Skirting Beck and Whangs Beck

Flood Risk Assessment

IMNW000818-VBA-XX-4ZZ-RP-HY-0001

January 2019

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Document history

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Contents

Introduction

Purpose of this report

The Environment Agency (EA) are proposing works to alleviate flood risk in the town of Egremont, Cumbria including various engineered solutions as part of the Skirting Beck and Whangs Beck Flood Alleviation Scheme (hereafter referred to as 'the Scheme').

This report summarises the assessment of flood risk for the Scheme. It presents the findings of the assessment of flood risk to and from the proposed Scheme and provides an appraisal of the Scheme. In preparing this report, the following tasks have been undertaken:

- An overview of the proposed flood alleviation scheme;
- A review of existing data and information related to flooding;
- An appraisal of the existing flood risk in the study area;
- An appraisal of the flood risk following the completion of the proposed Scheme; and
- Where necessary an appraisal of the proposed measures to reduce any residual flood risk to acceptable levels.

The Scheme includes various measures at a number of locations including the creation of new flood storage areas. The Scheme also includes for other measures including SUDS, culvert works, highways works and property level protection which are not subject to the application for full planning permission to which this report relates.

Background

Egremont was subject to severe flood events in 1999, 2009, and 2012 and has been subject to several smaller instances of flooding over the years. Following the 2009 event, the Environment Agency commissioned a study to better understand the mechanisms of flood risk within the catchment. Previous studies had considered fluvial and sewer flooding as separate issues. To fully understand the interactions between the fluvial and sewer systems, an integrated catchment model was built which allowed for interactions between the two systems and overland flow to be fully represented. The modelling found that flood risk in the catchment was due to capacity of the sewer system and culverted watercourses being exceeded during high magnitude events.

VBA initially modelled potential alleviation options which were then further developed by Capita for detailed design and economic assessment. The standard of protection required from the Scheme was a 1 in 30 year for surface water and 1 in 100 year plus climate change (2070 - 2115 epoch) for fluvial flooding. Further details of the climate change approach can be found in the "Flood Risk due to Climate Change" section of this report.

National Planning Policy Framework

This Assessment has been carried out in accordance with the National Planning Policy Framework (NPPF)[1] and accompanying guidance. As part of the planning process, the NPPF requires that all proposed development sites which are more than 1 hectare in area, lie within Flood Zones 2 or 3, or have critical drainage problems must be accompanied by a Flood Risk Assessment (FRA). Environment Agency flood maps have been reviewed and show that the Site lies within Flood Zone 3 and therefore requires an FRA as part of the planning application process.

The broad aim of the NPPF is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, Local Planning Authorities are required to ensure that flood risk is properly assessed during the initial planning stages of any development.

Responsibility for this assessment lies with developers and they must demonstrate the following:

- Whether the proposed development is likely to be affected by flooding;
- Whether the proposed development will increase flood risk to adjacent properties; and
- That the measures proposed to deal with any flood risk are sustainable.

The developer must demonstrate to the Local Planning Authority (LPA) and the Environment Agency (EA) that the existing flood risk or the flood risk associated with the proposed development can be satisfactorily managed.

The proposed Scheme lies within Flood Zone 3 and is classed as 'Water Compatible' as all elements are classified as Flood Control Infrastructure. The classification is based on Table 2: Flood Risk Vulnerability Classification, within the NPPF Technical Guidance. The proposed flood defence alignment lies within Flood Zone 3a (High Probability).

Based on the flood zone and vulnerability classification, the appropriateness of the proposed Scheme was assessed according to Table 3: Flood Risk Vulnerability and Flood Zone 'Compatibility' within NPPF Technical Guidance. This is shown in, which highlights the cell showing the suitability of the Site.

[1] National Planning Policy Framework and Technical Guidance to the National Planning Policy Framework, both July 2018

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone1 Low Probability	✓	✓	✓	✓	✓
	Zone2 Medium Probability	✓	✓	Exception Test required	✓	✓
	Zone 3a High Probability	Exception Test required	✓ Proposed Site	*x*	Exception Test required	✓
	Zone 3b 'Functional Floodplain'	Exception Test required	*x*	*x*	*x*	*x*
✓ Development is appropriate x Development should not be permitted						

Table 1: Appropriate Development for each Flood Zone

Sequential and Exception Test

The NPPF states that the Sequential Test should be carried out when allocating land for development to demonstrate that there are no sites available for development in areas that are at a lower risk from flooding from all sources. In this instance the proposed development is classified as Flood Control Infrastructure for Skirting Beck and Whangs Beck and therefore, as implied by its function, cannot be relocated to an area of lower flood risk.

Based on the suitability of this proposed development as shown in Table 1, no Exception Test will be required.

Flood Risk Definition

Flood risk includes the statistical probability of an event occurring and the scale of the potential consequences. The risk is estimated from historical data and expressed in terms of the expected frequency (or 'return period') of a flood of a given magnitude. The 10-year, 50-year and the 100-year floods have a respective 10%, 2% and 1% chance of occurring in any given year (this is termed the Annual Exceedance Probability [AEP]), however, over a longer period the probability of flooding is considerably greater. For example, for the 100-year return period flood:

- There is a 1% chance of the 100-year flood occurring or being exceeded in any year.
- A 26% chance of it occurring or being exceeded in a 30-year period.
- A 51% chance of it occurring or being exceeded in a 70-year period.

Table 2 provides a summary of the relevant AEP and corresponding return periods.

AEP (%)	Return period (years)
50%	2
10%	10
5%	20
4%	25
2%	50
1%	100
0.5%	200
0.1%	1,000

Table 2: Definition of AEP and 'return period' flood events

Site Description

Study Area

The proposed Skirting Beck and Whangs Beck Flood Alleviation Scheme is located in the town of Egremont, Copeland, Cumbria. Egremont is approximately 8 kilometres south of Whitehaven and 10 kilometres north of the village of Seascale. There are two watercourses within the study area which are Whangs Beck and Skirting Beck. Skirting Beck flows from the north west at How Bank Farm, through the urban area of Egremont, before discharging into the River Ehen downstream of Egremont Bridge. Whangs Beck originally flowed from west (from the culvert inlet at “The Oaks”) to the east, joining Skirting Beck in West Lakes Academy playing fields. This flow route still exists but the majority of the flow has been diverted south via culvert through the Orgill estate and Ashley Grove farm before discharging into the River Ehen to the east. Both watercourses are open channel in the upstream reaches before entering culvert as they flow toward the urban area of Egremont. There are open channel reaches on Skirting Beck both within and immediately downstream of the Falcon Club/West Lakes Academy playing fields. The watercourse is then culverted to a short reach of open channel just upstream of its confluence with the River Ehen.

The fluvial and surface water systems within Egremont are connected. Surface water sewers discharge into Skirting Beck and Whangs Beck culverts, and water can also back up into the sewers from theses culverts. Flooding and overland flow can occur at culvert inlets, manholes, and over bank flow. Overland flow can drain back into the system through road gullies or open channel sections.

