HORSESHOE	4
LEI	LEICESTER	9
W	WORCESTER	2
RT	RICHMOND	4
BR	BRIDLE	2
TOTAL		84

BARRATT

BARRATT HOMES LTD.

FAL	FALKIRK,	12,
PL	PALMERSTONE,	11,
DT	DERWENT,	6,
WO	WOODCOTE,	10,
GL	GLOUCESTER,	5,
WM	WINDERMERE,	8,
K	KENTMERE,	16,
F/G	FLAT OVER GARAGE,	1,
TOTAL,		69.

NORTH

Development Control
- 2 APR 2004
Received

A: 30.3.04 To accord with LPA Reqts
rev. description initials/date

Client
BARRATT SOUTH WALES
WESTBURY HOMES

Job title
ST JULIANS
NEWPORT

GRANTED
19 MAY 2004

Drawing title
SITE LAYOUT

Scale	Date	Drawn	Checked
1:500	25.2.04	PB	MF
Job	Dwg		Revision
5369	TP-01		A

WynThomasGordonLewis
Town Planning • Architecture • Landscape Architecture
Urban Design • Economic Development
21 Park Place Cardiff CF10 3DQ
T: 029 2039 8681 F: 029 2039 5965 E: mail@wtgl.co.uk
E: pbrown@wtgl.co.uk

D. FLOW MONITORING SURVEY DATA

Trueflow Surveys Ltd

Flow Survey at Herbert Road Newport

July – August 2013

Data Report

Document ID TFS/287/d1/1

Trueflow Surveys Ltd

for

Waterman Transport and Development Ltd

Flow survey at Herbert Road Newport

Data Report

Report Number: TFS287/d1/1

July – August 2013

Prepared By :	D. Bright	Trueflow Surveys Sutton Lane Ogmore by Sea Bridgend
Checked By:	D. Bright	Mid Glamorgan CF32 0PE
Authorised By:	D. Bright	Tel: + 44 (0) 1656 880922

TABLE OF CONTENTS

1 INTRODUCTION

This report describes the results of a flow survey requested by Waterman Transport and Development Ltd to provide information regarding flow rates in a surface water sewer in the Herbert Road area at Newport. The monitoring location selected was the junction of Archer Street and Margaret Street. The general objective of the study was to record flow rates arriving at the point to establish the response to rainfall events at the selected measurement point.

A total of 45 days survey work was carried out from 4th July to 18th August 2013. During this time a number of rainfall events occurred resulting in increased flow rates in the drainage system.

The equipment deployed comprised of 1 sewer flow monitor and 1 rain gauge.

2 METHODOLOGY

2.1 Rainfall Data

Rainfall data was collected over the survey period. Results from the raingauge measurements are presented in this report. The gauge was a Casella tipping bucket raingauge connected to a Newlog data logger. The logger recorded the time to tip for each 0.2 mm of rainfall measured by the tipping bucket raingauge.

2.2 Flow Recording

Flow rates in the incoming surface water sewer were recorded with a Detectronic MSFM flow logger. The instrument packages were originally designed to meet a specification proposed by the Water Research Centre. The instruments measure both the velocity and the depth of flow within a sewer in order to take into account changes in water slope, backwater effects and surcharge. The sensors consist of a differential pressure transducer, monitoring depth and a Doppler shift velocity transducer

Calibrations were carried out on the equipment prior to installation, during the survey and after the loggers had been retrieved.

3 SURVEY OPERATIONS

3.1 Reference Controls

All times quoted in this report are in GMT. Units of measurement refer to the metric system.

3.2 Rainfall Measurements

Rainfall data was collected over the survey period using a tipping bucket raingauge linked to a data logger. The logger recorded the time to tip for each 0.2 mm of rainfall measured by the tipping bucket raingauge. The raingauge was located on the manhole cover at the flow monitoring location.

3.3 Flow Data Collection

A sewer flow logger was installed at a manhole chamber in the garden of a property under construction at the corner of Archer Road and Margaret Street. The logger was installed with the sensor located in the incoming 1050 mm dia concrete pipe as it approaches the chamber.

The flow and depth data was retrieved from the monitor on a daily basis using a GSM modem. At the office, this data is then uploaded to Software and Trainings' SSAS software for analysis. Within the SSAS software site details are inputted along with any corrections that have been recorded for depth and velocity.

3.4 Data Presentation

3.4.1 Event Periods

Data is presented as flow/depth plots for the full period and for 2 separate storm events:

Full Period
4th July to 18th August 2013

Storm event 1
2nd August 2013

Storm event 2
5th August 2013

3.4.2 Output

Appendix A comprises flow site location maps.

Appendix B comprises graphical flow depth and rainfall data

Appendix C comprises tabulated flow depth and rainfall data

Appendix D contains details of photographs of the site installation

Appendix E contains details of the manhole dimensions

All logged data is included in data files in MS Excel format.

4.0 RESULTS

4.1 Raingauge sites

4.1.1 General

Following installation and at the equipment removal, the raingauge was inspected with the aim of retrieving the data recorded and checking that the instrument was functioning correctly. The initial period was relatively dry but a number of short thundery rainfall events occurred during the first week of August.

4.1.2 Schedule of Raingauge Sites

Raingauges

Site No.	Location
1	Junction of Archer Street and Margaret Street Newport

Schedule of Available Rain data

	Full Period
1	*

* Data available.
*NR Data available, no rainfall.
DWF Dry Weather Flow Days.
LOST Data Lost.
CORR Corrupt Data (partial blockage of raingauge spout)
NR Not Required
? Data Suspect

4.2 Flow Monitoring Sites

4.2.1 General

Following the installation and at approximately daily intervals thereafter, data was retrieved from the flow monitors using a GSM modem. The data was inspected with the aim of checking that sediment and/or ragging had not smothered the probe and ensuring the probe had not been dislodged;

4.2.2 Performance of Flow Monitoring Sites

Detailed below is a schedule of the available flow data that summarises the recorded data for the selected events. This is followed by more detailed comments on the performance of each of the monitoring sites and accuracy of the data obtained. During dry weather the flow rate in the culvert is generally less than 5 l/s. In storm conditions the flow rates reached a maximum of 225 l/s.

It was noted during the monitor installation that the cross section of the sewer changed to rectangular downstream of the chamber and that the height of the culvert changed from 1050 mm circular to approximately 350 by 1050 mm rectangular.

It should be noted that the accuracy of the computed flows is plus or minus ten percent where the flow monitoring site has suitable hydraulic conditions and, where the velocity and depth measurements are within the threshold limits of the equipment. When this is not the case, the accuracy of the data, particularly the velocity data, can be reduced.

The publication, "*A Guide to Short Term Flow Surveys of Sewer Systems",* published by the Water Research Centre (WRc), describes in greater detail the potential limitations of flow monitoring sites where the site or hydraulic conditions are not ideal

The schedule of available data and the comments provided for each monitoring site highlight any limitations. Provided these are fully taken into account, the results obtained will provide valuable information on the magnitude of the flows, even at poor sites.

