VIEWPOINT 17
LANDSCAPE SETTING

VP 17 was taken from the Drovers Way at a distance of approximately 1.5km from the site and at an elevation of 290m. There is a ridge and bank of existing trees in the foreground that have the effect of visually splitting the urban area of Peebles in two. This means that the proposals are viewed to the rear of a much smaller built up area and lose the context of the wider settlement, as visible in the previous viewpoint.

Again, the proposals sit higher than the existing immediately adjacent residential properties, this is more apparent from this viewpoint. Whilst tree planting will help to break up the scale of the development, we believe that the proposals do have a negative visual impact on this viewpoint. However, taking account of the impact of proposed planting, as this view is reasonably and the proposed development occupies a small portion of the wider view, the magnitude of change is not considered to be significant.

Viewpoint Location

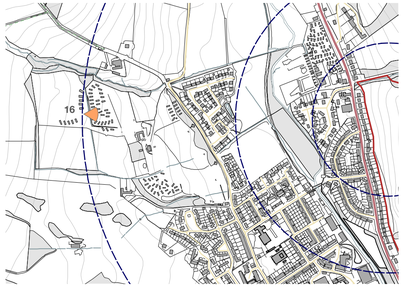
Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 16
LANDSCAPE SETTING

VP 16 was taken from the Rosetta Holiday Park, across the valley from the site. This viewpoint was taken from the lodges that are situated right at the top of the holiday park and the site is visible across the valley. However, the majority of the holiday park has scattered trees, hedges, walls, buildings and static caravans and as such has very limited long-distance views. The proposals are unlikely to impact on most of the holiday park users.

From this viewpoint the proposals are visible to the rear of existing development and the gaps between dwellings are also visible. This breaks up the development allowing the landscape to the rear to be viewed between the proposed dwellings.

Viewpoint Location



Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 16
MITIGATION VISUALISATION

The mitigation measures visual demonstrates that the landscape proposals would further screen the buildings with mixed native woodland planting. The material palette of the dwellings will also help minimise the visibility of the scheme. Taking account of the proposed planting and materiality of the proposed built development, the visual impact of the proposals from this viewpoint, is not considered to be significant.

Viewpoint Location

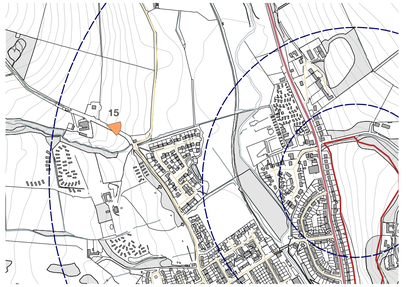
VIEWPOINT 15
LANDSCAPE SETTING

VP 15 was taken from Standalane Way, near Standalane Farm approximately 800m from the site. The development is visible across the valley sitting behind existing residential developments on both sides of the valley. Whilst the proposed housing sits at a higher level than immediately adjacent existing homes, notably existing houses to the north on Langside Drive sit at the same level as the proposed development.

The majority of the meadow is visible to the rear and the proposals do not interrupt the woodland boundary at the top of the field.

Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

Viewpoint Location



VIEWPOINT 15
MITIGATION VISUALISATION

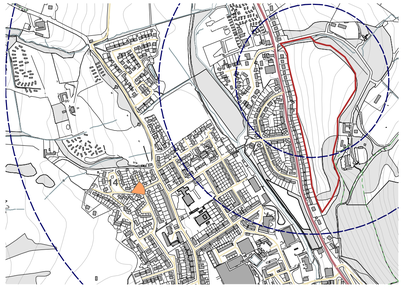
The mitigation measures visual demonstrates that the landscape proposals would further screen the buildings with mixed native woodland planting. In time, the woodland planting will also tie in with existing bands of woodland contributing to the character of development broken up by woodland. The material palette of the dwellings will also help minimise the visibility of the scheme.

The presence of new development in the foreground and existing development on the other side of the valley mean that the proposals will not appear incongruous to the character of the existing view. Overall, visual impact of the proposals from this position is assessed to be minor.

VIEWPOINT 14
LANDSCAPE SETTING

VP 14 was taken from Eliot's Park looking east. The proposals are visible to the rear of the existing properties in the foreground. The existing properties and tree planting largely screen the views of the development from this viewpoint. In addition, the gaps between the proposed dwellings are visible and so the meadow and woodland behind can be viewed.

Viewpoint Location



Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 14
MITIGATION VISUALISATION

The mitigation measures visual demonstrates that the landscape proposals would further screen the buildings, visually tying in with the tree planting in the foreground. The material palette of the dwellings will also help minimise the visibility of the scheme.

The limited amount of the development visible, coupled with the existing dwellings in the foreground mean that the visual impact of the proposals from this position is assessed to be minor.

VIEWPOINT 13
LANDSCAPE SETTING

VP 13 was taken from playing fields off Standalane Way. The proposals are visible beyond the tree planting of the Eddlestone Water. They are largely screened by existing tree planting to the foreground, with the meadow and woodland still visible to the rear. Gaps between the dwellings are visible and help to break up the proposed built development. Roofs of existing properties are visible amongst tree planting, in front of the proposals. There is a line of existing residential properties to the south of the playing field that are highly visible with no tree planting or screening at all. These properties are much more visually dominant than the proposed development.

Viewpoint Location

Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 13
MITIGATION VISUALISATION

The mitigation measures visual demonstrates that the mixed native woodland planting would further screen the buildings, visually tying in with the tree planting in the foreground. The material palette of the dwellings will also help minimise the visibility of the scheme.

The mitigation planting and colour palette of the proposals, with the existing meadow and woodland still visible to the rear mean that the visual impact of the proposals from this position is assessed to be minor.

VIEWPOINT 12
LANDSCAPE SETTING

VP 12 was taken from an unnamed road heading north from Standalane Way at a distance of approximately 750m to the north west. The proposals are viewed across the Eddlestone Water valley with a slight rise in the foreground. Peebles itself is not visible from this viewpoint but there are glimpses of the caravan park and residential properties on Langside Drive through the woodland and as such the proposals appear in what is essentially a rural view. The impact of the proposals on this viewpoint is considered to be potentially significant as they to some extent alter the character of the view from this location.

Whilst the proposals are visible, it is worth noting that this view is from an unnamed road without footways and so will mostly be experienced from vehicles. As such, any impact on the character of this road is likely to be glimpsed whilst travelling.

Note: The Proposed Local Development Plan intends to allocate the land in the foreground of viewpoint 12 as preferred sites for residential development. Should this land be developed in the future, views to the proposals will most likely be obscured by the new housing in this location and certainly the noted impact of the proposals in terms of change in landscape character would not be relevant / significant. However, this has not been taken account of in the assessment of the impact of the proposals.

Viewpoint Location

Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 12
MITIGATION VISUALISATION

The mitigation measures visual demonstrates that the mixed native woodland planting would help to screen the buildings, visually tying in with the tree planting in the foreground but would not screen the proposals entirely. The material palette of the dwellings will also help minimise the visibility of the scheme. The mitigation measures help to minimise the visual impact of the development but do not fully offset the change in landscape character.

VIEWPOINT 11
LANDSCAPE SETTING

VP 11 was taken from the same unnamed road as VP 12, just before the junction with the A703, approximately 1.5km to the north. The road has no footway and as such proposals will mostly be viewed from vehicles. The proposals are viewed along the Eddlestone Water valley with agricultural fields occupying the floodplain in the foreground. Peebles is not visible from this viewpoint being obscured by tree cover and topography. As such this viewpoint is of a rural landscape with limited, scattered buildings.

The proposals are visible on the eastern slope of the valley and appear in isolation from the rest of Peebles. As such, the proposals alter the character of the viewpoint although they are viewed at a greater distance than VP 12 which reduces the magnitude of the visual impact.

Viewpoint Location

Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 11
LANDSCAPE SETTING

The mitigation measures visual demonstrates that the mixed native woodland planting would help to screen the buildings, visually tying in with the tree planting in the foreground but would not screen the proposals entirely. The material palette of the dwellings will also help minimise the visibility of the scheme. Given the distance to the viewpoint and the mitigation measures, the impact on the character of this viewpoint is greatly minimised. As a result the change in landscape character of this view is substantially mitigated.

VIEWPOINT 10
LANDSCAPE SETTING

VP 10 was taken on the banks of the Eddlestone Water adjacent to the public foot bridge. The proposals are visible behind existing residential properties. Whilst it is clear that the development sits at a higher level they are not so far up the slope as to block views to the woodland, meadow and cottages behind. The gaps between the dwellings are visible helping to further reduce the impact of the proposals.

Viewpoint Location

Note:
Development shown in white to highlight location and massing, this is not representative of proposed materials.

VIEWPOINT 10
MITIGATION VISUALISATION

The mitigation measures visual demonstrates that the landscape proposals would further screen the buildings, visually tying in with the tree planting in the foreground. The material palette of the dwellings will also help minimise the visibility of the scheme.

The existing dwellings in the foreground mean that whilst the proposals are visible, they do not fundamentally alter the character of the view and as such the visual impact of the proposals from this position is assessed to be minor.

04

LANDSCAPE AND VISUAL MITIGATION AND CONCLUSION

MITIGATION
LANDSCAPE & VISUAL

The main design move, to minimise the visual impact of the proposals, is to site the built development to the lower portion of the slope allowing the much more visible portion of the site to remain undeveloped. This strategy is responsive to the landscape setting and limits the visual impact of the buildings as much as possible.

The scheme has been designed to minimise its visual impact and fit with the surrounding landscape. This includes but is not limited to:

- The levels of the buildings and access road are set as low as possible to embed the proposals into the topography, avoiding the more visible portion of the site to help minimise impact.
- Proposed planting is composed of mixed native woodland species, consistent with the character of surrounding woodland planting.
- The buildings have breaks in between them to reduce their visual impact, the materiality is also muted to help minimise impact.
- The buildings do not break the skyline in any of the views assessed, except those in close proximity to the west.

CONCLUSION

The foregoing assessment has considered landscape character and landscape structure within a roughly 3km study area from the proposed development site with limited consideration over 3km. It has identified potential effects that may result from the development.

Baseline and Design Response:
The baseline landscape assessment highlights the site's location at the edge of the existing urban area of Peebles, which is set in the two river valleys of the Eddlestone Water and Tweed. These valleys broadly have wide flat bottoms with steep sides that continue to rise to form upland summits.

Within the study area, visibility of the proposed development site is limited by existing topography and woodland structure. The extent of visibility (visual envelope / zone of theoretical visibility) is split broadly into two areas. Immediately around the site the visual envelope extends further to the west and north west, whilst being tightly contained to the north, east and south. Visibility extends up to 2.5km from the centre of the site.

In addition to this there is a secondary area of visibility along elevated land to the south of Peebles. This is generally agricultural fields transitioning to moorland at greater elevations. This area sits between 1.5-3.5km from the site.

The visibility of the scheme is quite far ranging in these two areas but the visibility from the majority of Peebles and the main transport corridors is minimal. Views from these locations have been assessed and represented in the study.

Landscape and Visual Effects:
Views from twelve representative viewpoints have been assessed, with consideration to visual impact with and without the proposed mitigation measures. Impacts on landscape character have been identified along the Eddlestone Valley to the north, although this is viewed from an unnamed B road without footways so views to the development are likely to be fleeting from vehicles. In addition to this, visibility and visual impact has been noted on views from the south and west, although to a lesser degree due to the main urban area of Peebles being between the viewpoint and the proposed development and the distances involved.

Conclusion:
A thorough, structured investigation has been conducted to assess the visual impact of the proposed development, as described in this document. Through desktop analysis, fieldwork and visualisation, the overall visual impact of the scheme has been assessed.

There will be localised visual impacts from the proposals on the A703 (notably as discussed in relation to viewpoints 02 and 03).

The wider views assessed (including viewpoints 10, 13, 14, 15, 16, 17, 18, 21, 22 and 24) demonstrate that whilst the proposed development is visible, the impact on views and landscape character is overall assessed to be minor/not significant.

Viewpoints 11 and 12 are notable as demonstrating more significant impact. In these cases the proposed development is assessed to result in a change to landscape character, this is minimised through the proposed mitigation measures.

Overall, the visual impact of the scheme is wide ranging but minimal from most viewpoints, however there are localised areas where the impact is more significant, as outlined above.

It is our assessment that the scale and character of the proposed development has through the design process addressed visual and landscape impacts as far as possible. Development has been limited and focused along the bottom edge of the site, thereby significantly reducing and minimising the landscape and visual impact that would result from more extensive development of the site.

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Carmichael Homes & Interiors

Peebles

Flood Risk Assessment

FINAL

May 2020

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Client Representative:	David Campbell of Woolgar Hunter
Kaya Consulting Job Number:	KC1725
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Author	Alexis Moyer

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Version	Date	Description	Created by:	Verified by:	Approved by:
1.0	16.04.2020	Draft Report	A Moyer	M Stewart	M Stewart
2.0	01.05.2020	Final Report	A Moyer	M Stewart	M Stewart

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SEPA CHECKLIST

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 14 - Last updated 28/05/2019

This document must be attached within the front cover of any Flood Risk Assessments issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. The document will take only a few minutes to complete and will assist SEPA in reviewing FRAs, when consulted by LPAs. This document should not be a substitute for a FRA.

Development Proposal Summary							
Site Name:		Peebles					
Grid Reference:	Easting:	325052	Northing:	641600			
Local Authority:		Scottish Borders Council					
Planning Reference number (if known):							
Nature of the development:		Residential	If residential, state type:				
Size of the development site:		2.6 Ha					
Identified Flood Risk:	Source:	Fluvial	Source name:	Cross Burn			
Land Use Planning							
Is any of the site within the functional floodplain? (refer to SPP para 255)		No	If yes, what is the net loss of storage?		m^3		
Is the site identified within the local development plan?		No	Local Development Plan Name:		Year of Publication:		
If yes, what is the proposed use for the site as identified in the local plan?		Select from List	Allocation Number / Reference:	If Other please specify:			
Does the local development plan and/or any pre-application advice, identify any flood risk issues with or requirements for the site.		No	If so, please specify:				
What is the proposed land use vulnerability?		Highly Vulnerable	Do the proposals represent an increase in land use vulnerability?	Yes			
Supporting Information							
Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)?		Yes					
Has sufficient supporting information, in line with our Technical Guidance, been provided? For example: site plans, photos, topographic information, structure information and other site specific information.		Yes				Flooding of caravan park west of Edinburgh Road in November 2016 (west of site, but much lower in elevation than site)	
Has a historic flood search been undertaken?		Yes	If flood records in vicinity of the site please provide details:				
Is a formal flood prevention scheme present?		No	If known, state the standard of protection offered:				
Current / historical site use:		Empty field					
Is the site considered vacant or derelict?		No					
Development Requirements							
Freeboard on design water level:		0.6 m					
Is safe / dry access and egress available?		Vehicular and Pedestrian	Min access/egress level:		m AOD		
Design levels:	Ground level:	178.83 m AOD	(cross-section S2)	Min FFL:	(see right) mAOD	0.6 m above surrounding ground	
Mitigation							
Can development be designed to avoid all areas at risk of flooding?		Yes					
Is mitigation proposed?		Yes					
If yes, is compenstory storage necessary?		No					
Demonstration of compensatory storage on a "like for like" basis?		No					
Should water resistant materials and forms of construction be used?		Yes					

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 14 - Last updated 28/05/2019

Hydrology

Is there a requirement to consider fluvial flooding?		Yes			
Area of catchment:		0.76	km^2	Is a map of catchment area included in FRA?	Yes
Estimation method(s) used (please select all that apply):		Pooled Analysis ☐		If Pooled analysis have group details been included?	Select from List
		Single Site Analysis ☐			
		Enhanced Single Site ☐			
		ReFH2 ☑			
		FEH RRM ☑			
		Other ☑		If other (please specify methodology used):	Q_{med} rural with FSR scaling
Estimate of 200 year design flood flow:		0.76	m^3/s		
Qmed estimate:		0.24	m^3/s	Method:	Select from List
Statistical Distribution Selected:		Select from List		Reasons for selection:	

Hydraulics

Hydraulic modelling method:		Linked 1D 2D		Software used:	HEC-RAS
				If other please specify:	
Number of cross sections:		13			
Source of data (i.e. topographic survey, LiDAR etc):		LiDAR / survey		Date obtained / surveyed:	Mar-20
Modelled reach length:			m		
Any changes to default simulation parameters?		No		If yes please provide details:	
Model timestep:		1 sec			
Model grid size:		2 m			
Any structures within the modelled length?		Combination		Specify, if combination:	bridges, culverts
Maximum observed velocity:		3.54	m/s		
Brief summary of sensitivity tests, and range:					
variation on flow (%)		35	%	Please specify climate change scenario considered:	35% increase in rainfall intensity
variation on channel roughness (%)		20	%		
blockage of structure (range of % blocked)		25-50	%		
boundary conditions:		**Upstream**			**Downstream**
(1) type		Flow			Normal depth
	Specify if other			Specify if other:	
(2) does it influence water levels at the site?		No			No
Has model been calibrated (gauge data / flood records)?		No			
Is the hydraulic model available to SEPA?		No			
Design flood levels:	200 year	178.77	m AOD	200 year plus climate change	178.83 m AOD
Cross section results provided?		Yes			
Long section results provided?		Yes			
Cross section ratings provided?		No			
Tabular output provided (i.e. levels, velocities)?		Yes			
Mass balance error:		< 5	%		

Coastal

Is there a requirement to consider coastal / tidal flooding?		No		
Estimate of 200 year design flood level:			m AOD	
Estimation method(s) used:		Select from List		If other please specify methodology used:
Allowance for climate change (m):			m	
Allowance for wave action etc (m):			m	
Overall design flood level:			m AOD	

Comments

Any additional comments:	

Approved by: Y Kaya
Organisation: Kaya Consulting Ltd.
Date: 15-Apr-20

Note: Further details and guidance is provided in 'Technical Flood Risk Guidance for Stakeholders' which can be accesssed here:- CLICK HERE

1 Introduction

Kaya Consulting Ltd was commissioned by Carmichael Homes & Interiors through Woolgar Hunter to undertake an assessment of the risk of flooding to a proposed development on land located along Edinburgh Road, Peebles. A general location plan is shown in Figure 1.

