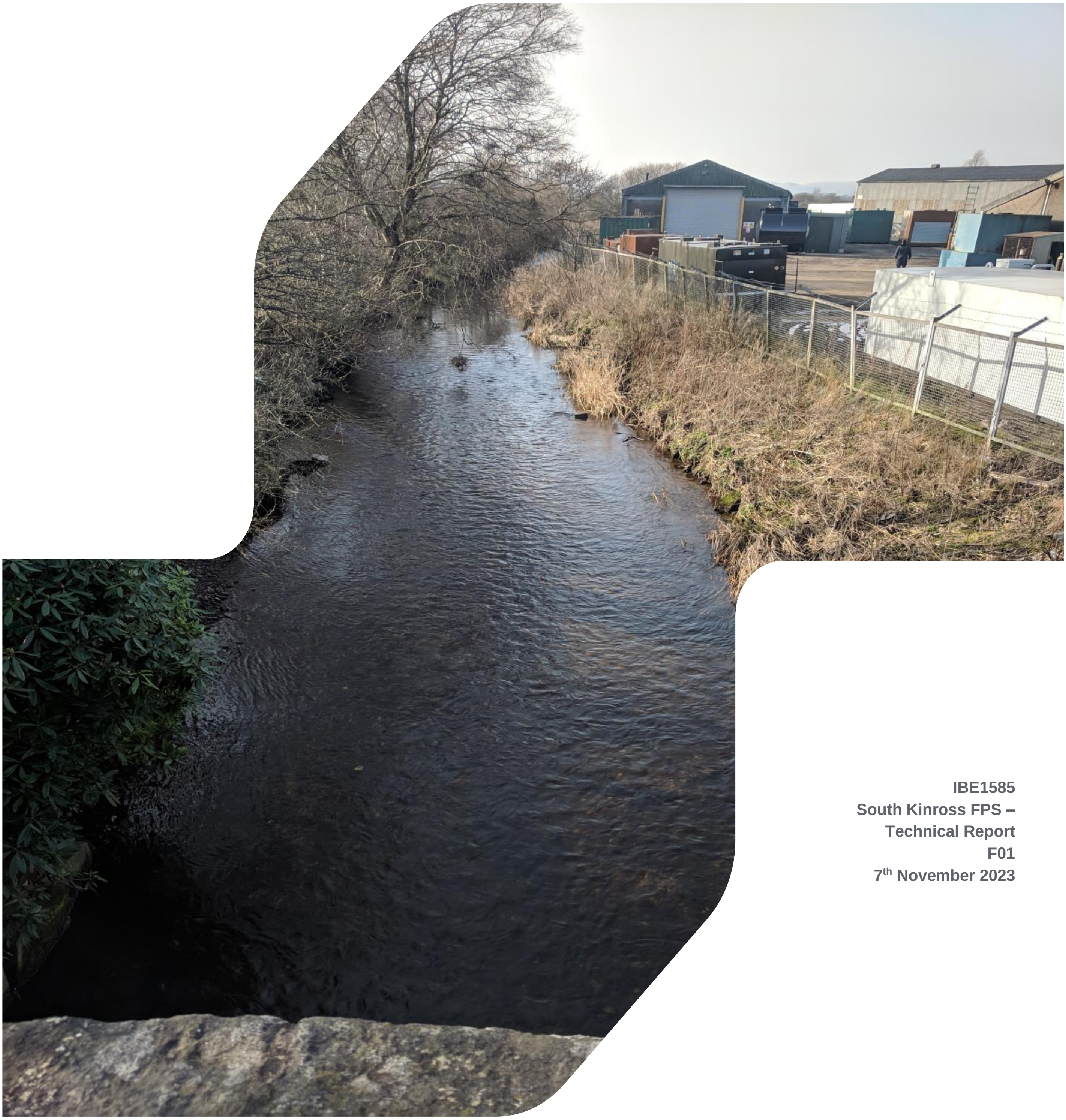
SOUTH KINROSS FLOOD PROTECTION SCHEME

Technical Report



IBE1585
South Kinross FPS –
Technical Report
F01
7th November 2023

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D01	Draft	AMG	SP	AJ	04/05/23
D02	Draft	AMG	AJ	AJ	29/06/23
DF01	Final Draft	AMG	SP	SP	24/08/23
F01	Final	AMG	SP	AJ	07/11/23

Approval for issue

Andrew Jackson	7 November 2023

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1 INTRODUCTION

1.1 Background

Kinross is located within the River Leven catchment and was identified within Potentially Vulnerable Area (PVA) (10/04) in the Forth Estuary Flood Risk Management (FRM) Strategy (December 2015), Forth Estuary Local FRM Plan & Forth Estuary Local FRM Plan (June 2016). Perth & Kinross Council commissioned RPS to undertake the South Kinross Flood Protection Scheme (FPS) in December 2018, to develop, promote and implement a flood protection scheme for South Kinross. A previous Flood Study[1] was carried out by Mouchel in 2010 which forms the basis of the FPS.

Kinross is situated along the west bank of Loch Leven in the south of the Perth and Kinross Council area (Figure 1-1). It is bounded to the west by the M90 motorway, which links Edinburgh with Perth. Fluvial flooding presents the greatest risk of flooding to the area with the majority of calculated damage relating to flooding from the South Queich and Gelly Burn watercourses. Both the South Queich and Clash Burn discharge into Loch Leven. The loch is also a source of flooding with a small number of properties directly at risk from the increasing water levels within the loch during high magnitude flood events.

The aim of this report is to describe; the scheme origins, the development of the scheme and provide a description of the extent and scale of the FPS. This report will also detail the outline design process. This report should be read in conjunction with the Outline Design Drawing package in Appendix F (IBE1585_OD_001 – 002, IBE1585_OD_2000 – 2010, and IBE1585_001-004).

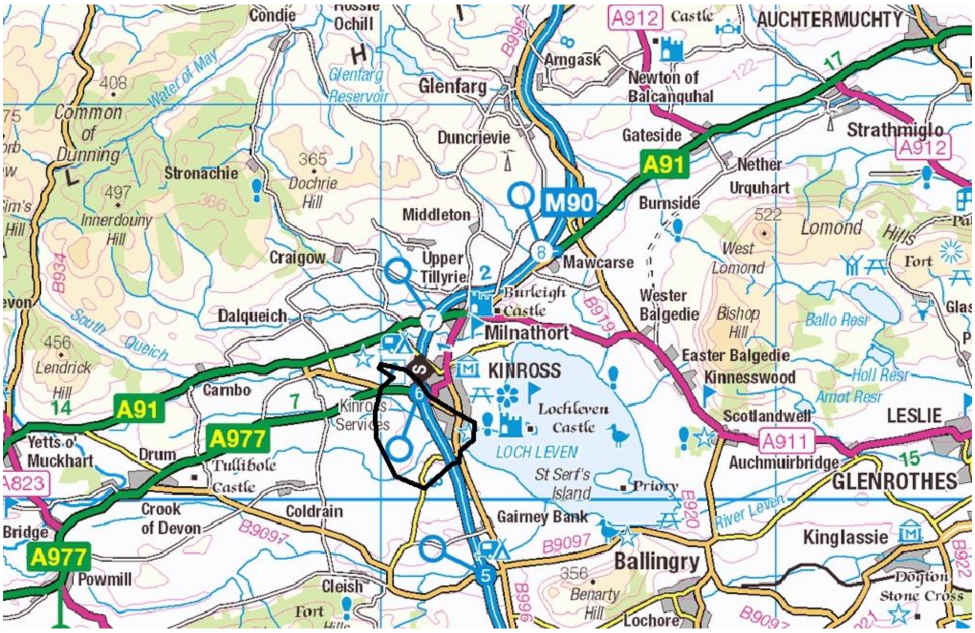

Figure 1-1: Location of Kinross

[1] South Kinross Flood Study, Mouchel, Sept 2010

1.2 Legislative Framework

The Flood Risk Management (Scotland) Act 2009 provides PKC with general powers to manage flood risk in its area and to carry out flood protection work. The South Kinross FPS will be promoted under Part 4 of the Act which enables local authorities to seek permission from the government to implement a flood risk 'scheme' in areas of high flood risk. This Scheme will be published in accordance with the statutory process under the Flood Risk Management (Scotland) Act 2009 and the Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Amendment Regulations 2017 following outline design and consultation with the local community.

The scheme forms part of SEPA's Flood Risk Management Strategy for this PVA and is identified as an action for PKC to deliver in the Forth Estuary Local FRM Plan (Action ID 100110006). The scheme relates to Objective ID 10011 in both The Strategy and Local FRM Plan to "*Reduce economic damages to residential and non-residential properties in the Kinross, Milnathort, Glenrothes and Kinglassie Potentially Vulnerable Area caused by river flooding*."

1.3 Previous Work

Previous studies have investigated the risk of flooding in the South Kinross area. These include reports by Mouchel published in September 2010, a number of biennial flood prevention reports produced by PKC and a report on The Great Flood of January 1993. These reports along with any other available data have been reviewed to help inform the development of the FPS and to highlight potential areas that required further investigation.

1.3.1 South Kinross Flood Study (2010)

Mouchel were commissioned to undertake a Flood Study in South Kinross, to get a better understanding of flooding issues in South Kinross and to explore practical options which may reduce flood risk in the area. Information was collected, collated and reviewed, with consultation with local stakeholders. Following a survey of watercourses, structure and surrounding lands, both hydrological and hydraulic modelling exercises were undertaken. A MIKE model was developed for the study, including the South Queich, Gelly Burn and Clash Burn to provide a representation of a range of flooding return periods for the area. At the time it was not possible to calibrate the model due to the lack of reliable extreme flood water levels. This report is provided in Appendix A.

A range of options for flood alleviation were investigated, including technical feasibility and economic viability. The Study outlined a hard defence option to alleviate flooding from the fluvial 0.5% AEP event. This option addressed flooding from the South Queich and Gelly Burn, with no preferred option outlined for the Clash Burn.

1.3.2 Link Road FRA (2011)

Mouchel completed a Flood Risk Assessment for a proposed distributor road in South Kinross, which fed into plans for the now completed Junction Road. This report was completed in July 2011 and involved a hydrological analysis and development of a hydraulic model.

Using the same hydraulic model developed for the South Kinross Flood Study completed in 2010, floodplain loss and mitigation were assessed as part of the FRA. A compensation area to the north of the link road, was designed to mitigate any loss of floodplain storage. The link road has since been constructed and was represented within the hydraulic model for the South Kinross FPS.

2 FLOODING ISSUES

2.1 Flooding Background

South Kinross has a long history of flooding dating back to 1852 where flood waters of 1-2 feet deep were reported at houses near the 'Myre' and agricultural land. In 1999, flooding was also reported affecting properties on Montgomery Way. As part of the Hydraulics[2] assessment of baseline conditions, RPS reviewed historic flood records related to flooding within the study area. Sources of information included the South Kinross Flood Study undertaken by Mouchel (2010), The Great Flood (PKC, January 1993 and recorded flooding events around the Smith Street and The Myre locations in July 2007, August 2008, November 2009, September 2010, February and July 2011, and September 2012, from the Clash Burn and heavy rain, as well as Biennial Flood Reports and photographs provided by PKC.

Historically, fluvial flooding has presented the greatest risk of flooding to Kinross with the majority of flooding associated with the South Queich and Gelly Burn watercourses. Surface water flooding is also a potential risk, particularly along the Clash Burn. Most of this watercourse is culverted and insufficient pipe capacity results in surcharging from manholes. The South Kinross FPS focuses on fluvial risk emanating from the watercourses. Additional surface water risk is a known cause of flooding in Kinross and will be reviewed through a Surface Water Management Plan (SWMP) planned for the next FRM cycle (2022-2028).

2.2 Significant Recent Flood Events

2.2.1 2006 Flooding Event

During the 13th December 2006 flood event (estimated as 1 in 15 year return period) there were a number of factors which influenced flooding. Sewer flooding was reported as the cause of flooding to several properties such as 229 & 244 High Street. The Scottish Motor Auction Group was recorded to be impacted by pluvial flooding. Figure 2-1 shows the pluvial flooding to a property at South Queich Place. The Koronka, Bridgend and Kinross areas were flooded as a result of fluvial flooding from the South Queich.

Figure 2-1 Flooding Event taken at 4a South Queich Place 14/12/2006.

[2] South Kinross FPS, Hydraulics Report, RPS, August 2021

2.2.2 2008 Flooding Event

As per the PKC 2009 Biennial Flood Report, most flooding incidents that occurred from November 2007 to early November 2009 were not due to blocked inlets or exceeding open channel capacity but exceedance of capacity in the culverted sections of this drainage network at Smith Street and Montgomery Way. However, the 25th/26th January 2008 flood event was a result of fluvial flooding from the South Queich watercourse. It is estimated that this flood event had a 1 in 32 year return period. **Figure 2-2** shows flooding at property level from this flood event in South Queich Place.

Figure 2-2: Flooding Event associated with South Queich 25/01/2008.

2.2.3 2011 Flooding Event

As per the PKC 2011 Biennial Flood Report, several flood events occurred between November 2009 and March 2012 (publish date). The majority of flooding incidents were noted to have occurred due to flows exceeding the capacity of the culverted sections of the Clash Burn rather than the open channels being exceeded. Pluvial flooding was noted as being responsible for street level flooding around Myre Terrace on the 10th and again on the 23rd of July 2011 as illustrated in **Figure 2-3**.

Figure 2-3: Flooding Event at Smith Street 12/07/2011

2.2.4 2020 February Flooding Event

The Met Office issued a yellow weather warning for wind and heavy rain on 22nd February 2020. Antecedent conditions may have contributed to the flooding, with two storms experienced during the weeks leading up to this event. Storm Ciara occurred on the 2nd February 2020 and Storm Dennis arrived on the 16th February with heavy and persistent rain. The 22nd February flood event was estimated to be a 2% AEP fluvial event. It caused flooding to at least 22 residential and commercial properties throughout South Kinross, with an example shown in **Figure 2-4**.

Figure 2-4: Flooding Event on 23/02/2020, land adjacent to Old Cleish Road

2.2.5 2020 August Flooding Event

During the night of 11th August 2020, the entire Perth and Kinross Council area suffered extensive rainfall, thunder, and lightning for 6 hours from around 11pm. This severe weather resulted in widespread flooding. A Met Office rain gauge site in Kinross recorded 61.6mm of rainfall where the area would normally experience an average of 65mm of rain in the whole month of August reflecting the extreme nature of the event. Several properties flooded on Queich Place, Todd and Duncan, BCA Site, High Street and Bridgend Industrial Estate.

Figure 2-5 August 2020 Flooding at Bridgend Industrial Estate

3 HYDROLOGICAL/HYDRAULIC MODELLING

Following a review of the 2010 Flood Study, a hydrological and hydraulic analysis for the South Kinross FPS has been carried out to assess and quantify flood risk from the South Queich, Gelly Burn and Clash Burn watercourses. This work is fully detailed in the South Kinross Hydrology report.[3] A key part of this process was the construction of a numerical model of the three watercourses.

3.1 Design Flood Estimation

A detailed hydrological analysis was undertaken for the South Queich, Gelly Burn and Clash Burn watercourses to determine the design peak flood flow and flood hydrographs as described in the South Kinross Hydrology Report. Flood Estimation Handbook (FEH13) parameters were used in the analysis, in accordance with national guidelines.

After determining the extents of the river survey, numerous Hydrological Assessment Points (HAPs) were established at the most upstream and downstream extremities of the model, upstream and downstream of any tributaries, and on any tributaries just before their confluence with the main river channel (**Figure 3-1**). Intermediate HAPs were also created along the main channel and tributaries for generating lateral flow contributions. Intermediate HAPs serve as check points along the modelled reaches to ensure that the hydraulic modelling is anchored to the hydrological analysis. Individual catchments were delineated for all HAPs. Delineating the catchments required the superimposition of data such as 10k OS background mapping, rivers/streams feature classes, urban drainage networks and high resolution DTM using Arc Hydro.

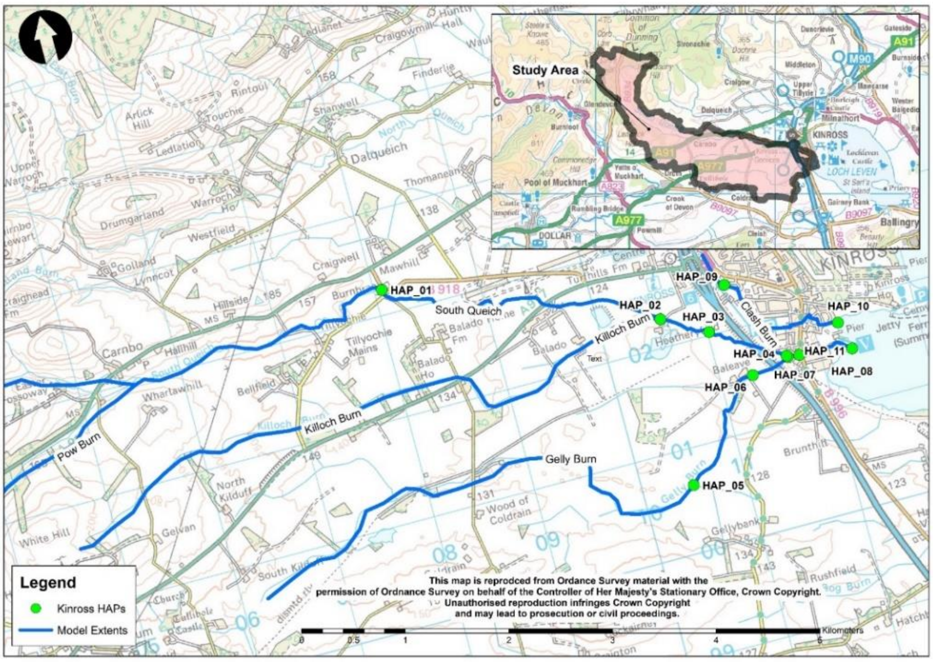

Figure 3-1 HAP Location Map

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[3] South Kinross FPS, Hydrology Report, RPS, June 2020

3.1.1 Methods Adopted

Based on national guidance, FEH Statistical and FEH Revitalised Flood Hydrograph (ReFH2) rainfall runoff methods were applied. The FEH Statistical method is based on recorded data whilst REFH2 is a deterministic model and aims to represent the main hydrological processes which occur at a catchment scale. Based on the availability of local gauged data and catchment size the FEH Statistical method was deemed to be the most suitable. Additionally, comparing the results from the Statistical method resulted in much larger flows allowing a degree of conservatism to be included in the design flows.

A review of all available hydrometric and hydrological data was conducted and FEH statistical methods employed to predict peak flood flows. FEH analysis is rooted in a robust estimate of the Index Flood (QMED); the flow expected to be exceeded on average every 2 years. QMED can be estimated using catchment descriptors or from Annual Maxima data recorded at gauges. On this basis, confidence in the gauge data available locally, was important to increase confidence in calculated flows. RPS carried out a rating review of the South Queich @ Kinross (17008) gauging station due to uncertainty highlighted by SEPA and to attempt to validate (or otherwise) the peak flow estimation.

Rating curves were derived for Central Model Estimation (CME) and High Model Estimation (HME) scenarios. The CME represents the modellers best estimate of model parameters based on photos and site visit and the HMS represents slightly elevated model parameters which RPS deemed to be reasonable but at the upper limits of the physical model parameters. The rating review conducted on the South Queich gauge allowed the calculation of a new AMAX series based on the detrending method of the HME rating curve which was determined to be the best fitting rating curve to the spot flow gauging's. The updated at-site flood frequency curve was then used to factor estimated QMED and produce robust design peak flood flows.

The ReFH2 rainfall runoff method produces flood hydrographs, whereas the statistical method only generates peak flow estimations. As is common practise, the predicted hydrograph shape from the ReFH2 model was used and scaled to match the statistical peak flows with consideration given to the shape of the hydrograph by comparing to gauged data.

3.1.2 Adopted Design Flows

Table Peak Flood Flow Estimations Design Flows

HAP	2yr	5yr	10yr	30yr	50yr	75yr	100yr	200yr	500yr	1000yr
HAP_01	9.784	13.111	15.567	19.950	22.308	24.343	25.899	30.047	36.544	42.376
HAP_02	2.309	3.122	3.753	4.923	5.575	6.152	6.598	7.815	9.784	11.616
HAP_03	10.660	14.274	16.938	21.703	24.262	26.490	28.174	32.694	39.782	46.136
HAP_04	10.531	14.016	16.523	20.851	23.126	25.074	26.538	30.392	36.289	41.460
HAP_05	2.427	3.393	4.133	5.500	6.255	6.920	7.432	8.823	11.063	13.126
HAP_06	2.951	4.125	5.025	6.687	7.605	8.413	9.036	10.727	13.450	15.959
HAP_07	3.060	4.278	5.211	6.934	7.886	8.724	9.370	11.123	13.948	16.549
HAP_08	12.494	16.630	19.603	24.738	27.437	29.748	31.485	36.058	43.054	49.189

HAP	2yr	5yr	10yr	30yr	50yr	75yr	100yr	200yr	500yr	1000yr
HAP_09	0.042	0.055	0.065	0.085	0.097	0.107	0.115	0.138	0.176	0.213
HAP_10	0.267	0.348	0.413	0.540	0.613	0.679	0.730	0.874	1.114	1.345
HAP_11	12.365	16.458	19.400	24.482	27.153	29.441	31.159	35.685	42.609	48.680

3.2 Hydraulic Modelling

Following a review of the existing Flood Study model (2010) it was determined that building a more detailed model to progress the design was appropriate. A new 1D-2D model was developed in Infoworks ICM, to provide full solution modelling of open channels, floodplains, embankments and hydraulic structures. The modelled watercourses are shown in Figure 3-2. The South Queich and Clash Burn were modelled in 1D whilst the Ury Burn is represented in 2D. This work is fully detailed in the South Kinross Hydraulics Report[4].

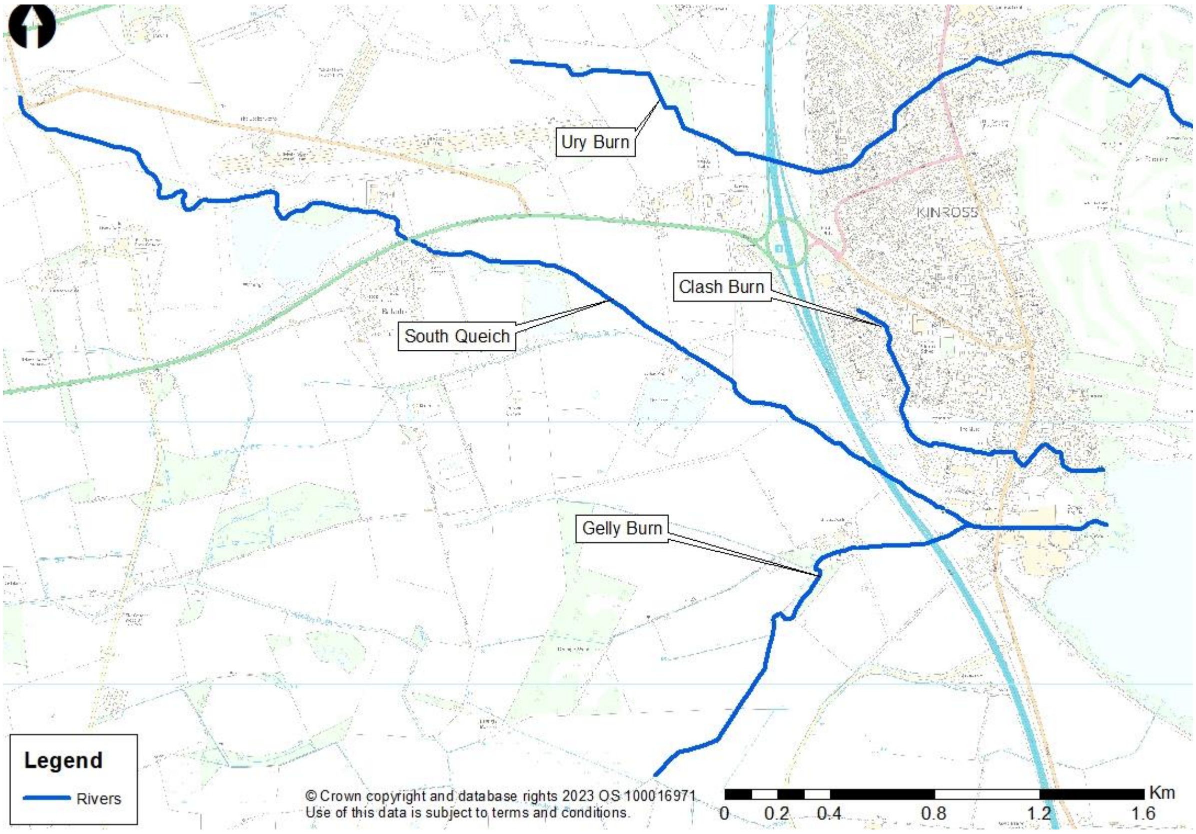

Figure 3-2 Modelled watercourses within the South Kinross study area.

3.2.1 Topographic Survey

RPS reviewed the existing survey data received from the Mouchel Flood Study (2010) and procured additional survey information (July 2019) to facilitate the more detailed hydraulic modelling required for scheme development. This included the following:

[4] South Kinross Flood Protection Scheme, RPS, August 2021

- River cross section survey of the South Queich, Gelly Burn and Clash Burn (Figure 3-3)
- Survey of all hydraulic structures along the South Queich, Gelly Burn and Clash Burn (Figure 3-3)
- Manhole Cover levels (Figure 3-3)
- Finished Floor Level (FFL) survey, encompassing 312 properties/buildings. FFLs were incorporated into both the hydraulic model and the economic damage assessment.

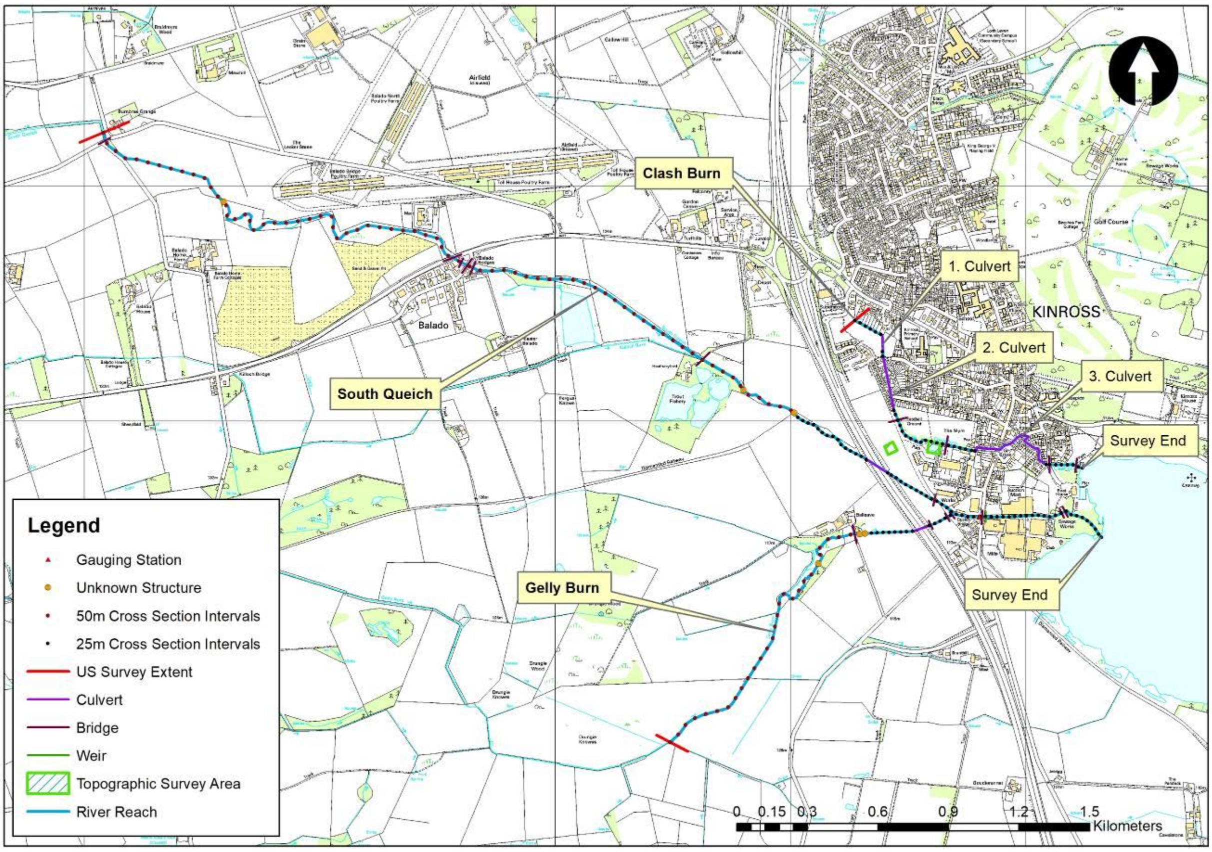

Figure 3-3 River Reach Survey Extents

3.2.2 1D Domain

The in-bank portion of the river model (1D) was created using the cross-section survey information from the topographical surveys discussed in Section 3.2.1. Within the 1D domain the in-bank roughness was given a Manning's n value between 0.03 and 0.045 based on photographs from the topographical cross-section surveys. Out-of-bank 1D roughness values varies from a minimum of 0.015 to a maximum of 0.1 as the banks vary from short grass to medium/dense bush.

This survey was also used as the basis for incorporating all structures within the 1D model. There are 16 no. bridges, 4 no. weirs/pipe crossings and 7 no. culverts across the South Kinross hydrodynamic model. No formal flood defences are present within the 1D model domain; therefore, no flood defences have been modelled.

3.2.3 2D Domain

The 2D area represents the floodplain to allow mapping of flow routes and flood extents. The bare earth DTM data has been used within the modelling package to generate the computational mesh. Junction Road however was found to have been constructed after the LiDAR for the area had been flown. LiDAR elevations were therefore altered to represent the road based on drawings received from PKC and WSP.

A triangular flexible mesh is used in Infoworks which allows for high levels of detail in specific areas (for example at river banks and around buildings) and a broader approach in other areas (for example open floodplains) to reduce simulation times. When creating the 2D zone the level of detail required and the potential increased meshing and model run times due to higher detail need to be considered. The maximum mesh size used in the model was 100m² which was considered sufficient for modelling larger open spaces. In the more urban areas where known flow paths such as historic flooding has been reported or where it is suspected that smaller flow paths might not be picked up with the larger mesh size, the mesh was refined with a maximum mesh size of 5m². Use of a detailed mesh zone in the area above Kinross services enabled representation of the Ury Burn river channel in 2D which had not been previously surveyed. The location of the more detailed 2D mesh areas is shown in Figure 3-4.

The mesh was augmented to include buildings which will affect flow paths. Building footprints were defined by a GIS shapefile extracted from the OS MasterMap geodatabase supplied by PKC. The building footprints were then imported into the model as porous polygons and designated as having a porosity of 0.01 to enable buildings to store some water, in line with SEPA modelling guidance. Threshold levels were also applied to survey buildings through a mesh level zone to ensure these buildings would only start to store water whenever flood levels reached the designated floor levels. A small informal effective earthen bund constructed by PKC at Myre playing fields was also included within the model, to represent its effect on overland flow paths.

The 2D model domain was split into different land uses based on the OS MasterMap and roughness values were assigned using Chow 1959. Roughness values were assigned to different land classes to represent different friction losses potential applied to overland flows.

The Ury Burn is not a source of flood risk in Kinross so was not modelled in 1D. However, it is represented in the 2D Mesh using detailed topographic survey stamped onto the LiDAR grid. A detailed mesh zone was used in this location ($5m^2$-$2m^2$) to ensure the channel was picked up in suitable detail.

The 1D channel model is connected to the 2D floodplain by bank lines. The bank lines are created using the levels at either end of the river cross sections. Levels between cross sections are either interpolated from the cross sections or extracted from the DTM. Bankline discharge coefficients were set between 0.6 and 0.8 depending on the bank conditions in line with Innovyze recommendations.

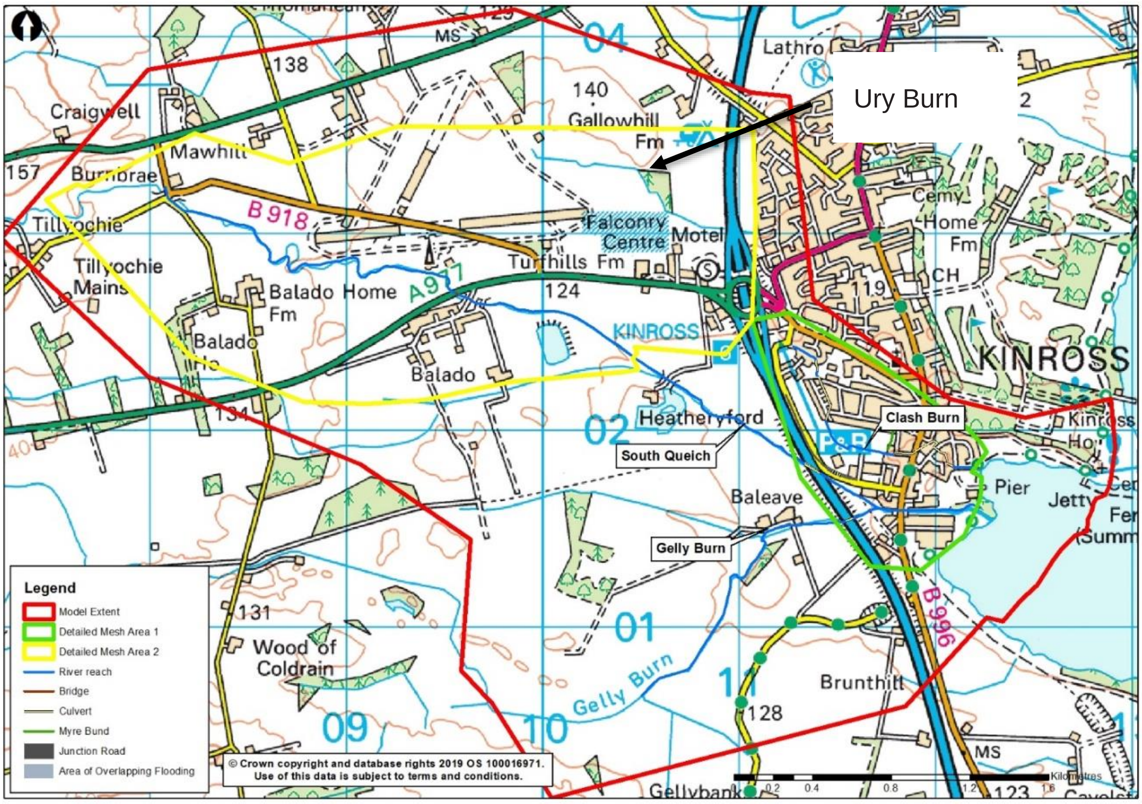

Figure 3-4: Location of Detailed Mesh Zones within 2D Domain of the ICM Model

3.2.4 Model Boundaries

The locations of the model boundaries were selected at sufficient distances upstream to allow the model to replicate flooding mechanisms in the impacted areas.

Upstream boundary conditions and input hydrographs for the model were provided from the Hydrological Assessment (Section 3.1) and have been introduced directly to the 1D domain as point or lateral inflows. An input hydrograph was applied as a point flow at each upstream boundary (for the Gelly Burn, South Queich and Clash Burn). Lateral inflows were also applied along the length of each river. The lateral inflows were disaggregated between Hydrological Assessment Point (HAP) nodes and distributed pro-rata, based on length, and applied to each river reach along its length.

The Clash Burn and South Queich both discharge into Loch Leven. The levels within this loch are likely to impact upon the flood levels and extents in South Kinross. The loch has been replicated within the model by a continuous level 2D boundary set at the predicted water level (mAOD) for each AEP to account for any backwater impact on watercourses. The water levels were presented in the Hydrology report[5] and agreed with SEPA. These levels are considered as conservative estimates.

[5] South Kinross FPS, Hydrology Report, RPS, June 2020

The modelled flows from the design event simulations were compared with the estimated flows at each Hydrological Assessment Point and updated accordingly to ensure that the hydraulic model is anchored to the hydrological analysis.

3.2.5 Calibration and Verification

The main flood event used to calibrate the model was an event which occurred from the 21st – 22nd February 2020. This was estimated as a 2% AEP fluvial event (1 in 50 year return period) during the hydrological assessment. It should be noted however that there was uncertainty with the South Queich Gauge Station (17008) data used to estimate the AEP of the February 2020 event and other historical events. This has been acknowledged within the South Kinross Flood Protection Scheme Hydrology Report. The issues with the gauge data relates to the defining of the stage-discharge relationship, the stage zero and the significant extrapolation of data beyond the maximum observed spot gauging flow of 3.5m^3/s. Following discussion with SEPA the staff gauge zero for the South Queich Gauging Station was taken as 108mAD. A rating review was carried out in order to help validate the hydrology and hydraulic model. More detail is available within the South Kinross Flood Protection Scheme Hydrology Report for the steps taken to ensure that the estimated AEPs for historical flooding and model inflows are accurate.

Detailed information was collected by PKC and shared with RPS, including photos, flood levels, approximate flood extent drawings as well as anecdotal evidence from residents and business owners. This led to multiple improvements being made in the model, most notably regarding the resolution of the topography where mesh zones were incorporated to capture finer detail and ensure the model was representing all known flow paths.

The modelled flood extents of the calibration/verification event (2% AEP fluvial event) were very similar to the flooding observed during the February 2020 event, capturing the main areas of concern recorded during this event. The model was also shown to have a good correlation with the hydrological estimates especially around the hydrometric gauge station. This indicates that the model can match the observed 50% AEP flows which demonstrates the model has a high degree of accuracy. Significant out of bank flooding and floodplain storage, especially during higher return periods, helps explain the poorer correlation between the hydrologically estimated flows and modelled output flows for the higher magnitude flood events. It should be noted surface water flooding is also believed to be a contributor in this event which is not accounted for in the hydraulic modelling.

Discussions were held with SEPA during the hydraulic modelling process and concluded in August 2021. It was agreed limitations in the flow and flood data have been clearly stated in the Hydraulic and Hydrology Reports to caveat calibration confidence which is limited due to quality of available flow and flood data. RPS and Perth and Kinross Council consider that the model has been calibrated/verified to best represent the fluvial flooding mechanisms based on the data available and is suitable to be used as a basis for identifying fluvial flood alleviation options for all areas.

A number of sensitivity tests to core elements of the model such as floodplain and channel Roughness, Flow, Blockage to Structures, Downstream Boundary Conditions, Structure coefficients have been undertaken. This is so potential uncertainty in model parameters can be considered during the design process.

3.3 Flood Impacts

The hydraulic model has been used to simulate the baseline (i.e. present-day) condition at the following range of return period events: 50%, 20%, 10%, 3.33%, 2%, 1.33%, 1%, 0.5%, and 0.1% annual exceedance probability events, as well as for the 3.33% and 0.5% plus climate change (40% uplift to flows) events.

The study area has been split into three flood cells to facilitate the option review process. This decision was made due to the unique flooding mechanisms and constraints that have been observed across three distinct areas in South Kinross.

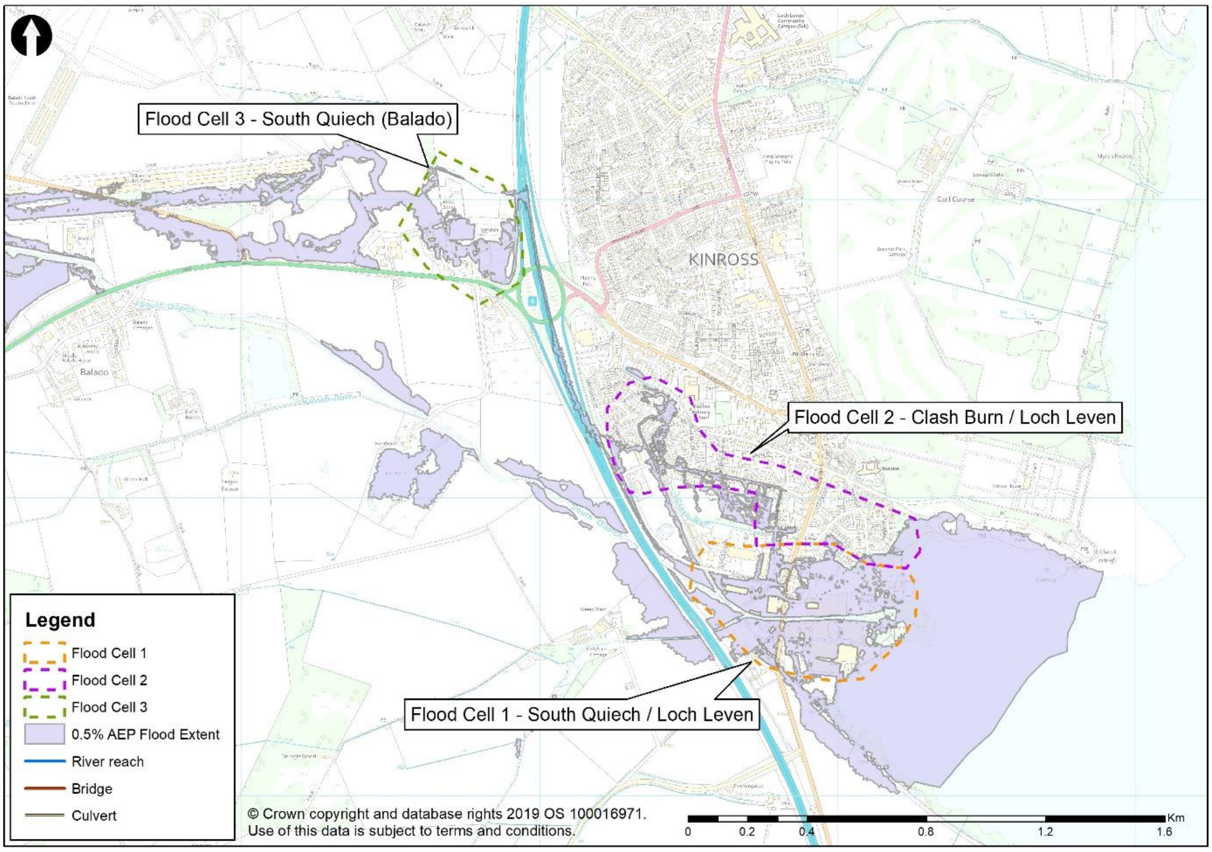

Figure 3-5 Overview of the South Kinross FPS Flood Cells

An assessment of the flood risk was carried out for Flood Cells 1, 2 and 3. Table 3-1 presents the receptors at risk during a 0.5% AEP flood event and any constraints to the potential flood management solutions.

Table 3-1 Receptors at Risk across all three Flood Cells

Receptor/Asset affected	Frequency of risk 10% AEP = Low frequency 0.5% AEP = Medium frequency 0.1% AEP = High frequency	Impact of flooding
Residential properties	Low frequency – 195 properties at risk (fluvial)	Properties at risk from fluvial flooding

Receptor/Asset affected	**Frequency of risk** 10% AEP = Low frequency 0.5% AEP = Medium frequency 0.1% AEP = High frequency	Impact of flooding
	Medium frequency – 128 properties at risk (fluvial) High frequency – 20 properties at risk (fluvial)	
Commercial Properties	Low frequency – 84 properties at risk (fluvial) Medium frequency – 62 properties at risk (fluvial) High frequency – 4 properties at risk (fluvial)	Properties at risk from fluvial flooding
Motorway M90	Low & medium frequency of risk	Traffic disruption (significant)
A Road A977	Low frequency of risk	Traffic disruption
Primary Road B918 B996	Low & medium frequency of risk	Traffic disruption
Minor Road Bowton Road Clashburn Way High Street Hopefield Place Levenbridge Place Montgomery Street Montgomery Way Myre Terrace Nan Walker Wynd Old Causeway Pier Road Queich Place Ross Street Sandport Sandport Close Sandport Gait	Low frequency – Levenbridge Place, Nan Walker Wynd, Old Causeway, Pier Road, Sandport, Sandport Close, Sandport Gait Medium frequency – M90, Clashburn Way, High Street, Hopefield Place, Myre Terrace, Smite Street High frequency – Bowton Road, Montgomery Road, Montgomery Street, Queich Place, Ross Street	Traffic disruption

Receptor/Asset affected	Frequency of risk 10% AEP = Low frequency 0.5% AEP = Medium frequency 0.1% AEP = High frequency	Impact of flooding
Smith Street		
Utilities 1 Electricity Substation (Clashburn Road)	Low & medium frequency of risk – Clashburn Road Electricity Substation	
Scottish Water Assets South (High Street) Sewage Pumping Station (SPS) Pier Road SPS SPS & CSO behind commercial premises north of the South Queich Sewage Works behind industrial premises south of the South Queich	Low & medium frequency of risk – South (High Street) Sewage Pumping Station (SPS) and Pier Road SPS High frequency of risk – SPS & CSO behind commercial premises north of the South Queich and Sewage Works south of the South Queich	Potential disruption to service
Listed Buildings (Bridges): None	-	-
Listed Buildings (Structures): Old Manse, 8 Sandport, Kinross Market Cross, Sandport, Kinross	Low frequency of risk – Old Manse & Market Cross	-
Sites of Special Scientific Interest Loch Leven SSSI	Low, medium & high frequency of risk	-
Conservation Areas Kinross Conservation Area	Low & medium frequency of risk	-
Special Protection Areas Loch Leven SPA	Low, medium & high frequency of risk	-
RAMSAR Loch Leven RAMSAR site	Low, medium & high frequency of risk	-
Community Services None	-	-
Paths Loch Leven Heritage Trail	Low, medium & high frequency of risk (fluvial & coastal)	Disruption to service

4 SCHEME DEVELOPMENT

Following hydrological and hydraulic modelling, RPS reviewed the extent of the flood risk within the Kinross Study Area. This work is fully detailed in the South Kinross Options Review Report[6]. Three flood cells were identified, and their flood risk assessed. Flood Cell 1 identified and assessed the fluvial risk from the South Queich and Gelly Burn as well as flood risk emanating from Loch Leven. Addressing flood risk from Loch Leven was not included within the scope of the FPS, however resilience measures were considered during the option review stage. Flood Cell 2 assessed fluvial risk from the Clash Burn and the impacts from Loch Leven. Flood Cell 3 assessed fluvial flood risk from the South Queich identified upstream of the M90, which was upstream of the initial study area defined at the outset of the project. In total 177 properties were identified to be at risk of flooding from fluvial sources in the 0.5% AEP event. A total of four properties were also identified to be at risk from water levels in Loch Leven.

Once flood risk was understood from a source, pathway, receptor perspective, optioneering was carried out to determine the most feasible option to reduce flood risk in South Kinross. Potential options were developed primarily by building upon the findings of the 2010 South Kinross Flood Study which outlined a hard defence option to alleviate flooding from the fluvial 0.5% AEP event. This option addressed flooding from the South Queich and Gelly Burn, with no preferred option outlined for the Clash Burn. RPS were commissioned to assess the hard defence option, as well as undertaking a review of other potential options in the form of an agreed optioneering long list. The options for the Clash Burn were less defined where a full range of options were considered, similarly, to address fluvial flooding to the fluvial 0.5% AEP event.

Some options from the long list were reassessed based on new information on flood mechanisms not covered in the original study from residents and business owners as well as the requirement to achieve a minimum 0.5% AEP standard of protection overall. The baseline model was used as a design tool for iterative testing of various short-listed options summarised in Table 4-1 to determine their feasibility and impact on flood risk. Outputs from the model have also been used to inform the economic appraisal, network results polygon and network results line elements provided estimated depths within and outside the building (respectively) for each simulation run.

Table 4-1 Short Listed Options

Flood Cell 1 South Queich / Loch Leven	Flood Cell 2 Clash Burn / Loch Leven	Flood Cell 3 South Queich
Improvement of Conveyance: Channel / Structures	Improving Channel Conveyance / Diversion;	Storage
Diversion	Property level protection (PLP);	
Direct Defences	Property level resilience (PLR);	
Storage	Storage	
Property Level Protection (PLP)		

[6] South Kinross FPS – Option Review Report, RPS, December 2022

Flood Cell 1 South Queich / Loch Leven	Flood Cell 2 Clash Burn / Loch Leven	Flood Cell 3 South Queich
Property Level Resilience (PLR)		
Relocation		

Each option was appraised to determine the most suitable solution as described in the Options Review Report. The options were compared against one another, and an overall preferred option identified for the study area. The appraisal considered the flood risk management benefits, the wider positive and adverse impacts, the adaptability to climate change and other future flood risk, whole life cost and uncertainties.

4.1 Options Appraisal

The main aim of the FPS is to propose a suitable long-term option for addressing fluvial flood risk in South Kinross. Any secondary surface water flood risk arising from the scheme options is also considered and mitigation proposed. This scheme focuses on fluvial flood risk. The need for a Surface Water Management Plan will be considered by PKC at a later date. Several short-listed options were appraised based on their impact on reducing the 0.5% AEP flood risk as summarised in Table 4-2. The full process is detailed in the Kinross Options Review Report (Appendix B).

Table 4-2 Short List Options Screening

	Provides 0.5% AEP Fluvial Standard of Protection to majority of properties		
Action	**FC1** South Queich / Loch Leven	**FC2** Clash Burn	**FC3** South Queich
Improvement of Conveyance (ICC)	-	-	N/A
Diversion	✗	✓	N/A
Direct Defences	✓		
Storage	-	-	✓
Property Level Protection (PLP)	-	N/A	N/A
Property Level Resilience (PLR)	-	N/A	N/A
Relocation	✗	N/A	N/A

✓ effective in protecting majority of properties at risk, - unable to protect majority of properties at risk but may be used in combination with other actions, ✗ screened out based on shortlist action screening.

RPS undertook a benefit-cost analysis to demonstrate the economic case for the identified effective options (defences, diversion, ICC, PLR, PLP and storage). This involved an assessment of the benefits (i.e., reducing flood impact) and the costs of the options over a 100-year design life span. This approach ensures that the

South Kinross FPS is supported by a robust economic justification which shows that the preferred option provides best value for money. Following the completion of the Options Appraisal in December 2022, a preferred option was identified as illustrated in Figure 4-1. It consisted of; direct defences along the South Queich, culvert upgrades and diversion culverts on the Clash burn, upstream storage, pond storage at Myre Playing fields and PLP at Loch Leven.

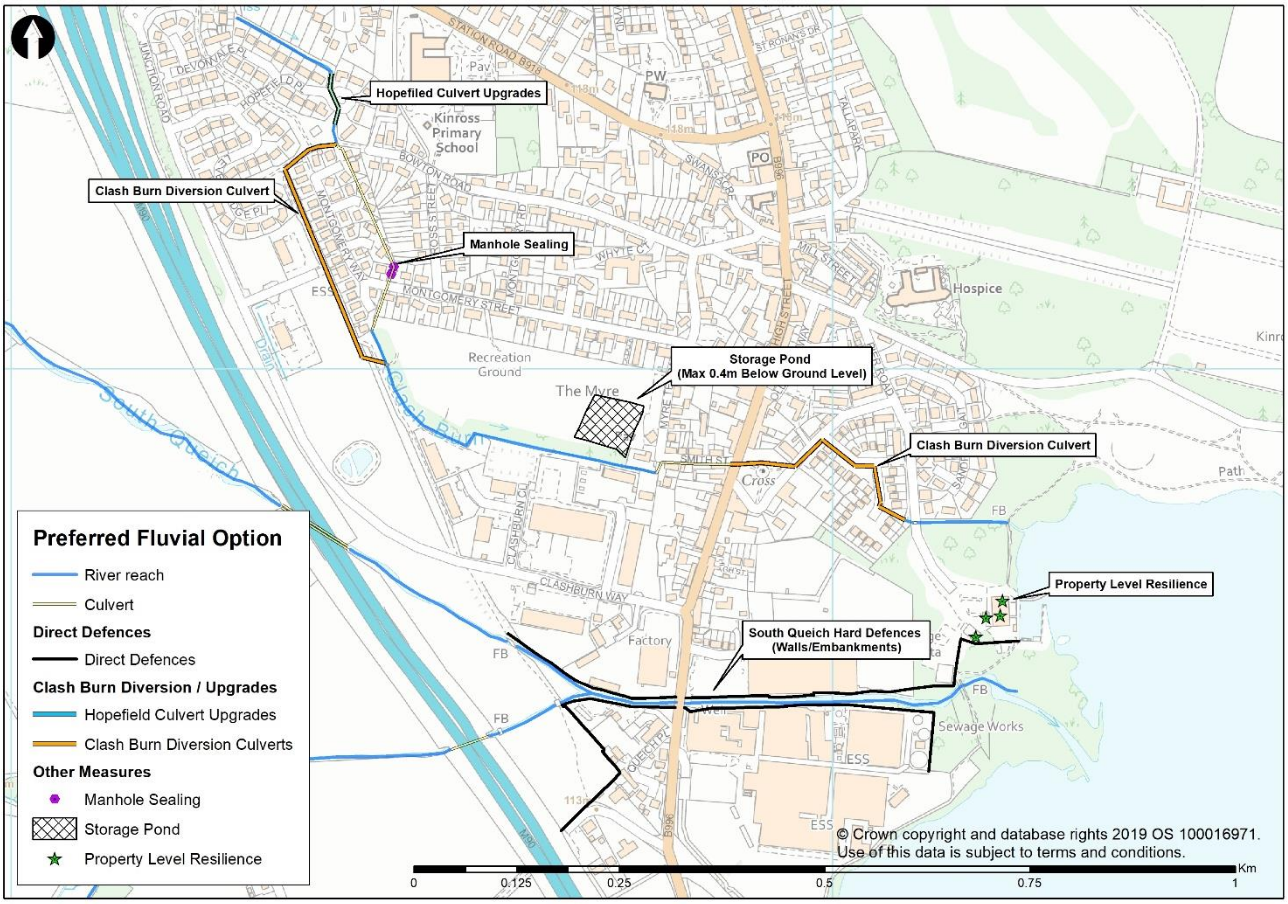

Figure 4-1 Preferred Option

4.2 Preferred Scheme – Outline Design Updates

Based on the Kinross Options Review report (Appendix B), during the development of the outline design, updates have been made to the preferred option based on engineering judgement and as more detailed information has become available.

4.2.1 Culvert alignment at the Myre Playing Fields

The Clash Burn runs as an open channel between the Myre and Smith Street through an existing property. Overtopping from the Burn in this location is predicted due to a backup of flow from the culvert downstream. The original scheme design involved upsizing the downstream culvert along its existing route through a private access at the junction of Myre Terrace/Smith Street. This would not provide a 0.5%+CC standard of protection to all properties at Smith Street. To allow a consistent standard of protection a new route for the culvert is recommended (Figure 4-2).

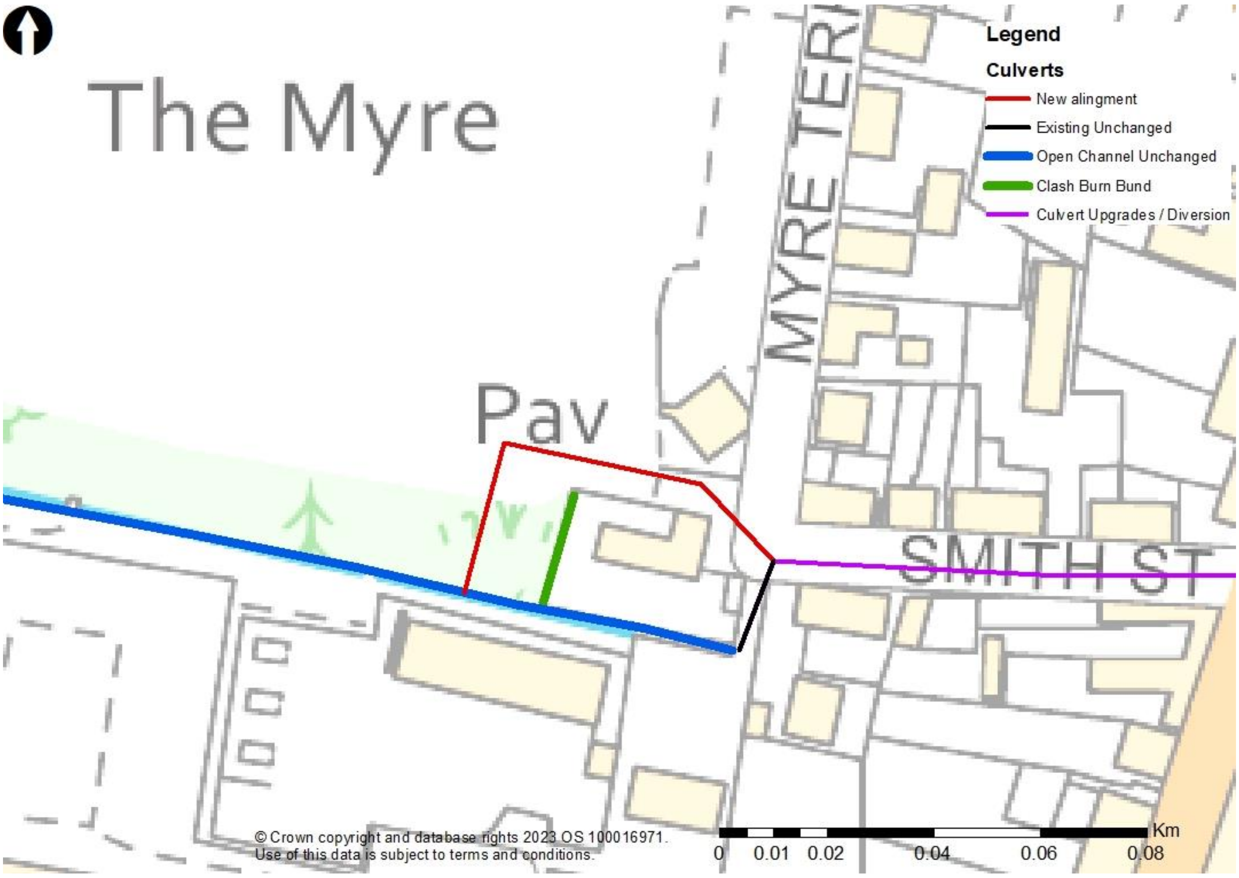

Figure 4-2 Myre Culvert Realignment

A new offtake is proposed to split flow in the Clash Burn between the existing route and a new pipe culvert. This would result in a similar cost as the original route due to the new alignment being within green space with a less complex working area and lower cost reinstatement requirements. The design will essentially split flow 50/50 between the new route and existing route. This will allow capacity in the culvert diameter downstream to be increased to better manage extreme flows whilst also allowing flow to be maintained through the channel for the property owner. Within this open channel through private property, the 0.5% AEP+CC flood level will be dropped by 820mm. During more day-to-day flows (50% AEP) a 300mm flood depth will still be present in the channel maintaining the aesthetic quality for the property owner (Figure 4-3). The section of culvert through the private access will be unchanged. This approach prevents the need to raise bank levels within the property boundary to provide freeboard in the 0.5% AEP+CC event.

Figure 4-3 Clash Burn Open Channel through private property.

4.2.2 Storage Pond at the Myre Playing Fields/Bund at the Myre

With the proposed culvert upgrade some residual overtopping remains from the Clash Burn at the 0.5%AEP+CC though this is expected to pond in the playing fields. The purpose of the storage pond was to prevent any residual overtopping from Clash Burn reaching property at Smith Street. The storage pond at the Myre Playing Field has been replaced with a small bund. A small amount of residual overtopping is predicted to occur from the open Clash Burn in the Myre from the 0.5% AEP+CC with the scheme in place. It was decided that given the low vulnerability of the land use at the Myre some residual ponding was acceptable given its shallow depth of <100mm.

More detailed topographic survey at outline stage identified an existing informal flood bund along the east boundary of the playing fields. To provide additional resilience for Smith Street properties to the residual overtopping a small bund (Figure 4-2) will be constructed to extend the existing informal flood defence existing along Smith Street which is in place to retain any floodwater on the playing field. The condition of this bund has been assessed and deemed suitable to form part of the new flood protection scheme[7]. This informal bund should be adopted by PKC as a formal flood defence structure. This would create resilience to any future overland flows due to overtopping of the Clash Burn in the Myre playing fields.

[7] Informal Flood Defence Review, RPS, August 2023

This approach avoids the permanent loss of amenity space and cost/disruption associated with the significant excavation and disposal of material which would have been required to form a pond in the Myre. It is recognised there is a minor increase in flood risk downstream of Nan Walker Wynd at vacant green space which retaining the detention basin here could offset. However, it was decided on balance this increase in flood risk affects no receptors and is more acceptable than the introduction of a flood storage area near property and which would result in loss of well valued amenity space.

4.2.3 Direct Defences at downstream of BCA site

The line of defences on the north bank of the watercourse between the Scottish Water Pumping Station and the Loch Leven Boat House have been removed. During utility mapping, a large above ground Scottish Water main was identified crossing the river above ground immediately upstream of the Loch Leven Heritage Trail footbridge entering the Pumping Station. This has been identified as a critical asset which may not be possible to move. If the sewer could be moved this would likely be extremely technically complex and require moving of the pumping station and other adjoining sewer systems adding excessive cost and time to the project. Moving a minimum of 400m of pumping mains could cost in the region of £250K for this single diversion. This does not account for temporary replacement of pumping mains or the fact there is likely to be a significant contingency cost to any quote from Scottish Water to cover the risk of damage to a asset critical for the suitable operation of sewerage systems in Kinross. From previous experience in flood schemes these risk items can be in excess of £1M in addition to the cost of permanent and temporary diversion. This makes continuing the defences here economically challenging and uncertain. Moreover, given the sensitivity of Loch Leven as an environmental receptor and critical asset to the livelihoods and recreation value of the area it was felt that construction of defences so close to the Loch would not be acceptable from an environmental perspective. The original line of defences also covers a densely wooded area which would require a significant loss of habitat within the designated Loch Leven Nature Reserve which is not likely to be acceptable. From a flood risk perspective, a review of modelling indicated that properties in this location are more frequently impacted by high water levels in Loch Leven, therefore the scheme would offer limited protection to these properties. It was decided on the balance of these factors the best solution to reduce damage and disruption to these businesses and maintain linkage with the Loch on which they depend, a Property Level Flood Resilience Approach would be the most practical, cost-effective and environmentally sensitive solution.

Additional detailed topographical survey information was obtained. Based on this information defences were realigned slightly to ensure tie in with high ground.

4.2.4 Hopefield Place Open Channel

Utility mapping indicated a foul sewer clash along the route of the Clash Burn culvert upgrade downstream of Hopefield Place. To provide more favourable crossing depth and improve the alignment of the Burn hydraulically the small open reach of the culvert (approx. 21m) will now be culverted in a 600mm dia pipe. This will also reduce the number of headwalls and trash screens required and increase the available green space in this amenity area for the public with no loss in environmental or amenity value.

5 SCHEME SUMMARY

Following the Options Appraisal, the preferred option was identified which consists of; direct defences, culvert upgrades, diversion culverts, storage and property level protection and resilience as described below and illustrated in Figure 5-2.

The preferred option was identified through the findings of cost, levels of protection, impact upon the natural environment and any potential impact on social receptors. This was driven through iterative testing in the hydraulic model to test effectiveness of measures. The preferred scheme model outputs are illustrated in Figure 5-1 and show significant benefit to receptors for the 1 in 200 year plus 40% climate change event. The Economic Appraisal has now been updated following the development of the outline design as detailed in Section 14.

- **Direct Defences at South Queich/Gelly Burn -** Direct Defences including embankments, retaining walls and sheet pile walls. These would be situated predominantly along the banks of the South Queich from just upstream of the Old Railway Bridge to the Loch Leven Heritage Trail footbridge to protect from river overtopping. Embankments would be placed between the M90 and Queich Place to utilise an existing area of floodplain while preventing a flow path through to Queich Place and the surrounding areas. A small stretch of embankment would also be placed near the woollen mill's wastewater treatment plant at the right bank of the South Queich close to Loch Leven to prevent this area from flooding. **Standard of Protection - 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation.**
- **Hopefield Place Culvert Upgrade** - Culverts would be upgraded at Hopefield Place to increase flow capacity **Standard of Protection 0.5% + Climate Change Fluvial AEP**
- **Clash Burn Diversion Culvert** - Immediately downstream of Hopefield Place culvert at Bowton Road a diversion culvert would divert the flow from the Clash Burn behind the properties on Montgomery Way before discharging back into the Clash Burn at the Myre playing fields. This will reduce pressure on the existing culvert which is under capacity and will now continue to only take drainage flows rather than river flows. Two manholes require to be sealed at Montgomery Street to prevent these from overflowing during high flow events. **Standard of Protection 0.5% + 40% Climate Change Fluvial AEP**
- **Clash Burn Bund** - A small bund is proposed on the Myre playing fields as a resilience measure to force any exceedance from the Clash Burn here away from property at Smith Street and onto the playing fields. A small temporary flood storage area was considered on the Myre playing fields but was deemed to be a more disruptive and costly option which would impact the use of the playing fields. **Standard of Protection 0.5% + 40% Climate Change Fluvial AEP**
- **Clash Burn Diversion Culvert, Smith Street** – At the top of Smith Street a second diversion culvert would take flow towards High Street, Sandport Road, then along Nan Walker Wynd. The culvert would continue between two properties here and extend to the open reach of the Clash Burn downstream of the Boathouse access road. The culvert will provide a greater capacity to manage flood flows. **Standard of Protection 0.5% + 40% Climate Change Fluvial AEP**

- **Upstream Storage -** An embankment would be constructed close to the M90 services to protect commercial properties, intercepting an overland flow path that is shown to impact the M90, before travelling along the road and into South Kinross. Flood levels upstream of the storage area are unchanged. **Standard of Protection - 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation.**
- **Property Flood Resilience -** to four properties affected by Loch Leven to provide resilience to properties impacted by high water levels in Loch Leven**.** Direct defences were considered here but were discounted due to loss of connection to the Loch on which businesses here rely and that resilience was the most cost effective option.