Schedule of Flow Sites

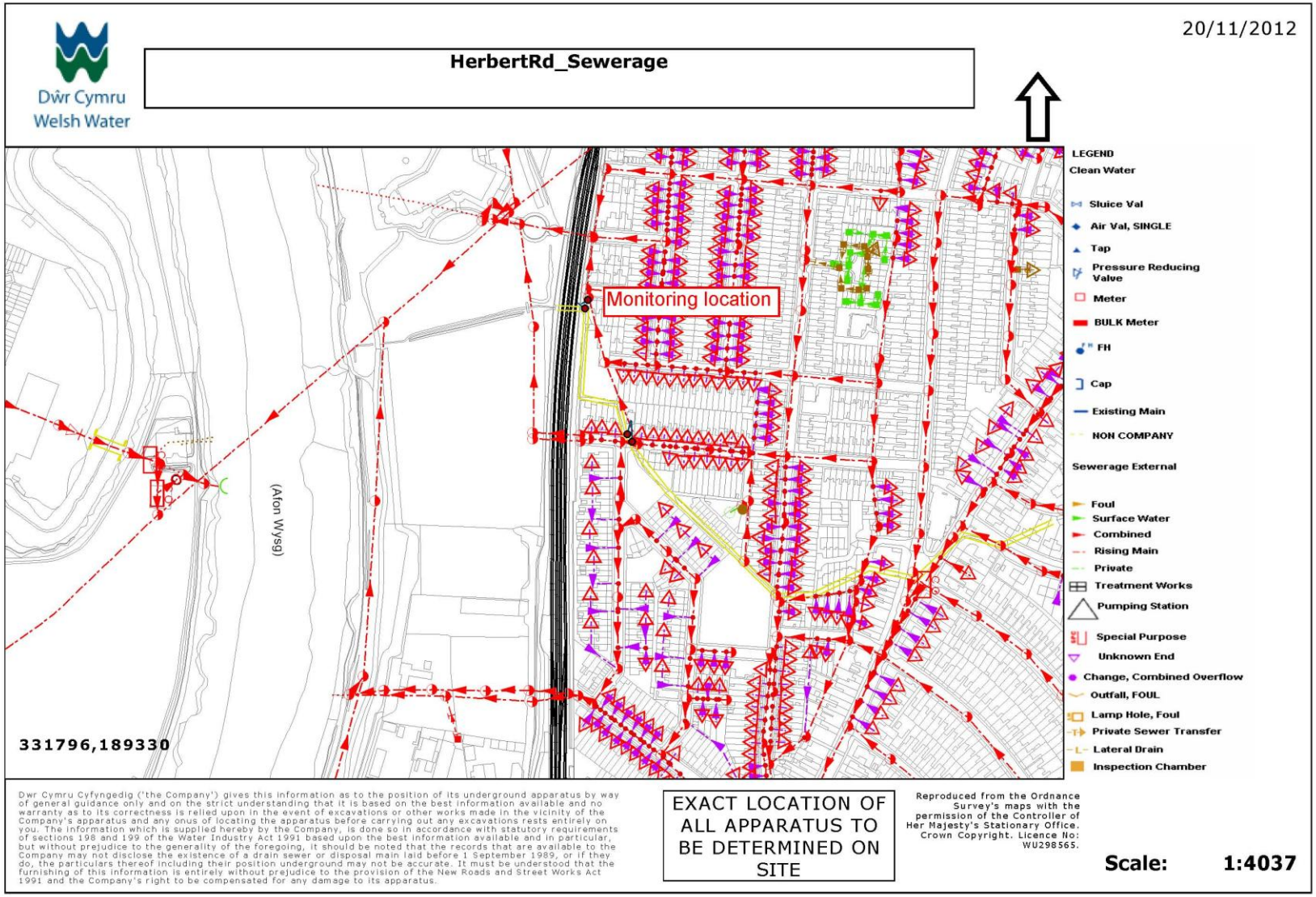
Flow Monitors

Site No.	Manhole No.	Location	Size (mm)	Shape	Monitor Position	Installation Date
1	N/A	Junction of Archer Street and Margaret Street Newport	1050	C	In	04/07/13

Schedule of Available Flow Data

Week No	Data Available
1	OK
2	OK
3	OK
4	OK
5	OK
6	Ok
7	Ok

Appendix A – Flow Monitoring Location

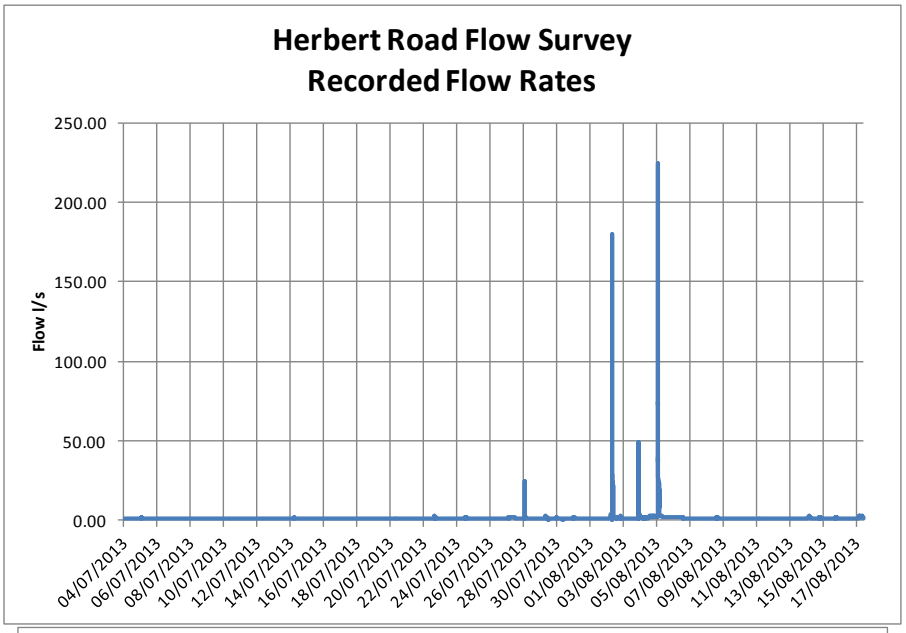

Dŵr Cymru
Welsh Water
20/11/2012
HerbertRd_Sewerage
Monitoring location
(Afon Wysg)
331796,189330
LEGEND
Clean Water
Sluice Val
Air Val, SINGLE
Tap
Pressure Reducing Valve
Meter
BULK Meter
FH
Cap
Existing Main
NON COMPANY
Sewerage External
Foul
Surface Water
Combined
Rising Main
Private
Treatment Works
Pumping Station
Special Purpose
Unknown End
Change, Combined Overflow
Outfall, FOUL
Lamp Hole, Foul
Private Sewer Transfer
Lateral Drain
Inspection Chamber
Dwr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the Company's apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. The information which is supplied hereby by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 based upon the best information available and in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a drain sewer or disposal main laid before 1 September 1989, or if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.
EXACT LOCATION OF ALL APPARATUS TO BE DETERMINED ON SITE
Reproduced from the Ordnance Survey's maps with the permission of the Controller of Her Majesty's Stationary Office. Crown Copyright. Licence No: WU298565.
Scale: 1:4037

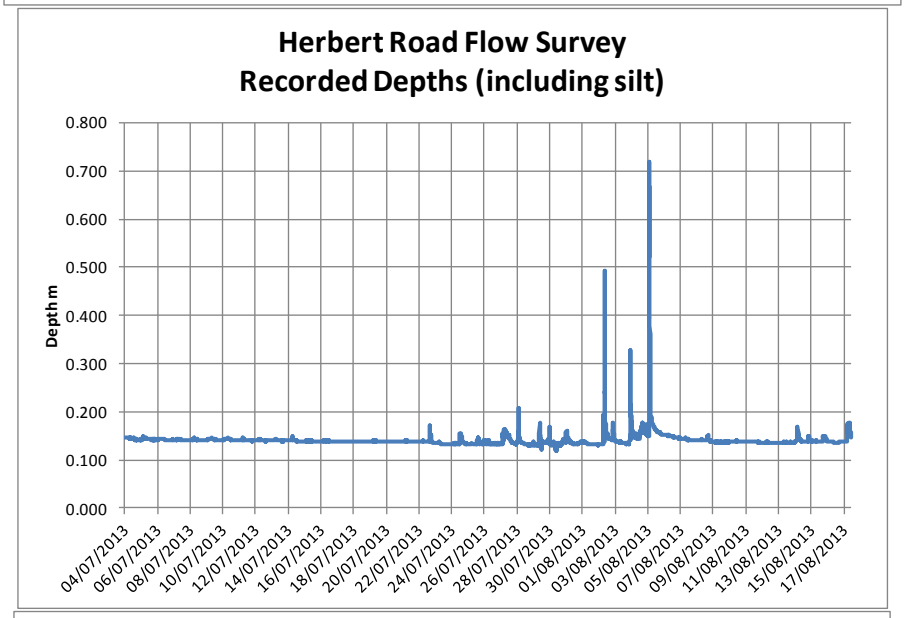
Appendix B – Graphical Flow and Depth and Rainfall Data

