



Five Fords WwTW Access Road Improvements

Flood Consequence Assessment

June 2015

Dŵr Cymru Welsh Water

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Executive Summary

Dŵr Cymru Welsh Water proposes to upgrade an existing access road to its Five Fords wastewater works near Wrexham, North Wales. Mott MacDonald Bentley has been commissioned to carry out a Flood Consequence Assessment to assist with planning for this proposed development.

Based on the publically available national flood maps, fluvial flood risk posed by the River Clywedog is dominant in this area with the alignment of the access road crossing its channel and floodplain. Welsh Government Development Advice Maps indicate that the proposed development is partially within Zone C2, i.e. in an area of floodplain without significant flood defence infrastructure.

The existing access road will be widened and a new road bridge will be built crossing the River Clywedog. Modifications to the road are minimal and will not have a significant impact on flood risk, either upstream or downstream of the site.

A hydraulic assessment has been undertaken to determine if the proposed development has a detrimental impact on flood risk. Results from the assessment show that the proposed develop will likely result in small decrease in upstream flood risk.

It is therefore considered that the proposed development meets the requirements of current planning policy subject to the following:

- A site Flood Management Plan is prepared prior to the construction phase; and
- The operator of the waste water treatment site registers for the Flood Alert service.

1 Introduction

Dŵr Cymru Welsh Water (DCWW) is upgrading the access road to the existing wastewater treatment work (WwTW) at Five Fords on the outskirts of the town of Wrexham in the North of Wales. The site is located at SJ 36696 48467 and the nearest postcode is LL13 0PA.

Mott MacDonald Bentley has been commissioned by DCWW to undertake a Flood Consequence Assessment (FCA) to assist with a planning application for the proposed upgrade of the access road.

1.1 Study Objectives

This FCA is provided solely for the planning application process to ensure that DCWW meets its obligations under Planning Policy Wales (PPW) (Welsh Government, 2014) by identifying the sources of flood risk to the site and assessing whether, subject to suitable mitigation measures, the development is appropriate from a flood risk perspective. It is not the intention of the report to provide a guarantee against flooding. This FCA includes the following:

- An appraisal of the availability and adequacy of existing information;
- An appraisal of the flood risk posed to the site and in particular the zones of interest in which sensitive uses are proposed;
- The potential impact of the development on flood risk elsewhere; and
- An appraisal of the scope of possible measures to reduce the flood risk and consequences to acceptable levels.

The assessment presents a review of the existing available information and sets out the requirements of PPW Technical Advice Note 15 (TAN15) (Welsh Assembly Government, 2004) and those of the Natural Resources Wales (NRW) and WW in relation to flood risk and drainage.

1.2 Study Area

The access road starts from Cefn Road before crossing the River Clywedog and continuing south, before taking 90 degree turn west, continuing west until it reaches the wastewater treatment plant. The grid reference of the site is SJ 36696 48467.

The location of the access road is shown in Figure 1.1 and Figure 1.2.

Figure 1.1: Access road location (red polygon)

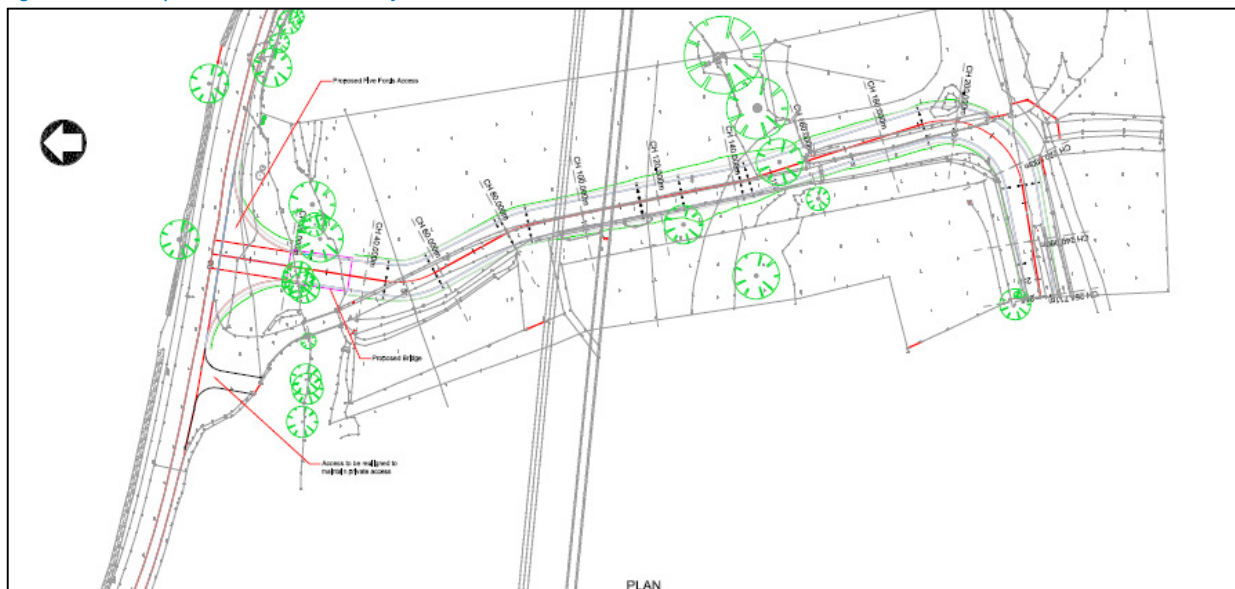


Source: Mott MacDonald 2015

1.3 Proposed Development

It is proposed to upgrade the existing access road. This upgrade will consist of a new bridge across the River Clywedog and resurfacing and minor re-profiling of the access road. The layout of the proposed new access road is shown in Figure 1.2. A full sized version of this figure can be found in Appendix A.1.

