Robson Liddle
consulting engineers

OCTOBER 2012

NPPF TECHNICAL GUIDANCE FLOOD RISK ASSESSMENT

DEVONIA PRODUCTS MILL SITE HIGHER TOWN BUCKFASTLEIGH

FOR

AXMINSTER CARPETS LTD

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REPORT REF. NO.: /NAS/12082/FRA2
V2 – 30.10.2012

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1.0 INTRODUCTION

1.1 Context

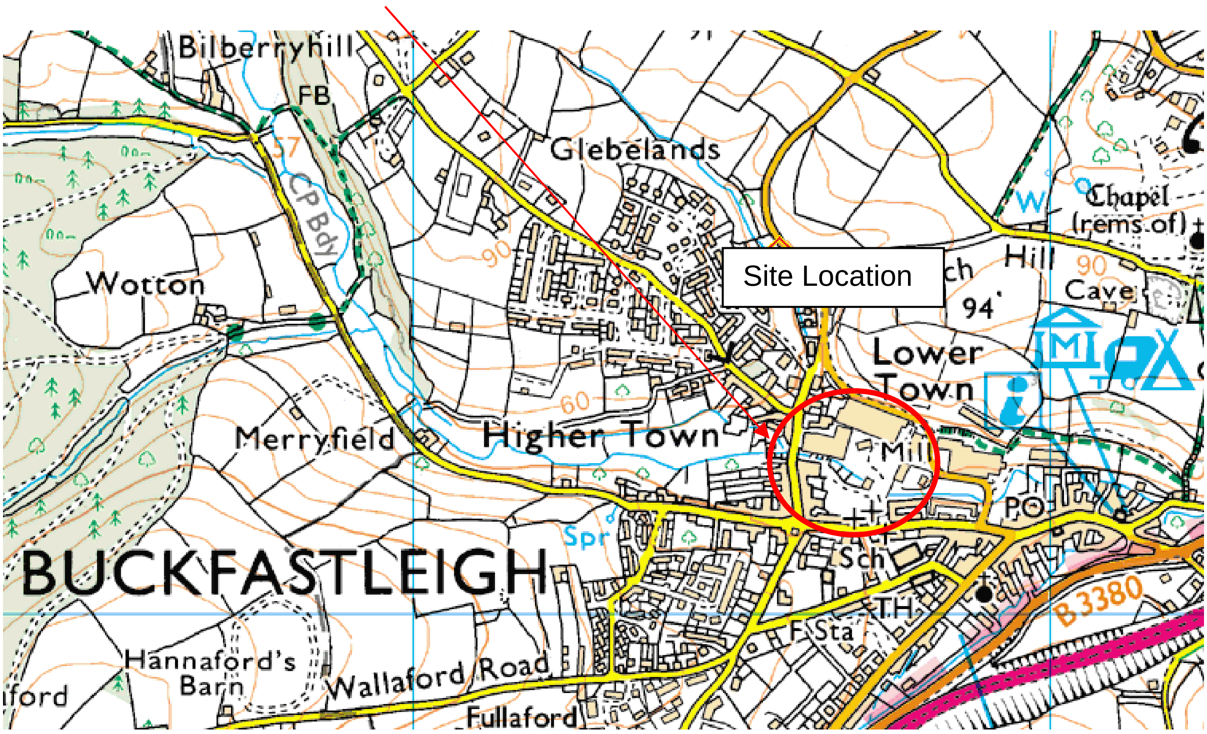
Robson Liddle Limited has been retained by Axminster Carpets Ltd to undertake a Flood Risk Assessment (FRA) and hydraulic modelling report for the site in Buckfastleigh. The FRA will be used to inform the Level 2 Strategic Flood Risk Assessment as the site is being promoted in the Core Strategy as available for redevelopment for mixed use and will be considered in the Examination in Public process.

Because the River Mardle runs through the centre of the site much of the local area is mapped as having a flood risk zoning. This FRA has been prepared to confirm the actual flood zones more accurately than the generic JFlow method used by the Environment Agency to define flood risk zones. The FRA will also consider the impact of removing existing buildings and a sprung arch culvert located on the site which constrains flows.

Although much of the site has impermeable areas the potential increase in paved areas could affect the risk of flooding downstream of the site. As such a sustainable drainage strategy is required in the redevelopment proposals. This FRA will be updated in the future to develop the surface water drainage strategy once the potential redevelopment areas and a masterplan exercise has been carried out.

1.2 Site Location & Features

The Ordnance Survey National Grid Reference (NGR) for the centre of the site is 273690, 66235. The site location is shown below:



The site occupies a mainly Brownfield site approximately 2.56 hectares in area. The site has been previously used for manufacturing and processing of wool and sheepskins. The current intention is that the sheepskin business of Devonia Products will remain on the site in various buildings.

The site is currently accessed from Mardle Way in the northeast and Chapel Street in the south. Additional access off Bridge Street to the west is also possible to parts of the site. The site is bounded as follows:

- to the north by Mardle Way and residential property off Church Street;
- to the east by Mardle Way, employment units and some residential property in the southeast corner;
- to the south by residential property and a church off Chapel Street;
- to the west by Bridge Street and residential property;
- The River Mardle runs through the centre of the site, partly in a culvert.

1.3 Development Proposals

The site is being promoted through the Local Development Framework (Development Management and Delivery Plan) process for mixed use. A public consultation process is underway to determine what residents and locally interested bodies consider the site should be used for in the future.

This is likely to consist of a mix of employment, residential, community building and retail use with associated access roads, open space and landscaping.

No master planning has taken place yet, the results of this FRA will feed into that process and the development extent and mix.

Devonia Products will remain on site, utilising existing buildings and external areas. These are centred on the southwest corner. A plan provided by the Client showing these buildings is included in Appendix A.

1.4 Flood Zone Allocation

Based upon the latest Flood Zone Mapping issued by the Environment Agency (EA), the site lies within Flood Zones 1, 2 and 3.

Flood Zone 1 (FZ1) – Defined as being low risk comprising land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1% AEP).

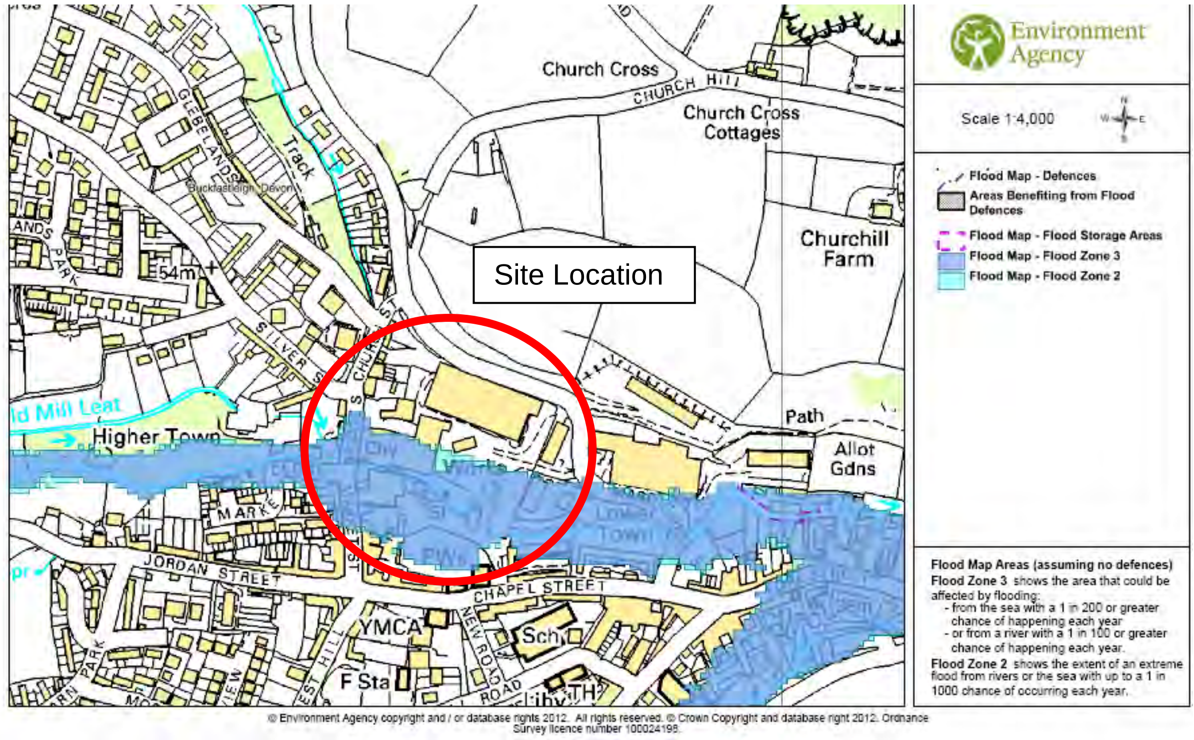
Flood Zone 2 (FZ2) - Defined as being at moderate risk of flooding. FZ2 is land with a probability of 1%-0.1% river flooding and 0.5%-0.1% sea flooding.