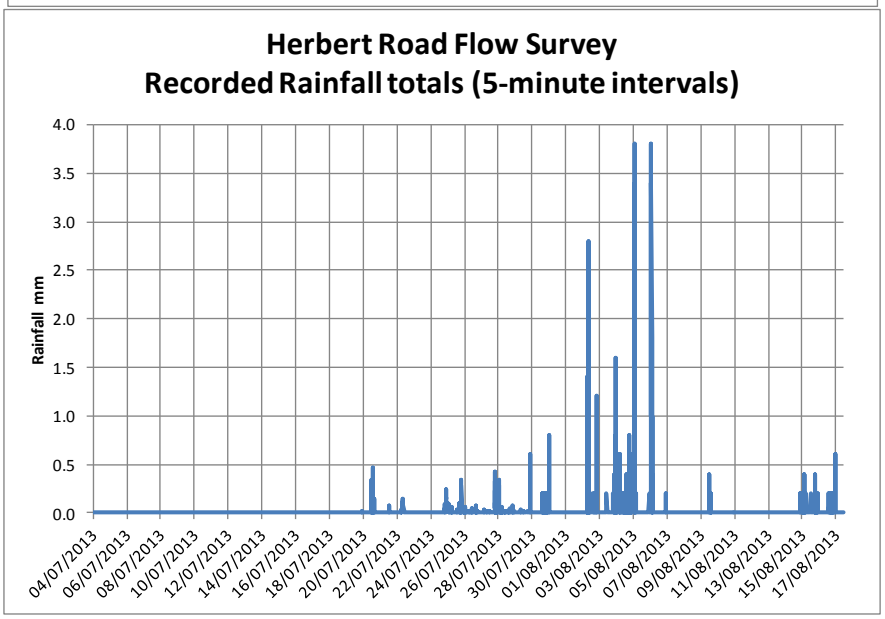
Full Period
4th July to 18th August 2013

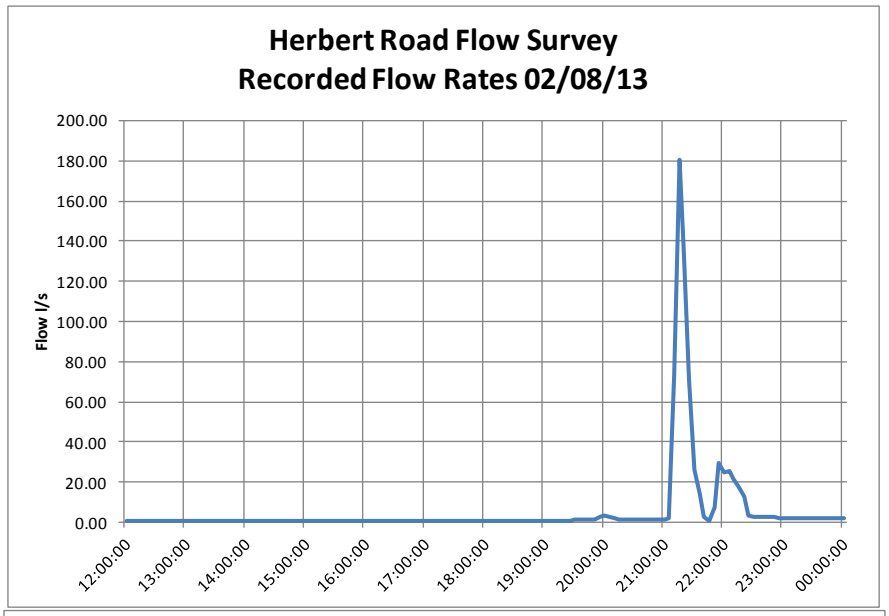
Storm event 1
2nd August 2013

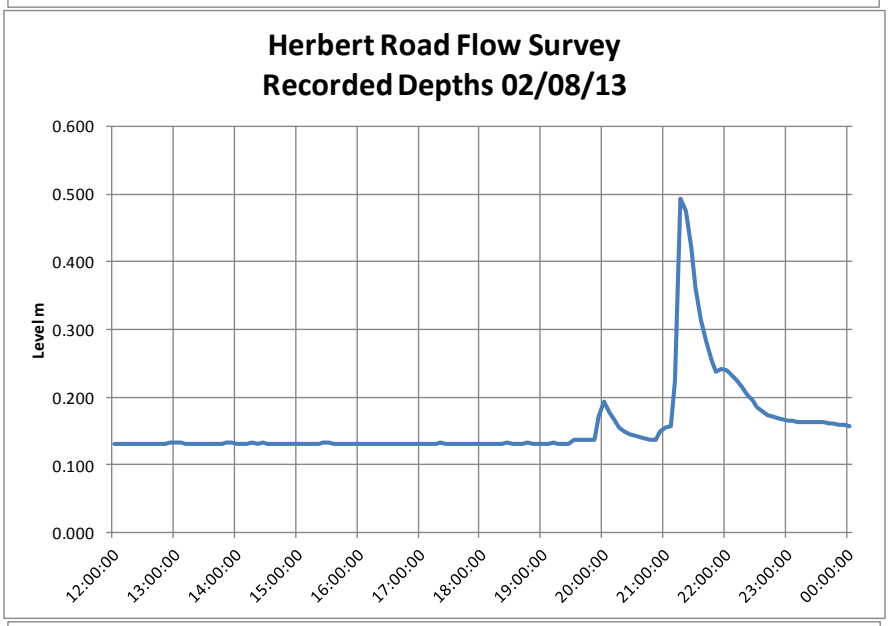
Storm event 2
5th August 2013

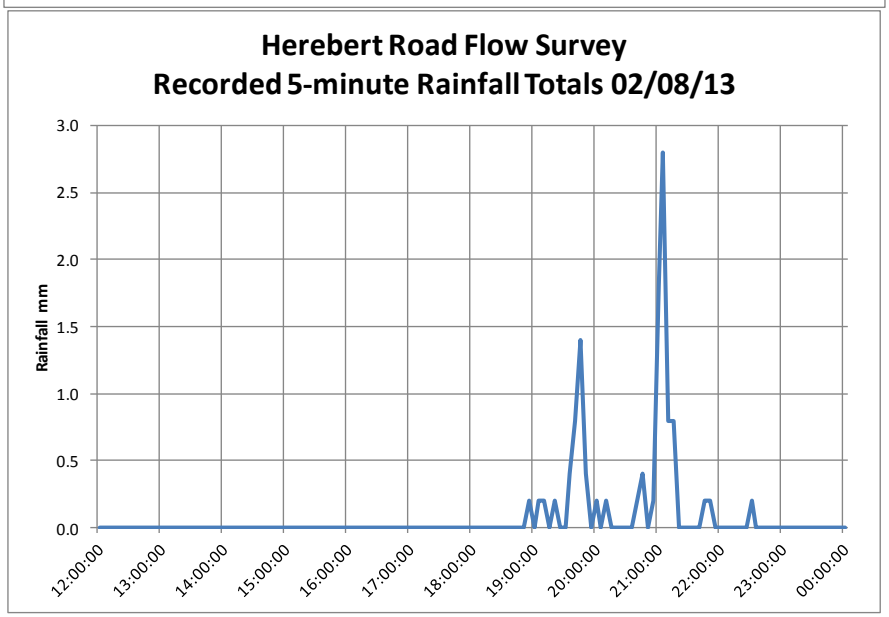

Herbert Road Flow Survey
Recorded Flow Rates
Flow l/s
250.00
200.00
150.00
100.00
50.00
0.00
04/07/2013
06/07/2013
08/07/2013
10/07/2013
12/07/2013
14/07/2013
16/07/2013
18/07/2013
20/07/2013
22/07/2013
24/07/2013
26/07/2013
28/07/2013
30/07/2013
01/08/2013
03/08/2013
05/08/2013
07/08/2013
09/08/2013
11/08/2013
13/08/2013
15/08/2013
17/08/2013

