



HILBRE ESTATES LTD

**THE NAGS HEAD PUBLIC HOUSE
CHESTER ROAD, LAVISTER**

FLOOD CONSEQUENCES ASSESSMENT

**OCTOBER 2013
Ref: 3918**

OFFICES AT:

26 Mostyn Road, Colwyn Bay, Conwy LL29 8PB
Tel: (01492) 533117 Fax: (01492) 530895
Email: broun@rba.ltd.uk

RICHARD BROUN
A S S O C I A T E S
Chartered Engineers & Architects

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APPENDICES

A: Drawings

Richard Broun Associates

- 3918/01 Site Location Plan
- 3918/02 Environment Agency Indicative Assessment of Flooding
- 3918/03 Welsh Assembly Government TAN 15 Development and Flood Risk Advice Map
- 3918/04 Existing Level Survey

McCormick Architecture

- A(200)01C Proposed Site Plan

Powers & Tiltman Ltd

- 6649/01B Topographical Survey

B: Photographs

C: Natural Resources Wales: Flood Maps

D: Hydraulic Analysis

E: Smith Grant: Site Investigation

F: Timber Slatted Fence Details

1.0 INTRODUCTION	
1.1 Purpose	This report records the results of a flood consequences assessment (FCA) for the erection of 7 detached dwellings on land to the rear of The Nags Head, Chester Road, Lavister. The assessment, which has been undertaken at the instruction of the Developer, has been prepared in accordance with the Planning Policy Wales Technical Advice Note 15: Development and Flood Risk, which was issued by the Welsh Assembly Government in July 2004.
2.0 EXISTING SITE USAGE/PROPOSED DEVELOPMENT	
2.1 Location	The proposed development is located in the centre of Lavister between Chester Road and the Lavister Brook, to the rear of the Nags Head Public House. According to the flood map prepared by Environment Agency Wales (EAW) the proposed development is located outside the fluvial flood plain. See Drawings 3918/01 & 02 in Appendix A and the photographs in Appendix B.
2.2 Development Advice Map (DAM) Classification	Zone A: defined by TAN15 as "areas considered to be at little or no risk of fluvial or coastal/tidal flooding". See Drawing 3918/03 in Appendix A. However despite the above classification Natural Resources Wales (NRW) have advised that the proposed development should be subject to an FCA as their flood maps do not take into consideration catchments smaller than 3km² (Lavister Brook catchment is approximately 1.7km²).
2.3 Existing Site Levels	Using Topographical/Lidar data, levels around the site range from 9.28m AOD to 10.04m AOD. See Drawing 3918/04 in Appendix A .
2.4 Existing Pedestrian / Vehicular Access Routes	Vehicular and pedestrian access to the site are both gained from Chester Road where channel levels are between 9.85m AOD and 9.89m AOD.
2.5 Estimated Fluvial Flood Levels	Information provided by NRW (included in Appendix C) shows the site to be outside the predicted flood outline for the Pulford Brook. An hydraulic analysis of the Lavister Brook has been undertaken in order to determine the potential for flooding of the site from this source. The result of this assessment is included in Appendix D .
2.6 Current Classification / Use	The site is currently undeveloped land and would therefore be defined by Section 5 TAN 15 as "less vulnerable development".
2.7 Proposed Classification / Use	"Highly vulnerable development" as defined by TAN 15. The proposed development comprises the erection of 7 detached residential dwellings.
2.8 Justification for Proposed Development	Section 6 of TAN 15 sets out "tests" for justifying the location of a development. In this case, it is considered that residential developments should be located on suitable land in Zone A. The potential consequences of a flooding event in terms of the criteria contained in Sections 5 and 7 and Appendix 1 of TAN 15 are considered below.

3.0 EXISTING DEFENCES	
3.1 Type	None
4.0 FLOOD RISK ANALYSIS	
4.1 Fluvial Inundation	The most likely cause of flooding of the site would be from the Lavister Brook when the flows are restricted due to flooding of the Pulford Brook. The outfall from the Lavister Brook into the Pulford Brook contains a flap valve, so if the Pulford Brook becomes flooded as a consequence of extreme storm conditions affecting the River Dee, water would be forced to back-up in the channel of the Lavister Brook. Calculations in Appendix D show that during 1.0% AEP (plus and allowance for climate change) and 0.1% AEP events the channel of the Lavister Brook can contain the peak flows associated with these storms, provided there are no blockages. Lidar and Topographical survey information show that ground levels to the east of the Lavister Brook are lower than those on the west. This would suggest that if a blockage of the watercourse were to occur then flood water would overtop the banks of the Lavister Brook and would likely drain away from the development site onto the golf course. Under these circumstances, depending on the severity of the blockage, it is possible that the edge of the development site would flood to shallow depths (say <150mm).
4.2 Climate Change	In accordance with NRW's current recommendations an allowance of 1% AEP plus 20% for the effects of climate change has been considered. Since no data is currently available for this scenario it is considered prudent to allow a 'freeboard' of 300mm to 600mm between the predicted 1.0% AEP flood level and the proposed finished floor level to cater for anticipated increases in flood level due to climate change.
4.3 Other Potential Flooding Mechanisms	Site investigations undertaken by Consultants (see Appendix E) indicate that the ground conditions are suitable for the disposal of surface water by infiltration devices. Even if, during extreme storm events, these facilities do not function effectively then any run-off from the site will drain to the fields to the south east. Levels around the building are slightly elevated from the adjacent road, therefore it is not anticipated that any surface water run-off will drain towards the existing building.
4.4 Proposed Floor Levels	If a blockage of the Lavister Brook were to occur it is estimated that the 1% + CC AEP flood level adjacent to the proposed development would be approximately 9.7m AOD. If 600mm 'freeboard' is added to this figure then the minimum finished floor level should be 10.3m AOD.

5.0 PROPOSED MITIGATION MEASURES	
5.1 General	The proposed development is shown on the Environment Agency's Flood Map to be outside of the flood plain for the 1.0% AEP and 0.1% AEP events.. However, given the proximity of the Lavister Brook, it is recommended that the following measures are incorporated into the development to protect the new dwellings during more extreme events.
5.2 Finished Floor Levels	The minimum finished ground floor level of the proposed buildings should be set at a level of 10.30m AOD approximately 600mm above the predicted flood level of the Lavister Brook (under blockage conditions).
5.3 Emergency Access / Evacuation Route	As any flooding of the site is likely to be relatively shallow and confined to the margin adjacent to the Lavister Brook, the rate of rise, speed of inundation and velocity of flood waters in any event is likely to be low. It is considered that there will be sufficient time for evacuation of the site (under exceptional circumstances). Emergency access/evacuation route is available along Chester Road (B5445).
5.4 Foundation / Superstructure Construction	The construction of the foundations and ground floor level of the new houses should allow for the possible future inundation of the site (in the event of an extreme storm more severe than 1.0% AEP). Techniques recommended by 'Preparing for Floods' issued by the Office of the Deputy Prime Minister in October 2003, should be adopted where applicable.
5.5 Services	Service entries and all electrical distribution boards/sockets etc should be located at a minimum height of 0.6m above finished ground floor level.
5.6 External Drainage	Access covers to any new manholes within the site should be fitted with locking devices which will prevent covers from being displaced by internal water pressure during flooding events.
5.7 Boundary Fences	Since it is possible that the edge of the site adjacent to the Lavister Brook may flood under a blockage scenario, the boundary fences between Plots 5, 6 & 7 should be constructed to avoid impeding any flood flows. A detail of timber slated fence is included in Appendix F.

6.0 SUMMARY

6.1 General

The flood outlines provided by the NRW suggests that the site is outside the fluvial flood plain. However this report shows that whilst the edge of the development site may flood to a shallow depth, the new dwellings will remain flood free during storm conditions up to 1.0% APE plus climate change.

Consideration has been given to the justification of this development in view of the potential risk to the occupants. It has been concluded that the tests set out in Sections 5 and 6 and Appendix 1 of TAN 15 can be satisfied and that, as a result, the risk to life and property can be properly managed.