There are no known existing flood defences within the study area.

The Scheme will alleviate flooding in Egremont through a combination of upstream storage, upsizing of existing culverts, SUDS, and individual property level protection. The main development of the proposed Scheme consists of four online storage areas which will store flood waters during storm events and reduce flood risk downstream. The storage will be created by constructing embankments or walls and limiting outflow from these areas with a control structure. The storage areas will begin to drain down once there is sufficient capacity within the system. The locations of these storage areas are shown on Figure 1 below.

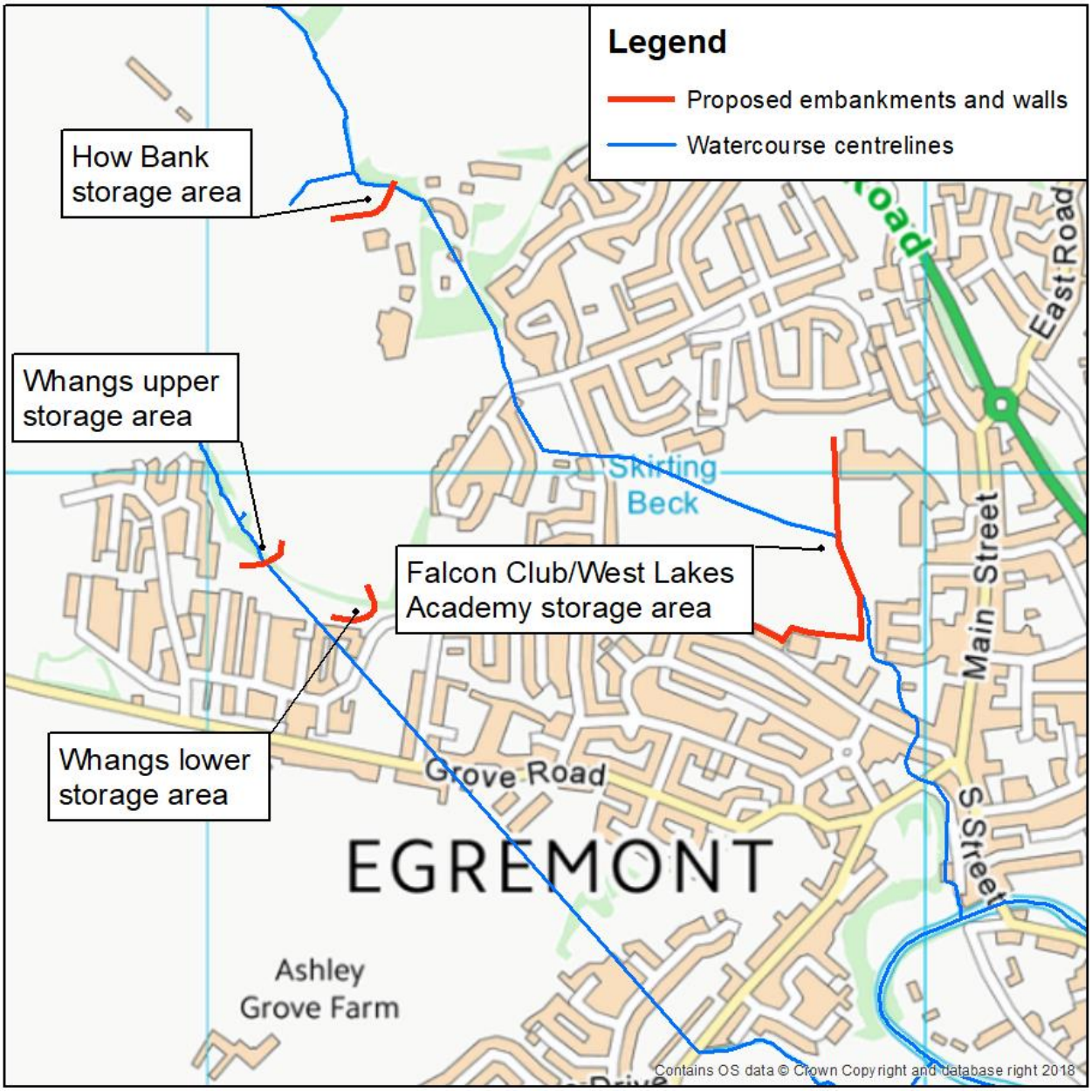

Figure 1: Site location plan

Proposed Development

The proposed Skirting Beck and Whangs Beck Flood Alleviation Scheme comprises the following packages of work:

- Site 1: Flood storage area at How Bank Farm upstream of Egremont comprising an embankment elevation of 68.5 mAOD, providing approximately 10,000 m3 of flood storage.
- Site 2: Two connected flood storage areas along Whangs Beck, comprising two embankments (upper and lower). Upper storage area will provide 6,000 m3 with an embankment elevation of 78.8 mAOD. The lower storage area will provide 4,500 m3 of flood storage with an embankment elevation of 70.62 mAOD. Work at Site 2 also includes abandonment of an approximate 180 metre length of culverted watercourse, and like-for-like replacement of existing culvert over small sections.
- Site 3: Flood storage area at West Lakes Academy (WLA) and Falcon Club sports ground comprising walls and embankments ranging in height to a maximum of 1.5 metres providing approximately 30,000 m^3 of flood storage.
- Also includes regrading of existing open channel along northern edge of WLA playing fields and creation of a new open channel section of Skirting Beck along the Eastern boundary, including construction of a new headwall and culverted connection to the existing open river channel. Both fields will be regraded; the north field to 1:150, falling north to south and the southern field at 1:100, falling west to east.
- Site Compound: A site compound will be constructed at the former Orgill Primary School Site south of Chaucer Avenue.

Each of the proposed storage areas has an outfall structure to limit pass forward flow and create storage upstream, and a spillway which will pass forward flow in a controlled way once the capacity of the storage area is exceeded. The storage areas have been designed such that no overtopping will occur during the 1 in 100 year plus climate change (2070 - 2115 epoch) event, with the exception of Whangs Beck upper storage area which will pass forward flow into the lower storage area downstream. The storage areas and works are outlined above and are shown on Figure 2.

Other works that form part of the Scheme but are not subject to the application for full planning permission include:

- Culvert works along Skirting Beck (Chaucer Avenue to Croadalla Avenue/WLA) to increase capacity;
- SUDS at various locations across Egremont;
- Highway works at various locations across Egremont, including raising curbs and construction of dwarf walls to manage any flood/surface water flow along highways and away from properties; and
- Property resilience measures to homes in the Church View area adjacent to the school playing fields and at various locations across Egremont.