Figure 1.2: Proposed access road layout



Source: MMB 2015

1.4 Existing Data

The following information has been referred to in undertaking this FCA:

- Topographic survey data;
- Development Advice Map (Welsh Government, 2015); and
- Planning Policy Wales Technical Advice Note 15: Development and Flood Risk (Welsh Assembly Government, 2004).

1.5 Flood Risk Classification

TAN 15 provides a framework with which risk arising from both river and coastal flooding, and from additional runoff from development in any location can be assessed. Figure 1 Section 4.2 of TAN 15 defines four Development Advice Zones (DAM), as summarised in Table 1.1.

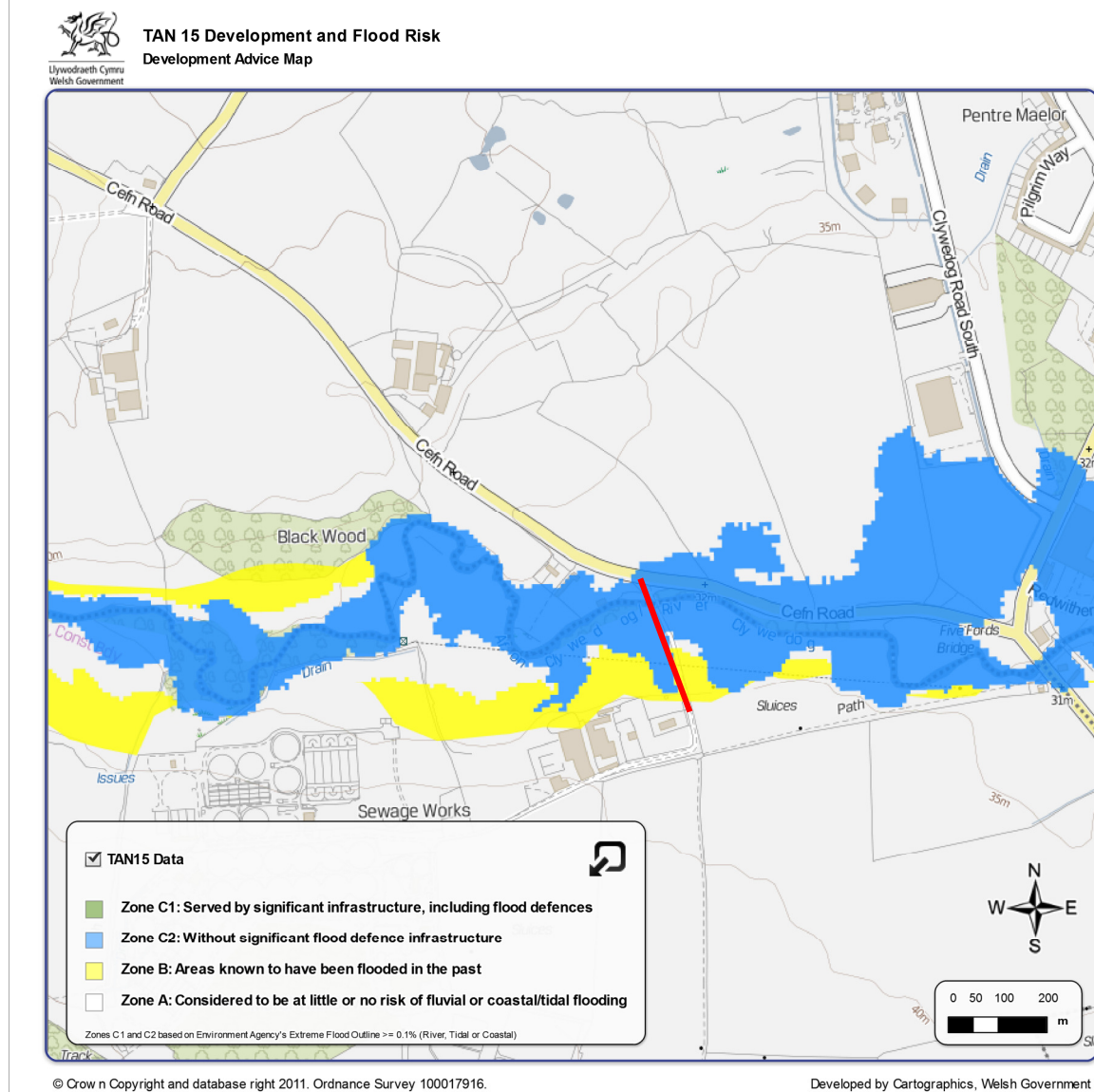
Table 1.1 Flood zone classification

Zone	Description of Zone	Use within precautionary framework
A	Considered to be at little or no risk of fluvial/coastal flooding	Used to indicate that the justification test is not applicable and no need to consider flood risk further.
B	Areas known to have been flooded in the past evidenced by sedimentary deposits	Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further.
C1	Areas of floodplain which are developed and served by significant infrastructure, including flood defences	Used to indicate that development can take place subject to application of justification test, including the acceptability of consequences.
C2	Areas of the flood plain without significant flood defence infrastructure	Used to indicate that only less vulnerable development should be considered subject to application of the justification test, including the acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