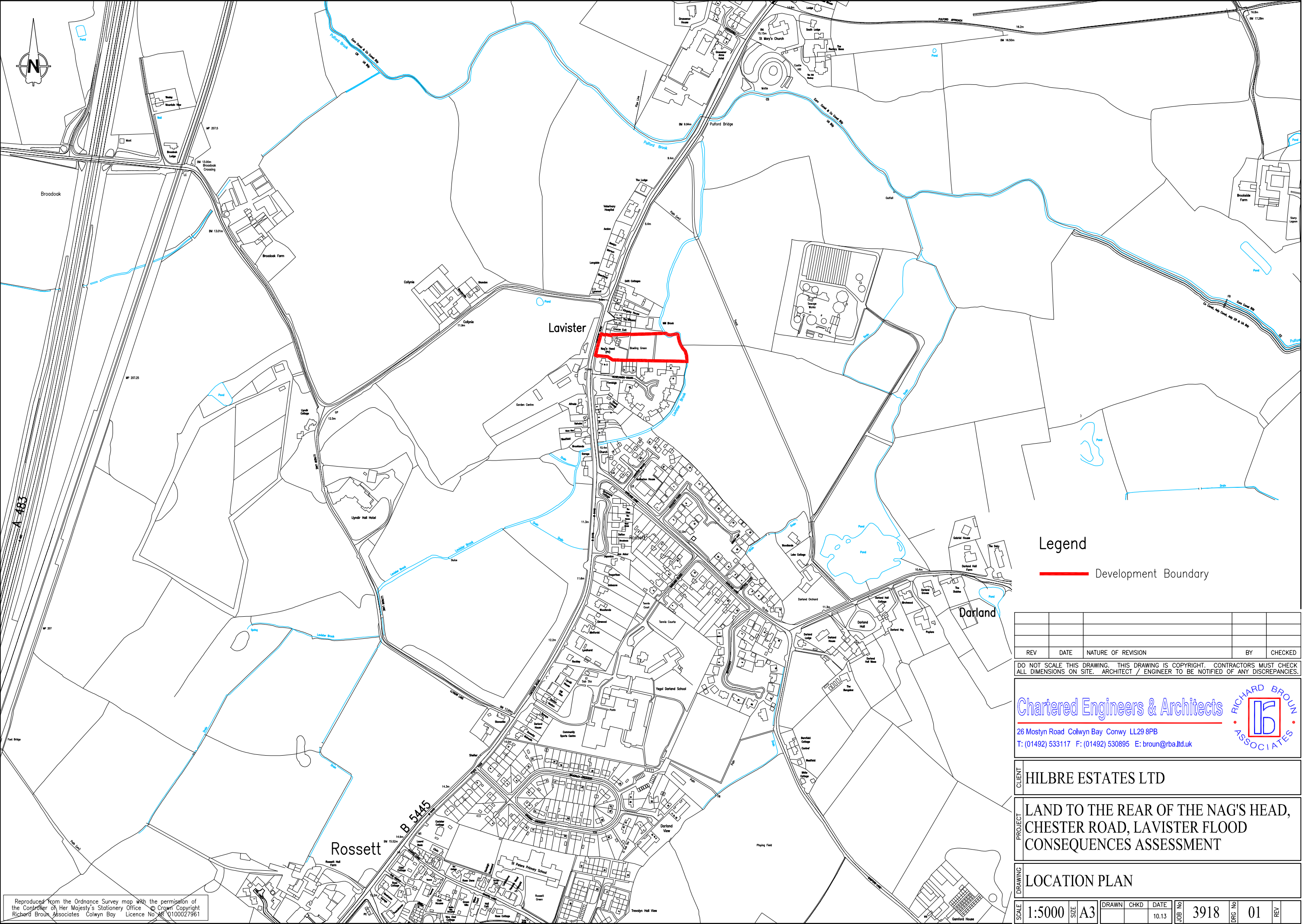
The consequences of any future flooding adjacent to the site have been assessed and mitigation measures incorporated into the development proposals to minimise the impact of any such event. The extent of these works is detailed in **Section 5.0** of this report.

A handwritten signature in black ink, appearing to read 'Richard Broun', is written over a horizontal line.

RICHARD BROUN ASSOCIATES
October 2013

APPENDIX A:

Drawings



Legend

Development Boundary

REV	DATE	NATURE OF REVISION	BY	CHECKED

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Chartered Engineers & Architects

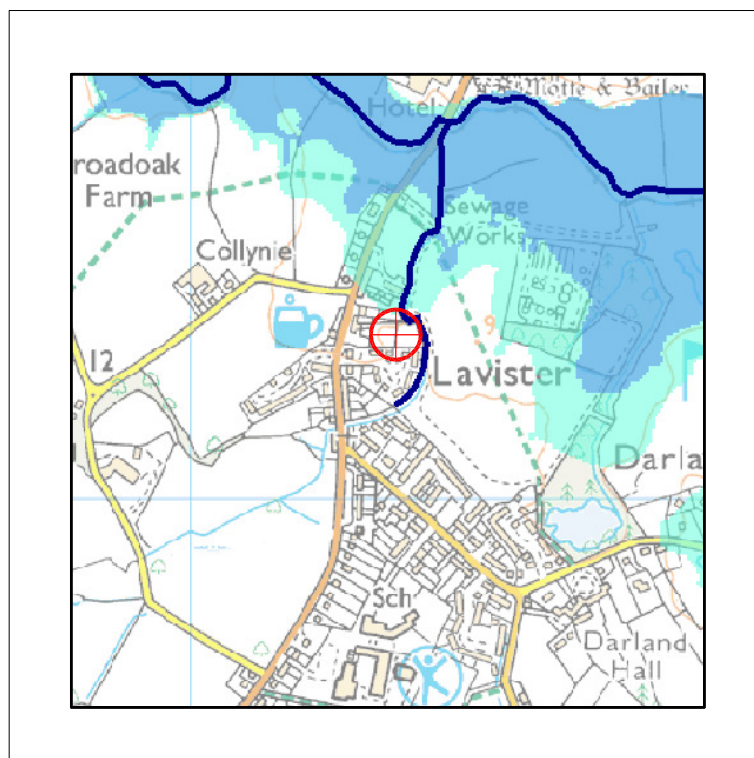
26 Mostyn Road Colwyn Bay Conwy LL29 8PB
T: (01492) 533117 F: (01492) 530895 E: broun@rba.ltd.uk



CLIENT	HILBRE ESTATES LTD
PROJECT	LAND TO THE REAR OF THE NAG'S HEAD, CHESTER ROAD, LAVISTER FLOOD CONSEQUENCES ASSESSMENT

DRAWING	LOCATION PLAN
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SCALE	1:5000	SIZE	A3	DRAWN	CHKD	DATE	10.13	JOB NO	3918	DRG NO	01	REV	
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Legend