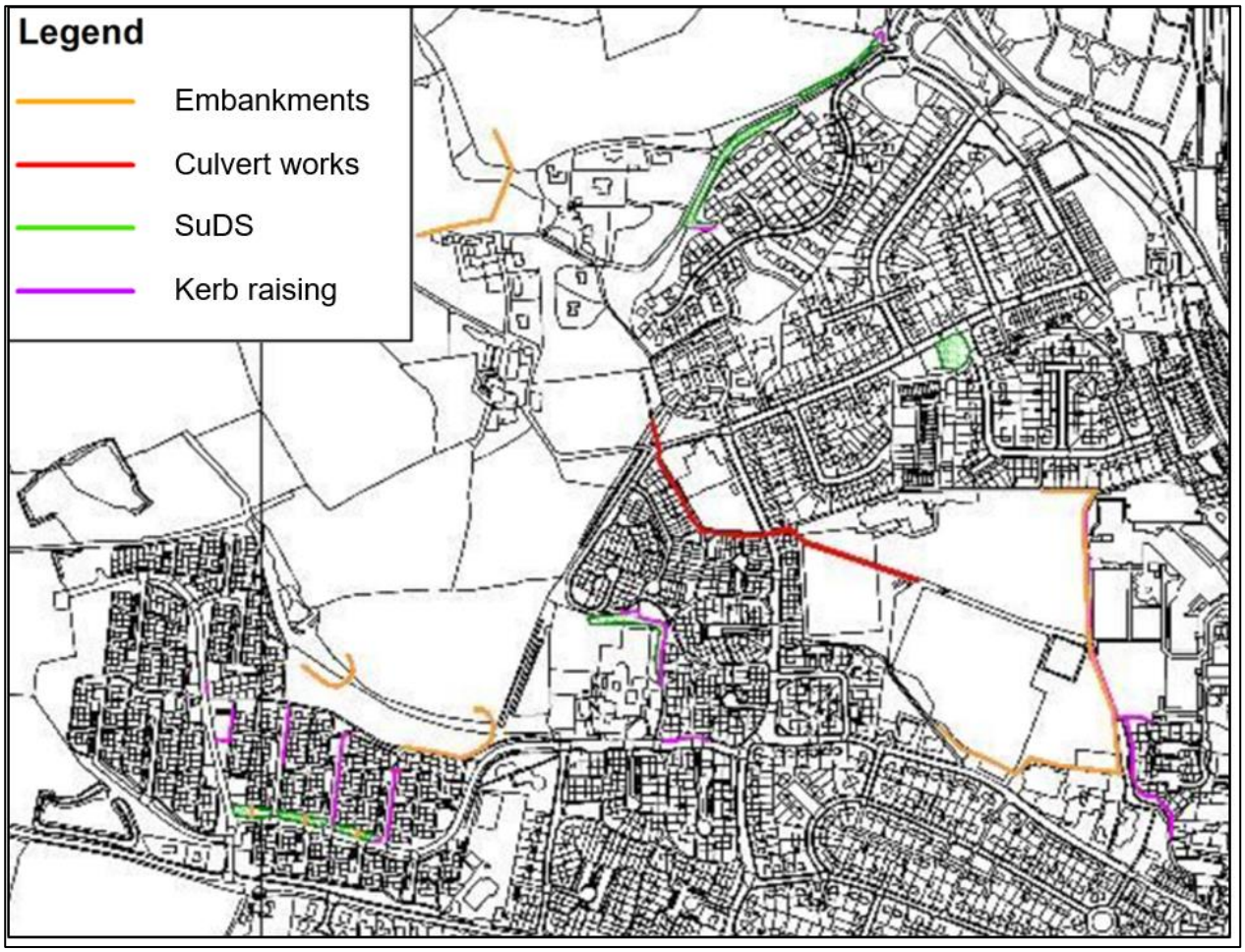

Figure 2: Skirting Beck FAS elements

Existing Flood Defences

There are currently no formal flood defences on Whangs Beck or Skirting Beck. There are linear defences on the River Ehen which protect the downstream extent of the catchment but these are not considered within this study.

Topography

The study area generally slopes from north to south. The catchment is steep with a general slope of 1 in 50. The catchment topography is shown on Figure 3.