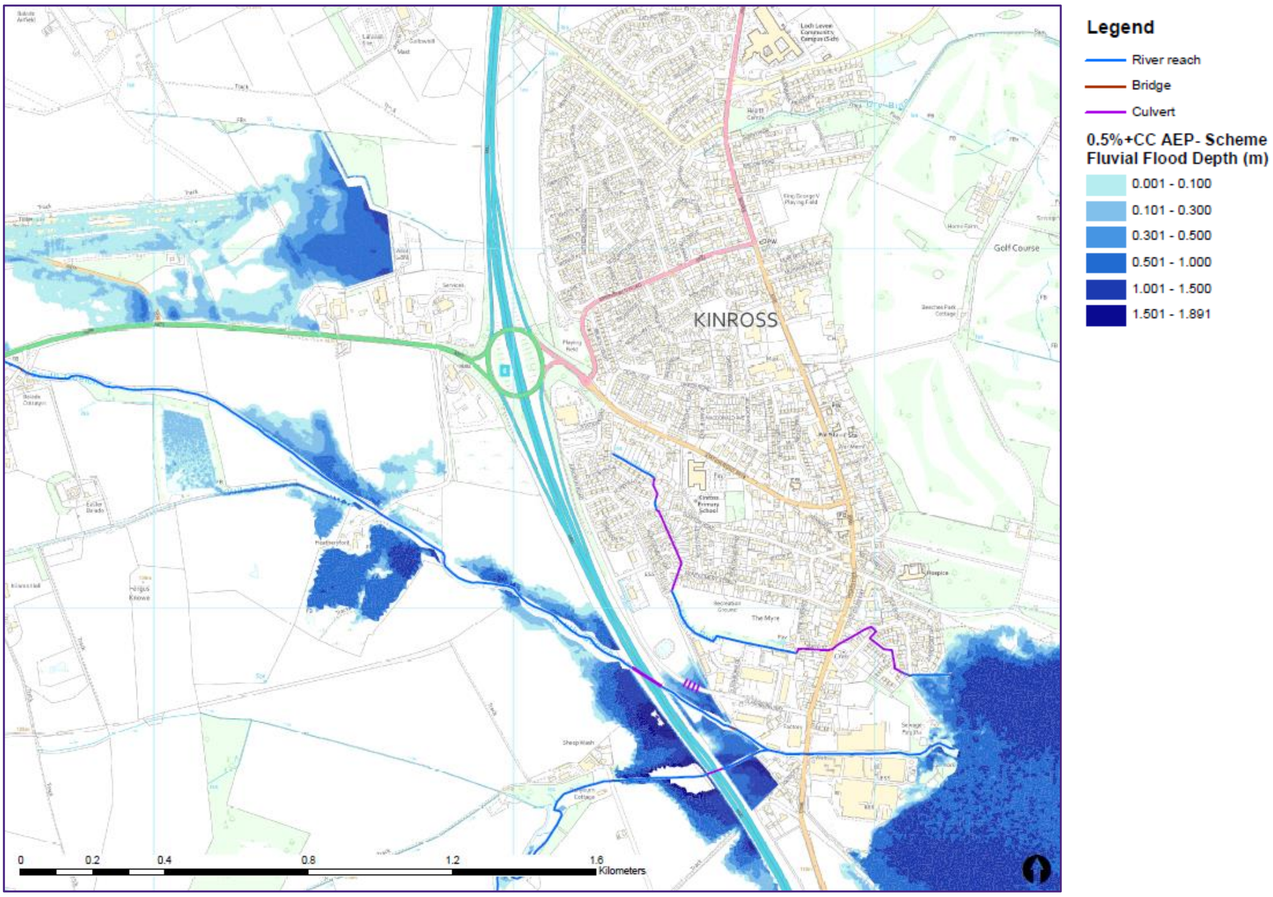

Figure 5-1 0.5% AEP+CC Post Scheme Flood Map

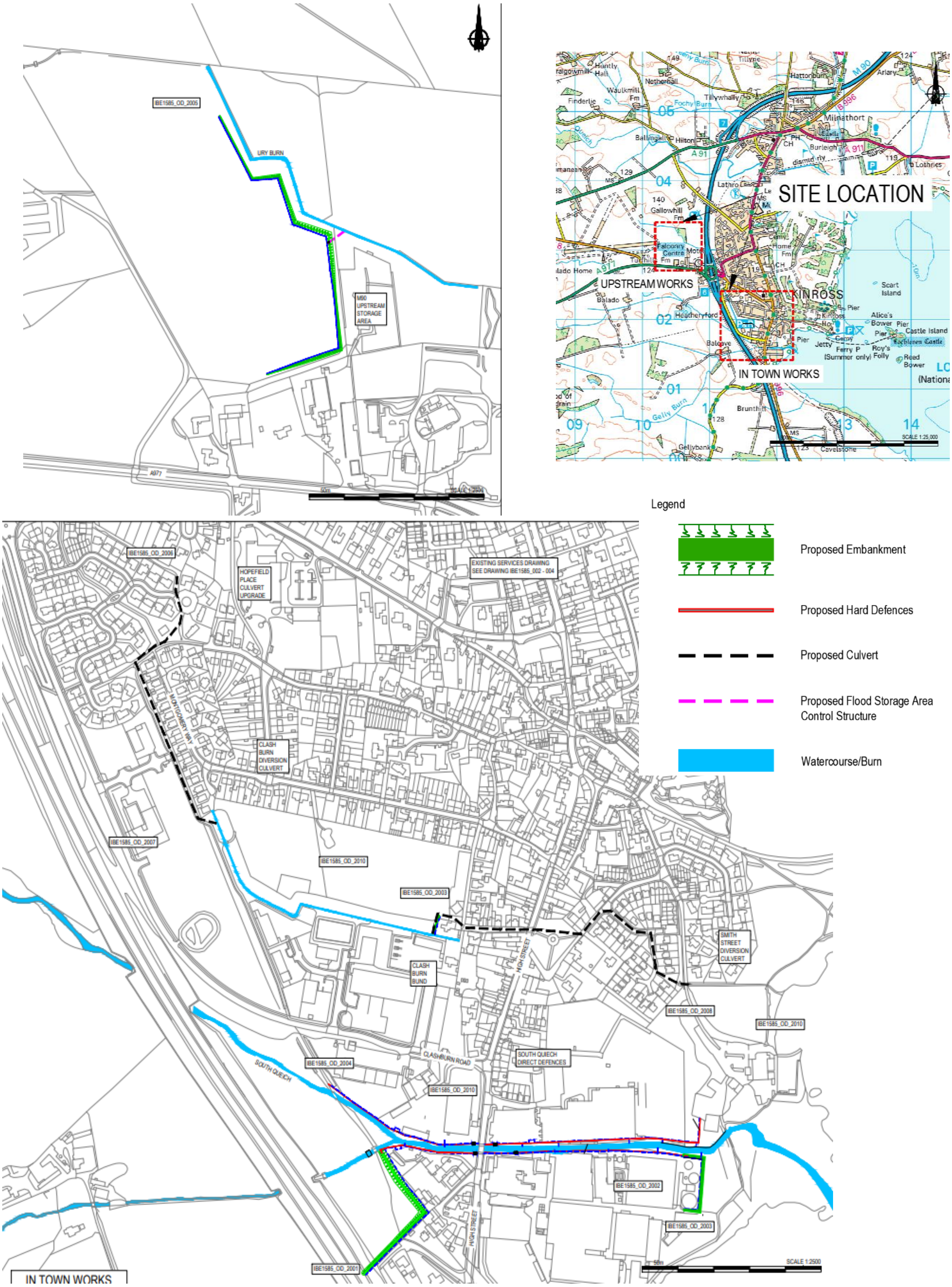

Figure 5-2 Outline Design Site Location Plan

5.1 Standard of Protection

RPS were commissioned to recommend the standard of protection (SoP) for the South Kinross Flood Protection Scheme[8]. This report is provided in Appendix H. A recommendation per Flood Cell was proposed, based on the outcomes of the Multi-Criteria Analysis and Benefit-Cost Ratios, which captured a broad range of technical, economic, social, and environmental criteria. The following SoP strategies were reviewed for each flood cell:

- 0.5% (Present Day) Fluvial AEP
- 0.5% + Climate Change Fluvial AEP
- 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation
- 0.5% (Present Day) Fluvial AEP with Natural Flood Management Strategy (NFM) in Upper catchment

Climate Change Adaptation involves designing/constructing flood mitigation for the present-day flood risk whilst futureproofing designs to be altered in response to changes in flood risk if/when flows increase because of climate change.

Two adaptation strategies were looked at for South Kinross. Firstly, the over-designing of elements of the capital flood works now (walls, embankments, culverts) to be able to support increased pipe sizes or higher flood defences in the future. Secondly, an NFM approach in the upper catchment would provide adaptation through attenuation which may offset some climate change uplifts to flows.

5.1.1 Flood cell 1 – Direct Defences, South Queich

SoP with an NFM Strategy was ruled out by having the lowest BCR and because the variables involved in implementing NFM and the confidence in the benefits realised and time this takes to accrue is highly uncertain.

The remaining potential SoPs showed no clear winner in terms of BCR or MCA metrics. As there was no clear deciding factor guidance was taken on board from the Flood Management (Scotland) Act 2009, recommending a managed adaptive approach rather than a precautionary approach where possible due to the uncertainties in projections of future flood risk. Therefore, fluvial defences are designed to the 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation (upsizing of foundations now to support future wall raising).

A remeasurement of costs carried out as part of the outline design (Section 14.3.1) indicates the CBR is only slightly above 1 (1.11). It is therefore a more sustainable and balanced approach to inbuild adaptation to the below ground elements of the defences rather than overdesign the scheme now.

5.1.2 Flood Cell 2 – Culvert upgrades, Clash Burn

As the flood alleviation options for Flood Cell 2, are primarily culvert upgrades, these are not by nature easily adapted without the need to re-excavate and replace pipes with larger diameter sections. This would result in

[8] Standard of Protection Recommendation, RPS, August 2022

significant disruption to the community/utilities and repeated construction cost. The Clash Burn culvert's full length will be able to accommodate a 0.5% AEP + 40% CC SoP.

5.1.3 Flood Cell 3 – M90 Storage, Kinross Services

Similar to Flood Cell 1, NFM was discounted due to the uncertainties surrounding this option.

MCA and BCR indicates the 0.5% AEP standard of protection to be most appropriate. As the cost of the options for this Flood Cell were significantly lower compared to the other flood cells, RPS recommended that climate change be considered, to ensure a 'no regrets' approach, and to follow the Flood Management (Scotland) Act 2009 recommendation to take forward managed adaptation wherever possible, RPS have recommended a SoP 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation.

It should be noted as is standard practise in flood defence design freeboard is included in the design flood level of walls and embankments to provide a factor of safety against uncertainty. This is discussed in more detail in Section 8.3.

5.2 Design Principles

Several design principles were established by RPS to guide the development of the outline design, as shown in Table 5-1.

Table 5-1 Design Principles

Construction	Operation	Maintenance
Minimise disruption to residents	Minimise visual impact	Ensure safe access for maintenance
Minimise disruption to local business	Maximise floodplain storage and river conveyance	Minimise whole life maintenance costs
Minimise impact on existing buildings and structures near watercourse	Effectively manage new surface water flood risk	Prioritise passive systems to reduce impact on PKC resources
Minimise construction cost	Mitigate risk of future bank erosion	
Minimise utility diversions	Minimise human intervention during a flood event	
Minimise in-river working	Minimise impact on existing key structures (e.g. High Street Bridge)	
Minimise waste material		
Minimise complexity and health and safety risks		

5.3 Design life

The main structural elements of the schemes (culverts, flood defences and upstream storage) have been designed for a minimum working life of 100 years with suitable maintenance activities included in the whole life cost of the scheme. The pumping station associated with back of wall drainage at Koronka Manufacturing is expected to have a design life of 50 years. This has been considered in the maintenance planning and whole life costing of the scheme.

RPS have complied with designer duties as required by the CDM Regulations 2020 for the outline design. A design risk management log is included as an Appendix D of this report. This is a live document which will be reviewed and updated regularly during the development of the scheme.

6 DESIGN CONSIDERATIONS

6.1 Local Development Plan

The preferred scheme has been reviewed against the Perth and Kinross Local Development Plan (Adopted in 2019)[9] to ensure proposals are cognisant of aspirations/plans for the area. Key Locations of interest to the scheme area are illustrated in Figure 6-1and discussed below.

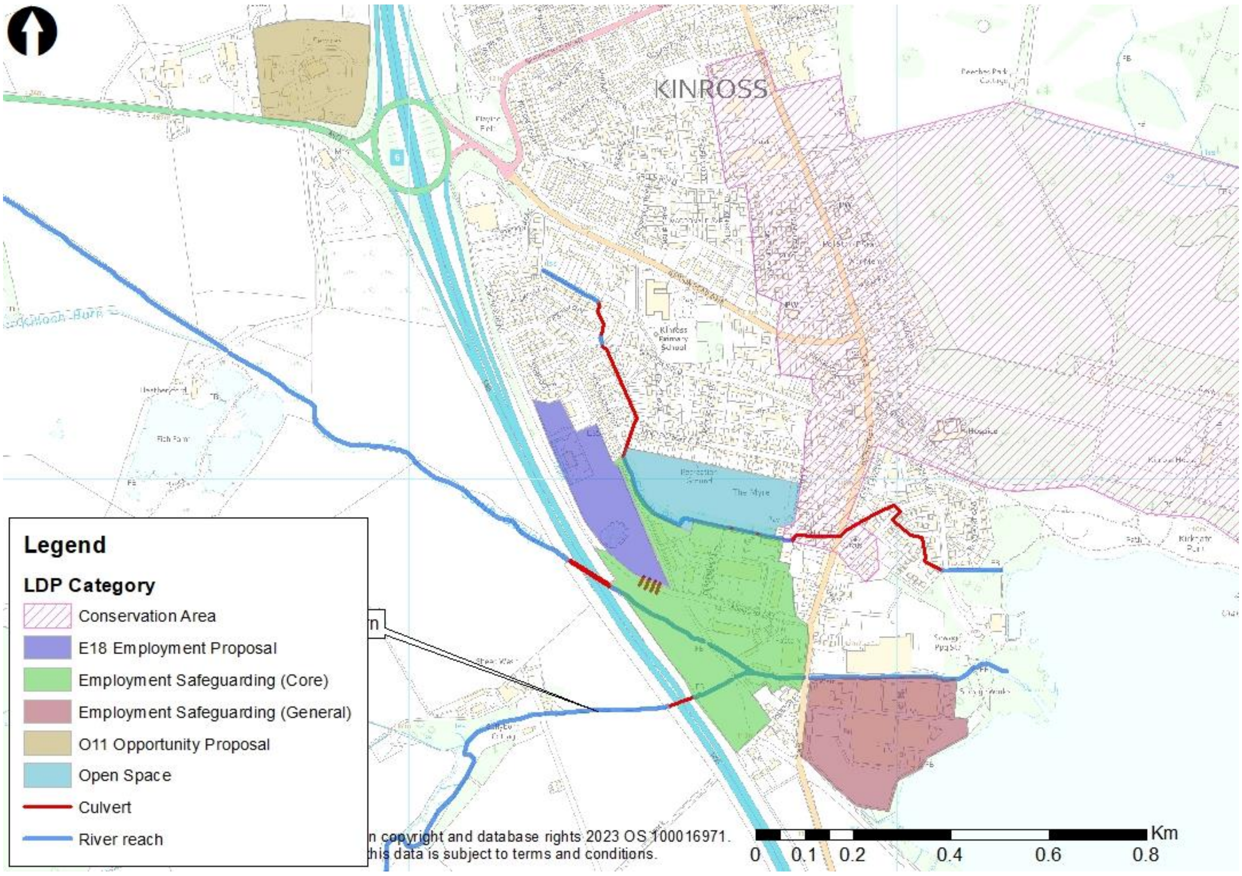

Figure 6-1 Key Local Development Plan locations within Scheme Area

The proposed footprint of the scheme is generally within already developed areas. There are three sites to be aware of within the scheme area. The LDP identifies an employment proposal area at Station Road South (E18) within vacant land bounded by M90 and the Myre playing fields. Part of the Clash Burn diversion culvert runs along the edge of this site boundary. As these works are below ground and outwith the development site, they would not be expected to adversely impact development of this area. An employment safeguarding area is also noted South of the Myre playing fields encompassing land in the south east of Kinross towards the Todd and Duncan site. Again, the footprint of proposals is limited in this area and will not affect the viability of businesses here. There may be some temporary disruption during works but the long-term impacts of the proposed scheme will be minimal through design decision of sheet pile construction to limit impacts on

[9] https://www.pkc.gov.uk/media/45242/Adopted-Local-Development-Plan-2019/pdf/LDP_2_2019_Adopted_Interactive.pdf?m=637122639435770000

surrounding businesses during construction and maintenance. This also has required land take for defence footprints. The scheme will contribute to safeguarding the existing and proposed employment centres by reducing flood damage and disruption to businesses and local residents. Additionally, the Clash Burn culvert elements of the scheme will be below ground and have no impact on these employment areas.

An opportunity to improve the existing motorway Service Area (O11) is shown in the LDP at the Turfhills Motorway Service Area. This is immediately downstream of the proposed flood storage area. The flood storage would not prevent development here and would reduce flood risk to the site which may encourage interest in development if considered in line with by National Planning Framework 4 (NPF4).

Proposed culvert works (Smith Street and Sandport) fall partially within a conservation area identified in the LDP. The works here will be below ground so the main impact will be disruption during construction. Some road raising up at Smith Street will be needed to provide cover for the new culvert below ground. Liaison will be carried out with PKC heritage officer during detail design to manage finishing works sensitively.

Another consideration of the LDP is the protection of local open space at Myre Playing fields. The scheme development has considered the value of this area to the local community and the design has been developed to avoid significant works in this area. A small bund will be constructed on the edge of the playing fields to block an overland flood route affecting properties at Smith Street. This will provide attenuation in the playing fields where flooding would be much less damaging. This is not expected to have a significant impact given the limited footprint of the embankment (3m wide, 0.4m high).

Informal consultation has been sought with Perth and Kinross Council regarding the redevelopment of the former BCA site. This has been considered in the scheme design by ensuring a suitable maintenance access strip can be retained within this development. Although identified as an employment safeguarding location in the LDP, land at the South Queich embankment is defined under NPF4 as floodplain. PKC are liaising with the landowner.

The FPS is therefore not expected to have any negative impacts to LDP proposals and is likely to have a positive impact on achieving the goals set out in the plan.

6.2 Early Contractor Involvement

In September 2020 contractor Balfour Beatty was invited to review the preferred scheme option with regards to the buildability of the proposed scheme and the suitability of the proposed flood defence structures. The result of the consultation highlighted that the proposed scheme does not propose any obvious difficulties with construction. The contractor was provided with the proposed scheme drawings and met with members of RPS's project team and Perth & Kinross Council on site on 3rd May 2023 to assess the suitability of the proposed scheme. Again no obvious difficulties with construction were highlighted. The contractor provided a feasibility report setting out likely construction methodologies, cost and programme.

Access constraints around BCA and Todd and Duncan were key considerations. Use of a reinforced concrete wall along both sites would require temporary sheet piles down the centre of the channel to allow construction of the north side then the south side (one side at a time). Access along the side of BCA building would require a minimum 4m wide working platform supported by temporary sheet piles. For the south side, the BCA car park would be used for access and temporary bridges constructed from north to south at east end and west end, with walls then constructed in 6m lengths of wall as per the north side. This approach would also require 6m gaps to be left and the next section constructed to allow concrete to cure. This would significantly slow construction with walls needing to be completed in 6m sections prior to backfill for a working platform and repeating along the length of the defences. Balfour Beatty advised 6m sections would require a 1 week cycle time. For the approx. 1km of walls required this would generate a long cycle time of approximately 166 weeks for completion of the defence works.

A sheet pile wall solution would result in less complexity in achieving a working area. The BCA car park (east and west) would be used for access and to service a Piling rig. Over the extent of the BCA building (140m) the piles can be installed “self-sufficiently” without in-river platforms. It was noted depending on the finish requirements a light duty river platform may be required over the length of the BCA building to support a small excavator for the finishing works. This would significantly reduce construction time to 48 weeks with an additional 24 weeks for cladding/finishes of walls.

Balfour Beatty provided a Construction Feasibility Report[10] which has been used to inform the design from a buildability perspective. Construction advice has been incorporated into the design sections of this report (Section 7- 9). The report and discussions centred around challenges of access space in some locations and the risk of undermining the foundations of existing buildings from vibration. Liaison with the contractor enabled us to have confidence that different sheet piling approaches could be used on site to overcome space constraints. A Giken Silent Pile Press (pre-boring as required) can be used to reduce vibration risk at areas of tight access (Queich Place) whereas other locations can use a traditional Movaxx piling approach where access can be gained from one side of the river bank (BCA, Todd and Duncan, Koronka). Based on this discussion and other factors discussed in Section 8 a sheet pile design has been adopted.

6.3 Contamination Assessment

The Preliminary Risk Assessment (PRA) Desk Study Report, which has been prepared by RPS, identifies the contamination risks which are to be considered in the design.

In Scotland the management and remediation of contaminated land that, in its current state, is causing or has the potential to cause significant harm or significant pollution of the water environment, is regulated by legislation contained within the Environmental Protection Act (1990) known as Part IIA. SEPA’s guidance on Part IIA and the Preliminary Risk Assessments[11] process directs the reader to the use of the Environment Agency’s (EA) model procedures for the Management of Land Contamination, CLR 11.

A desk study was carried out for the site and surrounding area to allow the identification of potential contaminant sources, potential pathways and potential receptors in accordance with The EA’s Contaminated

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[10] Feasibility Report, South Kinross FPS, Balfour Beatty, 16/06/23

[11] https://www.sepa.org.uk/regulations/land/contaminated-land/technical-concepts/, SEPA, accessed last 27/06/2023

Land Report 11[12]. This formed the basis of a Preliminary Risk Assessment and production of a Conceptual Site Model (CSM). New Land Contamination Risk Management (LCRM) guidance was published in October 2020, but this has not yet been accepted for use in Scotland.

Risk estimation involves detailed evaluation of source - pathway - receptor scenarios to determine whether a linkage exists between any sources of contamination and potential receptors. A risk exists where a receptor is exposed to a source of contamination, via a pathway. If any element of the source-pathway-target linkage is absent, then no risk is present.

The PRA focused on Flood Cell 1 where contamination sources were identified. No contamination sources posing a risk to the scheme or requiring mitigation have been identified for Flood Cells 2 and 3. It is recognised Flood Cell 3 contains potential contamination sources from Kinross Services and Baldo Poultry Farm. Kinross services lies downstream of the proposed works therefore the scheme would not be expected to affect any contaminated land here. Additionally, runoff from the Poultry Farm would not be considered a contaminated land issue.

The PRA has highlighted potential contamination sources, pathways and receptors which are likely to be present on the site. The main sources of contamination include those associated with historic industrial activity. This desk study provides suitable information on risk to inform outline design so that risks can be considered in the form and constructability of scheme components. The location of potential contamination sources is shown in Figure 6-2.

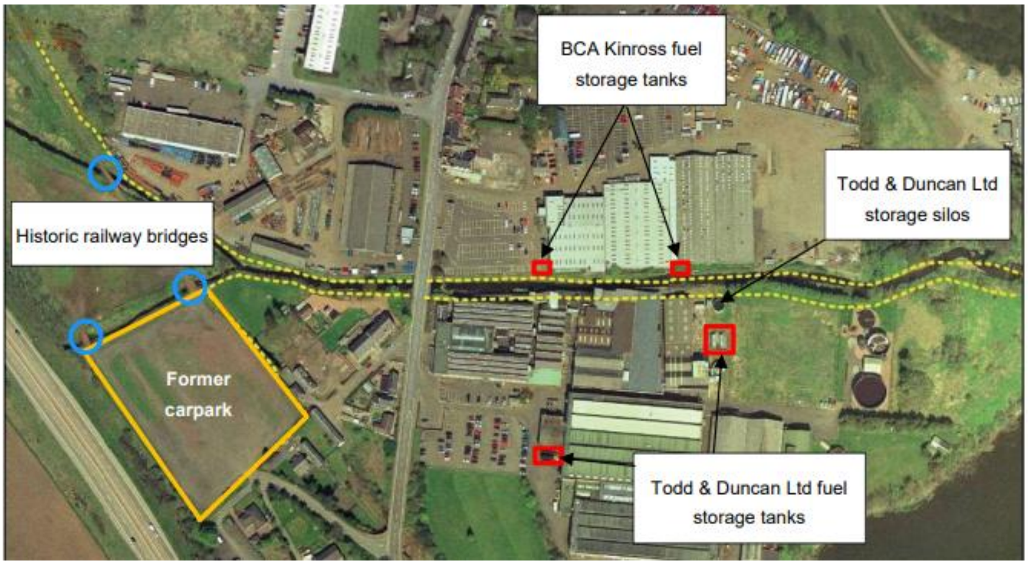


Figure 6-2 Location of Potential Contamination Sources

In order to consider potential risks at the site, a conceptual site model was developed, to examine the potential source - pathway - receptor linkages that may exist on the site. The conceptual model and the risk assessment for the site are illustrated in Table 6-1.

[12] Model procedures for the management of land contamination - CLR11, Environment Agency, September 2004

In accordance with recommendations in the Environment Agency's Contaminated Land Report 11 'Model Procedures for the Management of Land Contamination', an intrusive site investigation and quantitative risk assessment should be carried out to inform detail design. This should ascertain whether source-pathway-receptor linkages are present.

Table 6-1 CSM Contamination Risks

Source	Potential Pathway(s)	Potential Receptor(s)	Relevant Source – Pathway – Receptor Linkage	Further Investigation Required
Onsite Sources				
Potential contaminants from former railway lands	Subsurface infiltration, leaching from sub-soils and groundwater flow.	Shallow groundwater, bedrock aquifer South Queich River, Gelly Burn	Contaminants in soil have the potential to leach through sub-soils and effect shallow groundwater, adjacent surface waters and/or the bedrock aquifer.	**Yes** - Intrusive investigation and collection /analysis of sub-soil and groundwater samples followed by generic risk assessment as per CLR 11 methodology will be required prior to commencement of construction.
Soil Gas: Radon	Migration along cracks in foundations and service trenches	Humans in the form of future site users	As demonstrated on the UK Radon maps, the site falls within a 1km grid square with the lowest Radon potential; less than 1% of homes are above the action level.	**No**
Soil Gas Made Ground or highly organic soils may contain high organic content that is degrading and producing Methane, Carbon dioxide and depleted Oxygen gases.	Migration along cracks in foundations and service trenches	Humans in the form of future site users	No building receptor is proposed as part of the flood defence works.	**No**
Offsite Sources				
Historical factories Current vehicle servicing & maintenance workshops and factories Current and historic close to the South Queich River Scottish Water Wastewater Treatment Plant Hydrocarbons and PAHs from residential, commercial & industrial fuel storage	Subsurface infiltration, leaching from sub-soils and groundwater flow	Shallow groundwater, bedrock aquifer. South Queich River, Gelly Burn	Contaminants in soil have the potential to leach through sub-soils and effect shallow groundwater, adjacent surface waters and/or the bedrock aquifer.	**Yes -** Intrusive investigation and collection /analysis of sub-soil and groundwater samples followed by generic risk assessment as per CLR 11 methodology will be required prior to commencement of construction.

6.4 Geotechnical Considerations and Ground Investigations

The following section details the ground investigations undertaken to support the outline design. The works undertaken by RPS include an initial intrusive ground investigation and subsequent factual reporting. The initial GI works targeted the main areas for the flood scheme, along and adjacent to the South Queich Water.

The ground investigation undertaken by RPS was designed and executed in line with UK best practice, notably BS5930:2015 Code of Practice for Site Investigations and BS10175:2011+A2:2017 Investigation of Contaminated Sites - Code of Practice, together with BS EN 1997-1 (2004), BS EN 1997-2 (2007) and BS EN ISO 22475-1 (2006).

In addition to the above, a factual report on the Ground Investigation was produced, as detailed below:

- Factual report on site investigation for land at South Kinross Flood Protection Scheme, Rev 1, March 2020. Document Reference S1046/1.

It should be noted the GI carried out did not provide conclusive results sufficient to fully inform the detail design stage of the scheme therefore further GI is required.

6.4.1 Desk Based Assessment

A desk based review of all pertinent historical data relating to the Scheme was undertaken. The objective of the review was to summarise the available geotechnical and geoenvironmental data and provide a geotechnical and geoenvironmental assessment of the ground conditions within the Scheme area, and to identify any notable geotechnical or geoenvironmental constraints to design.

A number of main geotechnical constraints identified are summarised as follows:

- Insufficient historical ground investigation information to establish appropriate geotechnical parameters for design;
- Potential presence of soft compressible soils (particularly Lacustrine and Alluvium) throughout the Scheme area;
- Potentially difficult ground conditions for construction (i.e. driving sheet piles);
- Limited information available on the groundwater regime;
- Potential for shallow groundwater across the Scheme area;
- Complex superficial geology with varying engineering properties; and
- Uncertain bedrock profile, with potential for bedrock depths to vary significantly across the scheme.

In addition, a number of geoenvironmental constraints were identified:

- The potential for contamination associated with historical site uses and made ground associated with former land uses; and
- Uncertain extent, thickness and nature of made ground across the Scheme.

6.4.2 Ground Investigation Works

A ground investigation scope[13] was developed based on the findings of the desk-based assessment to investigate the identified ground risks. The initial phase of works was completed between November and December 2019.

The ground investigation was targeted on the location of the proposed flood defences for the Scheme. Plans and logs of the intrusive investigations, together with testing data are provided within the Factual Report for the works (referenced above). An overview plan of GI works is provided in Figure 6-3 and Figure 6-4The scope of the investigation is summarised below:

- 6No. Cable Percussive Boreholes (BH), within superficial soils;
- 4No. Windowless Sampler Boreholes (WS), within superficial soils;
- 13No. machine excavated trial pits (TP), within superficial soils;
- 2No. machine excavated trial pit trenches (TT), within superficial soils;
- Installation of 6No. groundwater and ground gas monitoring wells;
- In-situ testing, including SPTs;
- Laboratory testing of selected soil samples for geotechnical and geoenvironmental analysis; and,
- Groundwater and ground gas monitoring of selected borehole installations.

Figure 6-3 Exploratory Borehole Location Plan, Upstream High Street Bridge

[13] Ground Investigation Particular Specification, September 2019, RPS

Figure 6-4 Exploratory Borehole Location Plan, Upstream High Street Bridge

6.5 Geotechnical Considerations

6.5.1 Geotechnical Investigation Findings

Desk Studies and Investigations summarised in Section 6.4 have enabled geotechnical elements of the outline design to be developed. Quoted sample locations are illustrated in Figure 6-3 and Figure 6-4. The site is underlain by predominately lacustrine deposits comprising interbedded sand and gravel, with localised areas of more cohesive deposits. Detailed descriptions of the various encountered soils are detailed below:

- Topsoil was recorded across the majority of the site, varying in thickness between 0.02m and 0.35m. No deleterious materials were found to be present within the topsoil.
- Made Ground was encountered in a number of the cable percussive and windowless sampler boreholes across the site, extending to depths between 0.5m and 1.65m bgl. Made ground typically recorded granular deposits of sandy gravel, ashy sand and gravelly sand.

- The natural soils at the site consisted of granular materials across the site with deposits largely comprising sandy gravel and gravelly sand, with locally discontinuous strata of soft silt (BH03 & BH04).

Slightly more cohesive deposits were recorded within a small number of positions as noted below:

- Clayey sand recorded in BH2 between 1.4m and 3.0m bgl (N value of 4 recorded at 1.2m and 24 at 2.0m);
- Silt recorded in BH3 from 4.70m to the base of the borehole at 10.0m bgl (N values of 5 and 9 recorded);
- Silt recorded in BH4 from 2.45m to the base of the borehole at 10.0m bgl (N values between 6 and 10 recorded); and,
- Clay recorded within WS3 between 0.35m and 1.80m with an 'N' value of 20.

6.5.1.1 Groundwater

Groundwater strikes recorded during the GI works were typically limited to the cable percussive boreholes, with the exception of Trial trench 1. No groundwater strikes were recorded within the remaining machine excavated trial pits. Although no groundwater was encountered within the windowless sampler boreholes it is considered that this is due to the speed that the boreholes are advanced, which can mask water strikes and seepages.

The groundwater strikes recorded during the works varied between 1.2m and 8.5m bgl, which rose to between 0.8m and 7.6m bgl after 20mins.

6.5.1.2 Contamination

As discussed in Section 6 there is likely to be a number of contamination sources which may pose a risk during construction when material is being moved. Full assessment is required to determine the need for remediation. The risk of contamination is another reason for sheet piled walls being preferred to retaining walls for flood walls as this will reduce the amount of material which needs to be excavated therefore reducing contact with potential contaminated material, reduced risk of leaching through disturbance and reduced risk and cost of disposal of contaminated material.

6.5.1.3 Geotechnical Characteristics and Summary of Risks

Following completion of the ground investigation works the following geotechnical risks have been identified which will require to be addressed during the detailed design stage of the works. The identified risks are detailed below:

- Local variability of superficial deposits;
- Full extents of made ground present across the entire scheme extents;
- Soil Contamination;
- Unknown depth to bedrock - impact on construction (drivability of sheet piles);

- Presence of Shallow Groundwater; and,
- Insufficient GI to define design parameters to undertake detailed design of the scheme.

The development and implementation of mitigation measures for the identified risks will be continued through detailed design and construction of the Scheme.

6.5.2 Seepage Analysis

As part of the scope of works for the Scheme, seepage analysis was undertaken for the proposed flood defence structures. The aim of the analysis was to establish a suitable cut off level required to reduce the risk of ground water flowing under the proposed defences and causing surface water flooding behind the proposed defences. This work is fully detailed in the South Kinross Flood Protection Scheme Seepage Analysis[14] Technical Note.

Through use of the ground investigation data, a model of the soil permeability at nine locations (7No. through proposed sheet piled walls & 2No. through embankments) below each structure was developed, and subject to analysis in SEEP/W. The following key criteria were adopted:

- Key ground parameters (including soil permeability, existing groundwater levels) were derived from available ground investigation data and published data; and,
- A steady state analysis was undertaken utilising a single continuous flood level.

The analysis provided the seepage flow rate for each of the proposed cut-off levels for the walls and embankments. It has been based on the depth of ground surveyed in the borehole logs but as none of the boreholes reached bedrock or an impermeable layer it is impossible to know the full depth of the flow paths available. Allowing for this uncertainty, the analysis was also extremely conservative assuming the extreme 0.5% AEP flood level is constant rather than a varying level. The required cut off depths calculated range from 4m to 15m giving a worst-case indication of what is required suitable for outline design. Full seepage analysis will be required to be undertaken during the detailed design stage once further GI works have been undertaken including in-situ permeability testing.

The nature of any seepage cut off employed will depend on the ground conditions and nature of the structure but would most likely comprise of an impermeable barrier to seepage flow, either through placement of a sheet pile cut off wall, or a shallow trench infilled with impermeable material where embankments are being proposed. Back of wall drainage will be incorporated to drain and discharge any surface water ponding behind defences. Outfalls will be provided at various points to discharge flow to the watercourse. A pumping station will be required at Koronka Manufacturing due to the volume of surface water flow likely exceeding a typical drainage feature.

[14] South Kinross Flood Protection Scheme Seepage Analysis Technical Note. RPS, June 2021.

6.6 Geomorphological considerations

Physical changes to a river system can affect the morphology of the river which can have significant impacts on the biology and ecology from what would be expected in a natural system with no or limited physical changes. RPS have considered geomorphological impacts through a detailed Water Framework Directive (WFD) Assessment[15] which has been used to inform outline design.

An Environmental Standards Test (EST) was undertaken to determine whether the proposed activity or activities will result in deterioration in morphological quality and thereby increase the risk of failing to achieve the environmental objectives of the WFD. The EST for the South Kinross FPS has demonstrated that at the local reach level there is a risk of deterioration in morphological conditions for the Gelly Burn, however the South Queich is not significantly impacted as it’s status at the local reach level is already considered ‘bad’.

Overall, the EST for the South Kinross FPS has failed for both the South Queich and the Gelly Burn as the Local Reach Assessment was failed by both watercourses. As a result, a Good Practice test will be required as part of the Controlled Activities Regulation (CAR) application for both the South Queich and the Gelly Burn which is required for construction. A derogation test will also be required for the South Queich, in accordance with regulatory method WAT-RM-02: Regulation of Licence-level Engineering Activities, due to the exceedance of the Single Activity Limit (SAL) by proposed flood walls. However, the existing high impact realignment has already exceeded the SAL limit here indicating that hydromorphological supporting conditions have already been significantly affected in base conditions. It is therefore unlikely that the scheme will have any additional negative impact on the watercourse based on its current poor condition.

6.6.1 Scour Protection – Banks/defences

The requirement for scour protection was assessed using guidance Design Manual for Roads and Bridges, BD 97/12 The Assessment of Scour and Other Hydraulic Actions at Highway Structures, May 2012.

To assess scour potential and the risk posed to flood walls and river banks, the following steps were followed:

- The proposed scheme model was run for the 1 in 200 year plus climate change event and design flows, velocities, and water level extracted at key locations (Table 6-2).
- A level two scour assessment was carried out to calculate scour depth based on the worst case water level and velocities at the flood wall structure (Table 6-3).
- The relative scour is then calculated by dividing total scour depth by foundation depth. A Priority factor was then determined based on the foundation type, History of scour problem, foundation material, river type and importance of the structure (Table 6-4).
- The scour risk rating was then assessed based on the ‘Priority Factor’ and the ‘Relative Scour’ depth. Scour risk ratings range from low risk (1) to high risk (5).

[15] Water Framework Directive Assessment, RPS, October 2021

Erosion protection cannot be ruled out for risk ratings of 2 or above. Based on the assessment partnered with findings from RHAT indicates erosion protection may be required downstream of the High Street bridge to the boundary of the former BCA site.

Table 6-2 0.5% Design Flows, Velocities and Water levels

Parameter	Gelly Burn	South Queich U/S High Street Bridge	South Queich D/S High Street Bridge	Leven Nature Reserve
Design Flow Peak (m^3/s)	16.68	48.35	47.72	44.99
Flow velocity (m/s)	1.05	1.89	3.52	1.75
Water Level (mAOD)	111.19	111.17	110.15	108.97

Table 6-3 Estimated depth of Scour

Parameter	Gelly Burn	South Queich U/S High Street Bridge	South Queich D/S High Street Bridge	Leven Nature Reserve
Constriction Scour (m)	0.08	2.54	3.03	2.58
Local scour footing (m)	1.21	1.41	1.41	2.00
Total scour (m)	1.29	3.95	4.44	4.59

Table 6-4 Risk and Priority Rating

Parameter	Gelly Burn	South Queich U/S High Street Bridge	South Queich D/S High Street Bridge	Leven Nature Reserve	Comment
Foundation Depth (m)	10	7	4	7	Based on conservative seepage
Foundation type factor, F	0.75	0.75	0.75	0.75	Piled
History of scour problem factor, H	1	1	1	1.5	Identified from RHAT analysis. Some erosion issues identified within SQ at Loch Leven nature reserve
Foundation material factor, M	1	1	1	1	Granular material based on desktop GI
Type of river factor, TR	1	1	1	1	Lowland
Importance factor, V	1	1	1	1	Max value as failure would have serious consequence to people and property
Relative scour depth DR	1.29	0.56	1.11	0.66	Max scour depth/ foundation depth
Priority factor Pr	0.75	0.75	0.75	1.125	PF=F.H.M.TR.V
Risk Rating	5	5	4	5	Based on conservative seepage

Designs for the erosion protection will have to adhere to the SEPA Good Practice Guide for Bank Protection, SEPA has defined two classes of bank protection measures; Green (soft) and Grey (hard) which are;

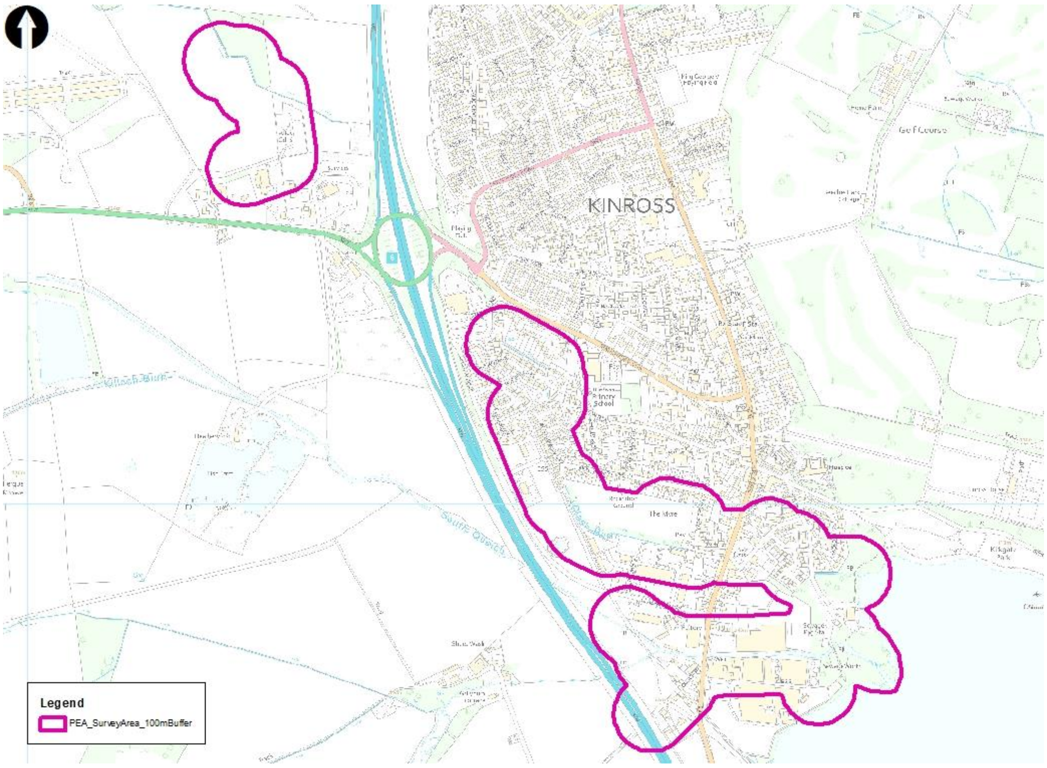
- Green Bank (Soft) Protection – such as biodegradable geotextiles, un-mortared rip rap at bank toe or re-profiling of the existing bank using local natural materials.
- Grey Bank (Hard) Protection – such as major bank modification using artificial materials, reinforced concrete and sheet piled walls, gabion mesh baskets or mattresses filled with stone, reinforced earth (compacted soil between layers of geotextile), stone revetments (large pieces of rock armour placed on the river banks), grouted revetments, non-biodegradable geotextiles (fabrics made from synthetic material).

The type of erosion protection will be determined during detailed design when foundations arrangements are finalised and will be designed to limit environmental impact (as far as practical), is cost effective and achievable, whilst considering the existing river channel characteristics and any future access and maintenance requirements.

Given the limited velocity increases, lower costs and environmental benefits green bank protection is preferred. However, PKC Structures Approval Procedures state that green bank protection is not recommended unless otherwise agreed. On this basis, liaison will be required with the Structures team during detail design to determine the final requirements of scour protection.

6.7 Ecology

A Preliminary Ecological Appraisal (PEA) of land within and around Kinross (Figure 6-5) was carried out. This work is fully detailed in the South Kinross PEA Report[16]. The purpose of the PEA was to determine the ecological baseline of the site and highlight any potential ecological sensitivities which would require investigating prior to commencement of the flood scheme. The PEA involved a desk study and Phase 1 Habitat Survey.



[16] South Kinross PEA Report, RPS, May 2021

Figure 6-5 PEA Study Area

6.7.1 Designated Sites

Loch Leven is within the survey area and is designated as a Ramsar Site, SPA, SSSI and NNR, qualifying features include waterfowl species such as pink-footed goose and whooper swan. The pasture/arable fields within Area A would provide foraging habitat for waterfowl associated with the Loch Leven SPA. The South Queich connects the development site to the Loch, therefore there exists a pathway for water contamination to occur. Therefore, Loch Leven is in close proximity to the proposed works and may be subject to negative impacts. This will be fully assessed as part of the Environmental Impact Assessment and Habitat Regulations Assessment (HRA).

6.7.2 Invasive Non-Native Species

Japanese rose, an INNS, was recorded within the survey area. As the survey was completed just at the start of the main growing season the presence of further INNS could not be fully assessed. Due to the presence of INNS within the survey area, a management plan for INNS will be provided with a targeted survey to map their locations as part of the EIA.

6.7.3 Protected Species

Table 6-5 summarises the protected species assessed and their potential to be found in the study area. Based on this, recommendations have been made for further survey work to mitigate impacts of the scheme against protected species.

Table 6-5 Protect Species Identified and Recommendations

Protected Species	Further Actions
Bats - Potential roosting features identified and potential for South Queich as a bat commuting corridor	Further survey required - presence/absence surveys by either aerial inspection or dusk emergence and dawn re-entry surveys. South Queich in Area B - static bat detectors to collect bat activity data during the main bat activity season (from May to September, inclusive).
Otters - Area B offers potential for foraging, commuting and for otter resting sites. Area A was dry therefore the likelihood of otters occurring in this area is low.	Survey for signs of otter activity and resting sites required on any watercourses, ditches or suitable habitat within the site and 30m of the site boundary and 250 m upstream and downstream of the South Queich.
Water Voles	Limited potential – no further surveys
Potential badger activity was recorded within the site (Area A).	Dedicated survey for signs of badger activity required on optimal habitat including scrub and woodland within the site and 100m of the site boundary.
Reptiles - Suitable habitat identified within the site	Potential refugia and/or hibernacula features that will be unavoidably disturbed should be dismantled prior to construction commencing under the supervision of a suitably experienced ecologist during late May to September whilst reptiles are active
Red Squirrel - potential and squirrel feeding signs were found	Survey for squirrel dreys required within the site and 50m of the site boundary.
Great Crested Newts - No habitat considered suitable	No further surveys
Nesting Birds	If tree and/or vegetation clearance is to be carried out between March and August (inclusive) then checks for nesting birds should be undertaken by an experienced ecologist no more than 24 hours prior to any vegetation clearance being carried out. Any active nests identified should be left undisturbed until the chicks have fledged.

Protected Species	Further Actions
Winter wader – potential presence for access to Loch Leven, the arable/pasture fields in Area A and the wetland habitats in Area B offer foraging and roosting grounds.	Winter wader surveys will be performed to assess their use of the site, as Loch Leven, the arable/pasture fields in Area A and the wetland habitats in Area B offer foraging and roosting grounds. Winter walkovers will be scheduled once per month from September to April to collect data for these species and inform HRA.

6.7.4 Trees

A scattered number of trees are present along the left and right banks of the proposed hard defences and isolated trees located at the Nan Walker Wynd culvert outlet (Figure 6-6). These will need to be felled to facilitate construction. Given the industrial setting of this area, the visual impact is expected to be minimal however there may be impact on nesting bird habitats which needs to be assessed. Minimal trees were identified at the site of proposed upstream storage (Figure 6-7) therefore only a small area of vegetation will need to be cleared to facilitate construction of the control structure outlet. As part of the EIA Arboriculture surveys, liaison with the LPA woodland officer will be carried out to determine where trees can be retained and replaced through planting.

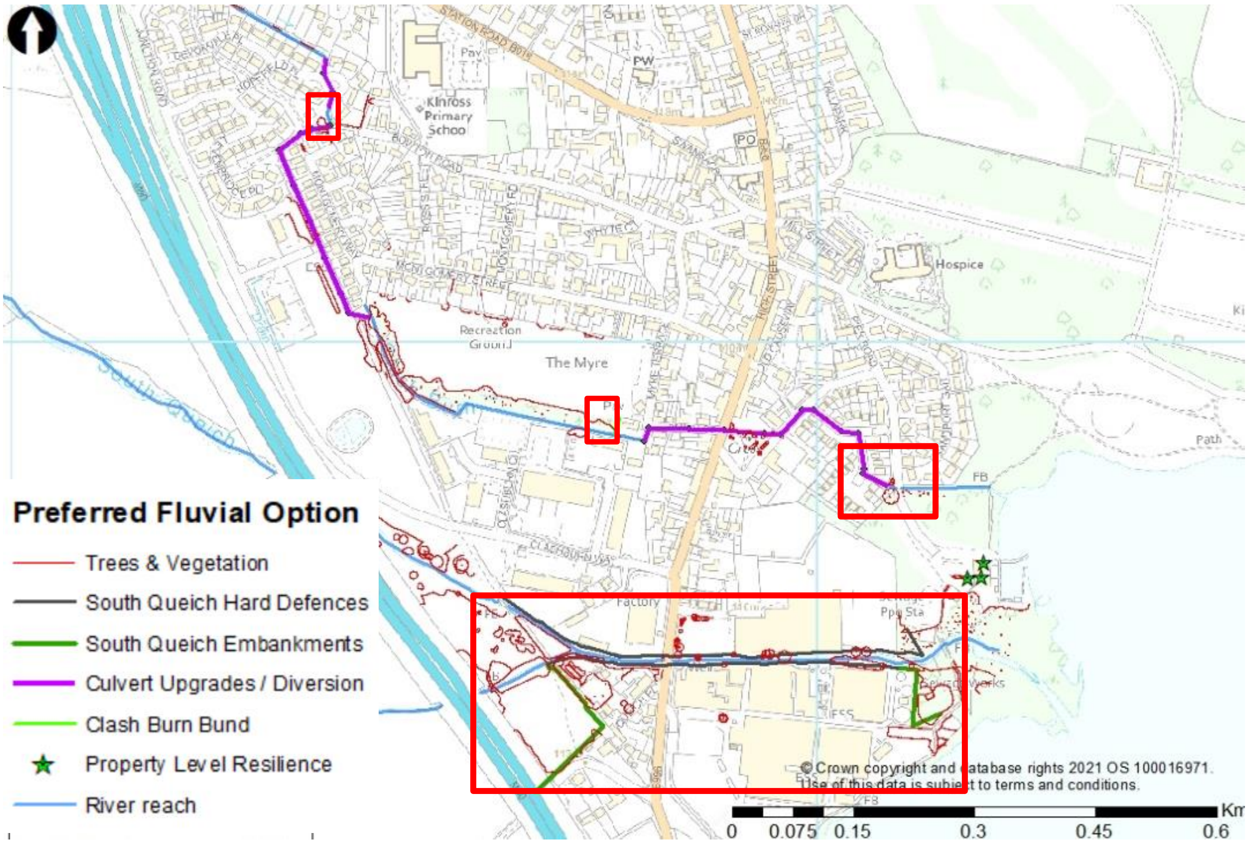


Figure 6-6 Tree and Vegetation Clearance Potential – South Queich

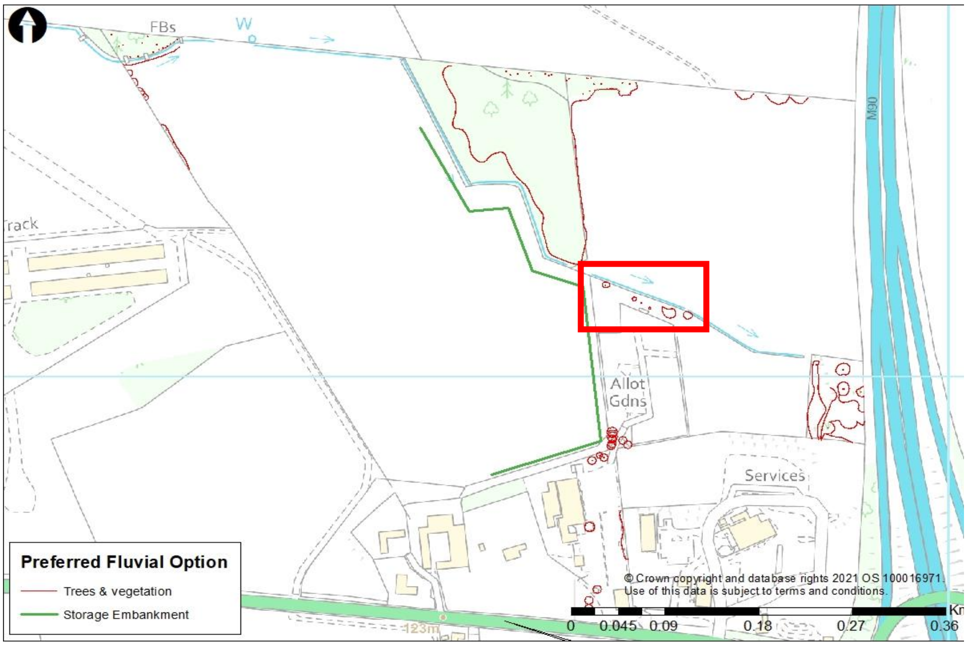


Figure 6-7 Tree and Vegetation Clearance Potential – M90 Storage

6.8 Interface with Existing Structures

In line with the scope, the impact of the flood scheme on any exiting bridges has been assessed to consider:

- water flow acting on the bridge structure (increased hydrodynamic loads);
- the potential for river bed or bank scour on bridge piers and abutments;
- changes in flow regime within the river;
- the tying in of new flood defences to existing bridges;
- temporary impacts during scheme construction.

Four structures are potentially impacted by the scheme as shown in Figure 6-8 below.

Table 6-6 illustrates changes in flood levels at remaining structures. This shows that generally water levels are increased by 200 – 300mm at the various structures however flood levels remain below deck level.

Table 6-6 Water Level Change at Non-Perth and Kinross Council Adopted Structures

Scenario	Deck Level mOD	Base 0.5% AEP+CC (mOD)	Scheme 0.5% AEP+CC mOD
Junction Road Footbridge	112.02	111.23	111.45
Loch Leven Footbridge	109.12	108.55	108.85
Boathouse Crossing	108.5	108.04	108.33

The High Street bridge and the Gelly Burn Crossing are the only structures which require tie in with the proposed defences. The loading and scour impact on non-PKC adopted structures is assessed in Section 11.3.3.

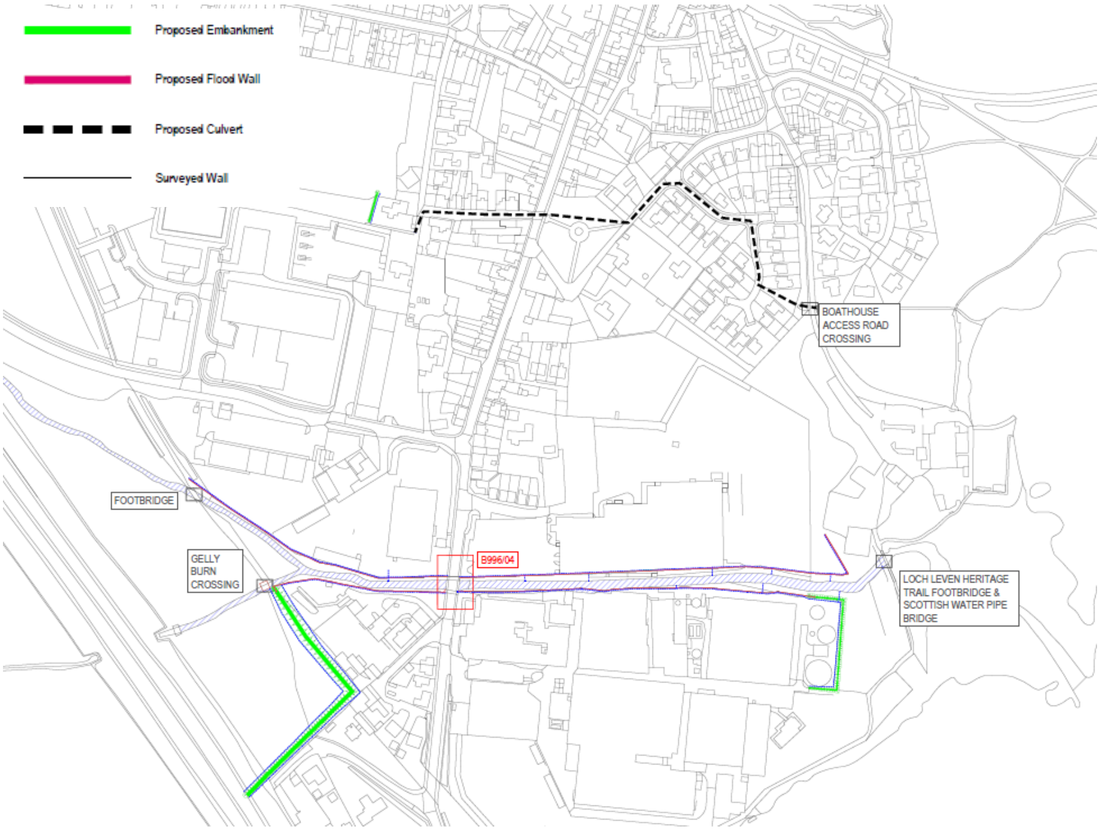


Figure 6-8 Significant Structures

6.8.1 High Street Bridge

High Street bridge is a PKC masonry arch bridge carrying the main access route through South Kinross. Its dimensions are summarised in Table 6-7. It is assumed walls picked up as part of the topographic survey along the Todd and Duncan and BCA sites take existing loading from the bridge. The new defence line will be installed in front of the walls with sheet piles to be structurally independent from the bridge. A central hydrophilic strip with sealant will be used to form a watertight joint between the existing bridge and new flood wall. The bridge deck level is significantly higher than the required top of wall level (111.9mAOD compared to 111.3mOD) therefore the bridge can remain unchanged without the risk of a new flow path being introduced.

Table 6-7 High Street Bridge Dimensions

Bridge Name	Soffit Level mAOD	Lowest level of bridge wall mAOD	Type	Span (m)	Width (m)	Arch rise (m)	Barrel thickness (m)
B996/04 South Queich	111.33	111.89	Masonry arch	9.43	10.8	2.1	0.52

The scheme's impact on flood levels has been reviewed. It can be seen in Table 6-8 that the water level at the bridge would increase because of the scheme and a freeboard of 0.9m and 0.49m would remain in the 0.5%AEP and 0.5% AEP CC event respectively.

Table 6-8 Water Levels at High Street Bridge

Scenario	0.5% AEP	0.5% AEPCC

Base	110.15	110.32
Scheme	110.43	110.84
Scheme with 50% blockage at bridge	111.27	111.65

A 50% blockage scenario was also tested to determine the worst case impacts on water levels. With the scheme in place, a 50% blockage at the bridge would result in the water level reaching 320mm above soffit level at 111.65mAOD. However, given the lowest level of the bridge parapet wall is 111.9mAOD in the 0.5% AEPCC event, no overtopping would occur. The risk of blockage has been assessed as low based on historical evidence, existing maintenance regime, cross-sectional area, capacity and catchment type. No record of past blockage was found and maintenance records available up to 2017 indicated that the most recent clearance of the bridge to be in 2003 suggesting the bridge is not frequently experiencing debris build up. On this basis the blockage scenario is considered to be overly conservative.

Although no overtopping is predicted in any scenario it is recognised freeboard would fall below the 600mm required in PKC Structures guidance therefore the bridge may need to be closed in events above the 0.5% as a safety precaution. Further analysis is required to ensure that the bridge is capable of withstanding increased water level and flow velocities associated with the scheme, both in terms of ensuring the bridge has sufficient scour resistance and load capacity. This is assessed in Section 11.3.

A SEPA gauging station is located upstream of the High Street bridge. This requires access to the watercourse and as such existing steps will need to be maintained in this location. The bridge will be temporarily impacted by temporary diversion/culverting of the watercourse to facilitate access downstream though no negative impacts are anticipated.

Figure 6-9 High Street Bridge

6.8.2 Gelly Burn Crossing

The metal bridge at the Gelly Burn is a private footbridge. The bridge deck levels sits at 110.9mOD whilst the proposed defences are at 111.3mOD. To tie into the defences, the bridge will either need to be raised by 400mm or replaced. The bridge is unlikely to take the additional load associated with increased water levels and therefore will be replaced.

Figure 6-10 Gelly Burn Metal Bridge

6.8.3 Junction Road Bridge

The Junction Road Bridge is just downstream of the flood wall tie in point at the Bridgend Industrial Estate. The flood wall needs to tie into high ground here which is formed from the former railway embankment. Although possibly formed of porous material (gravels) the embankment currently retains floodwater and there have been no reports of this breaching in its history. An analysis of informal flood defences[17] found this structure to be in good condition. Flood levels at the embankment tie in point will not be significantly increased by the scheme here (70mm increase in water level at 0.5%AEP+CC event). On this basis the structure is suitable for tie in. There is a risk of erosion at the tie in point so this needs to be carefully designed. On this basis the sheet pile flood wall will continue approximately 5m into the existing embankment to provide a watertight seal. This will cause any flow entering the tie-in to track alongside the pile on one side and continue around to the main flood walls. Testing of the embankment material will be carried out as part of the GI.

[17] Informal Flood Defence Review, RPS, August 2023

Figure 6-11 Junction Road Footbridge

6.9 Public Utilities Diversions

During the development of the outline design, utility information was collated from providers and utilities were mapped based on best available information to identify constraints. RPS reviewed the utilities against the proposed scheme to determine the potential disruption to utilities. Clash Drawings and outline designs proposals were issued to each utility provider in order that they were able to provide a preliminary estimate for any costs associated with the protection and diversion of their services. A register of affected services and their likely actions are summarised in Appendix C.

Some of the more significantly affected locations are;

- Smith Street
- Nan Walker Wynd
- High Street
- High Street Bridge

Requests for preliminary (C3) Cost estimates were made to Openreach BT, Scottish & Southern Energy (Power Distribution), Scotland Gas Networks, Scottish Water and Indigo. At the time of writing, only SSE and Indigo have provided preliminary cost estimates. On this basis, project knowledge has been used to supplement this information within the Economic Assessment. This will be updated again at detail design stage. Ongoing engagement is being carried out with the service providers to develop satisfactory approaches (diversions or protection).

6.10 Upstream and Downstream Impacts

6.10.1 M90 Storage

The M90 storage area impact will alter flood risk upstream by design. The proposed upstream storage area will capture an overland flow path from agricultural land blocking it from reaching the Kinross services. This will require the flooding of a less vulnerable field area for which the landowner will be compensated. Flows will be discharged to the Ury Burn. For outline design stage, a greenfield runoff rate has been assumed so as to prevent any increase in flood risk to this Burn.

6.10.2 Clash Burn

Sections of the Clash Burn will be upsized or diverted resulting in increased flow. This has been tested in the hydraulic model to determine if there are any detrimental impacts and identify mitigation measures where this is the case.

The open channel section of the Clash Burn through Myre Playfield will be unchanged, and modelling has indicated the Burn to overtop through much of this section. With the scheme in place most of this overtopping is removed due to improved conveyance downstream. Minor exceedance remains at the 0.5% AEP event with CC. This is limited to the end of the open reach, immediately upstream of the Smith Street and is much reduced (0.015m^3/s compared to 0.62m^3/overtopping).

There are 4 small crossings through this section of the Burn with the potential to be impacted by higher flows. These have been included in the baseline and optioneering models to factor in impacts to these structures. At the upstream end of the open reach, the first footbridge is shown to experience an increase in flood level due to increased flow from larger pipe upstream. However, this poses no flood risk to the bridge as the flood level would remain well below deck level (940mm) and flow is able to pass freely through the bridge.

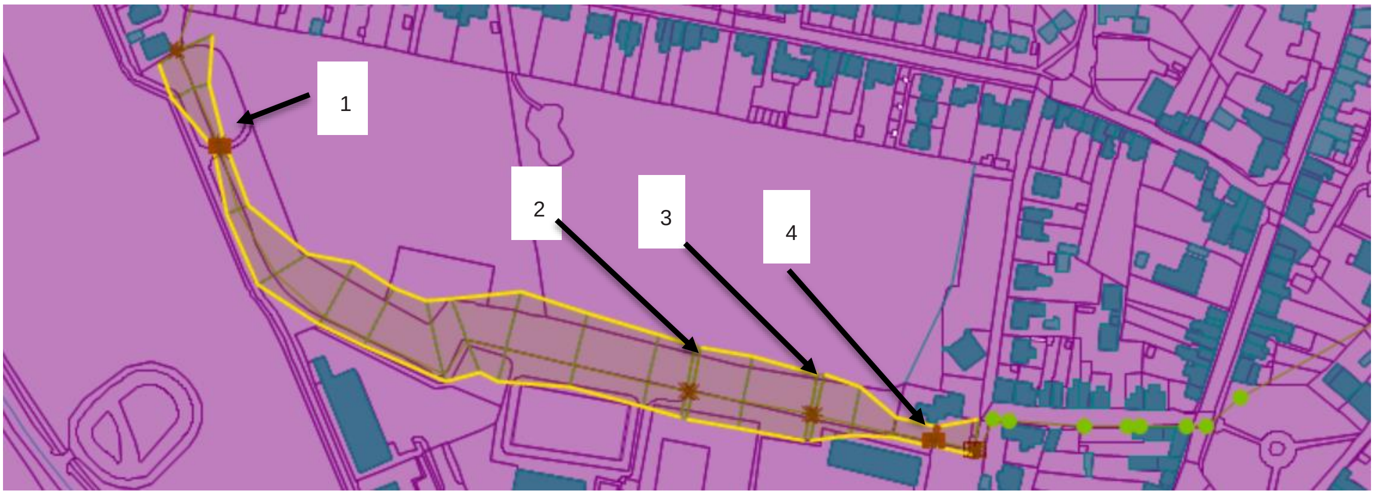


Figure 6-12 Myre Playing Field Crossings – Model Extract

There is no increase in flood risk to the other 3 structures as the capacity of the Clash Burn is able to manage increased flow. Flood levels are reduced at these structures compared to baseline as flow is no longer restricted at the downstream end due to the increased culvert downstream. At these structures, flood levels would exceed deck level during this extreme event but the volume of spill over the deck would be much reduced compared to current conditions as a result of the scheme indicating a betterment in the current flood risk. These crossings could be raised to prevent any overtopping but given the low vulnerability of land affected by minimal overtopping (parkland) and the non-critical nature of the bridges, the cost and disruption of these works is likely to outweigh the benefit. Resilience measures of trash screen installation are instead recommended for the two culverted structures to reduce any potential increased risk due to blockage.

Table 6-9 Upstream/Downstream Risk Clash Burn through Myre Playing Fields

Structure	200yrcc Base Flood Level (m)	200yrCC Scheme Level (m)	Deck Level (m)	Change in Flood Level (m)
1 Footbridge	112.00	112.21	113.15	+0.21
2 Culvert	110.50	110.27	110.10	-0.23
3 Culvert	110.38	110.21	108.83	-0.17
4 Clash Footbridge	110.40	109.88	111.85	-0.52

Downstream of the proposed culvert upgrade, water levels at Boathouse Access Road are increased because of the scheme by 380mm due to increased channel capacity. To mitigate this, it is proposed the bridge is replaced and the culvert extended to provide access and maintain consistent flow capacity.

Further downstream, there is a small footbridge structure. Flood levels are increased from 107.9mOD to 108mOD with the scheme in place. The bridge itself is predicted to overtop from the 0.5% AEP CC event in base conditions (deck level 107.8mOD). This remains the same with the scheme in place therefore there is no significant change in flood risk at the structure a result of the scheme though it is recognised the volume of overtopping would be increased. A review of loading and scour risk in Section 11.3.3.1 shows no increase in loading to the Loch Leven bridge despite the increase in water level. This is due to reduced velocity in the channel as overtopping on the right bank is increased. Extensive flooding is predicted along the right bank of the Clash Burn under current conditions between the boathouse road bridge and the footbridge at Loch Leven therefore although overtopping is increased there is no real change in flood risk. This area is green space, and no receptors experience increased risk. With the scheme in overland flow from Clash Burn culvert exceedance is removed therefore the overall impact is a net decrease in flood risk. Based on this analysis, proposed works to the Clash Burn will have no significant detrimental impacts upstream or downstream.

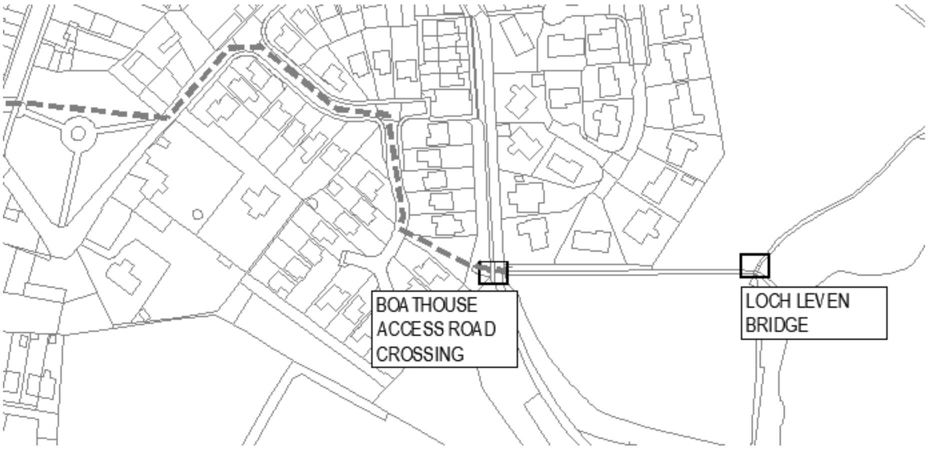


Figure 6-13 Clash Burn Downstream Structures

Consideration has also been given to potential increased risk to properties at Sandport Gait (Figure 6-14). It is recognised flood levels in the Clash Burn channel will increase here as a result of the scheme by up to 290mm at the 0.5% AEP+CC event (Table 6-10). However, the right bank of the Clash Burn is lower than the left providing protection to properties at Sandport Gait. Modelling indicates floodwater would remain within bank with a freeboard of 400 – 500mm available to properties with the scheme in place.

Figure 6-14 Model at Sandport Gait

Overtopping is predicted at the right bank of the Clash Burn. Extensive flooding is here under current conditions affecting green space here and travelling towards the South Queich. With the scheme in place this is reduced due to less overland flow from Clash Burn culvert exceedance and less overtopping from the South Queich therefore the overall impact in this area is a net decrease in flood risk despite the localised higher Clash Burn levels in this location. Based on this analysis, proposed works to the Clash Burn will have no significant detrimental impacts upstream or downstream.