Source: Technical Advice Note 15: Development and Flood Risk

Welsh Government Development Advice Maps (DAMs) (Welsh Government, 2015) indicate the location of the Development Advice Zones for areas in Wales. The DAM at the location of the site indicates that the proposed development is partially within both Zone C2, i.e. in an area of floodplain without significant flood defence infrastructure, and Zone B, i.e. in areas known to have been flooded in the past (Figure 1.3).

Figure 1.3 Development Advice Map



Source: Development Advice Map (Welsh Government, 2015)

TAN 15 classifies developments as either “emergency services”, “highly vulnerable development” or “less vulnerable development” (Figure 2, Section 5.1 of TAN 15). The proposed access road is classified under TAN 15 as ‘less vulnerable development’ within an area of flood risk. In accordance with the guidance given in Table 1.1 ‘less vulnerable development’ in Zone C2 should be subject to the justification test, including consideration of the acceptability of consequences. The justification test aims to direct development away from Zone C and towards suitable land in Zone A. Section 9 of TAN 15 states that for

highly vulnerable development in Zone C2, development can only proceed subject to justification of acceptable consequences.

1.6 Definition and Sources of Flood Risk

Based on the DAM fluvial flood risk posed by the River Clywedog is dominant in this area and is considered the main source of flood risk to the proposed development.

It is anticipated that there may also be flood risk from surface water runoff which will need to be managed as part of the development's drainage system.

1.7 Flooding History

Part of the proposed development site is shown to be within DAM Zone B and is therefore known to have flooded in the past.

2 Existing Conditions

2.1 Present Land Use

The site's current land use is as an access road. The existing road is made of asphalt. It is bounded by grass and shrub land to both the east and west.

2.2 Topography

At the northern extent of the existing access road ground levels are at 32.76mAOD, these levels fall towards the River Clywedog to approximately 30.88mAOD (the river bed). Ground levels then rise to 37.30mAOD at the southern extent of the access road. A detailed long section of the proposed development can be found in Appendix A.2.

2.3 Watercourses

The proposed development site crosses the River Clywedog, which flows from west to east. Based on Ordnance Survey mapping there are no other watercourses near the site.

2.4 Flood Defences

Based on the NRW/EA Flood Map there are no flood defences in the vicinity of the proposed development site.

3.2.1 Depth and extent of flooding

The flood map shown in Figure 3.1 is based on broad scale JFLOW modelling and therefore depths are subject to a high degree of uncertainty and have not been provided by NRW.

Most of the road is outside the flood extent, with only a small portion of the north section predicted to be within Flood Zone 2/3.

3.2.2 Flood risk upstream and downstream of the site

The nearest property at risk of flooding is approximately 100m upstream of the bridge crossing. Therefore variations to the road crossing have the potential to effect on flood risk at upstream receptors. The hydraulic impact of the proposed bridge variations are presented in Section 4.

Downstream of the site the nearest properties at risk of flooding are approximately 300m downstream in Five Fords. It is considered unlikely that the existing crossing provides a significant attenuation of flood flows and therefore the alteration of the crossing is very unlikely to have a significant effect on downstream flood risk.

3.3 Surface Water

The Environment Agency's Surface Water Flood Map (Environment Agency, 2015) shows that the proposed development site has a '**Very Low**' risk of flooding from surface water. Therefore it is considered that the flood risk of surface water flooding to the site is very low.

3.4 Reservoir flooding

The Risk of Flooding from Reservoirs Map (Environment Agency, 2015) indicates that the site could be affected by the failure of an upstream dam or reservoir. Failure of a dam or reservoir is extremely unlikely to occur, however flood mitigation measures detailed in Section 5, detail the mitigation measures that will be used in the unlikely event of a dam or reservoir failure.

3.5 Groundwater

The site is not situated in or near a Groundwater Source Protection Zone, as shown by the EA's online mapping. NRW does not have any groundwater level data or groundwater flooding information in this area nor is there any history of flooding from groundwater sources. Therefore it is considered that the risk of groundwater flooding to the site is low.

4 Impact of Proposed Development on Flood Risk

4.1 Floodplain infill and construction of a new access bridge

The access road crosses the floodplain of the River Clywedog, therefore any increase in the access road level will lead to an increase in water levels upstream of the road. The proposed development raises road levels by a **maximum of 0.42m**. This increase in level is offset by the lowering of the ground at other sections of the road and a marginal increase in the bridge opening.

It is proposed the new access bridge will have the following dimensions:

Bridge soffit = 32.117 (left bank), 32.322mAOD (right bank)

Bridge invert = 30.388mAOD

Bridge Parapet height = 0.45m

Bridge Deck level = 32.567mAOD (left bank), 32.772mAOD (right bank)

Full details of the proposed new access bridge can be found in Appendix A.3. The new access bridge has an opening area of 10.2m³, compared to an opening area of 9.4m³ for the existing access bridge.