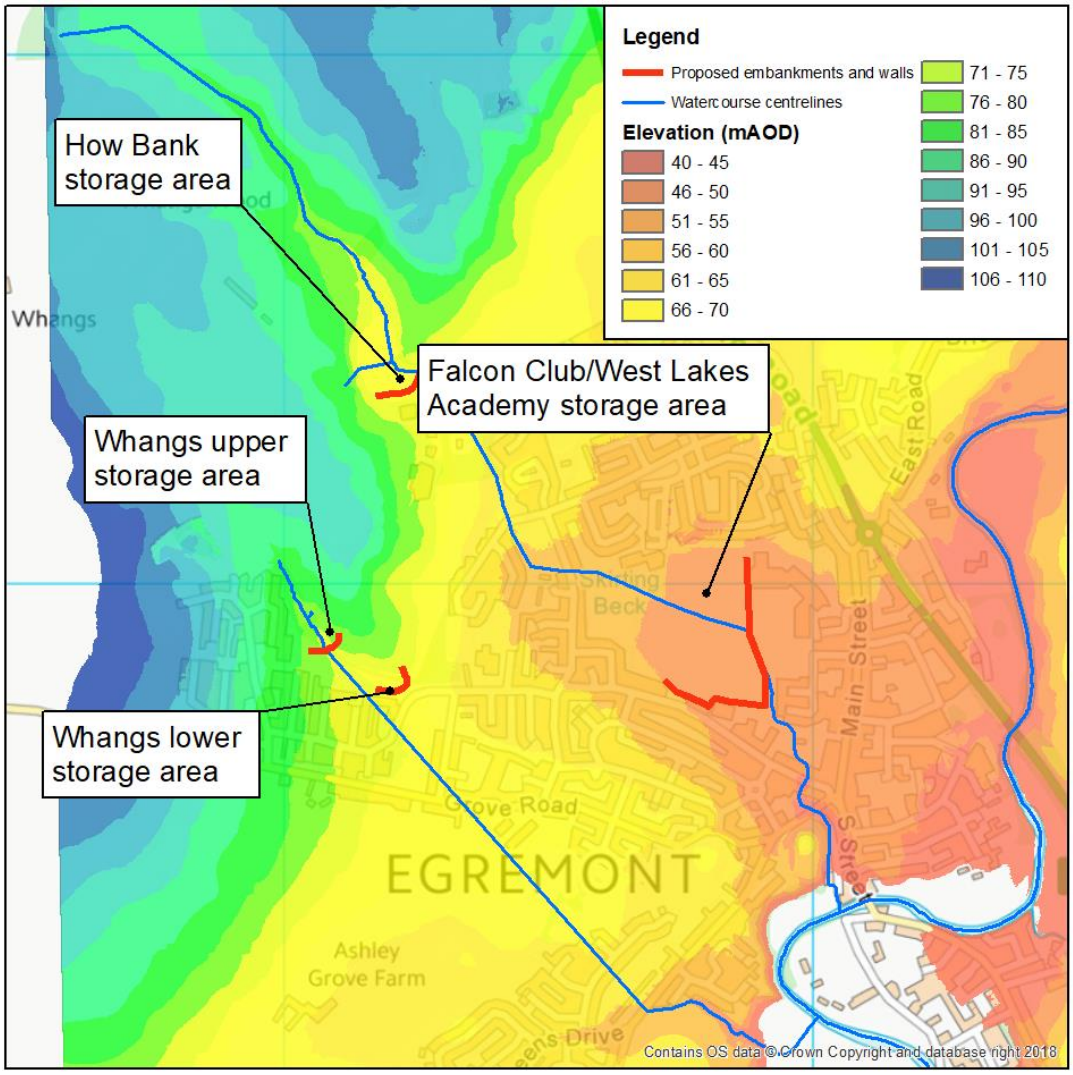

Figure 3: Skirting and Whangs Beck catchment topography

Geology

A geotechnical desk study of the site was undertaken using readily available information from online sources, published data and historical information. The British Geological Survey (BGS) viewer indicates that the How Bank and Falcon Club/West Lakes Academy storage areas are underlain with superficial deposits of Alluvium comprising of clay, silt, sand and gravel. The Whangs Beck storage areas are underlain with a mix of devensian till and glaciofluvial deposits of sand and gravel.

The bedrock which underlies the superficial deposits at the How Bank and Falcon Club/West Lakes Academy storage areas is the Frizington Limestone Formation. This formation is described by the BGS as sedimentary bedrock which '*are shallow-marine in origin'*. They are biogenic and detrital, generally comprising carbonate material (coral, shell fragments), forming beds and reefs. The Whangs Beck storage areas are underlain with Brockram which is described as sedimentary rock which is fluvial in origin. They are detrital, ranging from coarse- to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary

Historical boreholes indicate that the depth to bedrock is approximately 200 metres below ground level.

Assessment of Existing Flood Risk

Copeland Strategic Flood Risk Assessment

Historical flooding is considered as part of the Copeland Strategic Flood Risk Assessment (SFRA) which was published in 2007. The document identifies the following flooding incidents within the vicinity of the site:

- In 1999 a prolonged intense storm flooded 150 properties in Whitehaven and 30 properties in Egremont respectively; and
- Within Egremont (on the banks Skirting Beck) flooding was observed during three consecutive winters (1999- 2001). Out of a total of 150 properties at risk, 25 were affected during these events

The source of flooding is identified as blockage of culverts, culvert capacity issues, and changing land use from farmland to residential, increasing surface water runoff. The document also identifies that the nature of flooding (in which the flood waters are both fast flowing and deep) and the urban setting could pose a risk to life.

South West Lakes Catchment Flood Management Plan

The South West Lakes Catchment Flood Management Plan (CFMP) area has been divided into nine distinct sub areas that have similar physical characteristics, sources of flooding and levels of risk. These sub areas will allow the Environment Agency and the Local Authority to promote flood risk management approaches, policies and actions that are most appropriate to deliver the various Government and regional strategies.

The site falls within the Egremont sub area. The vision and preferred flood risk management policy is Policy Option 5. Policy Option 5 applies to areas of moderate to high flood risk where further action can be taken to reduce flood risk.

Review of November 2009 Flooding in Cumbria (River Ehen Catchment)

Exceptional weather in November 2009 led to extensive flooding within Cumbria. The report considers the rarity (frequency or return period) of the river flows associated with the November 2009 flood event at key locations in the River Ehen catchment, but also includes a brief section on flood history.

The report notes that much of the flooding issues experienced in the centre of Egremont was due to channel and culvert capacity issues which is exacerbated at the downstream extent by the backwater effects of the River Ehen. It is noted that previous flooding has occurred many times in the past but the severity, depths, extents of locations of these floods are not detailed.

Flooding from Rivers and Surface Water

EA Flood Map

The Flood Map published by the Environment Agency contains Flood Zones for use in accordance with the NPPF. The Flood Zones represent the risk of flooding from rivers and the sea. Flood Zone 2 delineates an extreme flood outline from both the sea and rivers and is considered to represent a 0.1% probability (1,000 year) flood event. Flood Zone 3 represents flooding from rivers with a 1% probability of flooding (100 year) occurring in any given year and with a 0.5% probability of flooding (200 year) from the sea occurring in any given year. Both delineated flood outlines illustrate flood extent without either fluvial or coastal flood defences.

The Flood Map of the study area shows that a significant area of the town is within Flood Zone 3: High Probability of Flooding. The EA Flood Zone extents are shown on Figure 4.