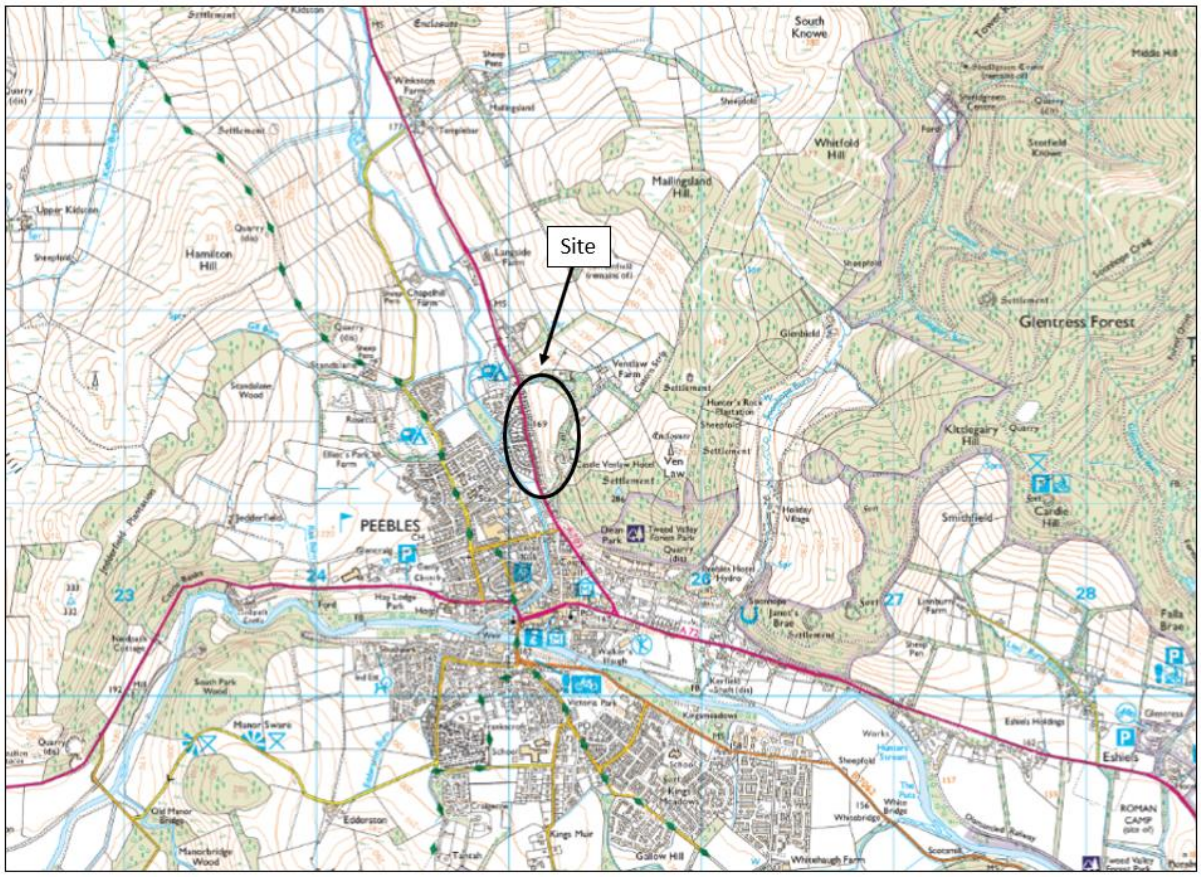
The development proposal includes the erection of 22 residential properties. These developments are considered to be in the 'highly vulnerable' category within SEPA's Land Use Vulnerability Guidance; as such, the site must be assessed for flood risk up to the 1 in 200-year event, with consideration of the impact of climate change.

The scope of the study includes the following:

- Site visits and walkover survey;
- Review of historical maps and available historical flood records;
- Liaison with local council to obtain any information on flood risk at the site;
- Hydrological analysis to estimate flows for the Cross Burn and nearby springs;
- Development of 1D/2D model to predict risk of flooding from the Cross Burn and nearby springs;
- Assessment of surface water flood risk to the site, based on watershed flow pathway analysis and LiDAR ground elevation data purchased for this study;
- Assessment of flood risk from local drainage systems;
- Assessment of flood risk from groundwater; and
- Preparation of a technical report summarising the study and its findings, including any recommendations; this report will be suitable for submission as a supporting document with planning application and will conform to the requirements of SEPA and the local council.

The work undertaken to assess flood risk to the site and findings of the study are summarised in the following sections.

Figure 1: Site location



2 Legislative and Policy Aspects

2.1 National Planning Policy

The current version of the Scottish Planning Policy (SPP) was published in June 2014 and replaces the previous version which was published in February 2010. The SPP sets out national planning policies which reflect Scottish Government's priorities for operation of the planning system and for the development and use of land. It relates to:

- the preparation of development plans;
- the design of development, from initial concept through to delivery; and
- the determination of planning applications and appeals.

The National Planning Framework (NPF) provides a statutory framework for Scotland's long term spatial development and sets out the Scottish Government's spatial development priorities for the next 20 to 30 years. The SPP sets out the policy that will help to deliver the objectives of the NPF.

Some extracts from the SPP are listed below:

Policy Principles

255. The planning system should promote:

- *a precautionary approach to flood risk from all sources, including coastal, water course (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change;*
- *flood avoidance: by safeguarding flood storage and conveying capacity, and locating development away from functional flood plains and medium to high risk areas;*
- *flood reduction: assessing flood risk and, where appropriate, undertaking natural and structural flood management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and*
- *avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface.*

256. To achieve this, the planning system should prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere. Piecemeal reduction of the functional floodplain should be avoided given the cumulative effects of reducing storage capacity.

257. Alterations and small-scale extensions to existing buildings are outwith the scope of this policy, provided that they would not have a significant effect on the storage capacity of the functional floodplain or local flooding problems.

Key Documents

- *Flood Risk Management (Scotland) Act 2009*
- *Updated Planning Advice Note on Flooding*
- *Delivering Sustainable Flood Risk Management (Scottish Government, 2011).*
- *Surface Water Management Planning Guidance (Scottish Government, 2013).*

Delivery

258. Planning authorities should have regard to the probability of flooding from all sources and take flood risk into account when preparing development plans and determining planning applications. The calculated probability of flooding should be regarded as a best estimate and not a precise forecast. Authorities should avoid giving any indication that a grant of planning permission implies the absence of flood risk.

259. Developers should take into account flood risk and the ability of future occupiers to insure development before committing themselves to a site or project, as applicants and occupiers have ultimate responsibility for safeguarding their property.

Development Planning

260. Plans should use strategic flood risk assessment (SFRA) to inform choices about the location of development and policies for flood risk management. They should have regard to the flood maps prepared by Scottish Environment Protection Agency (SEPA), and take account of finalised and approved Flood Risk Management Strategies and Plans and River Basin Management Plans.

261. Strategic and local development plans should address any significant cross boundary flooding issues. This may include identifying major areas of the flood plain and storage capacity which should be protected from inappropriate development, major flood protection scheme requirements or proposals, and relevant drainage capacity issues.

262. Local development plans should protect land with the potential to contribute to managing flood risk, for instance through natural flood management, managed coastal realignment, washland or green infrastructure creation, or as part of a scheme to manage flood risk.

263. Local development plans should use the following flood risk framework to guide development. This sets out three categories of coastal and watercourse flood risk, together with guidance on surface water flooding, and the appropriate planning approach for each (the annual probabilities referred to in the framework relate to the land at the time a plan is being prepared or a planning application is made):

- ***Little or No Risk** – annual probability of coastal or watercourse flooding is less than 0.1% (1:1000 years)*
  - *No constraints due to coastal or watercourse flooding.*
- ***Low to Medium Risk** – annual probability of coastal or watercourse flooding is between 0.1% and 0.5% (1:1000 to 1:200 years)*
  - *Suitable for most development. A flood risk assessment may be required at the upper end of the probability range (i.e. close to 0.5%), and for essential infrastructure and the most vulnerable uses. Water resistant materials and construction may be required.*
  - *Generally not suitable for civil infrastructure. Where civil infrastructure must be located in these areas or is being substantially extended, it should be designed to be capable of remaining operational and accessible during extreme flood events.*
- ***Medium to High Risk** – annual probability of coastal or watercourse flooding is greater than 0.5% (1:200 years)*
  - *May be suitable for:*
    - *residential, institutional, commercial and industrial development within built-up areas provided flood protection measures to the appropriate standard already exist and are maintained, are under construction, or are a planned measure in a current flood risk management plan;*
    - *essential infrastructure within built-up areas, designed and constructed to remain operational during floods and not impede water flow;*
    - *some recreational, sport, amenity and nature conservation uses, provided appropriate evacuation procedures are in place; and*

- *job-related accommodation, e.g. for caretakers or operational staff.*
- *Generally not suitable for:*
  - *civil infrastructure and the most vulnerable uses;*
  - *additional development in undeveloped and sparsely developed areas, unless a location is essential for operational reasons, e.g. for navigation and water-based recreation, agriculture, transport or utilities infrastructure (which should be designed and constructed to be operational during floods and not impede water flow), and an alternative, lower risk location is not available; and*
  - *new caravan and camping sites.*
- *Where built development is permitted, measures to protect against or manage flood risk will be required and any loss of flood storage capacity mitigated to achieve a neutral or better outcome.*
- *Water-resistant materials and construction should be used where appropriate. Elevated buildings on structures such as stilts are unlikely to be acceptable.*

Surface Water Flooding

- *Infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years).*
- *Surface water drainage measures should have a neutral or better effect on the risk of flooding both on and off the site, taking account of rain falling on the site and run-off from adjacent areas.*

Development Management

264. It is not possible to plan for development solely according to the calculated probability of flooding. In applying the risk framework to proposed development, the following should therefore be taken into account:

- *the characteristics of the site;*
- *the design and use of the proposed development;*
- *the size of the area likely to flood;*
- *depth of flood water, likely flow rate and path, and rate of rise and duration;*
- *the vulnerability and risk of wave action for coastal sites;*
- *committed and existing flood protection methods: extent, standard and maintenance regime;*
- *the effects of climate change, including an allowance for freeboard;*
- *surface water run-off from adjoining land;*
- *culverted watercourses, drains and field drainage;*
- *cumulative effects, especially the loss of storage capacity;*
- *cross-boundary effects and the need for consultation with adjacent authorities;*
- *effects of flood on access including by emergency services; and*
- *effects of flood on proposed open spaces including gardens.*

265. Land raising should only be considered in exceptional circumstances, where it is shown to have a neutral or better impact on flood risk outside the raised area. Compensatory storage may be required.

266. The flood risk framework set out above should be applied to development management decisions. Flood Risk Assessments (FRA) should be required for development in the medium to high category of flood risk, and may be required in the low to medium category in the circumstances described in the framework above, or where other factors indicate heightened risk. FRA will generally be required for applications within areas identified at high or medium likelihood of flooding/flood risk in SEPA's flood maps.

267. Drainage Assessments, proportionate to the development proposal and covering both surface and foul water, will be required for areas where drainage is already constrained or otherwise problematic, or if there would be off-site effects.

268. Proposed arrangements for SuDS should be adequate for the development and appropriate long-term maintenance arrangements should be put in place.

2.2 SEPA Flood Maps

The SEPA flood map shows the likely extent of flooding for high, medium and low likelihood for fluvial, pluvial (surface water) and tidal flows. Consultation of the map shows that the site is outside of any mapped fluvial and coastal floodplains. However, the flood map indicates that the site is potentially at 'medium' to 'high' risk from surface water flooding.

It should be noted that SEPA flood maps are indicative and a detailed assessment of flooding risk is required for sites immediately outside or within the SEPA flood extent.

2.3 SEPA Technical Flood Risk Guidance

The latest version of SEPA 'Technical Flood Risk Guidance for Stakeholders' would need to be consulted when undertaking flood risk assessments (current version is 12, May 2019). This technical guidance document is intended to outline methodologies that may be appropriate for hydrological and hydraulic modelling and sets out what information SEPA requires to be submitted as part of a Flood Risk Assessment.

SEPA Policy 41 sets out roles and responsibilities of SEPA and Planning Authorities.

2.4 SEPA Flood Risk and Land Use Vulnerability Guidance

The current version (July 2018) states that:

"*The purpose of this guidance is to:*

- *aid understanding of the relative vulnerability to flooding of different land uses;*
- *assist in the interpretation of SEPA's Flood Risk Planning Guidance, which is based upon the risk framework.*

SEPA has created this guidance to assist in our assessment of the vulnerability to flooding of different types of land use. Table 1 classifies the relative vulnerability of land uses, grouping them into five categories from Most Vulnerable through to Water Compatible Uses.

The classification comprises five categories: 1. Most Vulnerable Uses; 2. Highly Vulnerable Uses; 3. Least Vulnerable Uses; 4. Essential Infrastructure; 5. Water Compatible Uses.

The classification (Table 1) is linked to the risk framework in SPP by a matrix of flood risk (Table 2). Table 2 gives a very brief outline of SEPA's likely planning response for each of the three flood risk categories of the risk framework relative to each of the five vulnerability categories.

In producing this guidance, SEPA has sought to refine and enhance the vulnerability classification and definitions identified in the SPP risk framework.

Table 1: SEPA Land Use Vulnerability Classification[1]

1. Most Vulnerable Uses	2. Highly Vulnerable Uses	3. Least Vulnerable Uses	4. Essential Infrastructure	5. Water Compatible Uses[3]
For the purpose of this guidance, **Most Vulnerable Uses** include land uses that are defined as both ***civil infrastructure*** and ***most vulnerable*** in the SPP 2014 glossary. Civil infrastructure is denoted with an asterisk (*) in the list below. Most Vulnerable Uses therefore comprise: • police stations* • ambulance stations* • fire stations* • command centers and telecommunications installations required to be operational during flooding* • emergency dispersal points* • hospitals* • schools* • care homes* • nurseries • residential institutions, e.g. prisons, children's homes • basement dwellings • isolated dwelling(s) in sparsely populated areas • dwelling houses situated behind informal embankments[2] • caravans, mobile homes, chalets and park homes intended for permanent residential use • holiday caravan, chalet, and camping sites • installations requiring hazardous substance consent (but where there is demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or with energy infrastructure, that require a coastal or water-side location, or other high flood risk areas, then the facilities should be classified as **Essential Infrastructure – see column 4).**	Comprise: • buildings used for dwelling houses • social services homes (ambulant /adult) • hostels and hotels • student halls of residence • non-residential uses for health service • landfill and sites used for waste management facilities for hazardous waste	Comprise: • shops • financial, professional, and other services • restaurants and cafés • hot-food takeaways • drinking establishments • nightclubs • offices • general industry • storage and distribution • non-residential institutions not included in Most Vulnerable or Highly Vulnerable Uses • assembly and leisure • land and buildings used for agriculture and forestry that are subject to planning control • waste treatment (except landfill and hazardous waste facilities) • minerals working and processing (except for sand and gravel)	Comprises: • essential transport infrastructure (including mass evacuation routes) that has to cross the area at risk • essential utility infrastructure that has to be located in a flood risk area for operational reasons (this includes electricity generating power stations and grid and primary sub-stations, sewage treatment plants and water treatment works, wind turbines and other energy generating technologies) • installations requiring hazardous substance consent **only** where there is demonstrable need to locate such installations for the bulk storage of materials with port or other similar facilities, or with energy infrastructure that requires a coastal, water-side, or other high flood risk area location.	Comprise: • flood control infrastructure • environmental monitoring stations • water transmission infrastructure and pumping stations • sewage transmission infrastructure and pumping stations • sand and gravel workings • docks, marinas and wharves • navigation facilities • MOD defence installations • ship building, repairing, and dismantling • dockside fish processing and refrigeration and compatible activities requiring a waterside location • water-based recreation (excluding sleeping accommodation) • lifeguard and coastguard stations • amenity open space • nature conservation and biodiversity • outdoor sports and recreation and essential facilities such as changing rooms • essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific operational warning[4] and evacuation plan.