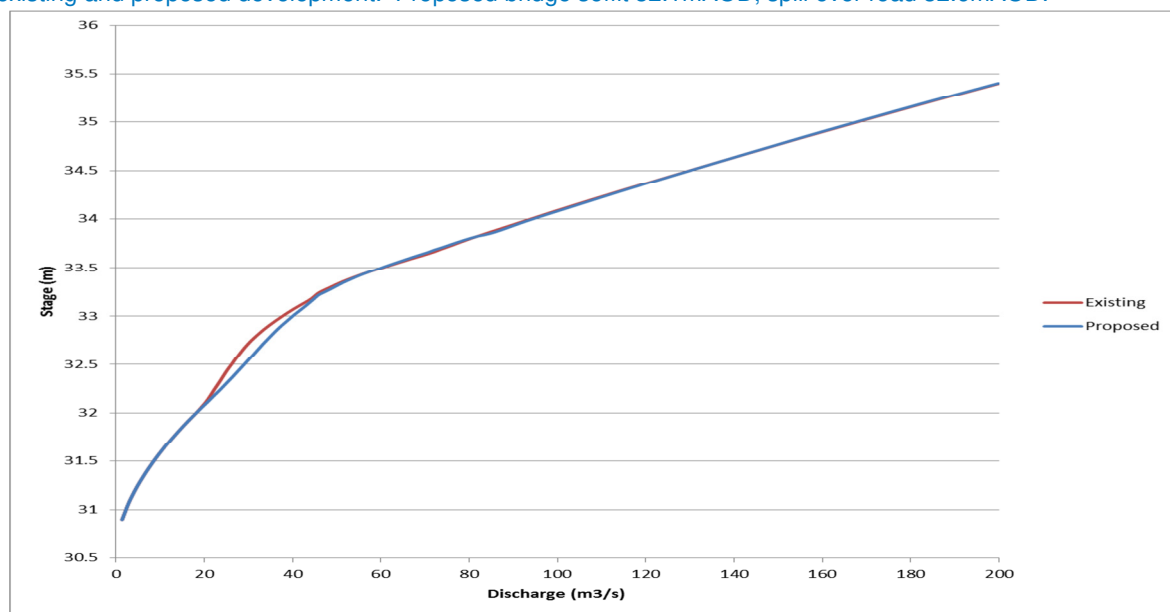
The new access road will result in a slight increase in ground levels in comparison to the existing development; however this may be offset by the slight increase in access bridge opening area. To fully understand the impacts of the proposed development on flood risk a hydraulic assessment has been undertaken. This is detailed in the following section.

4.1.1 Hydraulic assessment of proposed new development

An assessment of the new access bridge has been made using a small ISIS 1D hydraulic model to determine the impact of the new development on flood risk, in particular to the property located approximately 100m upstream of the proposed development. The assessment involved a comparison of the existing access bridge and road with the proposed access bridge and road. A full description of the methodology applied can be found in Appendix D.

Results from the hydraulic assessment show that the proposed development results in a small (up to 0.1m) decrease in upstream water levels in comparison to the existing development– this is shown in Figure 4.1. The slight decrease in upstream flood risk is due to the increase in the bridge opening area, and hence increased conveyance, in comparison to the existing development.

Figure 4.1: Stage-discharge relationship at the upstream face of the bridge providing a comparison between the existing and proposed development. Proposed bridge soffit 32.1mAOD, spill over road 32.6mAOD.