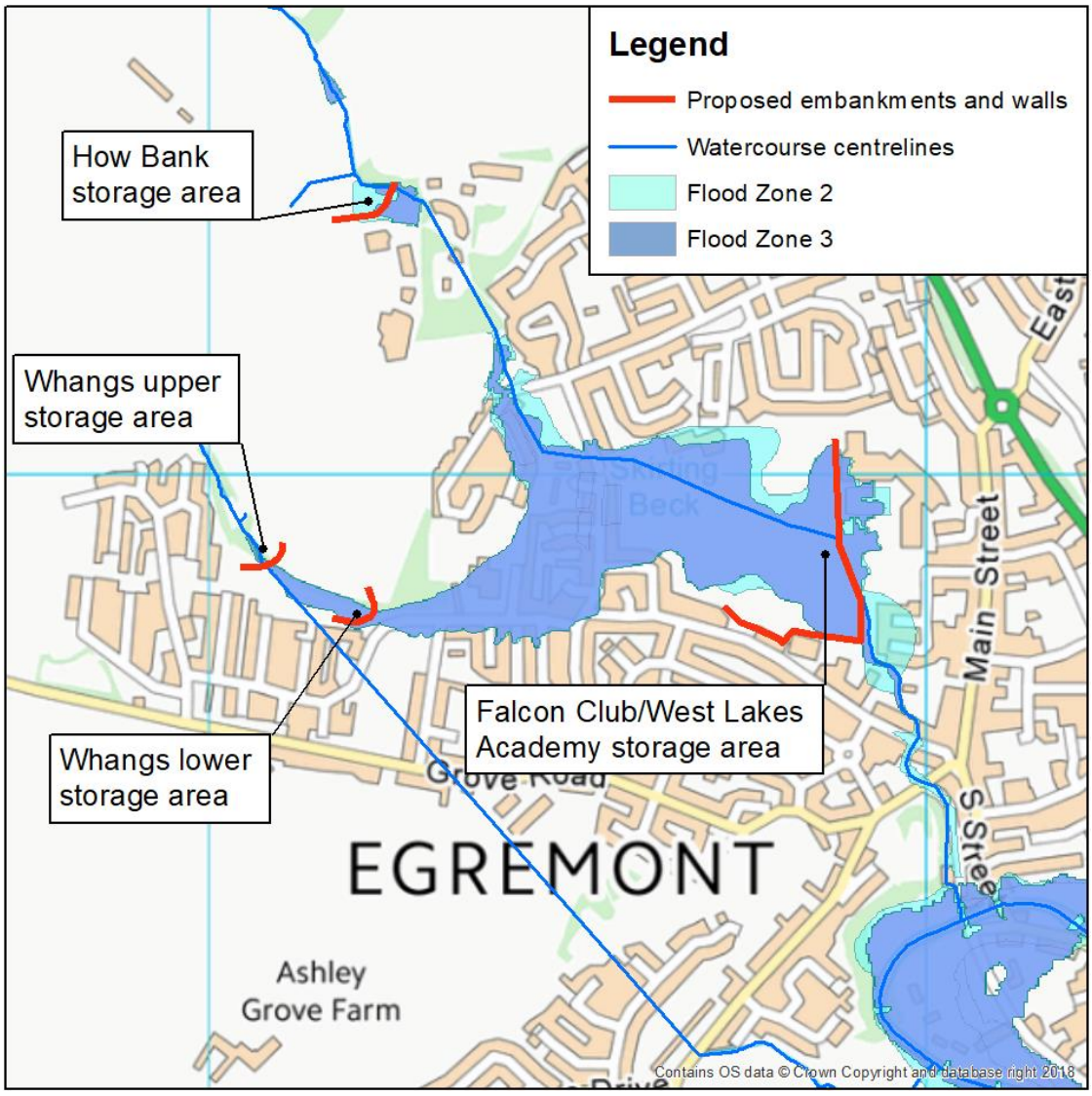

Figure 4: EA Flood Map for Planning

EA Surface Water Flood Risk Map

The surface water flood risk map shows that there are parts of the study area within the surface water flood risk zones and are at either medium or high risk. Medium risk of flooding means that each year this area has a 1% to 3.3% chance of flooding. High risk means that each year this area has a chance of flooding of greater than 3.3%. The EA surface water flood risk map is shown on Figure 5.

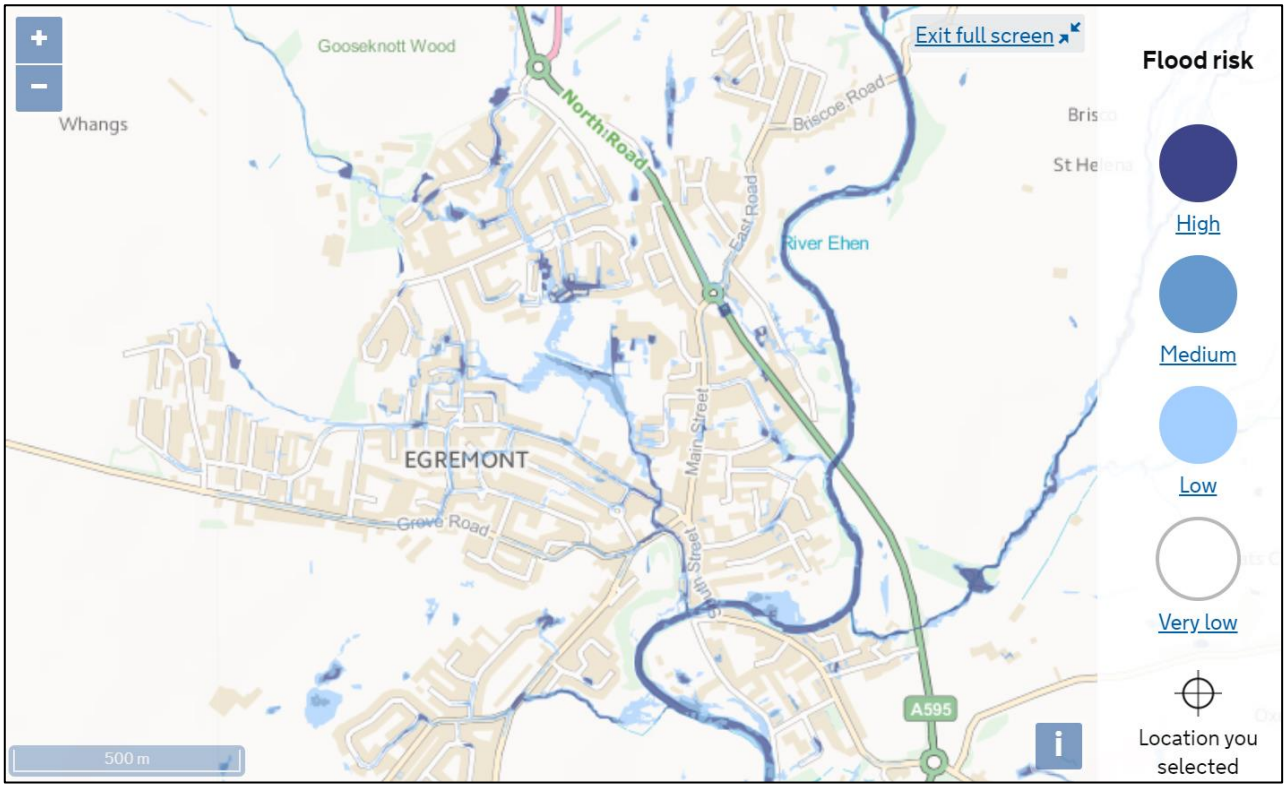

Figure 5: Surface Water Flood Risk Map (Source: Environment Agency website, 2019)

Capita Integrated Catchment Modelling – Fluvial and Surface Water Flooding

Within Egremont both the fluvial and surface water systems are interconnected with surface water sewers discharging into the fluvial system at various locations. Out of bank fluvial flood flows can drain back into the surface water network through gullies and manholes. The integrated catchment model represents this interaction. The flood map shown on Figure 7 shows the existing 1 in 100 year plus climate change (2070 - 2115 epoch) peak flood extent derived from the integrated catchment model. Figure 6 shows a basic schematisation of the integrated catchment model including the sewers, culverts, open channels and manholes modelled.