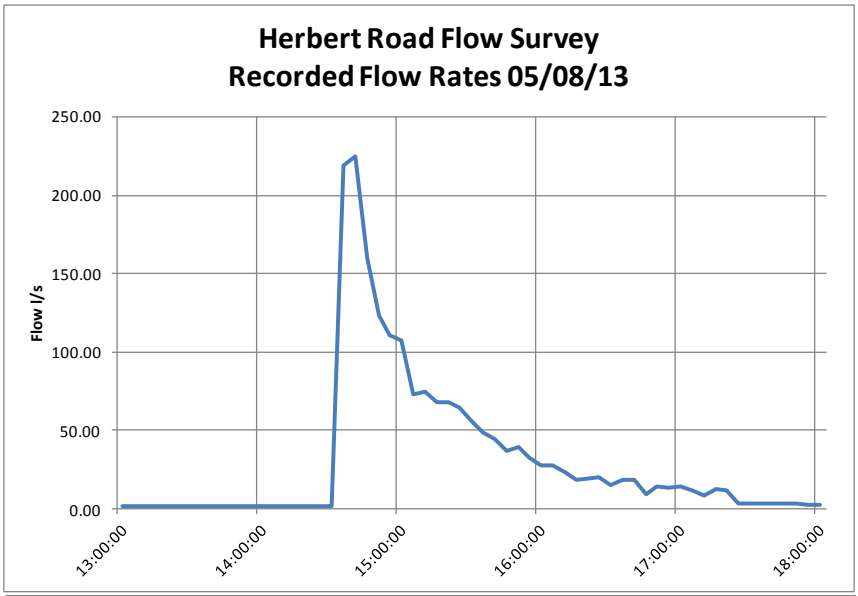

Herbert Road Flow Survey
Recorded Depths (including silt)
Depth m
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
04/07/2013
06/07/2013
08/07/2013
10/07/2013
12/07/2013
14/07/2013
16/07/2013
18/07/2013
20/07/2013
22/07/2013
24/07/2013
26/07/2013
28/07/2013
30/07/2013
01/08/2013
03/08/2013
05/08/2013
07/08/2013
09/08/2013
11/08/2013
13/08/2013
15/08/2013
17/08/2013

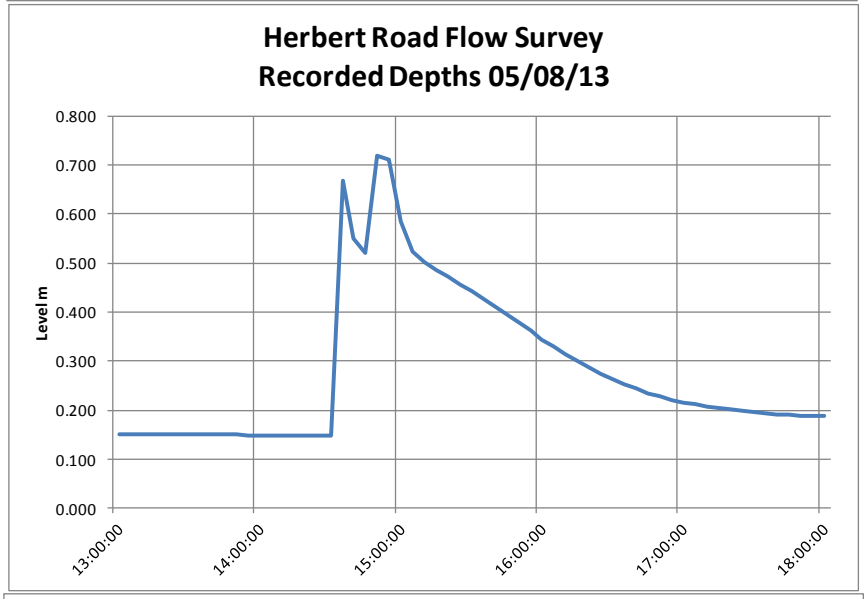

Herbert Road Flow Survey
Recorded Rainfall totals (5-minute intervals)
Rainfall mm
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
04/07/2013
06/07/2013
08/07/2013
10/07/2013
12/07/2013
14/07/2013
16/07/2013
18/07/2013
20/07/2013
22/07/2013
24/07/2013
26/07/2013
28/07/2013
30/07/2013
01/08/2013
03/08/2013
05/08/2013
07/08/2013
09/08/2013
11/08/2013
13/08/2013
15/08/2013
17/08/2013

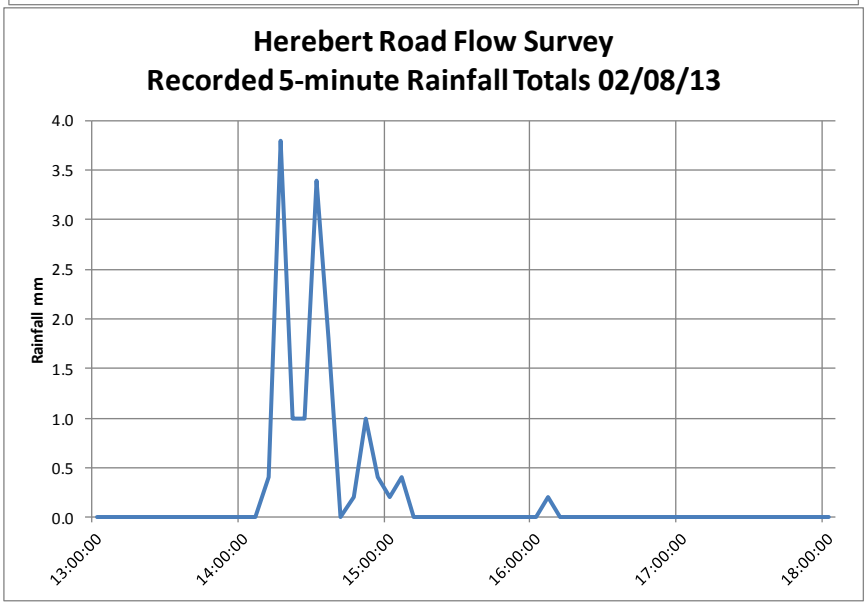

Herbert Road Flow Survey
Recorded Flow Rates 02/08/13
Flow l/s
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
00:00:00


Herbert Road Flow Survey
Recorded Depths 02/08/13
Level m
0.600
0.500
0.400
0.300
0.200
0.100
0.000
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
00:00:00


Herebert Road Flow Survey
Recorded 5-minute Rainfall Totals 02/08/13
Rainfall mm
3.0
2.5
2.0
1.5
1.0
0.5
0.0
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
00:00:00