Flood Zone 3 (FZ3) - Defined as being at high risk of flooding. FZ3 is land with a probability of >1% AEP river flooding and >0.5% sea flooding. This flood map takes no account of any existing flood defences.

Flood Zone 3 is split into two FZ3B defined as the 1 in 20 year (5% AEP) flood envelope and flood zone 3A defined as between the 20 year and 100 year flood event.

An extract of the EA Flood Zone map is included below; the full version is included in Appendix A:

EA Flood Zone map



1.5 Appropriateness of Development Proposals

Table 2 of Technical Guidance to the National Planning Policy Framework (TGNPPF) provides information on the Vulnerability Classification of various developments. Some of the potential uses (Residential) will fall in the "more vulnerable" classification of the Table; others will be less vulnerable (Employment, retail). Table 3 in TGNPPF details compatibility of the end use with the different Flood Zone classifications. Comparing the More Vulnerable use shows that "Development is appropriate" in only FZ1.

Table 3 in the TGNPPF will inform the development master planning and proposed layout.

1.6 Sequential Test

According to TGNPPF the Sequential Test gives preference to locating new development in Flood Zone 1 (FZ1 - least risk of flooding). However if there is no allocated land within FZ1 which meets the policy aims of the published Local Authority Local Plan or Local Development Framework then other sites in higher flood risk categories, FZ2 or FZ3 can be considered for that development.

The proposed site layout will be subjected to the Sequential Approach advocated in NPPF, Paragraph 101. No redevelopment will be located within FZ3 other than open space allocation.

1.7 Exception Test

It is not the intention of the client to trigger the Exception Test detailed in Table 3 of TGNPPF.

1.8 Influences of Climate Change

The influence of Climate Change on rivers and watercourses is likely to increase the frequency of flood events and the overall volume of water that passes the site. PPS 25 advises that an increase in watercourse flow of 20% should be considered when applying climate change over the lifetime of the development.

When considering surface water runoff from a site the increase in peak rainfall intensity varies over the lifetime of the development. For residential development with a typical lifetime of 100 years it is expected to be a 30% increase. For non residential development an increase of 20% must be applied.

As this is a mixed use redevelopment the higher figure of 30% will be applied to any drainage systems serving a range of end uses.

2.0 SOURCES OF INFORMATION

2.1 Flood Zone Maps & Flood Defence Data

Information relating to the current flood risk at the application site and local flood defence schemes has been obtained from the EA. The details are discussed later with a copy of this data included in Appendix A.

2.2 Watercourse Hydrology & Previous Modelling

The River Mardle runs through the centre of the site and is recognised on the EA flood zone maps. The Mardle is a Main River. A leat used to intercept flows approximately 500m upstream of the site and bring water via an aqueduct into the mill building. This link has been severed at the upstream feed end although some of the old aqueduct still exists in Bridge Street and the west end of the site.

The hydrology of the River Mardle was investigated in 2009 when the EA commissioned a modelling report for the River Mardle and Dean Burn which both run through Buckfastleigh. The report consisted of an ISIS TUFLOW model, mapped flood outlines and assessment of the number of properties at risk from flooding.

We have purchased a copy of the ISIS model produced at the time from the EA. The model consisted of 1941m of the River Mardle and 833m of the Dean Burn together with further ground level height data from a LIDAR base.

The modelling report provided design flows for this FRA; an extract of the 2009 report detailing the methodology for these design flows is included below:

5.2 Model inflows

Flows for the nodes shown in Figure 5.1 are shown in Table 5.1.

Table 5.1 – Design Flows from Devon Flows Study and EA Assessment

Inflow point / Return Period	Initial Peak flow (m^3/s)		Adjusted Peak flow (m^3/s)	
	Mardle	Dean Burn	Mardle	Dean Burn
QMED	27.03	27.64	15.83	12.09
10	40.00	41.20	23.42	18.02
25	47.56	49.16	27.85	21.50
50	53.91	55.88	31.57	24.44
100	61.00	63.36	35.72	27.71
250	71.68	74.72	41.98	32.68
1000	91.29	95.96	53.46	41.85

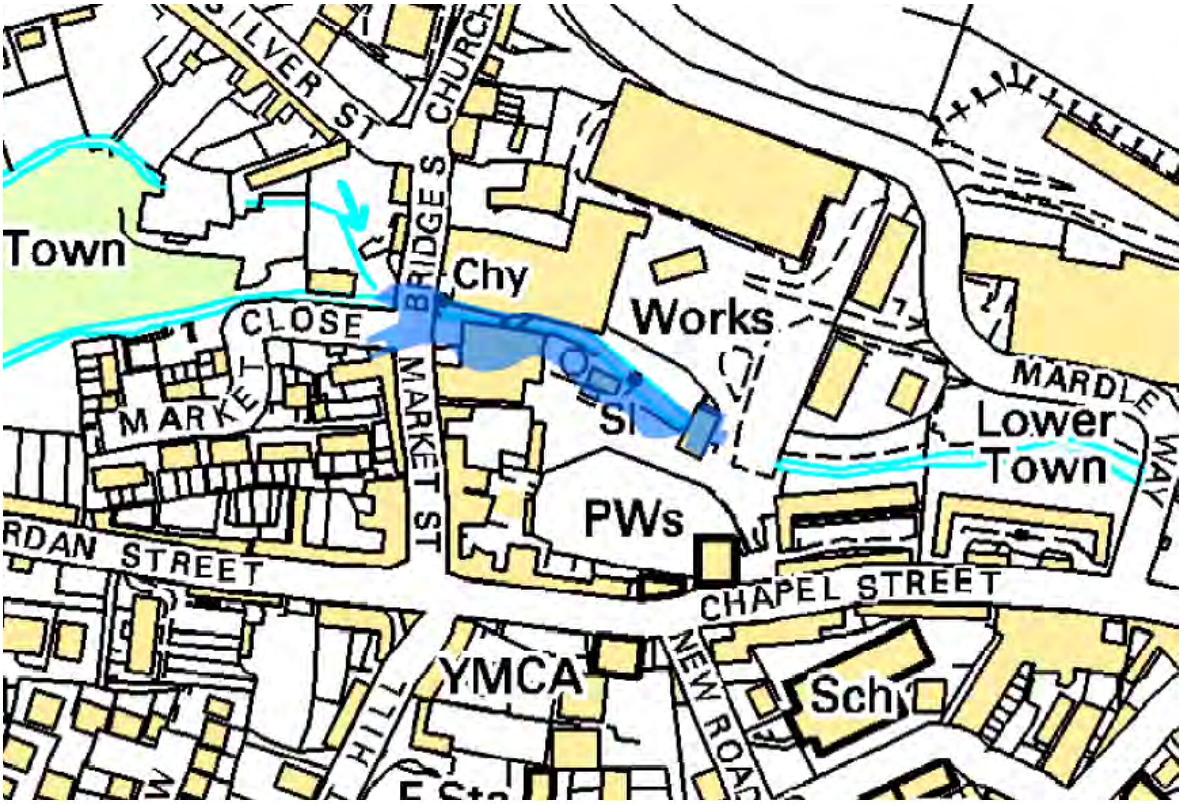
The initial flows were resulting in unrealistic frequency of flooding when compared with recorded flood incidents, and were causing some issues with model stability. Discussions with the Environment Agency resulted in a reassessment of the flows (performed by the Environment Agency).