The Site



Indicative assessment of flooding
for 100 year return period storms



Indicative assessment of flooding
for 1000 year return period storms

REV	DATE	NATURE OF REVISION	BY	CHECKED

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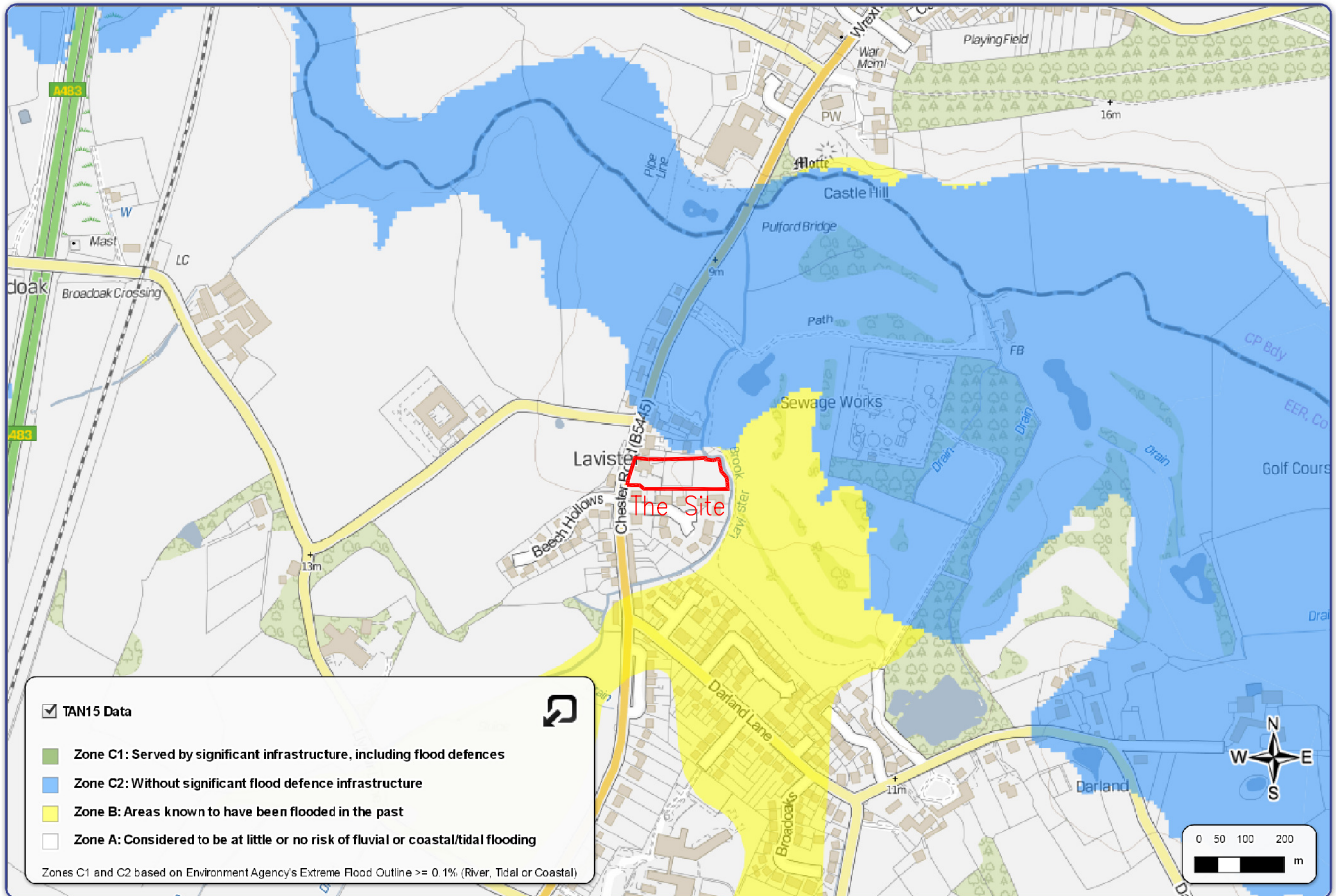
T: (01492) 533117 F: (01492) 530895 E: broun@rba.ltd.uk



CLIENT	HILBRE ESTATES LTD				
PROJECT	LAND TO THE REAR OF THE NAG'S HEAD, CHESTER ROAD, LAVISTER FLOOD CONSEQUENCES ASSESSMENT				
DRAWING	ENVIRONMENT AGENCY INDICATIVE ASSESSMENT OF FLOODING				
SCALE	1:20000	SIZE	A4	DRAWN	CHKD
				DATE	10.13
JOB No	3918	DRG No	02	REV	



TAN 15 Development and Flood Risk
Development Advice Map



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Developed by Cartographics, Welsh Government

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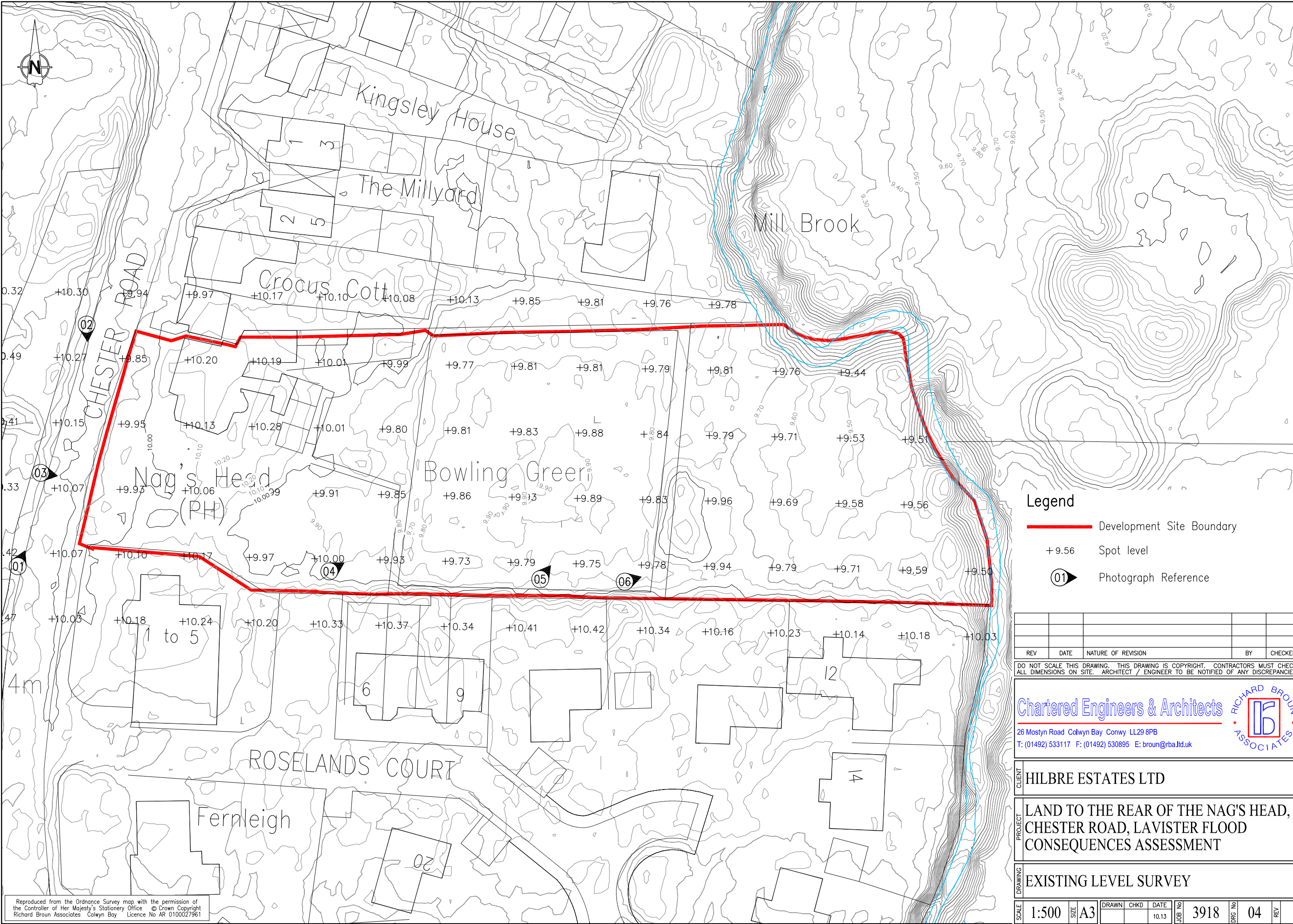
Chartered Engineers & Architects

26 Mostyn Road Colwyn Bay Conwy LL29 8PB

T: (01492) 533117 F: (01492) 530895 E: broun@rba.ltd.uk



CLIENT	HILBRE ESTATES LTD													
PROJECT	LAND TO THE REAR OF THE NAG'S HEAD, CHESTER ROAD, LAVISTER FLOOD CONSEQUENCES ASSESSMENT													
DRAWING	WELSH ASSEMBLY GOVERNMENT TAN 15 DEVELOPMENT AND FLOOD RISK ADVICE MAP													
SCALE	NTS		SIZE	A4		DRAWN	CHKD	DATE	JOB No	3918	WRC No	03	REV	
								10.13						



Legend

- Development Site Boundary
- +9.56 Spot level
- 01 Photograph Reference

REV	DATE	NATURE OF REVISION	BY	CHECKED

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RICHARD BROWN ASSOCIATES

CLIENT	HILBRE ESTATES LTD
PROJECT	LAND TO THE REAR OF THE NAG'S HEAD, CHESTER ROAD, LAVISTER FLOOD CONSEQUENCES ASSESSMENT
DRAWING	EXISTING LEVEL SURVEY
SCALE	1:500
SIZE	A3
DRAWN	CHKD
DATE	10.13
JOB NO	3918
DRG NO	04
REV	

M:\Draw\4107-1 - Land at Lavister\DRAWINGS\02-PLANNING\CURRENT-BOUND\4107-1-A(200)01C Proposed Site Plan.dwg



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- LEGEND**
- FOOTPATH AND PATIOS TO BE MARSHALLS PENDLE 450x450mm BUFF CONCRETE FLAGS.
 - DRIVEWAYS TO BE MARSHALLS KEYBLOCK VINTAGE PERMEABLE CONCRETE BLOCK PAVING; COLOUR: BURNT OCHRE.
 - HATCH DENOTES LANDSCAPED AREA.
 - 1800mm HIGH BRICK WALL WITH PIERS
 - 600mm HIGH RANDOM SANDSTONE WALL
 - 1800mm HIGH TIMBER FENCE
 - 1800mm HIGH CLOSE BOARDED GATE, SLAM TO LOCK WITH ACCESS KEY.
 - FRONT ENTRANCE DOOR,
 - PATIO / FRENCH DOORS.
 - GARAGE DOOR.
 - PERSONNEL DOOR.
 - TREES TO BE RETAINED.
 - TREES TO BE REMOVED.
 - INDICATIVE PLANTING.
 - HARDSTANDING FOR 4No. LAU PROVIDED BINS / BAGS.