[1] Developments that combine a mixture of uses should be placed in the higher of the relevant classes of flood risk vulnerability. The impact of a flood on the particular land use could vary within each vulnerability class. In particular, a change of use to a dwelling house within the 'Highly Vulnerable' category could significantly increase the overall flood risk, especially in relation to human health and financial impacts. Any proposal for a change of use to a dwelling house should therefore be supported by a flood risk assessment. The redevelopment (including change of use) of an existing building or site provides a valuable opportunity to reduce the vulnerability of that site to flooding and therefore to reduce overall flood risk. This can be achieved through changes to less vulnerable land uses and improvements to the management of flood risk on the site.

[2] Embankments not formally constituted under flood prevention legislation including agricultural flood embankments constructed under permitted development rights.

[3] Advice in the SPP risk framework on these activities is limited. The nature of the above activities necessitates locations that are prone to flooding. Generally, it is difficult to recommend a specific annual return period to guide development decisions for such uses. SEPA would recommend that the risk of flooding should be assessed giving particular consideration to:

1. Specific locational requirements of the development and availability of alternative locations;
2. Consideration of any loss of floodplain storage (in riverside developments) that may increase flood risk to nearby existing development and options to mitigate against this;
3. Appropriate mitigation measures, including water resistance and resilience measures;
4. Health and safety implications and the need for access, egress, and evacuation, with specific consideration of, and provision of, measures to provide for these where:
   - The development will attract the public especially vulnerable people such as children and old people.
   - Large numbers of the public may gather and where evacuation routes are limited.
   - Hazardous materials are stored or processed.

[4] In this context, specific warning does not mean a formal flood warning from SEPA. SEPA does not support the provision of flood warning as a viable reason to develop in flood risk areas. Warning is a non-structural measure that does not physically prevent flooding and has associated uncertainties.

Table 2: SEPA Matrix of Flood Risk (to be read in conjunction with our Flood Risk Planning Guidance)

Classification / Flood Risk	Most Vulnerable Uses	Highly Vulnerable Uses	Least Vulnerable Uses	Essential Infrastructure	Water Compatible Uses
Little or no risk (<0.1% AP)	No constraints	No constraints	No constraints	No constraints	No constraints
Low to medium risk (0.1% - 0.5% AP)	Generally not suitable for Civil Infrastructure: where Civil Infrastructure must be located in these areas, or is being substantially extended, it should be designed to be capable of remaining operational and accessible during extreme flood events (i.e. 0.1% AP). May be suitable for other Most Vulnerable Uses if the risk from a 0.1%AP event can be alleviated through appropriate mitigation, or where one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use. • Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim.	Generally suitable for development though an FRA may be required at upper end of the probability range (i.e. close to 0.5% AP).	Generally suitable for development though an FRA may be required at upper end of the probability range (i.e. close to 0.5% AP).	Generally suitable for development.	Generally suitable for development.
Medium to high risk within built up area (>0.5% AP)	Generally not suitable for development unless one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use.	Generally not suitable for development unless one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use.	Generally not suitable for development unless one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use.	Suitable for essential infrastructure, designed and constructed to remain operational during floods (i.e. 0.5% AP), and not impede water flow.	Generally suitable for development - job related accommodation and some recreational, sport, amenity and nature conservation uses are only suitable provided that appropriate evacuation procedures are in place

	• Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim.	• Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim. • The site is protected by a flood protection scheme of the appropriate standard that is already in existence and maintained, is under construction, or is planned for in a current flood risk management plan.	• Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim. • The site is protected by a flood protection scheme of the appropriate standard that is already in existence and maintained, is under construction, or is planned for in a current flood risk management plan.		
Medium to high risk within undeveloped and sparsely developed area (>0.5% AP)	Generally not suitable for development unless one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use. • Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim.	Generally not suitable for development unless one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use. • Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim.	Generally not suitable for development unless one of the following apply: • Redevelopment of an existing building, including changes of use to an equal or less vulnerable use to the existing use. • Redevelopment of a previously developed site where it involves the demolition of existing buildings and/or erection of additional buildings within a development site, and the proposed land use is equal or less vulnerable than the existing land use. • Where the principle of development on the site has been established in an up-to-date, adopted development plan or the National Planning Framework and flood risk issues were given due consideration as part of the plan preparation process and our assessment of risk has not changed in the interim.	Generally suitable where a flood risk location is required for operational reasons and an alternative lower-risk location, is not available – development should be designed and constructed to be operational during floods (i.e. 0.5% AP), and not impede water flow.	Generally suitable for development - job related accommodation and some recreational, sport, amenity and nature conservation uses are only suitable provided that appropriate evacuation procedures are in place, and an alternative, lower risk location is not available.

2.5 Flood Risk Management (Scotland) Act 2009

The Flood Risk Management (Scotland) Act 2009 came into force on 26 November 2009. The Act repealed the Flood Prevention (Scotland) Act 1961 and introduces a more sustainable and streamlined approach to flood risk management, suited to present and future needs and to the impact of climate change. It encourages a more joined up and coordinated process to manage flood risk at a national and local level.

The Act brings a new approach to flood risk management including a framework for coordination and cooperation between all organisations involved in flood risk management, new responsibilities for SEPA, Scottish Water and local authorities in relation to flood risk management, a revised and streamlined process for flood protection schemes, new methods to enable stakeholders and the public to contribute to managing flood risk; and SEPA to act as a single enforcement authority for the safe operation of Scotland's reservoirs.

2.6 Controlled Activities Regulations (CAR)

The Water Environment (Controlled Activities) (Scotland) Amended Regulations 2013 (CAR) brings new controls for discharges, abstractions, impoundments and engineering works in or near inland waters. Any such work requires authorisation (licence) from the Scottish Environment Protection Agency (SEPA) who are responsible for the implementation of the Act. The Regulations include a requirement that surface water discharge must not result in pollution of the water environment. It also makes Sustainable Drainage Systems (SuDS) a requirement for new development, with the exception of runoff from a single dwelling and discharges to coastal waters.

2.7 Climate Change

The SPP states that "*planning system should promote a precautionary approach to flood risk from all sources, including coastal, water course (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change.*"

One of the sustainable policy principles within the National Planning Framework is supporting climate change mitigation and adaptation including taking account of flood risk. SEPA previously recommended a 20% increase in peak flow for the 0.5% AEP (1:200) event, in accordance with DEFRA (Department of Environment, Food and Rural Affairs) and Scottish Government research.

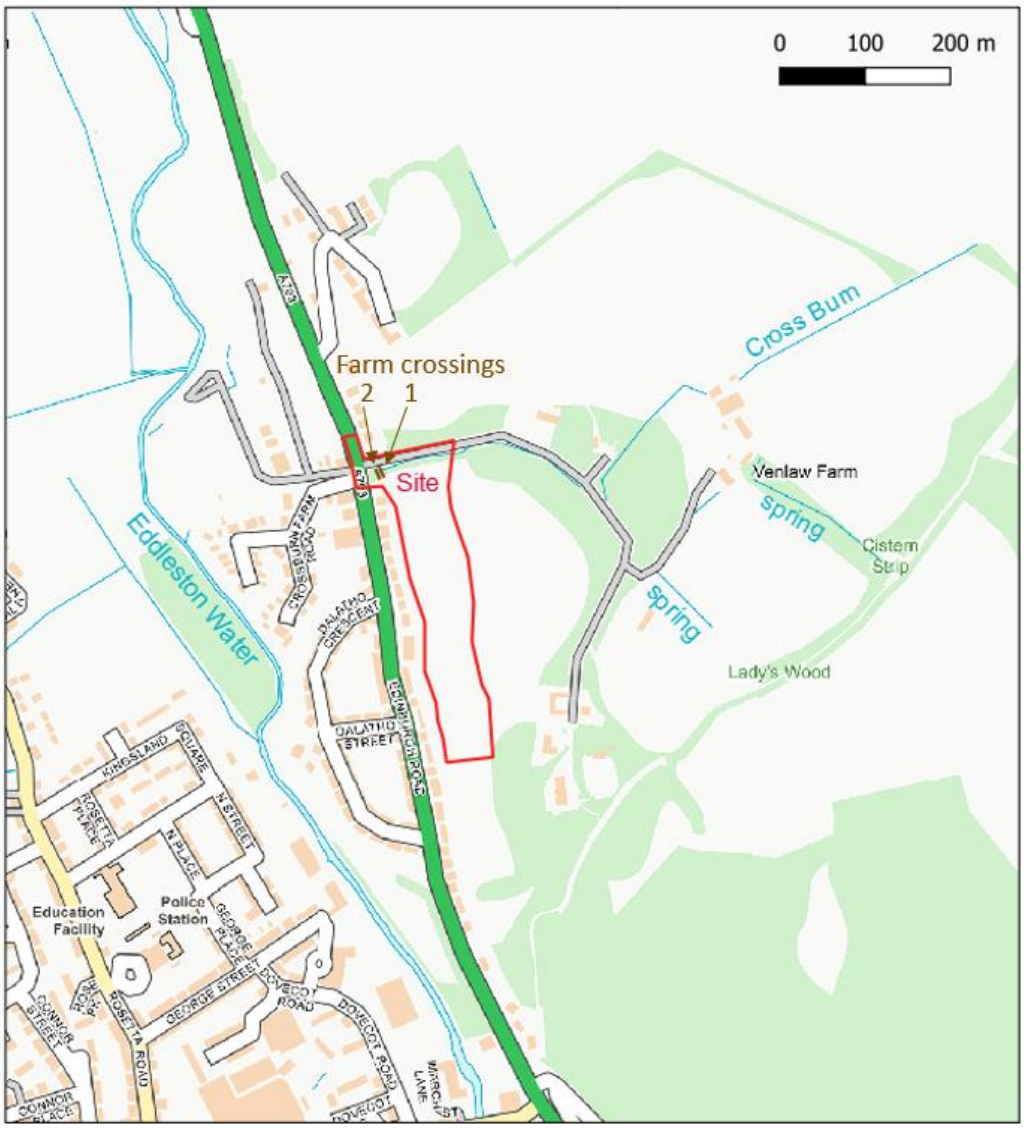
SEPA has recently released updated climate change recommendations by River Basin Region, based on UKCP18. These climate change uplifts range from 24% to 56%. For smaller catchments, an increase in peak rainfall intensity allowances of between 35% and 55% are now recommended. It is also recommended that any site drainage design considers future estimates of increased precipitation and follows an adaptive approach.

The Climate Change (Scotland) Act 2009 also makes reference to adaptation to climate change.

3 Site Location and Description

The proposed development site is located just off of Edinburgh Road in Peebles. The site is bordered to the north by a grassy field and a residential property, to the east and south by a grassy field and to the west by residential properties. The site currently consists of a grassy field and has an approximate plan area of 2.6 ha. A detailed location plan is shown in Figure 2.

Figure 2: Detailed location plan of development area



The Cross Burn flows in a westerly direction through the northern part of the site, emanating from the hills east of the site boundary. The burn flows through three culverts within the site, beneath two smaller farm crossings (see Photos 1 and 2) and Edinburgh Road. The culverts beneath the farm crossings measure approximately 0.9 x 0.6 m and 1.2 x 0.6 m. Beneath Edinburgh Road, the burn flows through an approximately 0.9 x 1 m brick culvert (see Photo 3). Directly downstream of Edinburgh Road, the burn enters a small open channel section (~1.8 m long) before flowing through a long circular culvert (~1 m diameter, some 200 m long), directing flow beneath the development west of Edinburgh Road.

Flow exits the long culvert and enters Eddleston Water, which flows south-easterly west of the site. There are also two small springs flowing north-west between ~220 and 300 m east of the site. All watercourses and crossings can be seen in Figure 2 above.

Photo 1: Cross Burn farm crossing 1 (farthest upstream)

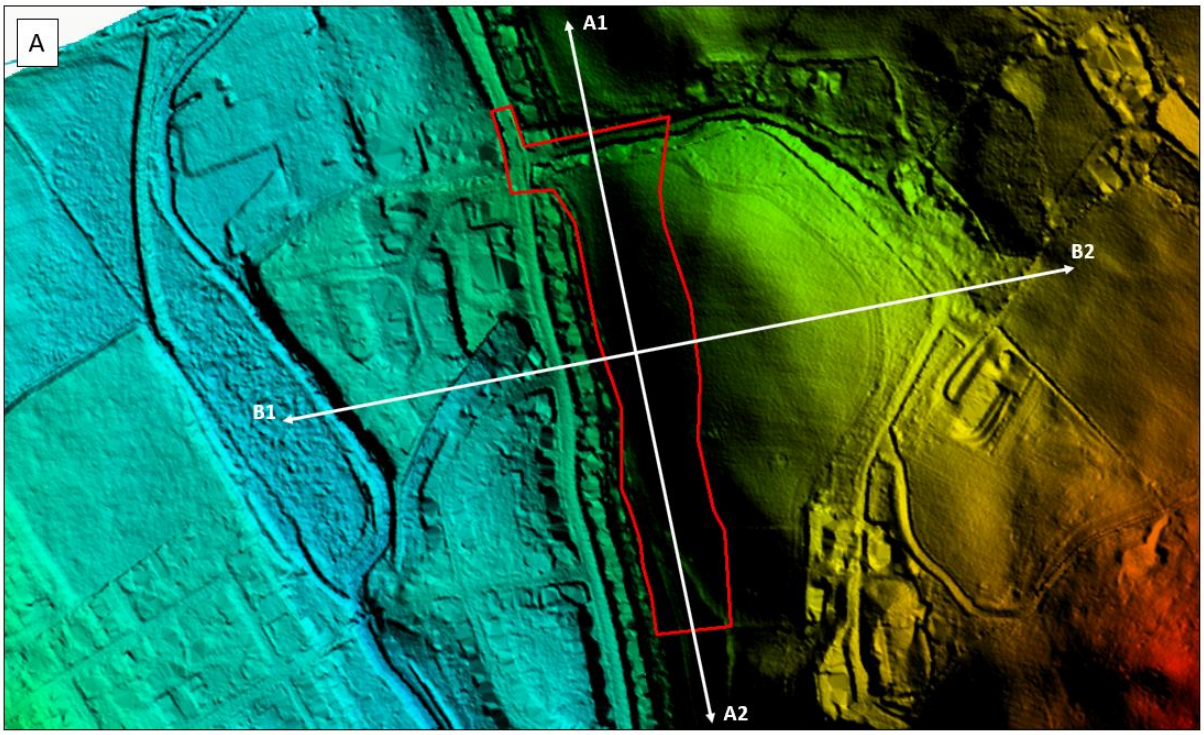
Photo 2: Cross Burn farm crossing 2 (just east of Edinburgh Road)

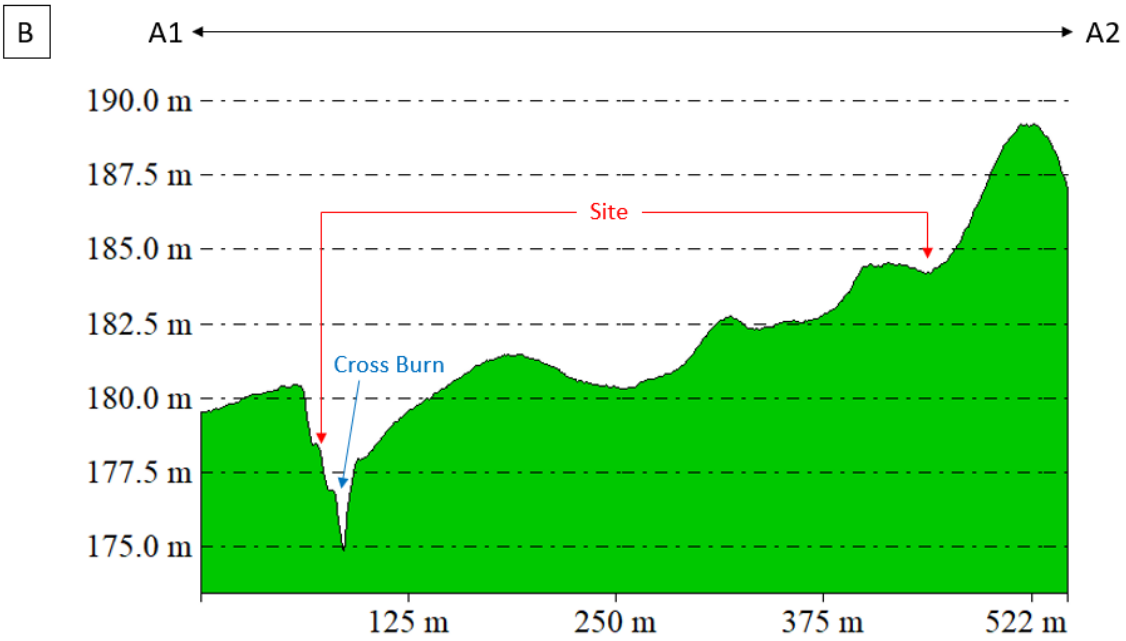
Photo 3: Cross Burn brick culvert beneath Edinburg Road (looking west)

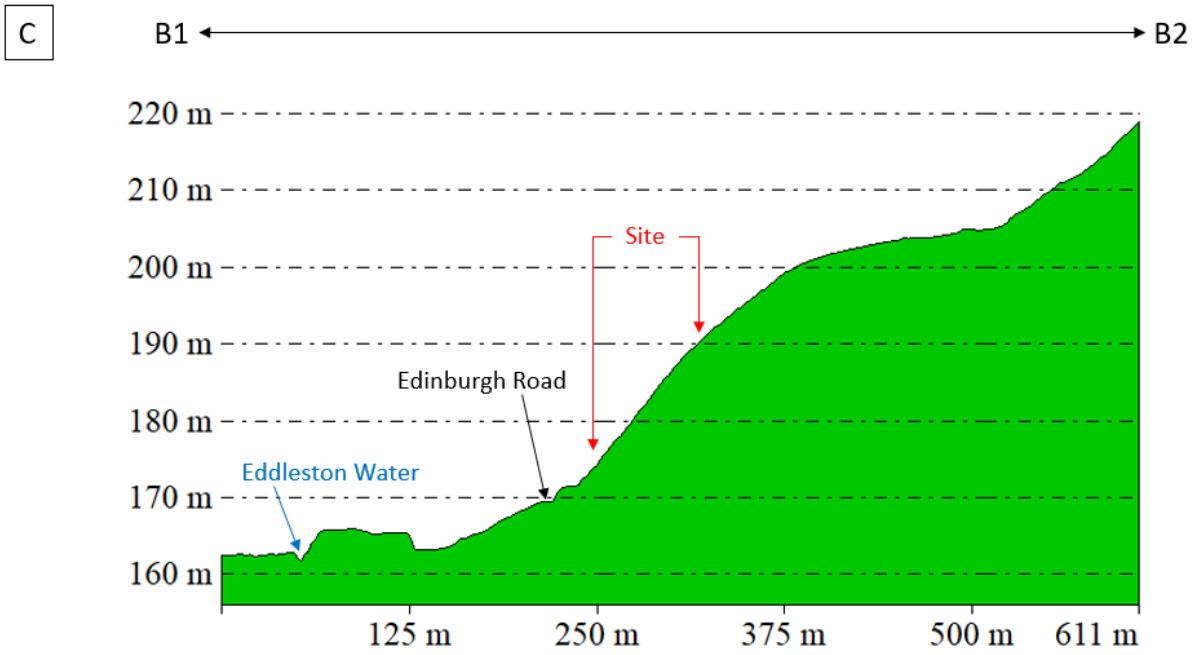
Ground levels within the site slope steeply downwards to the west (see Photo 4). Mean elevation within the site is approximately 181.5 m AOD (Above Ordnance Datum), with minimum and maximum ground elevations of ~170.6 and ~193.8 m AOD, respectively. The general topography and cross-sections through the site are shown in Figure 3.