Herbert Road Flow Survey
Recorded Flow Rates 05/08/13
Flow l/s
250.00
200.00
150.00
100.00
50.00
0.00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00


Herbert Road Flow Survey
Recorded Depths 05/08/13
Level m
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00


Herebert Road Flow Survey
Recorded 5-minute Rainfall Totals 02/08/13
Rainfall mm
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00

Appendix C – Tabulated Storm Event Data

Storm Event 1 – 02/08/13

Storm Event 2 – 05/08/13

Storm event 1 – 02/08/13

Date	Time	Flow Rate l/s	Depth mm	Rainfall mm	Cumulative rainfall mm
02/08/2013	18:55:00	1.01	0.132	0.2	0.2
02/08/2013	19:00:00	1.01	0.132	0.0	0.2
02/08/2013	19:05:00	1.01	0.132	0.2	0.4
02/08/2013	19:10:00	1.01	0.133	0.2	0.6
02/08/2013	19:15:00	1.01	0.132	0.0	0.6
02/08/2013	19:20:00	1.01	0.132	0.2	0.8
02/08/2013	19:25:00	1.01	0.131	0.0	0.8
02/08/2013	19:30:00	1.38	0.137	0.0	0.8
02/08/2013	19:35:00	1.38	0.138	0.4	1.2
02/08/2013	19:40:00	1.38	0.137	0.8	2.0
02/08/2013	19:45:00	1.38	0.137	1.4	3.4
02/08/2013	19:50:00	1.38	0.137	0.4	3.8
02/08/2013	19:55:00	2.54	0.172	0.0	3.8
02/08/2013	20:00:00	3.36	0.193	0.2	4.0
02/08/2013	20:05:00	2.54	0.178	0.0	4.0
02/08/2013	20:10:00	2.14	0.165	0.2	4.2
02/08/2013	20:15:00	1.75	0.155	0.0	4.2
02/08/2013	20:20:00	1.75	0.149	0.0	4.2
02/08/2013	20:25:00	1.38	0.145	0.0	4.2
02/08/2013	20:30:00	1.38	0.143	0.0	4.2
02/08/2013	20:35:00	1.38	0.141	0.0	4.2
02/08/2013	20:40:00	1.38	0.139	0.2	4.4
02/08/2013	20:45:00	1.38	0.137	0.4	4.8
02/08/2013	20:50:00	1.38	0.137	0.0	4.8
02/08/2013	20:55:00	1.75	0.149	0.2	5.0
02/08/2013	21:00:00	1.75	0.156	1.8	6.8
02/08/2013	21:05:00	2.14	0.158	2.8	9.6
02/08/2013	21:10:00	72.92	0.225	0.8	10.4
02/08/2013	21:15:00	180.48	0.493	0.8	11.2
02/08/2013	21:20:00	136.77	0.476	0.0	11.2
02/08/2013	21:25:00	71.29	0.421	0.0	11.2
02/08/2013	21:30:00	26.02	0.363	0.0	11.2
02/08/2013	21:35:00	14.42	0.315	0.0	11.2
02/08/2013	21:40:00	2.85	0.282	0.0	11.2
02/08/2013	21:45:00	0.64	0.255	0.2	11.4
02/08/2013	21:50:00	7.68	0.237	0.2	11.6
02/08/2013	21:55:00	29.28	0.242	0.0	11.6
02/08/2013	22:00:00	25.23	0.239	0.0	11.6
02/08/2013	22:05:00	25.54	0.233	0.0	11.6
02/08/2013	22:10:00	21.45	0.225	0.0	11.6
02/08/2013	22:15:00	17.83	0.215	0.0	11.6
02/08/2013	22:20:00	12.77	0.204	0.0	11.6
02/08/2013	22:25:00	3.36	0.195	0.0	11.6
02/08/2013	22:30:00	2.95	0.186	0.2	11.8
02/08/2013	22:35:00	2.95	0.180	0.0	11.8
02/08/2013	22:40:00	2.54	0.174	0.0	11.8

Storm Event 2 – 05/08/13

Date	Time	Flow Rate l/s	Depth mm	Rainfall mm	Cumulative rainfall mm
05/08/2013	14:10:00	1.75	0.149	0.4	0.4
05/08/2013	14:15:00	1.75	0.149	3.8	4.2
05/08/2013	14:20:00	1.75	0.148	1.0	5.2
05/08/2013	14:25:00	1.75	0.148	1.0	6.2
05/08/2013	14:30:00	1.75	0.148	3.4	9.6
05/08/2013	14:35:00	218.71	0.668	1.8	11.4
05/08/2013	14:40:00	224.78	0.552	0.0	11.4
05/08/2013	14:45:00	159.88	0.520	0.2	11.6
05/08/2013	14:50:00	123.37	0.718	1.0	12.6
05/08/2013	14:55:00	110.74	0.712	0.4	13.0
05/08/2013	15:00:00	107.25	0.585	0.2	13.2
05/08/2013	15:05:00	72.85	0.523	0.4	13.6
05/08/2013	15:10:00	74.80	0.501	0.0	13.6
05/08/2013	15:15:00	67.90	0.487	0.0	13.6
05/08/2013	15:20:00	67.72	0.472	0.0	13.6
05/08/2013	15:25:00	64.30	0.456	0.0	13.6
05/08/2013	15:30:00	56.54	0.443	0.0	13.6
05/08/2013	15:35:00	48.46	0.428	0.0	13.6
05/08/2013	15:40:00	44.25	0.412	0.0	13.6
05/08/2013	15:45:00	36.70	0.396	0.0	13.6
05/08/2013	15:50:00	39.17	0.379	0.0	13.6
05/08/2013	15:55:00	32.51	0.362	0.0	13.6
05/08/2013	16:00:00	27.50	0.345	0.0	13.6
05/08/2013	16:05:00	27.39	0.330	0.2	13.8
05/08/2013	16:10:00	23.32	0.315	0.0	13.8
05/08/2013	16:15:00	18.94	0.300	0.0	13.8
05/08/2013	16:20:00	19.25	0.287	0.0	13.8
05/08/2013	16:25:00	19.89	0.275	0.0	13.8
05/08/2013	16:30:00	14.85	0.263	0.0	13.8
05/08/2013	16:35:00	18.32	0.253	0.0	13.8
05/08/2013	16:40:00	18.22	0.244	0.0	13.8
05/08/2013	16:45:00	9.11	0.235	0.0	13.8