The assessment made by the Environment Agency involved looking at the relationships using local gauge data at two neighbouring sub-catchment locations. The one which was initially made use of for this study was deemed to be too high with the other too low. This was established by looking at the natural channels upstream and reviewing the relationships. Subsequently, the decision was made to use the basic FEH statistical method values (supplied by CEH) with the peak flow on the River Mardle raised by 20% to reflect estimates of QMED upstream. The flows on the Dean Burn remain the same as the raw FEH values.

The flows from this assessment, which are those taken forward to the hydraulic modelling are shown in the right-hand columns of Table 5.1.

2.3 Historic Flooding

There is a history of flooding in Buckfastleigh, the 2009 modelling report identified Fluvial and Pluvial events as far back as 1960. The EA have provided a copy of the flooded area map of December 1979 through the site which is reproduced below. Following this event the EA promoted and constructed a flood defence scheme in 1988 to a 1 in 50 year standard of protection. Works on the Mardle were located upstream in Market Close consisting of raised walls, a new culvert in Bridge Street and regrading of the river bed as well as pioneer clearance of trees and other obstructions:



Since construction of the scheme there has been flooding of properties from Fluvial sources in 1992, 1999 and 2000. Most of these were located in the lower town area east of Mardle Way.

2.4 Public Sewer & Highway Drainage Records

There is a South West Water public combined sewer running through part of the site which serves the buildings to the north of the River Mardle.

A combined sewer of 225mm diameter is shown running along the bed of the River Mardle through the whole length of the site. Several foul drainage pipes from properties and the church to the south cross the site to join the sewer in the River Mardle bed. There is also a combined sewer to the east in Mardle Way and to the west in Bridge Street.

A public surface water sewer is shown in Bridge Street

The SWW sewer records are included in Appendix A.

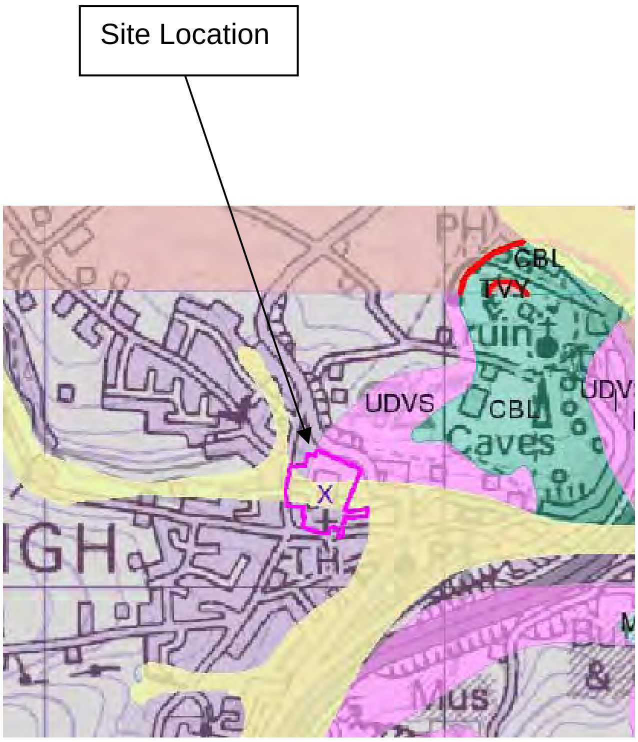
2.5 Topographic Data

Current (pre-development) site survey information has been provided by the Client, this is shown in Drawing 1. This survey is based on Ordnance Datum.

The site falls from 53m in the northwest to 37.2m in the east and back up to 45m in the south. The topography includes the valley bottom from 38.9m in the west to 37.2m in the east along which the Mardle runs.

2.6 Geological Data & Soakaway Suitability

The 1: 50 000 scale British Geological Survey map of the area – Sheet 338 Dartmoor Forest indicates the site to be underlain by Alluvium drift deposits in the centre of the site in a narrow band striking E-W, underlain by Basalt and Ignimbrites of the Upper Devonian Slate formation in the north of the site and Hornfelsed Slate of the Upper Devonian Slate Formation in the south of the site. With the exception of the alluvium these strata are relatively impermeable and not very suitable for infiltration drainage. The site has also had various potentially contaminative uses and as such infiltration should not be proposed until such time as the impact on groundwater or geology is confirmed. An extract of the geology map and key is included below:



Geology 1:50,000 Maps Legends

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Flandrian - Flandrian
	HEAD	Head	Clay, Silt, Sand and Gravel	Quaternary - Quaternary
	HEAD	Head	Clay, Silt, Sand and Gravel	Quaternary - Quaternary
	RTDU	River Terrace Deposits (Undifferentiated)	Sand and Gravel	Quaternary - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	SME	St Mellion Formation	Sandstone, Siltstone and Mudstone	Arnsbergian - Tournaisian
	TVY	Tavy Formation	Slate	Famennian - Frasnian
	TVY	Tavy Formation	Slate	Famennian - Frasnian
	GNL	Gurrington Slate Formation	Slate, Lava and Tuff	Tournaisian - Frasnian
	GNL	Gurrington Slate Formation	Basaltic Pyroclastic-Rock	Tournaisian - Frasnian
	GNL	Gurrington Slate Formation	Basaltic Lava	Tournaisian - Frasnian
	UDVS	Upper Devonian Slates	Basaltic Pyroclastic-Rock	Late Devonian - Late Devonian
	UDVS	Upper Devonian Slates	Slate	Late Devonian - Late Devonian
	UDVS	Upper Devonian Slates	Hornfelsed Slate	Late Devonian - Late Devonian
	UDVS	Upper Devonian Slates	Basaltic-rock	Late Devonian - Late Devonian
	FT	Foxley Tuff Formation	Tuff	Givetian - Givetian
	CBL	Chercombe Bridge Limestone Formation	Limestone	Givetian - Eifelian
	MDVL	Middle Devonian Limestone	Limestone	Mid Devonian - Mid Devonian
	UIIDC	Unnamed Igneous Intrusion, Devonian to Carboniferous	Microgabbro	Carboniferous - Devonian
		Faults		

3.0 FLOOD RISK ASSESSMENT

3.1 Flood Risk Assessment Methodology & Objectives

It is recognised that developments that are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. Current guidance on development and flood risk[1] identifies several key aims for a development to ensure that it is sustainable in flood risk terms. These aims are as follows:

- The development should not be at a significant risk of flooding and should not be susceptible to damage due to flooding;
- The development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, are threatened;
- Safe access to and from the development should be possible during flood events;
- The development should not increase flood risk elsewhere;
- The development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences;
- The development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk. The responsibility for any operation and maintenance required should be clearly defined;
- Future users of the development should be made aware of any flood risk issues relating to the development;
- The development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues;
- The development should not lead to degradation of the environment; and
- The development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change.

This Flood Risk Assessment is undertaken with due consideration of these sustainability aims, and has been prepared to inform the proposed scheme. A development lifetime of 100 years has been assumed in line with TGNPPF guidance for residential development life cycle.

[1] CIRIA, 2004, Funders Report CP/102 Development and Flood Risk – Guidance for the Construction Industry.

3.2 Project Scope

In order to achieve the aims outlined above, this Flood Risk Assessment has been undertaken in accordance with current best-practice guidance, including TGNPPF. A scoping study was initially undertaken to identify all potential sources of flooding at the site, which may warrant further consideration. Any potential flooding issues identified in the scoping study have subsequently been considered within this FRA. The aim of the scoping study is to review all available information and provide a qualitative assessment of the flood risk to the site and the impact of the site on flood risk elsewhere.