Source: Mott MacDonald 2015

4.2 Surface water runoff generated by the development

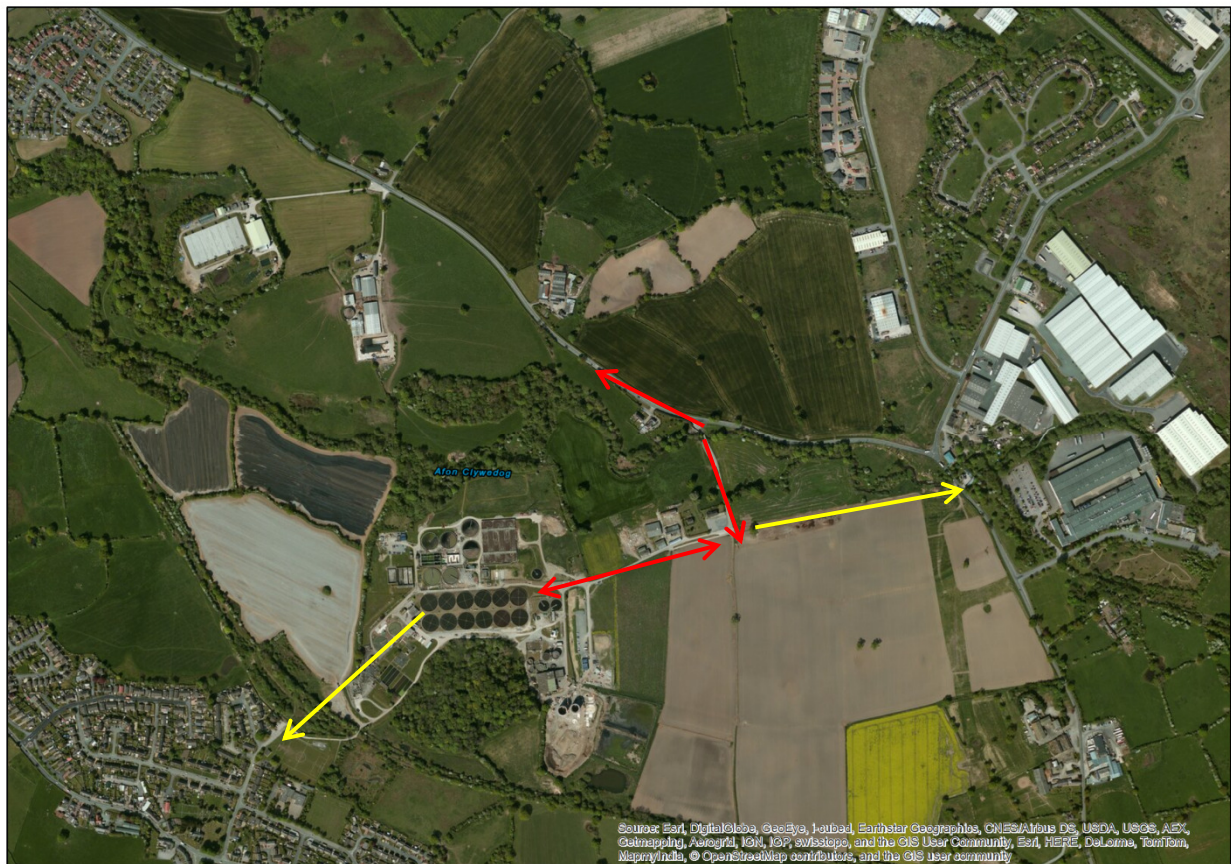
The proposed development will be drained by a SuDS system. The design of the system, which is not covered by this FCA, will be compliant with current best practice as detailed within the SuDS Manual (CIRIA, 2007). The system will safely remove surface runoff from the site and will be designed to attenuate runoff to greenfield rates.

4.3 Access and evacuation routes

NRW operates a Flood Alert service for the area. Flood evacuation procedures will need to be followed once a flood alert has been issued.

The access road continues to flood free land to the northwest as shown on Figure 4.2. It is recommended that a stage board is installed on the bridge deck to warn road users of the depth of water on the bridge prior to attempting to cross. Should the access track become unpassable then there are alternative pedestrian routes via public rights of way to dry ground as shown on Figure 4.2.

Figure 4.2 Emergency access and egress routes from the WwTW (primary route in red, alternate pedestrian routes via public right of way in yellow)



4.4 Flood consequences

The operator of the WwTW should sign up to receive flood alerts from NRW/EA. In the instance of a flood alert being issued, the operator should close the access road, to ensure that no vehicles are on it if it becomes inundated.

5 Flood Risk Mitigation Measures

5.1 Mitigating flood risk during construction

During the construction phase of the project, there will be a risk from a major fluvial flood event inundating the site of the access road. It is therefore advisable that the construction site manager prepares and implements a Flood Management Plan and arranges for registration with the NRW/EA Flood Alerts Service.

There is a risk of pollution of flood waters caused by construction material present on the site. In order to limit pollution risk, construction material and equipment/tools should be stored in areas above the 0.1% AEP event boundary or in containment units which should be secured in order to limit flood water contamination.

The site manager will need to co-ordinate quick evacuation of vehicular plant and relevant materials from the site in the event of a flood alert. It is advised that the construction programme be developed to avoid wetter seasons and with ample programme float to permit works to be postponed in the event of high rainfall or high river flows.

Induction of all site workers will be required to educate site personnel of the risks and the general procedures they should follow for the evacuation process. Liaising with NRW will also help to train personnel and reduce the risks to personnel during construction.

5.2 Mitigating flood risk during operation

The proposed development is of a new access road; therefore the site will be unmanned. Personnel using the existing WwTW will rely on the upgraded road for vehicle access to the site. As presented in Section 4.3 there are alternative pedestrian routes should the access track become unpassable.

5.3 Safe refuge

Should a flood event occur without warning (e.g. due to the failure of the flood alert system), safe refuge can be found at both ends of the access track, which will remain flood free for all events up to and including the 0.1% AEP event.

6 Conclusions and Recommendations

The development of a new access road and bridge to the Five Fords WwTW is defined as less vulnerable development within an area of flood risk not served by flood defences. It is therefore necessary to demonstrate that the consequences of flooding can be managed to acceptable limits.

A hydraulic assessment of the proposed new development has shown that it will result in a small decrease in upstream water levels; therefore the new development will not cause an increase in flood risk and may result in a slight betterment.

It is considered that flood risk and consequences at the proposed development site are within acceptable limits subject to the following:

- A site Flood Management Plan is prepared prior to the construction phase; and
- The operator of the WwTW registers for the EA/NRW Flood Alert service.

7 Bibliography

CIRIA. (2007). *SuDS Manual C697*.

Environment Agency. (2015). *Risk of Flooding from Reservoirs Map*.

Environment Agency. (2015). *Risk of Flooding from Surface Water*.

Welsh Assembly Government. (2004). *Technical Advice Note 15: Development and Flood Risk*. Cardiff.

Welsh Government. (2014). *Planning Policy Wales Edition 7*. Cardiff.