Photo 4: Site looking east

Figure 3: (a) Topography of site and surrounding areas with (b,c) cross-sections







A review of the British Hydrological Society (BHS) Chronology of British Hydrological Events website was undertaken searching for the following keywords: “Cross Burn”, “Eddleston Water”, “River Tweed” and “Peebles.” These refer to nearby locations marked on current and historic maps.

A record from September 1891 refers to heavy rainfall leading to swollen tributaries of the River Tweed, including the Eddleston Water, which washed away roads and bridges. No other records were found for any of the keyword searches.

A basic internet search found records of flooding from heavy rainfall in November 2016, with roads in Peebles being totally submerged after the Eddleston water burst its banks; the Crossburn Caravan Park directly west of Edinburgh Road was deemed at high risk of flooding.

4 Hydrological Assessment

A hydrological analysis was undertaken to estimate peak flows in the Cross Burn and two small springs east of the site. Catchment characteristics for the Cross Burn were extracted from the Flood Estimation Handbook (FEH) web-service for a location just upstream of Edinburgh Road, which also incorporates the two small springs. The full FEH catchment location and characteristics can be seen in Figure 4 and Table 1, respectively.

Design flows were estimated for the catchment using three methods:

- FEH Rainfall-Runoff Method (using FEH1999 winter rainfall);
- Revitalised FEH Rainfall-Runoff Method (ReFH2) using winter rainfall; and
- Rural Q_{med} with Flood Studies Report (FSR) scaling factors.

Figure 4: Catchments for the Cross Burn and two springs (east of the site)

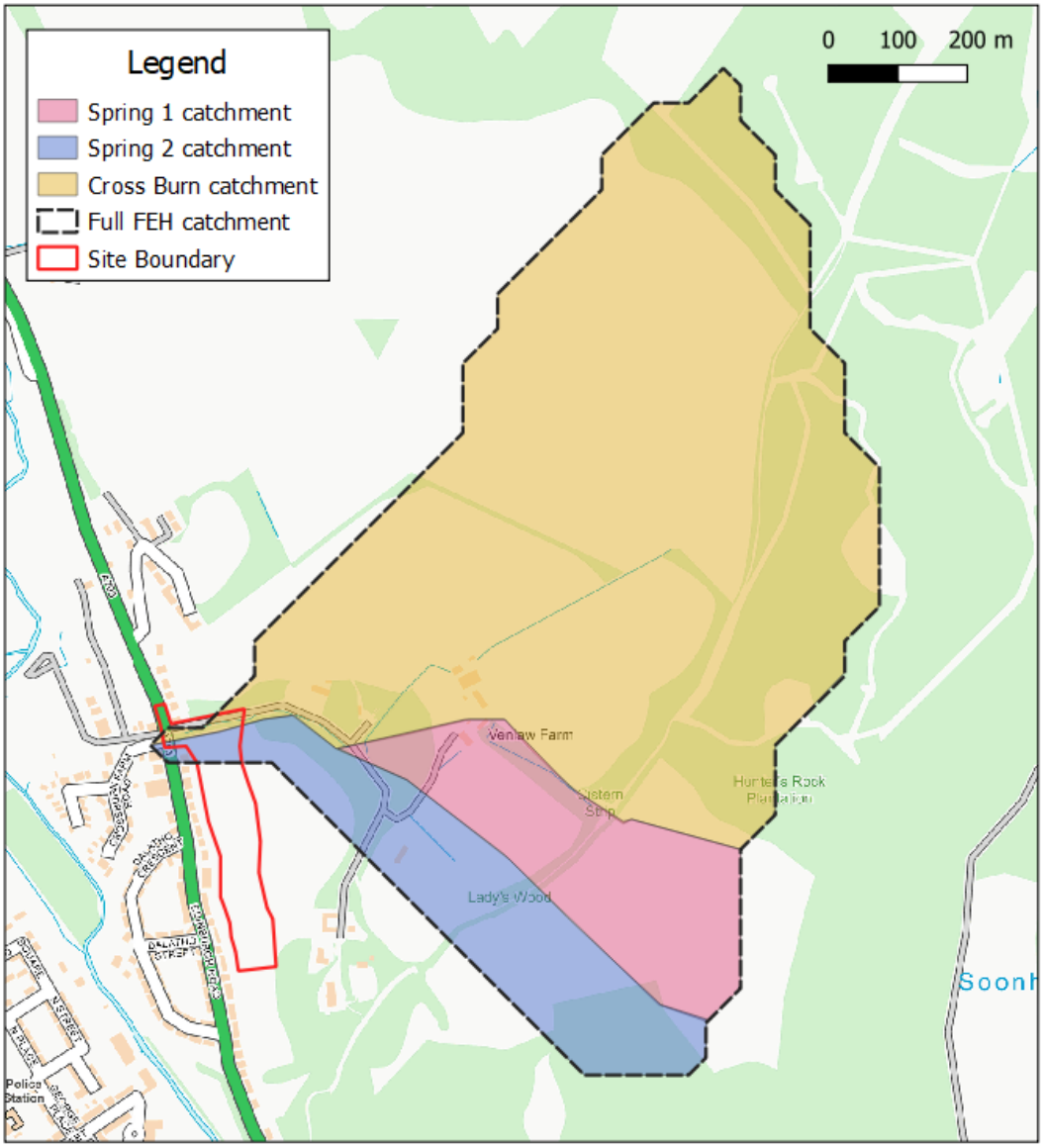


Table 1. Catchment characteristics for full Cross Burn catchment at Edinburgh Road

Parameter	Cross Burn @ Edinburgh Road
EASTING (m)	325052
NORTHING (m)	641600
AREA (km^2)	0.76
ALTBAR (m)	270
ASPBAR (°)	257
ASPVAR	0.75
BFIHOST	0.62
DPLBAR (km)	0.81
DPSBAR (m/km)	172.90
FARL	1.00
LDP (km)	1.42
PROPWET	0.49
SAAR (mm)	886
SAAR4170 (mm)	868
SPRHOST (%)	27.45
URBCONC1990	0.1990
URBEXT1990	0.0027
URBLOC1990	0.0350
URBCONC2000	0.4750
URBEXT2000	0.0191
URBLOC2000	0.5310

The estimated flows for the Cross Burn from all methods are shown in Table 2. Design flows for the Cross Burn incorporate flows from the two small springs east of the site. The most conservative 1 in 200-year event design flow was calculated using the FEH Rainfall-Runoff Method; however, it is known that this method often overestimates flows for small catchments. The Q_{med} rural with FSR scaling factors method is considered to be the most accurate for rural, small catchments. As such, a 1 in 200-year event peak flow of 0.76 m^3/s was used for the model analysis.

Table 2: Design flows for the Cross Burn catchment

Estimation Method	1 in 200-year (m^3/s)	1 in 200-year + 35% increased rainfall (m^3/s)
FEH Rainfall-Runoff [a]	1.43	2.70
ReFH2 Winter [b]	0.69	0.99
Q_{med} rural with FSR scaling [c]	0.76	1.39

a Design Storm Duration = 2.1 hours
b Design Storm Duration = 2.0 hours
c Estimated with Q_{med} rural of 0.24 m^3/s and FSR scaling factor of 3.18.

As per SEPA climate change guidance for catchments in eastern Scotland less the 30 km^2 in area, peak future flows for the catchment was predicted by increasing rainfall intensity by 35%. For flows estimated using the FEH Rainfall-Runoff Method, the increased rainfall depth was input manually in order to estimate peak climate change flow. For the ReFH2 method, a climate change factor of 1.35 was used.

For the Rural Q_{med} with FSR scaling factors method, a scaling factor of 5.78 was used to estimate the 1 in 200-year plus climate change flow, with the scaling factor estimated from the relationship between return period and FEH Rainfall-Runoff flows. Applying this scaling factor to the Q_{med} flow results in a 1 in 200-year plus climate change peak flow of 1.39 m^3/s.

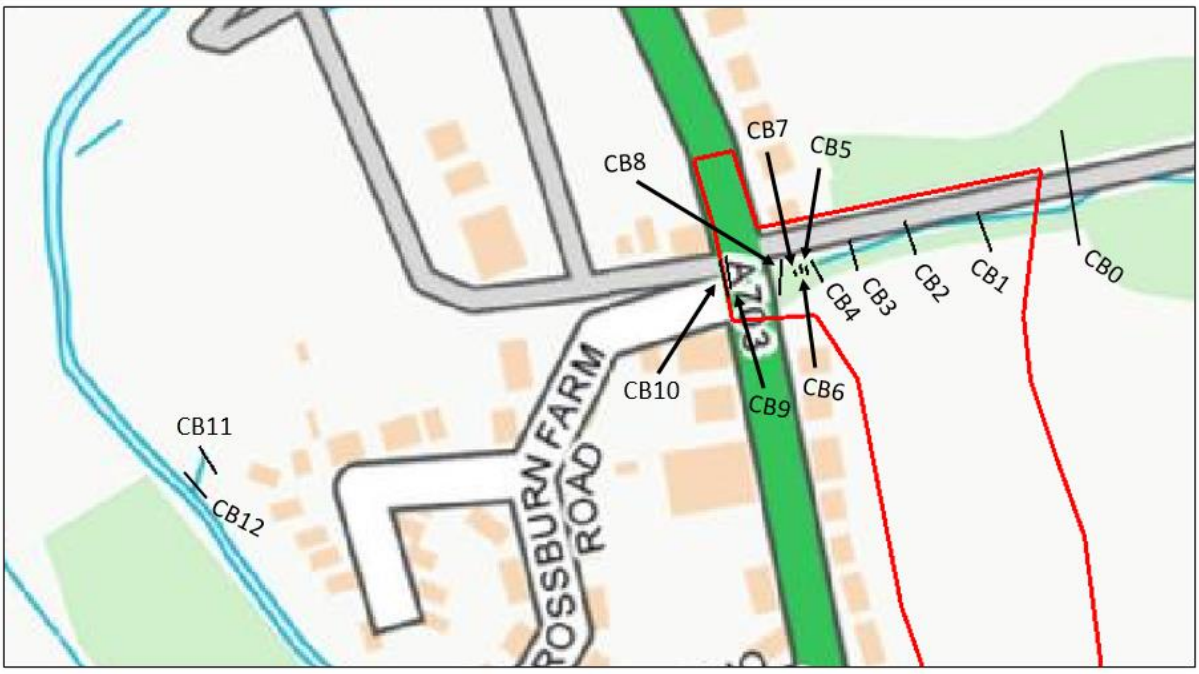
5 Flood Modelling

5.1 Modelling Set-up

A HEC-RAS 1D/2D linked model of the Cross Burn was developed using 11 cross-sections surveyed for the purpose of this study (CB1 to CB11) – see Figure 5. Two additional cross-sections were added to the model as follows: one upstream of the site boundary (CB0, based on LiDAR data) and one downstream of the final culvert in order to stabilise the model (CB12, duplicated from CB11). Model interpolates were also added every 5 m between cross-sections CB0 to CB1, cross-sections CB3 to CB4 and cross-sections CB7 to CB8 to improve model stability.

The model also includes four structures: two small farm crossings upstream of Edinburgh Road (see Figure 2), the culvert beneath Edinburgh Road and the culvert beneath the development west of the site. Details on the structures, including how they were modelled, are provided in Table 3. All inlet and outlet dimensions were taken from the cross-section survey of the site. As CCTV survey was not able to be undertaken at this time, there is no information available on the condition of the culverts beneath and west of Edinburgh Road. The impacts of culvert blockages are modelled in the sensitivity analysis.

Figure 5: Model 1D cross-section locations



For the 1 in 200-year flood event, the model upstream boundary for the Cross Burn is a hydrograph with a peak flow of 0.76 m^3/s, input along the Cross Burn at CS0 ~15 m upstream of the site boundary. For the 1 in 200-year plus climate change model run, the upstream boundary uses a hydrograph with a peak flow of 1.39 m^3/s. The model downstream boundary was set as Normal Depth at the slope of the channel in this area (~0.008). The use of a stage hydrograph downstream boundary is explored in the sensitivity analysis, as the Cross Burn outlets into the Eddleston Water.

The areas modelled in 2D are shown in Figure 6, using a 2 m grid spacing based on 1 m LiDAR ground elevation data. The 1D model was run using Manning's *n* (roughness) parameters of 0.045 and 0.060 to represent the channel and moderately vegetated areas of the floodplain, respectively and a universal Manning's *n* of 0.060 was used for the areas modelled in 2D. A timestep of 1 second was used for all model runs.

Figure 6: Model 2D domain

Table 3. Model structure details

Structure	Cross-sections either side of structure	Length	Dimensions	Modelled as:
Farm crossing 1	CB4 and CB5	~2.9 m	1.2 x 0.6 m	Flat-top bridge
Farm crossing 2	CB6 and CB7	~2.4 m	0.9 x 0.6 m	Flat-top bridge
Culvert beneath Edinburgh Road	CB8 and CB9	~19.5 m	0.9 x 1 m	Flat-top bridge
Culvert beneath development west of site	CB10 and CB11	~208 m	1 m diameter	Circular culvert

5.2 Model Results

Predicted water levels for modelled cross-sections are provided in Table 4 for the 1 in 200 and 1 in 200-year plus climate change events. A long profile of the model with the 1 in 200-year flood level is provided in Figure 7. Individual cross-section results plotted with the 1 in 200-year flood level can be seen in Appendix A, as well as a table detailing maximum velocity and Froude numbers for each cross-section.