The report has been undertaken with due regard to the EA's National Standing Advice on Development and Flood Risk.

3.3 Level 1 – Scoping Study

All potential sources of flooding must be considered for any proposed development.

Using the EA Flood risk zone mapping, public sewer records, topographical survey, Ordnance Survey maps and data collected in a site walkover a summary of the potential sources of flooding and a review of the potential risk posed by each source on part or parts of the application site is presented in Table 1.

Table 1: Potential Risk Posed by Flooding Sources

Potential Source	Potential Flood Risk to Site?
Fluvial flooding	Yes
Tidal flooding	No
Surface water flooding	Yes
Flooding from rising / high groundwater	No
Overland flow flooding	No
Flooding from piped drainage systems	No
Flooding due to infrastructure failure (Reservoirs, lakes etc)	No
Increase in flood risk due to urbanisation of the catchment	Yes

Following the Level 1 scoping study a more detailed Level 2 assessment has been undertaken which considers each of the potential flood risks identified above.

3.4 Level 2 - Technical Assessment of Flood Risk

3.4.1 Fluvial Flooding & Hydraulic Modelling

The site location was confirmed between nodes M1179 and M1009 in the ISIS model. 9 Nodes or section locations were included in the model through the site.

Following interrogation of the ISIS model and the results that came with the report test runs were undertaken to check the influence of the Dean Burn on downstream water levels in the Mardle and to identify any areas where the ISIS model did not include flood defences or walls raised as flood defences as part of the 1988 scheme.

In the EA modelling provided it was found that the downstream boundary conditions of normal depth based on a bed slope calculation were used as these were found to be the conditions that produced the highest water levels. These same conditions have been applied to any modelling undertaken for this FRA.

The confluence of the Mardle and Burn is at a level of 30.50m, or 7m lower than the Mardle at the site and following these runs it was concluded that the Dean Burn had no influence back upstream as far as the site on the River Mardle.

To simplify the ISIS modelling and reduce the extent of additional survey work required the Dean Burn nodes were removed from the model and the model rerun at the 1 in 100 and 1000 year flow events. It was then found that the influence of culverts and bridges downstream of the site in the Mardle only extended about 300m upstream toward the site. It was therefore possible to remove the lower 625m of the Mardle model without impacting on predicted water levels and still leave 380m of nodes downstream of the site. This also made the ISIS model more stable.

Following this exercise further topographical survey was undertaken in Buckfastleigh to supplement the site topographical survey and ISIS node data. The focus was on the existing bridges, flood defence walls and other areas where obstructions to flows existed.

LIDAR was also acquired to supplement the wider area. LIDAR was ground truthed at locations around bridges, upstream of the site and the site topographical survey and only used where it was found to be accurate. In some locations the bare earth LIDAR had been processed and where buildings or tree cover existed levels were up to 2m out.

This survey information together with the topographical survey provided by the client was used to add additional nodes upstream and through the site area picking up changes in the river corridor shape, buildings, tanks and extra ground levels.

Following the extending of the ISIS nodes the models were rerun at the 100, Climate change and 1000 year events. The 20 year event (FZ3B) flow of approximately 27 Cumecs was also extracted as a snapshot file.

The 20 year, 100 year and 1000 year flood extents / water levels have been mapped on drawings 2 and 3 in the FRA. The existing buildings on the site that would flood or are to be retained are also included on these drawings.

Sensitivity testing of ISIS model

The 100 year ISIS model has also been run with a 10% increase in surface roughness factor (Manning - n+10%). This is to test the impact of longer vegetation or deterioration in the wall finish and pointing. The results showed water level increase of between 101mm and 250mm with the largest increase being between the existing buildings (node M-1130) and the culvert inlet (node M-1048_U).

ISIS model results comparison

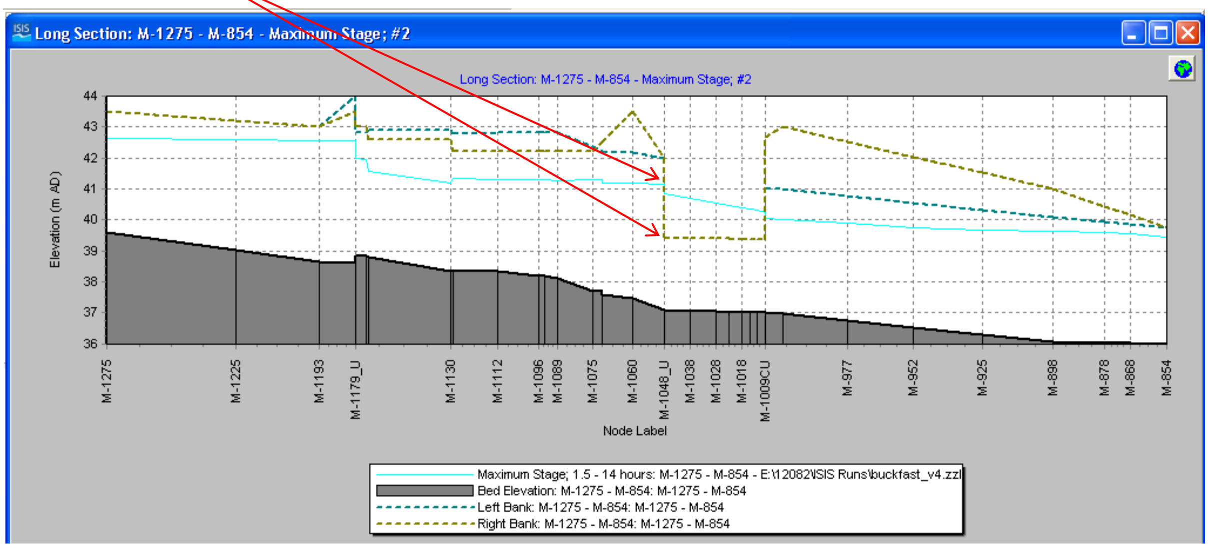
A summary of the levels is given below in Table 2:

Table 2: – Summary Flows and Flood Levels

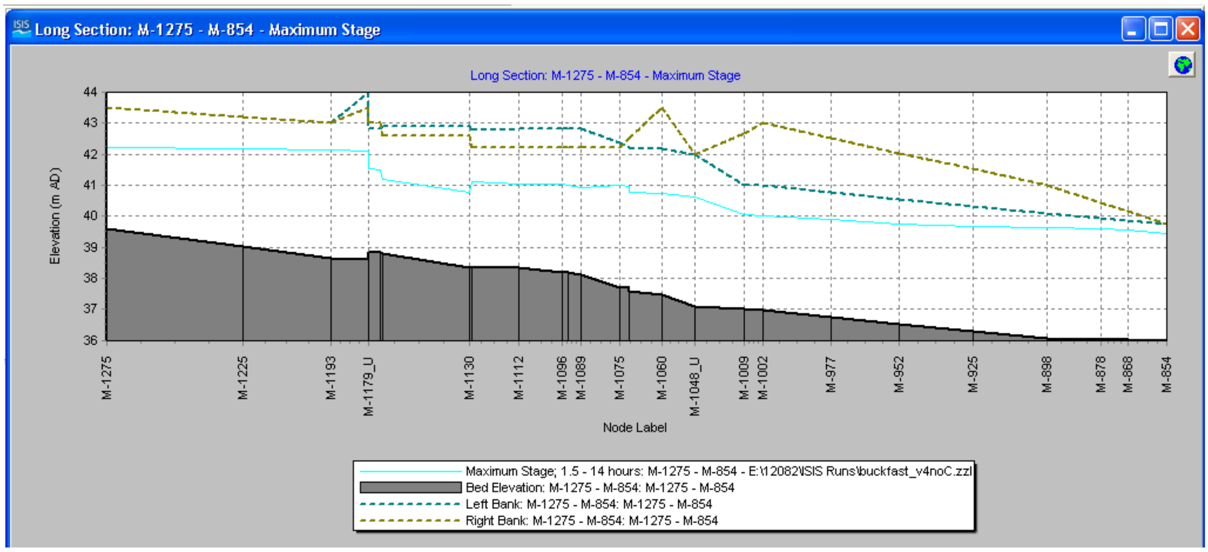
Return Period	Design Peak flow (m^3/s)	Upstream (Node M-1179U)	Building end (Node M-1096)	Culvert inlet (Node M-1048U)	Culvert outlet (Node M-1009)
20 year (FZ3B)	27.00	41.13	40.37	39.77	39.17
100 year (FZ3A)	35.72	42.16	40.96	40.66	39.90
CC20% Flow	42.86	42.57	41.32	41.17	40.03
CC20% +n10%	42.86	42.64	41.52	41.42	40.13
1000 year (FZ2)	53.46	43.11	42.03	41.96	40.15