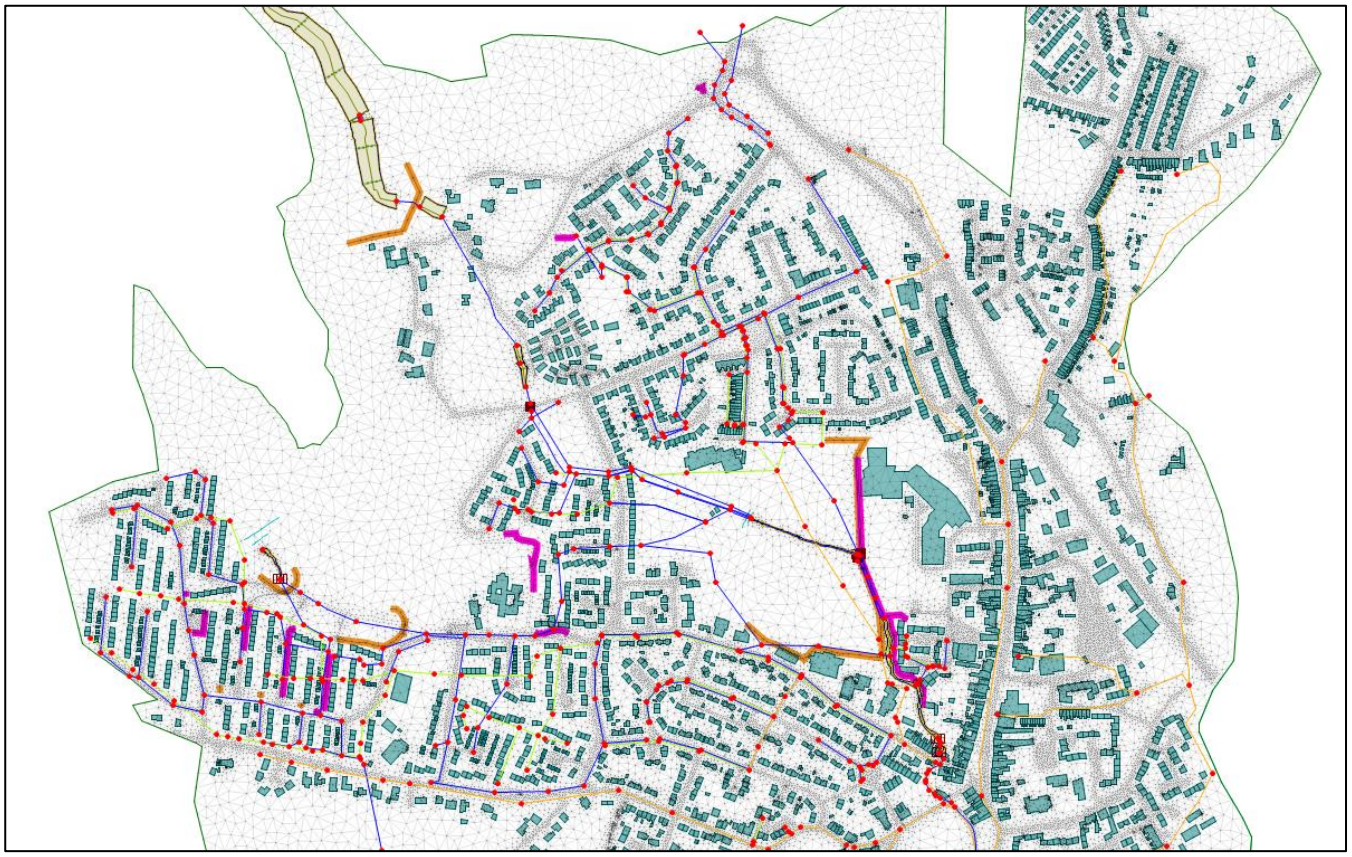

Figure 6: Capita integrated catchment model schematic

The detailed modelling showed that there is significant flood risk to the town of Egremont. The modelling includes representation of both the fluvial, sewer, and surface water flooding. The main sources of flooding are from overtopping of Whangs Beck and Skirting Beck, culvert capacity issues, surface water sewer capacity issues, and surface water flooding. The current onset of flooding is a 1 in 5 year event. Table 3 shows the number of properties at risk for several return periods from the Capita analysis.

The Capita reporting identifies that to reduce flood risk in Egremont improvements to both the fluvial and surface water network would be required. This is because there would still be significant residual flood risk from the surface water network if only flood risk from the fluvial network was addressed.

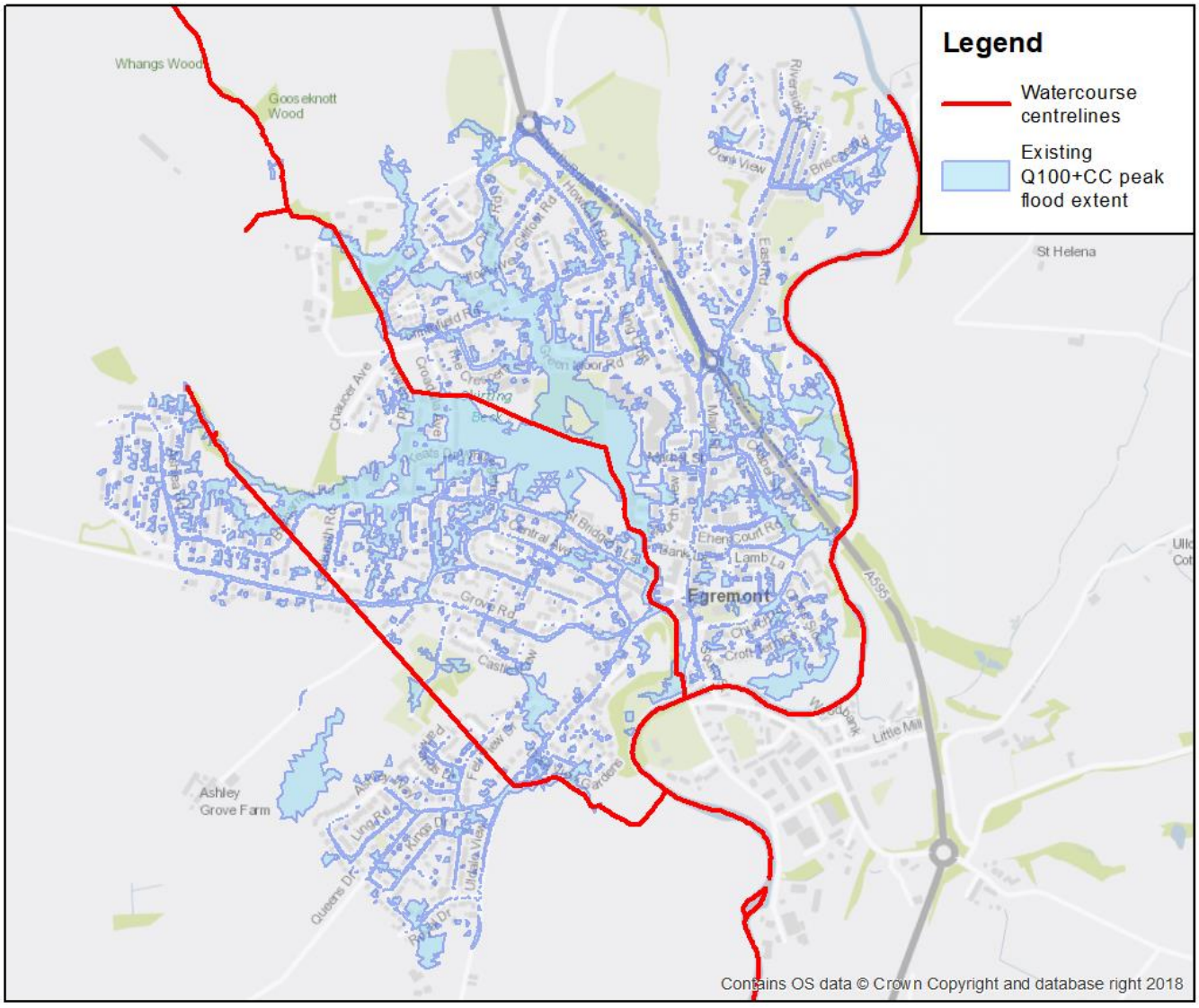

Figure 7: 1 in 100 year plus climate change (2070 - 2115 epoch) peak flood extent – Capita modelling

Groundwater Flooding

Detailed data used to determine the nature of groundwater flooding within the catchment was not available for this study. However, the area is not identified as an area with significant flood risk to groundwater in the Copeland SFRA.