Appendix D - Photographs

Photo 1 – Looking upstream from measurement location

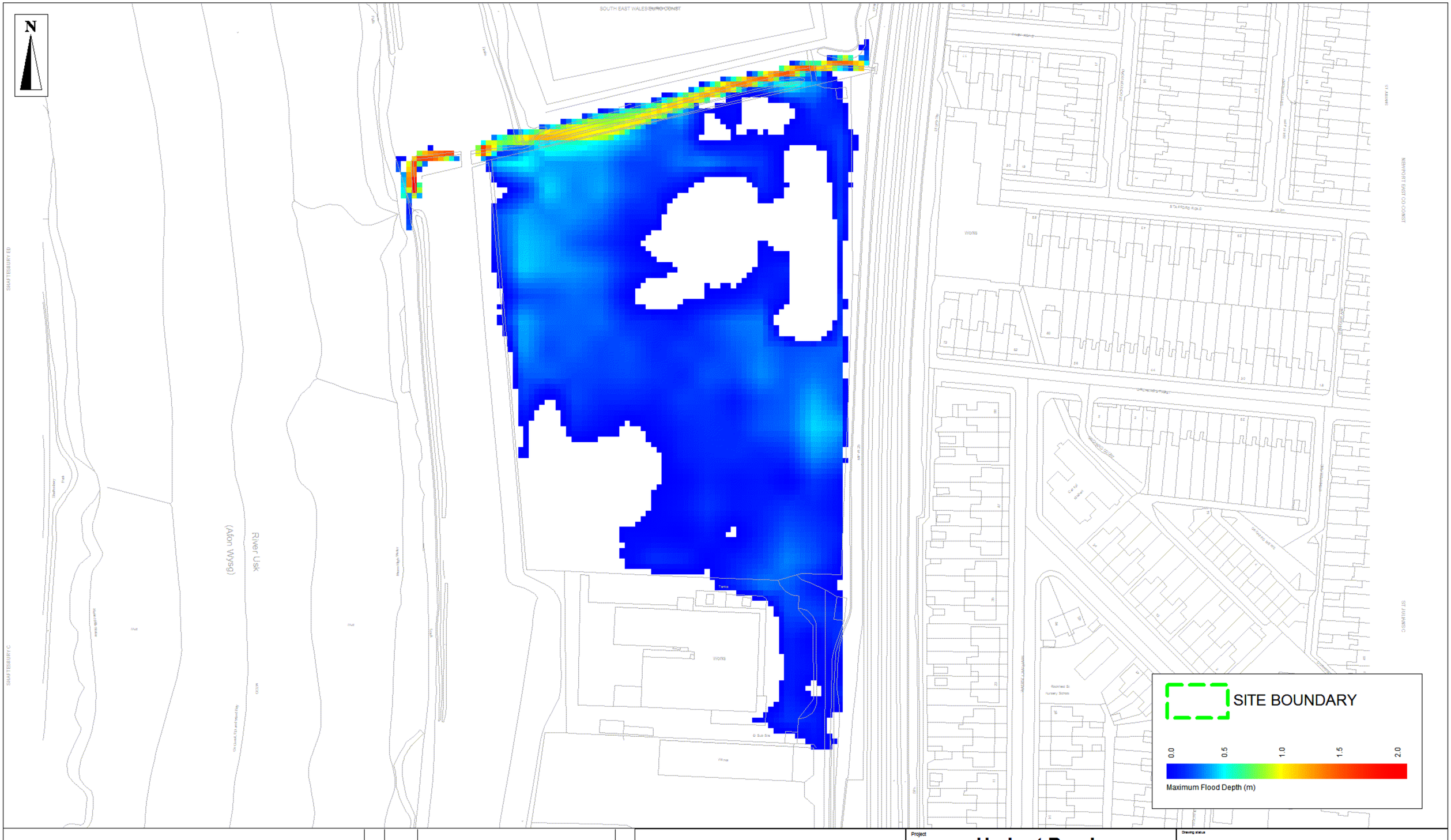
Photo 2 – looking downstream from measurement location
(Note severely restricted headroom for passage under roadway)

Appendix E – Manhole details and Pipe sizes

Site FM01

Site Number	1
Pipe Shape	Circular
Pipe Size	1050 mm
Hydraulics	Good
Silt	80mm
Normal Flow Depth	150 mm
Logging Rate	5 min

E. MODEL RESULTS



GENERAL NOTES

Rev	Date	Description	By
A02	26.03.14	SECOND ISSUE	LC
A01	21.11.13	FIRST ISSUE	LC

Amendments

Waterman
Transport & Development
38 Cathedral Road Cardiff CF11 9LL
t 029 2035 4400 f 029 2035 4544
mail@waterman-group.co.uk www.watermangroup.com

Project
Herbert Road

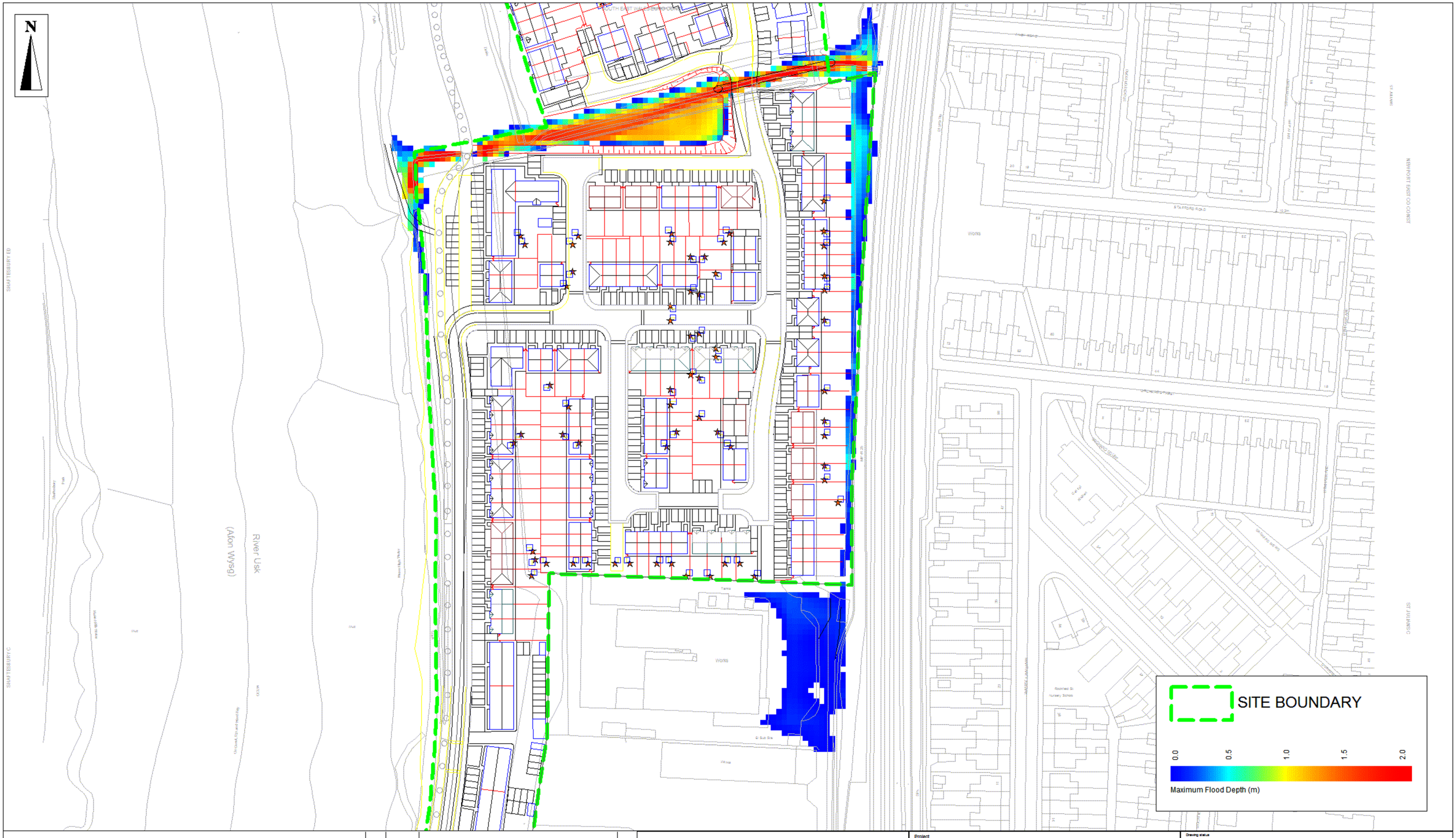
Title
Maximum Flood Depths for
Small Drainage Ditch
Existing Site Layout
1.0%+CC APE

Client
GREENHILL CONSTRUCTION

Drawing status
INFORMATION

Designed by LC	Checked by	Project No	CIV13980
Drawn by LC	Date MAR 2014		
Scales @ A3 work to figured dimensions only NTS		Computer File No	