Development options

The EA have indicated that the extent of flooding on site is in part due to the existing culvert between nodes M-1048 and M-1009. The predicted water level is shown on the long section extract of the ISIS model between nodes M-1275 (Market Close) and M-854 (Mardle Way bridge). In the climate change flow the surcharging of water above the culvert soffit at the inlet is 1.73m.



An ISIS model has been run at the climate change flow with the culvert removed to determine what impact this would have on water levels through the site. The results are shown below in the long section extract of the ISIS model between the same nodes:



Water levels at the downstream side of Bridge Street culvert (node M-1167_D) have dropped by 446mm, whilst at the location of the removed culvert inlet (node M-1048_U) levels have dropped by 553mm. The removal of the culvert will also benefit properties further upstream in Market Close lowering water levels by 380mm.

Further downstream at Mardle Way Bridge water levels have remained within a few millimetres.

Removal of the culvert would therefore reduce the extent of FZ3 and FZ2 potentially making more developable area available. Drawing 4 shows the outline of FZ3A and FZ3B should the culvert and office be removed.

The 1 in 1000 year flow ISIS model has also been run, this shows water levels at the downstream side of Bridge Street culvert (node M-1167_D) have dropped by 253mm, whilst at the location of the removed culvert inlet (node M-1048_U) levels have dropped by 1044mm. The removal of the culvert will also benefit properties further upstream in Market Close lowering water levels by 121mm.

3.4.2 *Increase in surface water runoff due to urbanisation*

Based on guidance in TGNPPF, the Environment Agency requests that applications for development where the site may increase the amount of surface water runoff include an appropriate drainage strategy to ensure that surface water runoff discharge mimics the existing pre-development regime. This can be via a series of different methods, including infiltration, attenuation and rainwater re-use so that the potential adverse impact, i.e. increase in downstream flood risk on the fluvial system is alleviated.

The regulating authorities require that the storage requirements are based on the critical 1:100 year storm event, including allowance for potential affects of climate change, with runoff not exceeding existing rates. Assessment of the runoff regime for the existing and proposed sites considers the runoff generated by the site for the 100 year return period event, for a range of durations. Using the effective rainfall and investigation of the existing and proposed site land use characteristics, a range of allowable discharge rates relating to return period storm events can be estimated.

The following sources of data can be used to complete this assessment:

- Topographical data for the existing site;
- Site walkover and inspection of existing surface water drainage outfalls;
- Land-use data for the existing and proposed sites, and
- Catchment descriptors and WINDES rainfall data.

Analysis of the following has been undertaken as part of this process:

- Determination of appropriate discharge rates based on existing Greenfield runoff areas and flow rates;
- Assessment of the mitigation requirements to ensure that appropriate discharge rates and runoff volumes are maintained; and
- An outline surface water drainage strategy that demonstrates no detrimental impact on the existing receiving water bodies, highway drains or third party property.

<u>Land Use – data to be inserted as masterplan is developed</u>

The site area has been measured and the different uses categorised. The FEH for the River Mardle catchment area suggests 35.7% is the runoff coefficient. Table 3 summarises the existing and proposed land uses within the site boundary:

Table 3: Land Use Summary

Land Use Type	**Total Land use Area**			
	Existing Site		**Proposed Development**	
	m^2	**%**	**m^2**	**%**
Bitumen Highways				
Block Paved Highways			Pending masterplan exercise	
Roof Areas				
Attenuation pond				
Garden areas / Open space				
TOTAL	25621	100		
Approx Runoff Coefficient	35.7% (FEH)			

The above table assumes that runoff coefficients for the site are as follows:

Roof areas positively drained	90% or 100% depending on type
Bitumen Highways	100%
Block paved highways	85%
Attenuation Pond area	100%
Gardens & Public Open space	35.7% (FEH is 35.7%)

3.4.3 Existing Greenfield Runoff Rates – to be added

Using the land use information, rainfall and catchment data from the FEH CD ROM the existing Greenfield runoff rates (including gravel / stone areas not directed to a positive drainage system) have been estimated at the site, using the ADAS 345 Method and Regional Growth Curve factors derived from the Flood Studies report and EA South West Region.

The ADAS345 runoff flows are high when the percentage of runoff from the catchment is considered. As the EA have already shown that the catchment characteristics over predict the run off the above figures and should be reduced by a similar amount that more closely reflects the overall catchment.

The EA have provided details of their flow nodes used in their hydrology / modelling report, one of which is located 180m upstream of the site (node 1877). Instead of the ADAS 345 figures the adjusted flows for the catchment will be applied in sizing any preliminary surface water attenuation / wetlands. The 100 year flow at node 1877 was 60.75m^3/s for the 13.33km^2 catchment and in the modelling report was 61.00m^3/s. The modelling flow was then adjusted to 35.72m^3/s. Using the various return period flows for node 1877 the Greenfield runoff can be recalculated to 58.6% (35.72/61.00) for each of the nodes return periods as a l/s/ha flow rate.

The results of this analysis are summarised in Table 3, below:

Table 3: Summary of Existing Greenfield Runoff Rates

Return Period (Years)	**ADAS 345 Method (l/s)**		**Revised Greenfield flows for site based on Node 1877 (l/s/ha)**
	l/s for north site (1.656ha)	l/s for south site (0.412ha)	l/s/ha to be applied to surface water drainage strategy
2	48.4	5.8	11.9
10	86.9	10.4	17.6
30	117.6	14.1	20.9 (25yr node flow)
100	161.1	19.3	26.8
100+30% Climate	209.4	25.1	34.8

The full spreadsheet used to derive the ADAS 345 figures is included in Appendix B.

3.4.4 Existing Brownfield Runoff

Some parts of the site have positive surface water drainage with down pipes on buildings and manholes. There are also down pipes on the sides of existing buildings which discharge direct to the Mardle and to the ground.

To enable the continued use of any of the Brownfield flows the connectivity of any positive pipe systems will have to be proved. For now it has been assumed that the Brownfield runoff flows on the site add only a few extra litres / second as the large yard and turning areas have no gullies or manholes.

No Brownfield discharge rates will be used to size the attenuation / wetland features. If this is to be pursued at a later date then additional survey work will need to be undertaken to prove any connectivity.

3.5 Disposal of Surface Water Runoff

Development of the site will lead to an increase in impermeable area, which will have a consequential impact on the runoff rates and volumes. It is therefore proposed to design a surface water drainage system to mitigate additional runoff from the proposed site and in fact to over compensate to provide other off site benefits.

For now a preliminary sizing of a wetland / attenuation pond has been undertaken, one of the north of the Mardle and one for the south. The pond will have 1 in 3 side slopes and not exceed 1.5m depth. The ponds have been sized as attenuation only between 0.3m and the rim level (effective depth) with the bottom 300mm being permanently wet.

A maximum contributing impermeable area of 70% based on density of development has been used as the basis of the pond sizing.

The existing buildings to remain on the south side have been excluded as they will be in separate ownership or operation and their surface water drainage system will not be connected to the proposed redevelopment drainage. The building to remain on the north side has been included in the gross / net calculations as this is to be converted to an alternative use.