The susceptibility of the sites to groundwater flooding is unknown, although there are no historic records of groundwater flooding and it has not been considered as an issue in the Copeland SFRA. Previous flood studies have not identified groundwater flooding as a source of flood risk.

Prolonged periods of rainfall in the surrounding catchment can lead to an increase in groundwater levels and contribute to groundwater flooding. At the downstream extent of the catchment the groundwater is likely to be in hydraulic continuity with the River Ehen, however all the proposed development sites are located much further upstream and are located on much higher ground.

It is difficult to confirm the possible extent of groundwater flooding within this area without understanding the local processes and undertaking groundwater monitoring. Generally the development sites are located on the watercourses and on steep ground, so it is unlikely that they would be affected by groundwater flooding. The Falcon Club/West Lakes Academy site is located on flatter ground. Site investigation works are currently being undertaken in the area which will better inform the potential risk of groundwater flooding within the study area.

Flooding from Reservoirs, Canals and other Artificial Sources

There are no known reservoirs, canals or other artificial sources within proximity to the study area and therefore flood risk is not influenced by these factors.

Failure of Flood Defence Infrastructure

There are currently no formal flood defences on Whangs Beck and Skirting Beck. There are linear defences on the River Ehen which protect the downstream extent of the catchment but are not considered within this study.

Flood Risk Due to Climate Change

Climate change is expected to have a major influence on future flood risk. The expectations are that winter floods will happen more often and in urban areas flooding from thunderstorms will be more frequent and of increased magnitude.

The Environment Agency Flood Map for planning does not currently take account of future climate change. NPPF advises that the effects of climate change at a regional level are likely to be an increase in peak river flows and rainfall intensities and these impacts should be considered in the preparation of site specific FRAs.

VBA initially modelled potential alleviation options which were then further developed by Capita for detailed design and economic assessment. The standard of protection required from the Scheme was a 1 in 30 year for surface water flooding and 1 in 100 year plus climate change (2070 - 2115 epoch) for fluvial flooding. Further guidance on Environment Agency climate change allowances can be found at "https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances". Section 5 of the Capita modelling Report (Skirting and Whangs Beck FRMS 2016/17. Modelling Report draft May 2017) provides details of the climate change uplifts used on the hydrological inflows into the model. It must be noted that this model is primarily a 'direct rainfall' model and as such, the climate change uplift associated with epoch (2070 - 2115) reflects this. To account for the increase in rainfall intensity, the central estimate for increased rainfall intensity was used. An increase in rainfall intensity of 20% had been applied as per Table 2 of the Environment Agency published guidance on climate change.

The proposed scheme provides a standard of protection (SoP) of 1 in 30 year for surface water and 1 in 100 year event for fluvial flooding with allowance for climate change (2070 - 2115 epoch).

Assessment of Flood risk with Scheme

Flooding from Rivers and Surface Water

The detailed Capita modelling shows that there is significant flood risk to the Town of Egremont. The main sources of flooding are from overtopping of Whangs Beck and Skirting Beck, culvert capacity issues, sewer capacity issues, and surface water flooding. The proposed scheme manages flood risk through a combination of storage areas, culvert upsizing, SUDS, and kerb raising options. It must be noted that the scheme has no specific proposals to address surface water capacity issues on the surface water network. The scheme as a whole provides an SOP of 1 in 30 year for surface water and 1 in 100 year for fluvial flooding plus climate change (2070 - 2115 epoch). Where residual flood risk remains individual property level protection is recommended.

The scheme reduces flood risk to a significant number or properties. A comparison of the current number of properties at risk and the number of properties benefitting from the proposed scheme are shown in Table 3 below.

	Existing Properties at Risk			Post Scheme Properties at Risk			Number of properties benefitting from scheme
Event	Residential	Commercial	Total	Residential	Commercial	Total	
5	111	32	143	1	15	16	127
10	127	33	160	2	16	18	142
20	144	35	179	2	18	20	159
50	166	40	206	2	21	23	183
75	173	42	215	2	21	23	192
100	180	42	222	6	21	27	195
200	189	43	232	13	22	35	197
1000	237	51	288	113	44	157	131

Table 3: Existing and post scheme properties at risk comparison

In general, the proposed scheme reduces flood levels when compared to existing water levels. In certain locations there is an increase in water level or depth, but these increases are located within the storage areas or within SUDS areas and do not increase flood risk to any key receptors. Figure 8 and Table 4 show the existing and post scheme flood levels at several locations across the study area for the 1 in 100 year plus climate change (2070 - 2115 epoch) flood event. Figure 8 also shows the existing and with scheme peak flood extents.