Table 6-10 Flood Levels at Sandport Gait

Location	Change in flood level from scheme (m)	200yrCC Base Flood Level (mOD)	200yrCC Scheme Level (mOD)	Left Bank Level (mOD)	Right Bank Level (mOD)	Freeboard at Left Bank (Sandport Gait)
Clash-034	+0.26	107.69	107.95	108.43	107.97	0.46
Clash-035	+0.28	107.66	107.94	108.35	107.69	0.41

6.10.3 South Queich

Direct defences along the South Queich have the potential to push flood risk downstream by canalising watercourses. Hydraulic modelling was reviewed and showed an increase in flood risk downstream. The existing footbridge here will be impacted by an increase in flood level of 300mm (108.85mOD) however the increased level does not exceed deck level (109.10mOD) resulting in no tangible increase in risk to the structure.

As shown in Figure 6-15, flood extents within green space to the east of the Scottish Water assets on the left and right banks of the South Queich are increased. The left bank is an area of existing flood risk with flood depths of 250 – 450mm predicted at a 0.5%AEP+ CC baseline event. Flood depths are predicted to increase by 300mm here with the scheme in place. In the context of existing flood risk and given no property receptors are affected the impact should be considered minor.

The impact on the right bank is more significant, with flooding predicted between the wastewater treatment works to downstream of the Loch Leven footbridge. This is a new area of flooding with depths of around 600mm predicted. It should be noted that this area is scrub land with trees and no receptors are impacted by the increase in flood extent here. Defences could be extended to protect this area, but this would incur additional significant cost to offset risk to a space with no receptors. Furthermore, the impact of extending defences here would require significant additional felling of trees within the Loch Leven nature reserve. This would also cut off views of the river. This is likely to have a greater negative impact on the land than infrequent flooding.

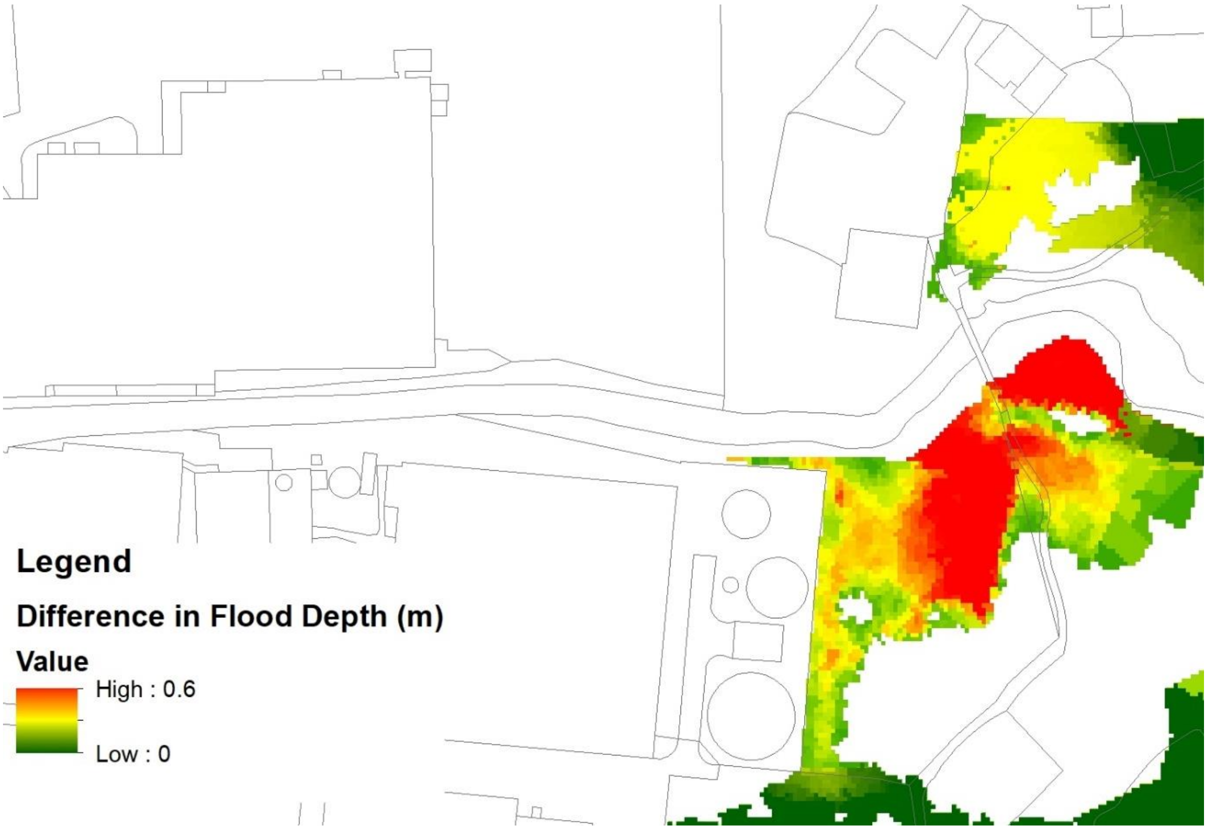


Figure 6-15 0.5% AEP CC Base and Scheme flood extents overlain

Based on this analysis, proposed works to the South Queich will have some detrimental impacts downstream in green space. It is considered that the social, economic and environmental benefits to South Kinross significantly outweigh the detrimental impact here. Within SEPA's Flood Risk and Land Use Vulnerability Guidance amenity open space and nature conservation and biodiversity areas like this would be considered water compatible land uses and therefore should be considered acceptable to flood[18]. It is recommended signage is instead adopted in this area to inform of the potential risk during extreme rainfall events.

6.10.4 Loch Leven

Water Levels at Loch Leven are increased because of the scheme moving floodwaters downstream. At the Clash Burn outlet and South Queich outlets to Loch Leven water levels are increased by 100mm and 220mm respectively. Although these are notable increases, they are minimal in the context of depths of water at both locations (0.9m and 1.6m respectively). Water levels at Loch Leven have been included in the model and no increase in flood risk to receptors has been predicted because of these increased levels.

The Loch has several small-scale inlets but only a single outlet, The River Leven Cut, at the loch's south-eastern extremity. Sluice Gates regulate water flow from the loch into the Cut, formed as part of a major project between 1828 and 1832, during which Loch Leven was partially drained, creating substantial areas of

[18] Flood Risk and Land Use Vulnerability Guidance, July 2018

reclaimed land and facilitating greater control and consistency of water flows for industrial users of the River Leven.

The impact of increased water levels has an overall negligible impact on the Loch itself and at the sluice gates. This is evidenced in the most downstream part of the model which contains representation of the north eastern section of the Loch and ends 5km north of the Loch Leven sluice gate at (NT 17053 99326). Modelling indicates at a 0.5% AEP+CC event water level at this point of the Loch would be increased by 8mm. This can be considered a negligible change and indicates the slight increases in flows entering the Loch are minimal.

Figure 6-16 Loch Leven Sluice Gate Location

6.11 Health and Safety

The Construction (Design and Management) Regulations 2020 (CDM 2020) require RPS to comply with their duties as set out in the Regulations. For the outline design of the Scheme, RPS undertook Designers' responsibilities and CDM coordinator responsibilities.

A Design Risk Management Log was developed during design decisions as the outline design progressed. This document records significant (high risk) hazards and details of how these have been eliminated. If a hazard is not able to be completely designed out, then this records how the hazard has been minimised and any residual risks mitigated. This is provided in Appendix D. Key residual risks are summarised below which will require further investigation and design work at the next stage to eliminate or control risks.

Table 6-11 Residual Risks

Risk Area	Residual Risk Remaining
Direct Defences	Potential for contaminated land
Direct Defences	Vibration risk to existing property
Construction of all elements of the scheme	Potential extreme weather events during construction creating risk to people, programme and cost
South Queich embankment	Area will become informal flood storage during extreme events and is used as an informal path by dog walkers' potential for someone to become trapped during flood
Utilities	Unexpected location and path
Ecology	Accommodate/mitigate for species leading to design changes – potential extra surveys also
Ecology	Invasive species in working area – may lead to design changes or changes in construction approaches
Utilities	Substantial number of utilities requiring diversion or protection – unclear based on current level of info the level of impact this will have on design complexity
Ground Conditions	GI may produce unfavourable results
Access	Risk access is not available through BCA demolished building
Utilities	Work near high voltage power lines
Access	Work exposing workers to the risk of drowning.

7 CULVERT UPGRADES DESIGN

This chapter presents the outline design process for culvert components of the South Kinross FPS. Culvert details are illustrated in **Drawings IBE1585_OD_2006-2009.**

7.1 Hydraulic design

Several culverts along the culverted Clash Burn were shown in hydraulic modelling to be undersized. Given the urban nature of the scheme area, increasing the capacity of the culvert over its full length is not feasible due to existing structures and infrastructure. For this reason, both upsizing and diversion are required to address flooding and avoid constraints. The hydraulic design was developed iteratively in the South Kinross FPS Hydraulic Model to generate the optimal reduction in flood risk.

At Hopefield Place there are three small culverts that would need to be upsized from 225mm dia. to 600mm dia. culverts to convey flow up to 0.5% + Climate Change Fluvial AEP. Upsizing is possible here due to suitable construction access.

Two diversions were identified on the Clash Burn with suitable construction and maintenance access. This allows new culverts to be installed which provides suitable conveyance capacity for the 0.5% + Climate Change Fluvial AEP event. The first diversion begins immediately downstream of Hopefield Place at Bowtown Road where a new 900mm dia. culvert would divert the flow from the Clash Burn behind the properties on Montgomery Way before discharging back into the Clash Burn at the Myre playing fields. Two manholes would be sealed at Montgomery Street to prevent these from overflowing.

Downstream at the Myre and Smith Street, a second 1050mm dia. diversion culvert would take more flow towards High Street then Sandport Road, then along Nan Walker Wynd and directed between two properties and back into the Clash Burn at Sandport Close.

7.2 Structural Considerations

Based on the shallow depth to cover over much of the route, concrete is the preferred material type. To ensure structural integrity of the pipe the culvert should have a minimum depth to cover of 1.2m below ground level. This is not achievable along most of the route therefore pipe protection or ground raising will be required to reduce risk of damage to the new culverts.

- Hopefield Place culvert depth to cover ranging from 0.66m to 0.22m
- Clash Burn Diversion culvert depth to cover ranging from 0.95m to 0.229m
- Smith Street diversion culvert depth to cover ranging from 0.26 to 0.5m

A concrete pipe protection slab is likely to be required where suitable backfill and slab depth can be achieved. In some sections (green space) ground raising is required where depth to cover is close to compliant or to facilitate 300mm minimum bearing on concrete protection slab. Ground will also be raised where feasible in green space. The approach will be confirmed in detail design. Where ground raising cannot be achieved more heavy duty concrete mix will be required for pipe protection slabs.

7.3 Access

Access for works is illustrated in **Drawings IBE1585_OD_001 – 002.** Access will be gained to the Hopefield culvert section from the Hopefield Place cul de sac. Access to the Clash Burn Diversion will be gained from Junction Road. It is likely that a satellite construction compound will be set up in parkland adjacent to Hopefield Place. Haul roads will need to be established through these access points and along the length of the working areas.

Access to the diversion section at Bowton Road will be from the carriageway itself with traffic diversions required to facilitate working in the carriageway. Once the culvert continues south, the existing access track will be utilised for access and extended into scrubland at Kipper hire where another satellite compound will likely be set up.

Access for the final section of works will again be at live carriageways including Smith Street, Sandport, Sandport Close and Nan Walker Wynd. Another potential route for the culvert through green space to the rear of residential houses at Nan Walker Wynd was assessed. This was to find an alternative to disruption at the at the Nan Walker Wynd cul de sac. However, development of this option indicated a suitable capacity of culvert could not be achieved while maintaining some cover and gravity tie into the existing Clash Burn. A third satellite compound will be set up in green space at the Sandport/Smith Street junction.

Culvert works will be carried out in sequential sections from downstream to upstream to minimise disruption to traffic throughout Kinross. Specific traffic management measures will be required along the sections of culvert which are located beneath the public road to minimise impacts on traffic particularly at Bowton Road, Smith Street, High Street and Sandport/Nan Walker Wynd. Every effort will be made to carry out the works as quickly as possible to minimise impacts on the residents and businesses in the area. It is envisaged that traffic measures such as a stop-go system, temporary one-way traffic systems or similar will be implemented to allow the trenches for the culverts and utility diversions to be constructed and at the same time to manage traffic. Utility diversions will be carried out as an enabling works contract so that where access is tight utilities can be moved to one side of the carriageway to allow some one way local access during culvert laying.

The main construction compound for work in Kinross likely to be located at the vacant yard at the former BCA site east of High Street. This will require co-ordination with the landowner. This area will house cabins and site facilities as well as storing plant and material until it is delivered to necessary operations. Due to the scattered nature of operations in Kinross it is likely the Contractor will choose to create satellite compounds for ease of access to plant and material. These satellite construction compounds are to be reinstated as soon as operations within their reach are complete. Recommended satellite compound locations are discussed in specific sections (**IBE1585_OD_001 – 002**)

The precise origin of material and plant has yet to be identified and would depend on the appointed Contractor. Material is expected to be sourced locally from Balado Quarry which lies 2.6 miles north of the site and can be accessed by the M90 and A Roads. The impact on surrounding road network is likely to be limited given the high density roads available for access.

7.4 Construction Method

The culvert elements of the scheme are complex due to the presence of congested services in working areas and constrained access adjacent to residential and commercial properties. There are also significant unknowns in relation to the exact location and depth of the existing services. This is discussed in Section 10. Based on the information known at outline stage the following is the likely construction methodology:

- Utilities in Kinross are congested, particularly where the proposed culverts pass beneath public roads, and will require substantial engagement and potential enabling works with the relevant providers to reach an agreement on any necessary alterations. All major utility diversions should ideally be carried out in advance of construction works where possible. The locations of the utilities are identified in (**Drawings IBE1585_002 – 004**).
- These will largely be constructed on public roads. There is minimal site clearance required at these locations but the establishment of temporary fencing of the working area will be required for the duration of the construction works for security and health and safety purposes. On roadways this will be in accordance with an agreed traffic management plan.
- For the section of the culvert at green space at Hopefield Place and Smith Street vegetation will be required to be cleared. Vegetation clearance of the area adjacent to Kipper hire and establishment of a haul road will be required. This will be accessed from the minor road which runs parallel to Montgomery Way. The culvert at Myre Playing fields will require connectivity of local drainage and access through the garden of a residential property which will require boundary fences to be removed and some smaller trees and shrubs to be removed. Some tree clearance within the working area will be required south at Myre Playing fields to enable the construction of a culvert tail wall and suitable trash/security screen.
- The construction of the Clash Burn culverts will generally be undertaken by excavating and craning in precast culvert units. The precast units come in standard lengths and will be joined on site.
- The Hopefield Place culvert section and Nan Walker Wynd section will have their existing culverts removed. Where the culvert route is being diverted the original culvert will remain in place to maintain drainage connectivity.
- Temporary over pumping or piping of the watercourse will be required to facilitate the construction of the Hopefield culvert sections. Thus the works will be carried out in the dry.
- Short lengths of the culverts may be cast on site at the location of bends or where any large diameter existing surface water sewers are identified during drainage surveys. The foundations will be excavated down to formation level and blinding concrete poured. The precast concrete culverts will be placed in position and where in situ culverts are required, formwork will be prepared and reinforcement bars fixed, followed by the pouring of the concrete. Utilities and drainage pipes will be diverted into permanent positions as required. The excavations will then be backfilled, and road surfaces reinstated. Landscaping and reinstatement of carriageway will take place in agreement with PKC.

- Manholes will be required at significant changes in direction and will be constructed from precast concrete units installed by the manufacturer's instructions. Manhole rings are likely to vary from 1500mm to 1800mm in diameter depending on the angles of the incoming and outgoing pipes.

7.4.1 Plant and Machinery

The plant and machinery required to undertake the construction works on culvert upgrades is likely to include the following:

- Excavator
- Concrete Mixer
- Dump Truck
- Culvert sections;
- Rammer Compactor
- Levelling Instrument
- Water Pump
- Wheel Barrows
- Hand Tools
- Hydraulic Breaker
- Import of ready mix concrete;
- Import of fill for export of unsuitable fill;
- Import of bedding materials

It is likely that the construction work associated with culvert upgrades will require approximately 8 staff (FTE), comprising:

- 6 operatives;
- 1 manager; and
- 1 employer supervisor

7.4.2 Ancillary works

There are likely to be some gullies along Montgomery Way which discharge to the existing Clash Burn culvert. The existing pipe will be retained to maintain these connections. This approach introduces surface water flood risk resilience to the area by increasing capacity in the surface water drainage and avoids further disruption by removing the existing culvert and reinstating new drainage connections for the length of the Clash Burn.

Records indicate storm drainage is separate at Hopefield Place and Nan Walker Wynd therefore replacing of existing connections is not expected. At Smith Street, Sandport and High Street stormwater drains to the combined sewer so again no ancillary drainage connection work is anticipated.

7.5 Trash Screens

Five new trash screens are required at the Hopefield culvert upgrade and Clash Burn diversion culverts to reduce blockage risk to the culverts. Two additional screens are required at the open reach of the Clash Burn in Myre Playing fields (Figure 7-1) to improve hydraulic efficiency at two small footbridge structures that are not being upsized.

Figure 7-1 New Trash Screens - Existing Structures

The trash screens were initially sized using hydraulic calculations to create a screen size which limit head loss through the screen. On this basis, the trash screen would not form a throttle to flow and increase water levels significantly during storm events. The initial sizing was tested in the hydraulic model and showed the designs were suitable for these purposes. At outline design stage, the designs have been further detailed using guidance from Culvert, screen and outfall manual, CIRIA 2021 to design a screen which is resilient to blockage risk and allows safe access for inspection and maintenance.

Based on the cross-sectional area being less than 2.5m^2 for all culverts the CIRIA Rule of Thumb method was adopted which involved calculating an effective screen area and considered the potential area of the screen that could be blocked based on this effective screen size and proposed bar spacing. Headlosses are also considered for clean and blocked scenarios to determine the top water level and flow which could be conveyed through the screen. The screens have been designed not to overtop in the 1 in 200year plus climate change event when considering head loss and to pass the modelled 200yrCC flow even during expected blockage condition. Screen design has also considered safe access for clearance and have incorporate catwalk access where a screen length exceeded 1.5m. This is to allow safe manual raking without requiring riverbed access reducing safety risks.

All screens will be prefabricated. This method of construction will minimise the in-channel works required to construct the screen and therefore will have a minimal impact on the Clash Burn. Construction of the trash screen will involve excavating to formation level, fixing steel reinforcement, pouring concrete and installing the steel trash screen.

7.6 Environmental Improvements - Clash Burn

Opportunities for environmental improvements within the scheme have been reviewed as part of the outline design. The potential to re-meander the open channel of the Clash Burn at Hopefield Place was reviewed. The line of the Burn at this location has been set since 1888 indicating stable planform. However, there may be environmental improvements by introducing meanders to this open reach by designing spaces for the community to interact with the water and potentially create new habitat.

A high level design process was carried out which involved laying out a planform after determining a meander wavelength. A hydraulic geometry approach was adopted to determine a meander wavelength and an appropriate channel length for one meander wavelength. This relies on the geometric relations between wavelength and width. Wavelength is predicted based on proposed channel width using linear regression equations.[19] The channel meander length can then be estimated by the meander wavelength times the valley slope divided by the channel slope. This is dictated by gradient, which in this case can only be altered slightly without significant rework to regrade the length of the Clash Burn.

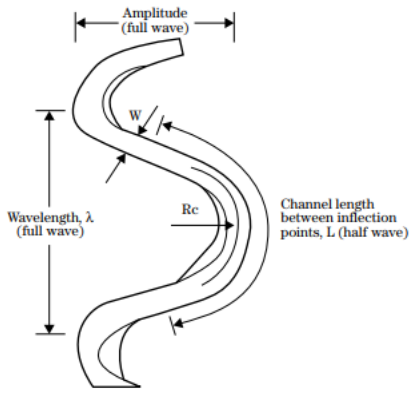


Figure 7-2 Planform Variables

Based on the current gradient, a meander length of at least 20m would be required considering the typical channel width (1.36m) which would likely reduce channel capacity here and increase flood risk. Considering the maximum channel width here (3.9m) the meander length would be 59m which is not achievable in the space. Even when using the minimum channel capacity, a wavelength of 15m is required resulting in land take encroaching into private residential areas which would not be acceptable. Meanders would also need to be steeply angled to achieve this length in the width available increasing scour risk and reducing opportunity for designed interactive and habitat spaces. On this basis, environmental improvement at this location would not

[19] Soar, P.J. and Thorne, C.R. (2001) Channel Restoration Design for Meandering Rivers. Coastal and Hydraulics Laboratory, US Army Engineer Research and Development Center, Vicksburg.

outweigh the challenges and therefore the open section of the watercourse will be culverted to improve the hydraulic alignment of the burn.

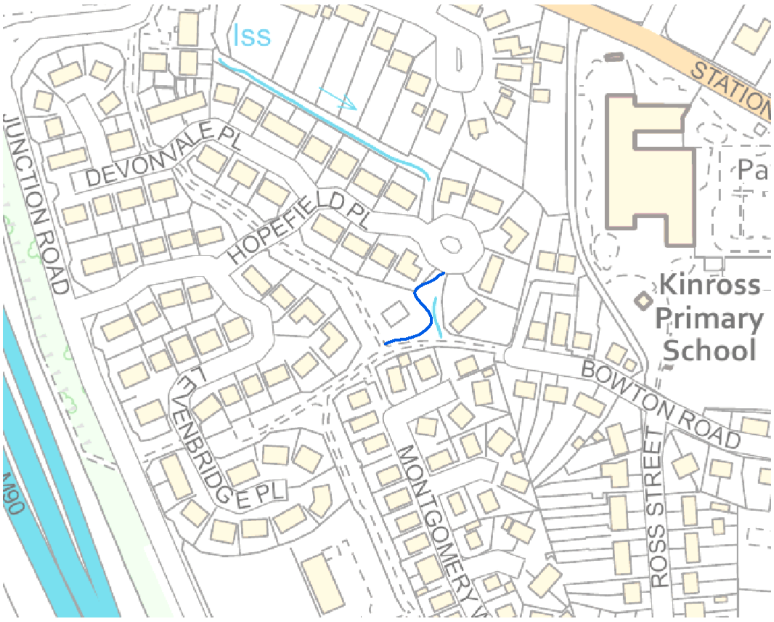


Figure 7-3 Remeandering planform

8 SOUTH QUEICH DEFENCES DESIGN

8.1 Defence Options

Direct Defence details are illustrated in **Drawings IBE1585_OD_2000 – 2004**. Hydraulic modelling has determined the required defence heights to provide the required standard of protection (0.5% AEP Present day with future adaptation) from South Queich as detailed in Table 8-1. Different types of structure that can be utilised to provide a hard defence have been assessed in the context of the design principles and specific site constraints to select the most appropriate structural form.

Table 8-1 Length of defences and type

Location	Type	Length (m)	Maximum height (m)
Queich Place	Embankment	219	1.42
Clash Burn	Embankment	24	0.56
South Queich LHB	Sheet Pile Wall	582	1.81
South Queich RHB	Sheet Pile Wall	437	2.78
Wastewater Treatment Works	Embankment	122	0.6

8.1.1 Flood Embankment

A flood embankment is constructed from earth and may include a clay core to reduce seepage through the embankment. They are generally up to a maximum of 3m in height and include gentle side slopes and a flat, wide crest for safe maintenance access. Depending on soil permeability, flood embankments are commonly constructed with an impervious core are grassed and can include scour protection.

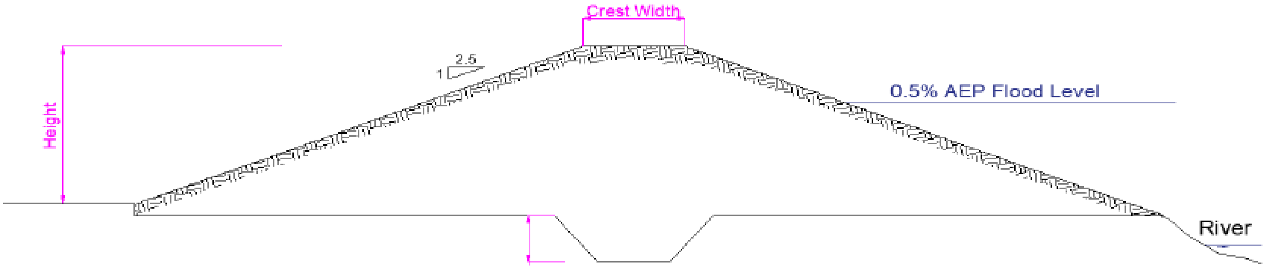


Figure 8-1 Sketch Typical Flood Embankment

Pro	Con
Unobtrusive and visually appealing (grassed finish)	Large footprint – high land take and challenging to find in urban setting
May be formed by site won material – reduce overall environmental impact	Require regular inspection and maintenance, including grass cutting, control of unwanted vegetation, dealing with infestation by burrowing animals
Typically, most economic to construct especially where site won material can be used	Erosion protection may be necessary
Based on underlying sands and gravels embankments may require a cut-off against seepage – longer seepage path less complicated to achieve than with wall	Large volumes of imported fill required to construct

8.1.2 Mass Concrete Wall

A mass concrete flood wall is cast in situ typically in 10-12m lengths and on a prepared formation.

Pro	Con
Simple form of flood wall to design and construct	Large volume of ready-mix concrete to be delivered to site – increasing traffic movements and environmental/carbon cost of scheme
Heavy piling and lifting equipment not required for construction	Inefficient use of materials
Design can incorporate high quality finishes – useful in high amenity and heritage value sites	Typically requires a wide and tapering section giving the appearance of a heavy bulky wall
Generally require minimal maintenance	Casting in situ introduces greater health and safety risk than use of precast units as well as increased risk of river contamination

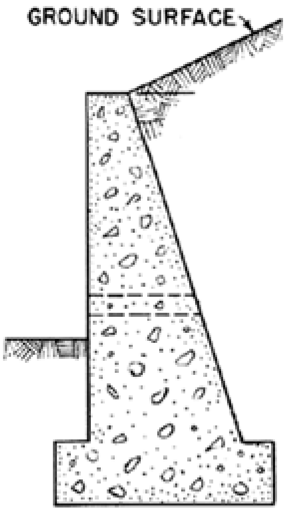


Figure 8-2 Sketch Mass Concrete Wall

8.1.3 In situ Reinforced Concrete 'L' Shaped Flood Wall

Reinforced concrete wall with asymmetric slab foundation cast in situ. Typically completed with natural masonry cladding and coping stones for aesthetic appeal.

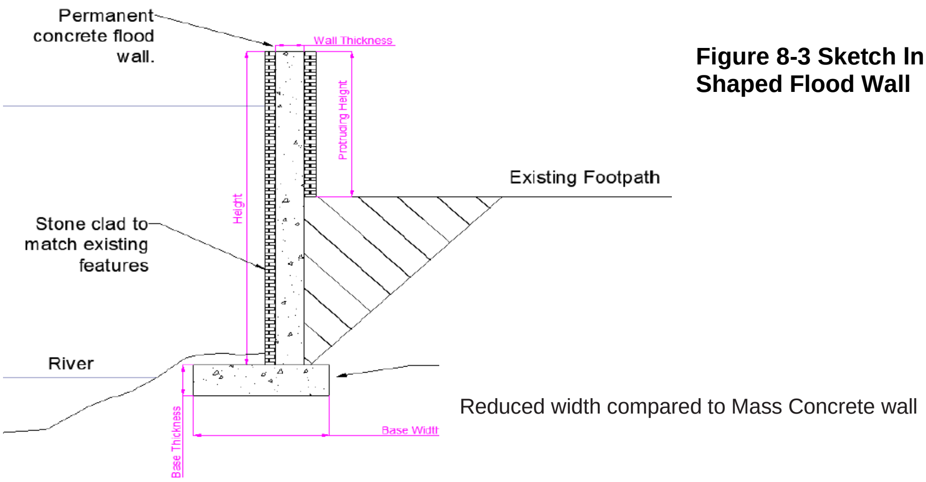


Figure 8-3 Sketch In situ Reinforced Concrete 'L' Shaped Flood Wall

Pro	Con
Traditional construction method utilising normal plant	Ready-mix concrete to be delivered to site – increasing traffic movements and environmental/carbon cost of scheme
Occupies a narrower footprint than an embankment equivalent	Wider footprint than a non-displacement structural form of wall e.g. SSP wall – not suitable for tight working areas
Moderately economic form of construction	Slower construction speed than precast or SSP alternatives increasing disruption
Geometry is highly adaptable in design and on site and can be readily designed to accommodate service diversions in Operations	Casting in situ introduces greater health and safety risk than use of precast units as well as increased risk of river contamination
Ground obstructions can be removed in excavation	
Generally, require minimal maintenance	

8.1.4 Precast Reinforced 'L' Shaped Flood Wall

Factory cast reinforced concrete wall and base slab delivered to the works as complete units.

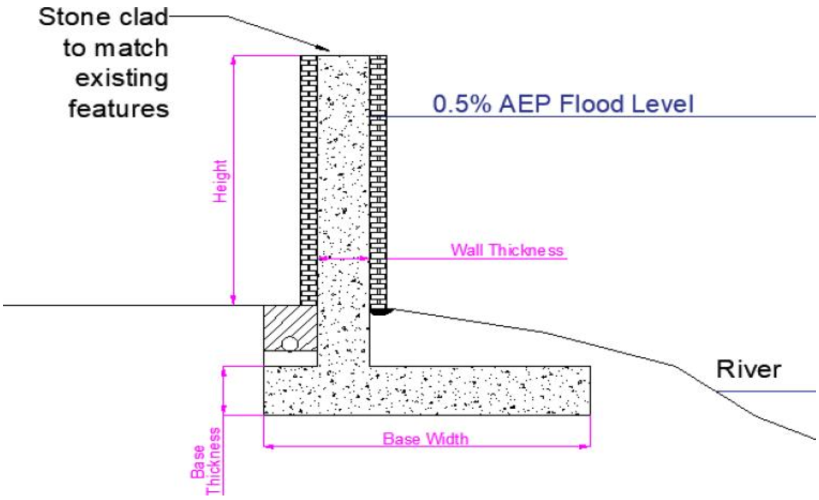


Figure 8-4 Precast Reinforced 'L' Shaped Flood Wall

Pro	Con
High quality factory cast product	Many joints along length to be made watertight and water stop required where hydrostatic head is greater than 1m introducing further complexity
Occupies a narrower footprint than an embankment equivalent	Wider footprint than non-displacement form of wall e.g. SSP wall
Moderately economic form of construction	More susceptible to uplift water pressures
Offers speedy construction on site	Less flexibility to adjust to site conditions e.g. to suit service diversions which will be a key issue
Low volume of heavy construction plant movements – reducing traffic movements and carbon cost of construction	Precast construction reducing health and safety risks and risks of concrete contamination from in situ casting
Precast construction reducing health and safety risks and risks of concrete contamination from in situ casting	May require significant excavation to achieve cut off depth in highly permeable ground increasing time and cost of construction considerably
Offers flexibility in finishing - profiled finish during casting or in situ cladding can be used	

8.1.5 Bare Steel Sheet Pile (SSP) Flood Wall

Figure 8-5 Image showing finish on SSP (courtesy of Sheet Piling UK)

This type of wall is formed from steel sheet piles driven to a depth to suit local ground conditions and required seepage protection. Based on high permeability deposits in Kinross, a deep cut off is expected likely between 5 and 15m depending on full seepage analysis.

Pro	Con
Fast on-site construction technique	Bare steel will rust giving flood wall an 'industrial' appearance that may be undesirable
Non-displacement (no arisings) form of construction	A painted finish will attract significant whole life maintenance costs
Economic form of construction	Will require large working space for piling rig including overhead clearances
Efficient approach to providing seepage cut off as well as structural requirements – useful for likely deep cut off requirement in Kinross based on permeable deposits	Waterproof sealant required between pile joints – can be more costly and complex where there are varied alignments
Potential to use recycled steel – reducing carbon footprint in construction	
Occupies a narrower footprint than embankment, mass concrete wall an L shaped walls	

8.1.6 Sheet Pile (SSP) Flood Wall with Facing

This wall is a SSP flood wall clad with non-structural reinforced in situ concrete or masonry facing to visible and above ground portion mainly for aesthetics and to reduce long term maintenance.

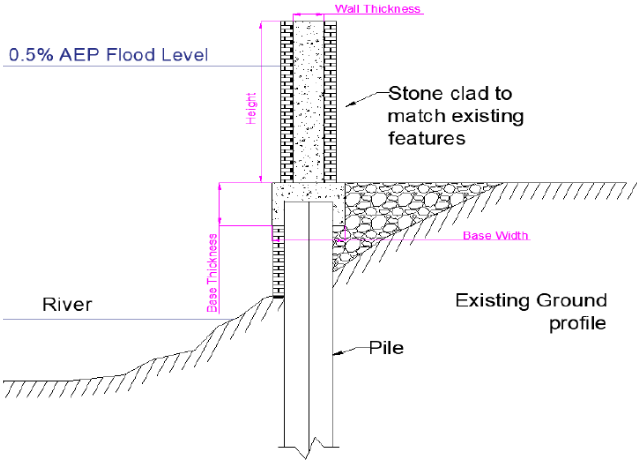


Figure 8-6 Sketch Sheet Pile (SSP) Flood Wall with Facing

Pro	Con
Fast on-site construction technique	Upper reinforced concrete section will slow construction rate
Economic form of construction	Multiple construction methods used; expensive
Efficient approach to providing seepage cut off as well as structural requirements – useful for likely deep cut off requirement in Kinross based on permeable deposits	Will require large working space for piling rig including overhead clearances
Potential to use recycled steel – reducing carbon footprint in construction	Waterproof sealant require between pile joints – can be more costly and complex where there are varied alignments
Can incorporate high quality finishes such as pattern profiled concrete, masonry cladding & coping stones	
Occupies a narrower footprint than embankment, mass concrete wall an L shaped walls	
Minimal long term maintenance	
Arisings are limited; only small excavations at head of SSP is required	

8.1.7 Steel Sheet Pile (SSP) 'I' Shaped Flood Wall

Flood wall incorporating a structural in situ or precast reinforced wall above ground. SSP's are driven to a depth (below ground) to suit local ground conditions and required seepage protection. High quality pattern profile or masonry cladding can be incorporated based on conditions of local area.

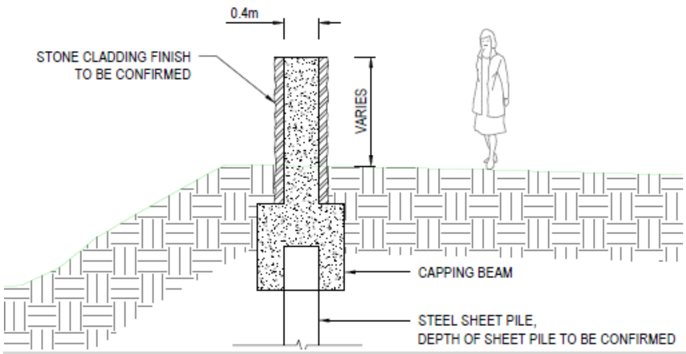


Figure 8-7 Sketch Steel Sheet Pile (SSP) 'I' Shaped Flood Wall

Pro	Con
Fast on-site construction technique	Upper reinforced concrete section will slow construction rate

Arisings are limited; only small excavations at head of SSP is required	Multiple construction methods used; expensive
Economic form of construction	Will require large working space for piling rig including overhead clearances
Efficient approach to providing seepage cut off as well as structural requirements – useful for likely deep cut off requirement in Kinross based on permeable deposits	Waterproof sealant required between pile joints – can be more costly and complex where there are varied alignments
Potential to use recycled steel – reducing carbon footprint in construction	
Can incorporate high quality finishes such as pattern profiled concrete, masonry cladding & coping stones	
Occupies a narrower footprint than embankment, mass concrete wall an L shaped walls	
Narrow above ground wall; potentially useful given limited space along some sections of the route	
Minimal long term maintenance	
Upper wall can be either in situ or precast panels	

8.2 Flood Defence Selection

Based on the above selection criteria, an 'I' shaped sheet piled wall has been proposed as the most appropriate form of defence to construct along the South Queich. The depth of the required cut off will be determined during the detailed design phase. Cost and visual requirements will determine the final form of the sheet pile wall from either those set out in 8.1.5 to 8.1.7. It is likely a mix of these type of walls will be used depending on the aesthetics requirements and space availability. This decision will be informed by landowner and community consultation. The main reasoning when selecting the proposed hard defence included the following:

- Sheet piling is most appropriate based on the space constraints for both construction access and long term footprint of the defence between the existing riverbank and adjacent property boundaries;
- Recorded weak/soft ground conditions which would result in potentially larger foundations for retaining walls and deeper excavation and replacement to satisfy the geotechnical design increasing risk associated with use of mass concrete or reinforced concrete walls (in-situ and precast);
- Additional land purchase can also be avoided by using sheet pile walls with smaller footprints than retaining walls/embankments over most of the defence length;
- Maintaining a single type of defence generally reducing connection points simplifying the construction process;
- Permeable soils (sands and gravels) have been recorded in the area are likely to require cut off below ground to prevent seepage.
- The use of sheet piles reduces the need to excavate to significant depths to install cut off. This also reduces the risk of contact with contaminated ground and reduced arisings will result in less contaminated material needing to be disposed of.
- The use of a piling rig will likely prevent need to construct from the “wet side” of the wall reducing risks associated with working in this environment;

- This method offers flexibility in the finish of defences depending on planning requirements on local opinion. It is likely a mix of finishes will be adopted based on the varying land use along the length of defences with higher quality masonry facing expected in residential areas and concrete facing expected in industrial settings.
- This approach is likely to reduce construction time frames compared to the reinforced concrete methods.

Where there is a greater working area available i.e. at Wastewater Treatment Works, Queich Place and Smith Street, flood embankments are proposed as a more cost effective and a simple constructed solution. As the embankments are generally in closer proximity to residential property, the use of an embankment will allow a more natural grassed finish to limit visual impact.

Based on the ground conditions detailed in the initial Ground Investigation[20] and the publicly available BGS data, the embankments will likely be founded on a mixture of made ground, soft clay or sand and gravel deposits. Where they are to be founded on soft clay or made ground then there may be a requirement for an element of excavation and replacement of these types of materials, where all embankment foundations shall be proof-rolled. Any soft compressible materials shall be excavated and backfilled with a suitably compacted material such as an SHW Class 1.

8.3 Freeboard

The defences have been designed to the 0.5% AEP Present Day event modelled flood level. As noted in Section 5.1, foundations will be designed to support future raising of defences for future climate change adaptation if/when flows/flood levels change. A freeboard height has then been added to the flood level to create the design defence level and account for uncertainty in scheme performance. Freeboard was determined using Environment Agency Guidance[21] Accounting for residual uncertainty: an update to the fluvial freeboard guide.

The methodology involves assigning confidence scores to different aspects of the evidence and combining these estimates into an overall confidence rating. Scores range from 1 which indicates that the criterion is highly likely to be locally reliable to 10 indicating the criterion is very unlikely to be locally reliable (Table 8-2). The different topics assessed are summarised in Table 8-3.

Table 8-2 Uncertainty Scoring Criteria

Description	Score
Very unlikely to be locally reliable - Poor representation	10
Unlikely to be locally reliable	5
Likely to be locally reliable - Basic local representation)	3
Good local representation - Highly likely to be locally reliable	2

[20] Factual report on site investigation for land at South Kinross Flood Protection Scheme, Rev 1, March 2020. Document Reference S1046/1.

[21] Accounting for residual uncertainty: an update to the fluvial freeboard guide, Environment Agency, February 2021

Very unlikely to be locally reliable - Poor representation	1

Table 8-3 Uncertainty Scoring

Topic	Score	Confidence (level of representation for the current situation)
How appropriate is the flood risk analysis?	1	There have been no changes, or the model or evidence has been updated or created to represent the current situation well (for example, new defences, changes in land use, boundaries updated).
How well is the floodplain modelled?	1	Data type or resolution reflects the variation in the floodplain topography using very detailed high resolution (1m resolution) LIDAR to represent complex floodplain features and in-channel survey at very frequent intervals with linear features identified along bank tops and in the out-of-bank areas.
What is the confidence in the hydrology?	1	Detailed gauging station analysis, moderate record of high flows and levels where one flow is at least as high as the design flow
How good is the coastal/ estuarine/ tidal boundary?	1	Loch Leven AMAX water level data from 1975-2007 - good local long record of data, no wave issues. Tested Q2 and Q200 boundary and showed little variation
How have fluvial threats been represented?	1	1D-2D linked hydraulic model simulating 5 or more annual likelihoods covering ones stated by planning policy and associated guidance.
How has surface runoff been represented?	1	1D-2D linked hydraulic model simulating 5 or more annual likelihoods covering ones stated by planning policy and associated guidance.
What is the strength of evidence?	2	Calibrated against 2020 flood event less frequent than design event Performed some sensitivity analysis and hydrological anchoring of multiple events

The two highest scores – in other words, the two topics with the least confidence are used with the matrix from the EA Guidance (Table 8-4) to determine the confidence rating. The worst topic score is the strength of the evidence for calibration with a score of 2. The other criteria have scored the same (1) therefore any can be used as the second worst topic score. Based on this matrix, the confidence in the design is assessed as having a 5-star rating.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="5">Worst topic 1 score</td></tr>
<tr><td>10</td><td>5</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td rowspan="5">Worst topic 2 score</td><td>10</td><td colspan="3">1 star</td><td>2 star</td><td>3 star</td></tr>
<tr><td>5</td><td colspan="2">1 star</td><td>2 star</td><td>3 star</td><td>4 star</td></tr>
<tr><td>3</td><td>1 star</td><td>2 star</td><td>3 star</td><td colspan="2">4 star</td></tr>
<tr><td>2</td><td>2 star</td><td>3 star</td><td colspan="2">4 star</td><td>5 star</td></tr>
<tr><td>1</td><td>3 star</td><td colspan="2">4 star</td><td colspan="2">5 star</td></tr>
</table>

Table 8-4 Scoring matrix to derive confidence rating

Applying this rating to Table 8-5, EA guidance therefore recommends a 300mm freeboard allowance for this confidence rating. This has been adopted for flood embankments. For flood walls, an additional 300mm has been applied to account for the fact that it is more costly to raise flood walls in the future compared to embankments once constructed. This provides a factor of safety in the design.

Table 8-5 Residual uncertainty allowance in development planning

Confidence rating	Confidence description	Minimum depth (mm)
1 star	Very unlikely to be locally reliable	900
2 star	Unlikely to be locally reliable	750
3 star	Likely to be locally reliable	600
4 star	Very likely to be locally reliable	450
5 star	Highly likely to be locally reliable	300

8.4 Construction Methods

8.4.1 Flood Walls

The available working area for hard defences is extremely constrained by existing properties. The following is the likely construction method based on this constraint:

- Utilities are congested and will require substantial engagement and potential enabling works with the relevant providers to reach an agreement on any necessary alterations. All major utility diversions should ideally be carried out in advance of construction works where possible (**Drawings IBE1585_002 – 004**).
- Undertaking site dilapidation surveys and level surveys as required to show the condition of the surrounding area and roads prior to the start of the works.
- A 20m working strip will be required to allow the construction of the defences and establishment of a haul road will be required in grassed areas. The existing tarmac areas are suitable, but these may need reinstated on completion of the works.
- Temporary fencing of the working area will be required for the duration of the construction works for security and health and safety purposes.

- Construction access for walls upstream of High Street will be gained from industrial areas at Clashburn Road on the left bank and Queich Place on the right bank. The working area available between the riverbank and properties will be sufficient for this construction from land and hardstanding areas on the left bank can be used to store equipment and materials (**IBE1585_OD_001 - 003**).
- Access downstream of the High Street bridge is more challenging due to limited space between buildings and the river. The BCA site and parts of the Todd and Duncan site will be demolished to facilitate access over the extent of the right and left bank defences.
- Over the extent of the BCA building (140m, left bank) and for most of the right bank (200m) it is anticipated temporary in-river platforms or temporary culverting will be required to provide access to the piling rig. It may be possible to install the piles “self-sufficiently” without in-river platforms, however it is likely an in-river platform would be required over these lengths to support the Pile Press and an excavator for finishing works where a reinforced or masonry finish is required.
- Topsoil will be stripped and stockpiled ready for reinstatement on completion of the works.
- The form of flood wall chosen offers flexibility in the design. ECI identified potential for piles to be installed using a Giken Silent Pile Press (pre-boring as required) where access cannot be achieved for a traditional piling rig. Depending on the appointed contractors plant availability, there may be a mix of traditional and silent piling depending on available working area and costs. This method is vibration free thus reducing risk to foundations from nearby buildings. Additionally, the Pile Press can ‘self-walk’ along the pile heads, reducing the required working area. No crane support is required to move the pile press along the line, meaning that the pile press can effectively be employed over water. A crane support will be required to move piles into position where traditional piling will be undertaken where clearance of 8m is available from one bank such as at BCA and Todd and Duncan.
- A reaction stand will be used for the initial piling work. A press in machine will be horizontally loaded onto the reaction stand and counterweights added depending on soil conditions and required pile length. The first pile will then be pressed in using all weights of the machine and counterweights as a reaction. After installing the first pile, this then becomes the first reaction pile for the second pile. Once the press in machine is fully sat on reaction piles the initial piling work is complete and the reaction stand, and counterweight will be removed.
- The Silent Piler self-moves and clamps the previously installed reaction piles to generate a reaction force from the negative skin friction and interlocking resistance of the reaction piles. The reaction force then provides the required press-in force to hydraulically jack subsequent piles into the ground.
- Depending on cost constraints, planning requirements and feedback from the public there is likely to be a mixture of sheet pile flood wall types. In industrial settings it is likely the sheet pile will form the above ground portion of the wall with no facing on the river side of the wall to reduce complexity in long-term inspection and maintenance.
- In areas where a more traditional finish is required such as residential areas upstream of the High Street bridge a concrete wall with cladding will form the above ground element of the flood wall. For

these sections once pile installation has completed, excavation will be carried out around the top of the pile will be undertaken to facilitate the construction of a capping beam. A blinding layer of site concrete will be formed, capping beam reinforcement will be tied and erection of formwork and pouring of in-situ concrete will bring the flood wall up to existing ground level with starter bars protruding to extend into the cantilevered, above ground, wall.

- The steel reinforcement for the above ground concrete wall can then be fixed, shuttering work erected and pouring of in-situ concrete. The walls can either be a patterned concrete finish -formed by fixing a mould to the inside of the shuttering or stone faced once the wall has cured depending on requirements of PKC Structures. Given the proximity of the historic bridge, it is anticipated that a sympathetic finish will be required. If required by PKC or residents, a pre-cast concrete coping will be fixed to the top of the wall.

8.4.2 Flood Embankments

The construction of the flood embankments will involve the following construction methodology:

- Utility diversions would be facilitated prior to main construction works.
- Treatment of invasive species will be required in advance of the works to avoid any spreading as a result of the works.
- Initial clearing of vegetation and trees within a working strip up to 40m wide for embankments. The clearance will facilitate the construction of the defences and provide sufficient space for the movement of site traffic.
- Temporary fencing of the working area will be required for the duration of the construction works for security and health and safety purposes.
- A stoned haul road will be required to enable the transportation of embankment, wall and culvert materials into the site and along the length of the proposed defences.
- Stripping and storage of topsoil for reuse.
- Import and storage of suitable clay material to form the core of the embankment by lorry and road. This will be stored within the working area and brought to a required location using excavators and dumpers. The working area is within the defined floodplain therefore care must be taken to locate materials/equipment closer to the M90 outwith the predicted flood area to provide suitable protection against flood risk during the duration of works. Care should be taken to carefully plan the volume of material and plant stored on site in tandem with reviewing weather forecasts.
- Excavation of a trench up to 2m deep and wide (subject to ground investigation and geotechnical design) will be undertaken by an excavator as a suitable cut off, and clay placed and compacted in layers until the defences have reached the necessary height.
- At present the embankments have been designed as a 1 in 2.5 or 1 in 3 slope. This is to provide stability assuming Class 2 cohesive material will be used. Opportunities to reduce these footprints will

be analysed during the detailed design stage following analysis of rapid drawdown scenario to determine if available embankment material can remain stable with steeper slopes to reduce embankment footprints.

- The remainder of the embankment will be constructed from inert material to meet the required gradient of 1 in 3 or 1 in 2.5. The embankment will then be topsoiled with a suitable, biodegradable geotextile and sown in grass. The geotextile will protect the embankment from erosion until such times as the vegetation has been established. Furthermore, use of a geotextile will provide long term protection to the embankment from grass cutting machinery.
- A back drain will be required at the rear toe of the embankment. It will require a trench dug by an excavator to facilitate the laying of typically a 100mm diameter perforated drainage pipe in clean stone. The drain will be wrapped in a geotextile to allow water to pass through the drain while larger stone or soil particles will be captured. This prevents the intermixing of granular sub-base layers and the passage of stone particles that could cause the failure of the surface and provides a level of treatment to surface water.
- Manholes will be required at 100m intervals or at changes of direction of the back drains. Outfalls from this back drain, passing beneath the earth embankment and discharging to the river will be required. These will need to be flapped to prevent backflow during times of flood.

8.4.3 Plant and Machinery – Direct Defences

This work is expected to be disruptive due to densely developed frontage of the South Queich within Kinross. Much of the works will involve import of material and sheet piling. The plant and machinery required to undertake the hard defence works is likely to include the following:

- dump trucks;
- tracked excavators;
- mobile crane;
- mobile generators;
- piling rig;
- vibratory/roller equipment;
- cement mixer;
- import of fill for replacement of unsuitable fill and for embankments
- export of unsuitable fill;
- Import of clay for embankment core
- Import of matting/grasscrete; and,
- Import of pipe, bedding materials, geotextile.

- import of sheet piles;
- import of ready mix concrete;
- import of precast sections (for outfalls);
- import of wall facing materials.
- Wheel scraper units;
- Dozer;
- HGV tippers;
- Grader;
- Pumps for dry working area

It is likely that the construction work associated with the channel capacity works within Kinross will require approximately 18 staff, comprising:

- 12 operatives;
- 4 managers / admin staff; and,
- 2 employer supervisors

8.5 Drainage

A secondary flood assessment[22] has been carried out and determined a minor increase in surface water flood risk as a result of the scheme. This is due to surface water flow paths to the open South Queich being cut off by the new defences. However, analysis indicates surface water flood extents are largely unchanged and flood depths generally increase by less than 20mm. To manage this, back drainage will be constructed behind defences to capture flow paths and ensure the land behind the defences does not become waterlogged. This will consist of a series of perforated pipes bedded into fine granular material and laid parallel to the defences. Precast concrete manholes will be provided at regular intervals to facilitate access for maintenance or changes in direction. At suitable locations the drainage pipe will need to be cored through the flood wall or laid underneath the flood embankment and outfall to the river via a flapped discharge. It will be necessary to provide a precast concrete headwall at all discharge location points and easy access for maintenance.

Some attenuation/pumping is required at the Koronka Manufacturing site where ponding was found to be more excessive (increase in flood depth of up to 100mm). Full drainage design will be carried out at detail design stage.

[22] Surface Water Flooding Solutions Technical Note, RPS, April 2023

Figure 8-8 Surface Water Flood Risk Post Scheme 0.5% AEP

8.5.1.1 Existing SuDS

At Hopefield Place and Levenbridge Place there are several soakaways. Soakaways infiltrate to the ground so will not be impacted by levels or flows in watercourses. The route of the culvert has been realigned to avoid soakaway locations.

SuDS basins are also present near the working areas (Figure 8-9). Stormwater from Clashburn Way/Clashburn Close drain to an attenuation basin adjacent to Myre playing fields before it discharges to the Clash Burn. A second SuDS basin drains the Kinross Western Edge Link Road discharges to the South Queich.

Care should be taken to maintain these outfalls. Modelling indicated a negligible impact on these features from the scheme. As a conservative approach it is recommended flap vales are installed on any outfalls within works areas to prevent back up of flow during climate change scenarios

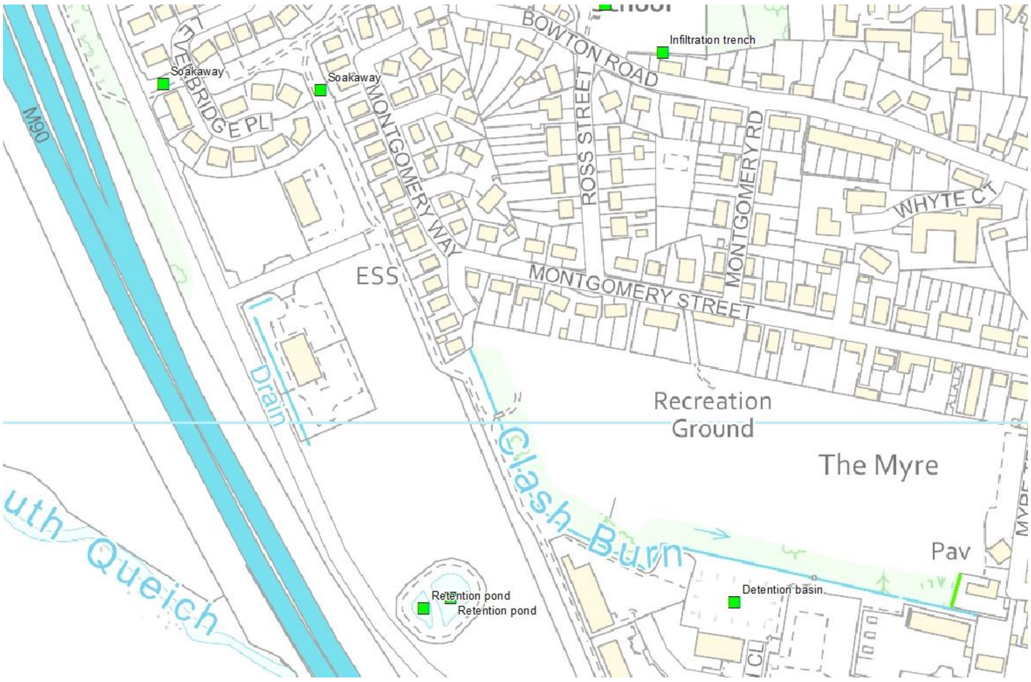


Figure 8-9 SuDS features in scheme area

8.6 Environmental Improvements

Opportunities for environmental improvements within the scheme have been reviewed as part of the outline design. Currently, untreated runoff enters the South Queich along the proposed line of defences. Cutting off this flow path and introducing new back drainage will introduce a level of attenuation and treatment to flows allowing solids and pollution to settle out before discharge to the watercourse. For these water quality benefits to be realised suitable long-term maintenance of the drain is required which would typically entail 3 yearly clearance of weeds and silt and cleaning of stone every 5 years. Ultimately this should provide a local improvement in water quality. Given the area is currently floodplain there is potential to purchase this field from the landowner and introduce wildflower meadow to enhance the amenity and biodiversity gains from the scheme.

9 M90 UPSTREAM STORAGE AREA

A Storage area is proposed to reduce flooding to the M90 services and the M90 motorway. Details of the design can be seen in **Drawings IBE1585 2005 and 2009**. This would be achieved by a flood embankment approximately 294m long with a maximum height of 1.1m. This embankment would also reduce flooding to Flood Cell 2 by preventing the flow path down the M90 and across Levenbridge Place. This option would prevent flooding to the M90 services but would not prevent flooding at the Balado Poultry Farm buildings. Flood depths at the Balado Poultry Farm buildings would not be increased due to the provision of flood storage.

Directly adjacent to the storage area is the Ury Burn, into which the stored water would most easily be discharged. The stored water should be discharged at a rate such that it does not increase any potential flood risk downstream. This would be achieved through a control structure that would limit the rate at which water would be released from the storage area. The total area draining to the embankment was calculated as 54ha. Using HR Wallingford Greenfield Runoff estimation tool and FEH statistical approach, the 50% AEP greenfield runoff rate was calculated as 594l/s. The control structure was sized to limit flow to this rate for all return periods using Colebrook White equations as a 450mm diameter concrete pipe.

This option was tested in the model by stamping the embankment elevation onto the 2D grid of the model to act as a barrier to flow. The control structure was also represented in the model in 1D with 2D outfall used to discharge flow to the Ury Burn. The Ury Burn is included in the model in 2D with a detailed mesh zone included in this area to ensure the 2D mesh is of appropriate resolution to pick up the channel definition. Modelling indicated this storage area would begin to retain water in a 1% AEP event.

Given the agricultural setting of the storage area, a grass-finished earth embankment is a cost effective and visually sympathetic form of impoundment. The levels are such that suitable tie-in to surrounding higher ground is achievable. Given the large working area, an optimal 3m crest is achievable on the embankment to facilitate vehicular access over the embankment for grass cutting. Permanent fencing and gated access will be required around the embankment to prevent any undermining of the embankment from grazing.

9.1 Constructability

The construction of the storage area will involve the following construction methodology:

- Access to the site will be gained from the A977 via an existing farm track. A new haul road will be constructed from here to allow permanent access to the structure. **Drawings IBE1585 001 – 002** illustrates access routes.
- No utility diversion work is anticipated in this work area.
- Treatment of invasive species will be required in advance of the works to avoid any spreading as a result of the works.
- Initial clearing of vegetation and trees within a working strip up to 40m in width for embankment. The clearance will facilitate the footprint and provide sufficient space for the movement of site traffic.
- Temporary fencing of the working area will be required for the duration of the construction works for security and health and safety purposes.

- Stripping and storage of topsoil for reuse.
- Import and storage of suitable clay material to form the core of the embankment by lorry and road. This will be stored within the working area and brought to a required location using excavators and dumpers.
- Excavation of a trench up to 2m deep and wide (subject to ground investigation and geotechnical design) will be undertaken by an excavator as a suitable cut off, and clay placed and compacted in layers until the defences have reached the necessary height.
- The control structure will then be constructed through the embankment. The foundations will be excavated down to formation level and blinding concrete poured. The precast concrete culvert will be placed in position. Pre cast headwalls will also be placed at the inlet and outlet of the culvert and joined to the pipe.
- The remainder of the embankment will be constructed from inert material to meet the required gradient of 1 in 3. The embankment will then be topsoiled with a suitable, geotextile and sown in grass. The geotextile will protect the embankment from erosion until such times as the vegetation has been established and to provide long term stability for machinery.
- A toe drain will be constructed along the base of the embankment to prevent excessive build-up of flows outwith fluvial events. This will be collected in a perforated pipe and either infiltrated to ground or discharged to the Ury Burn.

9.1.1 Plant and Machinery – Upstream Storage

This will involve heavy civil engineering works such as earth moving, concrete works and piling as well as the import of a significant amount of fill and clay (approximately 5300m^3) to construct the embankment.

- Tracked excavators;
- Dump trucks;
- Wheel scraper units;
- Dozer;
- Tracked mobile crane;
- Mobile generators;
- Vibratory/roller equipment;
- HGV tippers;
- Grader;
- Import of ready mix concrete;
- Import of puddle clay

- Import of fill for embankment/export of unsuitable fill;
- Import of matting/grasscrete; and,
- Import of precast culvert units and headwalls, bedding materials, geotextile.

It is likely that the construction work associated with the M90 storage will require approximately 6 staff, comprising:

- 4 operatives;
- 1 manager; and
- 1 employer supervisor

9.1.2 Environmental Improvements Storage

Opportunities for environmental improvements within the scheme have been reviewed as part of the outline design. The embankment upstream of Kinross services will form a flood storage reservoir which will remain dry but be flooded during storm events before managed release of flows to the Ury Burn. The area is currently used for crops which would no longer be feasible with the cycle of flooding and drying. Depending on landowner discussions and budgets PKC may purchase the land or agree a suitable compensation in perpetuity. The space would no longer be suitable for arable agricultural therefore it could be repurposed as a wildflower meadow to provide environmental benefits to the scheme.

Provision of a wildflower meadow in these areas would offer the following significant benefits:

- provide an important nectar source for pollinating insects such as bumblebees and hoverflies;
- support rare plant communities which are vital sources of seed for the restoration of meadows;
- trap sediment and store carbon, and will be increasingly valued for these functions as the climate changes;
- provide a link with the past, a living reminder of the traditional, rural landscapes and the ways of life that created them;
- Education about biodiversity and water management through signage and potential to facilitate public access to create amenity space within flood storage area through paths outwith times of flooding.

Water levels play a key role in floodplain meadows. Flooding is more usual in winter, although the timing, frequency and duration of floods vary from year to year. Less water is lost through evaporation in autumn and winter, and water levels tend to rise, falling again in the spring and summer when there is substantially more evapotranspiration. The characteristic floodplain-meadow plant communities are adapted to these changing conditions. A Planting Schedule will be developed in detailed design which specifies required plant types and locations based on the hydrology of that section of the flooded area based on their adaptability to flooding e.g. species such as Brown sedge, jointed rush, water avens and greater bird’s-foot-trefoil would be suitable for much of the flood storage area occasionally flooded whereas Common knapweed, devil’s-bit scabious, sharp-flowered rush would be more adapted to the field areas where floodwater would not reach. Flooding at the

M90 storage area is expected infrequently from a 1 in 100 year event therefore this land could also be repurposed for pastoral agricultural provided the embankment is fenced off to protect it from damage through grazing.

The field adjacent to Cleish Place in the vicinity of the proposed flood embankment along the South Queich will act as informal flood storage during more frequent flood events. The area is currently part of the floodplain and subject to regular flooding. The scheme will increase and formalise the available flood storage. Due to this use, this land is only suitable for Water Compatible Uses such as amenity open space or nature conservation and biodiversity per SEPA guidance. To enhance this space within these constraints it is proposed this area is also seeded as wildflower meadow with plants that are suitable for occasional flood condition. Given this area is used informally by local walkers this would add a further benefit by enhancing the amenity space.

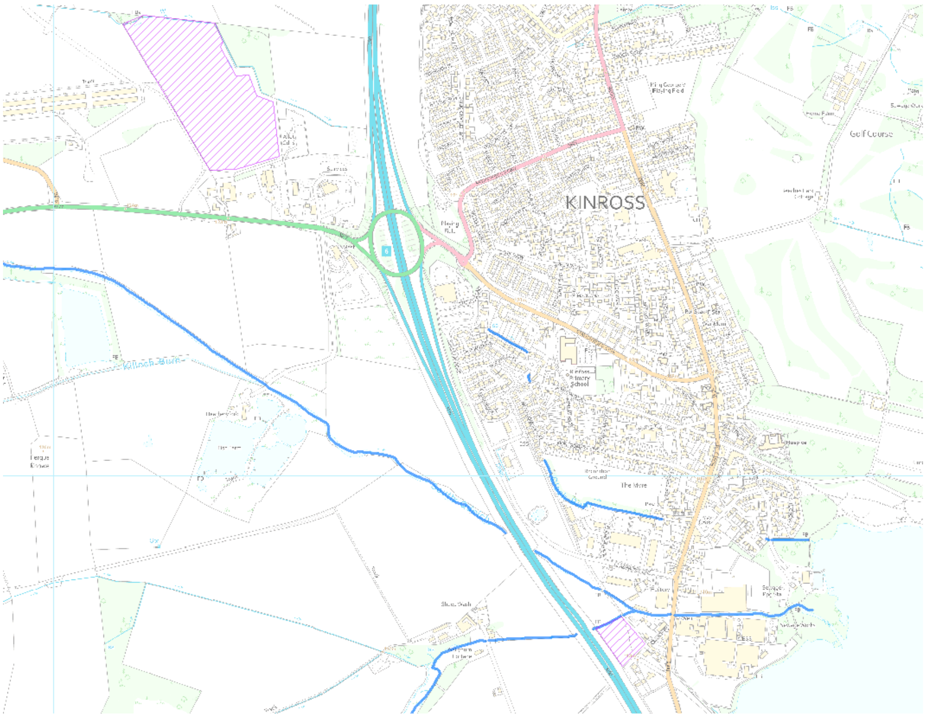


Figure 9-1 Locations for Wildflower Meadow Planting

10 OPERATIONAL CONSIDERATIONS

Perth & Kinross Council currently inspect flood schemes on an annual basis but specific elements of the Scheme, and their maintenance requirements, are outlined in 10.1.1to 10.1.5. Telemetry will also be installed to enable wider flood scheme monitoring and emergency action. Ten hydrostatic level sensor and staff gauges with associated telemetry are expected to be installed:

- Four monitors around defences,
- One monitor for pumping station,
- One monitor at the upstream storage control structure
- Four monitors at new Clash Burn headwalls

10.1.1 Proposed Flood Walls

Flood walls will require inspections which will be undertaken at 12 month intervals for determining the in-service physical condition of defences. A more comprehensive Principal Inspection – within touching distance of all inspectable elements will be required where issues have been detected during annual inspection. Where required, typical maintenance works for flood walls would include:

- defence repairs (concrete repairs, sealant replacement, and steel pile painting);
- tree work;
- graffiti removal;
- vermin control.

10.1.2 Embankments (Defence and Upstream Storage)

Flood embankments will require more regular inspection and maintenance activities including the following:

- localised embankment raising due to settlement;
- 5 yearly topographic survey of embankments to monitor levels/settlement
- Grass control 2 – 3 times a year;
- invasive weed control;
- Tree work where trees remain near defences to ensure structures are not affected - once a year;
- Vermin control - once a year.
- 0.5%AEP+CC storage volumes at the Old Cleish Road and the M90 Storage area are 8600m^3 and 5000m^3 respectively. These areas therefore do not fall under the 10,000m^3 requirement for Reservoir Act and the associated maintenance burden with these additional requirements.

It is anticipated that riverbanks, flood defences and existing bridges will require a more in-depth single inspection after any major flood event. These activities would typically include:

- Tier 2 (non-intrusive investigations carried out by an appropriate expert) intermediate inspection of foundations to determine occurrence of any scouring or undercutting of foundations;
- To look for signs of deposition of debris or blockages in the waterway; and
- An examination of defences for signs of collision damage, subsidence or other ground movement.

10.1.3 Culverts

Culverts will require the following maintenance and inspection activities:

- Superficial inspection –monthly combined with inlet/screen inspections/clearance;
- General inspection (non-entry inspection to examine all parts of the structure, including lifting of manholes) – every 1 to 2 years;
- CCTV survey – every 5 years;
- De-silting typically every 10 years for highest grade of operation;
- Culvert repair works – defect repair, vegetation clearance, signage replacement, sealant replacement, fencing repair - every 3 years for highest grade of operation.

10.1.4 Pumping Station

A surface water pumping stations is proposed at Koronka Manufacturing. This will require inspection and maintenance every 6 months to a year including the following activities:

- Inspection of pump(s) impeller for debris and damage unblock as required
- Remove and clean level control floats / ultrasonic head
- Check operation of Non-Return Valve(s)
- Check the condition of pipework and internals for defects
- Check condition/serviceability of pump(s) control panel
- Check and test all safety/alarm facilities

10.1.5 New Bridge

A replacement pedestrian bridge is proposed along the Gelly Burn. Regular inspection should be carried out to gather information on any structural defects and record deterioration over time. Based on industry standard guidance, the following will be required:

- Principal Inspections 6 yearly: This level of inspection requires a close examination (within touching distance) of all necessary parts of the structure, including access equipment and non-destructible testing.
- General Inspections 2 yearly: This consists of a visual inspection of all external parts of the structure. Access equipment may be required in some cases.

- Superficial Inspections Yearly: This type of inspection consists of a cursory check for obvious deficiencies, which might lead to traffic accidents or high maintenance costs.

11 PKC CONSULTATIONS

11.1 Community Greenspace

A review of rights of way and core paths was carried out to determine any impacts from the scheme. It can be seen from Figure 11-1 that there are limited statutorily protected accesses within the footprint of the proposals.