North pond – maximum catchment area 1.656ha gross or 1.159ha net

South pond – maximum catchment area 0.412ha gross or 0.288ha net.

The current proposals will place the pond in FZ1 and FZ2.

The north pond will be 1.5m deep overall with an effective depth of 1.2m and a footprint of 680m^2 at the rim and 370m^2 area at the 0.3m depth contour. A 130mm diameter pipe at 0.3m invert and a 1 metre wide overflow weir at 1.4m provide the necessary control to meet the Greenfield runoff rates. Maximum effective pond volume is 630m^3.

The south pond will be 1.1m deep overall with an effective depth of 0.8m and a footprint of 330m^2 at the rim and 117m^2 area at the 0.3m depth contour. A Crown Vortex R2 flow control device at 0.3m invert of 118mm diameter based on 4.9l/s flow at 0.28m head and a 1 metre wide overflow weir at 0.99m provide the necessary control to meet Greenfield runoff rates. Maximum effective pond volume is 178m^3.

All these levels are local datum at present but will be adjusted once the master plan layout is completed. The results of this analysis are summarised in Table 4, below:

Table 4: Summary of Illustrative Surface Water Drainage Strategy

Return Period (Years)	Permitted flow (l/s)		Design flow and volume - North pond		Design flow and volume - South pond	
	for north site (1.656ha)	for south site (0.412ha)	l/s	m^3	l/s	m^3
2	19.7	4.9	19.4	177	4.9	40
10	29.1	7.3				
30	34.6	8.6	26.0	345	6.3	83
100	44.4	11.0	29.3	463	7.1	113
100+30% Climate	57.7	14.3	57.6	595	13.5	149

An illustrative location for these ponds is included on drawing 5. These will be located outside the 1 in 100 year plus climate change influence flood risk area.

The full output results from WinDes are included in Appendix D.

3.6 Off-Site Impact: Sustainable Drainage Design Statement

It is proposed that a new pond system will maximise infiltration potential if the ground conditions are suitable. The main drainage system is however likely to be attenuation in ponds with a discharge connecting into the River Mardle.

It can be demonstrated that with the input of mitigation measures and attenuation systems, the proposed development of the site represents no tangible increase in off-site surface water runoff rates and will provide opportunities to alleviate some of the runoff from the site which contributes to the flooding in Buckfastleigh.

3.7 Maintenance and Management

The continued maintenance of any site drainage systems will be by the Local Authority County Council (Highways), whilst private drainage systems will be maintained by each householder or adopted by South West Water if agreement can be reached to outfall to open pond systems. In recent discussions with SWW they have suggested that if the final manhole before the pond has a piped overflow facility should the pond fill to its maximum level then the upstream approach pipework would be adopted.

It is envisaged that the flood alleviation ponds and any other open surface water features would either be part of the public open space managed by the Lead Local Flood Authority or retained under a management company as appropriate. It is considered that with these measures, the potential residual risks can be managed and lowered to an acceptable level.

4.0 SUMMARY AND CONCLUSIONS

Robson Liddle Limited has been retained by Axminster Carpets Ltd to undertake a Flood Risk Assessment and Modelling report to inform the Local Development Framework (Development Management and Delivery Plan) process for a mixed use redevelopment of part of the Devonia Products site in Buckfastleigh and to ascertain the constraints to the redevelopment of the site, and assess the impact of the proposals with regard to flood risk.

The development site area is currently a mixture of buildings and paved or gravelled areas providing employment. There are some positive drainage systems which serve areas of the site but the connectivity of these has not been proven.

The site boundary lies within Flood Zone 1, Flood Zone 2 and Flood Zone 3 when considered against EA flood zone maps.

Hydraulic modelling has been undertaken to prove the existing FZ2 and FZ3 envelopes.

These outlines are shown on drawing SK100 and SK101.

The removal of the existing culvert that conveys the Mardle through the site can reduce water levels by 450-550mm through the site and benefit properties further upstream in Market Close by 380mm. The outline of the revised FZ3 is shown on drawing SK102.

The site masterplanning layout will be subjected to the Sequential Approach advocated in NPPF, Paragraph 101 and there is to be no development other than public open space within FZ3.

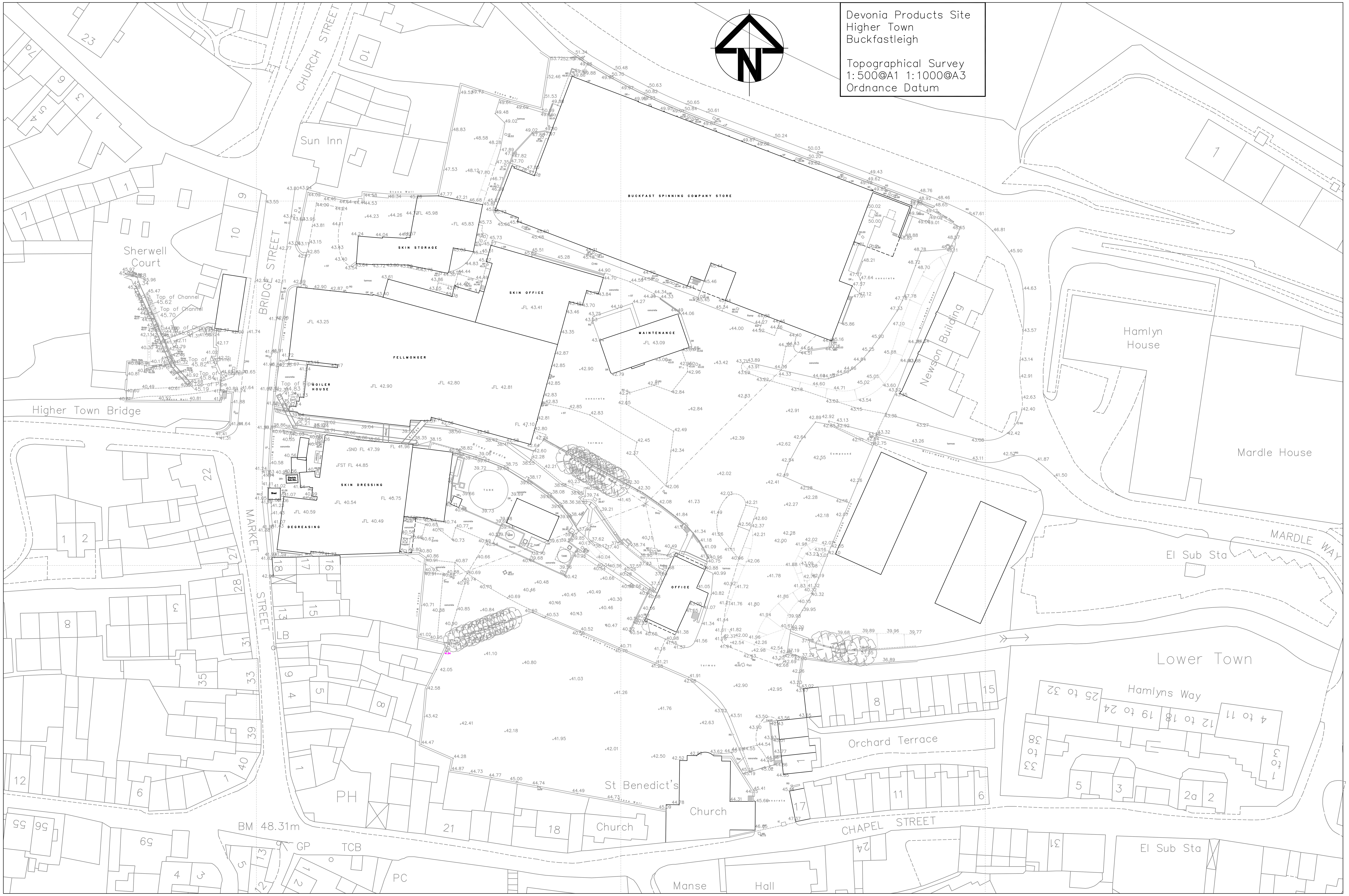
Any floor levels will be set at least 300mm above the FZ2 outline level in the detailed site layout design.