Welsh Government. (2015). *Development Advice Map*. Retrieved 5 1, 2015, from Development Advice Map: <http://data.wales.gov.uk/apps/floodmapping/>

Appendix A. Drawings

A.1 Site Layout

A.2 Site cross and long sections

A.3 Proposed bridge drawings

1. All dimensions are in millimetres unless otherwise stated.
2. Do not scale any items or information from this drawing.
- 3.

Longitudinal Elevation
1:50

Cross Section 1:50

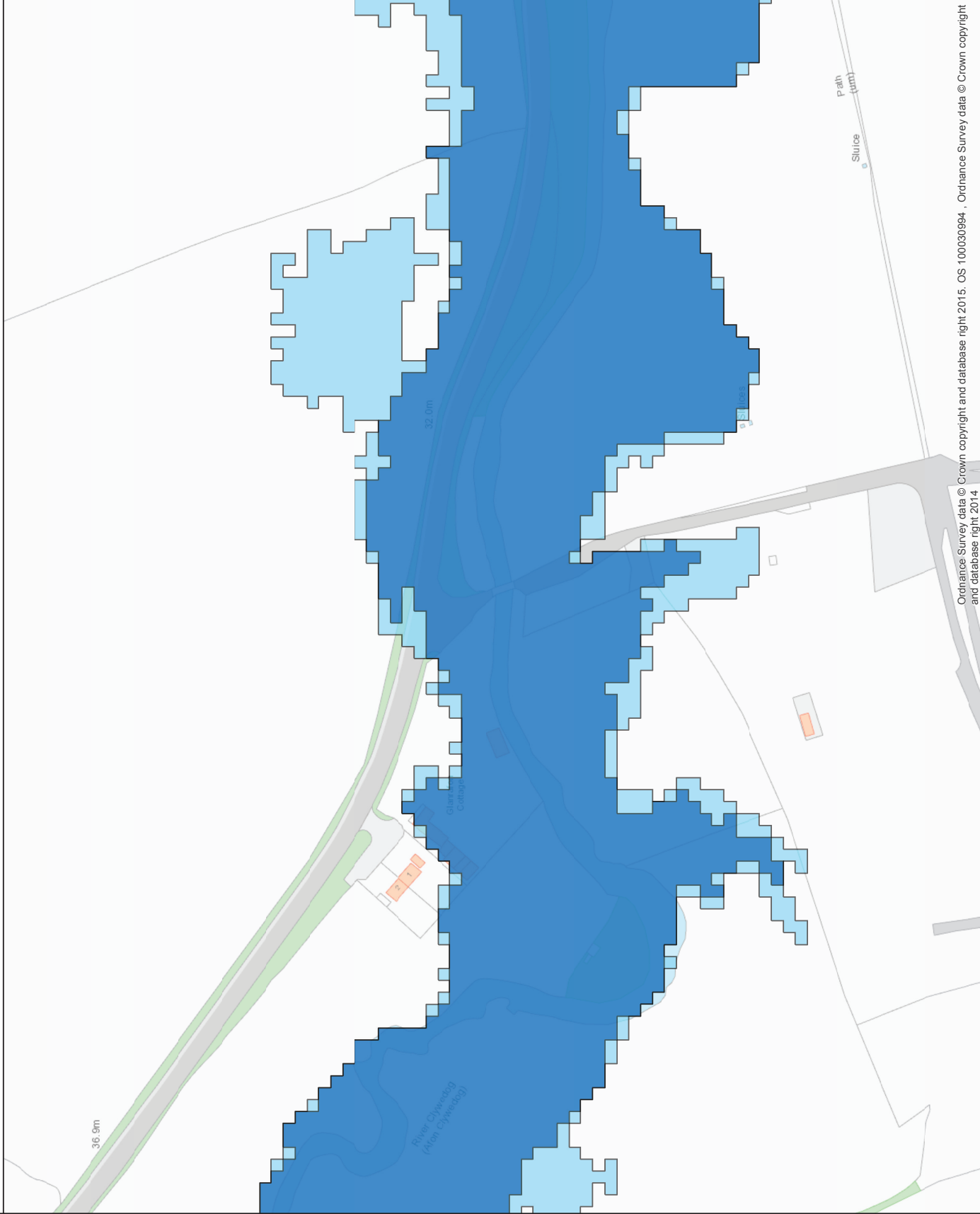
Schematic River Section at Proposed Bridge
(Existing bridge soffit level=32.065)

Drawn: MM	Checked: SR	Approved: JS	Date: 21/06/15
Submittal: FIT FOR INFORMATION			Submittal Code: S2
Printer Proj/N: 32301/1NN26	Scale: As Shown	Rev: P01	
Drawing ID: DCWVW-4791-S-201-MMD-00-XXX-DC-X-01025			

Appendix B. Topographic Data



Appendix C. Information Obtained from NRW



Legend



Fluvial Flood Zone 3



Fluvial Flood Zone 2

Flood Zone 3 (fluvial) indicates the area that could be flooded with a 1% (1 in 100) or greater chance of happening each year.