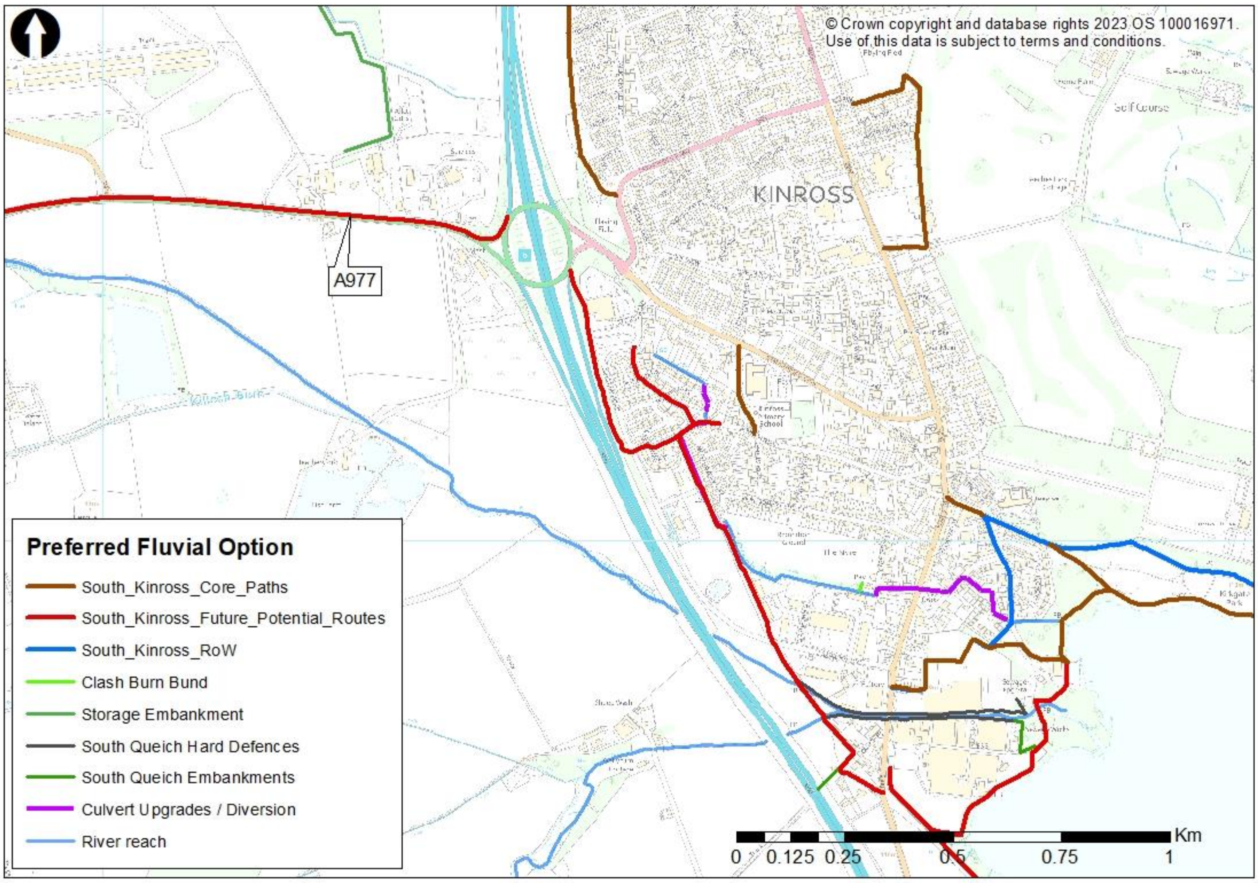


Figure 11-1 Public Access

Much of the hard defence line is within private land rather than being open to the public and access will not be altered by the scheme. Within the direct defences area of the scheme a future potential route was identified running across the Gelly Burn and South Queich which could be blocked by the proposed embankment at Queich Place. Consultation with the Community Greenspace team on 21st February 2023 determined this route has not been developed and there are no current plans to do this. The Greenspace team noted that this route is used informally by dog walkers so access needs to be maintained here. This will be facilitated by including a ramp up and over the embankment from Old Cleish Rd. Access can then be gained across the field or along the proposed access track along the foot of the embankment. A new footbridge will be provided across the Gelly Burn to maintain existing access. A lockable gate would be provided at Cleish Place and to the north of the new footbridge so that access can be prevented during flood events and maintenance. A core path exists along the northern boundary of the site. This may be disrupted/diverted during construction to prevent risks to the public entering an active construction site. Post construction this path will be unaffected. The

Greenspace team requested the local ranger be kept up to date with plans for this area and progress of the scheme. Discussion was also held around using the floodplain area as wildflower meadow.

Along the Clash Burn culvert upgrades, the main impact on access with be temporary disruption during construction. This is important at Sandport Close where the outlet of the downstream end of the culvert crosses a Right of Way. Boathouse access will be cut off during construction. Proposals are in place to construct a new access between the former BCA site and the boathouse which would provide an alternative route. PKC will work with this developer to phase this part of the construction, so this alternative access is in place. No statutory protected accesses were identified around the storage embankment.

Access to the watercourse and defences will be required by PKC for maintenance - this will be facilitated via stepped access points and a new access track along foot of embankments. Access for culvert maintenance will be via stepped access from headwalls to catwalks over trash screens. **Drawings IBE1585_2001 – 2009** illustrates maintenance access points.

11.2 PKC Heritage

A meeting was held with PKC Heritage team on 17th August 2023. The focus of the meeting was heritage consideration for the scheme finish. It was highlighted that although the site is not in a conservation area it is a historic part of Kinross which acts as an entrance to the town. It was recognised that budgets are constrained though impacts should be minimized impact where the scheme is most publicly visible i.e. around residential property and views from High Street Bridge. It is likely high specification finish will be applied in these areas with more likely bare sheet pile in industrial areas as this will be in keeping with the land uses in the areas. It was noted the bare sheet pile would be preferable to the RECKLI style cladding as it would tie in better with the industrial heritage of the area. It was also made clear that the new flood walls will be structurally separate from the historic High Street bridge which will reduce risk to this asset.

The proximity of the Clash Burn culvert to the war memorial at High Street was also highlighted and noted that a suitable buffer distance will be added, and reinstatement would be like for like. Overall, there were no significant concerns with the proposals and the team will continue to be consulted as the scheme progresses.

11.3 PKC Structures

11.3.1 Approvals Route

RPS consulted with the PKC Structures team via a virtual meeting on 16th February 2023. Based on discussions it was confirmed that Approval in Principle submissions are required for each of the proposed structures prior to the commencement of detailed design. Based on the provided PKC guidance[23] the approval routes were presented and agreed with all structures falling under either Category 0 or 1 approval routes.

[23] Housing and Environmental and Consumer Services, Strcurtures & Flooding Team, Structures Section Procedure, Technical Approval and Adoption Requirements Bridges, Culverts, Retaining Walls & Embankments, Perth and Kinross Council, Revision 5, June 2020

Prior to detailed design, an Approval in Principle submission will be submitted for all structures (including a detailed whole life cost appraisal confirming that the proposed option represents best whole life cost over 120 years) in accordance with CG 300 for approval by PKC. The detailed design will be checked independently by another engineer within RPS as per the Cat 0 and 1 approval process.

11.3.2 High Street Bridge

11.3.2.1 Scour Assessment

The only PKC adopted structure impacted by the proposed works is High Street Bridge. Consultation with the PKC Heritage Officer has confirmed that the bridge is not listed but would be considered a historic structure. It was recommended walls with the vicinity of the bridge are finished in keeping with the style of the bridge.

A review of hydraulic model outputs at High Street bridge indicates the scheme would have a negative impact in flood level at the bridge with levels raised by 230mm, and 520mm allowing for CC at the 0.5% AEP event. It will therefore be necessary to ensure that the bridge is capable of withstanding increased water level and flow velocities associated with the scheme, both in terms of ensuring the bridge has sufficient scour resistance and load capacity allowing for an appropriate risk of debris build up (i.e. will the bridge need to be closed during certain flood events etc).

The bridge has been assessed for scour and structural risk of bridge at baseline, scheme, and scheme + CC water levels / flow velocities allowing for debris build up as required.

Table 11-1 0.5%AEP Design Flows, Velocities and Water levels

Parameter	Base 200yr	Base 200yrcc	Scheme 200yr	Scheme 200yrCC
Design Flow Peak (m^3/s)	30.77	36.42	34.1	47.13
Water Level (mAOD)	110.15	110.32	110.43	110.84
Flow velocity (m/s)	1.60	1.70	1.49	1.70

Table 11-2 Estimated depth of Scour

Parameter	Base 200yr	Base 200yrcc	Scheme 200yr	Scheme 200yrCC
Constriction Scour (m)	3.49	3.49	3.49	3.49
Local scour footing (m)	2.67	3.49	3.67	4.32
Total scour (m)	6.15	6.98	7.16	7.81

Table 11-3 Risk and Priority Rating

Parameter	Value	Comment
Foundation Depth (m)	1	Foundation unknown estimate for masonry structures
Foundation type factor, F	1	Based on age assume spread
History of scour problem factor, H	1	No
Foundation material factor, M	1	Granular material based on desktop GI
Type of river factor, TR	1	Lowland
Importance factor, V	1	Max value as failure would have serious consequence cutting off Kinross
Relative scour depth DR Q200CC Base	6.67	Max scour depth/ foundation depth
Relative scour depth DR Q200CC Scheme	7.81	Max scour depth/ foundation depth

Parameter	Value	Comment
Priority factor Pr	1	PF=F.H.M.TR.V
Risk Rating	2	Based on DMRB VOLUME 3 SECTION 4 PART 21 - BD 97/12 Figure 5.1 – Scour Risk Rating Priority Factor vs Relative Scour - Further investigation and scour protection likely required in both base and scheme case

High Street bridge is currently at risk of scour falling into risk category 2 as set out in DMRB. This triggers a requirement for further investigation and if necessary, implementation of appropriate monitoring and scour protection measures as a high priority. The scheme is expected to increase scour risk with total scour increased by 12% at the 200yrCC event. However, this does not materially change the existing risk the structure remaining within the priority 2 rating.

Liaison with PKC Structures has indicated a scour assessment is planned for this bridge to manage baseline risk. It is expected scheme funding will only cover the cost of works require to mitigate against increased water levels as part of the scheme. RPS will liaise with PKC Structures as the scheme develops to ensure a partnership approach in the protection of this bridge.

11.3.2.2 Structural Risk

Predicted flood levels and flow velocities from hydraulic modelling were reviewed to compare the baseline and defended scenarios. Simplistic analysis using hydrodynamic drag and lift equations from CD356 were used to determine if there were risk of increased hydrodynamic loads on structures because of the scheme. The 0.5%AEP+CC event was taken as the most likely worst case scenario. Analysis indicates the increase in flood level of 520mm results in an increase in hydrodynamic loads on the structure of 21% at this event. Based on the order of magnitude strengthening works rather than replacement of the bridge should be sufficient to manage the increase in load. This would likely consist of steel plates with a tie road between concrete backing or precast concrete arches. Full structural design will be carried out for strengthening works in detail design with an allowance included in outline design costing.

Table 11-4 Difference in Loading at High Street Bridge

Bridge	Change in water level (m)	Change in velocity m/s	% increase in hydrodynamic lift and drag
High Street Bridge	+0.52	+0.01	+22

11.3.3 Non-Perth and Kinross Adopted Structures

The same assessments were carried out for non-adopted structures with the potential to be impacted by the scheme in line with CD365 for loading checks and BD97/12 for scour checks.

11.3.3.1 Structural Risk

Increased water levels and velocity at the Gelly Crossing and Sandport Close are likely to increase hydrodynamic loads on these structures. To mitigate this, the Gelly Burn crossing will be replaced with a heavier duty structure and the open reach of the Clash Burn upstream of the Boathouse access crossing will be replaced with an extension of the Clash Burn culvert. Reduced velocity at the Loch Leven Footbridge due to new out of bank flow discussed in Section 6.10 will result in a reduction in bridge loading. There is a decisive increase or decrease in loading determining actions for all structures except for Junction Road Bridge. First principles analysis of weight versus loading at this structure indicates the overall hydraulic loading would be less than 1% of the force exerted by the structure from its own mass. On this basis no additional works are expected here.

Table 11-5 Difference in Loading at existing bridges

Bridge	Change in water level (m)	Change in velocity m/s	% increase in hydrodynamic lift and drag
Gelly Crossing	+0.41	+0.22	+90
Junction Road Bridge	+0.22	+0.01	+12
Loch Leven Footbridge	+0.21	-0.31	-40
Boathouse Access Crossing	+0.28	+0.14	+168

11.3.3.2 Scour Risk

As the Gelly crossing and Boathouse Access Crossing will be replaced, they have not been assessed for scour risk. This will be carried out as part of the structural design during the detailed design phase. Scour assessment was carried out for the Loch Leven trail footbridge and Junction Road bridge at the worst case 0.5%AEP+CC event. The assessment found both structures fall into class 5 risk rating with the scheme in place - therefore are at low risk of scour and require no further action beyond current monitoring and maintenance regimes

Table 11-6 0.5%AEP Design Flows, Velocities and Water levels

Parameter	Junction Road Bridge	Loch Leven Footbridge
Design Flow Peak (m^3/s)	20	40
Water Level (mAOD)	111.45	108.85
Flow velocity (m/s)	1.11	1.96

Table 11-7 Estimated depth of Scour

Parameter	Junction Road Bridge	Loch Leven Footbridge
Constriction Scour (m)	0.93	0.59
Local scour footing (m)	2.32	1.17
Total scour (m)	3.24	1.71

Table 11-8 Risk and Priority Rating

Parameter	Junction Road Bridge	Loch Leven Footbridge	Comment
Foundation Depth (m)	3	3	Foundation unknown estimate for concrete
Foundation type factor, F	1	1	Based on age assume spread foundation
History of scour problem factor, H	1	1	No
Foundation material factor, M	1	1	Granular material based on desktop GI
Type of river factor, TR	1	1	Lowland
Importance factor, V	0.7	0.7	Pedestrian or less than Broad access
Relative scour depth DR Loch Leven Footbridge	1.08	0.57	Max scour depth/ foundation depth
Priority factor Pr	0.7	0.7	PF=F.H.M.TR.V

Parameter	Junction Road Bridge	Loch Leven Footbridge	Comment
Risk Rating	5	5	Based on DMRB VOLUME 3 SECTION 4 PART 21 - BD 97/12 Figure 5.1 – Scour Risk Rating Priority Factor vs Relative Scour - No action required other than routine inspections in accordance with BD 63.

11.4 Transport Scotland

Consultation with Transport Scotland commenced in July 2023 and is ongoing regarding the tie in to the M90 embankment at Old Cleish Road.

12 PUBLIC CONSULTATION

A public exhibition was held in Kinross Parish Church (10 Station Road, Kinross, Scotland, KY13 8TG), on the 28th September 2023 and 5th October 2023, from 2pm to 8pm on both days. The outline design drawings, storyboards of the scheme, EIA and Technical Report were available for the public to view and comment.

A total of 35 people (excluding RPS and PKC representatives) attended the events. Attendees were provided information including an outline of the project, predicted flood risk in the area, the progress to date and future steps regarding the flood relief scheme. Attendees were given the opportunity to provide feedback and comments on potential flood alleviation schemes and provide details regarding the flood risk in the area. Full detail is provided in the Public Consultation Report[24]. In general, the impression received from the public consultation was that the local community continues to support the flood scheme. Comments related to the outline design were:

- **Pumping station of the Korkoka Yard** – to be moved to facilitate operations in the yard – this has been reflected on the drawings and landowner engagement will be carried out at detail stage to position the pumping station in the least disruptive location
- **Routing of the Myre culvert** – this has been addressed through the new route of the culvert from the Myre Playing fields allowing flow to be retained in open channel section discussed in Section 4.2
- **Wall finish –** There were no strong opinions regarding the finish of the wall and an understanding that cost would play a part in this
- **Drainage works at Todd and Duncan Site –** planned redevelopment work in this site may create an opportunity to realign drainage to avoid reinstating multiple outfalls and replace with a pumped solution to discharge flow above the wall. This would provide greater resilience for drainage in high flow events and simpler construction of walls. Noted that there is ongoing engagement with landowner here.

Figure 12-1 Photo from Public Consultation Event

[24] South Kinross Public Consultation Report, RPS, November 2023

13 ENVIRONMENTAL ASSESSMENT

The Proposed Scheme (Development) falls under paragraph 10(h) of Schedule 2 of The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Amendment Regulations 2017. As such, an Environmental Impact Assessment must be carried out in support of the Licence Application.

13.1 Purpose of the EIAR

Environmental Impact Assessment (EIA) is a procedure under the terms of European Directives[25] for the assessment of the likely significant effects of a project on the environment. An Environmental Impact Assessment Report (EIAR)[26] is a statement prepared by the applicant, providing information on the likely significant effects on the environment based on current knowledge and methods of assessment. It is carried out by competent experts, with appropriate expertise, to provide informed assessment within their discipline.

The primary objective of the EIAR is to identify the baseline environmental context of the proposed project, predict potential beneficial and/or adverse effects of the project and propose appropriate mitigation measures where necessary. In preparing the EIAR, the following legal provisions and guidelines were considered:

- The requirements of EU Directives and Scottish law regarding Environmental Impact Assessment (including The Town and Country Planning (Scotland) Act 1997, as amended by the Planning (Scotland) Act 2019, the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017), and The Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Amendment Regulations 2017;
- European Commission Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU) (European Commission, 2017);
- Planning Circular 1/2017: Environmental Impact Assessment regulations; and
- Environmental Impact Assessment Handbook: Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland, (Scottish Natural Heritage & Historic Environment Scotland, 2018).

In addition, specialist disciplines have had regard to other relevant guidelines, as noted in the specific chapters.

[25] EU Directive 85/337/EEC as amended by Directives 2011/92/EU and DIRECTIVE 2014/52/EU

[26] ENVIRONMENTAL IMPACT ASSESSMENT REPORT, South Kinross Flood Protection Scheme, Volume II – Main Report, RPS, August 2023

13.2 Function of the EIAR

This EIAR is a report of the effects, if any, which the Proposed Development, if carried out, would have on the environment, and includes the information specified in Annex IV of the Environmental Impact Assessment Directive and Schedule 2 of The Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Amendment Regulations 2017. The EIAR is the document prepared on behalf of the applicant that presents the output of the assessment conducted on behalf of the applicant.

The EIAR must include the necessary information for the competent authority to reach a reasoned conclusion and should be of a sufficient quality to enable this judgement. The EIAR has been prepared following an examination, analysis and evaluation of the direct and indirect significant effects of the project in relation to the receiving environment.

13.3 EIA – Process

13.3.1 EIA Screening

An EIA Screening Report on the Proposed Development was undertaken by RPS and issued to PKC planning department in July 2021 for their opinion. The report determined that the Proposed Development falls under paragraph 10(h) of Schedule 2 of The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017. In accordance with The Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Regulations 2010, as amended, it was determined that there is a potential for likely significant effects on the surrounding environment of South Kinross. Therefore, likely significant impacts need to be considered in a detailed Environmental Impact Assessment (EIA) for the Proposed Development. Perth & Kinross Council agreed to carry out the recommendation in the EIA Screening Report.

13.3.2 EIA Scoping

A request for a Scoping Opinion was subsequently submitted to PKC on 14th February 2022. This was accompanied by an EIA Scoping Report provided to assist PKC and the statutory and non-statutory consultees to form an opinion upon the likelihood of significant environmental effects and hence to topics to be assessed in the EIA. The scoping report also provided an opportunity for consultees to comment upon suggested methodologies for technical assessment.

13.3.3 Methodology & Structure

The main aim of this EIAR is to provide information on the Proposed Development to the public concerned, prescribed bodies and the competent authority. To this end, Article 3(1) of the EIA Directive requires that significant effects are identified, assessed and described in an ‘appropriate manner’.

Article 5(1) of the EIA Directive sets out the information should be presented in an EIAR to enable stakeholders and authorities to form opinions, and to make decisions regarding the project. While there are no formal requirements concerning the format and the presentation of the report, this EIAR clearly sets out the methodological considerations and the reasoning behind the identification and assessment of likely significant effects. Annex IV to the Directive, expands on these requirements. In short, this includes the following:

- A description of the project: this is an introduction to the project and includes a description of the location of the project, its characteristics, including land use requirements during capital dredging operations and operational phases, as well as estimates of the expected residues, emissions, and waste produced during each phase.
- Baseline scenario: a description of the relevant aspects of the current state of the environment, and the likely evolution thereof, without the implementation of the project, on the basis of the availability of environmental information and scientific knowledge.
- Environmental factors affected: a description of the environmental factors likely to be significantly affected by the project, including consideration of climate change mitigation and adaptation, biodiversity, natural resource sustainability, and the risks of major accidents and disasters.
- Effects on the environment: a description of the likely significant effects of the project on the environment. Such significant effects include direct and indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, and positive and negative, as appropriate.
- Assessment of alternatives: a description of the studied reasonable alternatives to the project, with an indication of the main reasons for the selection of the option chosen, including a comparison of environmental effects.
- Mitigation measures: a description of the measures envisaged to avoid, prevent, reduce and, where possible, offset any identified significant adverse effects on the environment, including a determination of the effectiveness of such measures, their reliability and certainty, as well as the commitment to ensuring their practical implementation and monitoring of results.
- Monitoring: a description of any measures proposed to monitor significant adverse effects on the environment and/or measures taken to mitigate them.
- Non-Technical Summary: an easily accessible summary of the content of the EIAR presented without technical jargon, hence understandable to anybody without a background in the environment or the project.
- Quality of the EIAR: the experts responsible for preparing the EIAR are competent.

Predicted impacts and the significance arising from the Scheme is assessed in the EIAR based on the outline design proposals. The sensitivity or value of the receptor is determined at the baseline stage and the scale of magnitude of the environmental impact is defined in order to assess the impact significance.

Mitigation measures are recommended where required to reduce any predicted impacts with a resultant residual impact identified for the Scheme. Where possible, mitigation measures have been considered in the design as outlined in Table 13-1. The mitigation measures proposed which are not included in the outline design should be taken forward and implemented as part of the detailed design phase.

The impact assessment adopts a matrix-based approach consistently across the EIA. Impact significance is a function of the sensitivity (value/importance) of an attribute and the magnitude of impact (assessed before and after mitigation).

Table 13-1 EIA Topics and how they have informed the outline design

Topic	EIAR Chapter Overview	Informed Outline Design Process
Chapter 6: Air Quality & Climate	There are significant short-term negative effects of the construction due to dust emissions. With mitigation, the issue is reduced to negligible. The issue of traffic is non-significant and the effect on air quality from possible traffic is also negligible. Effects are considered to be negligible and not significant in terms of climate change resilience	The direct defences have been designed to allow for future climate change adaptation and culvert elements of the scheme sized to account for climate change uplifted flows.
Chapter 7: Biodiversity Ornithology & Chapter 8: Biodiversity Terrestrial & Aquatic	Desk and field assessments were conducted to evaluate the potential effects of the Proposed Development. Collaborating with the Fife Nature Records Centre, surveys were conducted to study breeding and wintering bird populations as well as protected species such as otters, badgers, red squirrels, bats, and fish. Surveys found the habitats and vegetation present to predominately be of low sensitivity, with only a limited area of arable field habitat likely to be lost to the Proposed Development. Effects on habitats from the construction and operation of the Proposed Development have been assessed and are found to be Not Significant. The cumulative effects of the South Kinross FPS and proposed projects within 1km of the site have been assessed and deemed to hold Negligible significance for IOFs. The Proposed Development is not expected to significantly impact designated sites, species, or habitats. By implementing best practices, mitigation measures, habitat enhancement, and flood defence structures to protect trout spawning sites, no significant environmental impacts are anticipated from the Proposed Development alone or in conjunction with nearby developments	Pre-construction checks for otter, badger, red squirrel and bat roosts will be undertaken 3 months before construction. Surveys will target the two potential badger setts in Area A and monitoring by motion sensitive cameras will be required to confirm the activity status of both setts if construction works are to take place within 30 m. Following updated surveys, measures which should be implemented during construction will be detailed in the Construction Environmental Management Plan (CEMP). Management of INNS species known to be present within the construction/works area has also been included as part of the advance works for the scheme.
Chapter 9: Cultural Heritage / Archaeology	The construction phase won't impact designated or recorded non-designated heritage assets, and there's a low chance of affecting unrecorded assets. The operational phase won't change the setting or cultural significance of designated heritage assets.	Liaison has been held with PKC Heritage Officer to discuss sympathetic design solutions for the proposed wall finishes in most publicly visible areas.
Chapter 10: Landscape & Visual	The FPS assessed for its impact on Landscape and Visual resources in both the construction and operational phases. The local effect significance was found to be moderate/major during construction, but it decreased to a minor/non-significant level during the operational phase. The wider townscape resource has the capacity to accommodate the development, with potential minor direct effects on the townscape and immediate boundaries during the operational phase. The remaining area is expected to be unaffected by significant effects during the operational phase.	The landscape and townscape character has been established. The outline design seeks to maintain the visual aspect of the town through style of wall and type of cladding to be used. Maps were created using terrain modelling techniques to identify areas where the FPS was theoretically visible in worst-case scenarios. This was used to inform locations likely required to be higher specification in cladding materials.

Topic	EIAR Chapter Overview	Informed Outline Design Process
Chapter 11: Material Assets & Land Use	Major impacts on material assets through the proposed project were found to be unlikely. The construction phase is predicted to have impacts of Minor or Negligible significance for most types of material assets assessed, though there are possible Minor or Moderate impacts on the water supply and sewer network at Hopefield Place (a permanent re-routing of water mains pipes may be required during the operational phase). Cumulative effects are unlikely due to the small scale of other developments. However, indirect cumulative effects during the construction phase cannot be dismissed.	By design, the Proposed Development aims to avoid clashes with utilities where possible and reduce the number of roads, properties, businesses, services and community facilities. Culverts under roads and accompanying manholes will aim to avoid infrastructure wherever it is possible. Where required, utilities will be re-routed to avoid any interruptions in gas, water, electricity and telecommunications supplies. Any required network rearrangements have been brought to the attention of the responsible supplier/authority through consultation on C3 estimates.
Chapter 12 Noise & Vibration	An assessment of potential noise effects associated with the Proposed Development has been carried out. There are no significant noise or vibration generating sources associated with the operational phase of the Proposed Development and therefore, operational phase noise/vibration impact assessment has been scoped out. Operational phase traffic movements associated with the Proposed Development will be very low and substantially lower than the level that would be required to generate any significant traffic noise increases on the local road network. On this basis, operational phase traffic noise impact assessment has been scoped out. No residual impacts or residual significant effects are predicted for the operational stage of the Proposed Development.	Mitigation by careful scheduling of the works, timing of activities and using best practicable means will be implemented such that no significant effects arise, and levels are as low as possible at the nearest noise sensitive properties from construction plant and equipment. Residents will be informed of the timing and duration of activities that may produce high noise or vibration. Elevated levels can be tolerated if prior notification and explanation is given. With construction mitigation measures in place as proposed through the CEMP, and temporary construction noise barrier the noise impacts of construction activities is predicted to be temporary minor.
Chapter 13: Soils / Geology / Hydrogeology Contamination	The conceptual site model developed in the assessment could not identify any potential significant relevant pollutant linkages for the site. Through the assessment it is made clear that any impacts the FPS has on the soils, geology, and groundwater are all neutral, meaning the Proposed Development will not have any substantial, negative impacts on the soils, geology, and hydrogeology of the area.	The scheme accounts for the presence of potential contamination in the western section of the scheme and required removal.

Topic	EIAR Chapter Overview	Informed Outline Design Process
		The investigation identified that the site is underlain by made ground, sands, and gravels. It was also found that the site falls within an area of high groundwater vulnerability. These elements have informed the selection and design of direct defences.
Chapter 14 Waste	A carefully planned approach including asbestos surveys to the demolition of buildings and adherence to a SWMP and CEMP during the Construction Phase will ensure that the waste effects on the environment and on landfill void space capacity will not be significant. Materials not suitable for reuse onsite will go offsite for recycling, reuse or recovery as a priority over disposal to landfill. All waste materials leaving the site will be transported via a registered and licensed carrier and disposed or recovered at a licenced site in accordance with national waste legislation. Therefore, the effect of the Construction Phase in relation to waste management is predicted to be Neutral or Slight with the residual effect outcome being Not Significant.	Circular Economy principles have been implemented during the design of the Proposed Development to design out waste and consider the whole life cycle of the development. There are proposals to reuse excavated material in the Proposed Development which would facilitate less waste requiring off-site management and these materials would be a substitute for virgin aggregates which is a more sustainable use of resources. Invasive species should be handled and managed in accordance with the Invasive Non-Native Plan Species Management Plan.
Chapter 15: Flood Risk / Hydrology Drainage	The assessment identifies that the river is the greatest source of flood risk in the survey area, it has been deemed as a medium/high risk and found to have an Annual Exceedance Probability of 0.5%. there is a risk of flooding to the construction phase in the case of an extreme river event. There will be a residual flood risk as the flood defences may be exceeded by a flood event exceeding their design capacity, however, the residual flood risk is described as low due to the high standard of the defences. Once completed, the Scheme will take an estimated 180 properties in Kinross out of existing flood risk at the 0.5% AEP (1:200 year) event, a significant positive benefit of the scheme.	A secondary flooding assessment has been carried out to inform outline back of wall drainage assessment. Mitigation and standard work practice methods to prevent water pollution of the watercourses during construction activities are provided in the outline CEMP
EIAR Chapter 16: Water Quality	The impact of the Proposed Development has been assessed based on the existing baseline derived from the WFD Monitoring programme, Scotland River basin Management Plan 2021 – 2027, SEPA’s morphological pressure database (MPD) and morphological pressure surveys (MPS) undertaken to inform the Environmental Standards Test.	Scour protection has been included in the design where higher rates of erosion are predicted to occur as a result of the new flood defences. Mitigation has been recommended for both the construction and operational stages which will ensure

Topic	EIAR Chapter Overview	Informed Outline Design Process
	The baseline for the South Queich River is already significantly impacted and at a reach level is indicative of bad supporting morphological conditions. The Proposed Development will not significantly impact the morphological conditions given the existing realigned channel, grey bank reinforcement and embankments along the South Queich River. When assessed at the water body scale the Proposed Development will use some additional morphological capacity, but this is not significant as it will not result in a deterioration in the morphological condition, which is currently assessed to be moderate based on the MPS undertaken as part of the project. Construction and operational impacts have been assessed, the significance of the impact during construction is considered to be potentially Major in the absence of mitigation whilst the operation impacts are considered to be minor negative to major beneficial particularly in the context of the avoidance of flooding of potentially significant pollution sources. Less flood events meaning less pollution washed back into river systems and surface water bodies. There will also be improvement in sediment loading to Loch Leven Due to increased net flood storage upstream from FPS.	that the residual impact is Negligible to Minor which is not significant in EIA terms

14 SCHEME ECONOMICS

14.1 Previous Work

The feasibility phase of the project was concerned with identifying a preferred option after investigation of all feasible options. Initial, high level economic assessments were undertaken for the preferred option, and this provided an estimated BCR of 1.47, thus representing an economic benefit. Full details of the Economic Appraisal including damage assessment assumptions and concepts are presented in the Options Review Report[27] provided in Appendix B.

The previous economic appraisal was updated, to reflect the more detailed information relating to the design and construction of the to determine if the scheme is still economically viable. The appraisal of the outline design involved four key stages:

- Per Multi-Coloured Manual (MCM)[28] for economic appraisal in flood schemes, damage figures are to be updated annually using Consumer Price Index Data or a similar appropriate index. Flood economic damages, and flood damages avoided were calculated at the feasibility stage across the design life of the scheme. As this work was carried out in 2021 the calculated damages have been updated to account for the passage of time. As the bulk of the damage contribution comes from property damages the Consumer Price Index Uplift of 19.5% has been used to uplift damages from base year of 2021 to 2023. Per Green Book[29] guidance this allows the benefits (damages avoided) to be assessed in "real" base year prices i.e. the first year of the proposal. In other words, both the cost and benefit can now be estimated and compared from the same base year data (2023).
- Whole life costs of the preferred options (construction, maintenance, design etc.) have been remeasured using more detailed engineering design drawings and information of constraints
- The benefits (damages avoided as a result of the scheme) are then appraised against the whole life cost of the scheme to generate an updated BCR.
- This process will be repeated prior to construction to ensure economic viability of the scheme at all stages.

14.2 Damage Assessment

The RPS methodology to damage assessments follows the guidance in "Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal[30] accompanied by the Multi-Coloured Manual' (MCM). Its use,

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[27] South Kinross FPS – Option Review Report, RPS, December 2022

[28] "The Benefits of Flood and Coastal Defence: A Manual of Assessment Techniques" (Flood Hazard Research Centre, Middlesex University, UK, 2005

[29] The Green Book (2022), HM Treasury, November 2022

[30] Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal, Penning-Rowsell, et al., 2013

accompanied by the MCM-Online, is an industry standard approach for benefit assessment as part of a flood and coastal erosion risk management appraisal.

The MCM provides depth damage data for both residential and commercial properties. For certain depths of flood water, a monetary damage has been assigned to a property. This damage is a combination of the likely items within the building and the building structure itself. The damage to each property is dependent on the property type; as such the MCM has been used to categorise both the residential and commercial properties.

14.2.1 Property Damages

14.2.1.1 Direct Damages

Once the depths of flooding are known the damage can be calculated using the MCM depth damage data. This is known as direct damage in that the flooding directly damages assets; it does not account for indirect damages such as heating costs to dry out the house. For each property type, a typical damage based on historical data has been assigned to a depth of flooding. The latest version of the MCM data is sourced, where the damage per square metre of the floor area of a building is used. This assessment adopted the fluvial depth damage data.

14.2.1.2 Indirect damages

Indirect costs account for tangible costs incurred that are not included in the direct damages. The MCM provides damage data for a range of indirect costs. The South Kinross Flood Protection Scheme considered the following indirect costs; emergency, utility and evacuation costs.

14.2.2 Intangible impacts of flooding

Apart from the material damages to the building structure and the goods inside the property, it is recognised that there are monetary damages associated with stress, health effects and loss of memorabilia, which can be as important as direct material damage to householders. The MCM guidance assesses these impacts as intangible benefits that are associated with flood defence improvements. The calculated intangible benefits are summed with the benefits derived from direct damage avoided to provide the total benefit.

No intangible damages are assigned to commercial properties as these costs do not apply at the same level.

14.2.3 Capping

It is recognised that for certain properties the overall damage associated with it can far exceed the market value of the property. This can be due to either the depth to which it floods or the frequency with which it floods or a combination of both factors. Where such a situation occurs, it is necessary to cap the damages at the market value. In line with MCM guidance, is to cap the direct damages and to leave the intangible flood impacts uncapped before totalling up the overall damages.

14.2.4 Annual Average Damage and Present Value Damage

To gain an appreciation of the economic risk the overall damage needs to be calculated. This is represented by assessing the likelihood of each of these flood events occurring in any given year and applying this as a percentage to the damage; this is known as the Annual Average Damage (AAD). The AAD can then be taken over the lifetime of the study that has been set at 100 years and discounted back to present day costs; this is known as the present value damage (PVD).

For the damage value in each year to be comparable with each other they are discounted to represent the equivalent present damage value. Discounting damage values in the future is based on the principle that generally people prefer to receive goods or services now rather than later. This is known as time preference. The cost therefore of providing a flood management option will also be discounted to present day values.

The total economic benefit for study area is calculated as the sum of the direct and intangible benefits. Damages are assessed up the 0.1% AEP, protecting all properties in the assessment within the 0.5% AEP extent. A summary of the present value damages is shown in Table 14-1 with the figure shown in bold being the direct damages avoided through scheme implementation. These figures are all to 2023 prices, in line with retail price index inflation.

Table 14-1 Present Value Damage

Present Value Damage (0.1% AEP)	£102,267,269
Present Value Damage Avoided (0.5% AEP)	£15,469,520
Intangible Benefit	£480,741
Total Present Value Benefit	**£15,950,261**

14.3 Whole Life Cost Estimate

Whole Life Cost Estimation Costs were split into three categories:

- Capital expenditure (CAPEX): the direct costs associated with the construction of the scheme;
- Operational expenditure (OPEX): the maintenance and inspection costs associated with the scheme over its design life
- General items: indirect costs associated with the delivery of a flood scheme such as enabling works and contractor fees

Following their estimation, costs over the 100 year appraisal period were discounted to 2023 prices. This was to facilitate comparison with the estimated damages avoided to determine a Benefit Cost Ratio.

14.3.1 Capital Expenditure/Construction Costs

The capital cost estimate for the Kinross FPS was derived using rates given in the Spon's Civil Engineering and Highway Works Price Book 2023. The method adopted for preparing a Bill of Quantities for the Operations was the 'Civil Engineering Standard Method of Measurement' by the Institution of Civil Engineers. In some cases, a design choice remained to be made on the construction method and in these cases engineering judgement has been used to determine the most likely course of action.

Where a suitable rate was not available in Spon’s, Environment Agency benchmarked unit rates were adopted for different flood risk elements was used principally for culverts[31] and fluvial defences[32]. Additionally experience from similar projects across the UK and Ireland was used to estimate quantities. The estimated construction costs associated for the scheme are provided in Table 14-2. A detailed breakdown of costs is provided in Appendix H.

Table 14-2 Construction Cost Estimates

Scheme Element	Construction Cost
South Queich Embankment	£584,491
Flood Walls	£4,544,178
Property Flood Resilience	£96,377
Clash Burn Culvert Upgrades	£1,738,285
M90 Storage	£259,271
Total Capex	**£7,222,602**

14.3.2 Enabling and Preliminary Costs

Preliminary costs cover work led by the contractor required before the main construction works take place. Examples include setting up site compound areas, traffic management, provision of temporary access, watercourse management, etc. SEPA guidance suggests using a percentage of the construction costs as previous schemes have shown a relationship between the size of scheme's construction costs and the preliminary costs, with a range of 10% - 30% being typical. As ECI has been brough forward for this scheme a cost estimate was provided for preliminaries from the Balfour Beatty. This was used as a base figure and compared to recent schemes delivered in the PKC area with a cost estimated at approx. 33% of the ECI Construction quote for preliminaries (£2,663,645).

Enabling costs cover items required before the construction and preliminary works can take place. This includes items such as professional fees, design, consultation, modelling, licence / planning fees, etc.

SEPA unit cost database guidance recommends use of a percentage of the capital costs (construction & preliminary) based on a typical relationship between enabling costs as a percentage of the scheme costs. Guidance suggests enabling cost should range between 8 - 10 % for schemes > £1m. Based on RPS’ and PKC’s recent experience in flood schemes in Scotland, enabling estimates to have often exceeded this rough estimate. Additional information on early actions required to develop the project from outline to detail stage is available allowing for a more specific preliminary cost estimate to be carried out in. It is not possible at this stage to envision every enabling cost required to being construction of the scheme, but typical and principal elements of these costs have been included. Enabling Costs were estimated to be £1,846,355 in total. A breakdown of enabling costs is provided in Table 14-3.

[31] Cost estimation for fluvial defences – summary of evidence Report –SC080039/R2, Environment Agency, March 2015

[32] Cost estimation for culverts – summary of Evidence, Report –SC080039/R4, Environment Agency, March 2015

Table 14-3 Enabling Cost Estimate

Enabling Task	Estimate	Assumption in costing
Ecology surveys	£18,058	Assumed based on recent projects and likely preconstruction work required
General surveys - Precondition surveys, CCTV pre and post	£59,840	Assumed about 80 assets based on rough count, rate from recently completed scheme
Topo Survey	£10,000	Assumed based on recent projects
Drainage Survey	£15,000	Assumed based on recent projects
Ground Investigation	£209,351	National Research Council recommends that a minimum of 3% of the project value should be dedicated to ground investigation.
Council PM fees – Engineering admin	£373,200	1 person full time annually & Site PM fully time 2 years
Consultants detailed design fees	£348,918	5% of project cost
Site supervision fees	£194,400	Based on Site manager/Site Supervisor/RPS graduate Engineer
Consultant Project Management	£66,312	10 % Consultants detailed design fees
Licences	£10,000	CAR licence assumed
Compensation Claims	£40,000	Almondbank Scheme experience
Land Costs	£278,000	Rates based on Scotland’s Land Information Service, Scottish Assessors Website, SG 2019 Agricultural Survey, Rate from Stuart and Parker Scottish Farmland Market Review 2022
Legal and Valuation Fees	£60,000	PKC legal fees
Flood Study and Publication	£158,276	
Misc.	£5,000	e.g. venue hire consultation events
Estimated Enabling Costs	**£1,846,355**	

14.3.3 Operation and Maintenance (OPEX) Cost Estimate

Flood risk management measures require ongoing maintenance to ensure the scheme remains in good working order and the design life of the scheme is extended as long as possible.

Environment Agency guidance has been used to determine the likely maintenance and operational activities associated with the different elements of the scheme, the frequency of these activities and cost per m of a feature or cost per visit has been used to determine annual maintenance cost as well as account of intermittent maintenance costs. Annual OPEX cost estimates are summarised in Table 14-4. These are included in the whole life cost build up over the 100 year scheme design life. These costs (discounted to 2023 prices) were estimated to be £1,059,058.

Table 14-4 Operation and Maintenance Annual Cost Estimates Summary

Scheme Element	Annual OPEX Cost	Assumptions
Flood embankments	£2,504	Cost based on a rate of £2,725/km/year from EA cost estimation for fluvial defences. Maintenance includes for vegetation control, inspections, vermin control and back drainage improvements. 2 monthly grass cutting. Litter removal and monthly inspection for filter drains and removal of silt every 5yrs.
Telemetry	£5,172	Cost based on rate of £517 per monitor location for annual maintenance. Cost based EA Flood Monitoring Cost Estimation Guidance.
Flood Walls	£5,983	Cost based on a rate of £0.565/m/year from EA cost estimation for fluvial defences. The O&M costs provide for inspection, vegetation clearance from the wall base, minor concrete repairs and wall repair works. Pumping Station will require 6 monthly inspection and maintenance. Litter removal and monthly inspection for filter drains and removal of silt every 5yrs.
Property Level Flood Resilience	£0	Asset to be transferred to owner therefore not included in WLC for SG and PKC Funding
Culvert Upgrades	£21,640	CCTV - 5 yearly (£1,700), De-silting operation - every 10 years (36,000), annual general inspection (£2,100), monthly inspection (£300) and blockage clearance (£1,000). Rates from EA Cost Estimation for Culverts
Flood Storage Embankment	£2,733	Cost based on a rate of £2,725/km/year from EA cost estimation for fluvial defences. Maintenance includes for vegetation control, inspections, vermin control. Litter removal and monthly inspection for filter drains and removal of silt every 5yrs.

14.3.4 Optimism Bias

Optimism Bias relates to the unavoidable tendency for project appraisal cost estimates to be overly optimistic; this is inherent in early stage cost estimates because major project risks are not quantifiable at this stage. Optimism Bias is intended to account for uncertainty over project costs and the likely increase between the current project stage, i.e. capital expenditure review, and completion. Through a review of the current stage inputs, assumptions and remaining project risks; project risks are factored into an overall uncertainty for Optimism Bias.

The Flood Risk Management (Scotland) Act 2009 Flood Protection Schemes Guidance[33] gives direction for the application of optimism bias. The starting (upper bound) Optimism Bias for scheme costs at the design stage is 60%. The Optimism Bias (OB) consists of risk components, with each contributing a pre-defined percentage of the overall OB factor. These risk components can be reduced for if demonstrable action to minimise risks has been taken, or other evidence is provided that risks are not applicable to the degree indicated. For schemes with a high degree of risk or uncertainty, risk components can also be increased. In any case, the revised sum of risk components is divided by 100 and multiplied by 60 to obtain the new OB factor.

For this scheme, the design risks associated with degree of innovation and complexity can be reduced as the proposals are considered standard civil engineering works. Procurement and client specific risks have been reduced due to recent experience of PKC in delivering similar large flood schemes and due to ECI being brough forward from detail design to outline stage. The early involvement of the contractor and inadequacy in the business case risk elements have been reduced in response to early contractor involvement being undertaken. This should allow technical solutions and cost saving measures to be identified early in the detail design process.

Environmental risk allowances have been reduced as an EIA has been completed and indicates minimal receptors or risks. Poor project intelligence was also reduced slightly due to availability of some initial GI, detailed topo survey in most locations and slit trenching information. Finally, public relations risks have been reduced slightly following largely positive feedback to the scheme from the community after 2 public consultation events. It is recognized however significant engagement work is still required with affected landowners. This has resulted in an optimism bias of 38.7% being applied to the present value construction cost.

14.3.4.1 Key risks

There are several key uncertainties identified within the current costing. These include:

- Unknowns over the cost and scale of utility diversions particularly for Scottish Water Apparatus
- Limited account on geotechnical design requirements has been included as limited GI is available. This will impact costs as GI will inform cut off requirements.
- Land purchases are highly uncertain and only informal conversations with landowners have been held.

14.3.5 Whole Life Cost (WLC)

14.3.5.1 Do Something – South Kinross FPS

The Do Something Option represents the situation when the proposed scheme is implemented. This option scenario includes all the capital design, build, and operation and maintenance costs of the scheme over its

[33] The Flood Risk Management (Scotland) Act 2009 Flood Protection Schemes Guidance for Local Authorities, Chapter 5 Project Appraisal: Assessment of economic, environmental and social impacts, Scottish Government, February 2012

lifetime. To assess the benefits of the scheme over its 100 year design life against the cost to deliver the scheme the whole life cost of the scheme must be calculated.

Residual damages for flood events with greater magnitude than the 1 in 200 year return period event have also been included.

Whole life costs of the scheme (Table 14-5) are brought to a present value (PV), using 2023 as the base year. The current discount rates specified in the HM Treasury Green Book[34] have been adopted. An appraisal period of 100 years has been used, as recommended by Scottish Government for Flood Prevention works.

Table 14-5 Whole Life Costs Summary

Item	Cost
PV Enabling Costs	£1,846,355
PV Preliminary Costs	£2,663,645
PV Construction Costs	£6,978,359
PV Opex Costs	£1,059,058
Optimism Bias	£2,700,625
Total Whole Life Cost	**£15,248,042**

14.3.5.2 Do Minimum

The Do Minimum Option is the present case scenario. This option represents the present-day conditions, where routine maintenance is carried out to clear watercourses of any debris/blockages and banks are maintained. Therefore, an annual allowance is included in this option to cover the cost of routine maintenance.

There are no capital costs or project costs associated with this option. A summary of the benefits and costs associated with the Do Minimum option are presented in Table 14-6. Given the lack of formal defences within Kinross continuing to maintain existing culverts and drainage would merely maintain the existing level of baseline damages i.e. no damages are avoided. An Optimism bias of 30% has been applied here as this represents the starting OB factor recommended by Scottish Government Economic Appraisal Guidance. Given the works required are fairly certain and do not involve design with significant unknowns it is reasonable to apply the minimum standard OB to these costs.

Table 14-6 Do minimum Whole Life Cost

Scheme Element	Construction Cost
Present Value Damage	£102,267,269
PV of damage avoided	0
Annual Maintenance Cost*	£24,053
PV Maintenance costs +30% OB	£669,785*

[34] The Green Book, HM Treasury, November 2022

*Retaining culvert maintenance cost from scheme estimate and approximately accounting for approx. 3.5km of watercourse management in Kinross to be managed at a rate of £8,445per km/year from EA Cost Estimation Guidance[35]

14.4 Benefit Cost Ratio

In managing flood risk, the Council must have regard to the economic impact of its actions. The cost of the flood scheme can't exceed the benefits, i.e. the benefit/cost ratio must be greater than 1.0.

The benefits (damages avoided as a result of the scheme) have been appraised against the whole life cost of the scheme to generate an updated BCR of 1.05 showing the scheme is economically viable.

Table 14-7 Benefit Cost Ratio

Category	Value
Whole Life Cost (WLC)	£15,248,042
Total Present Value Benefit	£15,950,261
Benefit / Cost Ratio (BCR)	**1.05**

It should be noted there are other benefits to the scheme which have not been monetised. These include:

- Reduced flooding of residential homes and business would have positive impact on owner's health and wellbeing.
- During and post flooding there would be loss of transport routes for the community – roads currently affected would be protected up to the 0.5% event reducing disruption and improving connectivity
- The M90 would be significantly disrupted from a 1% AEP event and this will be avoided as a result of the scheme
- The community's way of life would be significantly improved through protection of properties, recreational sites and transport routes.
- The boathouse area is a key recreational asset and this will be made resilient through PFR which will reduce the amount of time this asset cannot be accessed during and post flood
- Key infrastructure assets which may previously have been experienced a loss of service due to flooding such as an electricity substation on Clashburn Road, sewage works at Todd and Duncan and the South Sewage Pumping Station (SPS) on High Street will now be protected up to the 0.5% AEP event.

[35] Cost estimation for channel management –summary of evidence Report – SC080039/R3, EA, March 2015

15 RISK

Flood Protection Schemes are complex projects with various components and associated risks. RPS have endeavoured to identify risk and suggest mitigation or controls where possible. A risk register has been developed (Table 15-1) which will be treated as a live document as the scheme progresses. This will allow identification, quantification and tracking of risks throughout the design and construction process. Where appropriate, these risks have been incorporated and factored into assessments and appraisals.

Table 15-1 Project Risks

No.	Risk Title	Risk Description (actual or potential)	Date Created	Before Mitigation			Mitigation	Actionee	Action Update	After Mitigation		
				Likelihood	Consequence	Risk Level				Likelihood	Consequence	Risk Level
1	Community Engagement	Residents and businesses in proximity to proposed work may oppose potential disruption due to the scheme during the construction, maintenance and operational phases of the scheme.	25-Apr-2023	Possible	Moderate	Medium	Following agreement of the outline design public engagement to be carried out to explain scheme and needs. Continued consultation with the community through newsletters and where there appears to be some opposition more engagement is recommended prior to formal notification to to minimise the risk of formal objections to the scheme. Continued engagement with the local community must continue throughout the detailed design and construction phases of the scheme.	PKC	Ongoing	Possible	Minor	Low
2	Limitations of Modelling Software	Design has been developed using industry standard modelling approaches., Any modelling contains inherent uncertainties with risks arising from differing degrees of accuracy in the predicted values and also the sensitivities of the modelling packages predicting the scheme response.	25-Apr-2023	Possible	Moderate	Medium	Sensitivity testing carried out. Calibration and verification of model against flood event and gauge data to increase confidence. Liaison with SEPA on acceptance of modelling. Additional topographical survey data with more detailed used to more accurate model overland flows in 2D. Input flows are assessed to be conservative, with the resulting flood defence levels providing the required level of protection to the community of Kinross. Freeboard considered in designs to account for uncertainty. Model will be updated during detailed design to incorporate any changes as the scheme develops and assess/mitigate any impacts. There may be a temporary increase in flood risk during construction of the scheme. The model will be used to assess any increase in flood risk and inform temporary works, construction planning and potential temporary defence measures.	RPS	Ongoing	Possible	Minor	Low
3	Scheme confirmation	FPS rejected during formal process of getting scheme confirmation	25-Apr-2023	Possible	Major	High	Targeted landowner communications and 2 community events will be carried out to reduce risk of objections during formal notification period. If objectors arise efficient review and response to valid objections to the scheme during the 28 day consultation will be carried out . If Perth & Kinross Council are not able to conclude the satisfactory withdrawal of any valid objections received then the scheme will need to referred to the Scottish Ministers who will consider the scheme further and may be required to hold a public local enquiry Consultation has been carried out with SEPA during development of scheme and statutory consultees have been informed of scheme via EIA Scoping and will be further informed by completion of EIA in Summer '23. Once consultation and design confirmed project will be swiftly moved to notification period to kick start formal timeframes - 28 day initial period, time to review objections, re-notify any modifications	RPS/PKC	Ongoing	Possible	High	High

No.	Risk Title	Risk Description (actual or potential)	Date Created	Before Mitigation			Mitigation	Actionee	Action Update	After Mitigation		
				Likelihood	Consequence	Risk Level				Likelihood	Consequence	Risk Level
							28 day period/respond to objectors 28 days, confirmation of scheme - 6 weeks, Public inquiry 24 weeks					
4	Changes to a scheme post-approval (Planning)	Requirement to change an aspect of the scheme (e.g. service clash, unknown constraint to work around or change in built environment)	25-Apr-2023	Possible	Moderate	Medium	No provision within FRM (Scotland) Act 2009 or its 2010 Regulations that deal with changes post-scheme approval. Need to consider nature of the change. Change management to be considered, identified and documented by Local Authority - Local Authority can advance change by agreement within a FPS. Where change affects multiple parties this would become more complex Where agreement is not reached it is considered unreasonable that an LA cannot proceed with that change if it has followed a reasonable approach to consulting with affected parties and mitigating any adverse effects on them and the environment. Early engagement with PKC Planner during notification period	RPS/PKC	Ongoing	Possible	Minor	Low
5	Deemed Planning	Time out of deemed planning consent in effect for 5 years from 27th April 2020	25-Apr-2023	Unlikely	Major	Medium	Review timeframe and programme at regular intervals and highlight potential for any significant delays	RPS/PKC	Ongoing	Rare	Moderate	Low
6	Landowners	Access for investigation works, site walkovers and construction	25-Apr-2023	Likely	Severe	Medium	Early dialogue to pick up any issues, manage the process. Statutory powers available where engagement cannot resolve issues	RPS/PKC	Ongoing	Possible	Moderate	Medium
7	Landowners	Mitigation agreement relating to individual property - challenge to delivery	25-Apr-2023	Possible	Moderate	Medium	Continue with dialogue and early identification of any issues to allow for resolution to be worked through	PKC	Ongoing	Unlikely	Minor	Low
8	Landowners	Compensation - Not reaching agreement/Costs	25-Apr-2023	Possible	Moderate	Medium	Process to be followed with statutory fall back position. Agreement likely but cost is uncertain	RPS/PKC	Ongoing	Unlikely	Moderate	Medium
9	Landowners	Some demolition of existing buildings required to facilitate access at Todd and Duncan and BCA site - potential landowner may not agree	25-Apr-2023	Possible	Moderate	Medium	Process to be followed with statutory fallback position. Agreement likely but cost is uncertain	RPS/PKC	Ongoing	Unlikely	Moderate	Medium
10	Ground Investigation	Uncertainty around ground conditions (final design and cost may be impacted)	25-Apr-2023	Likely	Major	High	Ground investigation being carried out to understand ground conditions and inform design/cost estimate. Some degree of residual risk associated with ground works. Desktop analysis only has been carried out at outline stage only. Appropriate geotechnical analysis of the GI results required. These investigations must include an assessment of any contaminated land and early identification of the need for the disposal of any contaminated material. Completion of a detailed site investigation should provide a level of information that	RPS/GI Contractor	Ongoing	Unlikely	Moderate	Medium

No.	Risk Title	Risk Description (actual or potential)	Date Created	Before Mitigation			Mitigation	Actionee	Action Update	After Mitigation		
				Likelihood	Consequence	Risk Level				Likelihood	Consequence	Risk Level
							would result in minimum risk of project delay and increased costs as a result of revisions to designs and construction methodologies due to unforeseen ground conditions and incorrect parameters.					
11	Scheme cost	Cost estimate beyond above current estimates and potentially above available funding	25-Apr-2023	Possible	Major	High	Cost review will be prepared after detailed design and business case updated to increase confidence. Current estimate is based on outline design with optimism bias.	RPS	Ongoing	Possible	Moderate	Medium
12	CAR Licence	Obtaining CAR licencing within timeframes required	25-Apr-2023	Possible	Major	High	Early preparation and dialogue with SEPA	RPS	Ongoing	Possible	Moderate	Medium
13	Construction Access	Access for construction tight around flood walls at South Queich potentially limiting construction methods reducing flexibility and requiring work in water	25-Apr-2023	Likely	Moderate	Medium	Early Contractor Involvement and Engagement with Landowners to determine suitable working areas	RPS	Ongoing	Possible	Moderate	Medium
14	Utilities	Utilities clashes (General) and diversion works required - additional scope/cost	25-Apr-2023	Likely	Major	High	Early dialogue with Utilities, review of information, slit trenching, manhole survey and topo survey to locate/ verify as much as possible (Utilities schedule being prepared for tracking and management). C3 engagement ongoing with providers. Given urban setting will always be a degree of uncertainty on site. Check before you dig approaches to be used on site	RPS	Ongoing	Likely	High	High
15	Utilities	Delays due to lengthy discussions	25-Apr-2023	Possible	Moderate	Medium	Early and appropriate dialogue with Utilities. RPS have engaged at early stage for C3 estimates and keeping ongoing dialogue with contacts well before detail design commencement	RPS	Ongoing	Possible	Minor	Low
16	Utilities	Number of complex SW clashes around Smith Street and High Street - may be no suitable diversion options or require complex and costly diversion significantly impacting cost of scheme	25-Apr-2023	Likely	Major	High	Early and appropriate dialogue with Scottish Water. Review of design in consultation with SW to help reduce impacts. Modelling of SW diversions to feed into C4 designs	RPS	Ongoing	Possible	Moderate	Medium
17	Ecology	Protected species (additional requirements).	25-Apr-2023	Possible	Moderate	Medium	Risks have been minimised by early preparation of PEA to inform design and highlight risks. Further survey work required for potential bat, otter, reptile, red squirrel and badger habitat. Further assessment being carried out as part of EIA to inform design development. Specific risk items to be added to risk register on completion of EIA to be updated throughout the life of the scheme. Joint working with engineers and environment professionals will enable any risks associated with this to be minimised. Continued environmental input prior to and during construction phases will be required including pre-construction surveys.	RPS	Ongoing	Possible	Minor	Low
18	Ecology	Japanese rose, an INNS, was recorded within the survey area. As the survey was completed just at the start of the main	25-Apr-2023	Possible	Moderate	Medium	Biosecurity management plan to be drafted by ecologists for Japanese Rose management.	RPS	Ongoing	Possible	Minor	Low

No.	Risk Title	Risk Description (actual or potential)	Date Created	Before Mitigation			Mitigation	Actionee	Action Update	After Mitigation		
				Likelihood	Consequence	Risk Level				Likelihood	Consequence	Risk Level
		growing season the presence of further INNS could not be fully assessed.										
19	Ecology	Cognisance of ecological survey calendar so survey timings do not impact overall project and construction programme	25-Apr-2023	Possible	Moderate	Medium	Biosecurity management plan to be drafted by ecologists for Japanese Rose management.	RPS	Ongoing	Possible	Minor	Low
20	Ecology	If programme is pushed out and 18 months have passed in EcIA surveys need to be redone	25-Apr-2023	Possible	Moderate	Medium	Continue dialogue with in house ecologists around timing for any re-survey works and if this can be captured as pre-commencement surveys. Highlight a milestone date in programme. EeCOW required as part of construction to monitor.	RPS	Ongoing	Possible	Moderate	Medium
21	Tree preservation	Tree removal required for construction and long term access. May not be sufficient locations to offset tree loss	25-Apr-2023	Likely	Moderate	Medium	Tree survey to be carried out to understanding root protection surveys and what trees can be saved. Plans for compensatory planting to be developed	RPS	Ongoing	Unlikely	Minor	Low
22	PFR at Loch Leven	Less dialogue and consultation on this - more engagement and one on one consultation needed	25-Apr-2023	Possible	Moderate	Medium	Individual property owner consultation to be carried out during community engagement events.	RPS/PKC	Ongoing	Possible	Minor	Low
23	PFR	Ability to deliver this successfully, resident uptake	25-Apr-2023	Possible	Moderate	Medium	Engagement with homeowners. Discuss in further detail requirements and establish mechanism for delivery and maintenance. PKC legal to be engaged on policy implementing PFR. Individual property owner consultation to be carried out during community engagement events. Small, isolated flood cell will not impact overall benefit of scheme	RPS/PKC	Ongoing	Possible	Minor	Low
24	Culvert Upgrades	Working in narrow streets - will require streets to be closed off during construction phase, disruption to local traffic and residents (potential negative feedback)	25-Apr-2023	Possible	Moderate	Medium	Keep PKC roads team involved in design development phase, communicate intentions early and seek advice for any issues identified. Early notification of affected areas using social media and other comms	RPS/PKC	Ongoing	Possible	Minor	Low
25	Council Committee Meetings (dates)	If meeting dates are missed or project cannot be brought before committee for approval to next gateway e.g. notification, construction tender this will impact upon programme.	25-Apr-2023	Possible	Moderate	Medium	Keep track of programme, through monthly meetings. Liaise with PKC officers to identify issues early to understand implications. If necessary, have risk reduction meetings	RPS/PKC	Ongoing	Possible	Minor	Low
26	Funding	The availability of funding for the scheme presents a risk that could arise through changes in funding policy, particularly rules for grant aiding of schemes that can apply at a local or national level. Currently the scheme should be funded 80% by SG and 20% by PKC budgets.	25-Apr-2023	Possible	Major	High	Update PKC Committees so scheme remains a priority for the 20% funding requirement. Engage in Public Body forums to stay abreast of any changes in SG funding	RPS/PKC	Ongoing	Unlikely	Major	Medium
27	Wall finish (Industrial estate)	Potential wall finishes to be considered and communicated to affected parties, in good time, as this has potential to raise concerns and differing opinions	25-Apr-2023	Possible	Moderate	Medium	Consider early in consultation post outline design, utilise council to articulate views - engage with affected/interested parties and PKC planning team. Keep discussions informal until construction stage as this condition of planning is inflexible	RPS/PKC	Ongoing	Unlikely	Minor	Low

No.	Risk Title	Risk Description (actual or potential)	Date Created	Before Mitigation			Mitigation	Actionee	Action Update	After Mitigation		
				Likelihood	Consequence	Risk Level				Likelihood	Consequence	Risk Level
28	Material management - Waste Acceptance Criteria	Potential for excavated material to be classified as non-inert and to incur high disposal costs	25-Apr-2023	Possible	Major	High	Design to minimise excavated material/maximise reuse and development of a Material Movement Plan to minimise quantities of material to be disposed off site.	RPS	Ongoing	Possible	Moderate	Medium
29	Data gaps in ground levels and drainage	Some ground levels based on LIDAR due to gap in survey. Assumptions regarding existing drainage based on strategic SW model - risk associated with unknowns	25-Apr-2023	Likely	Moderate	Medium	Detailed topo and drainage surveys to be carried out in targeted locations	RPS	Ongoing	Unlikely	Minor	Low
30	Topographical Survey + MH Survey	Delays in receiving topo and MH survey from subcontractor	25-Apr-2023	Possible	Moderate	Medium	Early programme management and tender prior to detail design	RPS	Not started	Unlikely	Minor	Low
31	No returns to construction tender	Increase to programme if there are no returns to original tender due to availability of contractors	25-Apr-2023	Possible	Major	High	Option A contract provides best balance to prevent full risk of variation in groundworks on client whilst not pushing fully onto contractors and detracting from bids. ECI limits change of no one bidding	RPS/PKC	Not started	Unlikely	Major	Medium
32	Resourcing	Change in staff and availability of resources - risk to programme	25-Apr-2023	Possible	Moderate	Medium	Raise issues with client at early stage and review programme	RPS	Ongoing	Possible	Moderate	Medium
33	Materials	Risk of increased material costs associated with current inflationary pressures and Brexit impacting business case	25-Apr-2023	Likely	Moderate	Medium	Cost review will be prepared after detailed design and business case updated to increase confidence. Current estimate is based on outline design with optimism bias.	RPS	Ongoing	Possible	Moderate	Medium
34	Operation and Maintenance	Risk to affectedness of scheme if operation and maintenance is not budgeted and planned for	25-Apr-2023	Possible	Moderate	Medium	Operational costs considered in BCR through whole life costing. Any future development outside of the scheme must also be monitored. The Local Authority Planning Department will need to consider the impact of any proposals prior to planning approval, specifically the discharge of any additional surface water adjacent to the proposed defences. Operation and maintenance access points included at early stage in outline design. Statutory powers to maintain access. Passive features with limited maintenance burden taken forward for design.	RPS/PKC	Ongoing	Unlikely	Minor	Low
35	Human interaction	Risk to effectiveness of scheme due to unplanned human interaction. Other capital works or developments may affect scheme performance. Risks remain with individual property and land owners being unaware or unconcerned of the impact of their activities on the performance of the protection scheme.	25-Apr-2023	Possible	Moderate	Medium	Planning powers would refuse or allow with mitigation any works which could affect the scheme performance. Engagement of individuals and community on potential impact of activities on scheme. In particular attenuation storage or pump system located in Korkoa Manufacturing site	RPS/PKC	Ongoing	Unlikely	Minor	Low
36	Utilities	Significant unknowns remain on Gas, Sewer and Openreach works	25-Apr-2023	Likely	Major	High	Early and appropriate dialogue with providers continued throughout the detail phase	RPS	Ongoing	Possible	Moderate	Medium

No.	Risk Title	Risk Description (actual or potential)	Date Created	Before Mitigation			Mitigation	Actionee	Action Update	After Mitigation		
				Likelihood	Consequence	Risk Level				Likelihood	Consequence	Risk Level
37	Design Changes	Changes design resulting in rework adding cost and delays or changing notification details	5th-May-2023	Likely	Major	High	PKC introducing ECI in outline stage to bring this risk earlier in programme prior to notification stage	PKC/RPS	Ongoing	Possible	Moderate	Medium
38	Design Changes - EIA	Changes to design resulting in changes to EIA which may impact notification timeframes	5th-May-2023	Likely	Major	Medium	Engagement with EIA subs on earliest design freeze. Review of draft chapters to determine impacts and timeframes	PKC/RPS	Ongoing	Possible	Moderate	Medium
39	Cost of contaminated material removal	Based on exiting GI assumption has been made that disposal of material will fall into inert material rates	23rd-Aug2023	Possible	Major	High	Existing GI indicates low likelihood, some asbestos has been identified and accounted for in disposal costing. More detailed GI to be carried out to inform design and next stage of costing	PKC/RPS	Ongoing	Unlikely	Major	Medium
40	Design Changes	Tie into disused railway embankment - porous material	23rd-Aug2023	Possible	Moderate	Medium	Reviewed as part of informal defences. It appears the embankment currently retains floodwater and this will not be significantly increased by the scheme here (70mm increase in water level). tie piles into the embankment for 5m. Testing required for GI.	PKC/RPS	Ongoing	Unlikely	Minor	Low

16 CONCLUSION

Records of flooding in Kinross extend back as far as 1852. The town has been subject to regular inundation from the Gelly Burn, South Queich, Clash Burn and Loch Leven with recent extreme events in 2020.

Kinross was identified within Potentially Vulnerable Area (PVA) (10/04) in the Forth Estuary Flood Risk Management (FRM) Strategy (December 2015), Forth Estuary Local FRM Plan & Forth Estuary Local FRM Plan (June 2016). This has enabled the council to access funding to develop a Flood Study and following this work now promote a viable Flood Protection Scheme for Kinross.

This document summarises the technical work undertaken to develop the preferred option to an outline design standard suitable for scheme notification. The preferred option has emerged from a thorough design process that has identified an appropriate engineering solution, judged to be technically, economically, environmentally feasible to meet the primary objective to reduce flood risk to Kinross. The outline design has been developed in close consultation with stakeholders including statutory and non-statutory consultees. Two public consultation events have been held to enable community feedback to be captured in the outline design prior to the scheme notification process.

The scheme consists of flood embankments/walls that are sympathetic to the character of the area. The Standard of Protection was selected after weighing the benefits of higher defences, against the damages avoided. The 0.5% AEP fluvial event was targeted for the Standard of Protection, this does not feature an allowance for climate change. Although the scheme does not account for climate change, it will allow for adaptation, if required, in the future by providing foundations suitable of supporting higher defence heights. Additionally, although Natural Flood Management Measures were not found to provide a significant Standard of Protection, NFM could be taken forward in future in partnership with landowners to slow flows higher in the catchment to mitigate the effects of climate change on the performance of the preferred option. A study has been produced outlining the best recommendations to achieve this.

The scheme also consists of culvert upgrades to better manage flow from the Clash Burn and an upstream storage area to manage out of bank flow from the South Queich higher in the catchment. Both these options have been designed to include climate change uplifts as it would be less feasible to retrofit these measures for higher flows given as they contain below ground pipes.

An assessment to determine any increased risk of damage to existing and historical river bridges, as a consequence of constructing new town defences, was undertaken. This assessment concluded that existing bridges can be safely incorporated into the Scheme with potential strengthening works required to High Street Bridge and replacement of the crossing at the Gelly Burn required.