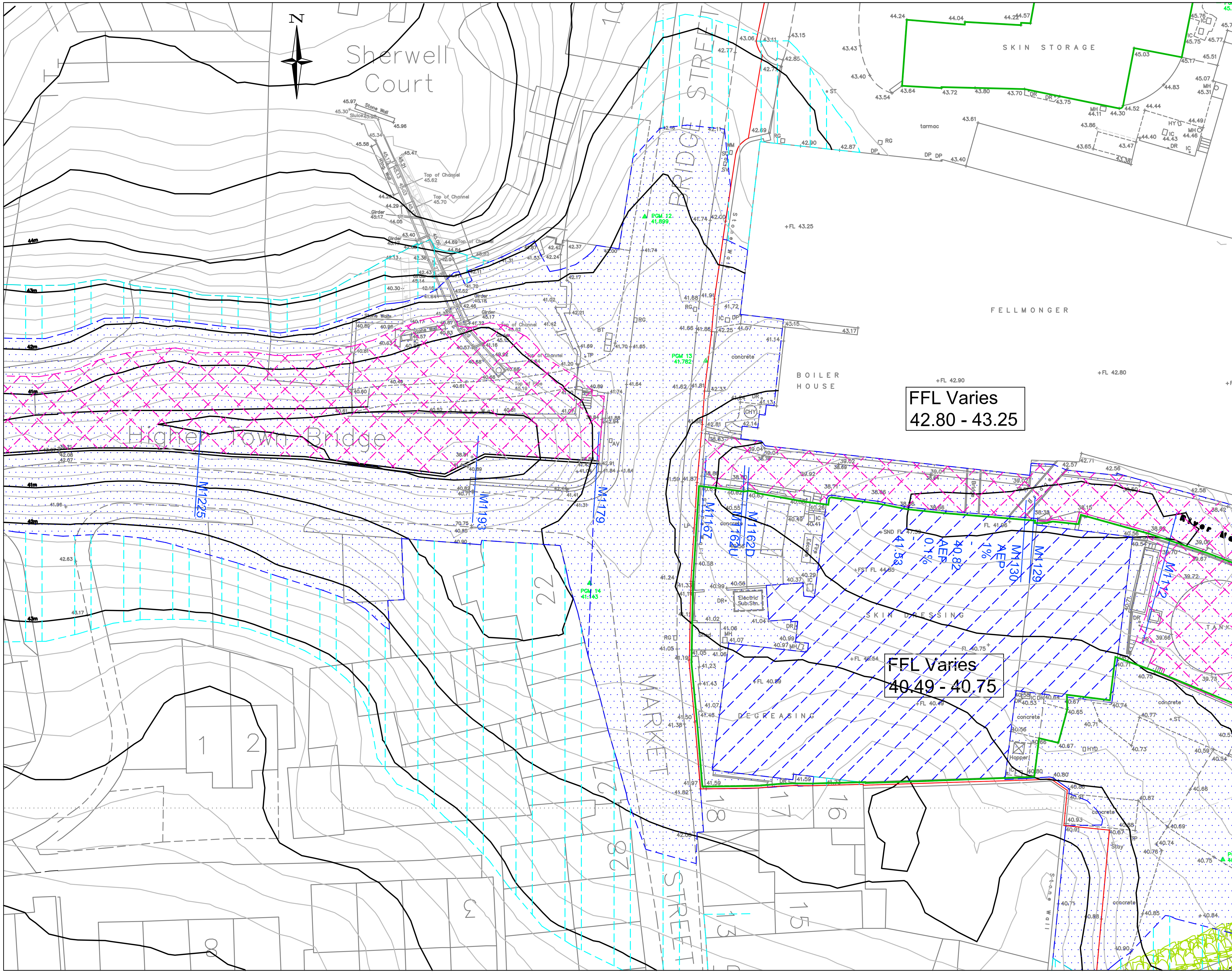
The site surface water runoff from the development will drain via an attenuation pond to the existing watercourse. The illustrative pond layouts are included on drawing SK103.

If this site is redeveloped it can provide betterment to the existing Brownfield / Greenfield run-off scenario providing wider area benefit to downstream flood risk.

DRAWINGS

1. Existing Topographical Survey
2. SK100 – Flood zoning and routing from hydraulic modelling – west
3. SK101 – Flood zoning and routing from hydraulic modelling – east
4. SK102 – Flood Zone 3A and 3B with and without culvert under office removed
5. SK103 – Illustrative surface water drainage strategy


Devonia Products Site
Higher Town
Buckfastleigh
Topographical Survey
1:500@A1 1:1000@A3
Ordnance Datum
N
BUCKFAST SPINNING COMPANY STORE
SKIN STORAGE
SKIN OFFICE
FELLMONGER
BOILER HOUSE
MAINTENANCE
SKIN DRESSING
DEGREASING
OFFICE
Sun Inn
Sherwell Court
Higher Town Bridge
BRIDGE STREET
CHURCH STREET
MARKET STREET
Newson Building
Hamlyn House
Mardle House
MARDLE WAY
El Sub Sta
Lower Town
Hamlyns Way
Orchard Terrace
St Benedict's Church
Church
CHAPEL STREET
BM 48.31m
GP
TCB
PC
PH
Manse
Hall



This drawing is not to be scaled: work to figured dimensions only.

Any discrepancy on this drawing to be reported immediately to Robson Liddle Ltd. for clarification.

Key

- Site boundary
- Flood Zone 3B - 20 year / 5% AEP
- Flood Zone 3A - 100 year / 1% AEP
- Flood Zone 2 - 1000 year / 0.1% AEP
- Buildings on site with floor levels below 100 year water level
- Devonia Prodcuts buildings / operational areas to be retained

Rev	Date	Revision

Drawing Status: **Planning**

Robson Liddle consulting engineers — Part of the nps group

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Job Title: **Devonia Products Mill Site Higher Town Buckfastleigh**