Figure 7: Model long-profile with 1 in 200-year flood level for (a) full reach length and (b) subset of reach adjacent to the site

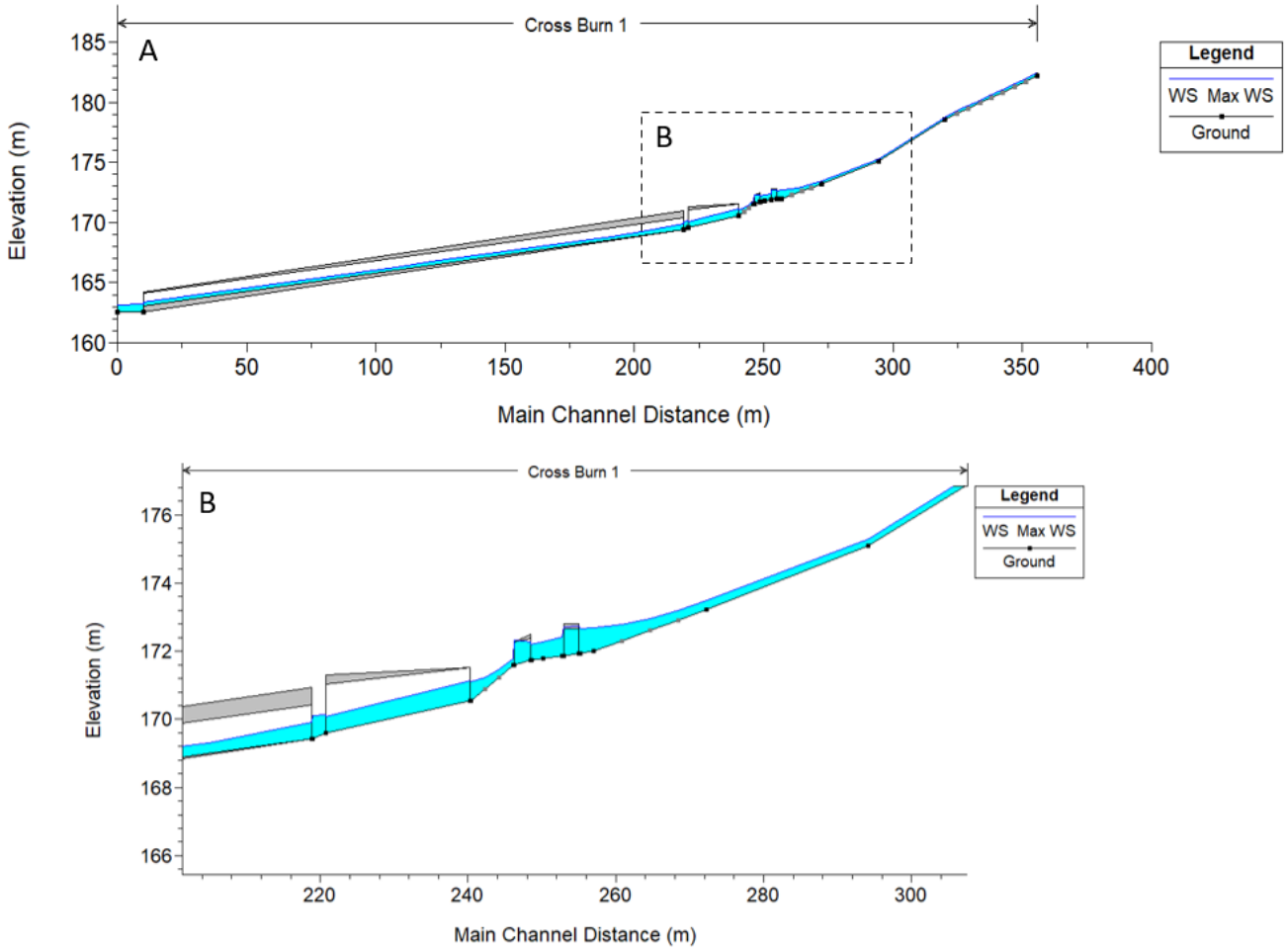


Table 4. 1D model cross-sections results

Cross-Section	1 in 200-year max flood level (m AOD)	1 in 200-year + CC max flood level (m AOD)
CB0	182.44	182.54
CB1	178.77	178.83
CB2	175.30	175.38
CB3	173.49	173.57
CB4	172.69	173.21
CB5	172.27	172.48
CB6	172.20	172.42
CB7	171.80	171.89
CB8	171.10	171.39
CB9	170.12	170.42
CB10	170.10	170.44
CB11	163.22	163.36
CB12	163.15	163.28

Model results for the 1D/2D model of the Cross Burn indicate that for the 1 in 200-year event, flood waters remain within channel banks along the length of the reach – see Figure 8. While farm crossing 1 is surcharged during the 1 in 200-year event, flood water remains within the channel and does not overtop the crossing. Neither farm crossing 2 nor the culverts beneath Edinburgh Road or beneath the

development west of the site are surcharged during the 1 in 200-year event. Model results show that the culvert beneath Edinburgh Road has enough capacity to pass the 1 in 200-year event flow (0.76 m^3/s), as well as the 1 in 200-year plus climate change flow (1.39 m^3/s).

During the 1 in 200-year plus climate change event, both farm crossings upstream of Edinburgh Road experience overtopping. However, although the flood waters overtop the channel banks, water extends less than one metre into the floodplain before flowing back into the channel. The area of the site proposed for development is located at higher elevations and is not impacted by the overtopping of the small farm crossings.

Figure 8: Modelled 1 in 200-year floodplain

5.3 Model Sensitivity

A model sensitivity analysis provides an illustration of the effect of changing key model parameters on the important model outputs (in our case flood levels). By re-running the model for a range of scenarios and changing one input parameter for each model run, the effect of each input on the model results can be isolated. If model parameters are varied within the range of possible input values, then a sensitivity analysis can also provide an indication of uncertainty associated with the model predictions.

A sensitivity analysis was undertaken considering the following parameters:

- Scenario 1 (S1): Increase in rainfall intensity by 35%;
- Scenario 2 (S2): Increase in roughness by 20%;
- Scenario 3 (S3): Change of downstream boundary to static water level in Eddleston Water at bank full during an estimated 200-year flood event (as derived from comparison of LiDAR data to SEPA flood maps); and
- Scenario 4 (S4): Blockage scenario with 25% blockage of all bridges and culverts;
- Scenario 5 (S5): Blockage scenario with 50% blockage of all bridges and culverts.

Results of the sensitivity analysis can be found in Table 5. Comparison of the results to the base case (1 in 200-year flow) model run indicate that the model behaves as expected, specifically:

- A 35% increase in rainfall intensity results in increased flood levels within the channel between 0.06 and 0.52 m AOD, with a maximum increase in level adjacent to the site of +0.52 m AOD.
- An increase in model roughness (Manning's *n*) by 20% increases flood levels within the channel by 0 to 0.11 m AOD, with a maximum increase in level adjacent to the site of +0.11 m AOD.
- Setting the model downstream boundary to a static water level of 163.5 m (1 in 200-year level in Eddleston Water) results in a significant increase in flood level at the two most downstream cross-sections only, having no effect at the site.
- The 25% blockage scenario results in an increase in flood levels upstream of the blocked structures with a maximum increase of +0.42 m upstream of farm crossing 1. When blocked by 25%, the two farm crossings are surcharged, with flood water only overtopping farm crossing 1 (i.e., between cross-sections CB4 and CB5) by ~6 cm. Water does not overtop farm crossing 2. The 1 in 200-year event design flow is still able to pass through the culvert beneath Edinburgh Road and the subsequent downstream culvert (beneath the residential area west of the site) when blocked by 25%.
- The 50% blockage scenario results in a significant increase in flood level upstream of the blocked structures with a maximum increase of +1.59 m upstream of the culvert beneath Edinburgh Road. When blocked, both farm crossings and the culvert beneath Edinburgh Road are predicted to be surcharged. For the farm crossings, flood water overtops the structures and continues to flow downstream within the channel, with flood water coming out of bank upstream of the structures by less than one metre. The area of proposed development within the site adjacent to the watercourse is raised above the left channel bank and the development is not predicted to lie within the blockage floodplain. However, surcharging of the culvert beneath Edinburgh Road results in flood waters spilling onto the road; based on available topographical data, flood water is predicted to flow either west across or north along Edinburgh Road. Flood water depth on the road is predicted to be no more than ~0.15 m.

Table 5: Model sensitivity analysis results

Cross-Section	200-year flood level (m AOD)	Difference from Base Case (m)				
		S1	S2	S3	S4	S5
CB0	182.44	+0.10	+0.03	0	0	0
CB1	178.77	+0.06	+0.01	0	-0.01	-0.01
CB2	175.3	+0.08	+0.02	0	0	0
CB3	173.49	+0.08	+0.02	0	-0.01	-0.01
CB4	172.69	+0.52	+0.03	0	+0.42	+0.51
CB5	172.27	+0.21	+0.02	+0.03	0	+0.76
CB6	172.2	+0.22	0	0	-0.01	+0.86
CB7	171.8	+0.09	+0.02	+0.05	0	+0.91
CB8	171.1	+0.29	+0.11	0	0	+1.59
CB9	170.12	+0.30	+0.01	0	+0.18	+0.52
CB10	170.1	+0.34	0	0	+0.21	+0.54
CB11	163.22	+0.14	+0.04	+0.29	0	+0.01
CB12	163.15	+0.13	+0.04	+0.35	0	+0.01

While small increase in flood level are seen within cross-sections adjacent to the site, increases in level due to changes in model roughness, increased flow or 25% structure blockage do not result in flood water entering the proposed development area of the site. While blocking all structures by 50% does not result in flood water entering the site, water does spill over onto Edinburgh Road.

6 Flood Risk Assessment

The flood risk assessment considers flooding from:

- The Cross Burn and nearby springs;
- Surface water flooding;
- Groundwater flooding;
- Site drainage systems; and
- Site access.

6.1 Risk of Flooding from the Cross Burn and Springs

The Cross Burn flows in a westerly direction through the northern part of the site, emanating from the hills east of the site boundary. The burn flows through three culverts within the site, beneath two smaller agricultural crossings and Edinburgh Road. There are also two small springs flowing north-west between ~220 and 300 m east of the site. Design flows for all three watercourses were combined for modelling purposes.

Detailed mathematical modelling of the Cross Burn predicted that the proposed development area of the site does not lie within the 1 in 200-year functional floodplain. While the 25% structure blockage scenario model run predicted increases in flood levels upstream of the blocked structures, the proposed development area of the site remains outwith the 1 in 200-year plus blockage floodplain. The culvert beneath Edinburgh Road is predicted to have the capacity to pass the 1 in 200-year flow when blocked by 25%.

When blocked by 50%, all structures adjacent to the site are predicted to be surcharged. The two farm crossings upstream of Edinburgh Road are overtopped, however flood water comes out of bank by less than one metre and does not extend into the area of the site proposed for development. Surcharging of the culvert beneath Edinburgh Road results in flood water spilling onto Edinburgh Road, where it is likely to follow the elevation gradient and flow either north along the road or west directly across the road and on to Crossburn Farm Road or the access road for the development west of the site.

Water depth on Edinburgh Road during the 1 in 200-year plus 50% structure blockage scenario is predicted to be no more than ~0.15 m, with maximum depths near the upstream end of the road where water initially overtops. The addition of a trash screen upstream of the Edinburgh Road culvert would reduce the risk of the culvert from becoming significantly blocked. In addition, the site access road will cross the watercourse upstream of the Edinburgh Road culvert and can also be provided with a screen.

We would also recommend the removal of the two farm crossings upstream of Edinburgh Road (as they are not currently or planned to be in use). This would allow for a more natural channel. At present, the farm crossing 1 is already predicted to be surcharged during the 1 in 200-year event, but if blocked flood waters overtop the crossings within the channel valley, so their removal would not impact flood storage upstream.

The 1 in 200-year plus climate change model run predictions indicate that the proposed development area of the site does not lie within the climate change floodplain, and that the culvert beneath Edinburgh Road also has the capacity to pass the 1 in 200-year plus climate change design flow (~1.39 m^3/s). Based on SPP and in line with SEPA ‘Land Use Vulnerability’ criteria, development considered ‘highly vulnerable’ should be located outside of the 1 in 200-year floodplain extent. Therefore, the whole site

(excluding the watercourse channel and banks) would be considered suitable for development. However, the site should be protected against a 1 in 200-year plus climate change flood event.

Finished Floor Levels for the development should be discussed with the local council with reference to the latest climate change guidance. It is recommended that Finished Floor Levels should be raised at least 0.6 m above the 1 in 200-year plus climate change event flood level within the site. Given the watercourse sits in a valley we would recommend that Finished Floor Levels are set at least 0.6 m above the surrounding ground levels along the edge of the site on the southern side of the watercourse.

In addition, care will need to be taken in the design of the site to take account of the potential future risks due to climate change and the sensitivity of the modelled floodplain to flows and structure blockages.

6.2 Risk of Surface Water Flooding

A pluvial flood model was set up using Flood Modeller Pro to assess the risk to the site from overland flow during both 1 in 200-year and 1 in 200-year plus climate change rainfall events. The model is based on 1 m resolution LiDAR elevation data and simulates rainfall runoff within the site and surrounding areas.

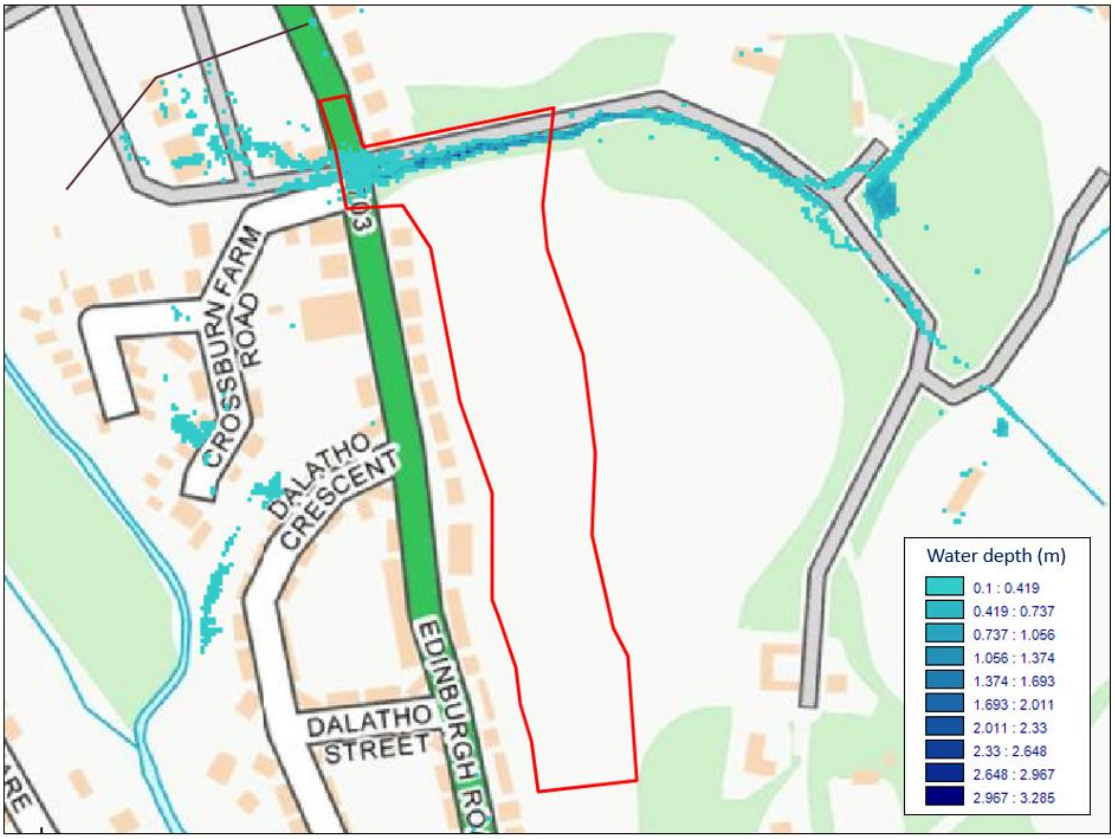
Rainfall hyetographs were developed from the winter rainfall totals for the area based on the Flood FEH online web-service, with the hyetograph shape based on the standard methods within the FEH Rainfall-Runoff model. The rainfall was applied to the site and catchment that could flow towards the site.

The model was run with a grid size of 2 m and a Manning's roughness (n) of 0.065. Several different design rainfalls using FEH13 values were run for storm durations of 1, 3, 5 and 7 hours.

The surface water model results for a 1 in 200-year rainfall event are shown in Figure 9 for the 1 hour run – the 1 hour storm resulted in the highest total volume of surface water flooding on site. The model results show that there is localised ponding on Edinburgh Road where the road intersects with Crossburn Farm Road and on the local access track north of the Cross Burn; maximum water depths on Edinburgh Road are ~0.12 m. There are also raised water levels within the Cross Burn in the northern part of the site.

The proposed development area of the site sits at a higher ground elevation than the Cross Burn and Edinburgh Road and slopes downwards to the west. Surface water originating from the hills east of the site and from within the site itself should be directed through the site without flooding properties (or roads) or increasing the flood risk to others outwith the site.

Figure 9: Results from 2D surface water model



6.3 Risk of Groundwater Flooding

The SEPA flood map shows that the site is not at risk of flooding from groundwater sources. Flooding from groundwater as a primary source is uncommon in Scotland.

There is no information on groundwater levels within the site. Any groundwater level measurements taken during Site Investigations will need to be taken into account in the design of the site. If there are elevated groundwater levels, suitable precautions may need to be considered during detailed design.

6.4 Risk of Flooding from Drainage Systems

Scottish Water service drawings of the area indicate that there are combined sewers running along Edinburgh Road (80 to 225 mm diameter) and the access road just north of the Cross Burn and site boundary (100 mm diameter). Any flows surcharging from these sewers would follow the slope of the roads as follows:

- Edinburgh Road: water considered likely to flow either north or south along the road, depending on where along the road it originates (Edinburgh Road elevation peaks just south of the culvert);
- Access road: water considered likely to flow west towards Edinburgh Road.

The site itself sits at a higher ground elevation than Edinburgh Road and slopes downwards to the west. Therefore, the risk of flooding from surcharging sewers is considered low.

The design of the site drainage system is not part of this commission. However, it is our understanding that surface water originating from the hills east of the site and within the site will be drained to the north into the Cross Burn. This could be considered additional flow into the burn. However, modelling has shown that the culvert downstream of the site can pass the 1 in 200-year event flow, with additional capacity. The site runoff will also be attenuated to greenfield rates. We would recommend that the capacity of the culvert with site discharge is checked as part of the drainage design.