The scheme has been designed to be passive in operation. No flood gates need to be shut in the event of a flood, reducing the risk of the defence failing. A small pumping station has been proposed to manage back of wall drainage upstream of the High Street though this will require only routine annual maintenance rather than active deployment during a flood event.

The design of the defences has been carefully selected to ensure that in terms of visual impact and public access, impact to the community is minimal. Ecological mitigation including pre-construction checks for otter, badger, red squirrel and bat roosts will be undertaken 3 months before construction. Management of INNS species known to be present within the construction/works area has also been included as part of the advance works for the scheme.

The estimated whole life (construction, maintenance and operation) present value cost of the scheme has been estimated to be approximately £15.2M. This compared favourably to the estimated present value flood damages avoided of approximately £16.0M across the 100-year design life of the scheme. From these, the benefit-cost ratio was calculated as 1.05, suggesting a net economic betterment from the proposed scheme.

16.1 Next Steps

The Kinross FPS has been shown to be viable and as such is being promoted under the Flood Risk Management (Scotland) Act 2009 and the Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Regulations 2010.

As part of the scheme publication, affected landowners, the community and statutory consultees will be informed under the Flood Order. The consultees will have an opportunity to object to the Scheme which will be taken into consideration by Scottish Ministers prior to planning consent (Statutory Process). Any objections to the proposed scheme must be made in the manner described in the notice.

16.1.1 Process and Possible Decisions

Where the Council receives no valid objections to the Scheme after the date by which objections may be made to the Scheme the Council will take the final decision to confirm or reject the Scheme.

If a valid objection to the Scheme is received and not withdrawn, after considering the objection, any late objection (as defined by paragraph 3(4) of Schedule 2 of the Act), and any other matters it considers appropriate the Council must make a preliminary decision to either confirm the Scheme (with or without modifications) or to reject the Scheme.

a. The Council must give notice of its preliminary decision to every person who made an objection which it considered. Such a person being referred to as a ‘relevant objector’. Where a relevant objector is a person

    i. having any interest in any land on which the proposed operations are to be carried out,

    ii. whose interest in any other land may be affected by any of the operations or by any alteration in the flow of water caused by any of the operations or

    iii. referred to in paragraph 1(1)(e) or (f) of Schedule 2 of the Act, the Council must also give notice to the Scottish Ministers.

b. The Scottish Ministers must, within 28 days of receipt of the Council’s preliminary decision, advise the Council either that they will not consider the Scheme, or that they will consider the Scheme.

c. If the Scottish Ministers decide to consider the Scheme and valid objections remain, a Public Local Inquiry will be held. If the Scottish Ministers decide not to consider the Scheme, the Council must hold a hearing to consider the Scheme. Notice of the Hearing will be given and relevant objectors invited to attend the hearing. After any hearing (or public local inquiry) the final decision must be taken by the Council (or the Scottish Minsters where there has been a public local inquiry) to confirm the Scheme (with or without modification) or to reject the Scheme.

d. Where the Scottish Ministers do not require to be notified the Council will take the final decision to confirm the Scheme (with or without modification) or to reject the Scheme.

Notification of the final decision, whether made by the Council or the Scottish Ministers will be given by the Council in accordance with the relevant provisions of the Act and Regulations

Appendix A

South Kinross Flood Study Report (2010)

Perth & Kinross Council - Environment Service

South Kinross Flood Study

September 2010

Perth & Kinross Council
The Atrium
137 Glover Street
Perth
PH2 0HY

Mouchel
Unit 11
Scion House
Stirling University Innovation Park
Stirling
FK9 4NF

	Name	Signature	Date
Prepared by	Milivoj Kojic / Simon McGee		
Checked by	Simon McGee		
Approved by	Paul Swift		

FIGURES

TABLES

APPENDICES

1 INTRODUCTION

Perth and Kinross Council commissioned consultants Mouchel to undertake a Flood Study in South Kinross. There are known historical flooding issues associated with the South Queich, the Gelly Burn and the Clash Burn. Areas known to have been affected by flooding in the past include the Bridgend Industrial Estate, Queich Place, parts of the High Street and the Auction Mart. There have also been flooding issues reported around Myre Terrace and Smith Street. The Council has commissioned this flood study to get a better understanding of flooding issues in South Kinross and also to explore the practical options which may be available to reduce flood risk in the area.

The full study has comprised two key phases (Phase 1 and Phase 2) which are combined within this Flood Study Report.

Phase 1 of the study collated existing information and reviewed data relevant to flood risk and associated issues within the South Kinross area (where available). In addition to the collation and review of available data and consultation with local stakeholders, this phase also included extensive topographical survey of the watercourses, structures and surrounding lands. Phase 2 of the study assessed the current status of fluvial flood risk to South Kinross using detailed hydrological and hydraulic modelling of catchments and watercourses. Possible options for flood alleviation such as flood defences, river diversions and upstream storage were then explored. This included an appraisal of technical feasibility, economic viability together with an assessment of associated environmental and health & safety constraints.

2 STUDY AREA

2.1 Location of Study Area

The general focus of these studies is South Kinross as shown on Figure 1. An aerial view of South Kinross is shown below in Figure 2.

The south of Kinross is largely urbanised with the exception of an area of undeveloped land that extends along the east side of the M90. The south Kinross area has been subject to periodic flooding in recent years and the council are keen to explore the potential options available to mitigate flood risk in the area. Perth and Kinross Council also wishes to understand the potential impact on flood risk of the construction of a possible new link between the M90 and the existing industrial estate area. Other parts of Kinross to the north are not included in this study.

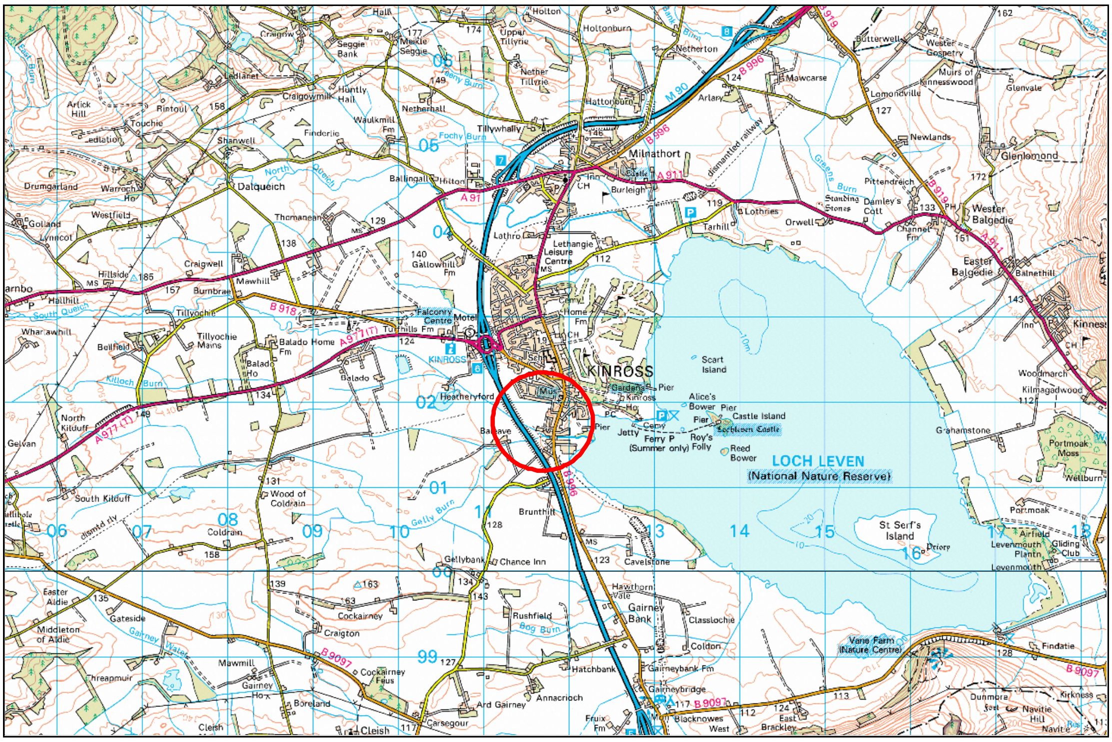

Figure 1 - Study Area Location

Figure 2 – Aerial View of Study Area

2.2 General Topography of the Study Area

South Kinross occupies a low lying area on the westerly side of Loch Leven. The general topography of the South Kinross area is relatively flat with a gradual slope towards Loch Leven.

The general topography of South Kinross is illustrated by contours as shown below in Figure 3. The highest elevations are located on the north and westerly sides of the study area and the lowest elevation is on the south easterly side near the Loch's edge. Drainage generally flows in a south easterly direction towards the South Queich and Clash Burn. It is possible that there may be some localised areas where surface water ponding and overland flow could occur during heavy and prolonged rainfall events.

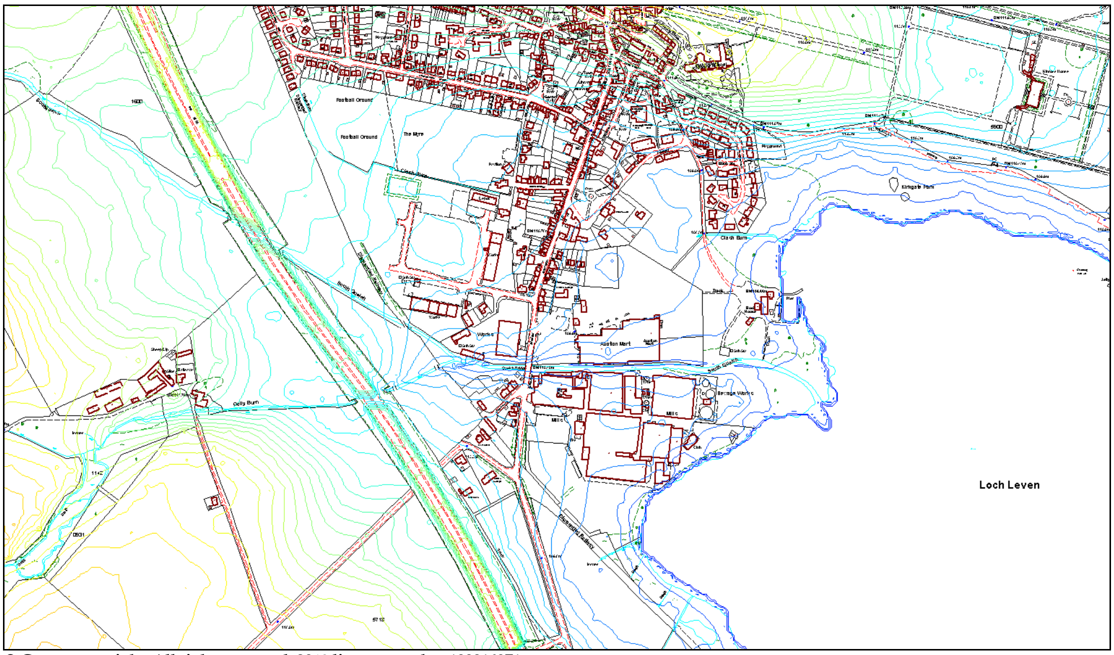

Figure 3 - South Kinross Contour Map

2.3 Potential Sources of Flooding

Potential sources of flooding relevant for the study area include:

- Fluvial flooding including bank overtopping and associated overland flows
- Loch Leven water levels;
- Groundwater flooding;
- Sewer flooding;
- Localised surface water ponding;
- Pluvial flooding (overland surface water);
- Surface water runoff from future new development.

Fluvial flooding is considered to be the dominant source of flood risk in the area and will have the greatest influence upon land-use planning.

3 EXISTING INFORMATION

3.1 Site Inspection

Mouchel undertook an inspection of watercourses and topography in South Kinross to determine likely sources of flooding and possible extents of flooding emanating from the South Queich, Gelly Burn and Clash Burn. Flooding in Kinross is due to both, river flooding and under-capacity culverts / watercourses within the town.

The South Queich is considered to be the most significant potential source of flooding in the area and stretches for almost 1km from the M90 motorway through South Kinross before discharging directly into Loch Leven. The confluence with the Gelly Burn is adjacent to Bridgend Industrial Estate and just downstream of the former railway line.

The Clash Burn flows generally in a southerly / easterly direction and is culverted for approximately 330m from 'The Myre'. It then flows in mainly open section for approximately 140m before discharging into Loch Leven.

Figure 4 shows the location of the main watercourses. A number of photographs were taken during the site visit. These, illustrate the nature of the area and the watercourses of South Queich, Gelly Burn and Clash Burn. The main watercourses of the South Queich, Gelly Burn and Clash burn are shown in Figure 5, Figure 6, Figure 7 and Figure 8. A wider selection of South Kinross site photographs are collated in Appendix A.

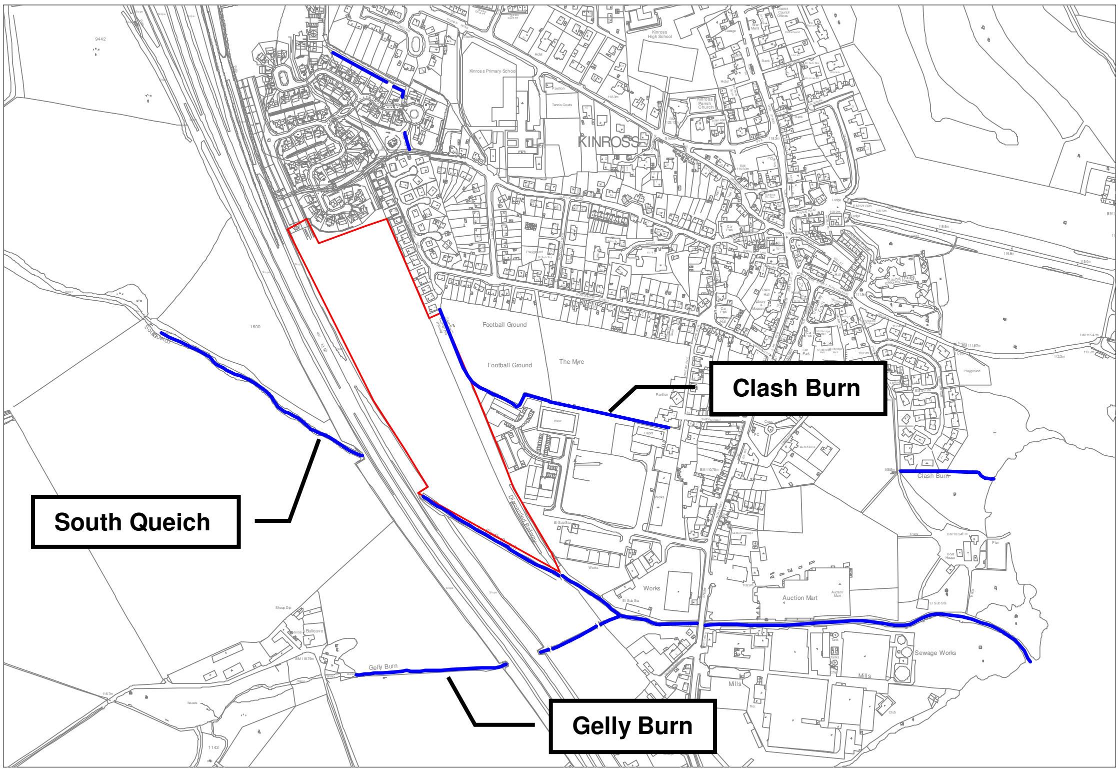

Figure 4 - Main Watercourses in South Kinross

Figure 5 - South Queich (downstream of M90)

Figure 6 - Downstream face of Queich Bridge

Figure 7 - Gelly Burn (downstream of M90)

Figure 8 - Clash Burn (open section west of 'The Myre')

3.2 Data Collection

Relevant data has been collected and collated from a number of sources including Perth & Kinross Council, SEPA, Scottish Water, local residents and Mouchel. This data includes the following:

• Ordnance Survey 1: 2500 Landline series maps	(P&K Council)
• Aerial photography	(P&K Council)
• Digital Terrain Mapping (DTM) data (5m grid)	(Mouchel)
• Previous flood risk studies – Kinross	(P&K Council) (Mouchel)
• Topographical survey	(P&K Council) (Mouchel)
• CCTV pipe survey	(P&K Council)
• Development plans \ drawings	(P&K Council)
• Scottish Water sewerage network data	(Scottish Water)
• Kinross sewerage network model	(Scottish Water)
• Rainfall records	(SEPA)
• Loch Level records	(Loch Leven Trustees)
• South Queich flow records	(SEPA website)
• Flood mapping (1 in 200 year)	(SEPA)
• Newspapers \ newsletters	(Kinross Newsletter)
• Local info & photographs	(P&K Council) (Locals) (Mouchel)
• Geology maps	(BGS)
• Hydrological catchment data	(FEH CD-ROM)

All the “electronic” data collated from the various sources outlined above will be provided on CD.

3.3 Survey Data

3.3.1 DTM Data

DTM (Digital Terrain Model) data was acquired for the site study area. DTM data typically supplements surveyed data (saving time and cost) and usually facilitates extensive flood-mapping. The Nextmap 5m DTM has been produced using airborne RADAR technology that provides a one-meter vertical resolution for the first reflective surface; this is subsequently interpolated using a bespoke algorithm to derive the underlying ‘bald earth’ or terrain model. The bald earth DTM is thus inherently less accurate than the DSM (Data Surface Model) with a vertical accuracy from +/- 60cm. This level of accuracy is often unsuitable for detailed hydraulic modelling, but provides a good overview of the local topography, facilitating a broad assessment of drainage paths and potential overland flow routes.

There was some correlation between the surveyed data and DTM data in open areas. The correlation was not good in urbanised areas. Study of the DTM / survey data has found large differences related to the survey of channels, structures and bridges, roads, heavy vegetation and bunds (as would be expected). However, generally the DTM data yielded lower levels than those surveyed. Consequently, the DTM data was not considered suitable for detailed hydraulic modelling or flood-mapping.

3.3.2 Topographical Survey Data

Existing topographical information for the proposed South Kinross link road was supplied by the Mouchel roads design team. For the purposes of the Flood Study, Mouchel undertook supplementary topographical survey work using GPS. This included a number of cross sections along the South Queich, Gelly Burn and Clash Burn (including potential floodplain areas), relevant bridges and culvert details and numerous spot levels.

This information was used to create an accurate contoured map of the area which facilitated an assessment of the likely route of local runoff, potential river breach flow paths and any low lying areas that could be at risk from any flooding / ponding.

The survey used a combination of Leica System 1200 Real Time Kinematic (RTK) GPS and Leica 1205 Total Stations. The Total Stations were used in areas where the GPS was unable to function (under trees, near high buildings), but for the bulk of the survey, 2 surveyors, each equipped with a GPS (rover) receiver radio linked to a "master" base station, were used.

The base station is set over a permanent ground marker (PGM) fixed on site, in a suitably safe area. GPS data is logged at 5s intervals. The master GPS receiver transmits its position and correction parameters to the rover receivers, the positions of which are updated in real-time.

The base receiver GPS data is processed in Leica Geo-office, together with the simultaneous GPS data for the Ordnance Survey National Active GPS Network. The accuracy of the base receiver co-ordinates is affected by the length of occupation and the amount of detail recorded. At Kinross a minimum of 6 hours continuous data was recorded each day. The position of the base station was determined to +/-15mm in position & level.

The GPS Rovers are linked in real-time to the Master (i.e. a 3D vector is calculated from the Master, for each point). The accuracy is largely controlled by the Master, but is also affected by various factors, including the proximity to high objects (buildings, trees), and the surface type. With hard surfaces, an accuracy of better than +/- 20-25mm is expected. The total extent of all topographical survey used in this study (comprising a mix of existing data and recently gathered) is shown below in Figure 9. This information was required to undertake detailed flood modelling and mapping as detailed later in this report.

All topographical survey data gathered and used for the study will be provided in digital format.

Figure 9 - Surveyed Topographical Data

3.3.3 Watercourses Condition Assessments

A site walk-over and watercourse condition assessment along the main watercourses likely to have an effect on the area in terms of flooding; South Queich Water, Gelly Burn and Clash Burn was undertaken. Standard datasheets provided by Perth & Kinross Council have been completed for these watercourses, comprising key information relating to the watercourse, associated structures, discharge points and any other relevant features. Photographs were also taken. Refer to Appendix B for details of these watercourse condition assessments, where data was available.

South Queich / Gelly Burn

The South Queich Water flows through a heavy vegetated channel for most of its route. There were some man made embankments evident along its route. These embankments were picked up during topographical survey. The predominant bed type was mud and gravel with some larger cobbles. The bed elevation of the South Queich Water varies between approximately 110.8m AOD just upstream of the M90 Bridge and approximately 106.9m AOD upon discharge into Loch Leven. The South Queich Water has an average gradient of approximately 1 in 250 over the extent of the surveyed reach.

The Gelly Burn is a tributary of South Queich Water tributary which also flows through a heavy vegetated channel for most of its route. It runs through rural lands for most of its route before joining the South Queich Water 120m after flowing under the M90 motorway. The predominant bed type was also mud and gravel with some cobbles.

Clash Burn

The Clash Burn is a relatively small watercourse fed by a mix of urban areas, green-field runoff and some groundwater. The predominant bed type was mud and gravel. The Clash Burn flows in a southerly direction through Montgomery Way in a combination of culverted and open sections before discharging to an open reach west of 'The Myre'. Just before Smith Street the Clash Burn becomes fully culverted for approximately 450m before discharging into another open section prior to discharge to Loch Leven. The culvert route is not direct and has a number of bends. The bed elevation of the open Clash Burn varies between approximately 112.0m AOD at the start of the open reach south of Montgomery Way and 106.50m AOD at the point of discharge into Loch Leven. The Clash Burn has an average gradient of approximately 1 in 190 over the extent of the surveyed reach (approximately 1km). Along its route several incoming pipes were identified.

A CCTV survey of the culverted sections of the Clash Burn, carried out in November 2008, was provided by the Perth & Kinross Council. This data was supplemented by a manhole survey undertaken by Mouchel. This survey included manhole cover levels and sizes and was undertaken to confirm detailed manhole information for potential future modelling purposes. Details of this manhole survey can be found in Appendix C (refer to Figure 10 below for route and surveyed manhole locations). From CCTV analysis, the intrusion of numerous pipes along the surveyed route was noted, mainly between Manhole 1 and Manhole 7. There was a relatively low debris percentage noted in the majority of the surveyed reach.

Anecdotal evidence of previous flood events in the area suggested that the culverted Clash Burn could possibly be undersized for large rainfall events and may be prone to blockage.

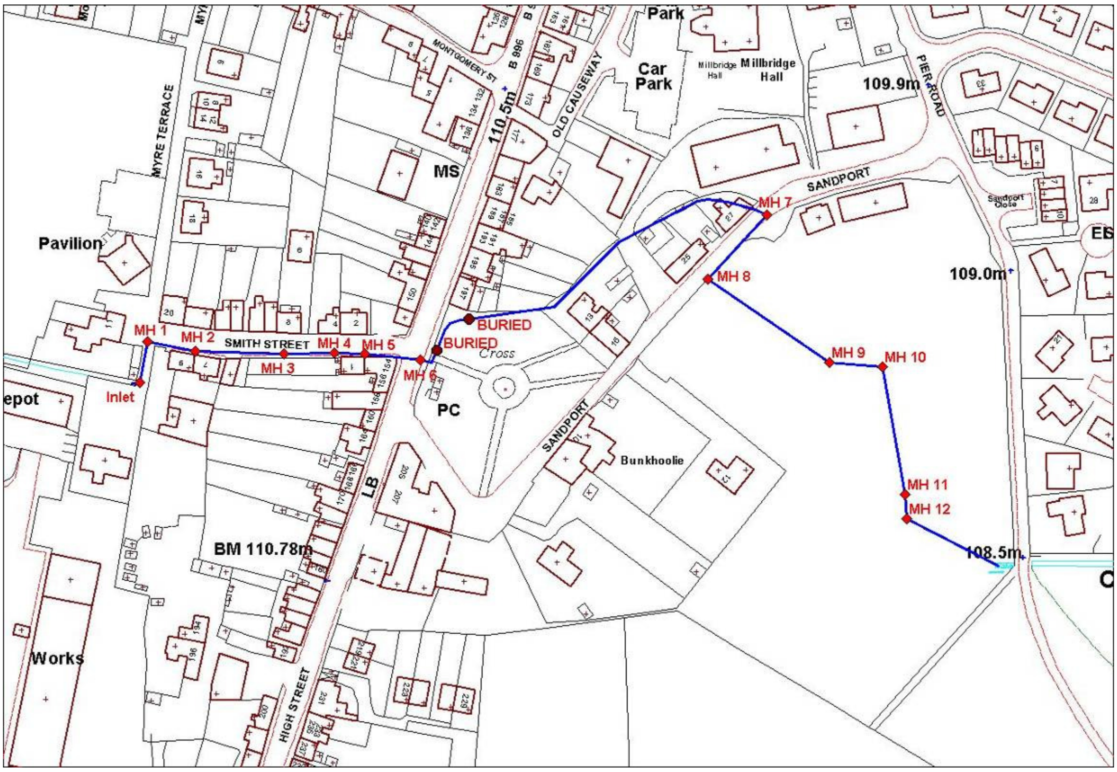

Figure 10 - Route of Culverted Clash Burn and Surveyed Manholes

3.4 Existing Flood Protection Features

During the watercourse assessment the following structures were identified as a form of flood protection (see locations in Appendix B):

- SUDS pond / attenuation basin (located in Bridgend Industrial Estate);
- Low masonry wall (downstream of South Queich Bridge).
- Earth bund on westerly edge of Bridgend Industrial Estate

The SUDS pond in the Bridgend Industrial State (see Figure 11 and Figure 12 below) is understood to be fed by runoff from recently developed industrial areas in the vicinity. Attenuated flows are then discharged into the adjacent Clash Burn. The flow is reportedly controlled such that the flow rate to the Clash Burn from the surrounding impermeable surfaces does not exceed the pre-development flow from the green-field site. Details can be found in the document entitled "Extension to Bridgend Industrial State – Health & Safety File" as compiled by consultants Fairhurst for Perth & Kinross Council. The potential for any increase in flooding to the Clash Burn is reportedly removed.

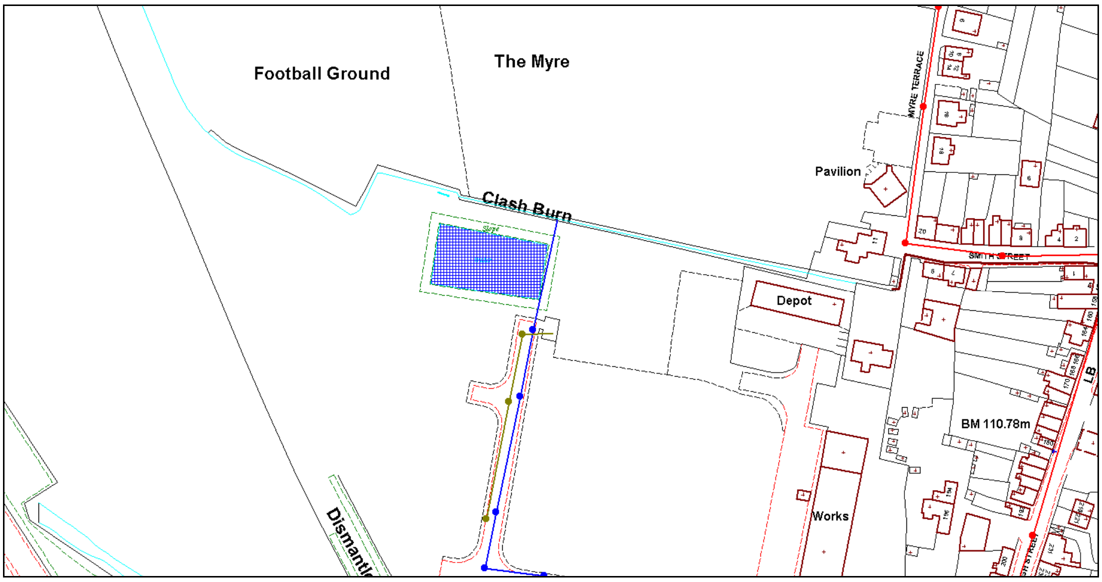

Figure 11 - Bridgend Industrial Estate SUDS Pond Location

Figure 12 – Bridgend Industrial Estate SUDS Pond Photograph

The low masonry wall on the left bank of the South Queich Water just downstream of the Queich Bridge (see Figure 13 below) will offer some degree of protection to the Scottish Motor Auction and surrounding area. This wall will be included in any hydraulic modelling of the current state however, the structural integrity of this wall is not known. There are a number of other locations downstream of the Queich Bridge where there are some buildings and walls directly adjacent to the river. These walls would not be designed to current flood defence standards however will be assumed to remain structurally intact in any hydraulic modelling.

Figure 13 - Low Masonry Wall on Left Bank of South Queich

The existing dismantled railway along the westerly edge of Bridgend Industrial Estate is likely to provide some degree of flood protection to buildings in the vicinity. The dismantled railway is at a slightly higher elevation in some places (as can be seen in Figure 14 with red and yellow shading indicating higher ground). There has also been a small earth embankment constructed between the former railway line and the industrial estate (see Figure 15). It is thought that this embankment has been constructed to afford some flood protection to the Industrial Estate.

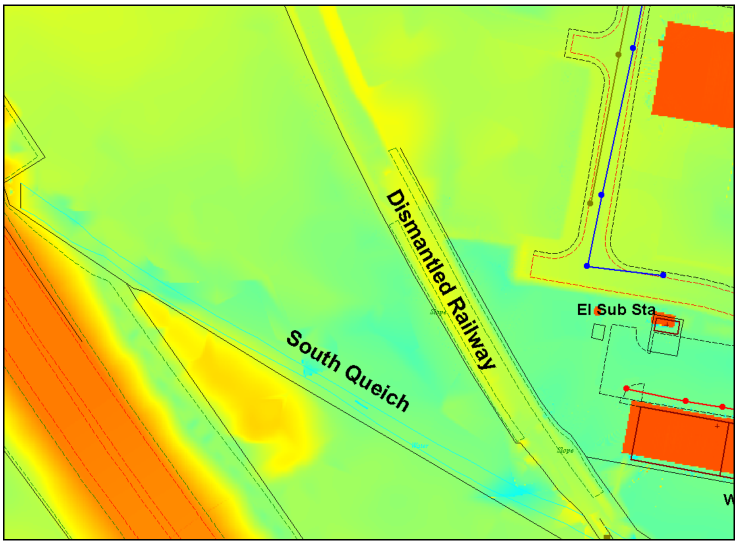

Figure 14 - Elevation of Former Railway Line

Figure 15 - Small Earth Bund on Westerly Edge of Bridgend Industrial Estate

3.5 Existing Hydraulic Models

3.5.1 Scottish Motor Auction site, Kinross

A previous Flood Risk Assessment entitled "Scottish Motor Auction site, Kinross" was undertaken between February and April 2007 for Redrow Homes by Jacobs and was supplied by Perth & Kinross Council.

In this study the modelled reach was based on a one-dimensional ISIS river model and extended along a short length of the South Queich to its discharge into Loch Leven.

The hydraulic model included the following design events; annual, 5years, 10yrs, 25years, 50years, 100years and 200years. No allowance for climate change was included.

This study highlighted that this proposed development site is likely to be at risk of direct or indirect flooding for a 200 year return period flood event. It was noted that the south eastern corner of the proposed development site is likely to be affected by flooding due to extreme water levels in Loch Leven.

From this study it was proposed that the existing masonry wall on the left bank of the South Queich Water downstream the Queich Bridge should be replaced by a floodwall to an appropriate standard, with a level approximately 0.3-0.5m above the predicted peak water level (109.86m AOD) for the 200 year return period flood event. Indicative flood extents from this report are shown below.

Figure 16 - Indicative flood outline at Scottish Motor Auction Site (Jacobs, 2007)

3.5.2 Link Road – Flood Risk Assessment (FRA), Kinross

Mouchel were commissioned in June 2008 to undertake a FRA for Perth & Kinross Council for a proposed new link road to facilitate a new industrial / commercial development in southwest Kinross, just east of the M90.

The work undertaken to develop this FRA has been extended into the wider flood study of South Kinross. Much of the data requirements are the same and a single model has been developed to progress both the site specific FRA and the wider flood study.

3.6 Historic Flooding

3.6.1 Historical Drainage Paths & Land Use

A number of historical maps of Kinross were obtained from Perth & Kinross Council. These were examined and reviewed in comparison with the current OS Landline map, to determine any changes that have occurred to the land use and the water courses around South Kinross over the years.

Historical maps dated between 1857 and 2000 show how much Kinross has developed over the years.

With the exception of the railway, dismantled some time after 1965, most of the Bridgend Estate in Kinross area was undeveloped green-field until 2000.

It is likely that the watercourses would have always been subject to periodic flooding. However the consequences of such flooding have increased over time as agricultural land has slowly made way for urban development.

In terms of the historic routes of the three main rivers in the study area, major modifications are evident on the Clash Burn. These changes appear to have been made gradually along with the development of Kinross. The Clash Burn is now culverted for most of its route.

The CCTV survey provided by Perth & Kinross Council helped to confirm the current route of the Clash Burn and allow comparison with the historical maps.

3.6.2 Perth and Kinross Council

Perth and Kinross Council were contacted regarding any known flooding issues in the area. A meeting with Perth and Kinross Council confirmed historical fluvial flooding events in the town. The most recent flooding events of note occurred in December 2006 and January 2008.

The council described some known past flooding issues together with some general observations on the watercourses in the area. Some issues highlighted by Perth & Kinross Council included;

- On the 26th January 2008 properties were affected on the north and south banks of the South Queich Water in the surrounding area of the Industrial Estate and Queich Place.

- On the 13th and 14th of December 2006 properties were affected on the north and south banks of the South Queich Water in the vicinity of the Industrial Estate, Queich Place, High Street and the Auction Mart.

- In 1999 properties on Montgomery Way are understood to have flooded.

- Issues regarding floodwaters to the east side of the 'Myre' bypassing some localised flood bunding near Myre Terrace.

- Flooding to low lying areas of Smith Street as a result of flooding on the Clash Burn.

- Floodwaters have been reported to escape the Gelly Burn upstream of a footbridge just east of the M90. These floodwaters have been reported to flow towards Queich Place.

Biennial reports produced by Perth & Kinross Council have been assessed in order to review all recorded flood events in the area as well as the maintenance works undertaken on the watercourses. A summary of pertinent information from these reports can be found below in Table 1, Table 2 and Table 3.

Perth and Kinross Council also provided a digital copy of a document entitled "The Great Flood: A Chronicle of the events and people of Perth & Kinross during the flood of January 1993" which describes the biggest flood in recent years in the Perth & Kinross area. Page 63 of the report makes specific reference to flooding in the study area:

"*In Kinross, the South Queich Burn caused problems at the south end of the town, flooding a number of houses in Queich Place and also affecting Todd & Duncan's mill, the Koronka Agriculture factory, a block of flats and a doctor's surgery. The burn rose very quickly on the Saturday and if the level had climbed only another few inches the problem would have been much worse. Prompt sandbagging by council workers deflected the water very effectively*".

Appendix D contains a layout plot of known historic flood issues in South Kinross collated into GIS.

Table 1 - Historical flooding records

Date	Location	Damage to	Extent of flooding	Notes	Source
13/12/2006	Edwards grass machinery	Surrounding area	Localised	Sand Bags delivered	Biennial Report 2007
13/12/2006	Koronka Bridgend	Surrounding area	Localised	Sand Bags delivered	Biennial Report 2007
13/12/2006	229 High Street	Surrounding area	Localised	Tayside Fire & Rescue in attendance. Sand Bags delivered	Biennial Report 2007
13/12/2006	Queich Place	Dwelling houses and surrounding areas	Localised	Tayside Fire & Rescue in attendance. Sand Bags delivered	Biennial Report 2007
13/12/2006	Todd & Duncan Business	Surrounding area	Localised	Sand Bags delivered	Biennial Report 2007

Table 2 - Proposed maintenance measures (from Biennial Reports)

Biennial Report	River	Grid Ref	Remarks	Freq. of Inspection	Maintenance
2007	South Queich	NO114017 – NO123015	Some overgrown vegetation, some erosion along channel	Annual	Monitor
2007	Clash Burn	NO118024 - NO120025	Some overgrown vegetation and rubbish in channel. Below new houses an inappropriate screen has been put on culvert. Developer is being asked to remove this. Survey piped section under Smith Street (CCTV)	Annual and after heavy rainfall	Clear vegetation and debris as required. Survey piped system 2008 (CCTV)
2005	South Queich	NO114017 – NO123015	Some vegetation in places undercutting and erosion occurring but water moving well.	Annual	Monitor
2005	Clash Burn	NO118024 - NO120025	Some debris/vegetation in some sections. Screen needs to be provided above Montgomery Way piped section surveyed not in very good condition. Toward outfall at Loch Leven work has been undertaken to remove heavy vegetation from the channel this should be monitored. A positive outfall may also need to be considered here.	Annual and after heavy rainfall	Clean and clear as necessary throughout entire section. Re-survey piped section Montgomery Way 2006 and monitor. Screen should be provided at inlet to culvert at Montgomery Way.
2003	South Queich	NO114017 - NO123015	Some erosion and undercutting at various sections along channel. Vegetation overgrown in places.	Annual	Monitor

Biennial Report	River	Grid Ref	Remarks	Freq. of Inspection	Maintenance
2003	Clash Burn	NO118024 - NO120025	Vegetation/debris in channel various places. Culverts need to be assessed. A screen needs to be supplied and put in place.	Annual and after heavy rainfall	Burn needs major attention throughout its full length. A proper screen should be fitted at inlet all culverts should be assessed and necessary repairs carried out.
2001	South Queich	NO114017 - NO123015	Debris in channel, wood collecting around pipe. Heavily silted in places, ground erosion and undercutting.	Annual	General clearance, wall should be monitored. Ground erosion adjacent to Loch Leven Mill.

Table 3 - Maintenance work undertaken (from Biennial Reports)

Date	River / Area	Location / Watercourse	Grid Ref. (approx.)	Description of work
Dec. 2006	Various Burns	Kinross	Various	Removal of fallen trees and branches
Mar. 2005	Clash Burn	Kinross	NO118024 - NO120025	Clear culvert
Feb. 2005	Clash Burn	Kinross	NO118024 - NO120025	Spray reeds and strim back
Apr. 2003	Clash Burn	Kinross	NO114023 – NO123018	Clear debris from culvert

3.6.3 Local Information

During the site visits, several residents recalled past experience of flooding at a number of locations in the town. Anecdotal information and a number of photographs have provided insight into the frequency and mechanisms of flooding in the area.

The most significant floods of recent years occurred in January 2008 and before that, in December 2006. Photographs taken by local residents, Mr Robert Ellis and Mr Craig Nisbet (SNH) were provided.

Information gathered from Mr. Robert Ellis, a resident in Queich Place was very useful in developing an understanding of the flood mechanisms in the area. According to Mr. Ellis, before the water starts to overtop the river banks, surface ponding occurs in the back yards of Queich Place. After the water overtops the banks of the Gelly Burn, it generally flows to the south through the open ground in the direction of the road and gardens at Queich Place and the back yards resulting in damage to some properties in the area.

Mr. Ellis stated that he was not the worst affected by these events. His neighbours were more seriously affected. At the time of writing, it had not been possible to get further information from these residents.

Occurrences of flooding in Smith Street were noted by local resident, Mr. Craig Brown. Recent events took place on the 1st July 2007 and 9th of August 2008. Mr. Brown stated his assumption that the existing storm drainage network in Smith Street cannot cope with heavy rainfall resulting in pluvial flows. The worst flooding occurs when water generally flows from the nearby football ground, Myre Terrace and Montgomery Street. Mr Brown has previously contacted and informed the council about these issues. He indicated a water depth of around 40cm depth at Smith Street.

Photographs and info provided by the local residents of these flood events are shown in Appendix E.

3.6.4 Scottish Water

Historic sewer flooding information for the study area has been obtained from Scottish Water register where one location in the study area is listed. This location at Pier Road (see Appendix D), has an anecdotal flood recurrence return period of twice in 10 years. The Scottish Water flooding register has limited information regarding the actual causes of flooding.

3.6.5 Newspaper Archives / Newsletter

Research in local libraries yielded no useful detailed flood records for the study area.

Information recalling past flood events in Kinross was however sourced on the internet. Extracts of relevant flood account data found is shown below in Figure 17, Figure 18 and Figure 19.

TAYSIDE POLICE
'Here for you'

Telephone 0300 111 2222 (In an emergency dial 999)

Flooding in Perth and Kinross

13-12-2006

A number of households in Perth and Kinross have been evacuated tonight as a result of atrocious weather conditions that have led to flooding in the area.

As of about 11pm tonight (Wednesday, December 13, 2006), emergency services, working in conjunction with Perth & Kinross Council, had evacuated a number of residential properties that had been worst affected by flooding in the Milnathort area.

As the water level rose Hydro-Electric cut the power in those areas worst affected in Milnathort, some of which were submerged under at least two feet of water.

Some residents were evacuated to Kinross High School and are being provided with overnight warmth and shelter - with support from the Red Cross and WRVS - whilst alternative accommodation is arranged.

The majority of householders, however, have made their own arrangements to stay with friends and relatives.

Sandbags were piled up in Kinross as waters rose during the early evening as it quickly became clear that houses in the New Road, Station Road and Wester Loan areas were vulnerable.

During the course of the night as the situation deteriorated arrangements were made to evacuate affected houses in those streets and the electrical power in the area was shut off.

Clashburn Industrial Estate was under two feet of water and some households in Queich Place, Kinross, were also affected.

The emergency services are presently monitoring the situation in the Comrie area, and various other parts of Perth & Kinross.

There are no reported casualties as a result of these incidents.

Clearly, heavy rains have also led to problems on the roads in Perth & Kinross.

Deep flooding has been reported on a number of roads throughout the evening, with certain routes deemed impassable.

The M90 at its junction with the A91 was closed due to flooding prior to 7pm, although a northbound lane was re-opened shortly after 10pm.

The River Earn was reported to have burst its banks at Strowan Road/Dalginross leading to flooding in the area and the Braidhaugh Caravan Park at South Bridgend, Crieff, was also reported to be under water.

Traffic was being diverted away from the A827 at Ballinluig and the Lethangie Road is presently impassable, as was the Dalguise to Pitnacree Bridge road. A number of other roads have also been affected by flooding.

Figure 17 - Tayside Police Report, December 2006
(source: http://www.tayside.police.uk)

The matter of the recent flooding in Kinross at Smith Street/ Myre Terrace was discussed. The state of the Myre Car Park has been mentioned previously and is in urgent need of repair. It was mentioned that the Myre Burn might need cleaning out. It was noted that GS Brown are to arrange a visit in relation to their neighbouring development and that they are to culvert the burn.
In order to clean out the burn a licence is required from SEPA (at a charge). The local authority used to clean these every two years; the water flowed better and the current problems were not experienced. It was further stated that the Loch water is too high to allow for the wildlife habitats. It was agreed that the CC should write to local MSPs, MP and SEPA in relation to this matter.

Figure 18 - Flood issues in Kinross 2007
(Source: Kinross Newsletter, August 2007)

Flooding **31.01.08**
Is Perth and Kinross Council Planning Department and SEPA going to create a flooding disaster in Smith Street, Kinross and surrounding areas by allowing G.S. Brown Construction and other contractors, including their own environment department, to discharge site and rain water from their building sites into the Clash Burn? I am led to believe that stringent measures were to be applied to the various sites before planning permission was granted. If these measures have not been adhered to, why has P&KC and SEPA not brought charges as the contamination of the Clash Burn (Myre Burn) has been ongoing for the past two years.

Flooding: CCllr Bathgate had received a call from Mr Karon, a High Street resident, requesting details of who to approach regarding flooding at the front of his house. Cllr Miller suggested that his contact details be given to Mr Karon and he would address the matter.

Myre Park: A communication has been received from P&KC advising that they are aware of the condition of the car park and have been carrying out some drainage works to help prevent some of the flooding problems. In addition they are obtaining quotes for works to improve the surface.

Flooding: Cllr Robertson commented on the flooding at the bottom of Kinross. Various properties were affected, e.g. Queich Place. He has asked the authorities to carry out further investigation with a view to alleviating this problem. The Loch level was high again. A discussion is being held between all the various organisations responsible to try to do something about this. CCllr D Mackay mentioned that the area at Westhall/Tannery was also affected. Cllr Miller confirmed that he had spoken to various householders who experienced problems, including Mr Karon from the High Street. Scottish Water is to be contacted. The areas affected included MacDonald Avenue and Montgomery Way and there were reports of a significant amount of water running from the G S Brown site. The Flooding Officer is to address this problem with the developer.

Figure 19 - Flood issues in Kinross 2008
(Source: Kinross Newsletter, March 2008)

3.7 SEPA

3.7.1 Flood Maps

SEPA publish strategic flood maps, showing areas potentially at risk from both, fluvial and coastal flooding (http://www.sepa.org.uk/flooding/flood_map.aspx).

For the area of Kinross, these maps were digitised and geo-referenced for comparison with existing data. These maps indicate that much of the study area is at risk of flooding for 200 years return period event. It should be noted that SEPA flood-mapping is based on a digital terrain model with a vertical accuracy in the range 0.7m – 1.0m, on a grid spacing of 5m. It is also not relevant to catchments smaller than 3km^2. SEPA flood-mapping also does not provide enough detail to accurately estimate the flood risk associated with individual properties or specific locations. Local factors such as flood defence schemes, structures and other local influences which might affect a flood have not been included. Furthermore, the flood map does not account for flooding from sources such as surface water runoff or surcharged culverts.

3.7.2 Loch Leven Levels

Information regarding water level records for Loch Leven was requested however, SEPA did not hold any loch level data.

3.7.3 Flow Records

To facilitate detailed hydrological analyses for the South Queich, SEPA was contacted in order to obtain annual maxima data for the existing station in the South Queich. SEPA provided 22 years of annual maximum flow data and water stage records (calendar years) for the existing river gauge station (Ref: 17008) at South Queich (NO 118 016). This data is detailed in Table 4 below.

Table 4 - Estimated Flow / Stage Records @ South Queich

Date	Estimated flows (m^3/s)	Stage (mAOD)
27/12/87	6.07	109.10
18/04/88	5.63	109.08
09/03/89	6.26	109.11
06/10/90	11.06	109.29
01/01/91	22.24	109.57
08/01/92	16.64	109.45
16/01/93	31.66	109.75
11/12/94	22.00	109.57
31/01/95	15.47	109.42
28/10/96	18.24	109.49
20/02/97	14.83	109.40
21/11/98	26.58	109.66
28/02/99	28.71	109.70
26/10/00	15.24	109.41
10/02/01	13.63	109.37
09/09/02	14.64	109.39
29/11/03	8.155	109.19

Date	Estimated flows (m^3/s)	Stage (mAOD)
25/10/04	14.79	109.40
10/01/05	19.80	109.52
13/12/06	38.15	109.85
09/01/07	12.91	109.35
26/01/08	39.03	109.87

The three highest flows recorded for the period of record correspond to the three most severe historically recorded floods experienced in Kinross. These floods occurred on 16th Jan 1993, 13th Dec 2006 and the most recent flood event on 26th January 2008.

It should be noted that the 1993 event is locally regarded as 'the great flood'. In terms of recorded flows, this flood is recorded at $31.66m^3/s$. This is markedly lower than the 2006 and 2008 recorded flows. SEPA consider their records as reliable at the Kinross gauging station. Flows are calculated using calibration gauging and an established rating curve. However, there is no cableway winch available at this gauging station making high flow gauging difficult. High flows are simply an extrapolation of gauged values exceeding stage heights of about 109.0m which will impact on the calculated annual maximum flow data. Consequently, high flows records should be treated with caution.

3.7.4 Rainfall Records

Rainfall data with a 15 minute temporal resolution was available for Fife Airfield and Saline and has been supplied to Mouchel by SEPA. Both sets of data have been analysed for the period corresponding to the three largest recent flood events. It should be noted that SEPA consider the rainfall gauge data to be reliable but that it is not quality controlled.

3.7.5 Determination of Equivalent Rainfall Return Periods

The Saline gauge is considered to be nearer and more representative of the hydrological catchment of the South Queich. Rainfall data from the Saline rain gauge has been analysed for the storm events around 16th Jan 1993, 13th Dec 2006 and the most recent flood event experienced 26th Jan 2008. This analysis was undertaken to determine the nature of the storm event which caused the reported localised flood events in the town.

Upon examination of the rainfall data, the most prolonged and intense period of rainfall around the time of the recorded flooding was identified. Flood Estimation Handbook (FEH) software allows the estimation of the return period of a rainfall event that has been observed at a particular location based on depth, duration and grid reference. Rainfall frequency estimates are calculated using a model of rainfall depth-duration-frequency (DDF) model within the FEH software. The estimated return periods and durations for the rainfall events around 16th Jan 1993, 13th Dec 2006 and 26th Jan 2008 are shown below in Table 5.

Table 5 - Rainfall Event Analysis

Main Storm Period	Duration (hrs)	Total Rainfall (mm)	Estimated Return Period
15th January 1993	$21^{1}/_{4}$	105	≈ 250 years
13th December 2006	$30^{3}/_{4}$	25.2	< 1month
26th January 2008	13	15.6	< 1month

It can be seen that 1993 event has an estimated return period of around 1 in 250 years. This is an extreme rainfall event and corresponds to the anecdotal magnitude of flooding experienced at that time.

Conversely, the 2006 and 2008 rainfall events are considered to be of a relatively small magnitude return period in contrast to the magnitude of flooding experienced in the town. Upon further investigation of this apparent anomaly, it is understood that the high flows registered at the South Queich gauge on the 26th January 2008 are likely to have been caused by a combination of heavy rain and snow melt. This cause is indicated in a weather report from the Kinross Newsletter from March 2008 (see Figure 20). At the time of writing there was no other information for the 2006 event to enable any similar conclusions to be drawn. The reliability of the rainfall data is also questionable considering the rainfall recorded on the 25th at Carnbo is noted as 74.6mm. These apparent anomalies would require further detailed investigation.

Weather

January Weather Report From Carnbo

January 2008 broke all records when it came to rainfall, the rain at times was more like an Indian Monsoon and will long be remembered by Kinross-shire folk for the threat to homes and the flooding of local roads and fields.

Rainfall for month	374 mm* (271% of normal)
Heaviest fall	74.6 mm (25th)
Highest temperature	10°C (23rd)
Lowest temperature	-4°C (13th)
Average temperature	2.8°C
Air Frost	13 nights
Ground Frost	23 nights

1 day with temperature 10°C or above
1 ice day recorded (max. temperature below 0°C)
9 snow days, 9 days with lying snow total depth 16cms

* The previous highest rainfall total was recorded in January 1993 with 275mm. This was the great Perth, Auchtermuchty and of course, Milnathort flood. This event was called the Braer storm named after the tanker that ran aground off Shetland at the height of the storm. The flooding was caused by the large amount of snow that fell during mid January subsequently melting very fast within two days.

Figure 20 - Weather in January 2008 (Source: Kinross Newsletter, March 2008)

3.8 Loch Leven

Loch Leven lies in a glacial depression east of Kinross. The loch covers an area of approximately 13.3km^2 and has a hydrological catchment of around 145km^2. The water levels of the Loch are controlled by a sluice house and spillway structure in the River Leven as shown in Figure 21 below.

A group called River Leven Trustees were contact to obtain Loch Leven water level information to be used as the downstream boundary of the hydraulic models. The role of the River Leven Trustees is understood to be to control the outflow of water from the loch for the benefit of the industries and other interests on the river, not necessarily to control the level of the loch itself.

The River Leven Trustees confirmed that they didn’t hold data regarding water levels for the Loch and forwarded us to consultants Blyth & Blyth, who provided 30 years of loch level monthly maxima data (contained in Appendix F) However, to date, no information has been obtained regarding the sluice regime during this period of record.

It is understood that there are water level records in existence for Loch Leven stretching as far back as 1850 however these have been unable to be sourced. It is also understood that a report on water levels in Loch Leven exists and was compiled by Binnie, Black and Veatch. However, at the time of writing, this report had not been able to be obtained.

The levels contained in Appendix F are understood to be depth (mm) above the sluice gate sill. The level of the sluice gate is reportedly 105.918 m AOD. However, for the period of record, there is no information in relation to the sluice regime / level at the time of the recordings.

Figure 21 - Loch Leven Sluice House

3.9 Scottish Water

3.9.1 Sewer Records

Sewer records for the area were obtained from Scottish Water. It can be seen that sewers in the area are predominantly combined. The local surface water sewer network is shown in Appendix G. There are only a few separate surface water sewers from more recent developments which connect into watercourses. There are three storm water sewer outfalls identified in South Kinross discharging directly into the open reach of the Clash Burn. One combined storm water overflow discharges into the South Queich. Scottish Water outfalls are shown below Figure 22.

Scottish Water also stated that there is currently no spare capacity within their wastewater network within the Kinross catchment. This is reportedly a function of the hydrological capacity at Kinross Treatment Works to treat wastewater to the required standard rather than necessarily the capacity of the sewer network itself.

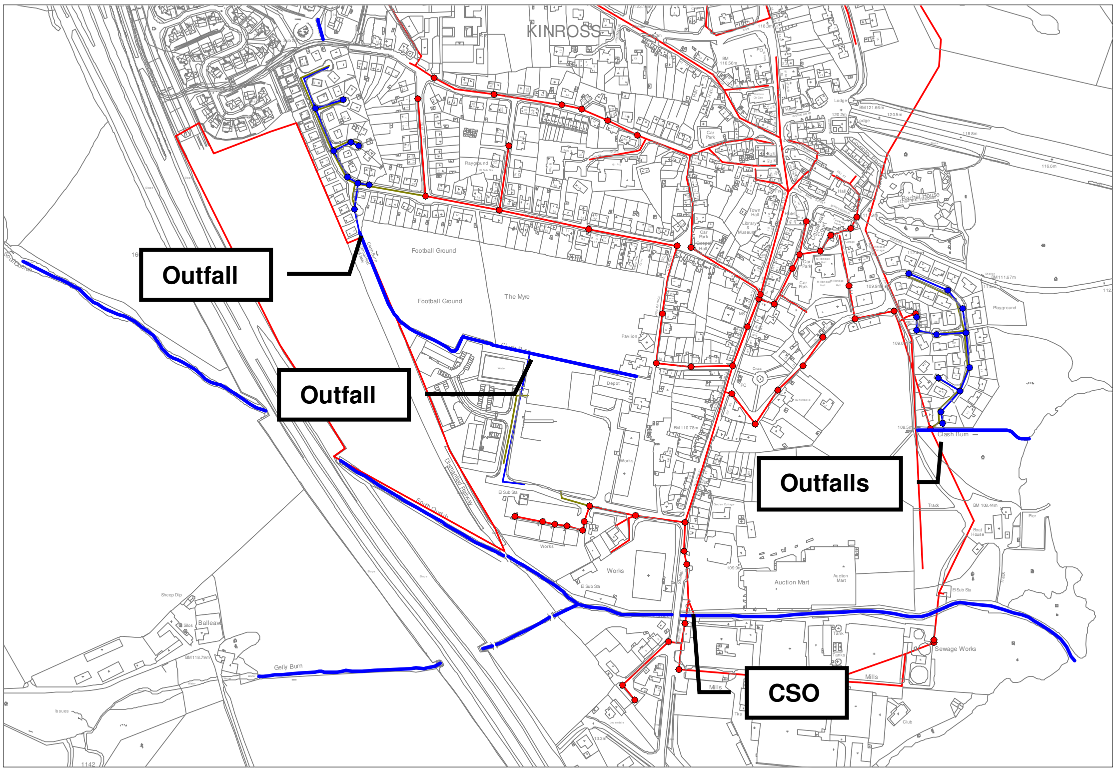

Figure 22 - Existing Scottish Water Sewers

3.9.2 Sewer Model

Any detailed flood study of South Kinross should include flooding from all sources including possible flooding / interaction with the sewer network. An assessment of the existing Scottish Water model was undertaken. The most up to date Kinross Drainage Area Plan (DAP) model was obtained from Scottish Water and assessed. However, based on the accompanying audit report it was confirmed that the model was not suitable for flood modelling purposes which may have fed into the South Kinross flood study. The existing network model needs brought up to standard before it could be used to assess current network performance and the identification any potential manhole flooding or interaction. A scoping of the South Kinross Scottish Water sewer model was been undertaken by Mouchel as part of the flood study which outlines the deficiencies of the existing model and also outlines the work required (and indicative costs) to update the existing Scottish Water sewer model to an appropriate standard. This scoping report is contained in Appendix H. Any proposals to update the existing model will require full partnership with Scottish Water.

A detailed and integrated study is not possible with the current Scottish Water model and therefore, detailed assessment of Kinross surface water systems is beyond the scope of this flood study. However, in assessing any potential solutions for fluvial flooding in Kinross, some consideration needs to be given to the potential for exacerbating surcharging issues in existing drainage systems, up to the design event.

The Kinross DAP model was tentatively used to crudely assess the potential spill issues from the sewer network. Using a design storm of critical duration for the Kinross DAP model, Annual, 30 year and 200 year storm events were simulated. As expected, there was flooding predicted from the system. Importantly, the Annual flood event was resulting in significant spilling indicating that the system was significantly overloaded or the current DAP model is over-predicting (i.e. not accurate). Figure 23, Figure 24 and Figure 25 show the predicted manhole spilling (m^3) for the Annual, 30 year and 200 year design storm events respectively.

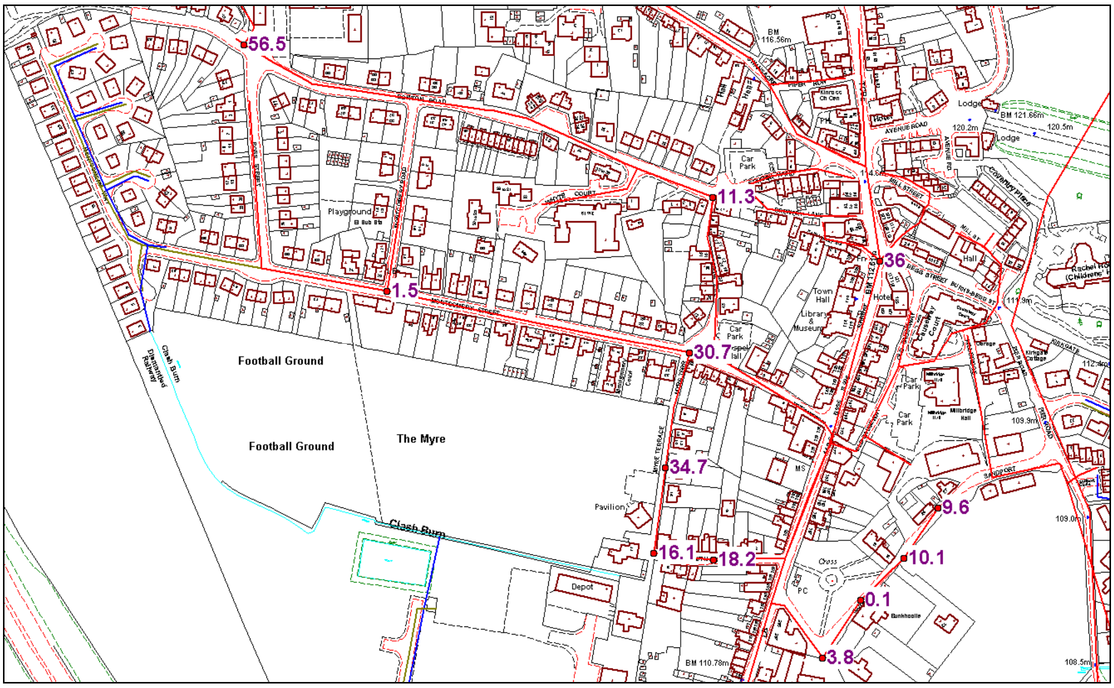

Figure 23 - Predicted Scottish Water Sewers Flooding for Annual Storm (m^3)

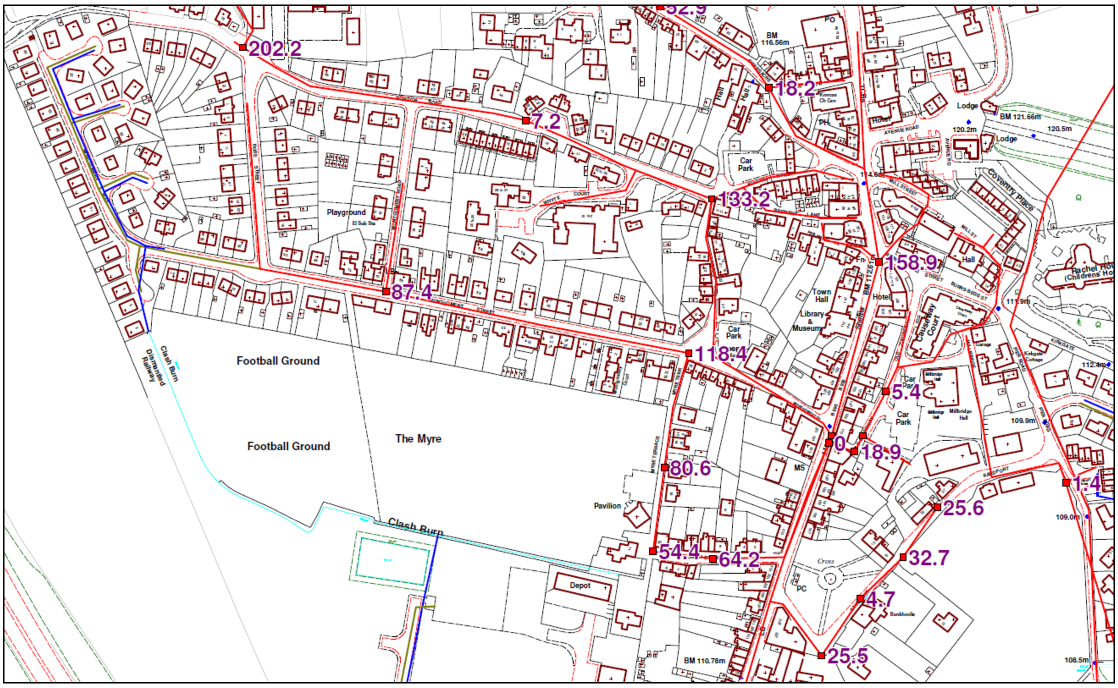

Figure 24 - Predicted Scottish Water Sewers Flooding for 30 Year Storm (m^3)

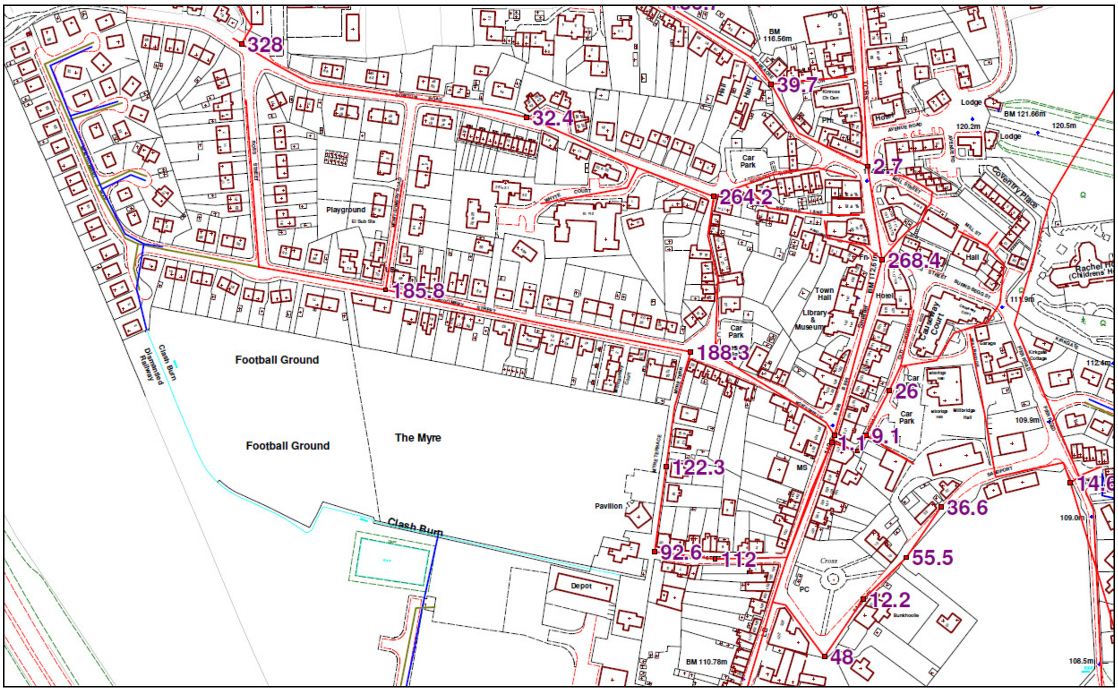

Figure 25 – Predicted Scottish Water Sewers Flooding for 200 Year Storm (m^3)

3.10 Kinross Council Planning & Development

3.10.1 Current Planning Applications

Perth & Kinross Council hold planning application info on-line. These applications can be viewed on the Council website at the following link:

http://193.63.61.22/publicaccess/tdc/DcApplication/application_searchform.aspx

A general search was undertaken of planning applications in the South Kinross study area which may be affected by flood risk or have the potential to affect any flood alleviation measures pursued by the Council. Brief details of these applications are contained in Table 6.

3.10.2 Local Development Plan

The current 'Kinross Area - Local Plan 2004' was reviewed. This document shows that some outlined development areas are located within some historical floodplain areas. The Local Plan identifies the 'Western Edge' area as a key development area which will contribute towards housing and business land supply. Reference should be made to "Kinross Area – Local Plan 2004" and "Kinross Western Edge Development Brief" for more detailed information.

Perth & Kinross Council is currently working on the new Local Development Plan (LDP) which will replace the existing Kinross Area Local Plan (KALP). A Main Issues Report (MIR) is due to be published in September 2010 which will set out the preferred sites which the Council will consider to be taken forward. The Council have received a number of representations for inclusion into the MIR with some due to be included in the final LDP. The areas that have been suggested to date can be viewed on the Council website at the following link:

http://www.pkc.gov.uk/NR/rdonlyres/8468085F-614F-453C-88D7-84D63C5B1792/0/Kinross.pdf

An extract of this document centred on South Kinross is shown in Figure 26.