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McCORMICK
ARCHITECTURE

SAIGHTON, CHESTER. CH3 6EG
TEL: 01244 332020 FAX: 01244 335139
email: info@mccormick-architecture.co.uk
web: www.mccormick-architecture.co.uk

Client:
HILBRE ESTATES LTD

Project:
LAND TO THE REAR OF THE NAGS HEAD
CHESTER ROAD, LAVISTER

Detail:
PLANNING DRAWING
PROPOSED SITE PLAN

Status:
FOR APPROVAL

Drawn By:	Date:	Scale:
DCI	10/07/13	1:500 @ A3
Checked By:	Date:	Signature:
PM	10/07/13	P. McCORMICK

Job No:	Drg No:	Revision:
4107/1	A(200)01 C	

Schedule of Accommodation:

Type A1 (4-Bed @ 1382sqft) 2no.	Type C (4-Bed @ 1750sqft) 1no.
Type A2 (4-Bed @ 1382sqft) 1no.	Type E (4-Bed @ 1395sqft) 1no.
Type B (4-Bed @ 1489sqft) 2no.	TOTALS (10,269sqft) 7no.

Revision: C	By: DCI	Date: 14/08/13	Chkd: PM	Revision: B	By: DCI	Date: 14/08/13	Chkd: PM
PLOT 5 BUILDING FOOTPRINT UPDATED.				GARAGE TO PLOT 5 OMITTED. PLOT 7 GARAGE LOCATION UPDATED. PARKING SPACES 10-19 UPDATED. TREE CANOPIES UPDATED BASED ON ARBORICULTURAL ASSESSMENT.			

APPENDIX B:

Photographs



◀ **3918/01**
View north along Chester Road
across site entrance.

3918/02
View south along Chester Road
across site entrance.



◀ **3918/03**
General view of site entrance
looking east.



◀ **3918/04**
View of site to rear of The Nags Head.

3918/05
General view of site.



◀ **3918/06**
General view of site.

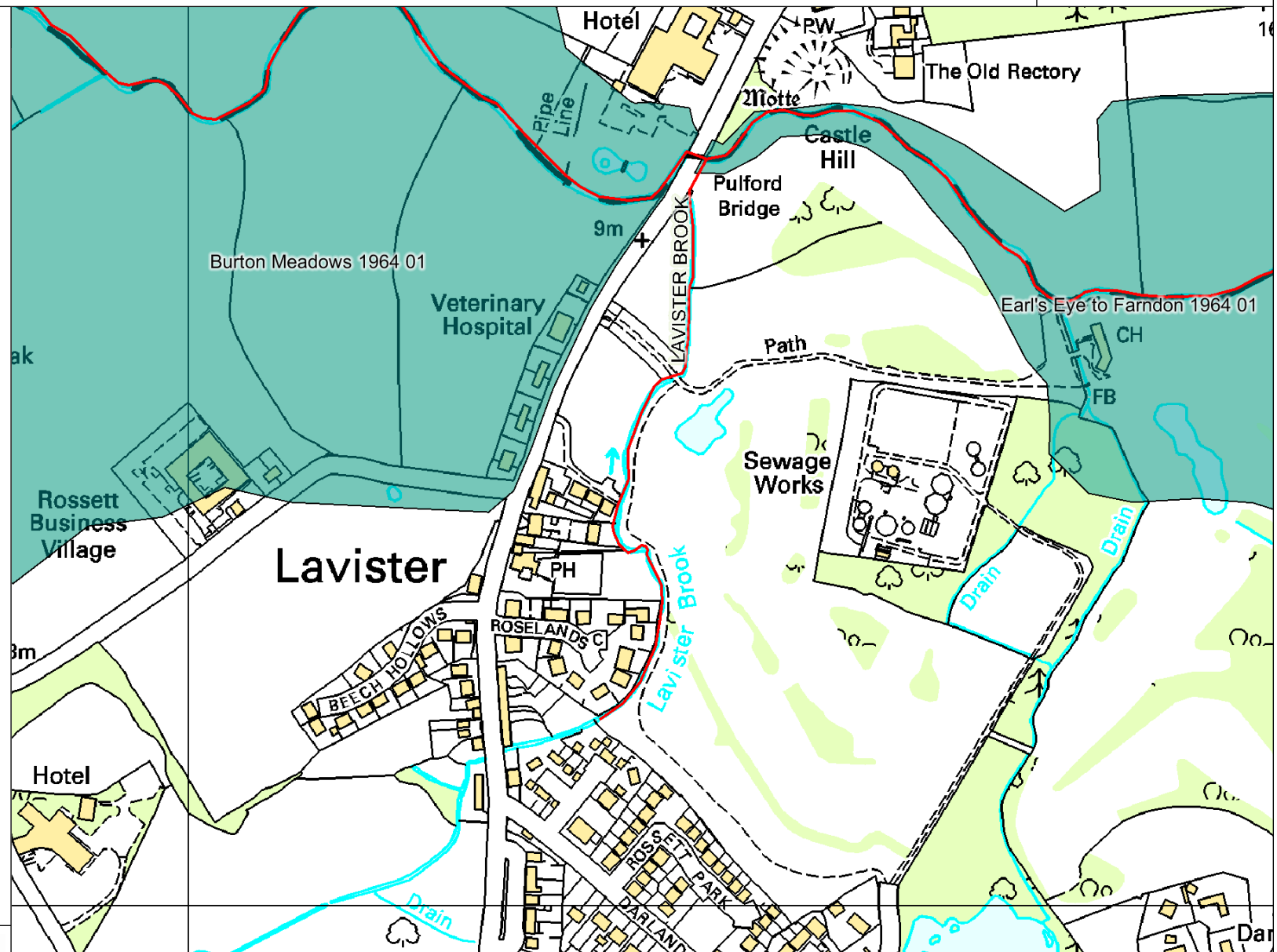
APPENDIX C:

Natural Resources Wales Flood Maps

Flood Event Outlines

Legend

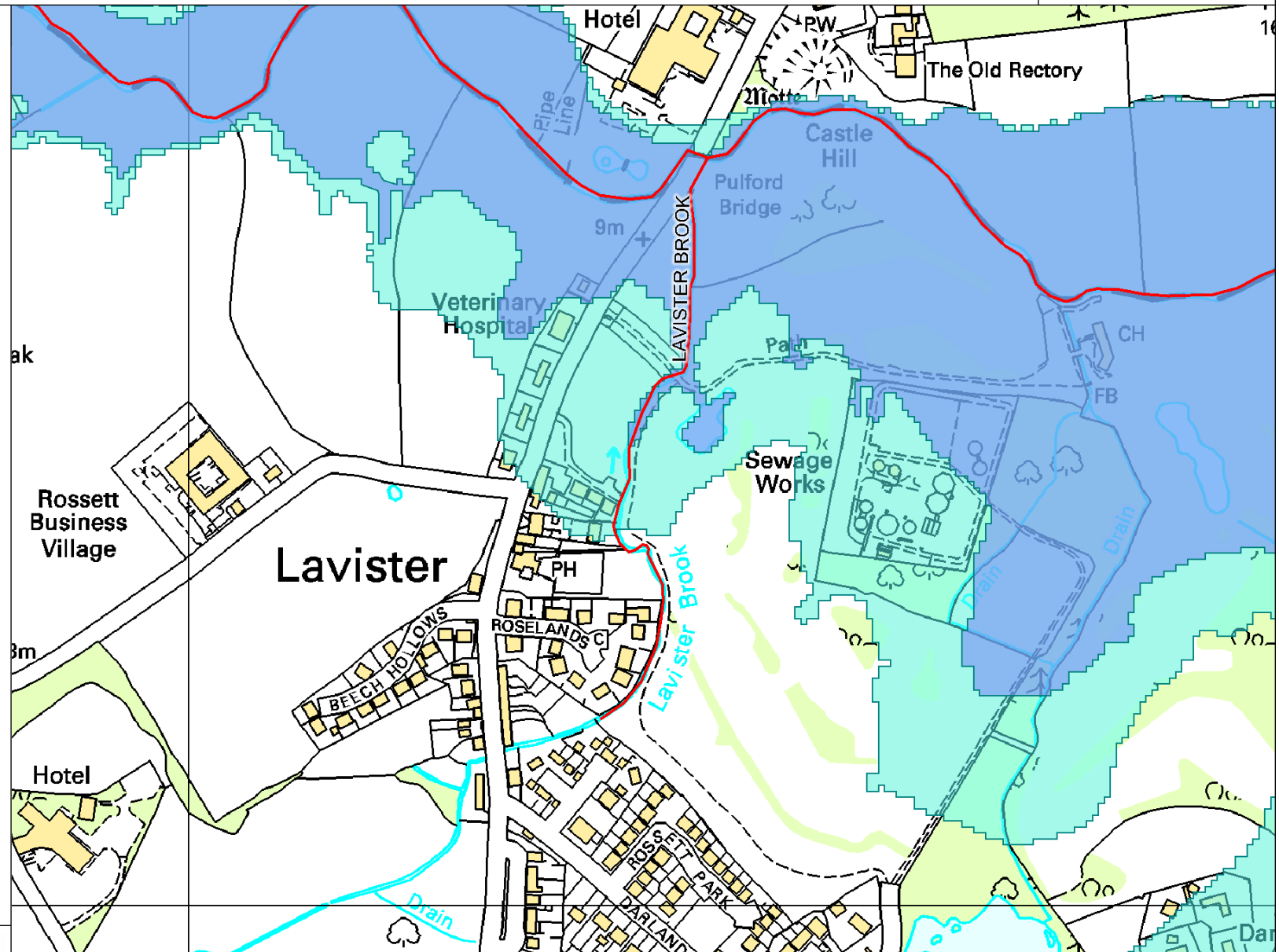
- Sealed Main Rivers
- Flood Event Outlines



Flood Map

Legend

-  Sealed Main Rivers
-  Flood Map - Flood Zone 3
-  Flood Map - Flood Zone 2



0 47 94 141 m.



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APPENDIX D:
Hydraulic Analysis

CALCULATION SHEET



Client HIBRE ESTATES LTD			Job Title LAND TO THE REAR OF THE NAGS HEAD, CHESTER ROAD, LAVISTER		Job No 3918
By JME	Date 10.13	Chkd RB	Element FLOOD CONSEQUENCES ASSESSMENT: HYDRAULIC ANALYSIS		Sheet No H 1
DATA		CALCULATIONS			RESULTS
1.	<u>OBJECT</u> As part of the planning process associated with the above development, Natural Resources Wales (NRW) have requested that the flood risk to the site and neighbouring properties is assessed in accordance with TAN 15. The principal potential source of flooding is the watercourse (Lavister Brook) running adjacent to the site. The object of these calculations is to determine the depth of flow that would occur in the channel during the peak fluvial flow resulting from a 1% annual probability event (ie a 1 in 100 year return period storm) PLUS a 20% allowance for climate change and a 0.1% event (1 in 1000 year event) (in accordance with NRW requirements) and to determine the likely flood routing should the watercourse break its banks.				
2.	<u>THE SITE</u> The location of the watercourse and the development site is shown on the drawings in Appendix A.				
3.	<u>FLUVIAL FLOW</u> Using the Revitalised RSR/FEH rainfall run-off method the 1% to 0.1% storm events the fluvial flow in the watercourse has been calculated as follows: 1% = 0.900m³/s 1%+20% CC = 1.080m³/s 0.1% = 1.600m³/s				

CALCULATION SHEET



Client HIBRE ESTATES LTD			Job Title LAND TO THE REAR OF THE NAGS HEAD, CHESTER ROAD, LAVISTER	Job No 3918
By JME	Date 10.13	Chkd RB	Element FLOOD CONSEQUENCES ASSESSMENT: HYDRAULIC ANALYSIS	Sheet No H 2
DATA		CALCULATIONS		RESULTS
4	<u>OPEN CHANNEL FLOW</u> Based on a visual assessment of the watercourse as it runs adjacent to the site and the results of topographical and LiDAR survey information the average dimensions of the existing channel are given below. Width (W) = 9.902 m Base (b) = 1.289 m Depth (D) = 1.808 m Gradients = 0.0026 m/m The depth of flow (d) for the 1%, 1% + CC and 0.1% AEP events have been calculated by Manning's formula using an 'n' value of 0.06 (refer Ciria Report No. C689 Table A1.1) as follows: 1%: d = 0.441 m 1%+CC: d = 0.494 m 0.1%: d = 0.625 m For the 1%, 1% + CC and 0.1% AEP events considered the 'unrestricted' peak water level is contained within the existing banks of the watercourse running along the development site boundary.			

CALCULATION SHEET



Client HIBRE ESTATES LTD			Job Title LAND TO THE REAR OF THE NAGS HEAD, CHESTER ROAD, LAVISTER	Job No 3918
By JME	Date 10.13	Chkd RB	Element FLOOD CONSEQUENCES ASSESSMENT: HYDRAULIC ANALYSIS	Sheet No H 3
DATA	CALCULATIONS			RESULTS
5	<u>SUMMARY</u> The results of the analysis can be summarised as follows: 1% Fluvial Flow plus 20% for climate change 1.080m³/s 0.1% Fluvial Flow 1.600m³/s The depths of water which result from the 1.0%, 1.0% + CC and 0.1% AEP events are likely to be contained within the channel of the watercourse. The capacity of the channel is sufficient to convey the peak fluvial flows resulting from storms greater than a 0.1% AEP event however, in the event of a complete blockage of the culvert downstream or an obstruction of the Lavister Brook, water <i>may</i> back-up and rise to a level where the watercourse breaks its banks. If this were to happen, flood water would flow out of the banks on the eastern side of the Lavister Brook (LiDAR information suggests that ground levels are generally lower on the eastern side to those on the western side) and on to the golf course, where it would eventually re-enter the downstream watercourse. The elevated position of the proposed development means that it is unlikely to be at risk of flooding during this scenario. Based on the results of this analysis the minimum finished floor level of the proposed new buildings should be set at 10.300mAOD, which is some 600mm above the potential flood/overlapping levels.			