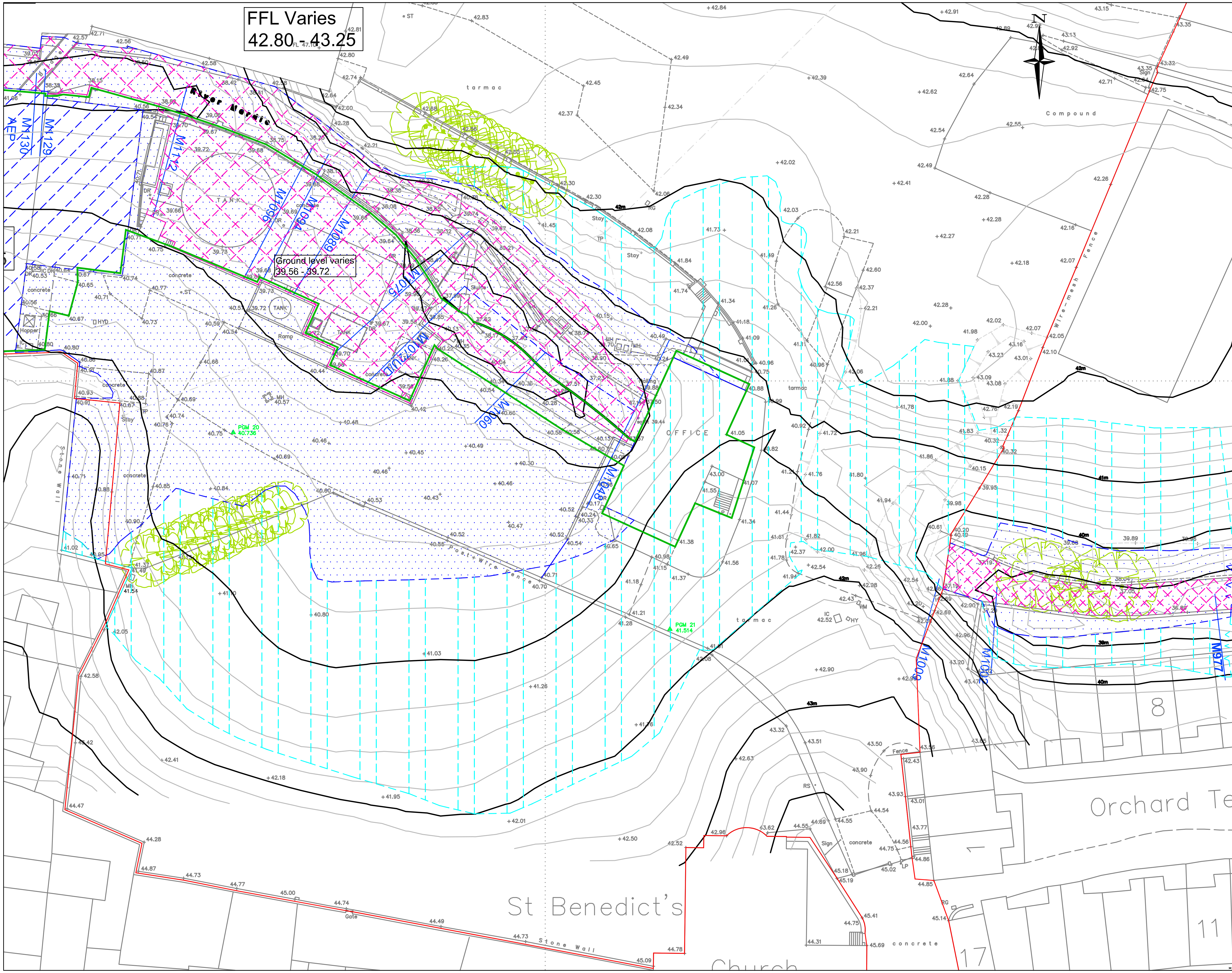
Dwg Title: **Flood Zoning and Routing from Hydraulic Modelling Sheet 1 of 2 - West**

Client: **Axminster Carpets Ltd**

Scale 1:200@A1 / 1:400@A3 Drawn RLL

Date Oct 2012 Checked NAS

Drawing no: **12082-SK100** Rev -



This drawing is not to be scaled: work to figured dimensions only.

Any discrepancy on this drawing to be reported immediately to Robson Liddle Ltd. for clarification.

Key

- Site boundary
- Flood Zone 3B - 20 year / 5% AEP
- Flood Zone 3A - 100 year / 1% AEP
- Flood Zone 2 - 1000 year / 0.1% AEP
- Buildings on site with floor levels below 100 year water level
- Devonia Prodcuts buildings / operational areas to be retained

Rev	Date	Revision

Drawing Status: **Planning**

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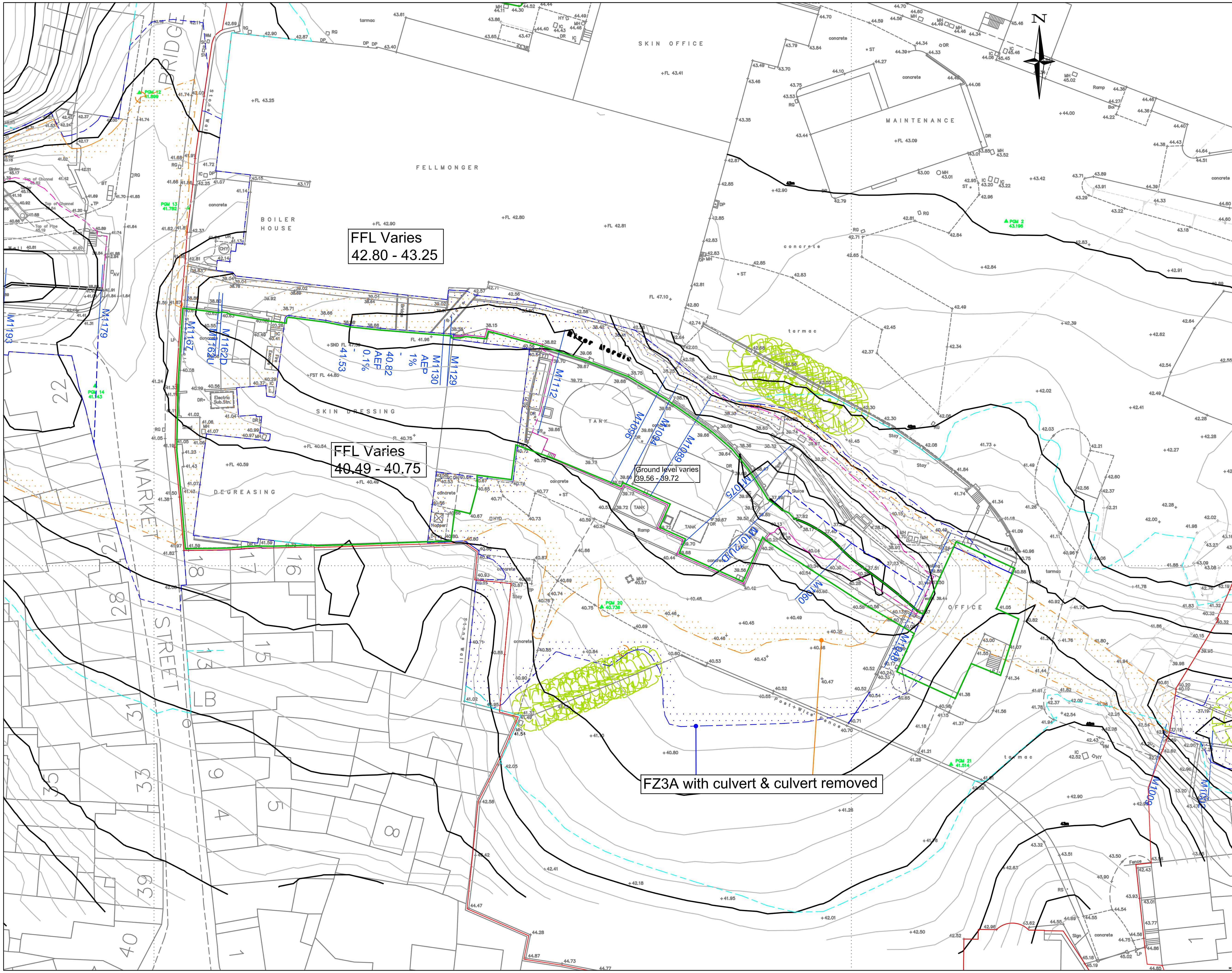
Job Title: **Devonia Products Mill Site Higher Town Buckfastleigh**

Dwg Title: **Flood Zoning and Routing from Hydraulic Modelling Sheet 2 of 2 - East**

Client: **Axminster Carpets Ltd**

Scale 1:200@A1/1:400@A3 Drawn RLL
Date Oct 2012 Checked NAS

Drawing no: 12082-SK101 Rev -



This drawing is not to be scaled: work to figured dimensions only.

Any discrepancy on this drawing to be reported immediately to Robson Liddle Ltd. for clarification.

Key

Site boundary

Flood Zone 3B - 20 year / 5% AEP

Flood Zone 3A - 100 year / 1% AEP

Flood Zone 3A - with culvert removed

Flood Zone 2 - 1000 year / 0.1% AEP

Devonia Prodcuts buildings / operational areas to be retained

Rev	Date	Revision

Drawing Status: **Planning**

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Job Title: **Devonia Products Mill Site Higher Town Buckfastleigh**

Dwg Title: **Flood Zone 3A & 3B with and without culvert under office removed**

Client: **Axminster Carpets Ltd**

Scale 1:250@A1/1:500@A3 Drawn RLL

Date Oct 2012 Checked NAS

Drawing no: **12082-SK102** Rev -