Table 6 - Planning Applications

Planning Ref.	Address	Proposal	Status
10/00491/FLL	Unit C Kinross Business Park Clashburn Close Bridgend Industrial Estate Kinross KY13 8GF	Modification of existing consent (09/00592/FUL) to erect an industrial unit	Application Approved
10/01197/FLL	Unit C Kinross Business Park Clashburn Close Bridgend Industrial Estate Kinross KY13 8GF	Change of use of land, erection of palisade fence and formation of hard core area	Application Approved
09/01810/FLL	Unit D Kinross Business Park Clashburn Close Bridgend Industrial Estate Kinross KY13 8GF	Erection of office, showroom and works with associated parking	Application Approved
10/01365/FLL	Site 50 Metres South West Of 2 Clashburn Close Bridgend Industrial Estate Kinross	Installation of temporary cabin	Pending Consideration
05/02457/FLM	Scottish Motor Auctions Bridgend Kinross KY13 8EN	Proposed residential development and ancillary works (72 dwelling houses and 125 flats)	Pending Consideration
10/01092/FLL	Stewart Funeral Directors Ltd Queich Place Kinross KY13 8DF	Erection of a funeral operations centre	Pending Consideration
10/00752/FLL	1 Smith Street Kinross KY13 8DD	Extension to dwelling house	Application Approved
09/01763/FLL	25-27 Montgomery Street Kinross KY13 8DZ	Alterations and extension to house	Application Approved

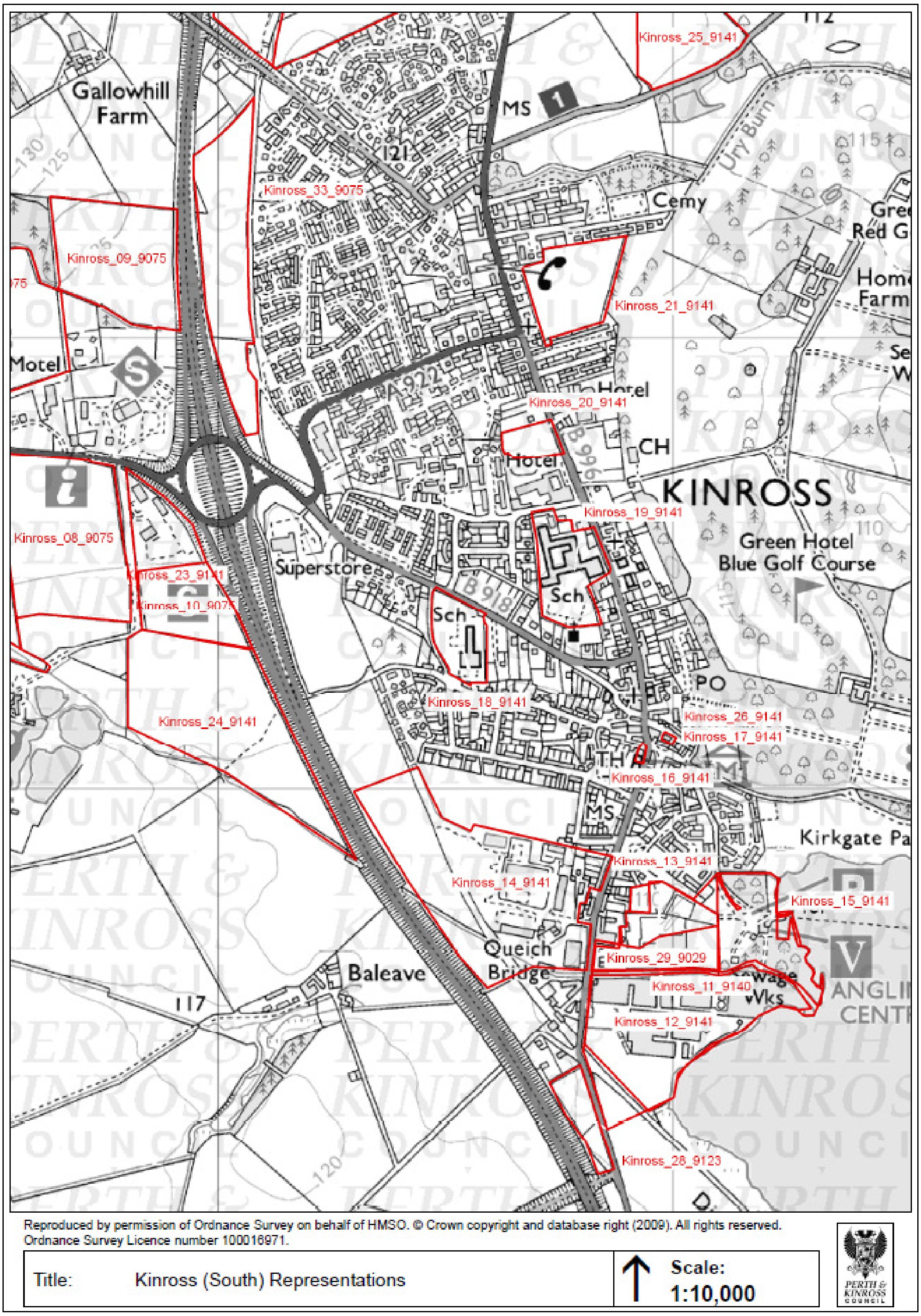

Figure 26- South Kinross Planning Representations for Main Issues Report (MIR)

4 FLOODING ASSESSMENT

Following on from the data collection and scoping, this section explores flood risk in detail (for a wide range of return periods) through detailed hydrological analysis and hydraulic modelling.

4.1 Topography (Surveyed)

Using the detailed survey data, the topography of the South Kinross area is illustrated by contours as shown in Figure 27. It is evident that South Kinross occupies a relatively low lying area near the edge of Loch Leven. The detailed topography would indicate potential for complex overland flows if rivers banks were to be overtopped.

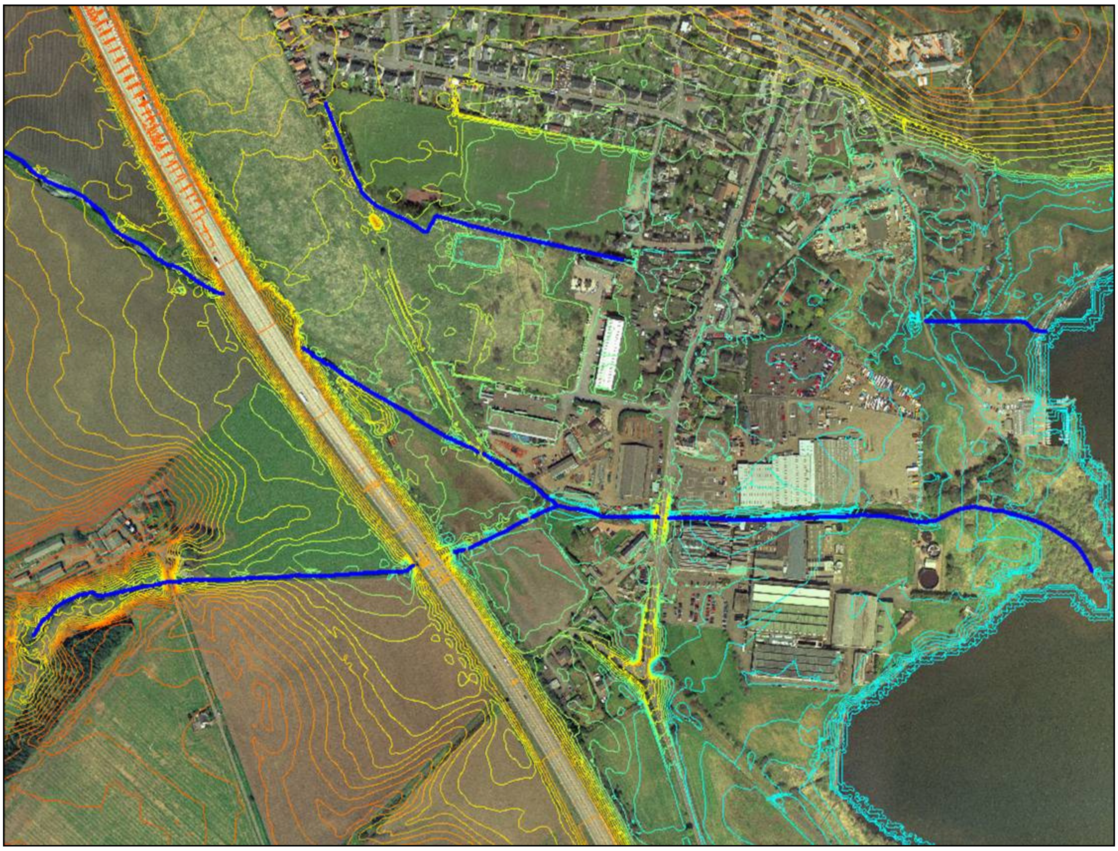

Figure 27 - Site Topography

4.2 Watercourses

The South Queich, Gelly Burn and Clash Burn are the main watercourses likely to affect South Kinross in terms of flooding. Loch Leven would periodically cause flooding to areas on the loch fringe. Extreme water levels in Loch Leven are considered in the South Kinross flood assessment.

4.3 Geology / Hydrogeology

4.3.1 Geology

The study area is underlain by Upper Devonian sandstone bedrock belonging to the Stratheden Group of the Upper Old Red Sandstone facies. This comprises for the most part a series of fluvial sandstones with minor mudstones, siltstones and conglomerates with variable grain size and cementation. One section, the Knox Pulpit Formation, is now believed to be of aeolian deposition. The Stratheden sandstones have a regional dip to the south-east.

Immediately to the north and north-west of the study area, the Old Red Sandstones give way to the underlying Lower Devonian volcanic succession, consisting predominantly of andesitic and basaltic lavas. South and east of Loch Leven, the Devonian sandstones grade conformably into the overlying Carboniferous sequence. This also contains intrusive igneous bodies mainly of quartz dolerite composition, which form the Lomond Hills.

The bedrock is overlain by Quaternary drift deposits. The study area lies within or adjacent to the old lake shore of Loch Leven, so drift is dominated by glaciolacustrine clays overlying till, sands and gravels. There are some alluvium deposits associated with the South Queich watercourse which underlie part of the western section of the study area.

4.3.2 Hydrogeology

The Stratheden Group sandstones are widely recognised as forming a productive regional aquifer for Perth & Kinross and Fife. They have a high permeability, through both intergranular porosity and interconnecting fractures in the upper levels, which allows a fairly rapid shallow flow through the aquifer. The adjacent Lower Devonian and Carboniferous igneous bodies, due to their crystalline texture, have a very low permeability except in shallow fractures and fault lines. These formations demonstrate low productivity, with limited storage and flow capacity.

The overlying glaciolacustrine deposits have very variable permeability owing to their variable composition of clays, sands and gravels. The till is mostly poorly permeable although the presence of fractures allows rapid groundwater flow through the till deposits. Alluvium deposits typically have high permeability but tend to be of limited extent. The Quaternary deposits overall are classed as forming a locally important aquifer.

Bedrock and superficial deposits are exploited locally for public and private water supplies. These are mainly wells or boreholes. Groundwater infiltration in the area, based on geology, topography and baseflow data, is estimated to be >300mm per year.

The Groundwater Vulnerability Map of Scotland classes the study area as 'Vulnerable' (4b). This reflects the uniformly shallow position of the water table in the area, the permeability of the superficial deposits and the fracture permeability of the underlying bedrock. These factors will facilitate fairly rapid transfer of contaminants into the groundwater and their rapid transfer and spread through the aquifer. The low clay mineral content will also restrict the removal of contaminants by adsorption onto the clay mineral surfaces.

4.3.3 Groundwater Assessment

Parts of the study area have been the subject of several ground investigations, focussing mainly on the proposed link road site east of the M90 motorway. The available data from boreholes and trial pits have been collated and compared to give as good an understanding of the sub-surface regime in this area as possible.

Ground investigations indicate that the area is predominantly underlain by sands and gravels in varying proportions, with subordinate silts and clays in some areas. Most of the trial pit and borehole logs indicate the presence of cobbles, typically described as 'occasional' but more frequent in some sections. Organic material is noted in some areas and made ground is described towards the northern and central parts of the proposed link road site.

The water table in the area is shallow, typically less than 3m below ground level (bgl) and in places less than 1m bgl (Figure 28). The shallowest recorded level is 0.3m bgl, just north of the South Queich (Fairhurst Site Study, 1999). Transects across the site indicate that the water table becomes shallower towards the south-east and mirrors the ground surface fairly closely (Figure 29). Seasonal fluctuations in water table level in the wider catchment are of the order of 1 to 4m (Gaus & Ó Dochartaigh, 2000).

Due to the high permeability of the aquifer, borehole water levels typically respond to local rainfall events within hours (Gaus & Ó Dochartaigh, 2000). Although heavy rainfall at greater distances will have a delayed impact this is likely to affect surface water levels more strongly than groundwater due to the low permeability of the surrounding igneous strata.

The study area lies very close to the western boundary of the Stratheden sandstones. Rainfall events further west and north (up-catchment), over the Ochil Hills, will fall predominantly on very poorly permeable igneous bedrock. Infiltration in this region is very low and most rainfall will become surface runoff, affecting the surface water regime but having very little effect on the groundwater in the wider area.

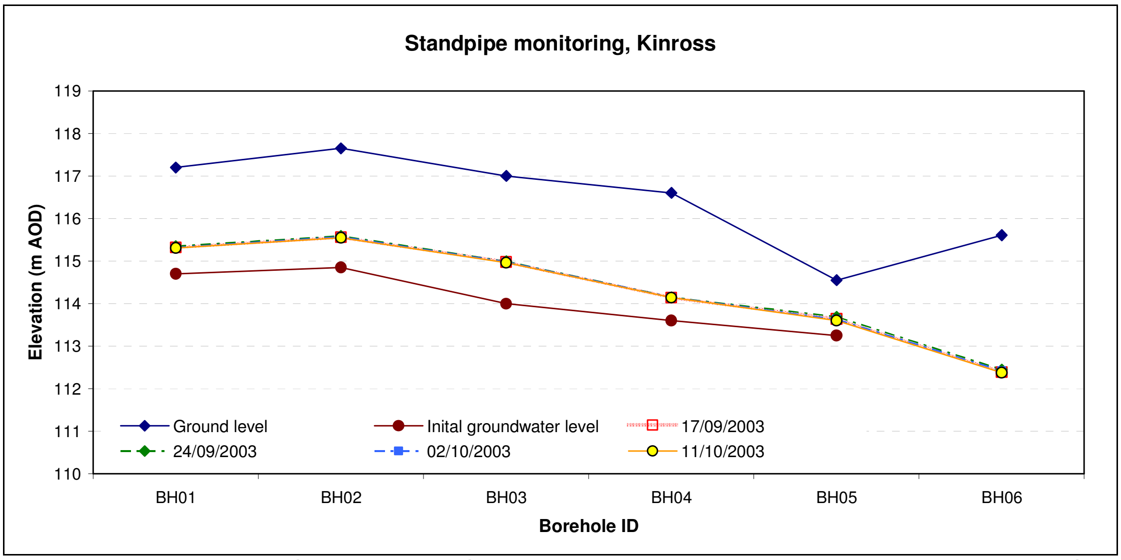

Figure 28 - Example Groundwater Standpipe Monitoring Data (data courtesy of URS Corporation)

Aquifer modelling undertaken by Gaus & Ó Dochartaigh (2000) indicates that the region has a high horizontal intergranular permeability, which promotes the flow of groundwater through the aquifer. This modelling also indicates that groundwater flow is largely governed by the surface water bodies, in this case Loch Leven and the River Eden. There is some groundwater discharge into Loch Leven from the aquifer system but a significant proportion of the regional groundwater flow crosses into the Eden Valley system.

This rapid movement of groundwater through the aquifers and the subsurface connection with the Eden Valley catchment suggests that any risk of groundwater flooding is small. High infiltration rates from heavy rainfall events will contribute to raised water levels in Loch Leven and to high flow in the River Eden, but groundwater flooding is more likely to affect areas further down the catchment. As the water level in Loch Leven is regulated by means of sluices at the outflow, it is unlikely that high water levels consequent on a raised water table level will have a significant or prolonged effect.

It should be noted that this assessment is qualitative only and is based on interpretation of the available ground investigation data and published material concerning the geological and hydro-geological regime in the area. Long-term monitoring of standpipes and detailed groundwater modelling would be required to provide an effective quantitative assessment of flood risk from groundwater in this study area.

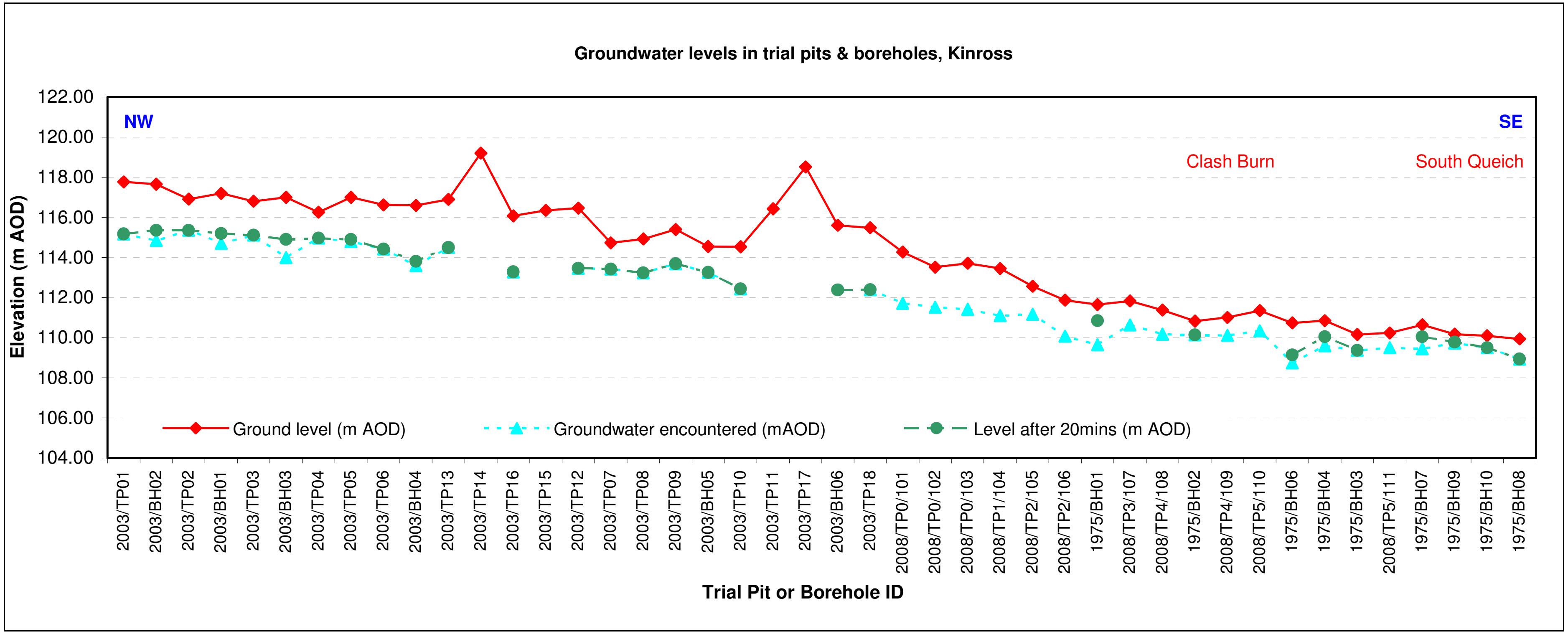

Figure 29 - Transect NW–SE through the central part of the study area showing levels of ground surface and water table in trial pits and boreholes (data labelled 1975 courtesy of WA Fairhurst & Partners; data labelled 2003 courtesy of URS Corporation; data labelled 2008 from the Mouchel ground investigation)

Note: Trial pits showing no groundwater level were dry so no data are available for groundwater in these areas.

4.4 Hydrological Catchment Analyses

There are three main hydrological sub-catchments in the study area. These are as follows:

- Clash Burn (relatively small and significantly urbanised)
- South Queich (mainly rural)
- Gelly Burn (mainly rural)

To facilitate catchment extents and design flow estimation, an assessment was undertaken based on Flood Estimation Handbook (FEH) techniques, OS mapping, Scottish Water sewer records, DTM data and topographical survey data. The appropriate hydrological catchments were identified.

4.4.1 Clash Burn Catchment

The catchment of the Clash Burn is largely urbanised. Historical mapping shows the Clash Burn and associated hydrological catchment to have been heavily modified over the years. The catchment is not defined in FEH software. An estimation of the total hydrological catchment was made based on topography, site assessment, development layout plans and Scottish Water sewer records. It is important to note that the hydrological catchment based on topography does not take into account flows entering combined sewer systems and leaving the natural catchment. During times of heavy rain, manhole spills and pluvial flows are also likely to increase this urbanised catchment complexity.

The estimated hydrological catchment outline for the whole Clash Burn is shown in Figure 30 and is approximately 0.5 km^2. The sub-catchment is roughly bounded by the M90 motorway and Station Road.

For the purposes of flow estimation for modelling, the hydrological catchment of the Clash Burn (up to the point of discharge into the culverted section of the Clash Burn near Smith Street) has been estimated. Large areas of South Kinross where Scottish Water combined sewers are present have not been included. Open areas and urban areas known to be on separate surface water sewers have been included. For the purposes of hydraulic modelling and assessment of Clash Burn flood risk, the total hydrological catchment area is taken as approximately 0.22 km^2. To be conservative, the relatively recent development of Sandport Gait is included in the flow applied to the open reach of the Clash Burn upstream of Smith Street.

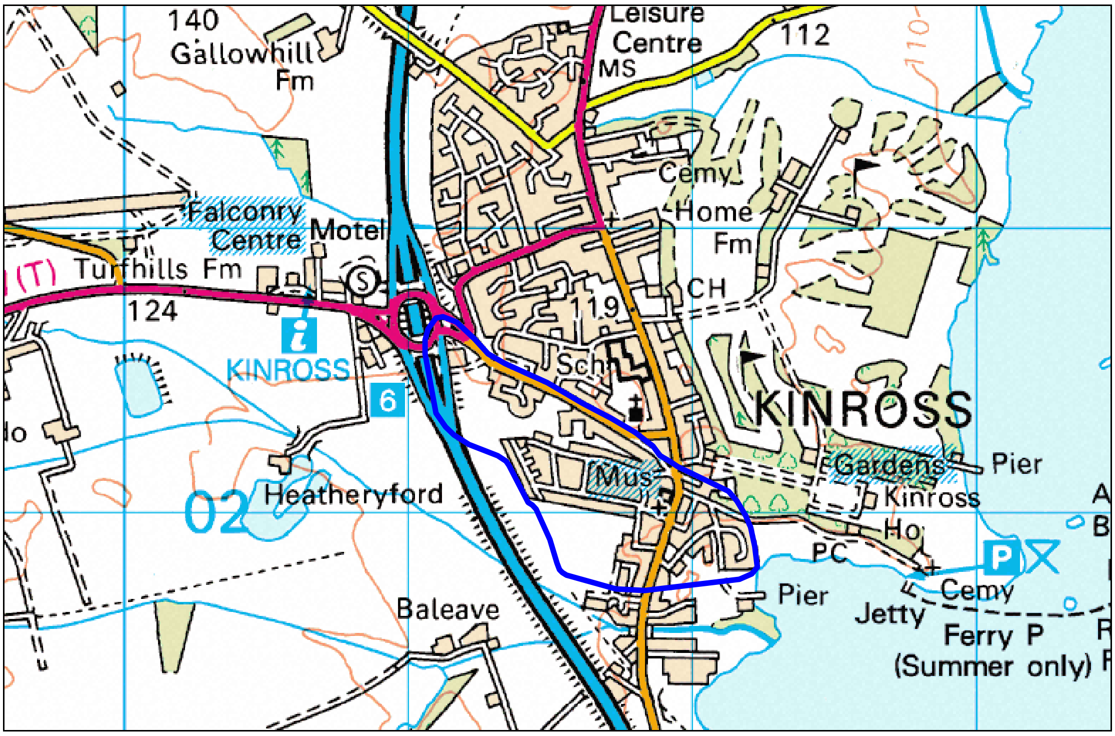

Figure 30 - Clash Burn Hydrological Catchment

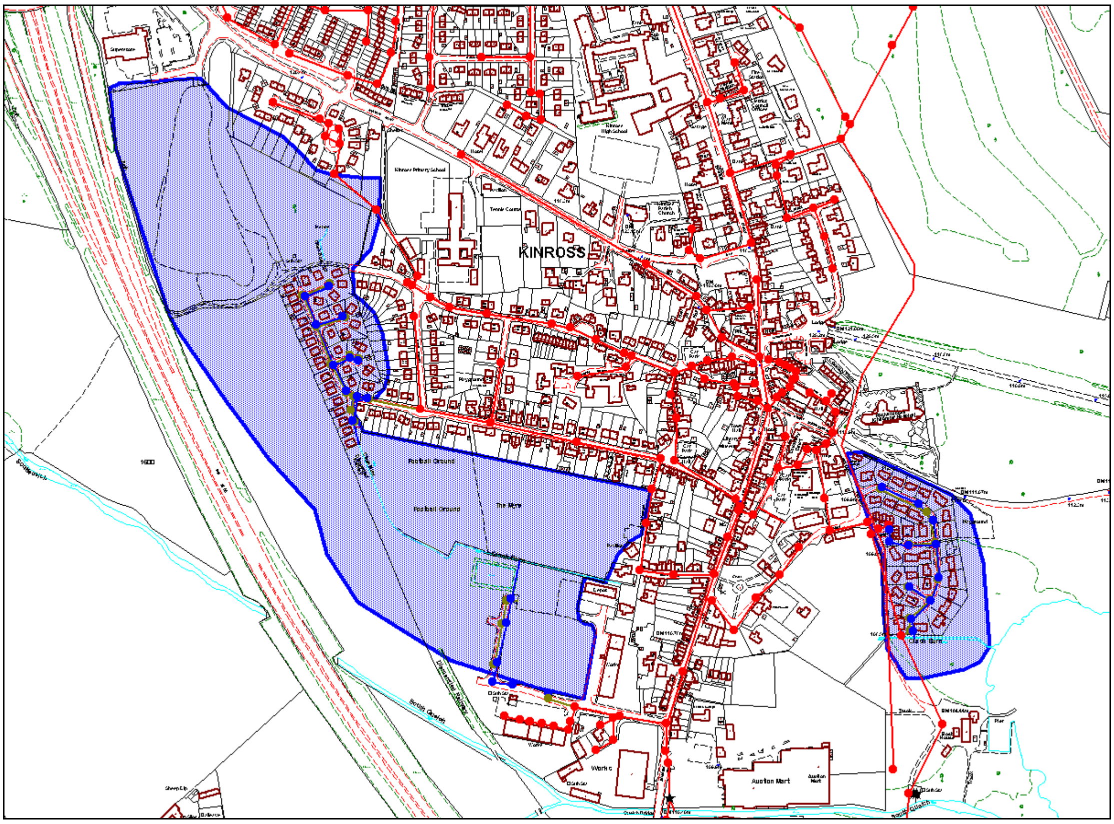

Figure 31 - Clash Burn Hydrological Sub-Catchments (as modelled)

4.4.2 South Queich and Gelly Burn Catchments

West of the M90 the South Queich catchment is relatively flat and dominated by agricultural land. The upper reaches of the catchment north of the A91 are located in the Ochil Hills.

The soils in the South Queich catchment have a Winter Rainfall Acceptance Potential (WRAP) of 3. This is indicative of:

1. relatively impermeable soils in boulder and sedimentary clays and alluvium;
2. permeable soils with shallow ground-water in low lying areas;
3. mixed areas of permeable and impermeable soils in approximately equal proportions.

The entire hydrological catchment of the South Queich prior to discharge into Loch Leven is approximately 34 km^2. The estimated hydrological catchment outline for the South Queich is shown in Figure 32. The Gelly Burn catchment (which is a tributary of the South Queich) is also shown.

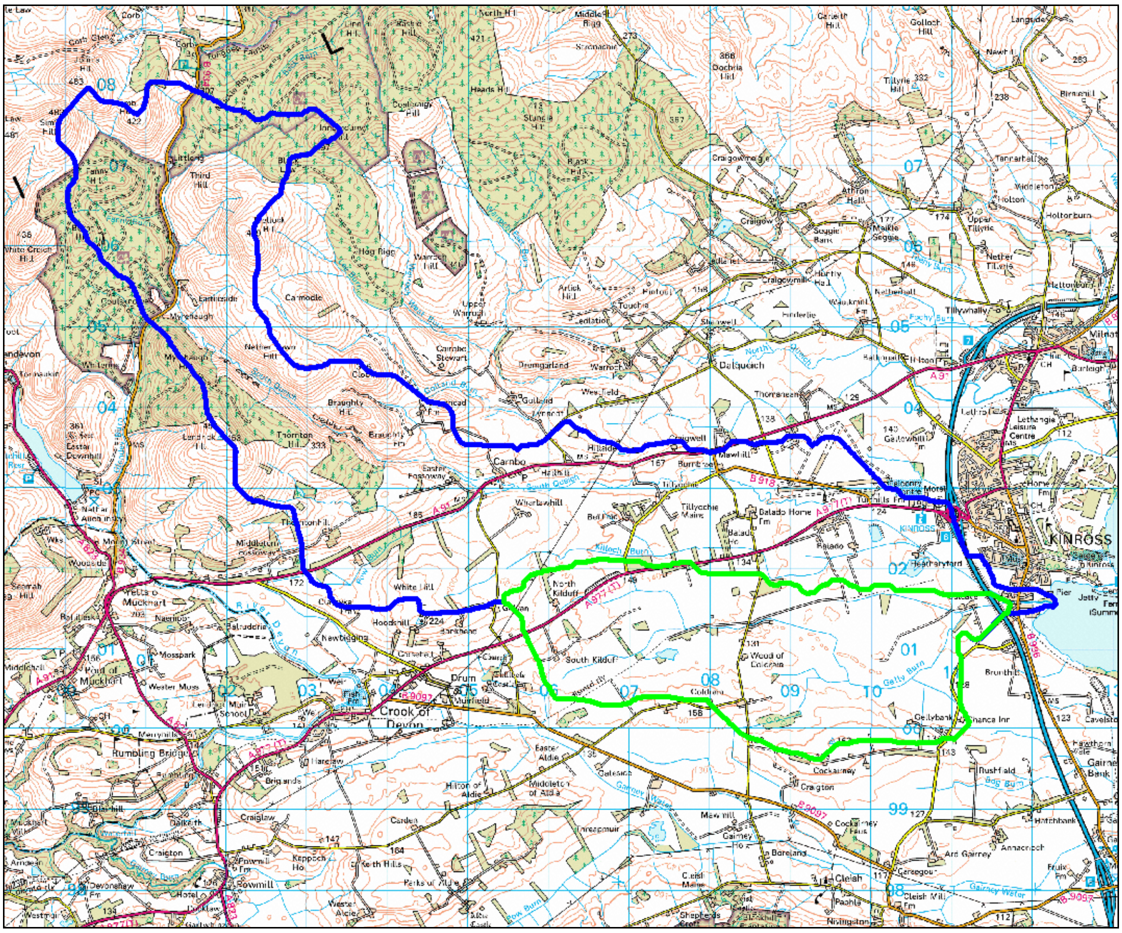

Figure 32 - Estimated Hydrological Catchment of South Queich / Gelly Burn

The three main hydrological catchment areas identified are summarised below in Table 7.

Table 7 – Main Hydrological Catchments

Catchment	OS Grid Ref	Area (km^2)
South Queich	NO 11690 01600	34.42
Gelly Burn	NO 12290 01550	10.05
Clash Burn	NO 12230 01800	0.5

4.5 Design Flow Estimation

Flow estimation techniques are varied. There are a number of methods available such as the Flood Estimation Handbook (FEH), Flood Studies Report, and a number of other associated guidance notes.

The FEH provides two main approaches to flood frequency estimation: the statistical analysis of peak flows, and the rainfall-runoff method. Statistical analysis is generally the first choice method where there are long records of gauged floods at or near the site of interest. The statistical approach is more suited to larger gauged catchments as the concept of a catchment wide design storm becomes less realistic the larger the catchment. FEH software is then used to 'pool' a number of similar gauged sites based on catchment similarity to aid statistical flood flow estimation for a range of return periods. The size of the pooling group is tailored to the target return period.

For this study, design flow hydrographs were derived using the FEH Statistical Procedure for the South Queich. Estimated peak flow values for a range of return periods are shown in Table 1. The critical storm duration for the South Queich is approximately 12 hours. The detail of the Statistical Procedure process followed to derive the South Queich QMED value and growth curve is outlined in Appendix I. It should be noted that estimated design flow values for high return periods such as 500 and 1000 year should be treated with caution as there is not possible to achieve the recommended number of pooled stations.

FEH flow estimation procedures are not appropriate for the small and highly urbanised Clash Burn catchment. Consequently, flow estimation was undertaken using InfoWorks CS hydraulic modelling software and the New UK rainfall runoff model. The New UK model is the standard model used in development impact assessments for Scottish Water and is better suited to low impermeability urban catchments. Default percentage runoff parameters were used as it was not possible to verify percentage runoff against any observed data. The standard values assume that 75% of rainfall which falls on a road or roof enters the system with the remaining 25% being 'lost'. The routing values chosen in conjunction with the New UK model determine the speed of the runoff response following the storm.

The critical storm duration of the receiving Clash Burn (near Smith Street) was estimated to be around 0.5 hours with a time to peak of 20 minutes. It should be noted that peak flows in the Clash Burn will occur in advance of a later peak in the South Queich.

At the time of writing no detailed drainage layout information was available in relation to some of the new development areas east of the M90. However, it is conservatively assumed that these areas will connect to the Clash Burn. For modelling purposes and where drainage information wasn't available, a nominally sized pipe connection was assumed in the model. Resulting peak design flows entering the Clash Burn are also shown below in Table 8. Two sets of flow values are included in Table 8 for the Clash Burn. These correspond to two different critical storm durations. Modelling would test critical storm durations that coincided with both that of the Clash Burn alone (0.5 hours) and that of the South Queich (12 hours). This was to ensure that a conservative worst case coincidence of Clash Burn and South Queich flows was assessed.

For the purposes of design flow estimation and flood risk assessment, no reliance has been placed upon any restrictions caused by upstream culverts. This is considered a robust and conservative approach as it is possible that during extreme storm events any upstream culverts which may currently serve to restrict flows could be overtopped and bypassed. This approach also removes the risk of underestimating flows which could result if there was future work to upgrade any existing upstream culverts.

Table 8- Peak Design Flow Estimation

Location	Method	Estimated peak flows (m3/s)										
		Annual	5 Year	10 Year	25 Year	50 Year	75 Year	100 Year	200 Year	200 Year +cc	500 Year	1000 Year
Clash Burn @ 'Myre' - 30 min storm duration	InfoWorks New UK Runoff Model	0.30	0.41	0.51	0.67	0.82	0.93	1.01	1.25	1.50	1.63	1.99
Clash Burn @ 'Myre' – 12 h storm duration	InfoWorks New UK Runoff Model	0.16	0.21	0.26	0.34	0.42	0.48	0.52	0.65	0.78	0.87	1.09
South Queich u/s confluence with Gelly Burn	Statistical Procedure (FEH)	12.51	17.73	21.37	26.47	30.74	32.91	35.47	40.73	48.88	48.64	55.46
Gelly Burn u/s confluence with South Queich	Statistical Procedure (FEH)	2.53	3.51	4.27	5.34	6.27	6.79	7.18	8.42	10.10	9.96	11.76

4.6 Hydraulic Modelling (MIKE Flood)

The South Queich, Gelly Burn and Clash Burn were hydraulically modelled to facilitate an estimation of extreme water levels and the associated extent of flooding in South Kinross. Approximately 1250m of the South Queich, 400m of the Gelly Burn and 1010m of the Clash Burn have been modelled.

4.6.1 Modelling Approach

Initial investigations (including some preliminary 1D modelling in HEC-RAS) showed that flooding was complex and included over-bank spilling resulting in extensive unconfined overland flows. Consequently, the South Queich, Gelly Burn and Clash Burn have been modelled using MIKE Flood (Danish Hydraulics Institute software), a widely used 1D / 2D river modelling package. Full unsteady modelling would be required to assess potential flood mitigation options that involved flow attenuation / storage. Figure 33 below shows the extents of the modelled reaches. Main channels are described in the 1D domain and all floodplains in the 2D domain. 1D and 2D domains are dynamically linked within the MIKE model.

Simulations would be undertaken using the full range of design flows contained in Table 8.

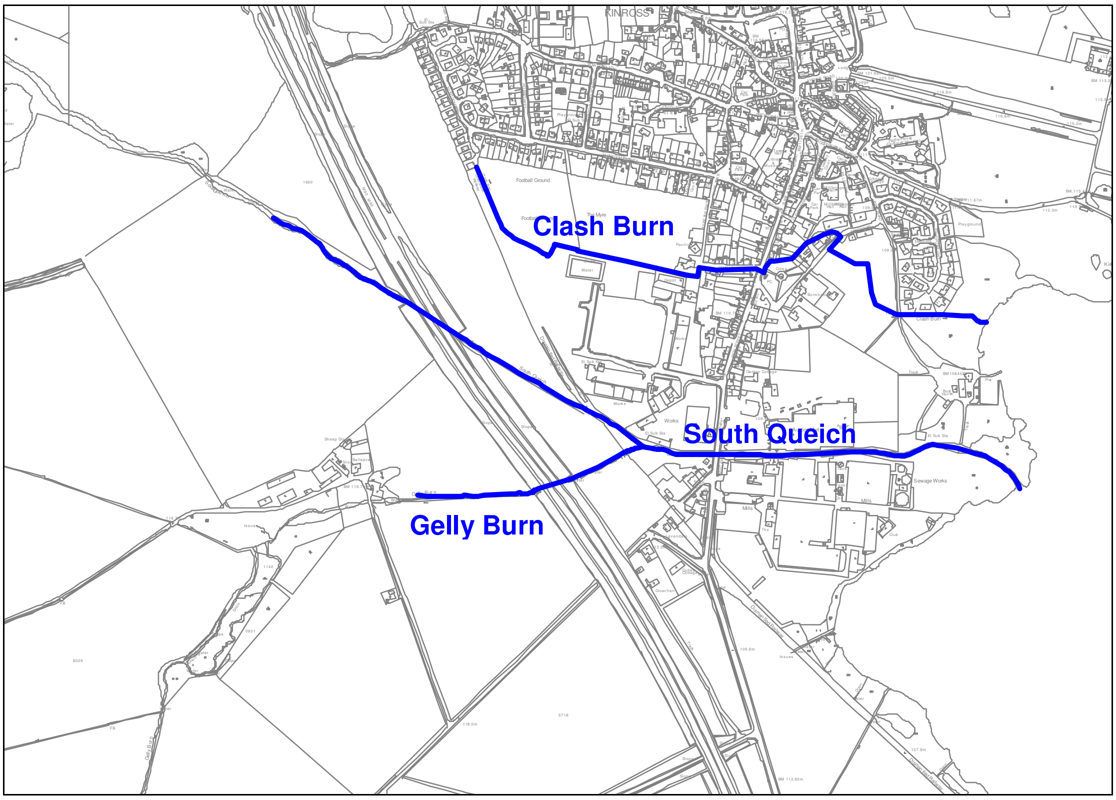

Figure 33 – Modelling Extents

4.6.2 Model Build

Site inspection and topographical survey data have been used to define model channel cross sections, floodplains and details of all relevant hydraulic control structures (bridges, culverts, etc). The 1D component of the model comprises the main channel and associated structures. Model cross sections are shown in Figure 34. A number of interpolated cross sections were also used in the modelling. This modelling exercise was based on channels flowing freely.

Site inspection and photographs taken during the survey enabled estimation of channel roughness to be made. A global Manning's 'n' roughness value of 0.04 has been assigned to the bed and 0.05 for the banks to account for the current channel type and vegetation. These two Manning's values were used in 1D domain of the model.

Floodplains are defined in the 2D domain. A key component of any 2D model is a detailed ground model. The topographical data had to be of sufficient detail and extent to include all significant drainage paths, areas of potential ponding and obstacles to flow. Survey data was processed to create a detailed 3D ground model of the land surface (3D visualisation shown in Figure 35) which then forms the main boundary condition for the MIKE 2D model. No DTM data had been used for 2D modelling purposes due to its noted inaccuracies around Kinross, particularly around heavily urbanised and/or vegetated areas. Only surveyed areas get 'wet' in the 2D model.

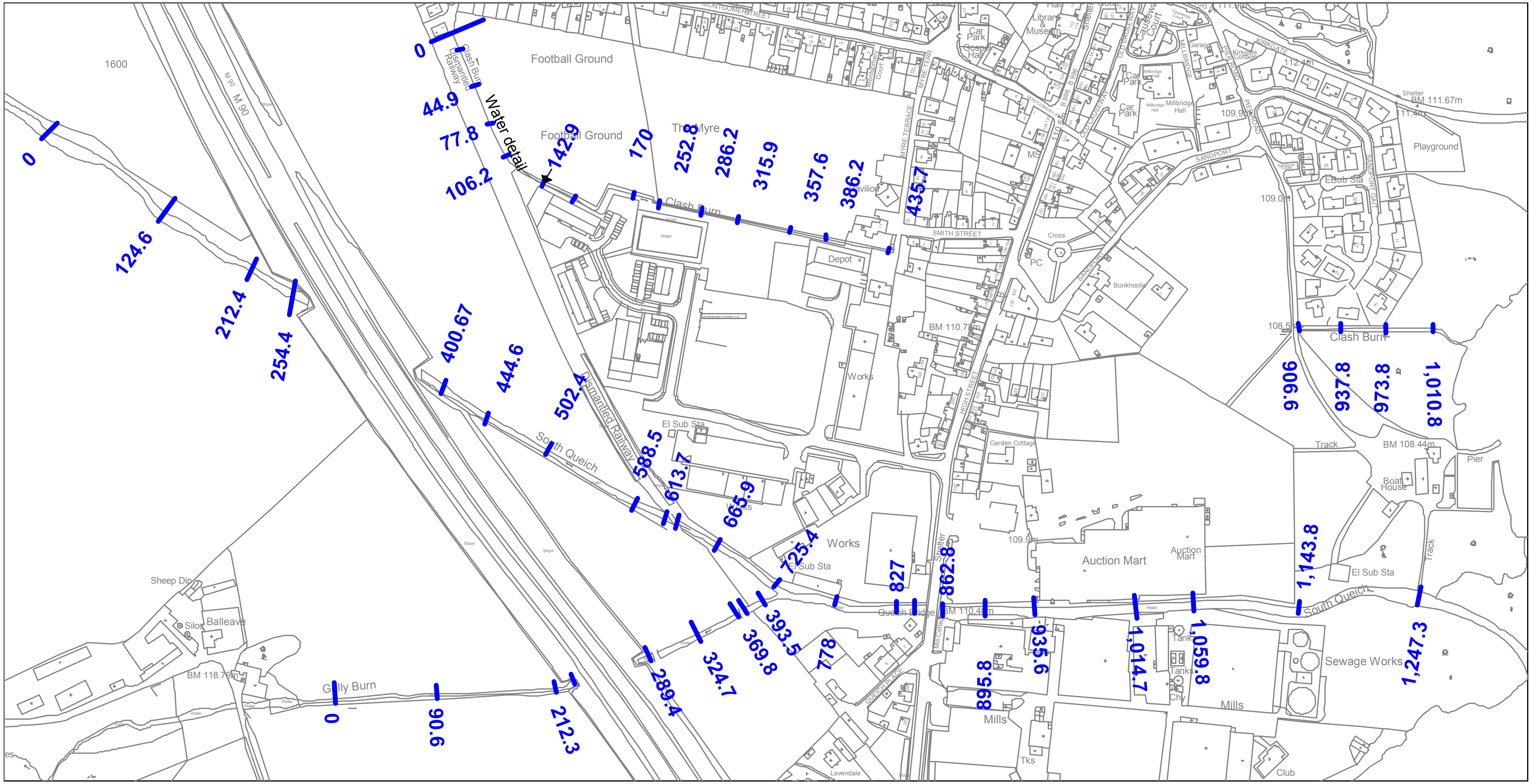

Figure 34 - Model Cross Sections

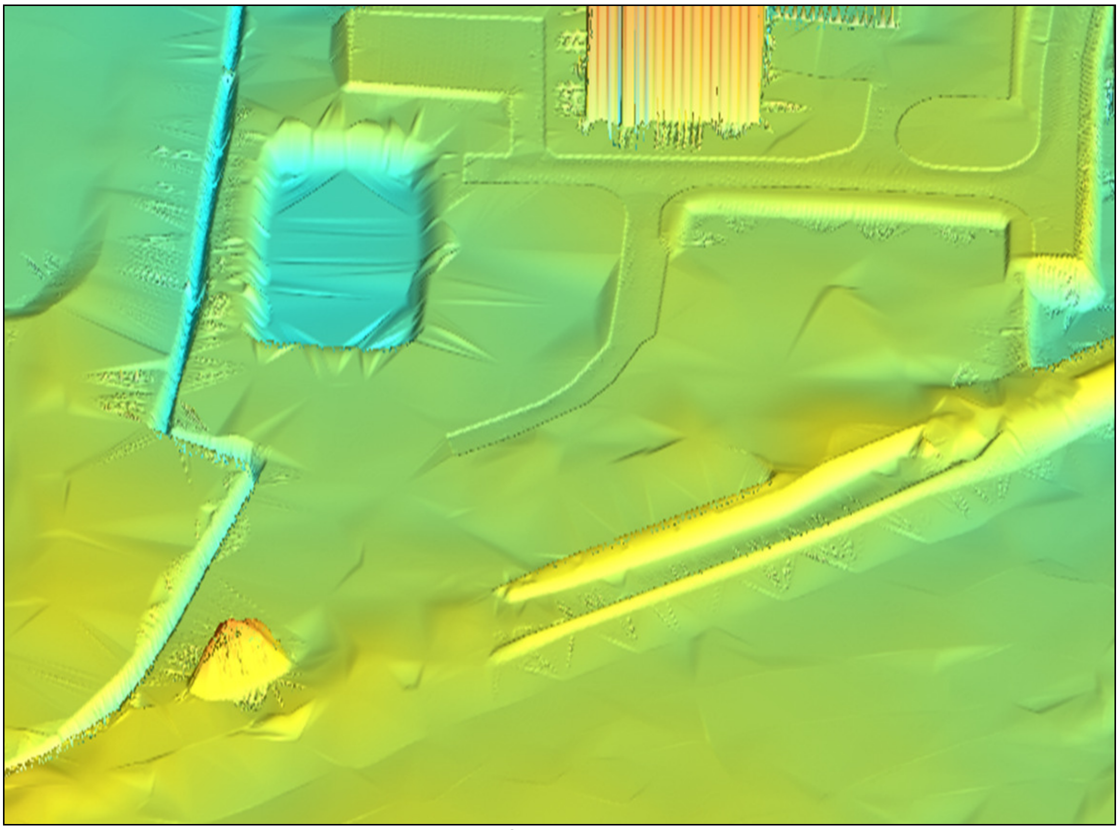

Figure 35- Kinross Ground Model Visualisation

A 2D ground model bathymetry of 5m x 5m cell size was selected within MIKE. This cell size resolution was selected as a practical balance between model accuracy, numerical stability, and model run time. A range of Manning's n values were used in the 2D model domain to account for different floodplain resistance types. These vary from 0.015 for roads and pavements to 0.05 for vegetated areas with bushes and long grass.

The large water body of Loch Leven forms the downstream boundary of the modelled reaches. Although peak loch level records were obtained for the last 30 years, no information was available regarding sluice operation at the time of the recordings. Consequently, no meaningful statistical return period analysis was able to be undertaken on loch levels. For simplicity, the maximum loch level within the period of the available record was chosen as the downstream boundary for all the events modelled (107.8m AOD). Although this approach is considered conservative, it is recommended that a detailed statistical analysis is undertaken to properly determine loch levels for a range of return periods, should more detailed information become available. This would then facilitate a more detailed joint probability assessment on combinations of flows and loch levels.

4.6.3 Model Calibration

Full calibration of the model was not possible due to the lack of reliable extreme flood water levels. According to SEPA, for high flows, associated water levels are simply an extrapolation of gauged values exceeding stage heights of about 109.m AOD. All recorded annual maxima for the site are higher than this level. The gauge is more set up for recording low / medium flows rather than high flood flows. However, the model output was sense checked against SEPA's predicted water levels for this gauge.

The stage / discharge (rating) curve created using model results was compared with SEPA's rating curve derived from Annual Maxima data from Table 4. Figure 36 below shows the two rating curves. It can be seen that the two curves concur for flows within the range of the gauge. The model is therefore considered to be accurately calibrated for flows within this range. For higher flows where the gauge height is exceeded there is a discrepancy between the curves. This difference is simply attributed to the low reliability of the gauge for high flows, since SEPA's curve is a simple extrapolation for water levels higher than 109 mAOD. Queich Bridge is located just downstream of the gauge station however, and a reason for this discrepancy is thought to be that water backed up behind this hydraulic control for higher flows is not accounted for in SEPA's extrapolated stage / discharge relationship.

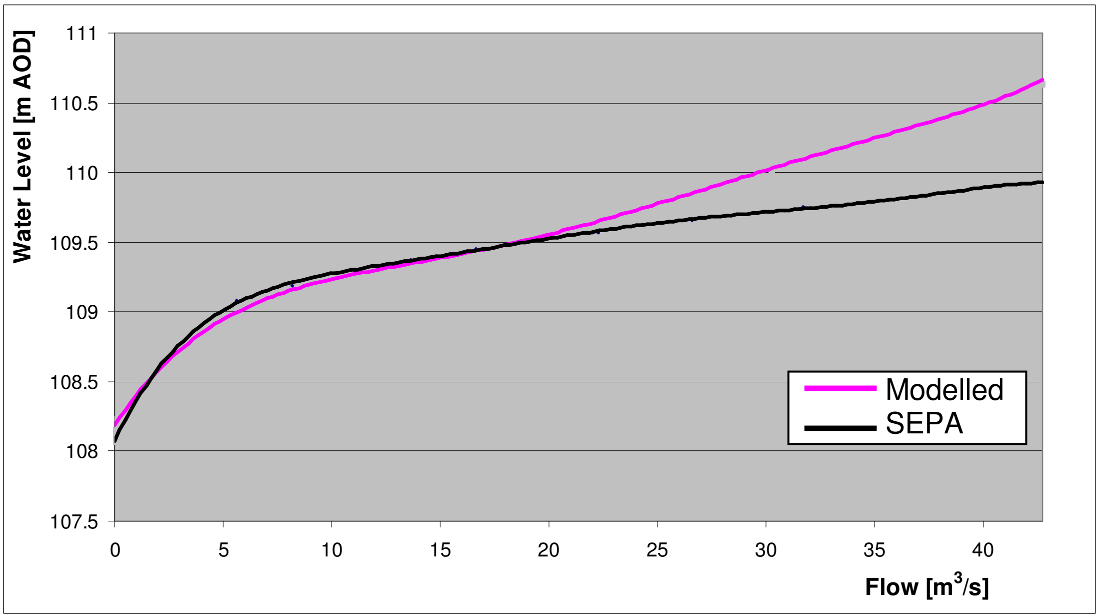

Figure 36 - South Queich Rating Curves

4.6.4 Model Sensitivity Analyses

The hydraulic models have been assessed in terms of parameter sensitivity (flow, roughness, downstream water level and structure blockage sensitivity). The model sensitivity analysis is presented below.

<u>Model Inflow Boundary Sensitivity Analysis</u>

The model inflow boundary condition was tested to determine the response / stability of the model for a large range of flows and identify parts of the model which are sensitive to flow variation. The model was run with all design flows contained in Table 8. The associated longitudinal profiles are shown in Figure 1, Figure 2 and Figure 3 in Appendix J. It can be seen that the model responds uniformly over all modelled reaches. This gives confidence in the stability of the model for a large range of return periods.

Model Roughness Sensitivity Analysis

The hydraulic model was tested by varying the roughness conditions (Manning's 'n') by +/- 20 % to assess model stability / sensitivity. The associated longitudinal profiles are shown in Figure 4, Figure 5 and Figure 6 contained in Appendix J. It can be seen that generally, the variation of Manning's 'n' roughness yields a sensible and constant / stable variation in water levels.

At the upstream side of the M90 culvert on the South Queich the water surface profiles are not particularly sensitive to variations in Manning's n roughness. This is considered to be mainly a consequence of the significant flows that are predicted to be spilling over-bank at this location (thus restricting the range of water levels in the channel).

Structure Blockage Sensitivity Analysis

As per SEPA recommendations, the sensitivity of water levels associated with scenarios where culverts/bridges are blocked was also assessed. This is important when considering how structures may cause or exacerbate flooding issues.

Queich Bridge and the Clash Burn culvert entrance near Smith Street were identified as the main structures where some blockage could have a significant impact on the existing flood levels in the town. The model was tested by blocking these two structures by a nominal 50%. It can be seen that blocking these structures doesn't significantly affect water levels in much of the model, apart from the immediate upstream vicinity of these blocked structures. Figure 7 and Figure 8 in Appendix J show the effect the blocked bridge/culvert have on the existing 200 year (+ 20% climate change) longitudinal water levels. Water levels immediately upstream of Queich Bridge are predicted to increase by approximately 275 mm. Although more over-bank spills are predicted upstream, the higher water levels are still below the bridge soffit level of 111.31 mAOD. The predicted water level increase upstream of the blocked Clash Burn culvert is approximately 175 mm.

4.7 Fluvial Flood Risk / Flood Mapping

From the MIKE Flood modelling exercise, water levels in the South Queich, Gelly Burn and the Clash Burn were calculated for a range of return periods. The 200 year and 200 year (+ 20% climate change allowance) flood outlines are shown in Figure 37 and Figure 38 below. Full flood outlines for all return periods are contained in Appendix K. Also contained in Appendix K are flood hazard maps indicating properties where water levels reach threshold levels or greater for 200 year and 200 year (+ climate change) scenarios.

The mechanisms of flooding are complex. Flood inundation animation videos of all modelled scenarios are available and show a more complete picture with regards to mechanisms of flooding.

4.7.1 South Queich / Gelly Burn Flood Risk

Flooding in Kinross is complex and includes overtopping of river banks and extensive unconfined overland flows. The existing culverts under the M90 motorway add to this complexity as they currently serve to throttle flows through the M90 resulting in large flows spilling from the South Queich and then flowing towards the Gelly Burn on the upstream side of the M90. The key points to note regarding flooding from the South Queich and Gelly Burn are:

- Water backs up behind the M90 motorway and flood waters from the South Queich spills across to the Gelly Burn.
- Downstream of the M90, the first areas to flood are the currently undeveloped lands immediately east of the M90.
- Eventually banks breach (left and right) in a number of locations and the floodwaters flow through urban areas of South Kinross
- Flows spilling from the South Queich pass overland to the Clash Burn

4.7.2 Clash Burn Flood Risk

Flooding from the Clash Burn is predicted around the area known as ‘The Myre’ and is largely as a result of backing up at the culvert entrance near Smith Street. Flood waters then pond in the low lying areas around Smith Street. Two critical storm durations were tested (0.5 hours and 12 hours). It was found that flooding was worse for the 12 hour storm duration due to the higher volumes for such a design storm, although peak flows are less.

Flooding to Smith Street is predicted for return periods of greater than 10 years. It is also known that Smith Street is periodically subject to flooding resulting from pluvial flows and possible manhole spilling emanating from the Myre Terrace / Montgomery Street direction. To fully understand these other known flooding issues, a fully integrated study (involving detailed and integrated appraisal of Scottish Water sewer network and complex urban pluvial flows) would be required. At present, no suitable model of the sewer network is available. It is important to note that the culverted Clash Burn has been simply modelled. The model does not include any siltation, blockages, connections, intrusions or manhole details. These details would only be included as part of any wider detailed integrated study which included the Scottish Water sewer network.

It is important to note that the area around ‘The Myre’ and Smith Street is also affected by overland flows emanating from the South Queich.

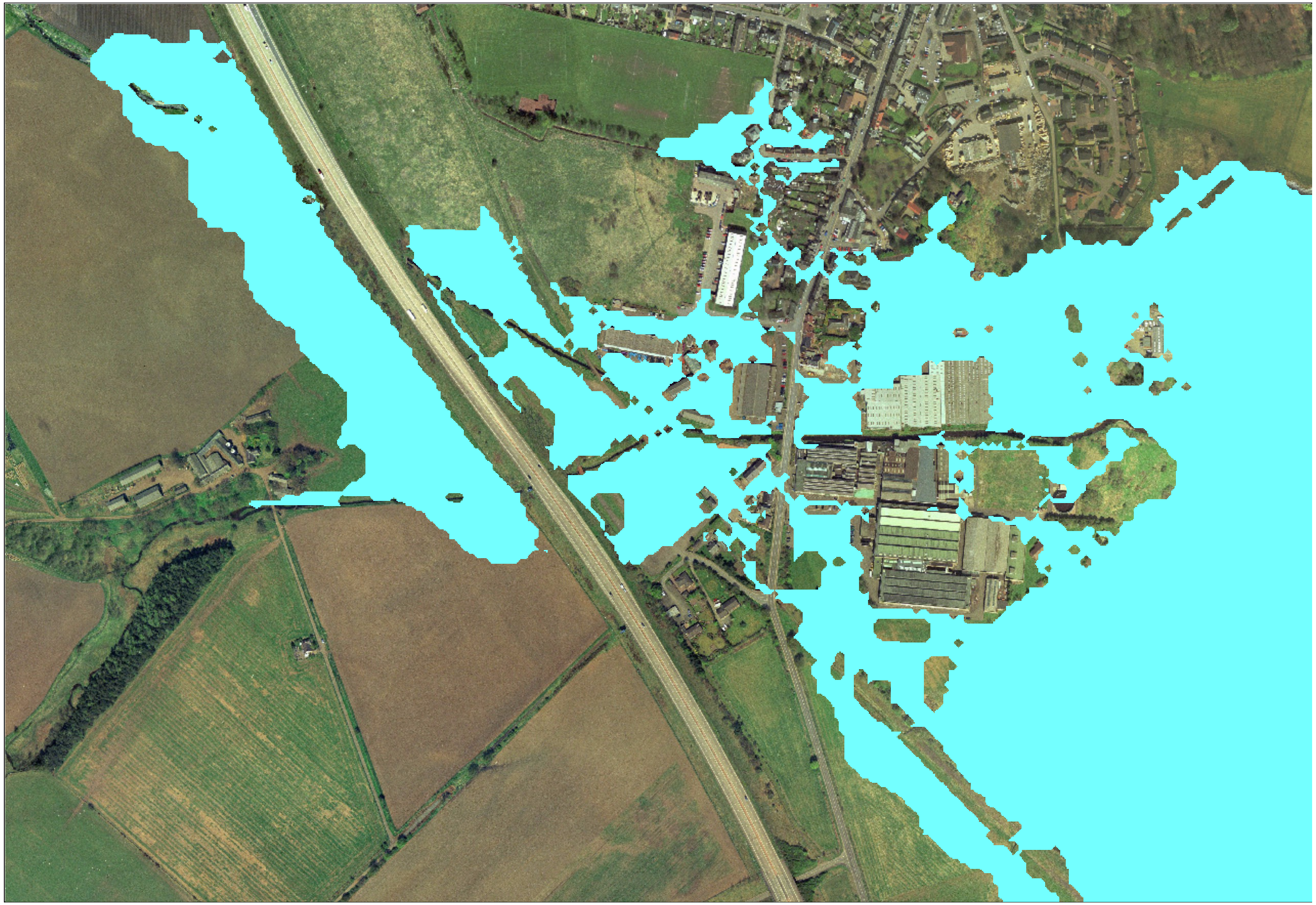

Figure 37 - Flood Outline (200 year)

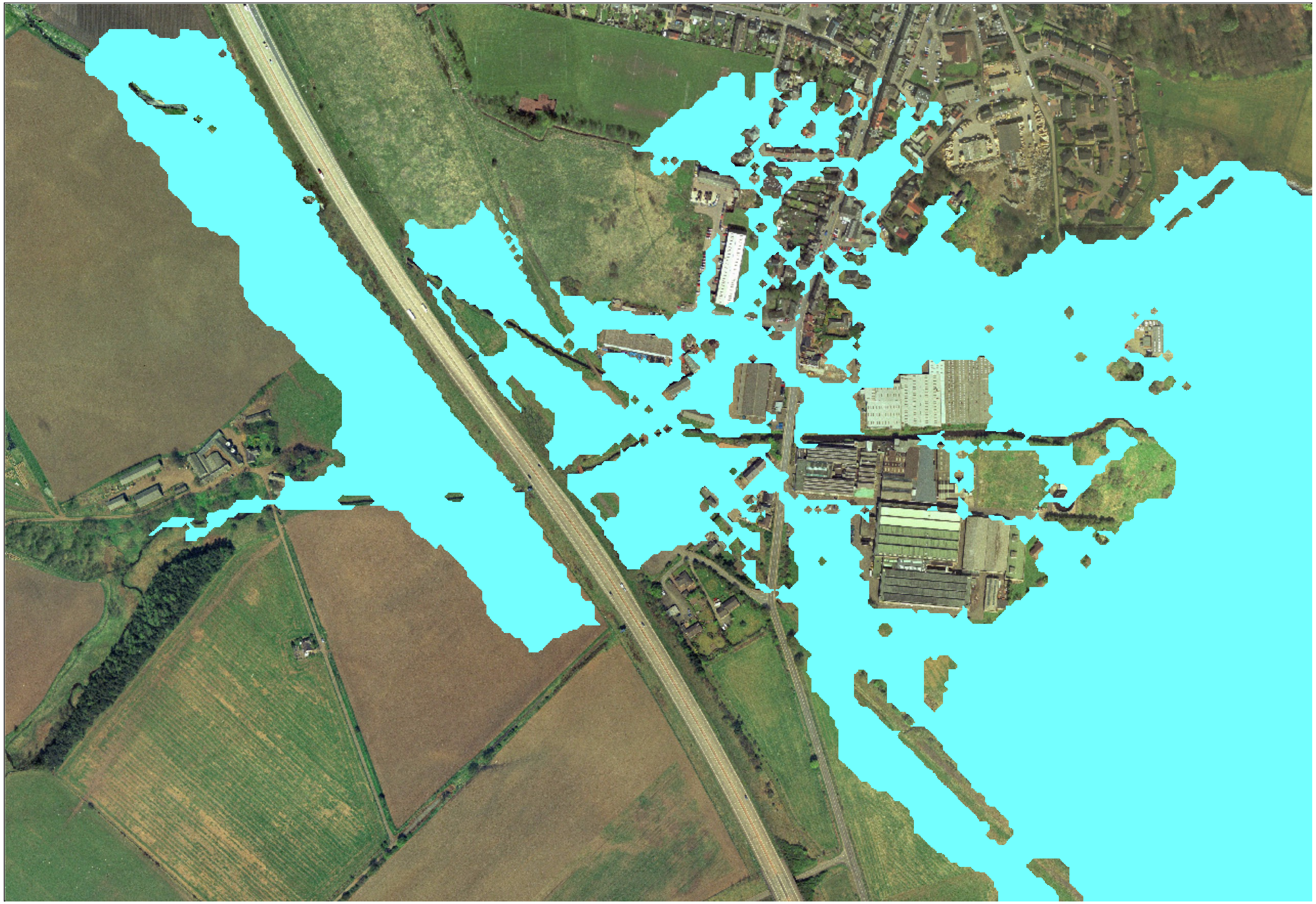

Figure 38 - Flood Outline (200 year + climate change)

Peak water levels for South Queich, Gelly Burn, and Clash Burn, for all return periods at the cross-section locations shown in Figure 34 above, are given in Appendix L.

4.8 Other Flood and Drainage Issues to Consider

4.8.1 Flow Velocities / Depths

From the modelling it is possible to extract flow depths and velocities for overland flows. An extract of the velocity / depth information is shown below in Figure 39 and Figure 40 respectively. These figures illustrate where the predicted flow paths result in greatest velocities and depths and is important information when considering safety issues, particularly access and egress, during times of flood. This information is available in digital format as required.

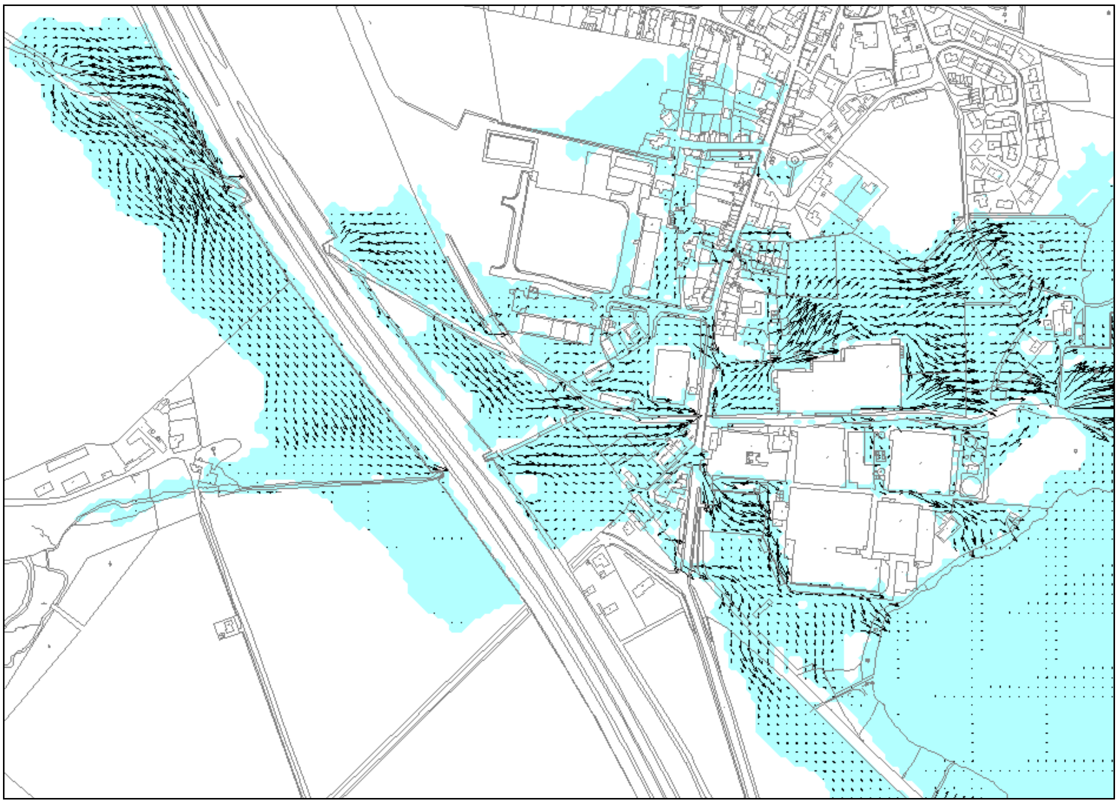

Figure 39 - Flow Velocity Vector Map

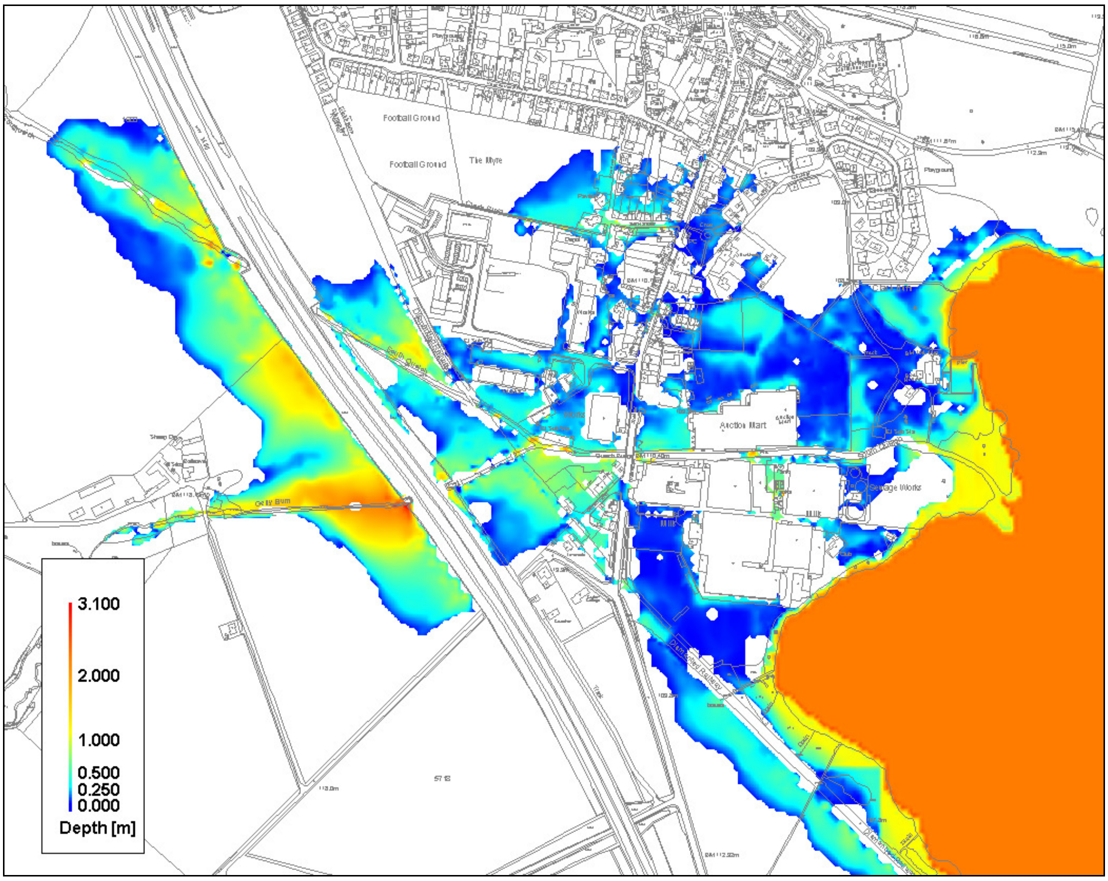

Figure 40 - Flow Depth Map

5 FLOOD ALLEVIATION OPTION APPRAISAL

5.1 Principal Flood Risk Issues to Address

Flooding in Kinross is complex and includes overtopping of river banks and extensive overland flows. The existing culverts under the M90 motorway currently serve to throttle flows through the M90 resulting in large flows spilling from the South Queich and flowing towards the Gelly Burn.