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	JME	Catchment name	3918	Date/time modelled	26-Sep-2013 11:05
Company name	RBA	Catchment easting	337400	Version	1.3
Project name	3918	Catchment northing	358550		
		Catchment area	1.67		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	1000	C_{max} (mm)	521	T_p (hr)	2.01	BL (hr)	30.3
Duration (hr)	2.66	C_{ini} (mm)	98	U_p	0.65	BR	2.1
Timestep (hr)	0.14	α factor	0.7	U_k	0.8	BF₀ (m³/s)	0
Season	Winter						

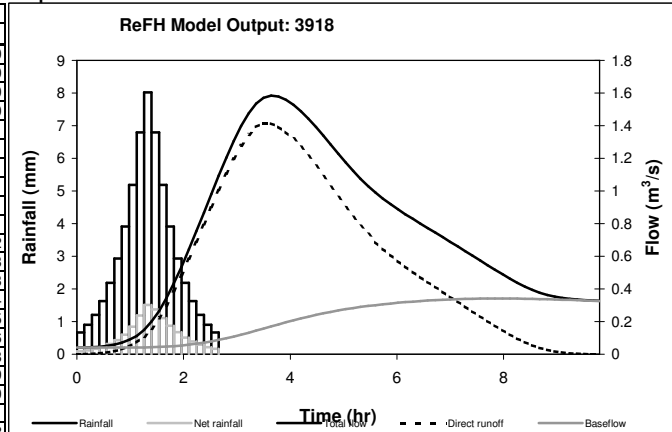
Summary of results

FEH DDF rainfall (mm)	95.3	Peak rainfall (mm)	8
Design rainfall (mm)	58.8	Peak flow (m³/s)	1.6

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m ³ /s	m ³ /s	m ³ /s
0.00	0.7	0.1	0.0	0.0	0.0
0.14	0.9	0.1	0.0	0.0	0.0
0.28	1.2	0.2	0.0	0.0	0.0
0.42	1.6	0.2	0.0	0.0	0.0
0.56	2.2	0.3	0.0	0.0	0.1
0.70	2.9	0.4	0.0	0.0	0.1
0.84	3.9	0.6	0.0	0.0	0.1
0.98	5.2	0.8	0.0	0.0	0.1
1.12	6.8	1.2	0.1	0.0	0.1
1.26	8.0	1.5	0.1	0.0	0.1
1.40	6.8	1.4	0.2	0.0	0.2
1.54	5.2	1.1	0.2	0.0	0.3
1.68	3.9	0.9	0.3	0.0	0.3
1.82	2.9	0.7	0.4	0.0	0.4
1.96	2.2	0.5	0.5	0.1	0.5
2.10	1.6	0.4	0.6	0.1	0.6
2.24	1.2	0.3	0.7	0.1	0.8
2.38	0.9	0.2	0.8	0.1	0.9
2.52	0.7	0.2	0.9	0.1	1.0
2.66	0.0	0.0	1.0	0.1	1.1
2.80	0.0	0.0	1.1	0.1	1.2
2.94	0.0	0.0	1.2	0.1	1.3
3.08	0.0	0.0	1.3	0.1	1.4
3.22	0.0	0.0	1.3	0.1	1.5
3.36	0.0	0.0	1.4	0.1	1.5
3.50	0.0	0.0	1.4	0.2	1.6
3.64	0.0	0.0	1.4	0.2	1.6
3.78	0.0	0.0	1.4	0.2	1.6
3.92	0.0	0.0	1.4	0.2	1.6
4.06	0.0	0.0	1.3	0.2	1.5
4.20	0.0	0.0	1.3	0.2	1.5
4.34	0.0	0.0	1.2	0.2	1.4
4.48	0.0	0.0	1.2	0.2	1.4
4.62	0.0	0.0	1.1	0.3	1.3
4.76	0.0	0.0	1.0	0.3	1.3
4.90	0.0	0.0	1.0	0.3	1.2
5.04	0.0	0.0	0.9	0.3	1.2
5.18	0.0	0.0	0.8	0.3	1.1
5.32	0.0	0.0	0.8	0.3	1.1
5.46	0.0	0.0	0.7	0.3	1.0
5.60	0.0	0.0	0.7	0.3	1.0
5.74	0.0	0.0	0.6	0.3	1.0
5.88	0.0	0.0	0.6	0.3	0.9
6.02	0.0	0.0	0.6	0.3	0.9
6.16	0.0	0.0	0.5	0.3	0.9
6.30	0.0	0.0	0.5	0.3	0.8
6.44	0.0	0.0	0.5	0.3	0.8
6.58	0.0	0.0	0.4	0.3	0.8
6.72	0.0	0.0	0.4	0.3	0.7
6.86	0.0	0.0	0.4	0.3	0.7
7.00	0.0	0.0	0.4	0.3	0.7
7.14	0.0	0.0	0.3	0.3	0.7
7.28	0.0	0.0	0.3	0.3	0.6
7.42	0.0	0.0	0.3	0.3	0.6
7.56	0.0	0.0	0.2	0.3	0.6
7.70	0.0	0.0	0.2	0.3	0.5
7.84	0.0	0.0	0.2	0.3	0.5
7.98	0.0	0.0	0.1	0.3	0.5
8.12	0.0	0.0	0.1	0.3	0.5
8.26	0.0	0.0	0.1	0.3	0.4
8.40	0.0	0.0	0.1	0.3	0.4
8.54	0.0	0.0	0.1	0.3	0.4
8.68	0.0	0.0	0.0	0.3	0.4
8.82	0.0	0.0	0.0	0.3	0.4
8.96	0.0	0.0	0.0	0.3	0.4
9.10	0.0	0.0	0.0	0.3	0.3
9.24	0.0	0.0	0.0	0.3	0.3
9.38	0.0	0.0	0.0	0.3	0.3
9.52	0.0	0.0	0.0	0.3	0.3
9.66	0.0	0.0	0.0	0.3	0.3
9.80	0.0	0.0	0.0	0.3	0.3
Total (mm)	58.8	11.1	11.1	4.6	15.7

Graph



Audit comments

Catchment

Catchment descriptors imported from file

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

Catchment descriptor file = '3918-catchment desc pulford.csv'
Catchment descriptor file exported from CD ROM version 3
Catchment descriptor file exported on 25-Sep-2013 16:00
BFHOST value of 0.731 used
PROPWET value of 0.51 used
SAAR value of 707 used
DPLBAR value of 1.61 used
DPSBAR value of 9.1 used
URBEXT value of 0.0459 used
C value of -0.02448 used
D1 value of 0.32086 used
D2 value of 0.38281 used
D3 value of 0.29144 used
E value of 0.28747 used
F value of 2.42248 used

Rainfall

Recommended season is Winter, as URBEXT < 0.125
ReFH design standard Seasonal Correction Factor of 0.64 applied
ReFH design standard Areal Reduction Factor of 0.97 applied

Loss Model

C_{Max} derived from catchment descriptors
ReFH design standard C_{in} used
ReFH design standard α factor used

Routing Model

T_p derived from catchment descriptors
ReFH design standard used for U_p
ReFH design standard used for U_k

Baseflow Model

BL derived from catchment descriptors
BR derived from catchment descriptors
ReFH design standard BF_o used

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	JME	Catchment name	3918	Date/time modelled	26-Sep-2013 11:04
Company name	RBA	Catchment easting	337400	Version	1.3
Project name	3918	Catchment northing	358550		
		Catchment area	1.67		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	100	C_{max} (mm)	521	T_p (hr)	2.01	BL (hr)	30.3
Duration (hr)	2.66	C_{ini} (mm)	98	U_p	0.65	BR	2.1
Timestep (hr)	0.14	α factor	0.83	U_k	0.8	BF₀ (m³/s)	0
Season	Winter						

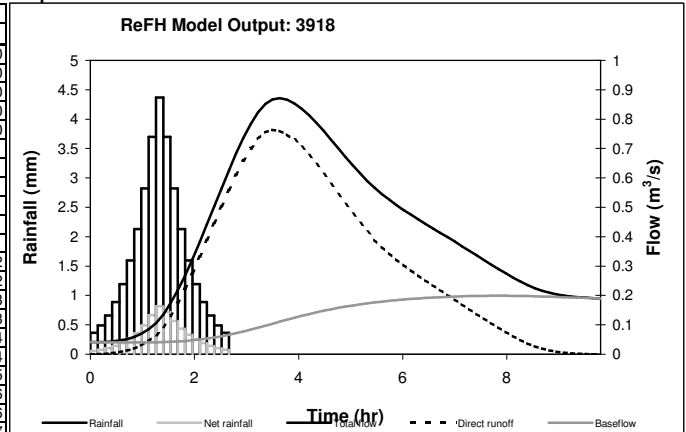
Summary of results

FEH DDF rainfall (mm)	51.9	Peak rainfall (mm)	4.4
Design rainfall (mm)	32	Peak flow (m³/s)	0.9