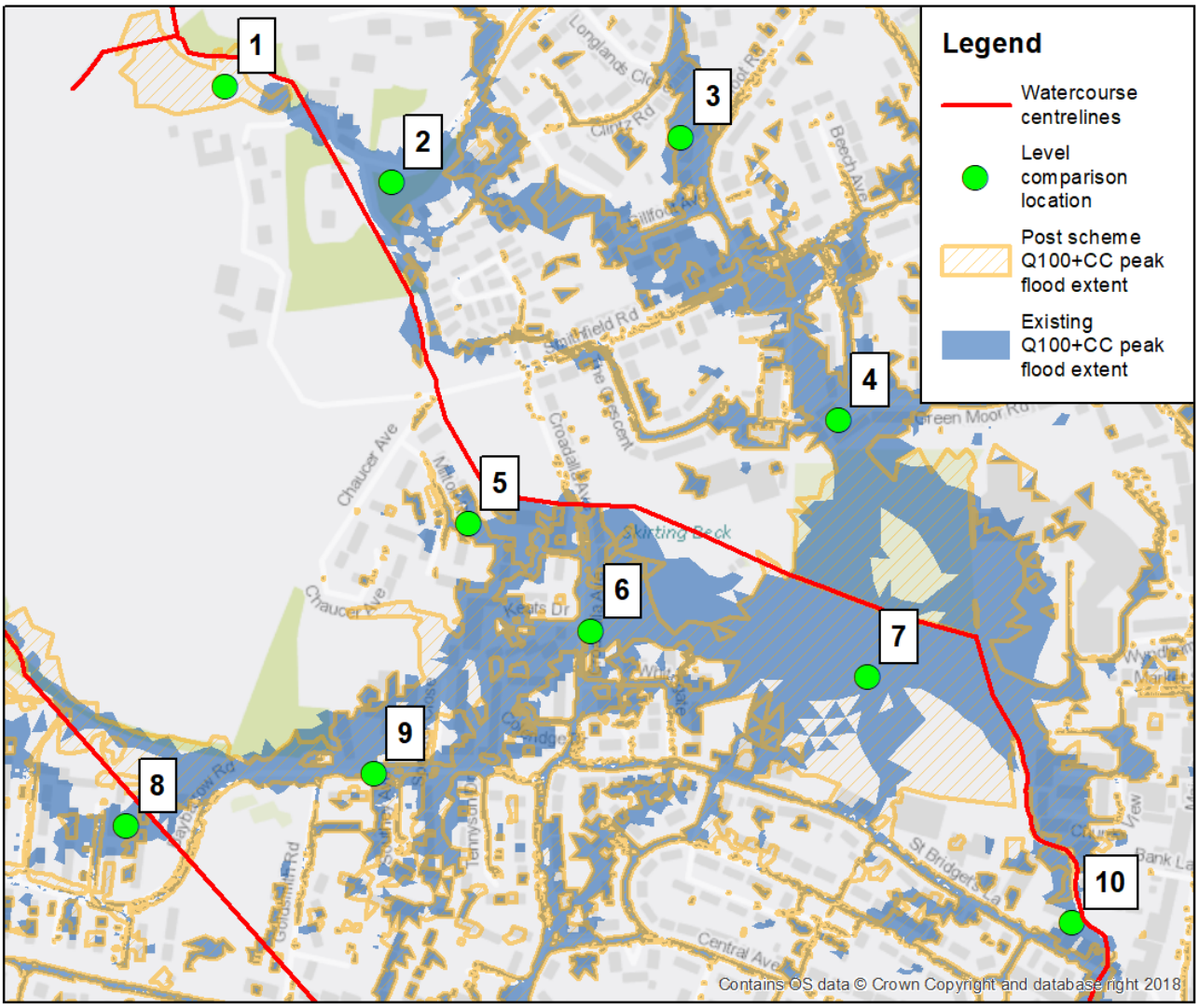

Figure 8: Existing and post scheme peak flood level comparison locations

Location	Existing Peak Flood Level (mAOD)	Post scheme Peak Flood Level (mAOD)	Difference (m)	Notes
1	0	67.65	N/A	No existing flood level - within proposed How Bank storage area.
2	60.11	0	N/A	No post scheme flood level, flow now stored in How Bank storage area.
3	56.24	56.214	-0.02	Reduction in peak flood level
4	50.21	50.19	-0.02	Reduction in peak flood level
5	53.69	53.68	-0.01	Reduction in peak flood level
6	52.62	52.5	-0.13	Reduction in peak flood level
7	48.87	49.71	0.84	Increase in peak flood level due to creation of West Lakes Academy & Falcon storage. Increased level does not increase flood risk to any receptors.
8	71.71	0	N/A	No post scheme flood level, flow now routed down roads by kerb raising
9	57.72	57.70	-0.06	Reduction in peak flood level
10	47.40	0	N/A	No post scheme flood level, flow now stored in West Lakes Academy & Falcon storage area.

Table 4: Existing and post scheme peak flood level comparison

The complex interaction between surface water and fluvial flood risk in the catchment means that flood storage provision alone is insufficient to provide an effective flood risk management solution. The flood storage provision within the catchment acts to attenuate flood flow and reduce the pass forward flow into the downstream fluvial and surface water system. This acts to alleviate current capacity issues within the fluvial and surface water system. The capacity issues are further alleviated with the addition of several SUDS schemes at key locations which reduce inflow into the system.

With the addition of culvert upsizing and several SUDS schemes at key locations within the catchment, the overall scheme provides most of the properties at risk within Egremont with a 1 in 30 year SoP for surface water flooding and a 1 in 100 year plus climate change (2070 -2115 epoch) SoP for fluvial flooding. It must be noted that the scheme has no specific proposals to address surface water capacity issues on the surface water network. Where residual flood risk remains above the SoP of the proposed scheme, such as Church View, property level protection will be installed.

Residual Flood Risk

There are areas of residual flood risk within Egremont that remain after implementation of the proposed scheme SoP. These areas have been identified and assessed as benefiting from property level protection using both output from the hydraulic modelling and Capitas consultation with the EA. In some instances, engineering judgement has been made to refine the total number of properties that would benefit from property level protection.

Although residual flood risk measures have been proposed as part of the overall management of flood risk within the Egremont catchment, they do not form part of the application for planning and are being undertaken under permissive development activities.

Conclusions

- The Skirting Beck & Whangs Beck Flood Alleviation Scheme Flood Risk Assessment has been undertaken in accordance with NPPF.
- The Environment Agency flood map shows that the proposed scheme is located within Flood Zone 3.
- The Environment Agency surface water flood risk map shows that there are areas within the catchment which are at high risk from surface water flooding.
- The site is categorised as 'Less Vulnerable' development and in accordance with NPPF, it is an acceptable development in this flood zone.
- Based on the suitability of this proposed development, no Exception Test will be required and there are no suitable alternative locations for the proposed flood control infrastructure.
- The flood storage provision within the catchment acts to attenuate flood flow and reduce the pass forward flow into the downstream fluvial and surface water system. This acts to alleviate current capacity issues within the fluvial and surface water system. The capacity issues are further alleviated with the addition of several SUDS schemes at key locations which reduce inflow into the system.
- The complex interaction between surface water and fluvial flood risk in the catchment means that flood storage provision alone is insufficient to provide an effective flood risk management solution and a 1 in 100 year plus climate change (2070 - 2115 epoch) SoP for fluvial flooding and 1 in 30 year for surface water flooding. To provide this SoP to the whole of Egremont other works such as culvert upsizing, SUDS, kerb raising, and individual property level protection are required. These additional works are being undertaken under permissive development activities. It must be noted that the scheme has no specific proposals to address surface water capacity issues on the surface water network.
- The scheme does not increase flood risk to property or critical infrastructure.
- All properties at risk of flooding in Egremont will be protected by the proposed scheme for the 1 in 100 year plus climate change (2070 - 2115 epoch) for fluvial flooding and 1 in 30 year for surface water. However, residual flood risk will always remain above and beyond the design SOP of the scheme. It is recommended that further analysis of the modelling study is undertaken to allow for appropriate flood warning areas to be defined.

VBA
Joint Venture Limited