As part of the development of the site, a suitable drainage system employing SuDS will be required to manage surface water within the site. Requirements for SuDS should be discussed with Scottish Water, the Scottish Borders Council and SEPA, where applicable. A maintenance regime should be put in place to ensure all components of the drainage system function as designed.

6.5 Site Access

A new site access road is proposed over the Cross Burn, with all flows directed beneath the road via a proposed 2.5 x 1.0 m rectangular culvert. As this culvert has a larger capacity than the current culvert beneath Edinburgh Road (which is able to pass both the 1 in 200-year plus 25% blockage and 1 in 200-year plus climate change flows), it is assumed that the new access road culvert will also be able to pass both flows. Therefore, flood free vehicular access will be available during a 1 in 200-year plus 25% blockage or climate change event. Flood free pedestrian access will also be available via the new access road, as well as via the footpath running east of the site, which loops back down towards Edinburgh Road south of the site.

Flood free vehicular access to the site is not predicted with 50% structure blockage, however there is predicted to be no more than ~0.15 m of flood water on Edinburgh Road and the intersection of Edinburgh Road with the planned new site access road. The installation of a trash screen upstream of the Edinburgh Road culvert would reduce the risk of high structure blockage and flooding of the road.

Care should be exercised in the design of the new access road planned linking Edinburgh Road to the site so that it does not act as a flow path for flood water spilling onto Edinburgh Road during a high blockage scenario or from surface water runoff from rainfall events. Any such flows should be accommodated within site drainage system.

7 Summary and Conclusions

Kaya Consulting Ltd was commissioned by Carmichael Homes & Interiors through Woolgar Hunter to undertake an assessment of the risk of flooding to a proposed residential development on Edinburgh Road, Peebles.

The development proposal includes the erection of 22 residential properties. These developments are considered to be in the 'highly vulnerable' category within SEPA's Land Use Vulnerability Guidance; as such, the site must be assessed for flood risk up to the 1 in 200-year event, with consideration of the impact of climate change.

The Cross Burn flows in a westerly direction through the northern part of the site. Detailed mathematical modelling of the watercourse predicted that the proposed development area of the site does not lie within the 1 in 200-year functional floodplain. While the 25% structure blockage scenario model run predicted increases in flood levels upstream of the blocked structures, the proposed development area of the site remains outwith the 1 in 200-year plus blockage floodplain. The culvert beneath Edinburgh Road is predicted to have the capacity to pass the 1 in 200-year flow when blocked by 25%.

When blocked by 50%, all structures adjacent to the site are predicted to be surcharged. The two farm crossings upstream of Edinburgh Road are overtopped, however flood water does not extend into the area of the site proposed for development. Surcharging of the culvert beneath Edinburgh Road results in flood water spilling onto Edinburgh Road, where it is likely to flow either north along the road or west directly across the road and on to Crossburn Farm Road or the access road for the development west of the site. Water depth on Edinburgh Road during the 50% structure blockage scenario is predicted to be no more than ~0.15 m, with maximum depths near the upstream end of the road where water initially overtops. The addition of a trash screen upstream of the Edinburgh Road culvert would prevent the culvert from becoming significantly blocked. In addition, the removal of the two farm crossings upstream (as they are not currently or planned to be in use) would provide a more natural channel and prevent additional channel overtopping in these areas.

The 1 in 200-year plus climate change model run predictions indicate that the proposed development area of the site does not lie within the climate change floodplain, and that the culvert beneath Edinburgh Road has the capacity to pass the 1 in 200-year plus climate change design flow. Based on SPP and in line with SEPA 'Land Use Vulnerability' criteria, development considered 'highly vulnerable' should be located outside of the 1 in 200-year floodplain extent. Therefore, the whole site (excluding the watercourse channel and banks) would be considered suitable for development. However, the site should be protected against a 1 in 200-year plus climate change flood event.

Finished Floor Levels for the development should be discussed with the local council with reference to the latest climate change guidance. It is recommended that Finished Floor Levels should be raised at least 0.6 m above the 1 in 200-year plus climate change event flood level within the site. Given the watercourse sits in a valley we would recommend that Finished Floor Levels are set at least 0.6 m above the surrounding ground levels along the edge of the site on the southern side of the watercourse.

There is potential for flooding from surface water from land east of the site. General ground levels should be finished in a way not to allow ponding of surface water within the site where it could increase the risk of flooding of properties. It is good practice to provide within the development site an appropriate overland flow route through which flood waters could escape in the event of the site being flooded during floods exceeding the design flows or following blockage of the site drainage system.

No significant risk of flooding of the site was predicted from any other sources considered at this time.

The design of the site drainage system is not part of this commission. However, as part of the development of the site a suitable drainage system employing SuDS will be required to manage surface water within the site. Requirements for SuDS should be discussed with Scottish Borders Council, Scottish Water and SEPA, where applicable. A maintenance regime should be put in place to ensure all components of the drainage system function as designed.

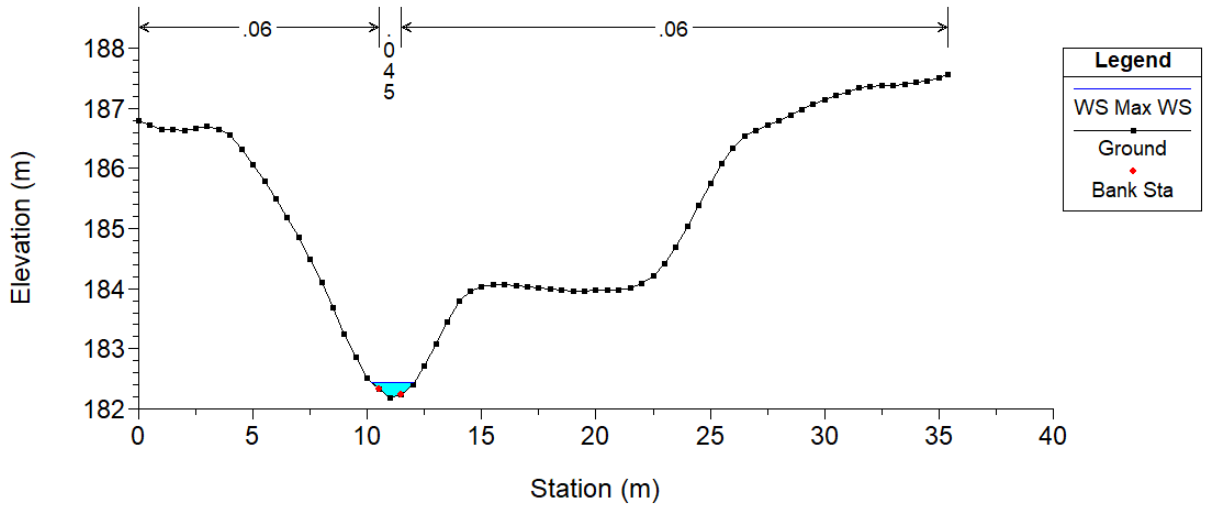
It should be noted that the risk of flooding can be reduced, but not totally eliminated, given the potential for events exceeding design conditions and the inherent uncertainty associated with estimating hydrological parameters for any given site.

8 Appendix A

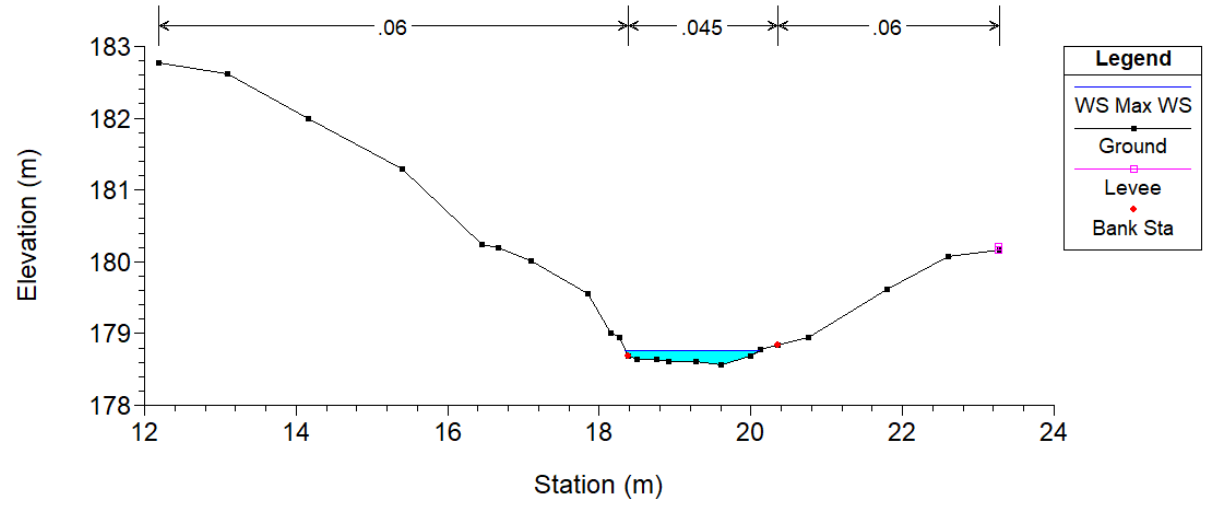
Table A1. Maximum velocity and Froude numbers for 1 in 200-year flood event

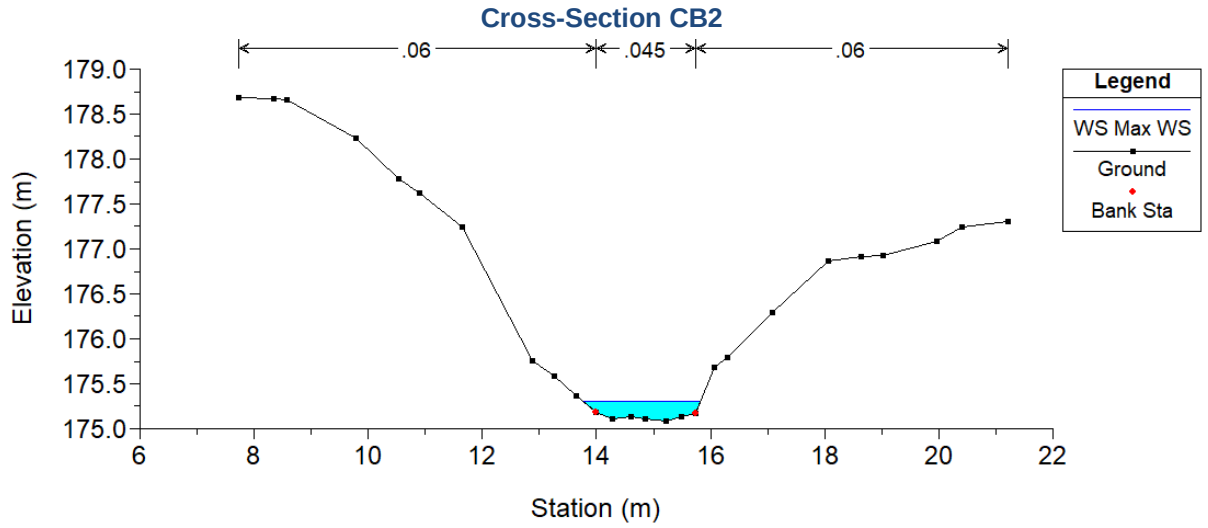
Cross-Section	Max velocity (m/s)	Max Froude Number
CB0	3.25	2.32
CB1	3.16	2.71
CB2	2.46	1.87
CB3	2.00	1.48
CB4	2.01	0.82
CB5	3.54	1.66
CB6	1.85	0.87
CB7	3.15	2.22
CB8	2.10	0.96
CB9	1.51	0.73
CB10	1.21	0.51
CB11	0.98	0.41
CB12	1.25	0.56

Cross-Section CB0



Cross-Section CB1




Cross-Section CB2
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
179.0
178.5
178.0
177.5
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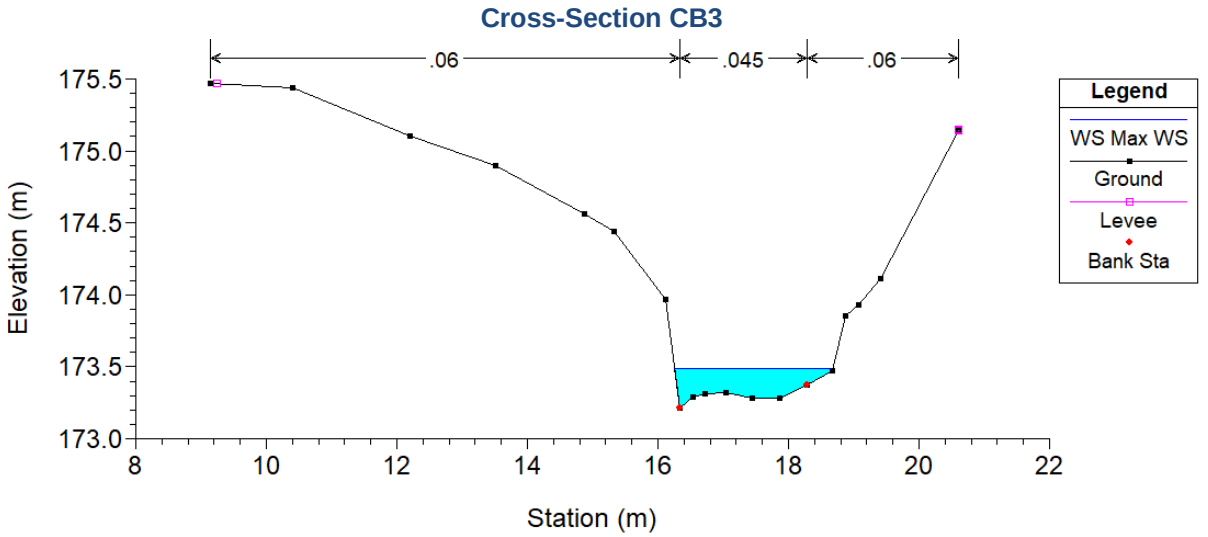
176.0
175.5
175.0
6
8
10
12
14
16
18
20
22
Station (m)


Cross-Section CB3
.06
.045
.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (m)
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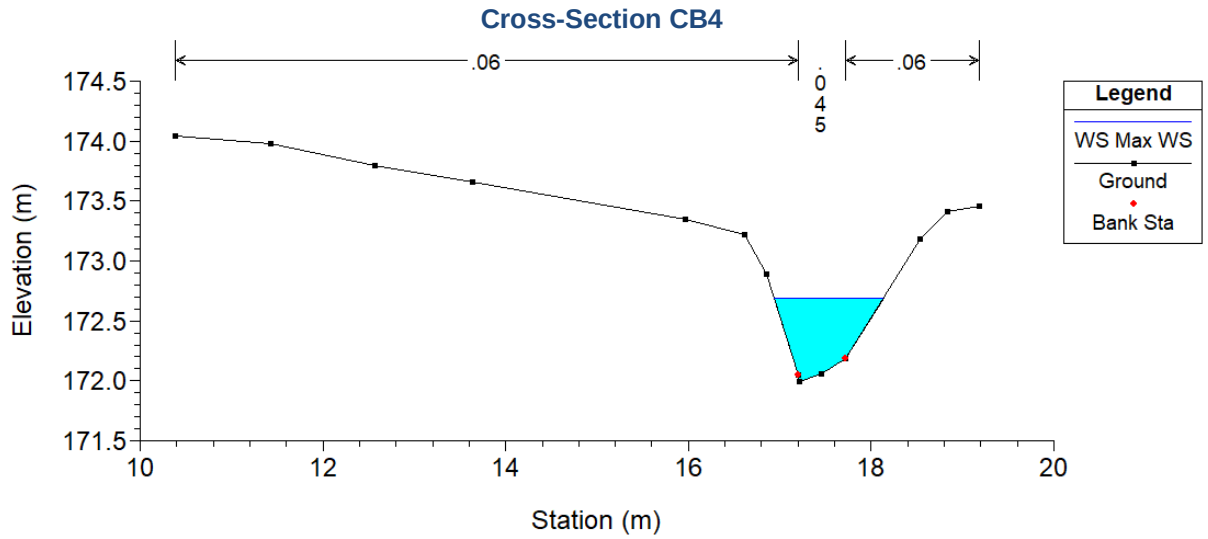
173.0
8
10
12
14
16
18
20
22
Station (m)