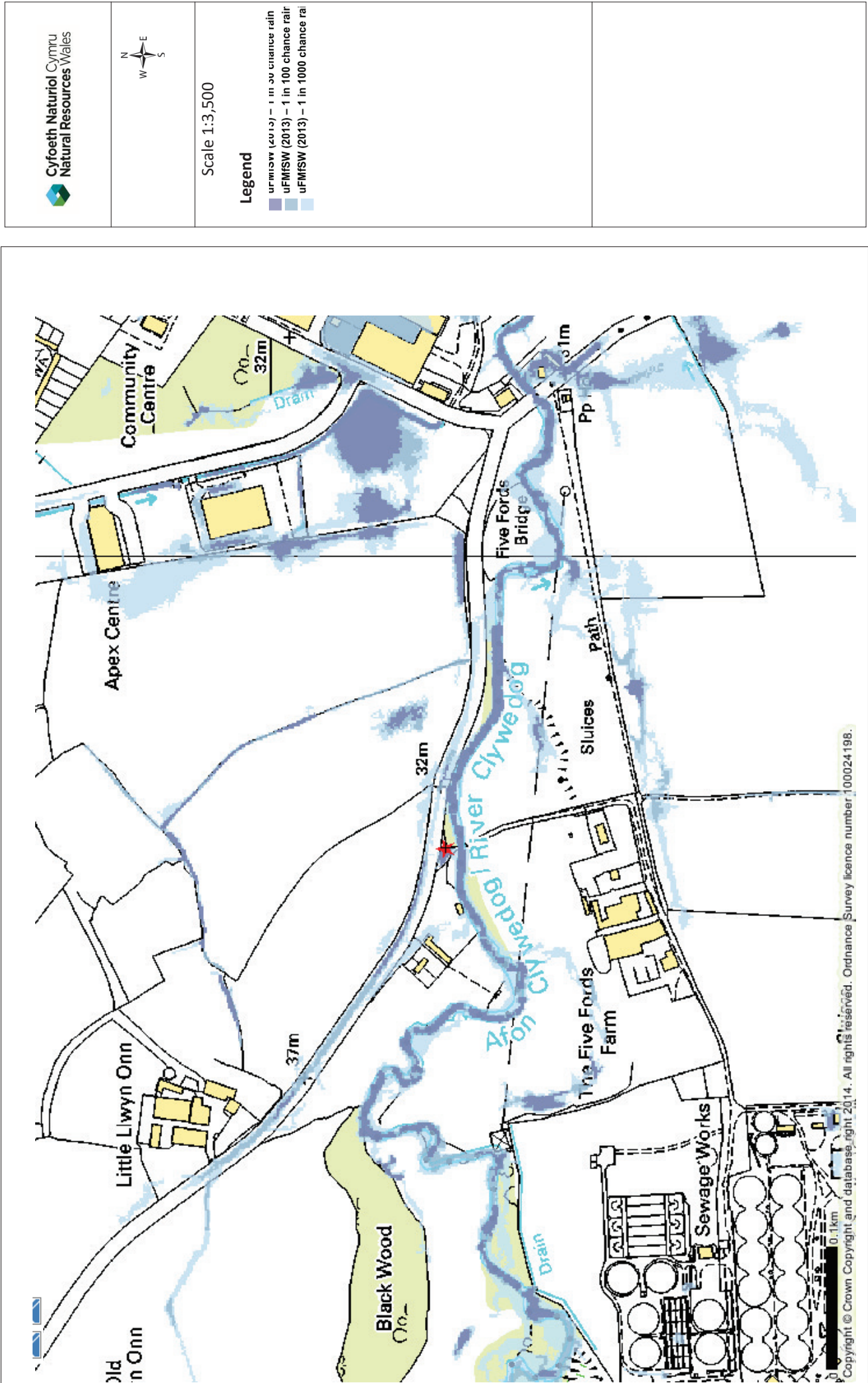
Flood Zone 2 (fluvial) indicates the extent of an extreme flood from a river. These areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year.

Flood Zones do not provide information on flooding from groundwater or other sources.



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Mawrhydi. © Hawlfraint a hawliau cronfa ddatari Goron 2013.
Rhif Trwydded yr Arlofw Ordnans 100019741.

Flood Map for Surface Water: 3.33%, 1% & 0.1% Annual Probability



Appendix D. Hydraulic assessment of proposed development

To	From	Our reference
Adam Sinclair	Anna Minchinton	
Office	Date	Your reference
Glasgow	27/05/2015	
Subject	Proposed Five Fords Access Bridge Stage – Discharge Relationship Calculation	

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We have followed the accepted procedures in providing the services, but, given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, we take no liability for and give no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This report has been prepared for the purposes of the flood study for the Riverside Project only.

Revision	Date	Originator	Checker	Approver	Description
0	27/05/2015	Anna Minchinton	Adam Sinclair		

Background

The proposed upgrade to the existing Five Fords Access Bridge has been assessed for its potential impact on flood risk. A property is located upstream of the bridge and is currently mapped as being at high risk of flooding on the Environment Agency Risk of Flooding from Rivers and Sea map.

This calculation has been undertaken to determine if the proposed change to the bridge will increase the risk of flooding at this location, by calculating the stage-discharge relationship for the existing and proposed conditions. Figure 1 shows the location of the bridge and the property of interest.