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m ³ /s	m ³ /s	m ³ /s
0.00	0.4	0.1	0.0	0.0	0.0
0.14	0.5	0.1	0.0	0.0	0.0
0.28	0.7	0.1	0.0	0.0	0.0
0.42	0.9	0.1	0.0	0.0	0.0
0.56	1.2	0.2	0.0	0.0	0.0
0.70	1.6	0.3	0.0	0.0	0.1
0.84	2.1	0.4	0.0	0.0	0.1
0.98	2.8	0.5	0.0	0.0	0.1
1.12	3.7	0.7	0.0	0.0	0.1
1.26	4.4	0.8	0.1	0.0	0.1
1.40	3.7	0.7	0.1	0.0	0.1
1.54	2.8	0.6	0.1	0.0	0.2
1.68	2.1	0.4	0.2	0.0	0.2
1.82	1.6	0.3	0.2	0.0	0.3
1.96	1.2	0.3	0.3	0.0	0.3
2.10	0.9	0.2	0.3	0.1	0.4
2.24	0.7	0.1	0.4	0.1	0.4
2.38	0.5	0.1	0.4	0.1	0.5
2.52	0.4	0.1	0.5	0.1	0.6
2.66	0.0	0.0	0.6	0.1	0.6
2.80	0.0	0.0	0.6	0.1	0.7
2.94	0.0	0.0	0.7	0.1	0.7
3.08	0.0	0.0	0.7	0.1	0.8
3.22	0.0	0.0	0.7	0.1	0.8
3.36	0.0	0.0	0.8	0.1	0.9
3.50	0.0	0.0	0.8	0.1	0.9
3.64	0.0	0.0	0.8	0.1	0.9
3.78	0.0	0.0	0.7	0.1	0.9
3.92	0.0	0.0	0.7	0.1	0.9
4.06	0.0	0.0	0.7	0.1	0.8
4.20	0.0	0.0	0.7	0.1	0.8
4.34	0.0	0.0	0.6	0.1	0.8
4.48	0.0	0.0	0.6	0.1	0.8
4.62	0.0	0.0	0.6	0.2	0.7
4.76	0.0	0.0	0.5	0.2	0.7
4.90	0.0	0.0	0.5	0.2	0.7
5.04	0.0	0.0	0.5	0.2	0.6
5.18	0.0	0.0	0.4	0.2	0.6
5.32	0.0	0.0	0.4	0.2	0.6
5.46	0.0	0.0	0.4	0.2	0.6
5.60	0.0	0.0	0.4	0.2	0.5
5.74	0.0	0.0	0.3	0.2	0.5
5.88	0.0	0.0	0.3	0.2	0.5
6.02	0.0	0.0	0.3	0.2	0.5
6.16	0.0	0.0	0.3	0.2	0.5
6.30	0.0	0.0	0.3	0.2	0.5
6.44	0.0	0.0	0.3	0.2	0.4
6.58	0.0	0.0	0.2	0.2	0.4
6.72	0.0	0.0	0.2	0.2	0.4
6.86	0.0	0.0	0.2	0.2	0.4
7.00	0.0	0.0	0.2	0.2	0.4
7.14	0.0	0.0	0.2	0.2	0.4
7.28	0.0	0.0	0.2	0.2	0.4
7.42	0.0	0.0	0.1	0.2	0.3
7.56	0.0	0.0	0.1	0.2	0.3
7.70	0.0	0.0	0.1	0.2	0.3
7.84	0.0	0.0	0.1	0.2	0.3
7.98	0.0	0.0	0.1	0.2	0.3
8.12	0.0	0.0	0.1	0.2	0.3
8.26	0.0	0.0	0.0	0.2	0.2
8.40	0.0	0.0	0.0	0.2	0.2
8.54	0.0	0.0	0.0	0.2	0.2
8.68	0.0	0.0	0.0	0.2	0.2
8.82	0.0	0.0	0.0	0.2	0.2
8.96	0.0	0.0	0.0	0.2	0.2
9.10	0.0	0.0	0.0	0.2	0.2
9.24	0.0	0.0	0.0	0.2	0.2
9.38	0.0	0.0	0.0	0.2	0.2
9.52	0.0	0.0	0.0	0.2	0.2
9.66	0.0	0.0	0.0	0.2	0.2
9.80	0.0	0.0	0.0	0.2	0.2
Total (mm)	32.0	6.0	6.0	2.9	8.9

Graph



Audit comments

Catchment

Catchment descriptors imported from file

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

Catchment descriptor file = '3918-catchment desc pulford.csv'
Catchment descriptor file exported from CD ROM version 3
Catchment descriptor file exported on 25-Sep-2013 16:00
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DPSBAR value of 9.1 used
URBEXT value of 0.0459 used
C value of -0.02448 used
D1 value of 0.32086 used
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D3 value of 0.29144 used
E value of 0.28747 used
F value of 2.42248 used

Rainfall

Recommended season is Winter, as URBEXT < 0.125
ReFH design standard Seasonal Correction Factor of 0.64 applied
ReFH design standard Areal Reduction Factor of 0.97 applied

Loss Model

C_{Max} derived from catchment descriptors
ReFH design standard C_{in} used
ReFH design standard α factor used

Routing Model

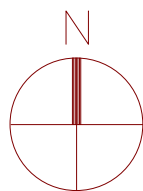
T_p derived from catchment descriptors
ReFH design standard used for U_p
ReFH design standard used for U_k

Baseflow Model

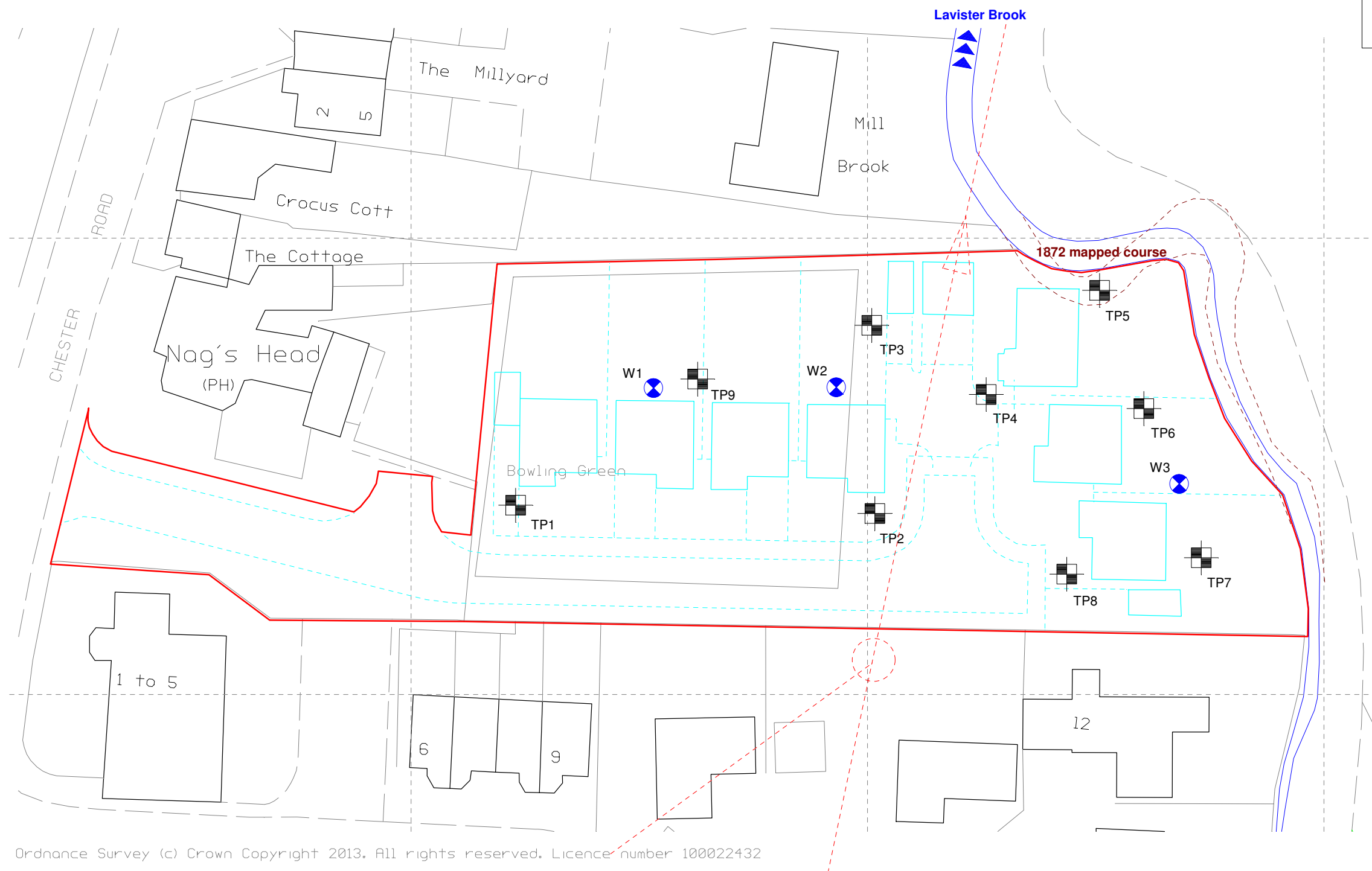
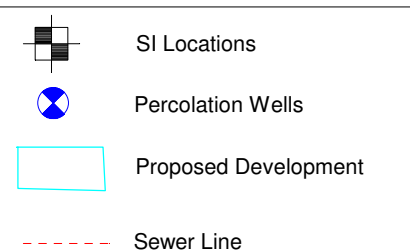
BL derived from catchment descriptors
BR derived from catchment descriptors
ReFH design standard BF_o used