Cross-Section CB4
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
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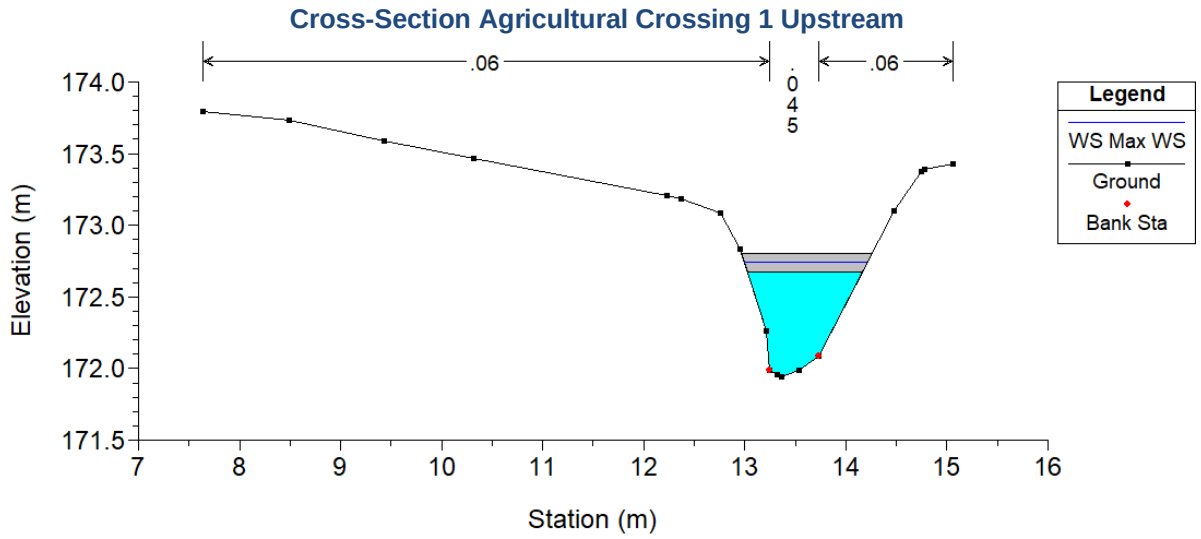
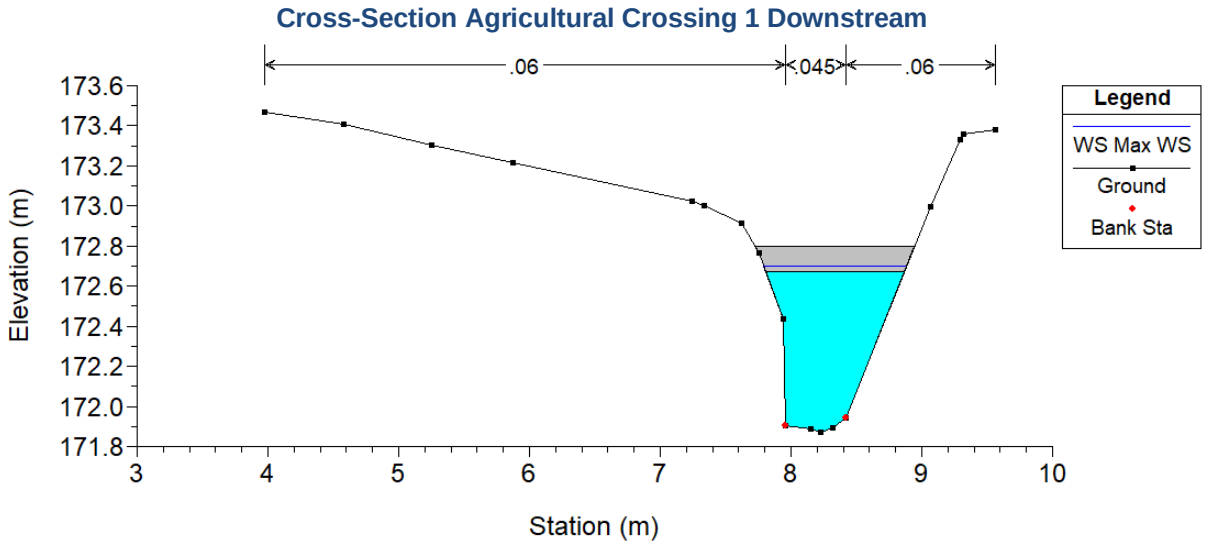
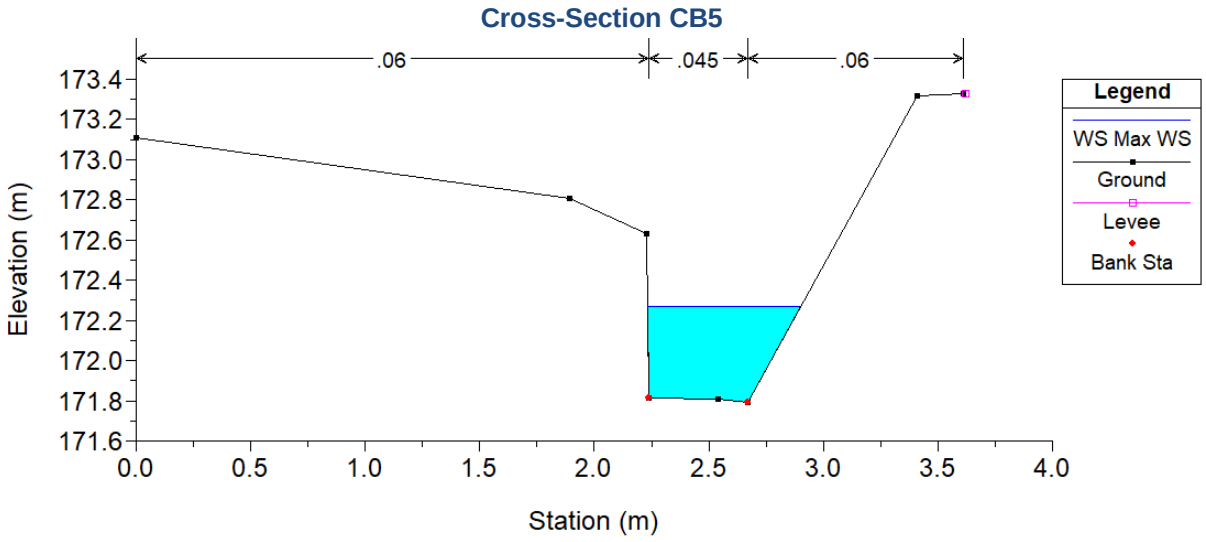
171.5
10
12
14
16
18
20
Station (m)


Cross-Section Agricultural Crossing 1 Upstream
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
Station (m)


Cross-Section Agricultural Crossing 1 Downstream
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
Station (m)


Cross-Section CB5
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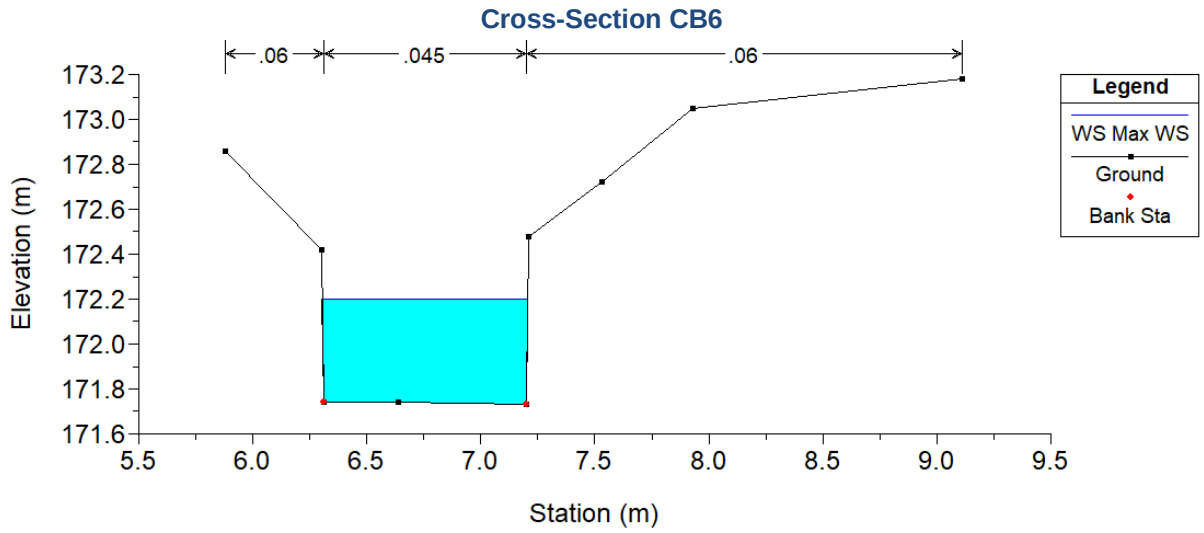
.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (m)
Station (m)


Cross-Section CB6
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
Station (m)
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173.0
172.8
172.6
172.4
172.2
172.0
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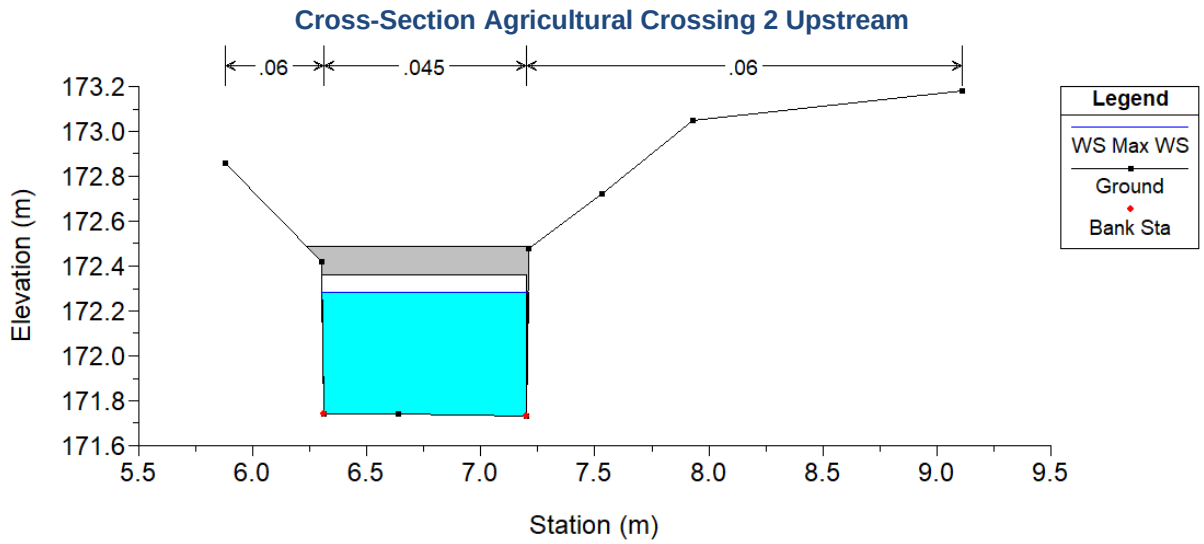
6.5
7.0
7.5
8.0
8.5
9.0
9.5


Cross-Section Agricultural Crossing 2 Upstream
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
Station (m)
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173.0
172.8
172.6
172.4
172.2
172.0
171.8
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6.5
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7.5
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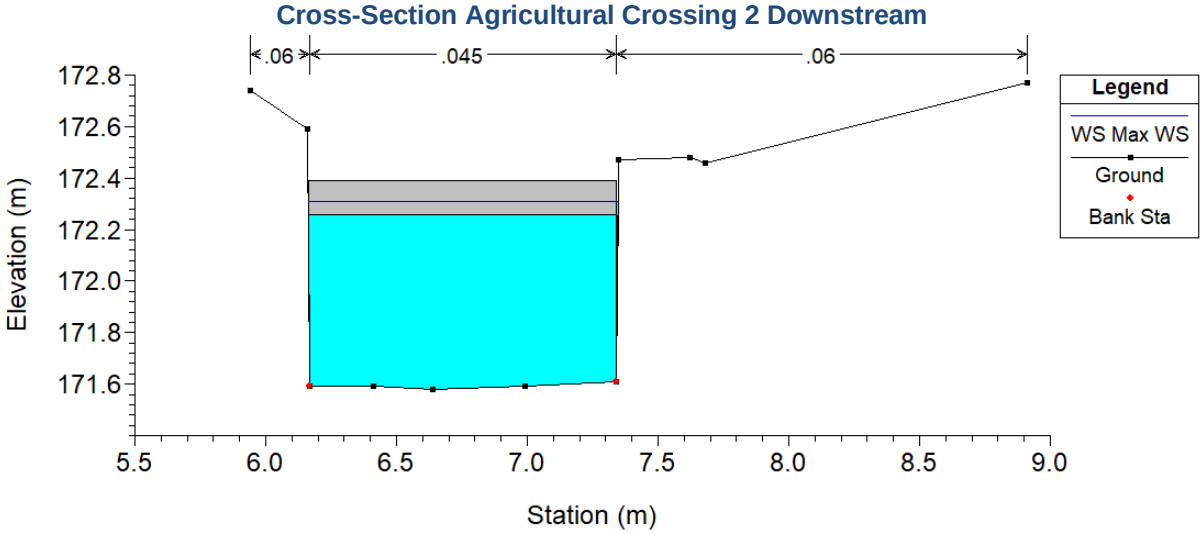
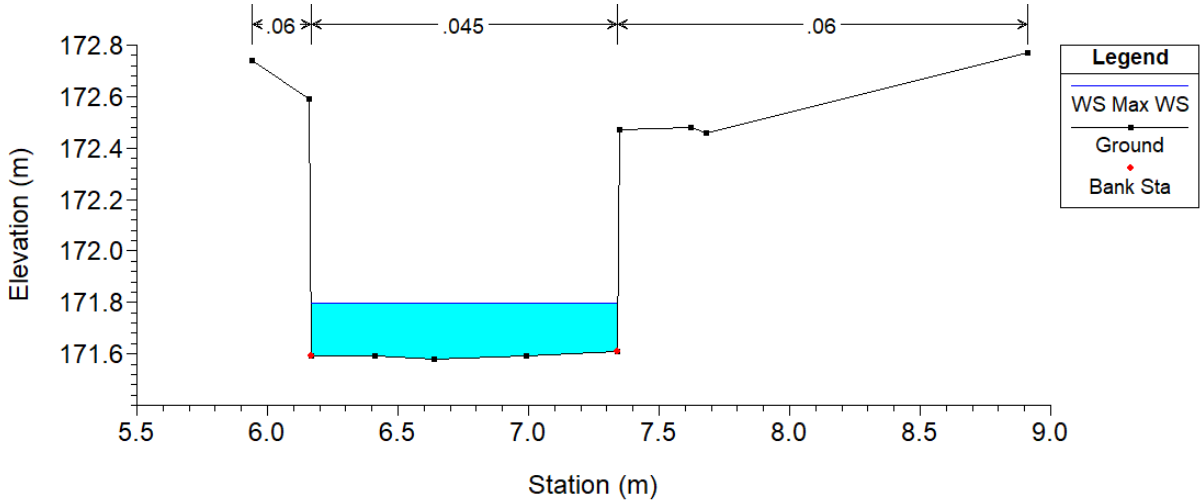
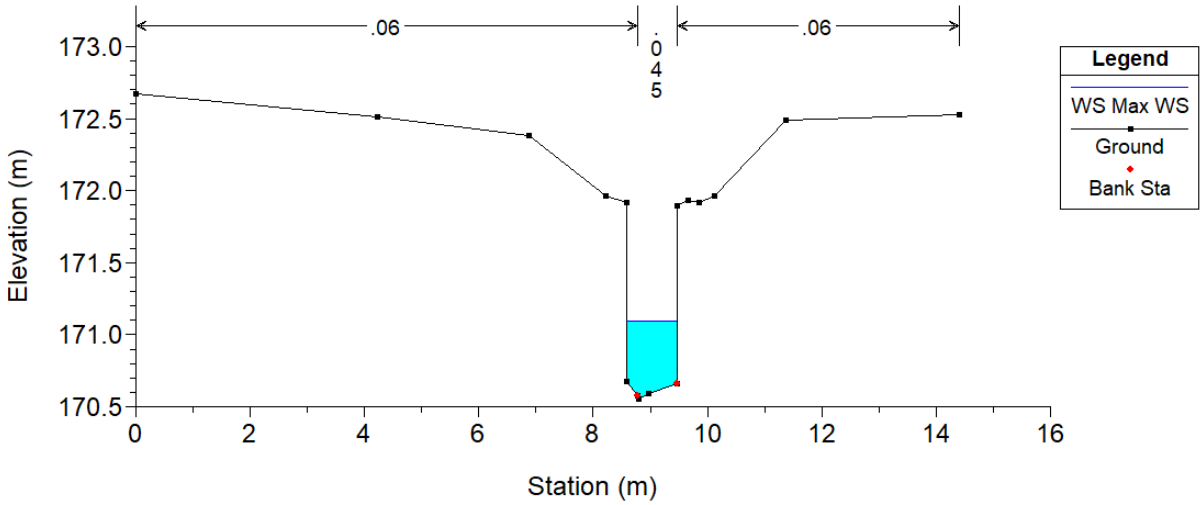
8.5
9.0
9.5


Cross-Section Agricultural Crossing 2 Downstream
.06
.045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
Station (m)
172.8
172.6
172.4
172.2
172.0
171.8
171.6
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0