Added to this flow complexity is the scale of the design flows to be accommodated by any flood alleviation scheme. The South Queich has an estimated 200 year (+ climate change) design flow upstream of the M90 of around 48.9 m^3/s. The Gelly Burn has an estimated 200 year (+ climate change) design flow upstream of the M90 of around 10.1 m^3/s. From the modelling, the capacity of the system downstream of the M90 (without significant flooding) is around 15 m^3/s. This flow roughly equates to an annual return period (i.e. flows in excess of annual return period results in some flooding in South Kinross) Therefore, substantial 'excess' flows require to be accommodated by any flood relief option.

5.2 Outline Options Considered

Any options for flood alleviation for South Kinross need to address the key issues outlined above. A number of options have been considered. These options are broadly as follows:

- Flow controls through the M90 and managed flooding to upstream farmland.
- Traditional hard defences (floodwalls, channel widening, etc.)
- Flow diversion (overflow) of South Quiech and Gelly Burn routed directly to Loch Leven (bypassing the town)
- Off-line / on-line storage attenuation
- Catchment land management
- Partial diversion of Clash Burn to South Queich
- Combinations of above.

These feasibility assessments are preliminary in nature and mainly assess hydraulic feasibility. Many other factors such as ground conditions, landowner issues, services and other technical constraints would need to be considered at the detailed design stage. No measures to remove direct flooding from Loch Leven have been explored. Properties which flood due to high loch levels would continue to be flooded if any of the schemes outlined below were put in place.

5.3 Flow Controls

5.3.1 Hydraulic / Technical Feasibility

Restricting the capacity of the existing culverts under the M90 motorway and utilising the M90 motorway embankment was considered as a possible way of alleviating flooding to South Kinross. The flow throttles would result in increased flooding to upstream farmland (which could be potentially managed) and would be impounded by the height of the existing M90 embankment. The general option schematic is shown in Figure 41 below. A number of modelling scenarios including various aperture sizes were tested. No options were able to remove flooding downstream. It was possible to restrict flows to the required level (around 15 m^3/s) but flood levels built up behind the M90 motorway embankment to such an extent that that they then overtopped the motorway and resulted in extensive flooding as per the existing situation.

Figure 41 – M90 Flow Throttle Option

5.3.2 Option Status

In theory it is possible to restrict flows but there would need to be a substantial flood embankment constructed along the westerly edge of the M90 motorway to impound all flood waters. Such a structure would require design and regulation under the Reservoirs Act 1975. There could be potentially issues with reduced productivity of upstream farmland due to increased frequency of flooding. Existing culverts through the M90 would need to operate under surcharge conditions which could present safety issues during times of flood. Downstream velocities where flows emerge from the M90 culverts would be greater and the consequences of culvert blockage could be significant. Access and maintenance would be difficult during times of flood if culverts are surcharged.

Due to large doubts over the feasibility and cost of this option it has been discarded from further assessment on its own. However, there is potential for some level of flow control to be used when combined with other options such as flow diversion as explored later.

5.4 Flood Walls / Channel Widening

5.4.1 Hydraulic / Technical Feasibility

The option of putting in traditional hard defences by way of a flood wall was explored. Figure 42 shows the extent of the floodwalls required to contain flows as modelled. On the upstream end of the flood wall, distant flood embankments are envisaged. This allows these areas of floodplain to continue to function. On the left bank, the upper extent terminates at the location of the proposed link road. It is envisaged that the floodwall will be designed to tie into the embankment formed by this new link road. On the right bank, the upstream extent terminates at the foot of the embankment of the M90 motorway.

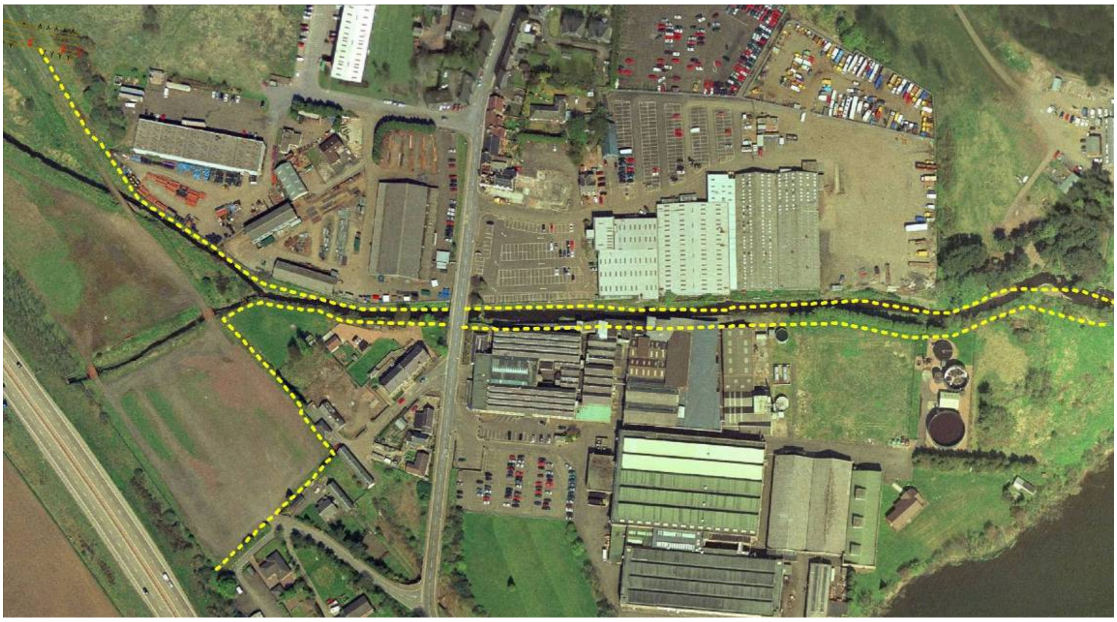

Figure 42 - Floodwall Option

The key points to note regarding the floodwall option are:

- Little scope for channel widening due to close proximity of buildings and existence of Queich Bridge hydraulic control.
- Walls would terminate near Loch Leven.
- Approximately 715m length required on left bank.
- Approximately 740m length required on right bank.
- No significant change to predicted water levels upstream of M90 after wall is installed.
- Maximum predicted water level increase just downstream of Queich / Gelly confluence is around 0.36m (200 + cc scenario).
- 0.2m predicted increase in water levels at Queich Bridge from 110.55m AOD to 110.75m AOD (200 + cc scenario). Bridge soffit level is 111.30m AOD.
- The average required wall height is around 0.8m above existing bank levels (200 + cc scenario). Freeboard will be additional.
- Construction difficulties envisaged with close proximity of existing buildings.
- Environmental disadvantages.
- Potential issues regarding connecting surface water drainage systems. Gravity fed longitudinal back drainage system will be required to deal with

existing pipe connections and surface runoff which currently discharge to the river

5.4.2 Option Status

This option is technically feasible and will be taken forward for full economic appraisal in Section 6 of this report.

5.5 Flow Diversions

5.5.1 Hydraulic / Technical Feasibility

A diversion channel was tested which would be designed to take excess flows from the Gelly Burn and bypass the town discharging directly to Loch Leven along the shortest practical route (see Figure 43 below). The diversion would start from the Gelly Burn via a lateral overflow weir. Flows would already spill under gravity from the South Queich to the Gelly Burn, negating the need for a formal channel running from the South Queich to the Gelly Burn. A number of weir height settings and channel dimensions were tested. Flooding still occurred in Kinross and was not able to be alleviated by the channel alone. It was evident that some form of flow control was also required on the M90 culverts to restrict flows passing through the M90 and to 'force' flows down the diversion channel. A number of flow control aperture sizes, channel dimensions and overflow weir heights were tested. A feasible solution was found which removed all significant flooding in South Kinross.

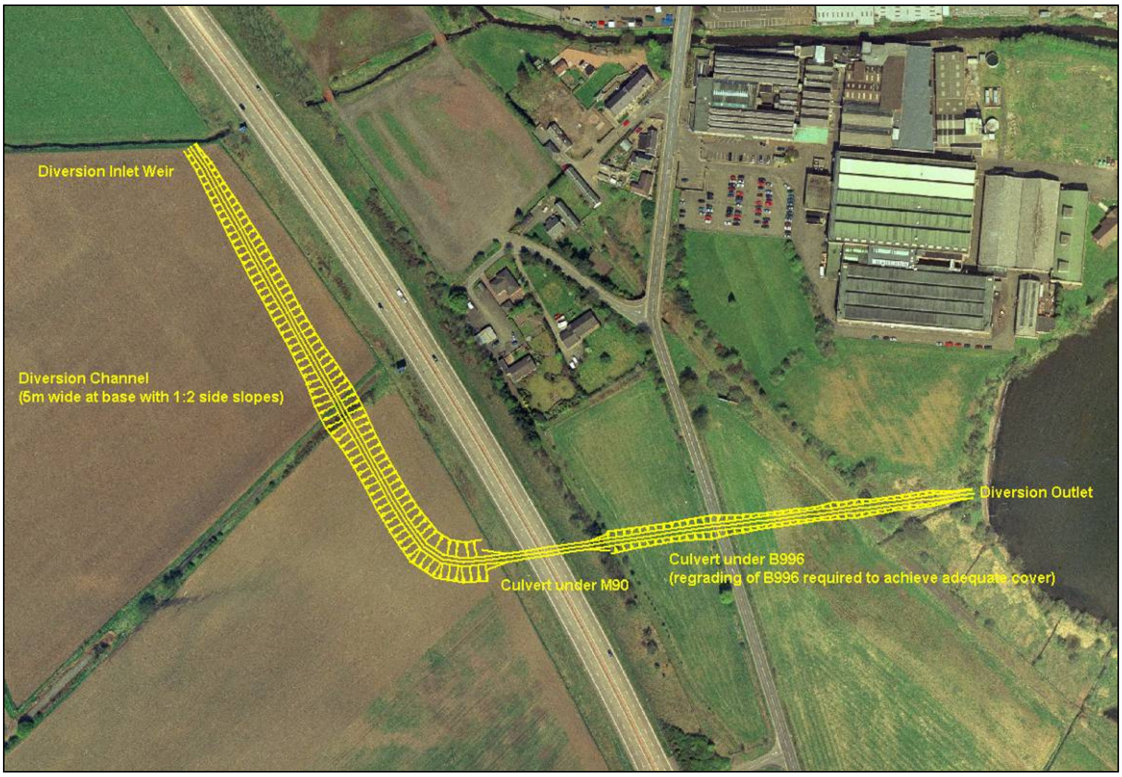

Figure 43 – Queich / Gelly Diversion Option

Some key points to note regarding this optimum diversion option are:

- Lateral weir crest level in Gelly Burn is just above base flow level.

- Diversion channel length ≈ 640m.
- Diversion channel gradient ≈ 1:230.
- Simple trapezoidal channel with 1:2 banks and 5m width.
- 60% culvert restrictions under M90 required.
- Would require culvert crossing of M90 motorway and some re-grading works on B996 to achieve adequate cover.
- Some minor increases in floodplain near loch edge.
- Some minor residual flooding remains to undeveloped areas east of M90 but nothing that significantly affects any properties.
- Minor changes in flood levels upstream of M90 avoiding possible issues with increased hydrostatic forces on the M90 motorway embankment. The maximum predicted increase is around 130 mm on the South Queich upstream of the M90 embankment and a decrease of around 750 mm on the Gelly Burn.

5.5.2 Option Status

This option is technically feasible and will be taken forward for full economic appraisal in Section 6 of this report.

5.6 Flood Storage

5.6.1 Hydraulic / Technical Feasibility

Options for flood storage fall into two general categories; on-line and off-line. On-line storage would effectively mean creating an impounding structure (dam) on the main line of the watercourse. Floodwaters are then stored on the upstream side and attenuated to the appropriate level through a sluice / weir arrangement. Off-line storage would comprise a floodable lagoon which would be connected to the main river via an overflow weir arrangement. The lagoon would store excess flows and then return the flows via a non return valve when peak flows subside.

Off-line Storage

Approximately 1.5 million cubic metres of flood water storage would be required to effectively remove the portion of the design flow hydrograph in excess of around 15 m^3/s. This is roughly the flow that can be accommodated by the South Queich through Sough Kinross without significant flooding. Figure 44 illustrates the potential scale of the lagoons required to store these excess flows. By inspection, the scale of works associated with creating these ponds would be significant.

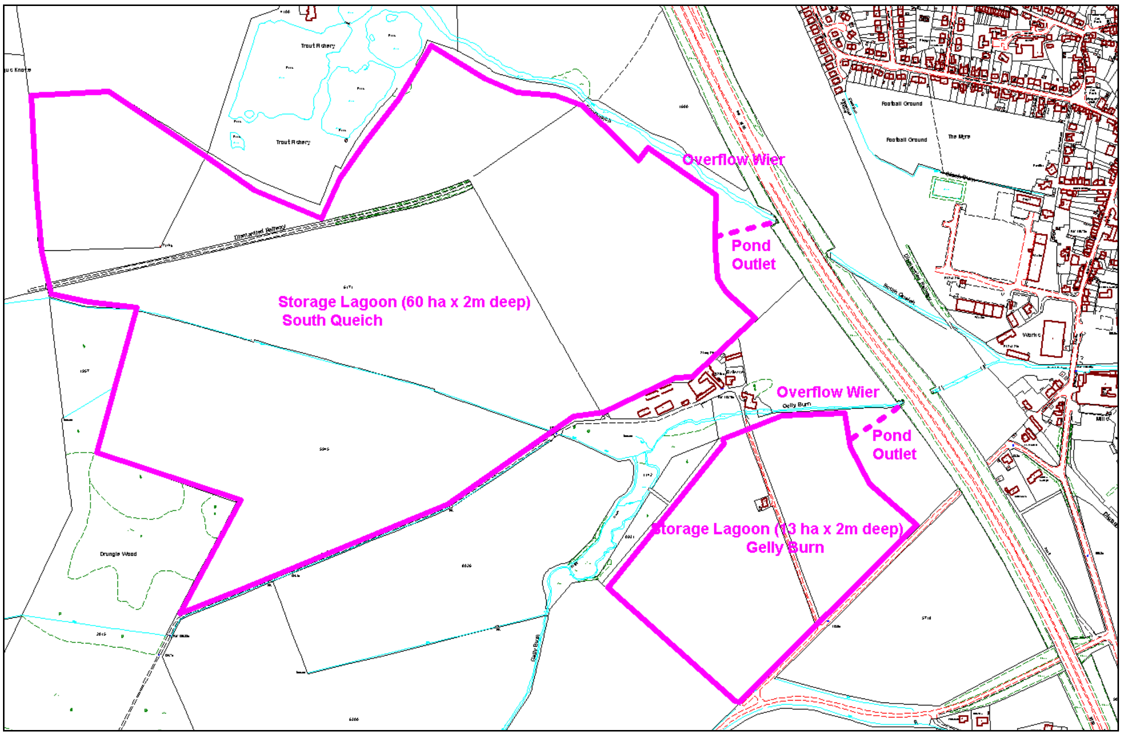

Figure 44 - Offline Storage Lagoon Option

On-line Storage

The A91 road forms a rough transition line between the steep upper reaches of the South Quiech and the lower flatter reaches. On the lower reaches south of the A91, on-line storage would be difficult to achieve due to the presence of existing floodplains. The effect of impounding on the lower reaches would be to increase existing flood levels and extents. From SEPA flood-mapping, a number of small farms and roads are already within floodplains. Without associated extensive flood protection works, a number of existing properties and roads would be put at an increased level of flood risk.

On the upper reaches of the South Quiech the steep topography and narrowness of the river valley would provide difficulties in providing the requisite storage. The further up the catchment the storage is situated, the less effective the storage would be as it would only intercept a small percentage of the catchment runoff. The placing of dam structures in the upper reaches was explored with dams tested at two locations (Easter Fossoway and Myrehill). The likely footprint of impounded water was roughly estimated that would be needed to attenuate flows to base flow levels. Damming at these locations would only provide a partial solution as these locations are nearer the head of catchment. Figure 45 illustrates the extent of floodplain areas on the lower reaches of the South Queich (from SEPA flood-mapping) and also an illustration of possible damming scenarios at Easter Fossoway and Myrehill.

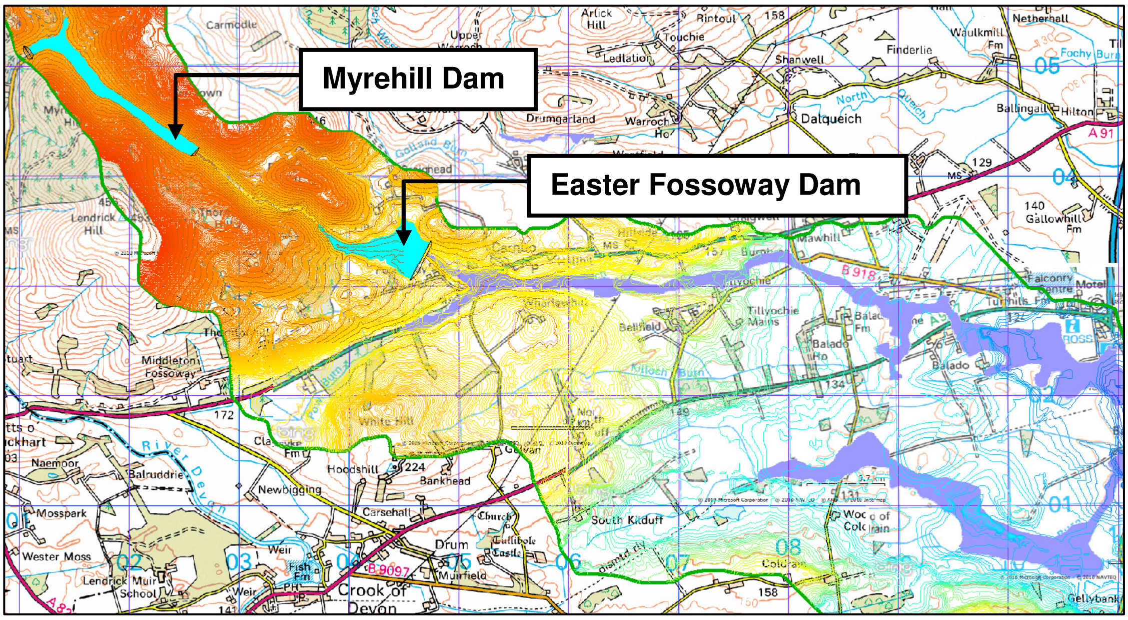

Figure 45 - On-line Impoundment Option

5.6.2 Option Status

Due to large doubts over the feasibility, effectiveness and cost (economic and environmental) of the storage options explored, they have been discarded from further assessment. The only realistic scope would be for partial attenuation on upper reaches with dams at Easter Fossoway and or Myrehill. In principle, upstream storage offers a potential and more sustainable partial solution and may warrant further detailed investigation in combination with other options. It should be noted that assessments have only been made based on the critical storm duration for South Kinross. Other storm durations would have different storage requirements and would require to be tested if storage options were explored in more detail.

5.7 Catchment Land Management

The scope for attenuating flows through some form of upstream land management activities would be limited. The level of flow attenuation required would, by simple inspection, not be achievable by a change in land management practices alone. This would also be a long term measure and there would be potential issues regarding the long term management of such options. The steepness of the upstream catchment would also be a key factor.

There is of course scope for reducing runoff by land management practices and these should be encouraged under the European Water Framework Directive. However, for Kinross it is not considered a practical option to be pursued in addressing the immediate and acute flood issues in South Kinross.

5.8 Clash Burn Options

5.8.1 Hydraulic / Technical Feasibility

Flooding on the Clash Burn and the low lying area east of 'The Myre' and around Smith Street is considered to be caused by flooding both directly from the Clash Burn but also from pluvial flows and possible manhole / gully spilling emanating from the general Myre Terrace / Montgomery Street direction. It is not considered possible to fully address these flooding issues without a more detailed and accurate understanding. This would require an integrated assessment including an appropriately detailed and calibrated Scottish Water sewer network model (including key road gulleys) and associated urban pluvial flow modelling.

The possibility of diverting the Clash Burn into the South Queich upstream of Smith Street was explored. This could potentially partly alleviate problems further downstream. See Figure 46 for route of partial Clash Burn diversion.

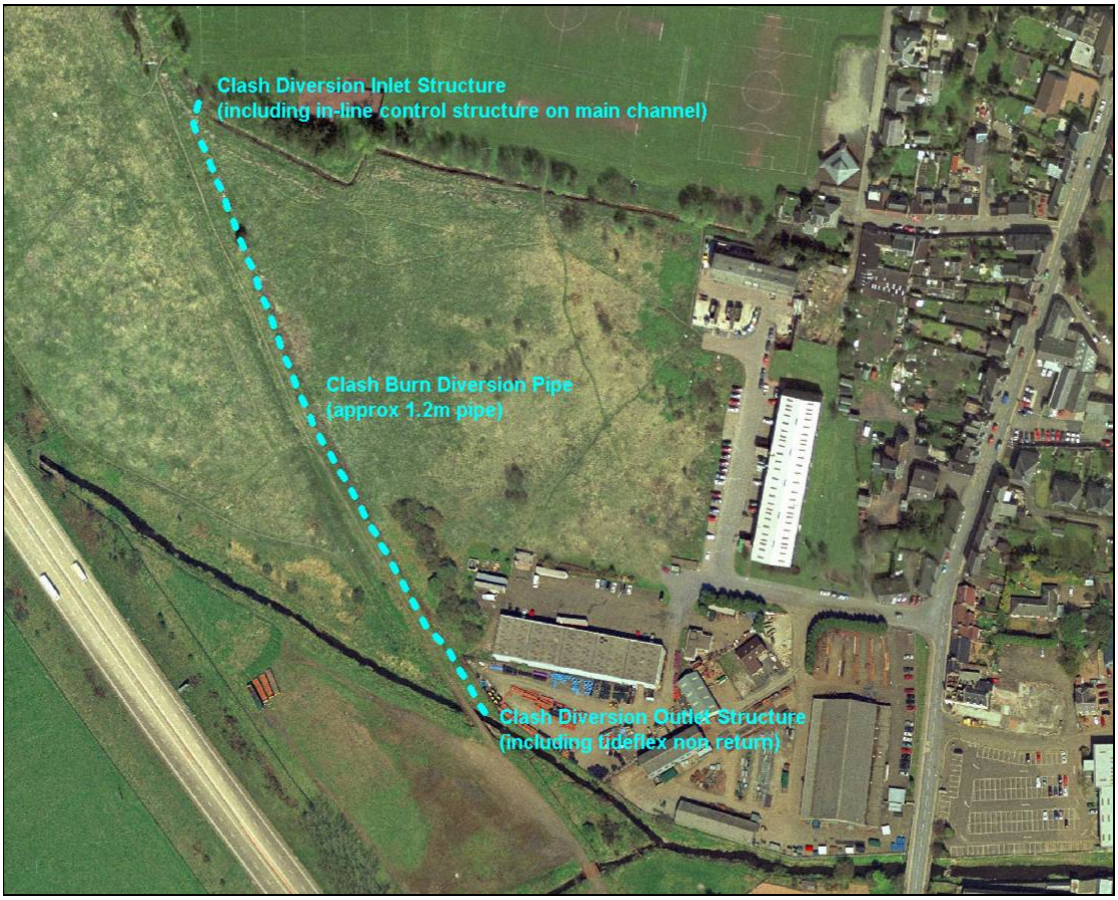

Figure 46 - Clash Burn Diversion Option

Some key points to note regarding this diversion option are:

- Hydraulically feasible and best route would be along line of former railway.
- Diversion ≈ 315m long.
- Less feasible to divert further downstream.
- Flow control structure required on Clash Burn (in-line weir) and non return valve on South Queich outlet (‘tideflex’ or similar).
- Care would be needed to prevent backflow from South Queich to Clash Burn.
- Option needs to consider the wider South Kinross FAS scheme implemented (Flood Walls on South Queich will elevate water levels at diversion outlet).

5.8.2 Option Status

Although this option is technically feasible, it would only provide a partial solution to problems around Smith Street. Likely costs are shown in Section 6 of this report.

5.9 Health & Safety Consideration for Preferred Option/s

A health and safety review of the preferred option/s has been undertaken to identify significant design issues and risks that will need to be addressed in any later stages if progresses. A Designer's Hazard Checklist and Hazard Elimination Management Schedule has been completed and is included in Appendix M. Some other key health and safety considerations that should be taken account of in any future scheme development are as follows:

- Consideration needs to be given to flood events in excess of the design event. Where the flood water may flow and how it will escape.
- Ensure no formation of 'islands' in flood storage areas.
- Ensure safe access and egress in times of flood.
- The impact on the urban drainage systems will need to be tested.
- Impact on services and if any diversions are required.
- Maintenance plans need to be carefully devised and implemented.
- Ensuring that all rights of way along the river bank have safe egress points in times of flood.
- Systems to ensure the flood storage areas can be safely evacuated prior to use in a flood event.
- Suitable warning measures in close proximity to the storage areas.
- Ensure scenario for blocked culverts is assessed. What would happen and is it safe?
- Are there any implications for increased velocities in the watercourses post scheme implementation?
- Will channels be dry most of time until flood wave comes (sudden flooding)?
- Will increased hydrostatic forces be placed upon existing M90 motorway embankment?

6 BENEFIT / COST ANALYSES

The economic performance of a flood prevention scheme is determined through its benefit/cost ratio. Benefits are measured in terms of the present value (PV) of damages avoided over the life of a scheme, with the present value of capital and maintenance costs being estimated over that period. To justify expenditure on any flood alleviation works, it is necessary to assess the economic viability of these options. For any option, benefit/cost appraisals generally consider the following:

- Do nothing

This is essentially the 'walk away and do nothing' option. Although this option is considered in the benefit cost analyses it is not an acceptable or realistic option for the Council.

- Do minimum

This is usually the provision of ongoing maintenance of the current situation (as per the Council's current statutory obligation).

- Do Something

This is the provision of flood alleviation works together with ongoing maintenance over the lifespan of the scheme.

For the purposes of these benefit/cost analyses the 'do minimum' option is generally considered to be the baseline for economic assessment. It is generally the net cost (i.e. the additional spend to 'do something') which needs to be considered in these benefit/cost analyses.

6.1 Economic Appraisal Guidance

The benefit / cost analyses have been carried out with reference to Chapter 5 of Flood Prevention Schemes: Guidance for Local Authorities - Economic Appraisal. This document (compiled by Scottish Government) provides guidance on the economic aspects of project appraisal for flood prevention schemes and is largely based on DEFRA guidance.

In order to evaluate the net benefits, the damage costs avoided with the preferred schemes in place are compared against those of the 'do nothing and/or do-minimum' options. The damages for flood events of a range of probabilities are calculated and an average annual damage value determined. Damage costs were calculated from 2005 flood loss tables, as detailed in the 'Multi-coloured Manual' prepared by the Flood Hazard Research Centre at Middlesex University. This assesses the damage to residential properties based on property type and age, social class of residents and depth and duration of inundation. Damages to non-residential properties are assessed based on property type (i.e. retail, office, public building etc), property size and depth and duration of inundation. Cleanup and emergency services costs (i.e. police, fire, ambulance, Council, military, etc) were also estimated from recommendations in the Multi-coloured Manual. Only direct damages have been included in the calculation of flood damage costs for Kinross. Indirect and intangible losses such as consumer/supplier losses, traffic disruption and effects on human health have not been taken into account for simplicity and to be conservative.

6.2 Present Values (PV)

The costs (including capital and maintenance) and damages incurred over the entire life of the scheme are discounted to present day values (PV). The appraisal period should reflect the physical life of the longest lived asset of a scheme. With the various scheme options involving earthworks, concrete and masonry structures, a 100 year timeframe is considered to be appropriate with capital replacement of the flood defence assets assumed after 50 years. The current test discount rates used (as specified by the Treasury Green Book) are 3.5% for years 0-30, 3% for years 31-75, and 2.5% thereafter.

6.3 Optimism Bias

There is a widely recognised tendency to be overly optimistic when estimating project costs, timescales and benefits compared with actual final outturn costs. This is known as 'optimism bias'. Under old guidance this bias was taken into account in a generalised way through a percentage premium embodied in the test discount rate. HM Treasury have since 'unbundled' this issue from the discount rate and now an explicit consideration of Optimism Bias is required. This bias is now applied as a percentage uplift of the estimated present value costs, this includes both capital and maintenance costs. For Kinross, an optimism bias of 60% has generally been applied to reflect the preliminary nature of scheme option development.

6.4 Benefits Methodology

The benefit of a scheme is measured in terms of the present value of the damages avoided over the life of that scheme. Using a range of flood events of different probabilities allows an annual average damage value to be determined for each scheme, which is then discounted to present day values. The damages are categorised into residential losses, non-residential losses, cleanup and emergency services costs.

To calculate the residential losses the type and age of each affected property and the social class of the occupants must be known, the depth of flood water in relation to ground floor level and the duration of the flooding must also be estimated.

The property type and doorstep elevation of each affected property was established from survey work. The social classes of the residents were determined from the April 2001 census data for South Kinross. As the social class variable derived from census data relates to areas as a whole, and not individual properties, the social class of each property has been calculated on the basis of averages. The percentage of the population of Kinross within each social class is shown in Table 9 and therefore the depth / damage data was weighted accordingly. The percentages used were based on the socio-economic classification data for South Kinross, provided on the Scotland's Census Results Online (SCROL) website (www.scrol.gov.uk).

Table 9 - Social Class Categories for Kinross

Social Class	Social Class Description	% of Population
AB	Upper Middle/Middle Class: higher/intermediate managerial, administrative or professional	20.85
C1	Lower Middle Class: supervisory or clerical and junior managerial, administrative or professional	25.10
C2	Skilled Working Class: skilled manual workers	13.97
DE	Working Class/Lowest Level of Subsistence: semi-skilled and un-skilled workers, state pensioners etc with no other earnings	40.08

The extent and depth of flooding associated with floods of a range of return periods was established from extensive hydraulic modelling. Modelled water level outputs were entered into GIS and compared to surveyed floor level data to estimate the flood depth at each property.

In order to derive depth damage relationships, a range of return periods had to be considered together with the calculation of damage associated with each event. Once the annual average damage value is derived it is possible to bring all future damage costs to a common timeframe. In this study, the return periods used to derive the depth / damage relationship were the annual, 5, 10, 25, 50, 100, 200, 500 and 1000 year events.

An allowance for climate change was accounted for through simply uplifting the flows on each of the watercourses to produce new climate change rating curves. A 10% climate change allowance was used for the period up to 2025 and a 20% allowance from 2025 onwards as per current guidance from SEPA, DEFRA and the United Kingdom Climates Impact Program (UKCIP). Revised return periods were determined by comparing the new climate change rating curves with the existing, which were in turn used to derive the depth / damage relationship.

The damages incurred are also dependant on the duration of inundation (i.e. whether properties are flooded for less than or greater than twelve hours). It was conservatively assumed that all affected properties would be flooded for less than twelve hours.

The Multi-coloured manual provides flood damage data for non-residential properties in terms of area of premises inundated, depth and duration of inundation and type of business. The depth of the flood water was estimated in the same way as for the residential properties. Information on business type was collected as part of the property survey and the area of each premises was calculated from 1:2500 O.S. plans. Where a single commercial property had more than one floor level, the depths, areas and damages were apportioned appropriately.

Research by FHRC has found that the emergency services costs for the Autumn 2000 floods expressed as a percentage of the total economic property losses, gives a percentage of 10.7%. The Multi-coloured Manual therefore recommends that the emergency costs are calculated as 10.7% of the property damage for floods of all annual probabilities and for all prevention schemes. The data sources used by FHRC for this estimation included District and County Councils, the fire, police and ambulance services, the military, water authorities and voluntary services. Cleanup costs are based on flood depth and are £9985 per property for depths greater than 0.1m and £5725 per property for depths less than 0.1m.

Economic appraisal guidance states that the total present value of long term economic flooding losses should not exceed the current capital value of the property. Where these damage values exceed estimated market value, a cap has been applied.

6.5 Summary of Benefit / Cost Methodology

In summary, the following parameter assumptions have been made in the course of the benefit/cost analyses:

- Damages based on all latest flood-mapping and modelling
- Climate change allowance included - 10% uplift up to 2025 and 20% uplift from 2025 onwards
- Prices and base year as of July 2010
- Optimism bias taken as 60%
- Test discount rate 3.5% for years 0-30, 3% for years 31-75, and 2.5% thereafter
- Indirect/intangible and traffic related losses ignored
- Flooding to land/gardens ignored
- 100 year scheme lifespan with capital replacement of flood defence assets assumed after 50 years.
- Residual damages included in analyses as appropriate
- Net costs used for B/C analysis as ‘do nothing’ is not an acceptable option
- 10.7 % of property damage value added to account for emergency services costs
- Cleanup costs based on flood depth and £9985 per property for depths > 0.1m and £5725 per property for depths < 0.1m.
- Damages capped at estimated property market values

Once the damages and cost figures have been evaluated, a set of excel worksheets (developed by DEFRA) were used to carry out the benefit/cost analysis. The benefit/cost worksheets calculate the present value (PV) damages and costs for the options. The damages can be categorised into damages due to a single major event, such as a wall breach, or repetitive damages, such as that due to overtopping. An evaluation of scheme viability can then be made based on the benefit/cost relationships of the various options.

6.6 Estimate of South Kinross Benefits

6.6.1 Kinross Flood Damages

Based on the hydraulic modelling outlined earlier in this report, the estimated flood damage costs for a range of return periods are summarised in Table 10 below (not including capping, emergency services costs or cleanup costs). This flood damage is associated with the South Queich, Gelly Burn and Clash Burn.

Table 10 - Estimated Flood Damages (Queich, Gelly and Clash)

Flood Event	Flood Losses
1000 year	£7,186,180
200 year	£4,590,347
100 year	£3,302,140
50 year	£2,657,001
25 year	£1,077,487
10 year	£0
5 year	£0
Annual	£0

As noted earlier, options for alleviating flooding around the Clash Burn would be limited until a better understanding of those flood issues are known (involving detailed and integrated appraisal of Scottish Water sewer network and complex urban pluvial flows). Consequently, if implementing measures that protect from the principal watercourses of the South Queich and Gelly Burn, then the damages associated with the Clash Burn need to be removed from the benefits as these damages (for now) will remain. The estimated flood damages associated with the Clash Burn alone are shown in Table 11 below.

Table 11 - Estimated Flood Damages (Clash only)

Flood Event	Flood Losses
1000 year	£774,452
200 year	£435,700
100 year	£332,634
50 year	£240,998
25 year	£55,170
10 year	£0
5 year	£0
Annual	£0

Flood damages associated directly with extreme water levels in Loch Leven have also been removed from the damages calculations. Protection of properties from direct flooding from Loch Leven has not been addressed as part of this study. The properties which are at direct flood risk due to Loch Levels only are shown below. No damages associated with these properties are included.

- Cafe (Pier Road)
- Workshop/s (Pier Road)

6.6.2 Capping

The PV damage associated with each property has been assessed to check that the accrued damage (over 100 year scheme lifespan) is not greater than the current market value. The largest PV damage values attributable to individual properties were assessed to see if any would likely be in excess of their current market value. These identified properties, together with accrued damages and suggested capping value are listed below in Table 12.

Table 12 – Flood Damage Capping

Property	Accrued Damages	Assumed Market Value (cap)
Scottish Auction Mart	£ 3,803,169	£ 1,000,000
Loch Leven Business Park	£ 3,521,052	£ 1,000,000

6.6.3 Residual Damages

Residual damages would likely be minimal as 200 year + climate change floodwall design heights will also include a 600mm (min) freeboard. However, a conservative residual damage has been simply taken as the damage value associated with flood events of 1000 year return period and greater for the existing culvert scenario.

Hence, a PV of approximately £0.9 million is the nominal residual damage value for flooding to account for the possibility of the design height (200 year + climate change) being exceeded within the 100 year design lifespan of the flood defences.

6.7 Estimate of South Kinross Flood Scheme Option Costs

6.7.1 Flood Wall Costing – Option A

The floodwall option as described in Section 5 has been provisionally costed. A breakdown of the total estimated costs of the flood walls along the left and right bank of the South Queich are presented in Table 13 and Table 14. The left and right bank flood walls are 715m and 740m long respectively and are provisionally assumed to comprise a steel sheet pile driven to approximately 3m below ground level, concrete surround and stone facing and coping to reduce visual impact. The flood walls also incorporate a nominal 300mm diameter porous drain behind the wall to deal with existing drainage connections (surface and piped).

Table 13 – Left Bank Flood Wall Cost Breakdown

Flood Wall - Left Bank	No.	Unit	Rate	Cost
General site clearance for wall	1000	m2	£5.00	**£5,000.00**
excavation	129	m3	£5.00	**£645.00**
disposal excavated material	129	m3	£25.00	**£3,225.00**
concrete wall	157	m3	£150.00	**£23,550.00**
concrete blinding	28	m3	£120.00	**£3,360.00**
piles driven area (approx 3m deep)	2145	m2	£30.00	**£64,350.00**
piles above ground area	715	m2	£110.00	**£78,650.00**
stone facing	234	m3	£480.00	**£112,320.00**
stone coping	715	m	£360.00	**£257,400.00**
300mmØ plastic structured wall perforated pipe	715	m	£50.00	**£35,750.00**
piling establishment				**£5,500.00**
			TOTAL	**£589,750.00**

Table 14 – Right Bank Flood Wall Cost Breakdown

Flood Wall - Right Bank	No.	Unit	Rate	Cost
General site clearance for wall	1000	m2	£5.00	**£5,000.00**
excavation	133	m3	£5.00	**£665.00**
disposal excavated material	133	m3	£25.00	**£3,325.00**
concrete wall	163	m3	£150.00	**£24,450.00**
concrete blinding	30	m3	£120.00	**£3,600.00**
piles driven area (approx 3m deep)	2220	m2	£30.00	**£66,600.00**
piles above ground area	740	m2	£110.00	**£81,400.00**
stone facing	296	m3	£480.00	**£142,080.00**
stone coping	740	m	£360.00	**£266,400.00**
300mmØ plastic structured wall perforated pipe	740	m	£50.00	**£37,000.00**
piling establishment				**£5,500.00**
			TOTAL	**£636,020.00**

The whole life of the flood prevention scheme is taken as 100 years and the useful design life of the flood walls is assumed to be 50 years, therefore the cost of capital replacement of the walls after 50 years has been included in the final PV Cost. In addition to the capital construction costs the following miscellaneous construction costs have been included:

- Preliminary Works (12%) = £ 147,092
- Utilities Diversion (15%) = £ 183,866
- Accommodation Works (12%) = £ 147,092

The project fees for consultancy and contracting services have also been included in the overall option costs. These include: project management, site data collection, detailed design, ground investigations and data collection, topographic and environmental surveys, contract preparation, tender, CDM, planning application, environmental report, land owner identification, consultation, site supervision and structural survey. Costs are included for client staff time and an allowance for compliance with the Controlled Activities Regulations (CAR) has also been included. The costs included are:

- Design and Consultation = £ 90,000
- GI and Environmental = £ 25,000
- Site Supervision = £ 45,000

The ongoing costs of routine maintenance to clear water courses of any debris and blockages, maintain banks, trim vegetation and maintain new flood defence walls to their current standard has also been included in the overall option costs. The operational and maintenance costs have been apportioned on an annual basis according to estimated requirements. The maintenance costs for the 100 year scheme lifespan are:

- 1 to 25 years = £ 4,800 per annum
- 26 to 49 years = £ 6,240 per annum
- 51 to 75 years = £ 4,800 per annum
- 76 to 100 years = £ 6,240 per annum

In addition, a 60% optimism bias will be factored into all the scheme costs as per standard procedure for a project at the feasibility stage.

6.7.2 Diversion Channel Costing – Option B

The diversion option as described in Section 5 has been provisionally costed. A breakdown of the total costs of the diversion channel from Gelly Burn, upstream of the M90, to Loch Leven and the associated culvert restrictions on the Gelly Burn and the South Queich are presented in Table 15 and Table 16.

The diversion channel will be excavated along the approximate line shown in Figure 43 and lined with geo-textile for slope stability and erosion protection purposes. Box culverts will be constructed under the M90 and B996 roads, which will require the existing carriageways to be cut back and reinstated afterwards. The existing culverts under the M90 on the Gelly Burn and South Queich will be restricted through reducing the area of the openings at the culvert headwalls.

Table 15 – Gelly Burn Diversion Channel Cost Breakdown

Gelly Burn Diversion Channel	No.	Unit	Rate	Cost
Land purchase / compensation	1	ha	£65,000.00	**£65,000.00**
General site clearance	1100	m2	£5.00	**£5,500.00**
Excavation topsoil (300mm)	2457	m3	£2.50	**£6,142.50**
Stockpile topsoil for re-use	2457	m3	£2.00	**£4,914.00**
Channel excavation	17715	m3	£12.00	**£212,580.00**
Disposal excess channel material	17715	m3	£25.00	**£442,875.00**
Geotextile Lining in Channel	8190	m2	£3.00	**£24,570.00**
Forming and compaction of side slopes	5670	m2	£2.00	**£11,340.00**
Grass Seeding and Preparation embankments	5670	m2	£1.50	**£8,505.00**
Fencing - timber post and rail	1260	m	£20.00	**£25,200.00**
M90 Culvert				
General site clearance	9000	m2	£5.00	**£45,000.00**
Excavate unacceptable material	1000	m3	£20.00	**£20,000.00**
Disposal unacceptable material	1000	m3	£25.00	**£25,000.00**
Excavation embankment topsoil (300mm)	40	m3	£2.50	**£100.00**
Stockpile topsoil for re-use	40	m3	£2.00	**£80.00**
Excavate acceptable material	3200	m3	£10.00	**£32,000.00**
Stockpile acceptable material for backfilling	1120	m3	£2.00	**£2,240.00**
Disposal excess acceptable material	2080	m3	£25.00	**£52,000.00**
Temporary Piles (driven 5m max)	1680	m2	£100.00	**£168,000.00**
5m x 2m concrete box culvert	60	m	£2,500.00	**£150,000.00**
Wing walls and apron	105	m3	£220.00	**£23,100.00**
Formwork	200	m2	£65.00	**£13,000.00**
stone facing	40	m3	£480.00	**£19,200.00**
Structural Backfill	1804	m3	£45.00	**£81,180.00**
Backfilling and forming embankments with acceptable material	1120	m3	£3.00	**£3,360.00**
Top-soiling embankments	40	m3	£2.50	**£100.00**
Grass Seeding and Preparation embankments	150	m2	£2.00	**£300.00**

M90 Reinstatement				
Type 1 unbound sub-base 220mm thick	159	m3	£40.00	**£6,360.00**
AC 20 HDM bin 40/60 base 130 mm thick	720	m2	£20.00	**£14,400.00**
AC 20 HDM bin 40/60 binder course 55 mm thick	720	m2	£10.00	**£7,200.00**
HRA 35/14 F surf 40/60 surface course 45mm thick	720	m2	£12.00	**£8,640.00**
Safety barrier	120	m	£70.00	**£8,400.00**
Traffic Management			rate	**£150,000.00**
B996 Culvert				
General site clearance	1000	m2	£5.00	**£5,000.00**
Excavate unacceptable material	200	m3	£20.00	**£4,000.00**
Disposal unacceptable material	200	m3	£25.00	**£5,000.00**
Excavation embankment topsoil (300mm)	6	m3	£2.50	**£15.00**
Stockpile topsoil for re-use	6	m3	£2.00	**£12.00**
Excavate acceptable material	450	m3	£10.00	**£4,500.00**
Stockpile acceptable material for backfilling	90	m3	£2.00	**£180.00**
Disposal excess acceptable material	360	m3	£25.00	**£9,000.00**
5m x 2m concrete box culvert	18	m	£2,500.00	**£45,000.00**
Wing walls and apron	105	m3	£220.00	**£23,100.00**
Formwork	200	m2	£65.00	**£13,000.00**
stone facing	40	m3	£480.00	**£19,200.00**
Structural Backfill	166	m3	£45.00	**£7,470.00**
Backfilling and forming embankments with acceptable material	90	m3	£2.50	**£225.00**
Top-soiling embankments	6	m3	£2.50	**£15.00**
Grass Seeding and Preparation embankments	68	m2	£1.50	**£102.00**
B996 Reinstatement				
Capping	200	m3	£35.00	**£7,000.00**
Type 1 unbound sub-base 220mm thick	176	m3	£40.00	**£7,040.00**
AC 20 HDM bin 40/60 base 130 mm thick	800	m2	£20.00	**£16,000.00**
AC 20 HDM bin 40/60 binder course 55 mm thick	800	m2	£10.00	**£8,000.00**
HRA 35/14 F surf 40/60 surface course 45mm thick	800	m2	£12.00	**£9,600.00**
Safety barrier	40	m	£70.00	**£2,800.00**
Footway Reinstatement	200	m2	£28.00	**£5,600.00**
New field access	75	m2	£40.00	**£3,000.00**
Traffic Management			rate	**£50,000.00**
			TOTAL	**£1,881,145.50**

Table 16 – Gelly Burn and South Queich Culvert Restrictions Cost Breakdown

Throttle South Queich Culverts (2no.)	No.	Unit	Rate	Cost
General site clearance for wall	40	m2	£20.00	**£800.00**
excavation	10	m3	£20.00	**£200.00**
stockpile excavated material	10	m3	£12.00	**£120.00**
reinforced concrete	20	m3	£280.00	**£5,600.00**
Formwork	84	m2	£65.00	**£5,460.00**
stone facing	5	m3	£720.00	**£3,600.00**
Backfill with stockpiled material	10	m3	£15.00	**£150.00**
Fencing - timber post and rail	20	m	£22.00	**£440.00**
Cofferdam and temporary diversion			rate	**£3,500.00**
Throttle Gelly Burn Culvert (1no.)				
General site clearance for wall	20	m2	£20.00	**£400.00**
excavation	5	m3	£20.00	**£100.00**
stockpile excavated material	5	m3	£12.00	**£60.00**
reinforced concrete	10	m3	£280.00	**£2,800.00**
Formwork	42	m2	£65.00	**£2,730.00**
stone facing	2.5	m3	£720.00	**£1,800.00**
Backfill with stockpiled material	5	m3	£15.00	**£75.00**
Fencing - timber post and rail	10	m	£22.00	**£220.00**
Cofferdam and temporary diversion			rate	**£3,500.00**
			TOTAL	**£31,555.00**

The whole life of the flood prevention scheme is 100 years and the useful design life of the diversion channel and culvert restrictions is taken to be 50 years, therefore the cost of capital refurbishment of the diversion channel and culvert restrictions after 50 years has been included in the final PV Cost; this has been taken to be 25% of the original capital construction costs in Table 15 and Table 16.

In addition to the capital construction costs the following miscellaneous construction costs have been included:

- Preliminary Works (10%) = £ 191,270
- Utilities Diversion (10%) = £ 191,270
- Accommodation Works (10%) = £ 191,270

The project fees for consultancy and contracting services have also been included in the overall option costs. These include: project management, site data collection, detailed design, ground investigations and data collection, topographic and environmental surveys, contract preparation, tender, CDM, planning application, environmental report, land owner identification, consultation, site supervision and structural survey. Costs are also included for client staff time and an allowance for compliance with the Controlled Activities Regulations (CAR) has also been included. The costs included are:

- Design and Consultation = £ 155,000
- GI and Environmental = £ 76,500
- Site Supervision = £ 102,500

The ongoing costs of routine maintenance to clear water courses of any debris and blockages, maintain banks, trim vegetation and maintain new diversion channel, associated culvert structures and restrictions has also been included in the overall option costs. The operational and maintenance costs have been apportioned on an annual basis according to estimated requirements. The maintenance costs for the 100 year scheme lifespan are:

- 1 to 25 years = £ 4,800 per annum
- 26 to 49 years = £ 6,240 per annum
- 51 to 75 years = £ 4,800 per annum
- 76 to 100 years = £ 6,240 per annum

In addition, a 60% optimism bias will be factored into all the scheme costs as per standard procedure for a project at the feasibility stage.

6.7.3 Present Value (PV) Scheme Costs

The estimated scheme costs of the flood wall and diversion channel options have been brought to a present value (July 2010) as outlined in Table 17. The ongoing maintenance costs of the 'do minimum' option are also included in Table 17.

The capital costs include the miscellaneous costs and project fees presented in the scheme costings for Option A and Option B and include the cost of capital replacement / refurbishment of defences after 50 years. Operation and maintenance costs are for 100 year lifespan of the scheme.

Table 17 - Flood Wall PV Costs

Scenario	Description	Capital Costs (PV)	Future Maintenance Costs (PV)
Do nothing	Walk away and no maintenance	£ -	£ -
Do minimum	Annual maintenance of existing situation over next 100 years	£ -	£ 116,940
Do something A	Construction of flood wall and associated works and maintenance costs.	£ 2,252,474	£ 164,965
Do something B	Construction of diversion channel and associated works and maintenance costs.	£ 2,962,308	£ 164,965

6.8 South Kinross Option Economic Viability

Using standard DEFRA Benefit / Cost worksheets, the following PV costs (including 60% optimism bias) and PV damages (including emergency services, cleanup costs and capping) figures were derived:

- PV Damage = £ 2,971,213
  (damages associated with Clash Burn removed)
- PV Residual Damage = £ 900,642
  (damages associated with Clash Burn removed)
- PV Cost (do nothing) = £ 0

- PV Cost (do minimum) = £ 187,104
- PV Cost (do something A (Flood Wall)) = £ 3,867,901
- PV Cost (do something B (Diversion Channel)) = £ 5,003,637

Since the Council are not legally or politically able to adopt the 'do nothing' option, the possible option/s (do something) need to be expressed in terms of net costs. At the very least, a 'do minimum' option would need to be continued to be implemented. The following benefit/cost ratio has therefore been derived based on net costs.

- Do something A v Do minimum =
  (£ 2,971,213 – £ 900,642) / (£ 3,867,901 – £ 187,104) = 0.56
- Do something B v Do minimum =
  (£ 2,971,213 – £ 900,642) / (£ 5,003,637 – £ 187,104) = 0.43

Currently, both options of providing either a flood relief channel and culvert restrictions under the M90 or traditional flood wall defences have a benefit/cost ratio of less than unity and represent non-viable economic solutions.

Printouts of the excel DEFRA benefit / cost worksheets used for Kinross are contained in Appendix N.

6.9 Further Comment

Other items to consider before considering scheme options further:

- It is understood that both the Auction Mart and Loch Leven Business Park areas may be subject to re-development at some point in the future. Consequently, it may be required to remove, or significantly re-evaluate the damages associated with these properties. At present, the rough capping value for each of these sites is taken as £1M. Capping estimates significantly affect the damage values and consequently scheme viability.

- The diversion pipe proposed for Clash Burn has not been included in either Option A or Option B. The estimated PV costs of constructing the Clash Burn diversion are £ 492,533 (including 60% optimism bias).

- The socio-economic benefits of each option have not currently been incorporated in the assessment through including the intangible benefits associated with flood defence improvements; as outlined in section 4.5 of the MCM. Inclusion of these intangible benefits would increase benefit cost ratios.

- In order for a scheme to be promoted further, the proposed flood alleviation works in this location should not impact upon flooding elsewhere.

- Since the time of writing, an updated edition of the MCM has become available. This replaces the current 2005 version of the MCM and includes increased allowances for building fabric repair and inflation since 2005. Updating the appraisal accordingly will likely increase the cost of flood damage and as such the economic viability of both schemes.

- There is significant scope for refining scheme details, costs and associated optimism bias thus influencing scheme viability.

7 ENVIRONMENTAL FEASIBILITY AND CONSTRAINTS

The purpose of this environmental feasibility assessment is to:

- Examine existing baseline conditions within the South Kinross study area.
- Identify any environmental constraints associated with potential options to alleviate flooding.
- Provide recommendations for environmental aspects to be considered further should any of the option proposals be progressed in more detail.

Possible flood relief options are considered earlier in Section 5 of the report. In summary, these outline options are as follows:

- Traditional hard defences (floodwalls, channel widening, etc.)
- Flow diversions (overflow) of Quiech and Gelly heading south then cross the M90 to discharge directly to Leven
- Off-line / On-line storage attenuation
- Flow controls through the M90 and more flooding to upstream farmland
- Catchment land management
- Combinations of above

7.1 Baseline Environmental Information

7.1.1 Methodology

The baseline information and environmental constraints identified within this report have been collated from an initial desk study only.

The desk study was undertaken to gather information regarding the area in which the possible flood relief options are located. A range of information sources were utilised and data reviewed, including OS maps and mapping websites, the Perth & Kinross Council Development Plan, Pastmap website, MAGIC website, SNH and JNCC websites.

Sources of information and desk study findings, together with field survey work that has or is currently being undertaken with respect to the preparation of the Environmental Statement for the Kinross Western Edge Distributor Road has also been reviewed and used to advise the feasibility study where appropriate.

It is recommended that if any of the options are to be developed in detail, a further site walkover and consultation with appropriate bodies, including relevant departments of Perth & Kinross Council, Scottish Environment Protection Agency, Scottish Natural Heritage, the Royal Society for the Protection of Birds and Historic Scotland, should be undertaken to verify the information collated from the desk study and to obtain any other information that would inform further stages of the studies.

7.1.2 General Context

Other than the possible storage option in the upper catchment of the South Queich, the outline flood relief options are located in and around the area of South Kinross which is divided by the M90 motorway. The residential edge of Kinross lies to the northeast and the Clashburn Industrial Estate to the east. Heatheryford fish farm is located to the west of the M90 and west of one of the possible off-line flood storage areas.

In addition to urbanised areas of South Kinross town, the study area comprises a combination of rough grassland and scattered shrub, occasional trees/tree groups, improved/semi-improved grassland and arable land.

7.1.3 Planning Policy

In the UK, development is guided and regulated through national, regional and local planning policy.

The National Planning Framework for Scotland sets out a vision of Scotland, guiding Scotland's development to 2030 and setting out strategic development priorities to support the Scottish Government's central purpose - promoting sustainable economic growth. Planning authorities are required to take the Framework into account when preparing development plans and it is a material consideration in the determination of planning applications.

The Planning Framework complements the statements of national planning policy set out in the Scottish Planning Policy (SPP). Planning Advice Notes (PANs) and circulars also provide guidance on planning issues.

Development Plans (Structure and Local Plans) form the basis on which decisions about development and future land use are made, and effectively incorporate national, regional and strategic policies within the local framework.

At a more local level, possible flood relief options fall within the jurisdiction of Perth & Kinross Council. The Perth & Kinross Council Structure Plan (approved 2003) sets out the proposed development strategy and supporting policies for the period up to 2020. The Kinross Area Local Plan (adopted July 2004) sets out more detailed guidance for new development in the region. The Plan provides all relevant policies and proposals that should be considered for any development proposal and this includes general policies to protect sites / species of specific nature conservation value (such as the Loch Leven National Nature Reserve and Special Protection Area), archaeology and trees.

The area to the east of the M90 where potential flood storage and direct defences on the South Queich are proposed is zoned within the Kinross Area Local Plan for employment generating developments, with reference to the use of the western edge of Kinross as business / industrial land. This includes options for the creation of a Town Centre Relief Road within the western edge which would also act as a local distributor / link road connecting the proposed housing and business uses of the area with the town. Policies 78 and 79 detail these proposals. The Local Plan also goes on to designate the western edge for tree planting and environmental improvements along with the provision of a multi-use path also. A Development Brief was prepared for the Kinross Western Edge in June 2005 setting out a land use and development framework for urban extension to Kinross as a basis for preparation of more detailed proposals.

The engineering detail for a Town Centre Relief Road is currently being developed further, under the title of the Kinross Western Edge Distributor Road, and an Environmental Impact Assessment is being undertaken.

7.1.4 Ecology and Nature Conservation

There are no statutory designated nature conservation sites within the footprint of the possible flood relief options in the vicinity of South Kinross. The closest designated site is the Loch Leven Special Protection Area (SPA; European designation) / Ramsar (Wetland of international importance; international designation) / Site of Special Scientific Interest (SSSI; national designation) and National Nature Reserve (NNR; national designation). Loch Leven is also designated as an Important Bird Area (IBA; non-statutory national designation). Loch Leven is the largest naturally nutrient rich eutrophic loch in Britain (covering approximately 13.3 km^2) that supports local, national and internationally important ecological communities.

Loch Leven SPA was designated in 2000 (JNCC, 2006) and covers an area of approximately 1612 hectares (ha). The site is designated for its populations of Annex 1 birds and other regularly occurring winter migratory species that are not listed within Annex 1. The general site character of the SPA is dominated by an inland water body (Loch Leven) with smaller areas of bog, marsh, fen and waterfringed vegetation; improved grassland; and mixed woodland. The site qualifies under Article 4.1 of the EC Birds Directive (79/409/EEC) as it supports 2% of the GB population of wintering whooper swan Cygnus Cygnus. It also qualifies under Article 4.2 as it supports 1% of the north western / central Europe wintering population of northern shoveler Anas clypeata and 8% of the Eastern Greenland / Iceland / UK wintering population of pink-footed goose Anser brachyrhynchus. The site also qualifies under Article 4.2 for its internationally important assemblage of waterfowl including northern shoveler, pink-footed goose and whooper swan.

The Loch Leven Ramsar site was designated in 1976 and covers the same boundary as the SPA. This site was designated due to meeting with Ramsar Criterion 1, 5 and 6 of the Ramsar Agreement. Under Ramsar criterion 1, the site supports nationally rare invertebrates including Macroplea appendiculata, Thanatophilus dispar and Saldula fucicola. For Ramsar criterion 5, the site supports wintering waterfowl assemblages of international importance and for criterion 6, several bird species occur at levels of international importance. These qualifying species are listed as great crested grebe Podiceps cristatus and northern shoveler (JNCC, 2008). Other species under consideration for future inclusion are the spring / autumn visitors, mute swan Cygnus olor and Eurasian teal Anas crecca and the winter visitor, pink-footed goose. The site is noted for the presence of nationally important floral species (Juncus filiformis and Hierochloe odorata) along with other noteworthy bird species.

The SSSI site designation form (SNH, undated) records the SSSI as covering an area of 1612 ha including parts of the NNR and Ramsar sites. This designation was given in 1985 for its ornithological value (as a goose roost for greylag goose Anser anser and pink-footed goose), botanical value (higher plants of national and local rarity) and entomological value (rare beetles and flies). The site operates in accordance with Site Management Plans and Statements.

Loch Leven NNR covers an area of approximately 1824 ha and was declared under Section 19 of the National Parks and Access to the Countryside Act 1949 in 1964. Under this designation, the site is formally managed to maximize public and recreational use while ensuring protection of its long history and nature conservation / cultural interests.

The South Queich discharges to Loch Leven after merging with the Killoch Burn and the Gelly Burn.

Habitats

The outline flood storage area on the upstream side of the M90 motorway comprises an area of rough grassland and scattered shrub. Improved grassland and arable land dominate the area with some linear hedgerows/tree groups also present. The flood walling option is located along the riparian corridor of the South Queich and Gelly Burn which generally comprises rough grassland and scrub. The diversion channel passes through areas of improved/semi-improved grassland, arable and unimproved grassland. The route may also cross some linear hedgerows/tree groups.

No records have been obtained to suggest that there are any European, nationally, regional or locally important floral species present within the study area.

Faunal Species

In terms of protected species present within the study area or surrounding area, records indicate the presence of two European protected species, as listed within the Conservation (Natural Habitats & c.) Regulations, 1994. The European otter is known to be present along both the South Queich and the Clash Burn watercourses, as well as along the shores of Loch Leven. This species is likely to be passing through the study area (as recorded within NBN Gateway as present to the west of the M90 on the Killoch Burn) and may also be breeding nearby, which can introduce legal implications associated with disturbance and / or damage offences. Pipistrelle bats Pipistrellus sp. (sub-species unidentified) are also recorded roosting within properties close to the site on the western edge of Kinross and this species may use the study area for foraging or commuting. Daubenton's Bat Myotis daubentonii have been recorded at Loch Leven.

Other protected species recorded nearby include badger Meles meles and water vole Arvicola terrestris. Although there are no known records of badger within the study area, there is one record of a RTA on the M90, at the B9097 / M90 underpass. Water vole have been recorded around Loch Leven. There are no records of red squirrel Sqiurus vulgaris within 10 km, although there are records of grey squirrel Sciurus carolinensis presence in the north of the study area (NBN gateway database using Scottish squirrel records).

Loch Leven supports numerous fish populations including protected species such as Atlantic salmon Salmo salar, brown / sea trout Salmon trutta and Arctic charr Salvelinus alpinus. Other species of value to biodiversity include European eel Anguilla anguilla, minnow Phoxinus phoxinus, perch Perca fluviatilis, pike Esox lucius, rainbow trout Oncorhynchus mykiss (non-indigenous), stone loach Barbatula barbatula and three-spined stickleback Gasterosteus aculeatus. Field surveys carried out as part of the environmental impact assessment for the proposed Kinross Western Edge Distributor Road confirm the presence of salmonid species on the South Queich and Clash Burn and the aquatic habitat present suggests these watercourses are used for spawning grounds / juvenile habitat.

In terms of ornithological interests, Loch Leven supports important populations of wintering birds. It is unlikely that any of these species are found foraging or roosting within the study area due to the habitats present, however smaller more common bird species such as sparrow, tit, finch and warbler along with riverine species may be present within the area, particularly during the breeding season. A winter bird survey carried out during January and March 2009 recorded a mixed flock of Pink-footed Geese Anser brachyrynchus and Greylag Geese Anser anser geese feeding to the west of the M90 motorway (i.e. within 20m of the motorway embankment) on a field to the north of the South Queich. However, during the survey period this field was ploughed, thereby removing geese feeding opportunities. Geese were also recorded feeding adjacent to the B996, just south of the edge of the Kinross.

The South Queich and Gelly Burn provide suitable habitat for a number of more aquatic bird species – with White-throated Dipper Cinclus cinclushas recorded during the 2009 winter bird survey. Common Kingfisher Alcedo atthis has also been recorded on the South Queich.

Other non-protected species such as invertebrates, fox Vulpes vulpes, rabbit Oryctolagus cuniculus, rat Rattus norvegicus and other small mammal species are likely to be present within the site. It is unlikely that the site supports any amphibian or reptile species due to a lack of suitable habitat.

7.1.5 Land Use

The possible flood storage area downstream of the M90 motorway comprises an area of rough grassland and scattered shrub used for informal recreation (mainly dog walking). Upstream of the M90 the area comprises land currently in agricultural use (improved grassland and arable). The possible flood walling option is located along the riparian corridor of the South Queich and Gelly Burn generally comprising rough grassland and scrub. The diversion channel option passes through agricultural land (improved/semi-improved grassland and arable) on the western side of the M90 and unimproved grassland to the east of the M90.

7.1.6 Landscape and Visual Amenity

The study area is not of a particularly high landscape value. The historical land use is described as 'fields and farming', 'built up' and 'transport' within the RCAHMS HLAMAP database. The Landscape Character Assessment commissioned by SNH (Land Use Consultants, 1999) shows Kinross to be within the 'Lowland Loch Basin' landscape character category. This landscape character focuses around Loch Leven with the settlements of Kinross and Milnathort to the west. The loch basin has formed where softer, Upper Old Red Sandstone deposits, enclosed by hard volcanic or carboniferous rocks, have been eroded away and it is rich in nature conservation value. Loch Leven, in the extreme south of Tayside, is enclosed by the Lomond and Cleish Hills to the east and south, and by the Ochils to the north. During the early part of the nineteenth century, Loch Leven was lowered by approximately 1.5 metres to provide greater farming opportunities and an improved water supply to the surrounding mills. The landscape around the loch comprises occasional woodland shelterbelts, agricultural land with boundaries dominated by stone walls and hedges.

One Area of Great Landscape Value (AGLV) is identified within the Kinross Area Local Plan and this covers Loch Leven and the Lomond / Benarty Hills. The western edge of Kinross is not included within the site boundary for this AGLV. There are no other statutory or non-statutory landscape designations covering the study area.

In terms of visual receptors, residential properties are located on the southern edge of Kinross, with scattered farmsteads also in proximity of the study area at Baleave and Heatheryford. The M90 motorway sits within some of the option areas, and other minor roads and tracks are present to the west of the M90. Informal paths run adjacent and through the outline flood storage area.

7.1.7 Cultural Heritage

There are no statutorily designated sites of cultural heritage within the footprint or within close proximity of the proposed flood relief options. The closest Scheduled Ancient Monuments (SAMs) are recorded as Brunthill settlement (an enclosed settlement of pre-historic date visible as a cropmark on aerial photographs) approximately 1km southeast of the Heatheryford Trout Fishery. Loch Leven Castle is also a SAM however this site is located within Loch Leven itself, on an island. Figure 47 shows the locations of these SAM sites.

A search of the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) PASTMAP database confirms the presence of Scottish Sites and Monuments Record (SSMR), sometimes referred to as Historic Environment Records, and National Monuments Records of Scotland (NMRS).

One SSMR comprises a findspot for a logboat at Bowton (Site 1 - shown on Figure 47 below), immediately east of the M90 southbound slip road. In or around 1862, a logboat was discovered during the construction of the Devon Valley railway across an area of north east sloping clayland at an altitude of about 125 metres OD. This was near to the former farmsteads of Bowton. The boat was taken to Kinross House but is now lost. The location of this findspot is recorded as NGR NO 112 022.

Two other NMRS records (Site 2 on Figure 47) are located just to the north of the logboat findsite. Only one report was obtainable from the PASTMAP database for these records at NO 112 023 where an evaluation was carried out in October 2005 in advance of proposed residential development works on the western outskirts of Kinross. No features of archaeological significance were encountered at the time.

A linear feature (visible cropmarks) (Site 3 on Figure 47), recorded as on the SSMR and NMRS, lies to the west of the M90 trunk road and immediately to the east of the farmstead known as Baleave at NGR NO 1129 0156. The farmstead itself is also noted on the NMRS (Site 4 on Figure 47).

Two other findspots are noted on the NMRS to the west of the M90 - two carved stones from a demolished house in the burgh at NGR NO 11 02 (now held in Kinross Museum) and a bronze pot at NGR NO 11 01. Due to the lack of precision regarding their location (within a 1km grid square) the location of these findsites in relation to the proposed flood relief measures cannot be confirmed.

Adjacent to the South Queich Burn, between Queich Bridge and Loch Leven, are a number of industrial buildings. Lochleven Mills (Site 5 on Figure 47) is recorded as wool-spinning mills dating from 1846 on the NMRS at NGR NO 11870 01563 on the south bank of the burn. A weaving factory (Site 6 on Figure 47) is also noted on the NMRS at NGR NO 1195 0163 opposite Lochleven Mills on the north bank of the burn.

At NGR NO 1215 0145 NMRS a post-medieval green-glazed pot was found 30m from the shoreline of Loch Leven in June 1993 during pipeline excavations (Site 7 on Figure 47).

The only other nearby cultural heritage records out with the town of Kinross are the Kinross / Loch Leven Station located at NGR NO 1175 0149 to the south of the South Queich between the M90 and the B996 (Site 8 on Figure 47).

The study area is located out-with the Kinross Conservation Area, which covers most of the town.

The historic land use assessment database, HLAMAP, records the land use within the areas outlined for possible flood storage and channel diversion as being dominated by 'fields and farming' whilst the proposed direct defences along the South Queich are within an area classed as 'built up' (industrial area adjacent to the South Queich between the M90 and Loch Leven).