APPENDIX E:

Smith Grant: Site Investigation



KEY:



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Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL

Tel: 01978 822367
Fax: 01978 8247182

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:
Nag's Head, Chester Rd.
Lavister LL12 0DN

Drawing:
Site Investigation Locations

Drawn: GC	Checked: AFS
Date: 11/09/2013	Scale: 1:500 @ A3
Job No: R1924	Drg No: R01-01

rba.mail

From: "Tony Smith" <tony.smith@smithgrant.co.uk>
To: "Iain Maclean" <iain@overlea.co.uk>
Cc: <broun@rba.ltd.uk>
Sent: 19 September 2013 13:13
Subject: Re: NAGS HEAD, LAVISTER
 Iain

Percolation tests were carried out in 3 standpipes installed to a depth of 1m below ground level; the locations were along the long axis of the site, with w1 nearest the pub, and w3 nearest Lavister Brook. w1 penetrated silty gravelly clay, reaching a silty sand at base. w2 reached silty gravelly sand at base. w3 reached gravelly sand at base. There may be a slight rise in the ground level from the stream towards the pub which may account for the apparent increased thickness of soil cover over the sand and gravel stratum in this direction.

No sign of seasonal waterlogging was seen in the soils. From the trial pitting, the water table is at around 1.8-2.0m depth, although this may of course rise in winter or in wet weather.

The percolation (falling head) tests were carried out on the 3 standpipes, repeated in W3 which demonstrated the most rapid drainage. The second wf test probably best reflects the likely permeability of the sand and gravel stratum, with the upper soils being less permeable due to the increased silt and clay content.

Preliminary test results are summarised below:

borehole	w1	w2	w3a	w3b
BS5930 falling head test (case d)				
basic time factor T (s)	~4800	720	188	240
soil permeability k (m/s)	3.40E-07	2.30E-06	8.80E-06	6.90E-06
Approved Document H2 (2010)				
average time for head to fall 1mm - vp (s)	10	1.5	0.35	0.61
soil infiltration rate f (m/s)	3.33E-05	2.22E-04	9.52E-04	5.46E-04
amended f for 60mm diam bh (m/s)	7.41E-06	4.94E-05	2.12E-04	1.21E-04
estimated soakage rate (l/m2/s)	0.1	0.7	2.9	1.6
estimated soakage rate (l/m2/min)	6	40	171	98

The findings suggest suitable conditions for soakaways for surface water at a minimum depth of 1m, although conditions would be unsuitable for septic tanks due to the lack of attenuation between the discharge height and water table. Soakaway construction below 2m depth is likely to intercept the water table and present construction difficulties. Soakaways should be a minimum of 5m from buildings to avoid potential instability due to wash-out of fines.

There remains a question over the winter water table height below the site, however the soils evidence suggests that this does not regularly rise above the top of the sand and gravel stratum at >1m depth below current ground level.

It should be noted that the above results and calculations are intended to be indicative and are based on preliminary investigations; definitive soil permeability testing will require either 150mm diameter boreholes or trial pit tests as per BRE365.

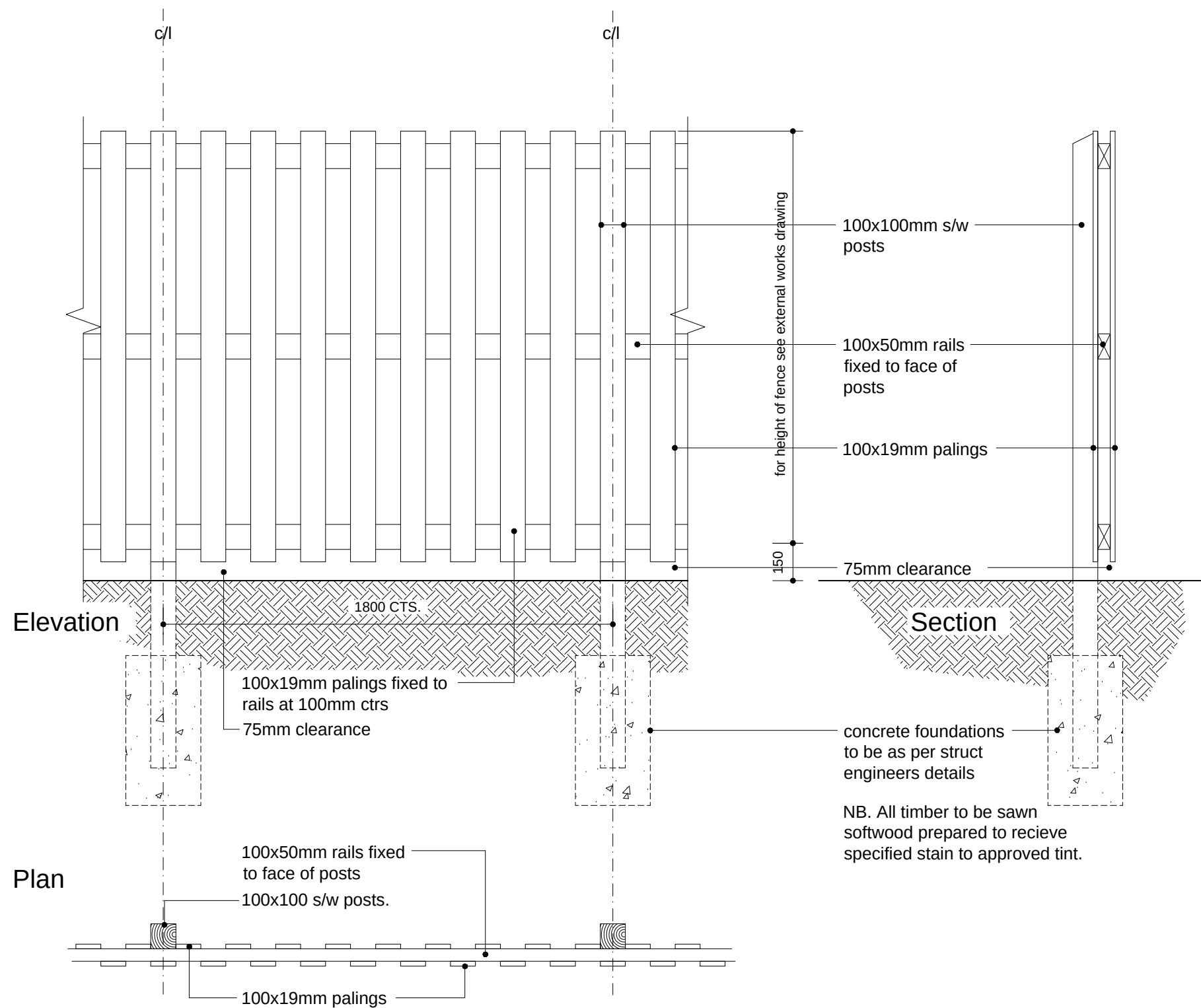
We are aiming to issue trial pit logs and location plan tomorrow.

Cheers

Tony

APPENDIX F:

Timber Slatted Fence Details



Hilbre Estates

Project:

Standard Details

Drawing Title:

Timber Slatted Fence Details

Project No:
13/STD

Drawing No:
/EXT/01

Revision:

Scale:
NTS

Date:
Sept 2013