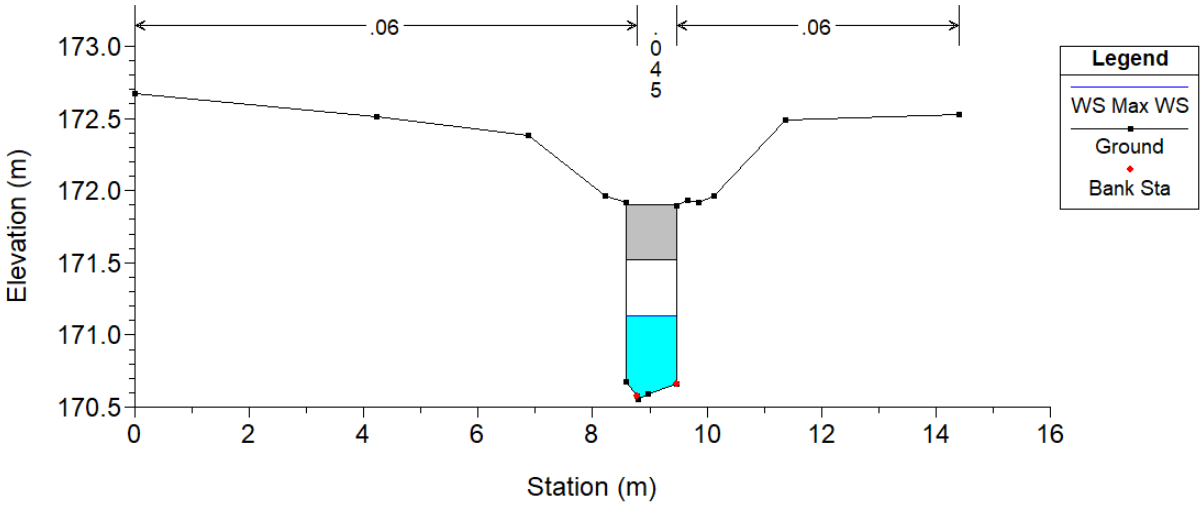
Cross-Section CB7

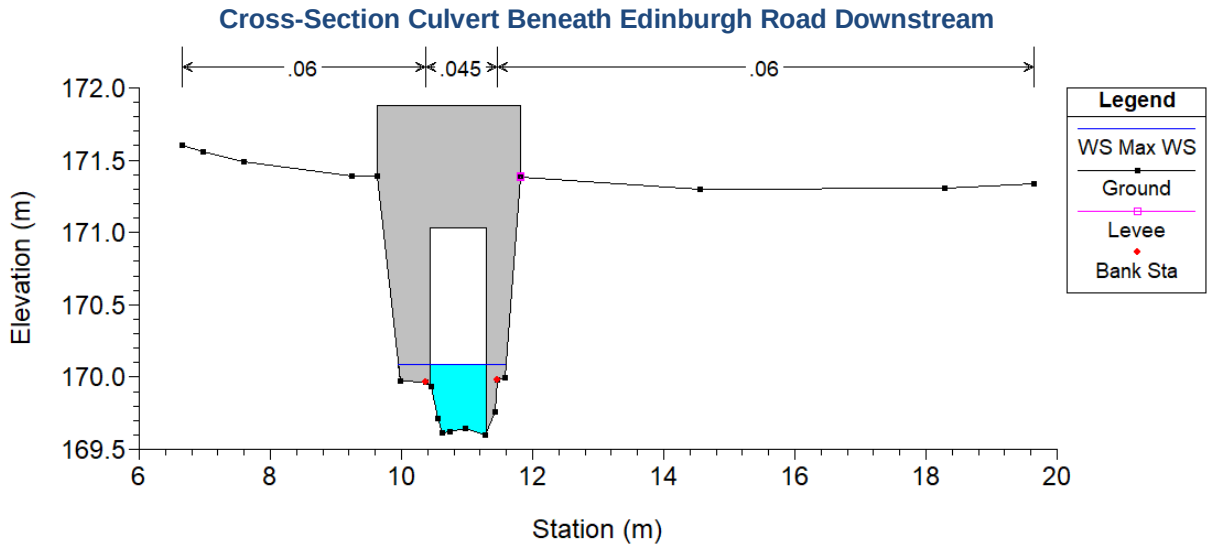


Cross-Section CB8



Cross-Section Culvert Beneath Edinburgh Road Upstream




Cross-Section Culvert Beneath Edinburgh Road Downstream
.06
.045
.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
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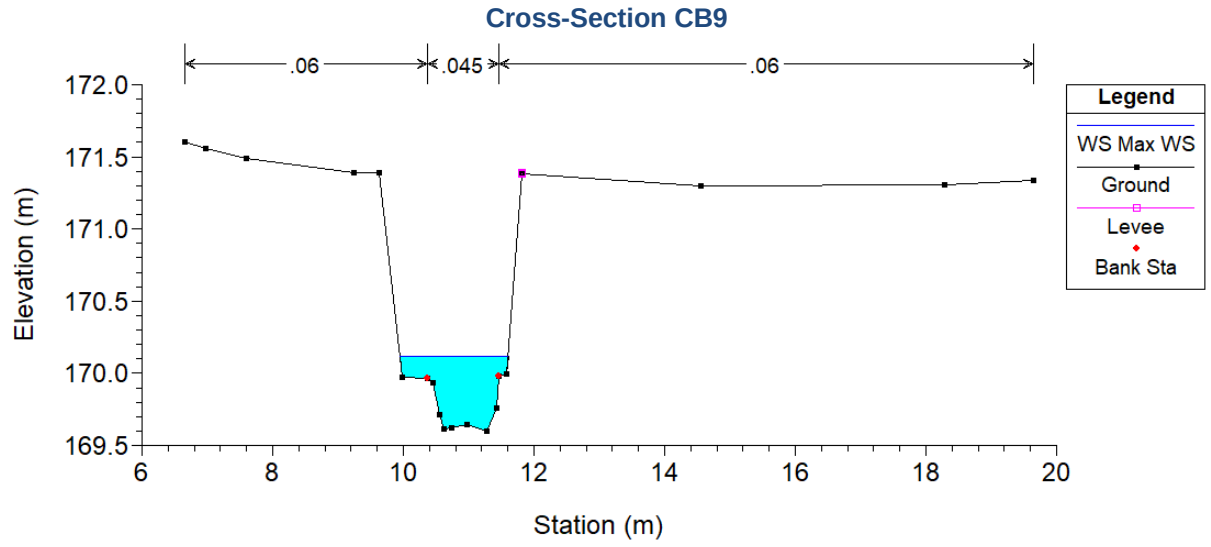
171.5
171.0
170.5
170.0
169.5
6
8
10
12
14
16
18
20


Cross-Section CB9
.06
.045
.06
Legend
WS Max WS
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
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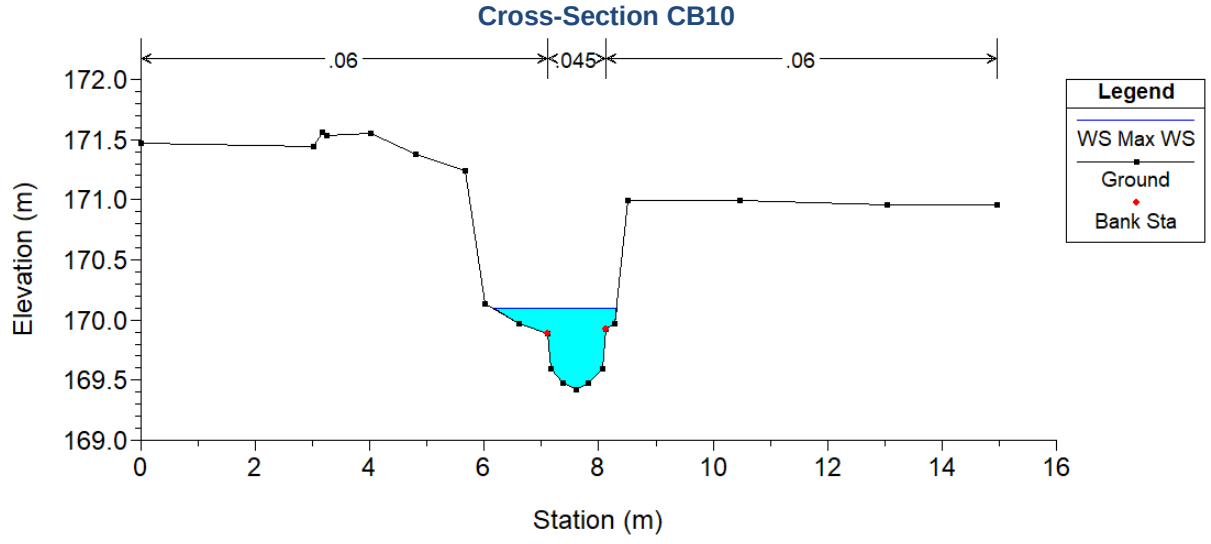
171.0
170.5
170.0
169.5
6
8
10
12
14
16
18
20


Cross-Section CB10
.06
045
.06
Legend
WS Max WS
Ground
Bank Sta
Elevation (m)
Station (m)
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171.5
171.0
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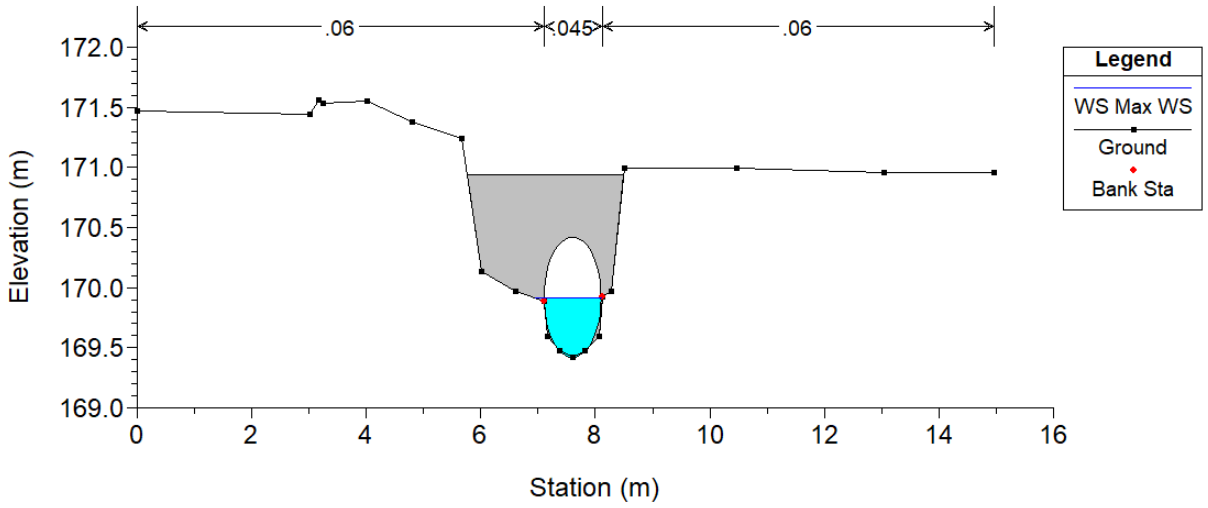
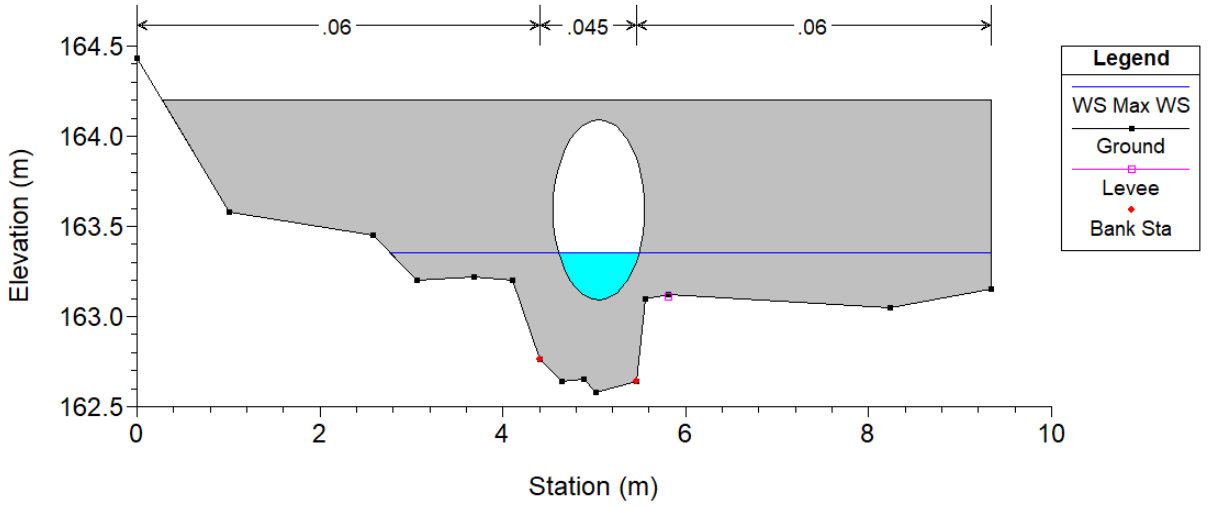
14
16

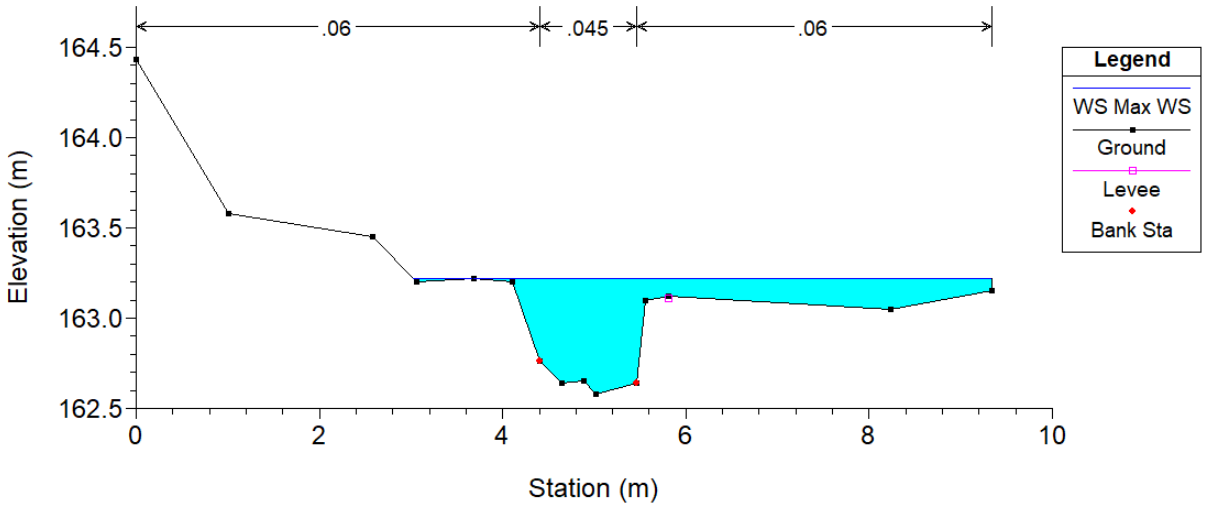
Cross-Section Culvert Beneath Caravan Park Upstream

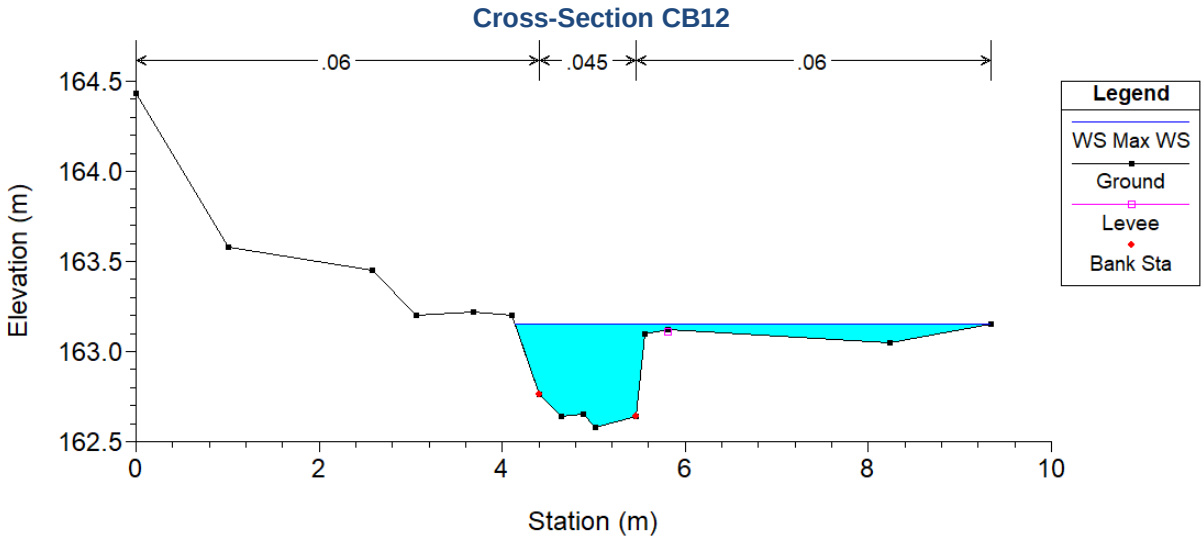


Cross-Section Culvert Beneath Caravan Park Downstream



Cross-Section CB11




Cross-Section CB12
.06
.045
.06
164.5
164.0
163.5
163.0
162.5
Elevation (m)
0
2
4
6
8
10
Station (m)
Legend
WS Max WS
Ground
Levee
Bank Sta