Publisher	Zone	Category	Number	Revision
C	SA	90	2001	A02



GENERAL NOTES

Rev	Date	Description	By
A02	26.03.14	SECOND ISSUE	LC
A01	21.11.13	FIRST ISSUE	LC

Amendments

Waterman
Transport & Development
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Project
Herbert Road

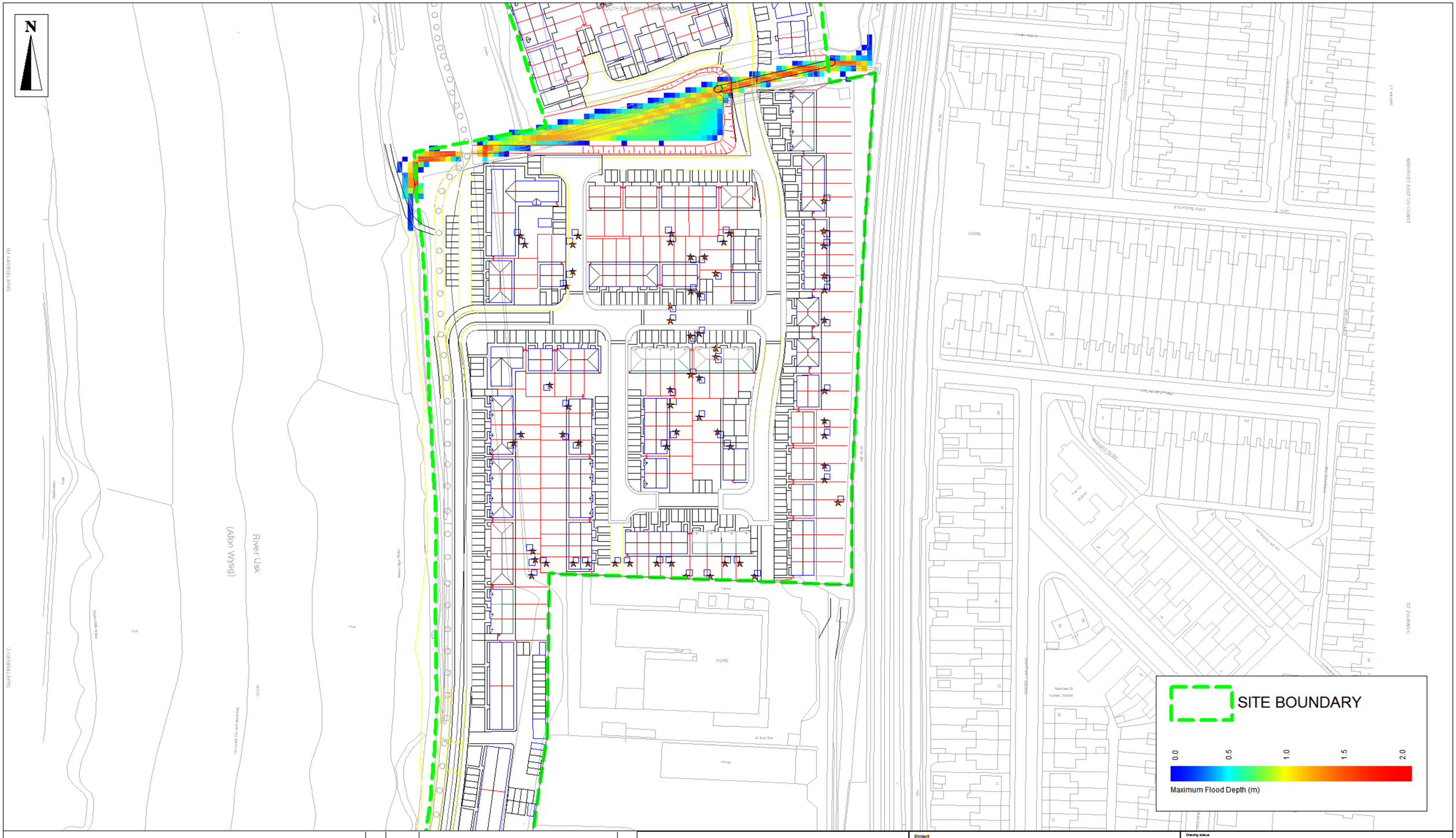
Title
Maximum Flood Depths for
Small Drainage Ditch
Proposed Development Layout
1.0%+CC APE

Client
GREENHILL CONSTRUCTION

Drawing status
INFORMATION

Designed by: LC	Checked by:	Project No: CIV13980	
Drawn by: LC	Date: MAR 2014		
Scales @ A3 (work to figured dimensions only): NTS		Computer File No:	

Publisher	Zone	Category	Number	Revision
C	SA	90	2002	A02



GENERAL NOTES

Rev	Date	Description	By
A02	26.03.14	SECOND ISSUE	LC
A01	21.11.13	FIRST ISSUE	LC

Amendments

Waterman
Transport & Development
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Project: **Herbert Road**

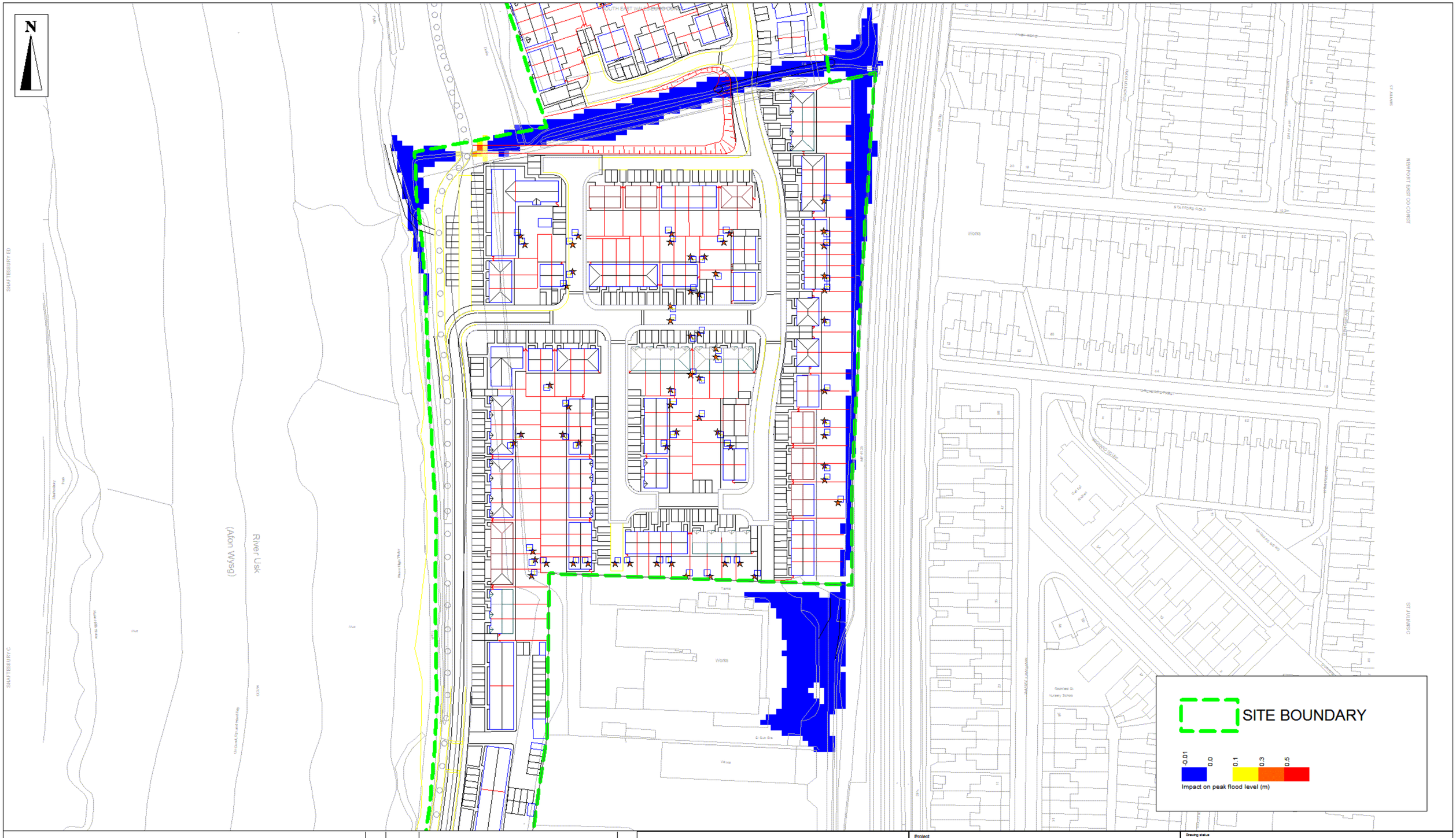
Title: Maximum Flood Depths for Small Drainage Ditch Proposed Development Layout 0.1% APE