Figure 1: Property Location

Method

A 1D ISIS model has been developed for the existing and proposed bridge scenarios. A short channel 10m upstream and downstream of the bridge has been approximate as a U shaped channel, the depth of which has been taken from a drawing of the existing bridge. A Manning's n value of 0.035 has been applied. The upstream boundary has considered linearly increasing flows from $1\text{m}^3/\text{s}$ to $200\text{m}^3/\text{s}$. A normal downstream boundary has been applied with a slope of 1 in 200 which has been approximated from OS mapping. Figure 2 shows a schematic of the model set-up.

The same baseline model has been adopted for the existing and proposed bridge scenarios. With a Bridge (USBPR 1978) and spill unit being included to represent both bridges. The dimensions of which have been taken from 2009 drawing of the existing bridge and drawing DCWW-4791-S-201-MMD-00-XX-DR-CX-01025 for the proposed bridge, with the spill dimension taken from DCWW-4791-S-201-MMD-00-XX-DR-CX-01020. The existing bridge is located perpendicular to the bank whereas the proposed bridge is located at an angle, however both bridges are considered to have equal openings in the direction of flow. A weir coefficient of 1 has been used within the spill unit, to represent the road.

The model of the existing and proposed bridge scenarios have been run using the same boundaries, channel geometry and roughness. The only difference between the two models is the bridge and spill dimensions, to allow a fair comparison between the two scenarios.

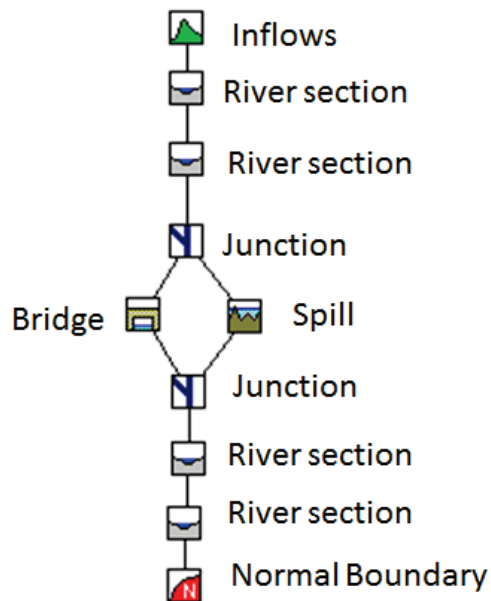


Figure 2: Schematic of model set-up

Results

A stage-discharge relationship has been extracted for the upstream bridge cross section. Figure 2 shows the difference between the existing and proposed bridge scenarios. It shows a similar relationship for both scenarios for the majority of flows. The proposed bridge scenario shows a slight reduction in water level of around 10cm, for flows between 20-45m³/s. Flows up to 200m³/s have been considered.

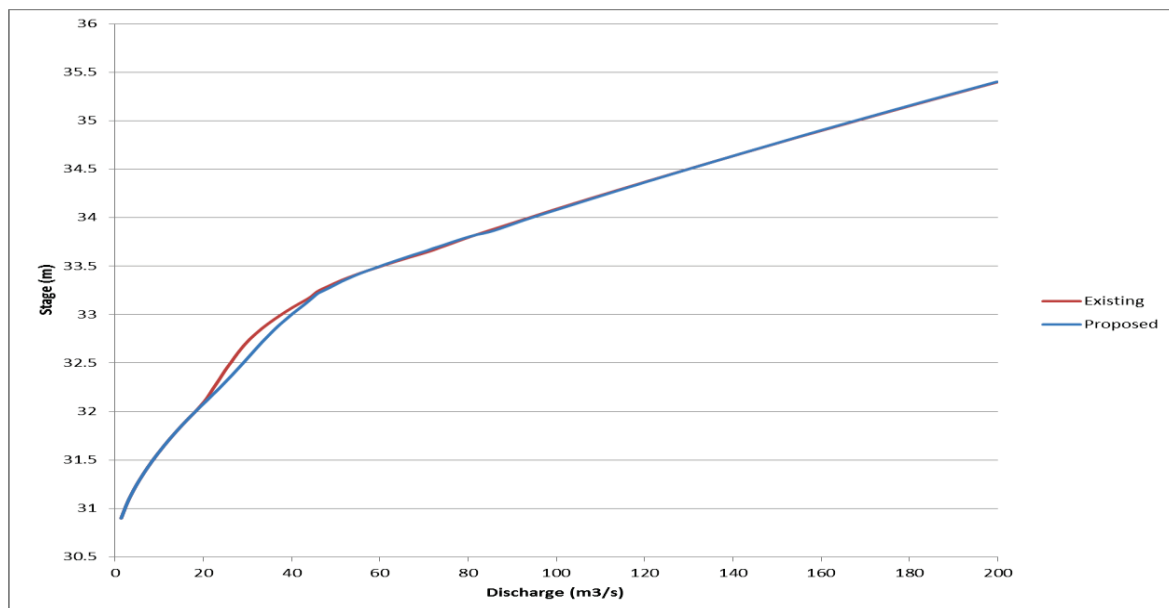


Figure 3: Stage - Discharge relationship comparison for the existing and proposed bridge upstream of the bridge.

Conclusion

The replacement of the existing bridge is unlikely to cause a significant difference to upstream flood risk, with the results of this modelling study showing a small reduction in water levels upstream for the proposed bridge. Therefore, flood risk to the property upstream of the proposed bridge will not increase.