Client: GREENHILL CONSTRUCTION

Drawing status: INFORMATION

Designed by: LC	Checked by:	Project No: CIV13980	
Drawn by: LC	Date: MAR 2014		
Scales @ A3: NTS (work to figured dimensions only)		Computer File No:	

Publisher	Zone	Category	Number	Revision
C	SA	90	2004	A02



GENERAL NOTES

Rev	Date	Description	By
A01	26.03.14	FIRST ISSUE	LC

Amendments

Waterman
Transport & Development
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Project: **Herbert Road**

Title: Comparison of Peak Water Levels Between the Proposed Scenario and the Consented Scenario 1.0%+CC APE

Client: GREENHILL CONSTRUCTION

Drawing status: INFORMATION

Designed by: LC	Checked by:	Project No: CIV13980	
Drawn by: LC	Date: MAR 2014		
Scales @ A3: NTS (work to figured dimensions only)		Computer File No:	

Publisher	Zone	Category	Number	Revision
C	SA	90	2007	A01

N

SITE BOUNDARY

-0.01 0.0 0.1 0.3 0.5

Impact on peak flood level (m)

GENERAL NOTES

Rev	Date	Description	By
A02	26.03.14	SECOND ISSUE	LC
A01	21.11.13	FIRST ISSUE	LC

Amendments

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38 Cathedral Road Cardiff CF11 9LL
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Project: **Herbert Road**

Title: Comparison of Peak Water Levels Between the Proposed Scenario and the Existing Scenario 1.0%+CC APE

Client: GREENHILL CONSTRUCTION

Drawing status: INFORMATION

Designed by: LC	Checked by:	Project No: CIV13980	
Drawn by: LC	Date: MAR 2014		
Scales @ A3 (work to figured dimensions only): NTS	Computer File No:		

Publisher	Zone	Category	Number	Revision
C	SA	90	2005	A02

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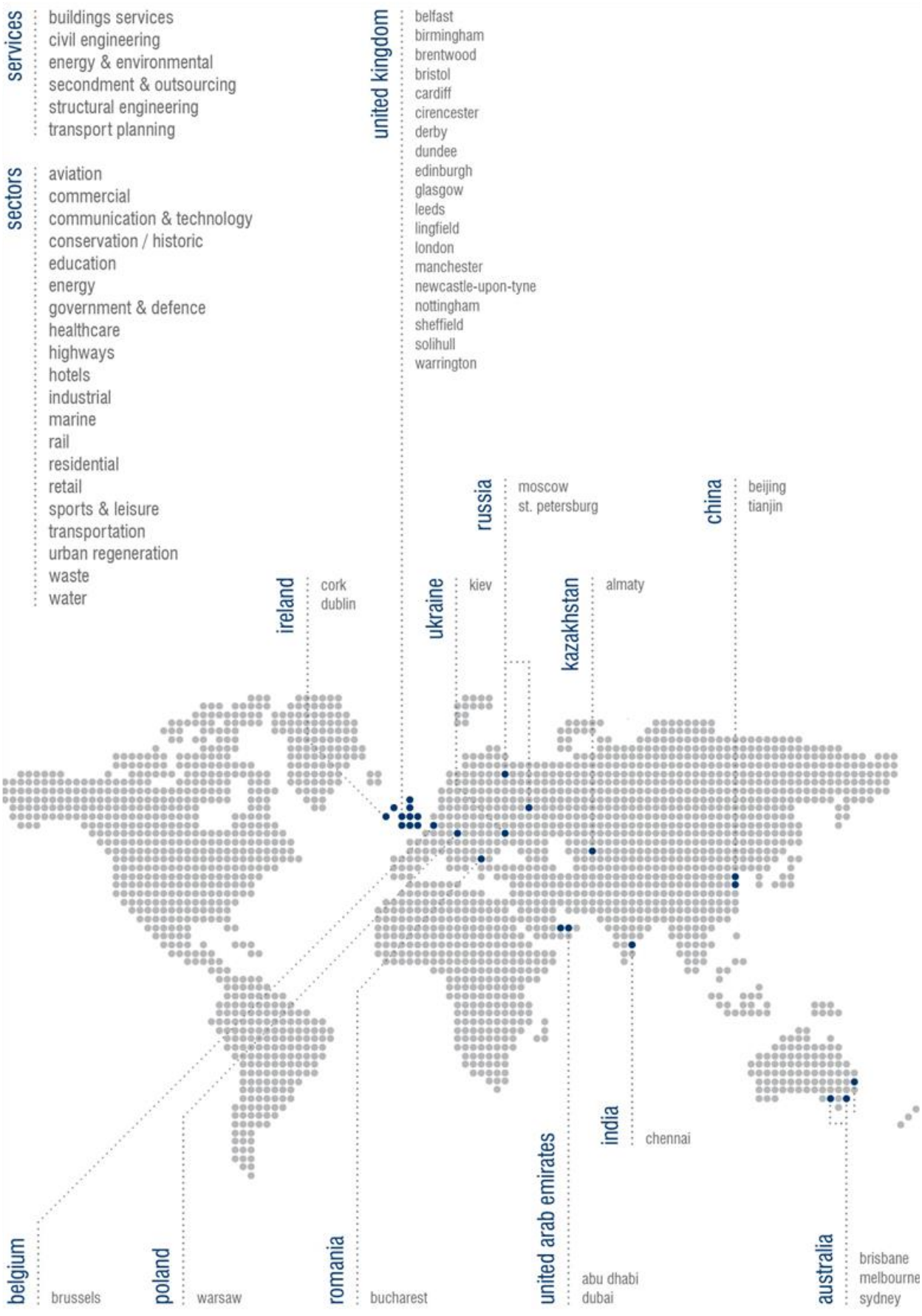
services
buildings services
civil engineering
energy & environmental
secondment & outsourcing
structural engineering
transport planning
sectors
aviation
commercial
communication & technology
conservation / historic
education
energy
government & defence
healthcare
highways
hotels
industrial
marine
rail
residential
retail
sports & leisure
transportation
urban regeneration
waste
water
united kingdom
belfast
birmingham
brentwood
bristol
cardiff
cirencester
derby
dundee
edinburgh
glasgow
leeds
lingfield
london
manchester
newcastle-upon-tyne
nottingham
sheffield
solihull
warrington
russia
moscow
st. petersburg
china
beijing
tianjin
ireland
cork
dublin
ukraine
kiev
kazakhstan
almaty
india
chennai
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abu dhabi
dubai
australia
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