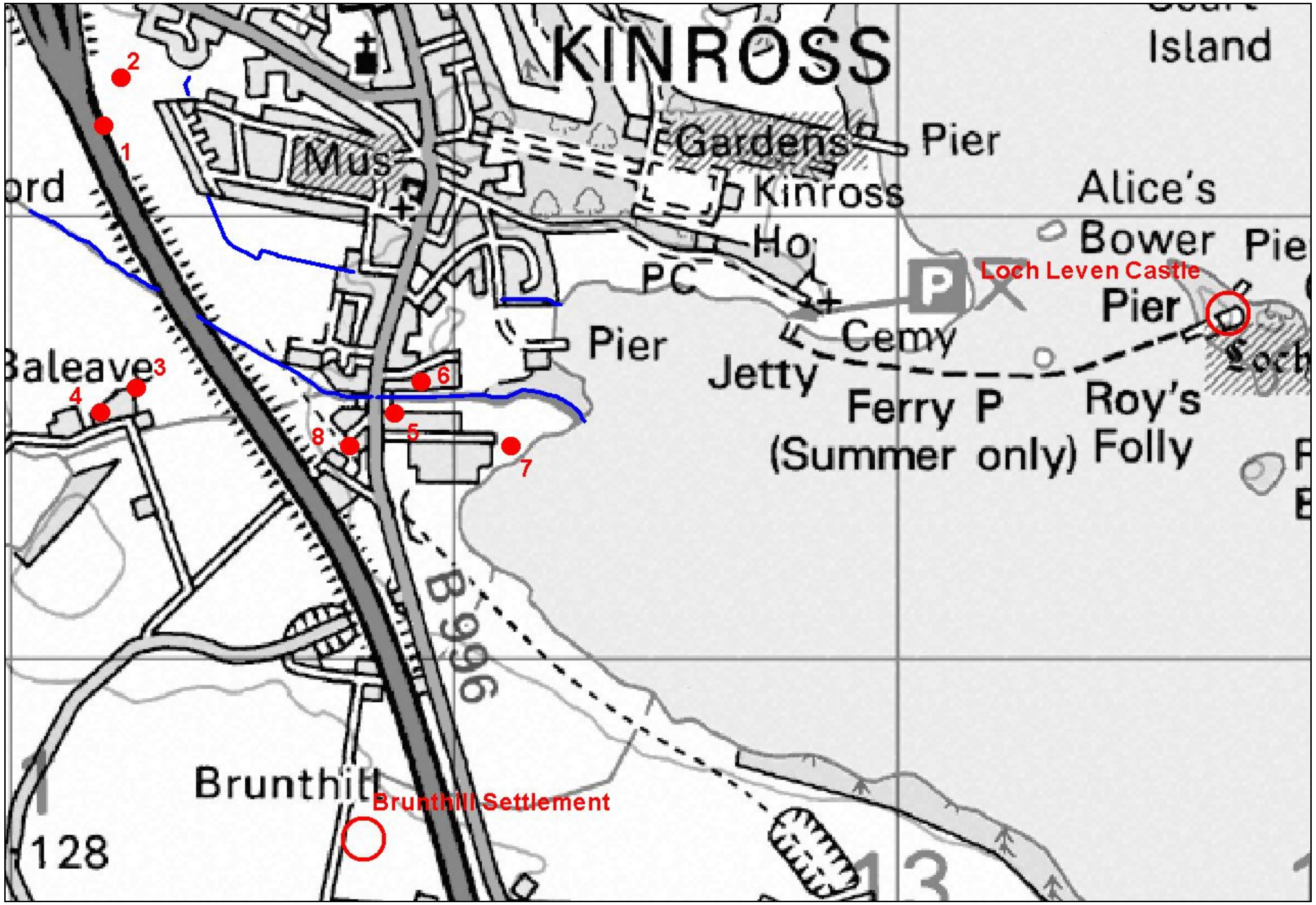

Figure 47 – Cultural Heritage Sites

7.1.8 Surface Water and Water Quality

The following surface water features are present within the vicinity of the proposed flood relief options:

- South Queich – passes beneath the M90 and Queich Bridge (which carries the B996 over the South Queich). The Killoch Burn merges with the South Queich at Heatheryford fish farm.
- Gelly Burn – merges with the South Queich just upstream of Queich Bridge.
- Clash Burn – located on the northern edge of the Clashburn Industrial Estate.
- Loch Leven – into which the South Queich discharges.

The South Queich has been classified by SEPA under the Water Framework Directive criteria as having an overall status of High. This watercourse is routinely monitored at Queich Bridge (NGR NO 1180 0157), where there is also a flow gauging station present. There is a recreational fishery (at Heatheryford) which comprises several ponds on the south side of the South Queich, sited about 700 m upstream of the M90.

Neither the Gelly Burn nor the Clash Burn is currently classified under the Water Framework Directive. However, under SEPA's previous water classification scheme the Clash Burn was a Class B watercourse ('fair' water quality), being routinely monitored by SEPA at Sandport (NGR NO1209 0177).

It is well documented that the water quality of Loch Leven is influenced by phosphorous inputs from the surrounding land, particularly land used for agricultural purposes. These increased discharges of phosphorous result in toxic blue-green algal blooms within the loch, which has an adverse effect on the ecology. Loch Leven is currently classified by SEPA as 'Poor' status; however, it is an important site for angling and is managed as a trout fishery.

The study area is not included within the Loch Leven Catchment Management Plan. However, within the Kinross Area Local Plan, the South Queich is noted as flooding in the vicinity of Kinross. It is therefore determined as a 'flood risk site'. The River and Coastal Flood Map for Scotland, held by SEPA, also suggests that there may be a risk of flooding for the study area.

The current flood study being undertaken by Mouchel indicates that during a 1:200 year flood event the area to the south of Kinross, including around Clashburn Industrial Estate and the residential area on the southern edge of the town would be affected by flood water from the South Queich and the Gelly Burn.

Groundwater aquifers are present below ground and SEPA classify these as of Vulnerability Class 4b (where vulnerability is highest at Class 5 and lowest at Class 1). Class 4 is defined as groundwaters 'vulnerable to those pollutants not readily adsorbed or transformed' with sub divisions of a to d indicating different permeability levels of overlying substrata. Under the recent WFD classification system, this is given a categorisation standard of '1a' (defined as 'definitely at risk'). There are also a total of four groundwater abstraction points (boreholes) to the south of the study area and Queich Bridge (at NGRs NO 1188 0145, NO 1185 0144, NO 1197 1038 and NO 1187 0138).

7.1.9 Geology and Soils

No geological Sites of Special Scientific Interest (SSSIs), Regionally Important Geological Sites (RIGS) or other designated sites of geological value have been identified in the area. No other features of special importance to geology have been identified.

7.2 Potential Impacts

7.2.1 Planning Policy

Flood storage options immediately upstream of the M90 motorway would preclude the expansion of South Kinross into this area. Tree planting and environmental improvements along with the provision of a multi-use path may, however, be compatible with flood storage.

Some trees would be affected by construction of flood relief options, however as no trees are protected by Tree Preservation Orders and assuming that loss/damage to trees is kept to a minimum and tree removal carried out in a sensitive manner in accordance with best practice, this is not considered to be a significant constraint in terms of planning policy.

The location of potential flood storage areas in the upper reaches of the catchment have been largely discounted technically however, any planning constraints would need to be identified for any specific site.

7.2.2 Ecology and Nature Conservation

Habitats

There will be some loss of existing habitat due to the physical footprint of flood relief options, but this generally comprises areas of arable/improved/semi-improved grassland and scrub of fairly low ecological value. For flood storage areas such habitat will also be temporarily inundated by flood water during a flood event. Some trees along the riparian corridor may by directly impacted upon but it is anticipated that this would be relatively small scale and could be carried out so that any loss would be minimised. The construction of flood walls along the South Queich may however result in greater loss of vegetation.

Channel widening provides a potential opportunity to provide habitat enhancement, for example through the creation of a ‘wet ledge’ type design and this should be further investigated where appropriate. The diversion channel option may also provide an opportunity for increasing biodiversity.

Indirect impacts include construction run-off entering into the South Queich and Gelly Burn and subsequently discharging into Loch Leven. This may potentially cause detrimental changes to water quality to an ecological system already under threat from increased phosphorous deposits and other pollutants. Due to the European designation of Loch Leven, the requirements of the Conservation (Natural Habitats & c.) Regulations 1994 (and Scottish amendments) will therefore need to be addressed.

Fauna

The otter is protected under Annex IV of the Habitats Directive as a European Protected Species and the places which they use for shelter/rest are offered European level protection under the Habitats Directive. Any activity, which would otherwise result in an offence under the legislation would require procurement of a European Protected Species licence from the Scottish Government.

Based on the results of field surveys carried out during 2009 and 2010 in relation to the Kinross Western Edge Distributor Road, no otter holts or couches will be directly affected by the proposed flood relief options. However, as signs of otter were recorded on the South Queich, it is considered that the area is used by this species. In addition, the fish populations contained in the South Queich provide a suitable food resource for otter. The Gelly Burn also has potential to support commuting otters. Engineering works in and adjacent to the South Queich therefore have the potential to disturb otter activity and possibly impede movement along the channel/banks. This may be of particularly concern where flood walls are proposed unless the walls can be set back on the banks of the burn allowing otter passage adjacent to the watercourse.

The Wildlife and Countryside Act (1981) and Nature Conservation (Scotland) Act (NCSA) (2004) provide protection to all wild birds, their nests and eggs and make it an offence to intentionally or recklessly take, damage or destroy the egg or nest of any wild bird while it is in use or being built.

Certain bird species receive special protection under Schedule 1 of the Wildlife and Countryside Act which prohibits intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building or is at (or near) a nest with eggs or young; or disturb the dependent young of such a bird, without a Schedule 1 licence from Scottish Natural Heritage. Kingfisher is a Schedule 1 species which has been recorded on the South Queich.

Any trees and areas of scrub affected by the constriction of flood relief measures have the potential to support breeding birds, and, without appropriate mitigation, this may lead to adverse impacts. Once completed, and with the assumed minimum loss of trees, it is anticipated that bird nesting opportunities will not be significantly impacted to the detriment of any bird species. However, potential disturbance to breeding birds during construction is a factor and will need to be considered further.

Bats are a European Protected Species and both the animals themselves and the places which they use for shelter/roosting are protected under Annex IV of the Habitats Directive. Some scrub habitat will be lost and a small number of trees potentially impacted by the footprint of the flood relief measures, and this may affect bat foraging opportunities. It is, however, anticipated that the existing general characteristics of the study area and bat commuting routes can essentially be maintained. The potential for any bat roosts to be directly affected by the proposed flood relief is considered to be low, however, this will require further evaluation should any of the options be progressed further.

Agricultural fields may provide foraging opportunities for badgers, with vegetated areas potentially providing suitable habitat for sett building.

7.2.3 Land Use

Flood storage areas would temporality take the land out of recreational use during a flood event when the area would be inundated, however, once the water subsides, it is assumed that the use of the area would not be compromised in the long term. Flood storage areas would also impact on agricultural land use, potentially influencing the viability of that land for grazing and cropping purposes.

Flood defence/channel widening would have little impact on existing land use.

The diversion channel would pass through some agricultural land but if designed as an open vegetated channel and constructed at the periphery along the existing field boundary, it is anticipated that effects on land use would be minimised.

Potential flood storage areas in the upper reaches of the catchment have been largely discounted technically therefore the potential impact on existing land has not been assessed.

7.2.4 Landscape and Visual Amenity

Considering the nature and characteristics of the flood relief options, no significant adverse impact on the existing landscape is anticipated. Neither are any nearby receptors likely to experience any overall adverse change in views or visual amenity.

Hard defences such as flood walls may have a negative impact on the amenity of the riparian corridor of the South Queich, however, this is already degraded in part and somewhat inaccessible through the industrial area. If the flood walls could be set back from the channel and sensitively designed/constructed visual amenity could be enhanced. Channel widening, where feasible, also provides the opportunity to improve the riparian zone of the South Queich between the M90 and Loch Leven, if a ‘wet ledge’ type structure can be created which increases the flood capacity of the channel whilst providing a suitable platform for planting.

It is anticipated that the channel diversion option would comprise an open vegetated overflow channel and, this being the case, no overall adverse impact on existing landscape value is predicted.

There will be a need to construct engineered inlet and outlet structures for any flood storage areas and overflow channel options, although, assuming that these will be designed and constructed suitable to their local setting, no significant adverse impact is predicted.

7.2.5 Cultural Heritage

No adverse impact on the known archaeological record for the flood relief options is envisaged. Neither will there be any affect on the setting or amenity of sites identified in the vicinity.

Floodwalls have the potential to impact on the industrial buildings adjacent to the South Queich Burn, between Queich Bridge and Loch Leven. Lochleven Mills on the south bank of the burn and the weaving factory on the opposite bank are recorded as having some historical interest and this should be considered further in relation to construction of any flood walls or embankments along the burn in this area.

Potential flood storage areas in the upper reaches of the catchment have been largely discounted technically therefore the potential for impact on any archaeological / historical remains has not been assessed.

There is a possibility of undiscovered archaeological remains being unearthed during site preparation, clearance and construction works for the flood relief measures, and this should be taken into account should any of the options be developed further.

7.2.6 Surface Water and Water Quality

The Water Framework Directive (WFD) (Directive 2000/60/EC) establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. The framework aims to:

- Prevent further deterioration and protect and enhance the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems.
- Enhance protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances, and the cessation of phasing-out discharges, emissions and losses of the priority hazardous substances.
- Ensure the progressive reduction of pollution of groundwater and prevents its further pollution.

Member States are required, under the WFD, to achieve “good ecological status” in inland surface waters, transitional waters and coastal waters. Ground waters must also be protected and restored to ensure the quality of dependent surface water and terrestrial ecosystems.

The WFD is formally transposed into Scottish law through the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR), as amended. Through these regulations the Scottish Environment Protection Agency (SEPA) are empowered to control activities likely to have an impact upon the water environment (i.e. pollution, abstraction, impoundment, and engineering). Any flood relief measures will therefore need to be considered in terms of licensing under CAR.

With any new development there is the potential for run off during construction (via direct physical disturbance to surface water features or indirectly through release of sediment and other pollutants) which can affect water quality. This may have a consequential impact on the assemblage of fish and other species within watercourses.

As the flood relief options are likely to involve some direct physical disturbance to the South Queich and Gelly Burn, there is a risk of detrimental impact (such as significant release of sediment and other pollutants during construction) which could affect water quality of the burns and potentially Loch Leven downstream. However, with due care and attention given to the construction phase and standard pollution control measures put in place, this risk can be substantially reduced so that significant impacts are avoided. However, due to discharge to the designated Loch Leven this would require further consideration under the Habitats Regulations.

It is anticipated that direct disturbance to the South Queich and Gelly Burn from the creation of flood storage options can be minimised with only localised disturbance around the inlet and outlet structure locations. Construction of flood defences set back from the channel on the banks would be preferable to flood walls within the channel itself in terms of reducing watercourse disturbance.

The proposed flood relief options will be designed to attenuate flows during a flood event with low flow conditions being maintained. However, any alteration to watercourses, whether through channel widening or construction of structures in the watercourse may alter the existing flow regime with potential consequential effects on sediment movement and habitat distribution.

7.2.7 Geology and Soils

It is anticipated that some degree of land re-contouring may be required for storage and diversion options and this may cause disturbance to soils and potentially any areas of shallow groundwater.

7.3 Recommendations

It is recommended that the following key aspects are considered further prior to any site clearance activities, whether in relation to ground investigations or in advance of the main works themselves, and before any construction on site. Other standard best practice measures to avoid or reduce any adverse impact on the environment should be adopted as appropriate.

7.3.1 Planning Policy

- Consultation with Perth & Kinross Council Planning department.
- Consider the compatibility of flood storage options with the desire for tree planting and environmental improvements and the provision of a multi-use path.
- Tree felling/trimming/lopping should be minimised to that essential for construction of any flood relief measures and for their effective operation.
- It is recommended that any trees that require felling should be first surveyed by an aboriculturist to assess their condition and value and their advice sought on the methods / extent of felling.

7.3.2 Ecology and Nature Conservation

- Consultation with Perth & Kinross Council biodiversity officer and SNH.
- The presence of the European designated Loch Leven downstream of the proposed options will require further consideration under the Habitats Regulations and the need for / extent of more detailed assessment of impacts associated with the works identified in consultation with relevant bodies.
- Ecological surveys will be required and likely to include Phase 1 Habitat Survey and protected species survey/habitat evaluation. Specific reference should be given to otter, badger, bats and birds.
- The need for and scope of any additional aquatic surveys (flora, benthic invertebrate fauna, and fish fauna) for the South Queich and Gelly Burn should be clarified with SEPA and SNH.
- Land take should be restricted to the footprint of the flood relief option and any areas temporarily affected during construction should be returned to current use or opportunities sought for enhancement and potential habitat creation.

- Any removed scrub and woodland areas should be replaced and enhanced by the new planting based on native species of local provenance.
- Clearance of any potential nesting bird habitat (woodland, scrub and hedgerows) should be undertaken out-with the main breeding season (April-July inclusive). If this is not possible, areas to be removed must first be checked for nesting birds by a suitably experienced ecologist/ornithologist. If active nests are present, the area must not be cleared until all the young birds have fledged.
- It is recommended that where possible site trees and hedgerows are retained. Should the removal of semi-mature/mature trees be required further evaluation should be carried out by a qualified and experienced bat ecologist to assess the potential for bat roosting.
- New structures within or adjacent to watercourses and flow restrictions should give due cognisance to the potential impact on species using the aquatic environment, such as fish and otter. Such structures should be designed to allow free passage of mammals and fish fauna.

7.3.3 Land Use

- The potential impact (temporary and permanent) on existing land uses, particularly agricultural uses will require further consideration and evaluation.

7.3.4 Landscape and Visual Amenity

- The visual amenity of any new structures/walls/embankments should be considered and sensitive design/construction principles used.
- Explore opportunities for landscape / biodiversity enhancements.

7.3.5 Cultural Heritage

- Floodwalls - assess potential for impact on Lochleven Mills and the weaving factory adjacent to the South Queich.
- All options - should any features or remains that may have archaeological potential be discovered during construction activities, then works should cease until Perth & Kinross Council archaeologists have been consulted for advice on how to proceed.

7.3.6 Surface Water

- Consultation with SEPA regarding licensing under CAR.
- Avoid or minimise works within the channel of watercourses wherever possible.
- Consider the implication in terms of changes in existing flow dynamics and sedimentation/erosion patterns.
- Consider channel widening as an opportunity to enhance the riparian corridor.
- Appropriate and standard best practice should be applied to control construction site run-off and to ensure that pollution of surface and groundwater does not arise.

7.3.7 Geology and Soils

- Where land re-contouring may be required - assess impact on agricultural soils and potential for disturbance to shallow groundwater.

8 FLOOD RISK PLANNING GUIDANCE AND REQUIREMENTS

Any future development in Kinross needs to consider existing policy and guidance regarding flood risk. Generally, new developments must not be subject to flood risk or exacerbate flood risk elsewhere.

8.1 Scottish Executive Planning Policy

The main requirements contained within the Scottish Government's policy on flood risk; Scottish Planning Policy (SPP) (2010) are:

For planning purposes, coastal and watercourse flood risk is characterised by an appropriate annual probability. These are currently defined in SPP as:

- Little or no risk area (less than 0.1% (1:1000)) – no general constraints.

- Low to medium risk area (0.1% to 0.5% (1:1000 – 1:200)) – suitable for most development but not essential civil infrastructure.

- Medium to high risk area (0.5% (1:200)) or greater – in built up areas with flood prevention measures most brownfield development should be acceptable except for essential civil infrastructure; undeveloped and sparsely populated areas are generally not suited for most development.

For planning purposes the functional floodplain will generally have a greater than 0.5% (1:200) probability of flooding in any given year. SPP states that built development should not take place on functional floodplain other than in specific, exceptional circumstances (subject to determination by the Planning Authority).

Essential civil infrastructure such as hospitals, fire stations, emergency depots, schools, care homes, etc, should not be located within 1000 year flood outlines. Moreover, essential civil infrastructure should remain operational and accessible during extreme flooding events.

8.2 SEPA

SEPA require all Flood Risk Assessments to adequately assess a proposed development site for risk of flooding to a 200yrs (+20% climate change allowance) flood probability and also address the potential for the development of the site to exacerbate flood risk elsewhere. All submitted flood risk assessments should be accompanied by SEPA's FRA checklist document to ensure a number of technical standards are met.

8.3 Climate Change

SEPA currently recommend that a climate change allowance of + 20% is made in addition to the 200 year appraisals and designs.

8.4 SUDS (Sustainable Urban Drainage Systems)

SUDS are generally recommended to be out-with functional floodplains. However, '…SUDS can be accommodated on functional floodplains only if they do not alter floodplain storage or functionality.' If the SUDS are bunded then they would affect the floodplain storage and would not be allowed (unless volumes are compensated). As an absolute minimum however, SUDS ponds should be situated beyond 30 year flood levels. The main reason is to avoid the SUDS feature from filling up and not being available for site runoff as intended.

9 CONCLUSIONS AND RECOMMENDATIONS

TBC after discussing report findings with client.

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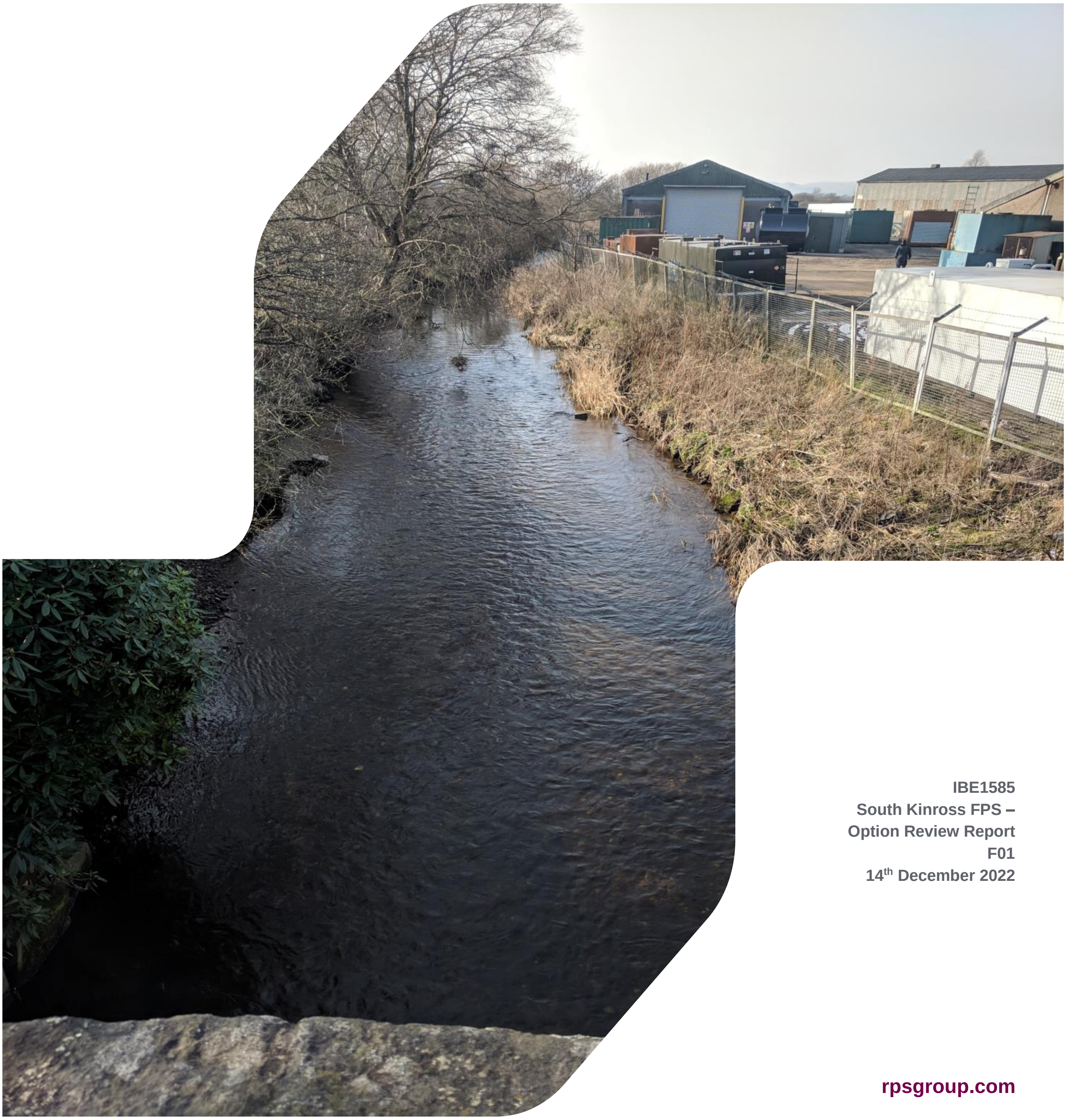
complete

Appendix B

Options Appraisal Report 2022

SOUTH KINROSS FPS

Option Review Report



IBE1585
South Kinross FPS –
Option Review Report
F01
14th December 2022

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D01	Draft	CMcG, JD	MW	AJ	02/11/2021
D02	Draft	CMcG, JD	MW	AJ	10/02/2022
DF01	Draft Final	CMcG, JD	MW	AJ	05/12/2022
F01	Draft Final	CMcG, JD	MW	AJ	14/12/2022

Approval for issue

Andrew Jackson	14 December 2022

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Abbreviations

1D	One Dimensional
2D	Two Dimensional
AAD	Annual Average Damage
AEP	Annual Exceedance Probability
ArcGIS	Arc Geographic Information System
BCR	Benefit Cost Ratio
BFIHOST	Base Flow Index derived using the HOST soil classification
BH Data	Borehole Data
Cap	Capping Value
CC	Climate Change
Df	Defended
Dp	Depth
DPSBAR	Index of Catchment Steepness
DTM	Digital Terrain Model
ELEV	Elevation
Emerg	Emergency
EvDam	Event Damage
FARL	Flood Attenuation due to Reservoirs and Lakes
FCERM_AG	Flood and Coastal Erosion Management Appraisal Guidance
FFL	Finished Floor Level
FPS	Flood Protection Study
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
GI	Ground Investigation
GL	Ground Level
GPS	Global Positioning System
HRA	Habitats Regulations Assessment
Int	Intangibles
LiDAR	Light Detection and Ranging
M2Dm	Damage per square metre
MCA	Multi-Criteria Analysis
MCM	Multi-Coloured Manual
mOD/mAOD	metres above Ordnance Datum
NFM	Natural Flood Management
NPV	Net Present Value
NRFA	National River Flow Archive
OS	Ordnance Survey
PDD	Principal Direct Damage
PDM Model	Probability Distributed Model

PLP	Property Level Protection
PLR	Property Level Resilience
PROPWET	Proportionate Wet
PV	Present Value
PVA	Potentially Vulnerable Area
PvD	Present Value Damage
QA	Quality Assurance
RBMP	River Basin Management Plan
RP	Return Period
SAAR	Standard Annual Average Rainfall
SAC	Special Area of Conservation
SEPA	Scottish Environmental Protection Agency
SI	Site Investigation
SoP	Standard of Protection
SPA	Special Protection Area
STREAM	(Sediment Balance Survey)
URBEXT2000	Fractional Urban Extent
Util	Utilities
WEF	Water Environment Fund
WL	Water Level

EXECUTIVE SUMMARY

Kinross is located within the River Leven catchment and was identified as part of the Potentially Vulnerable Area (PVA) (10/04) in the Forth Estuary Flood Risk Management (FRM) Strategy (December 2015), Forth Estuary Local FRM Plan & Forth Estuary Local FRM Plan (June 2016). Perth & Kinross Council (PKC) commissioned RPS to undertake the South Kinross Flood Protection Scheme in March 2019, to develop, promote and implement a flood protection scheme for South Kinross.

This Option Review report was carried out following the Scottish Government's Options appraisal for flood risk management: Guidance to support SEPA and the responsible authorities. This guidance uses three stages to appraise the flood risk management; Stage 1 – Defining the Purpose; Stage 2 – Develop, Describe, and Value; Stage 3 – Compare and Select the most Sustainable Solution.

For Stage 1 RPS reviewed the extent of the flood risk within the Kinross Study Area. Three flood cells were identified and assessed for risk. Flood Cell 1 identified and assessed the fluvial risk from the South Queich and Gelly Burn, as well as flood risk emanating from Loch Leven. Addressing flood risk from Loch Leven was not included within the scope of the FPS, however resilience measures were considered during the option review stage. The second flood cell assessed fluvial risk from the Clash Burn and the impacts from Loch Leven. The third flood cell assessed fluvial flood risk from the South Queich identified upstream of the M90, which was upstream of the initial study area defined at the outset of the project. In total 177 properties were identified to be at risk of flooding from fluvial sources in the 0.5% AEP event. A total of four properties were also identified to be at risk from water levels within Loch Leven.

For Stage 2 potential options were developed primarily by building upon the findings of the South Kinross Flood Study (Mouchel, Sept 2010), which identified a partial preferred option which addressed fluvial flood risk on the South Queich. The *do minimum* option was used as the baseline scenario. PKC identified a number of options for each flood cell to be investigated further in the updated hydraulic model, and additional options were formulated with the aim of addressing the observed flooding mechanisms and providing a minimum 0.5% AEP standard of protection. The options outside the preferred option to be reassessed were related to limitations within the flood study, input from the PKC flooding team and in response to issues / concerns raised by local residents and business owners.

These solutions were investigated further through the use of hydraulic modelling to determine their feasibility. Each option was appraised to determine the most suitable solution, which was brought forward to form part of the preferred option for the study area.

A separate Natural Flood Management (NFM) report was completed by RPS, which accompanies this Option Review report. This work was being developed into an NFM Study at the time of writing to improve confidence in effectiveness and viability of possible solutions which would be sustainable and environmentally beneficial while reducing flood risk.

For Stage 3 the options were compared by considering how well they met the objectives, which represented best value for money, which delivered multiple benefits or created adverse impacts, and which had uncertainties and risk associated with it. The options were compared with one another, and an overall preferred option identified for the study area. The appraisal considered the flood risk management benefits, the wider positive and adverse impacts, the adaptability to climate change and other future flood risk, whole life cost and uncertainties. The preferred option consists of direct defences, culvert upgrades, diversion culverts, storage and property level protection and resilience.

RPS were commissioned in April 2022 to recommend the standard of protection (SoP) for the South Kinross Flood Protection Scheme. A recommendation per Flood Cell was proposed by RPS, based on the outcomes of the Multi-Criteria Analysis and Benefit-Cost Ratios presented in an addendum report, which captured a broad range of technical, economic, social, and environmental criteria. The recommended SoP per flood cell, as agreed with PKC, were as follows:

Flood Cell 1: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

Flood Cell 2: 0.5% + Climate Change Fluvial AEP

Flood Cell 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

The Option Review Report includes recommendations of further work to be undertaken in order to refine the preferred option identified and then to facilitate scheme development through the outline and detailed design phases of the project.

1 INTRODUCTION

1.1 Background

Kinross is located within the River Leven catchment and was identified within Potentially Vulnerable Area (PVA) (10/04) in the Forth Estuary Flood Risk Management (FRM) Strategy (December 2015), Forth Estuary Local FRM Plan & Forth Estuary Local FRM Plan (June 2016). Perth & Kinross Council commissioned RPS to undertake the South Kinross Flood Protection Scheme in December 2018, to develop, promote and implement a flood protection scheme for South Kinross.

Kinross is situated along the west bank of Loch Leven in the south of the Perth and Kinross Council area. It is bounded to the west by the M90 motorway, which links Edinburgh with Perth.

Fluvial flooding presents the greatest risk of flooding to the PVA with the majority of damage relating to flooding from the South Queich and Gelly Burn watercourses. Surface water flooding is also a potential risk, in particular along the Clash Burn. Most of this watercourse is culverted and floods as a result of exceeding capacity and which results in surcharge from manholes. The South Kinross FPS focuses on fluvial risk emanating from the watercourses which have been highlighted in the South Kinross Hydraulics Report. Surface water risk is a known cause of flooding in Kinross however this study aims to primarily alleviate fluvial risk in the study area, whilst addressing any pluvial flood risk along the route brought about by the proposed defences, where surface water may pond behind a flood defence. A Surface Water Management Plan (SWMP) has been proposed in the next Flood Risk Management (FRM) cycle, which would aim to identify and manage surface water issues across Kinross. The Cycle 2 FRMPs were yet to be published and confirmed at the time of writing.

Both the South Queich and Clash Burn discharge into Loch Leven. The loch is also a source of flooding with a small number of properties directly at risk from the increasing water levels within the loch during high magnitude flood events. Although not set out as an objective of the scheme, protection of these properties was considered.

A hydrological and hydraulic analysis for the South Kinross Flood Protection Scheme (FPS) have focused on the main sources of flood risk, from the South Queich, Gelly Burn and Clash Burn. The Option Review report for South Kinross FPS builds upon the analysis and findings to inform the option development process, which has been presented in this report.
The Flood Protection Scheme follows on from a Flood Study undertaken in 2010, which outlined a partial preferred option for the area. This report builds on the findings of this report, with targeted analysis undertaken to determine if a technically, socially and environmentally sound option could be found for Kinross.

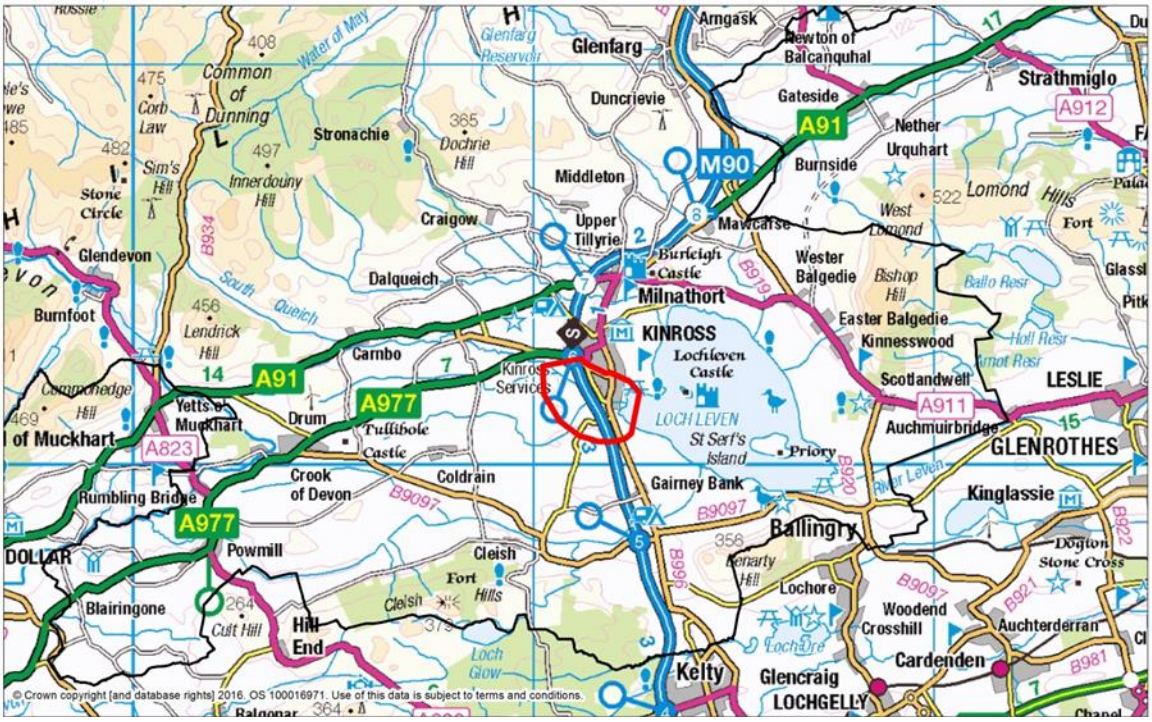

Figure 1.1: Location of Kinross

1.2 Aims and Scope

The main aims of the flood protection scheme are to propose a suitable long-term option for addressing fluvial flood risk in South Kinross. A previous report completed in 2010 outlined a hard defence option to alleviate flooding from the fluvial 0.5% Annual Exceedance Probability (AEP) event. This option addressed flooding from the South Queich and Gelly Burn, with no preferred option outlined for the Clash Burn. RPS were commissioned to assess the hard defence option, as well as undertaking a review of other potential options in the form of an agreed optioneering long list. The options for the Clash Burn were less defined where a full range of options were considered, similarly, to address fluvial flooding to the fluvial 0.5% AEP event.

The main objectives of this study are:

- Develop an improved understanding of flooding issues and mechanisms in the area based on a hydrological assessment and flood modelling, as well as other activities, including data gathering and review; assessments of bodies of water; clearance and repair works; flood history, site visit/survey work; and residents/community consultation.
- Review and update the existing fluvial flood model for the area and develop a new (and linked) pluvial flood model to study and manage the risk of surface water flooding in the vicinity of the proposed flood defences.
- Improve the knowledge of the existing flood risk to properties and businesses by assessing the status/condition/existing level of protection provided by flood defences (formal, informal and private) in the area.
- Develop and appraise measures to provide sustainable flood risk management to the South Kinross area. The Standard of Protection (SoP) to be achieved was 0.5% AEP event (fluvial).
- Develop options to manage surface water flood risk in the vicinity of any new flood defences and provide recommendations for the most sustainable options using baseline assessments, RBMP, baseline impacts, do nothing/do minimum scenarios, long list of options, short list of options, options appraisal, and recommendations for sustainable options.
- Develop an outline design for a preferred scheme (as identified in Mouchel's 2010 flood study) and any identified surface water measures in sufficient detail to allow the flood scheme to be submitted to the statutory process under the Flood Risk Management (Scotland) Act 2009. The preferred scheme from this flood study has been described in Section 1.3.
- Provide additional recommendations for the future management of flood risk in the area.
- Engage partners, stakeholders and land managers in the development of the flood scheme as required, to minimise any formal objections during the statutory process.
- Enable the Employer to implement the final proposed scheme by the successful promotion of a formal Flood Protection Scheme under the Flood Risk Management (Scotland) Act 2009.

- Secure other required permissions, statutory consents and approvals for the scheme (deemed planning consent, CAR licences, etc.).
- Produce the detailed design for the confirmed flood scheme, procure the necessary contractors and supervise the works on site.
- Implement a flood protection scheme to reduce the economic damages to residential and non-residential properties in the south Kinross area from the South Queich, Gelly Burn and the Clash Burn, and where possible to improve the WFD status of the bodies of water in the area.
- Ensure sound financial management of the scheme cost, the economic appraisal and the overall project budget.

The purpose of this report is to outline flood mitigation measures which will reduce the risk of flooding from the South Queich, Gelly Burn and Clash Burn to residential properties, non-residential properties and community facilities in Kinross. It will determine the technical, economic, social and environmental feasibility of those options and to outline conceptual design. Details of the work undertaken to fulfil the other objectives are located in separate reports.

1.3 Previous Study – South Kinross Flood Study & Preferred Option

Mouchel were commissioned to undertake a flood study in South Kinross, to get a better understanding of flooding issues in Kinross and also to explore practical options which may reduce flood risk in the area. Information was collected, collated and reviewed, with consultation with local stakeholders. Following a survey of watercourses, structures and surrounding lands, both hydrological and hydraulic modelling exercises were undertaken. A range of options for flood alleviation were investigated, also including technical feasibility and economic viability assessments. A figure displaying the modelled extent of the watercourses in Kinross within the flood study is included in Figure 1.2. The flood study report has been included in Appendix A.

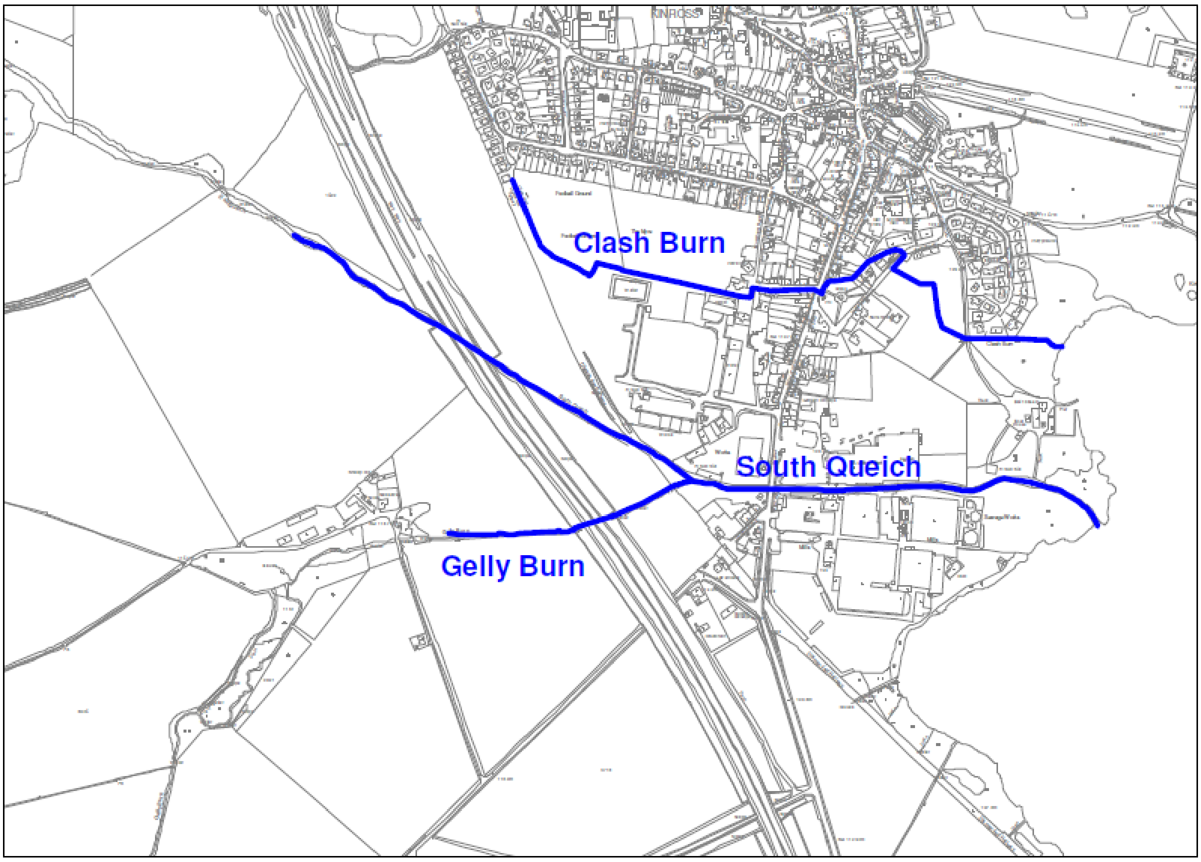

Figure 1.2: Extent of modelled watercourses in the 2010 South Kinross Flood Study

A preferred option was put forward in this report, for which an outline design was to be developed into a Flood Protection Scheme. This option aimed to alleviate fluvial flooding from the South Queich watercourse, reducing flood risk downstream of the High Street bridge. Not included in the preferred option were any suitable flood alleviation measures for the Clash Burn watercourse. The route of the hard defences which formed the preferred option are shown in Figure 1.3.

The option presented within the Mouchel report did not provide the target Standard of Protection across the Study Area, therefore various options were reassessed as part of the option review report, utilising the latest hydraulic model with the aim of identifying a suitable preferred option for South Kinross.

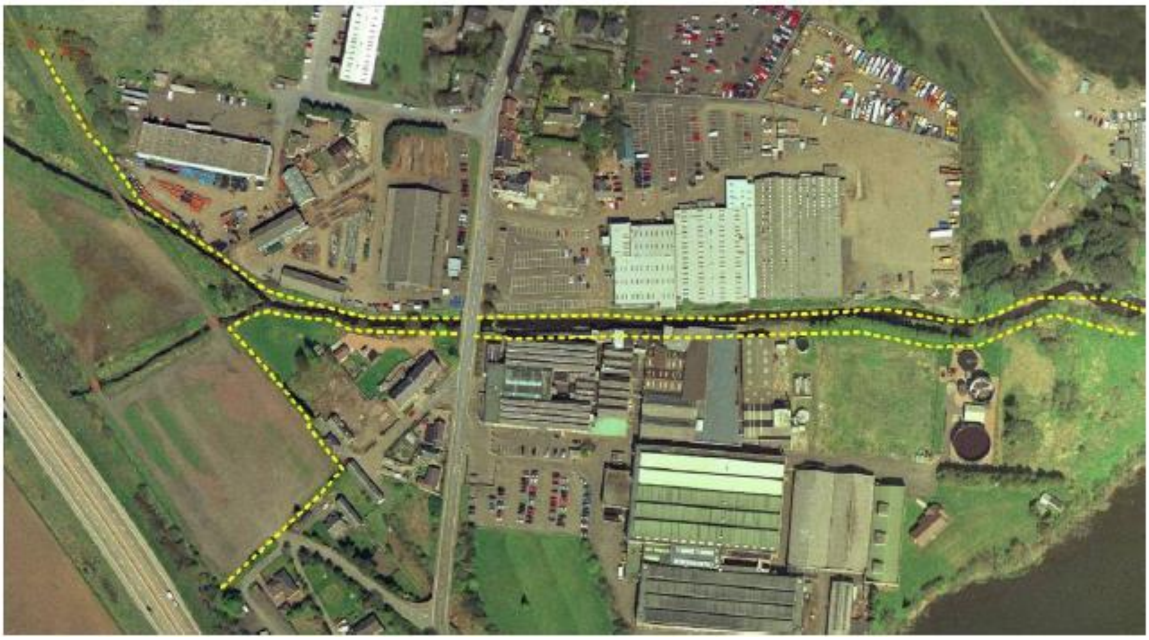

Figure 1.3: South Kinross Flood Study, preferred option hard defence route (Mouchel, 2010)

2 STAGE ONE – DEFINING THE PURPOSE

In defining the purpose of this study, a clear description is required of the problems to be addressed, including an understanding of the existing flood risk, how this risk will change over time and if there are any major constraints that may affect the choice of solution. This option review report builds upon the South Kinross FPS Hydrology report and Hydraulics report.

The study area has been split into three flood cells to facilitate the option review process. This decision was made due to the unique flooding mechanisms and constraints that have been observed across the three areas. Flood Cell 1 considers the flood risk mainly from the South Queich and its tributary, the Gelly Burn. Flood Cell 2 encompasses the Clash Burn. It is noted that there is interaction between Flood Cell 1 & 2, therefore whilst it was possible to present the costs of options by flood cell, the cost benefit analysis could only be presented for a combination of Flood Cells 1 and 2. The initial study area was extended to consider flooding across the entire hydraulically modelled area, following the identification of flooding to properties and roads associated with the network between Balado and the M90. Flood Cell 3 envelops receptors impacted by flooding in this area. There was some interaction identified between Flood Cell 3 and Flood Cell 2. The costs and benefits however were assessed within the boundary of Flood Cell 3.

The flood cells can be viewed in Figure 2.1. It was noted that the extreme level within Loch Leven was found to impact some properties directly, with some backwater effects also being observed. Due to interaction between flooding from the water courses and the loch, this flood risk has been captured within both Flood Cells 1 & 2, where the risk is predominantly associated with the watercourses.

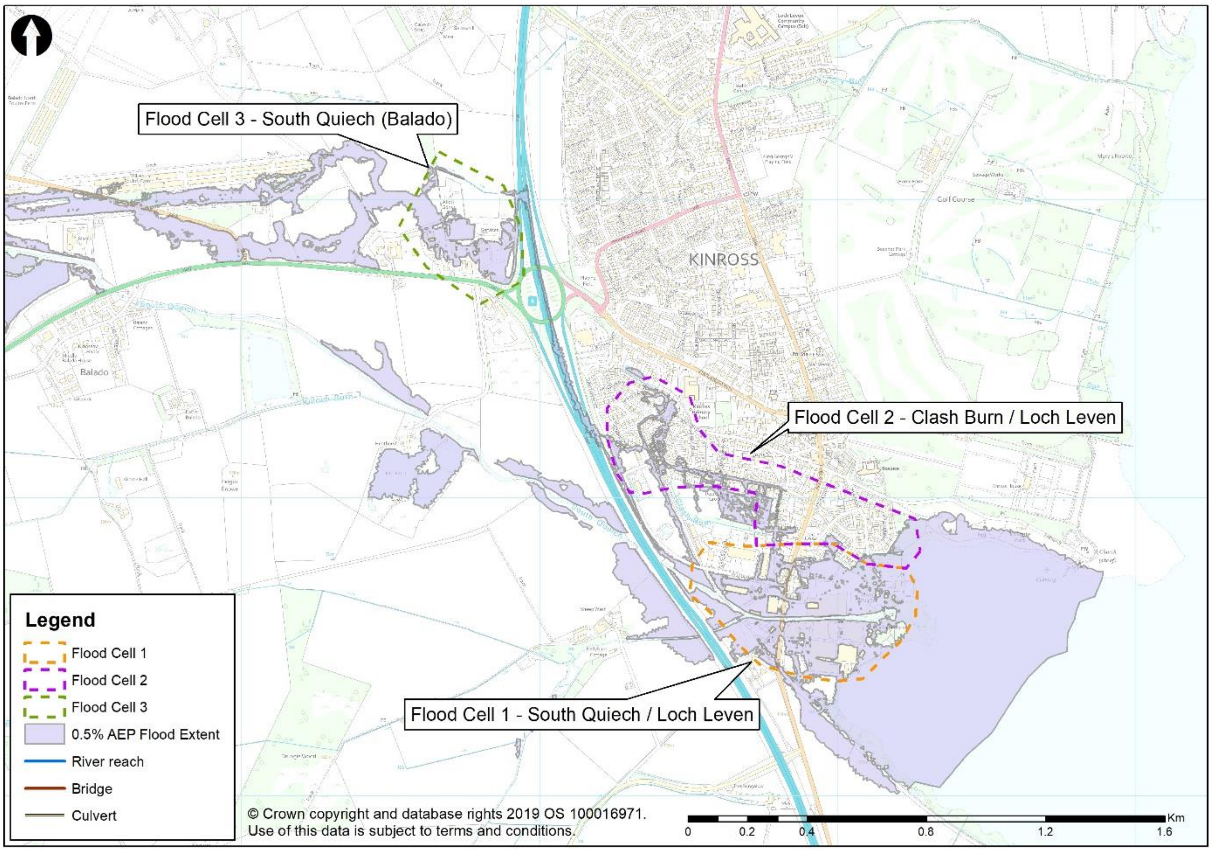

Figure 2.1: Overview of the South Kinross FPS Flood Cells

2.1 Flood Cell 1 – South Queich / Loch Leven

Flood Cell 1 incorporates various large commercial premises in Kinross, residential housing and sewage pumping stations.

Across 22nd and 23rd February 2020 an extreme storm event resulted in the flooding of many residential and commercial properties from the South Queich. This flood event was estimated to be a 2% AEP event, with details of flooding collected by PKC and provided to RPS, which included a flood extent and depth drawing, as well as records of flood levels observed at specific properties. This historic flooding information was utilised to calibrate the hydraulic model developed for this study, which has been detailed in the South Kinross Hydraulics Report.

Areas at which out of bank occurs in lower magnitude events included at rear of commercial properties on Clashburn Road / Junction Road, behind properties at Queich Place just upstream of the High Street bridge, along the left bank of the South Queich alongside a car auction building and along the right bank at a manufacturing site. The Clashburn Road was impassable due to flooding in this event. These flooding mechanisms were observed in the simulated 0.5% AEP fluvial event, with some additional areas also impacted.

The hydraulic model was used to simulate the 0.5% AEP flood event for the South Queich. The following flooding mechanisms were observed within Flood Cell 1:

- Both the South Queich and Gelly Burn are shown to flood out of bank due to a lack of channel capacity at various locations. This first occurs along the South Queich upstream of the High Street Bridge. Large areas of vacant land to the east of M90 are shown to be flooded initially. The left bank is generally lower than the right through Kinross, with more extensive flooding shown to the north of the South Queich.
- Flooding has been identified associated with extreme water levels in Loch Leven. This impacts commercial premises to the north of where the South Queich discharges to the loch. Some of these properties may require uninterrupted access to the pier at the loch to continue their function, which should be considered through the option development stage. Flooding from Loch Leven has also been identified to the south of the South Queich, impacting manufacturing premises which are also at risk of fluvial flooding.

2.2 Flood Cell 2 – Clash Burn / Loch Leven

Flood Cell 2 incorporates mostly residential properties and some commercial properties which are flooding from the Clash Burn.

This watercourse flows through a predominantly residential urban area and is heavily culverted. Flooding occurs as a result of a lack of capacity in the existing channel and network, leading to overland flowpaths where the flood water is not able to efficiently get back into the Clash Burn.

The hydraulic model was used to simulate the 0.5% AEP flood event for the Clash Burn. The following flooding mechanisms were observed within Flood Cell 2:

- Flooding occurs around Hopefield Place due to two surcharged culverts. The first culvert passes below a roundabout at the end of Hopefield Place. There is a short section of open channel immediately downstream of this before the next culvert. This culvert passes behind and under residential properties at Montgomery Way. The overland flow from these culverts travels in a southerly direction along Montgomery Way and Montgomery Street, resulting in low level flooding to various properties. The surface runoff then travels towards and collects at the Myre playing fields and floods residential properties on Smith Street.
- The surface runoff which collects at the Myre playing fields is directed towards an open section of the Clash Burn towards the South of Smith Street. This is achieved by a 250mm to 300mm bund along the eastern boundary of the Myre playing fields, constructed by PKC to direct flow and alleviate historic flooding issues at Smith Street.
- The Clash Burn is culverted from the south-eastern corner of the Myre playing fields to an outfall to the east of Sandport Close. There is a short length of open channel before it discharges to Loch Leven. There is a footbridge over this channel section which forms part of the Loch Leven Heritage Trail.

2.3 Flood Cell 3 – South Queich

Flood Cell 3 impacts a number of non-residential properties due to flooding from the South Queich. This area is outside the initial study area, which was extended to address flooding to properties, as well as the M90. The Flood Cell is situated between the A91 and A977, to the north-west of the Kinross Services.

This watercourse flows through a predominantly rural area, with flooding occurring as a result of a lack of capacity in the existing channel, leading to overland flowpaths developing in some areas. This Flood Cell is upstream of Flood Cell 1 & 2, therefore any alleviation measures may have impacts downstream. There was also some interaction identified between Flood Cell 3 and Flood Cell 2, via a flowpath identified along the M90, connecting flooding at the M90 services at Kinross to Junction Road in Flood Cell 2.

The hydraulic model was used to simulate the 0.5% AEP flood event for the South Queich. The following flooding mechanisms were observed within Flood Cell 3:

- Out of bank flooding on the South Queich within the modelled area upstream of the M90 due to a lack of channel capacity. Higher resolution mesh zones were included across all flooded areas to ensure the LiDAR was represented in detail. Flooding from the left bank continues overland across an old airfield where poultry buildings are situated and outside of the delineated catchment towards the M90. This flood water has not been modelled to be intercepted by any other drainage networks, therefore should be treated with caution.
- Flooding collects at the Kinross services off the M90 before spilling on to the M90 and flowing along the road in a southerly direction. This flow eventually passes through a pathway between

the M90 and Junction Road, where there is interaction with the flooding from the Clash Burn in Flood Cell 2. This interaction requires the flooding from the South Queich to be intercepted and to provide protection to Flood Cell 2.

- Flooding occurs on the upstream face of the M90 due to a low right bank and some throttling of flows from culverts through the motorway. This causes out of bank flooding on both the South Queich, which flows in a southerly direction towards and into the Gelly Burn, just upstream of the M90.

2.4 Summary of Flood Risk

An assessment of the flood risk was carried out for Flood Cells 1, 2 and 3. Table 2.1 below presents the receptors at risk during a 0.5% AEP flood event and any constraints to the potential flood management solutions.

Table 2.1: Receptors at Risk across all three Flood Cells

Receptor/Asset affected	Frequency of risk 10% AEP = Low frequency 0.5% AEP = Medium frequency 0.1% AEP = High frequency	Impact of flooding	Constraints to solution
Residential properties	Low frequency – 195 properties at risk (fluvial) Medium frequency – 128 properties at risk (fluvial) High frequency – 20 properties at risk (fluvial)	Properties at risk from fluvial flooding	-
Commercial Properties	Low frequency – 84 properties at risk (fluvial) Medium frequency – 62 properties at risk (fluvial) High frequency – 4 properties at risk (fluvial)	Properties at risk from fluvial flooding	-
Motorway M90	Low & medium frequency of risk	Traffic disruption (significant)	-
A Road A977	Low frequency of risk	Traffic disruption	-
Primary Road B918 B996	Low & medium frequency of risk	Traffic disruption	-
Minor Road Bowton Road Clashburn Way High Street	Low frequency – Levenbridge Place, Nan Walker Wynd, Old Causeway, Pier Road,	Traffic disruption	-

Receptor/Asset affected	Frequency of risk 10% AEP = Low frequency 0.5% AEP = Medium frequency 0.1% AEP = High frequency	Impact of flooding	Constraints to solution
Hopefield Place Levenbridge Place Montgomery Street Montgomery Way Myre Terrace Nan Walker Wynd Old Causeway Pier Road Queich Place Ross Street Sandport Sandport Close Sandport Gait Smith Street	Sandport, Sandport Close, Sandport Gait Medium frequency – M90, Clashburn Way, High Street, Hopefield Place, Myre Terrace, Smite Street High frequency – Bowton Road, Montgomery Road, Montgomery Street, Queich Place, Ross Street		
Utilities 1 Electricity Substation (Clashburn Road)	Low & medium frequency of risk – Clashburn Road Electricity Substation	Potential disruption to service	-
Scottish Water Assets South (High Street) Sewage Pumping Station (SPS) Pier Road SPS SPS & CSO behind commercial premises north of the South Queich Sewage Works behind industrial premises south of the South Queich	Low & medium frequency of risk – South (High Street) Sewage Pumping Station (SPS) and Pier Road SPS High frequency of risk – SPS & CSO behind commercial premises north of the South Queich and Sewage Works south of the South Queich	Potential disruption to service	-
Listed Buildings (Bridges): None	-	-	-
Listed Buildings (Structures): Old Manse, 8 Sandport, Kinross Market Cross, Sandport, Kinross	Low frequency of risk – Old Manse & Market Cross	-	-
Sites of Special Scientific Interest Loch Leven SSSI	Low, medium & high frequency of risk	-	Minimise any detrimental impact.
Conservation Areas Kinross Conservation Area	Low & medium frequency of risk	-	Minimise any detrimental impact.
Special Protection Areas Loch Leven SPA	Low, medium & high frequency of risk	-	Minimise any detrimental impacts to various bird species set out in SPA conservation objectives

Receptor/Asset affected	Frequency of risk 10% AEP = Low frequency 0.5% AEP = Medium frequency 0.1% AEP = High frequency	Impact of flooding	Constraints to solution
RAMSAR Loch Leven RAMSAR site	Low, medium & high frequency of risk	-	-
Community Services None	-	-	-
Paths Loch Leven Heritage Trail	Low, medium & high frequency of risk (fluvial & coastal)	Disruption to service	-

The receptors at risk during a 0.5% AEP flood event have been summarised below in Table 2.2 for Flood Cell 1. These receptors and their locations are also represented in Figure 2.2

Table 2.2: Receptors at risk of flooding in Flood Cell 1 (0.5% AEP event)

Receptor/Asset affected	Impact of flooding	Constraints to solution
Residential properties	39 residential properties at risk from fluvial flooding	-
Commercial Properties	42 commercial properties are at risk from fluvial flooding	-
Primary Road B996	Traffic disruption	-
Minor Road Clashburn Way Queich Place High Street	Traffic disruption	-
Utilities 1 Electricity Substation (Clashburn Road)	Potential disruption to service	-
Scottish Water Assets South (High Street) Sewage Pumping Station (SPS) SPS & CSO behind BCA commercial premises on the left bank of the South Queich Sewage Works behind industrial premises south of the South Queich	Potential disruption to service	-
Sites of Special Scientific Interest Loch Leven SSSI	-	Minimise any detrimental impact.
Conservation Areas Kinross Conservation Area	-	Minimise any detrimental impact.
Special Protection Areas Loch Leven SPA	-	Minimise any detrimental impacts to various bird species set out in SPA conservation objectives

Receptor/Asset affected	Impact of flooding	Constraints to solution
RAMSAR Loch Leven RAMSAR site	-	
Paths Loch Leven Heritage Trail	Disruption to service	-

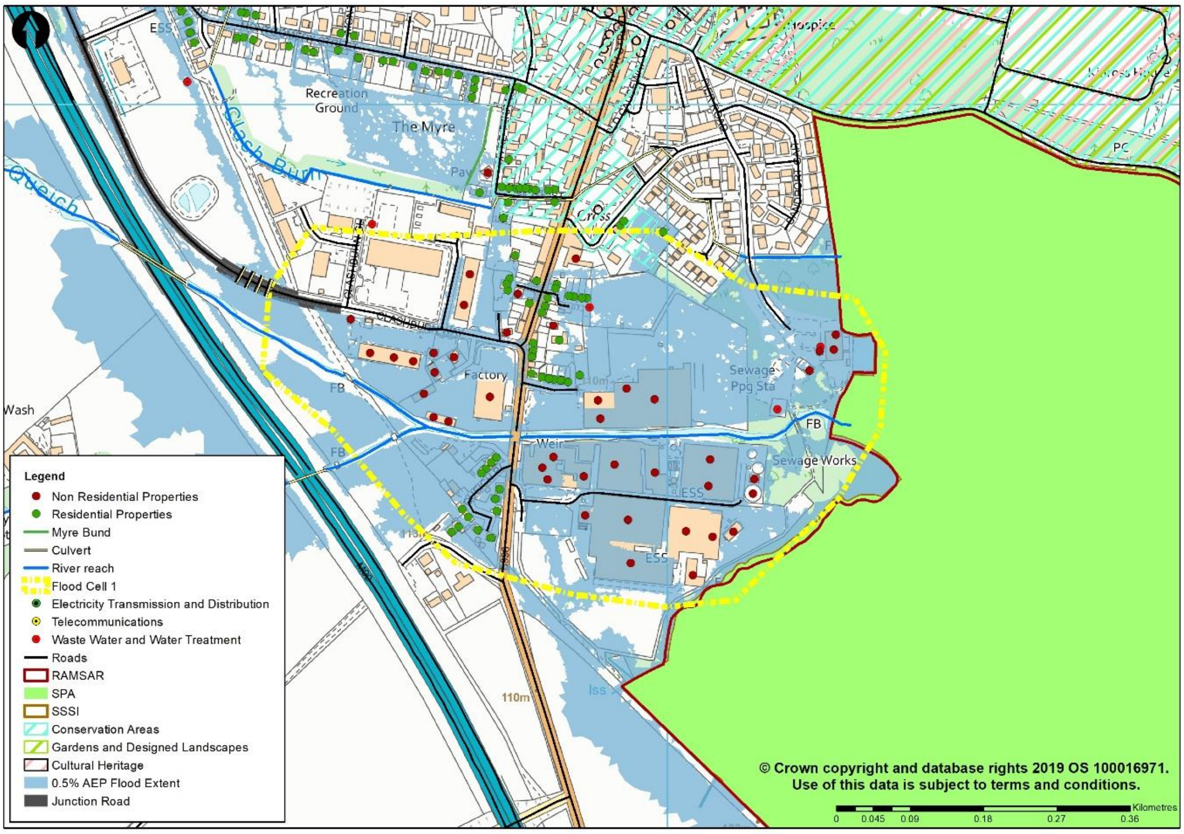

Figure 2.2: Overview of Flood Cell 1

The receptors at risk during a 0.5% AEP flood event have been summarised below in Table 2.3 for Flood Cell 2. These receptors and their locations are also represented in Figure 2.3.

Table 2.3: Receptors at risk of flooding in Flood Cell 2 (0.5% AEP event)

Receptor/Asset affected	Impact of flooding	Constraints to solution
Residential properties	87 residential properties at risk from fluvial flooding	-
Commercial Properties	2 commercial properties are at risk from fluvial flooding	-
Minor Road Bowton Road Hopefield Place Levenbridge Place Montgomery Street	Traffic disruption	-

Receptor/Asset affected	Impact of flooding	Constraints to solution
Montgomery Way Myre Terrace Sandport Sandport Close Smith Street		
Sites of Special Scientific Interest Loch Leven SSSI	-	Minimise any detrimental impact.
Conservation Areas Kinross Conservation Area	-	Minimise any detrimental impact.
Listed Buildings (Structures): Old Manse, 8 Sandport, Kinross Market Cross, Sandport, Kinross		
Special Protection Areas Loch Leven SPA	-	Minimise any detrimental impacts to various bird species set out in SPA conservation objectives
RAMSAR Loch Leven RAMSAR site	-	
Paths Loch Leven Heritage Trail	Disruption to service	-

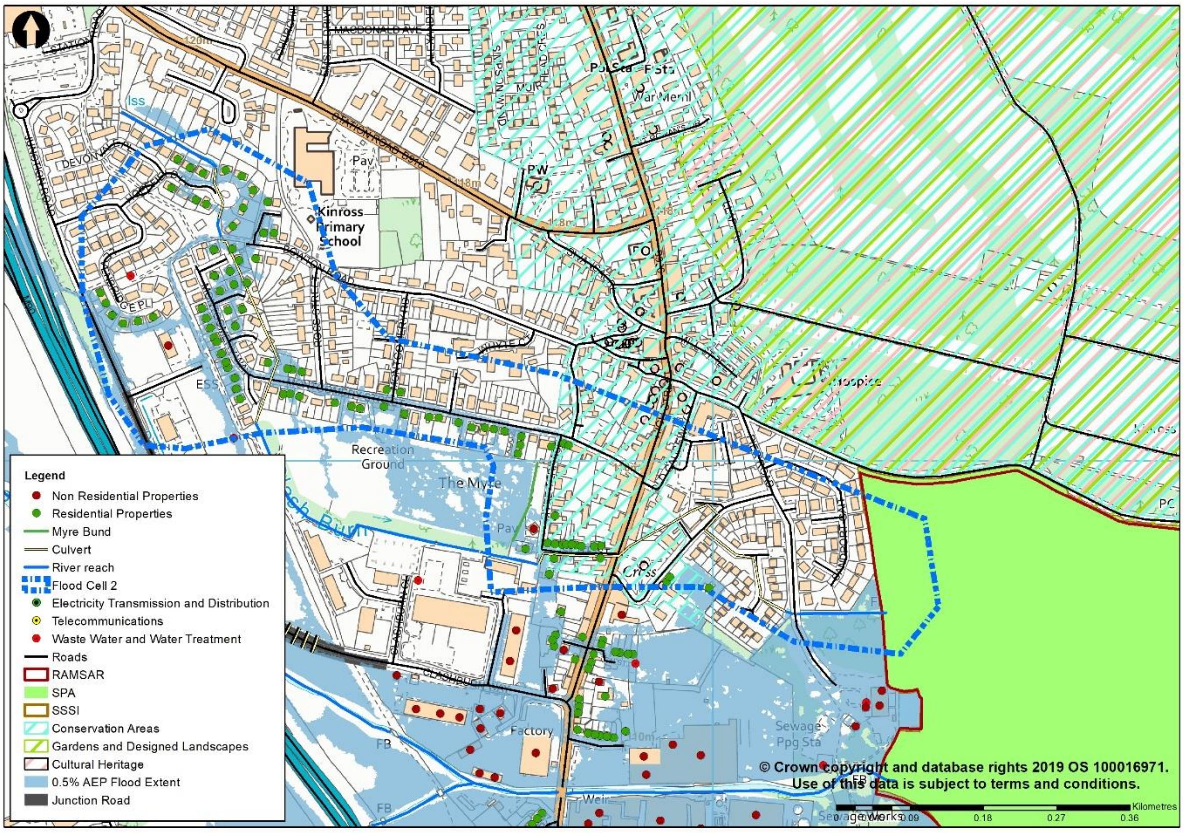

Figure 2.3: Overview of Flood Cell 2

The receptors at risk during a 0.5% AEP flood event have been summarised in Table 2.4 for Flood Cell 2. These receptors and their locations are also shown in Figure 2.4.

Table 2.4: Receptors at risk of flooding in Flood Cell 3 (0.5% AEP event)

Receptor/Asset affected	Impact of flooding	Constraints to solution
Residential properties	0 residential properties at risk from fluvial flooding	-
Commercial Properties	10 commercial properties are at risk from fluvial flooding	-
Motorway M90	Traffic disruption	-
Primary Road B918	Traffic disruption	-

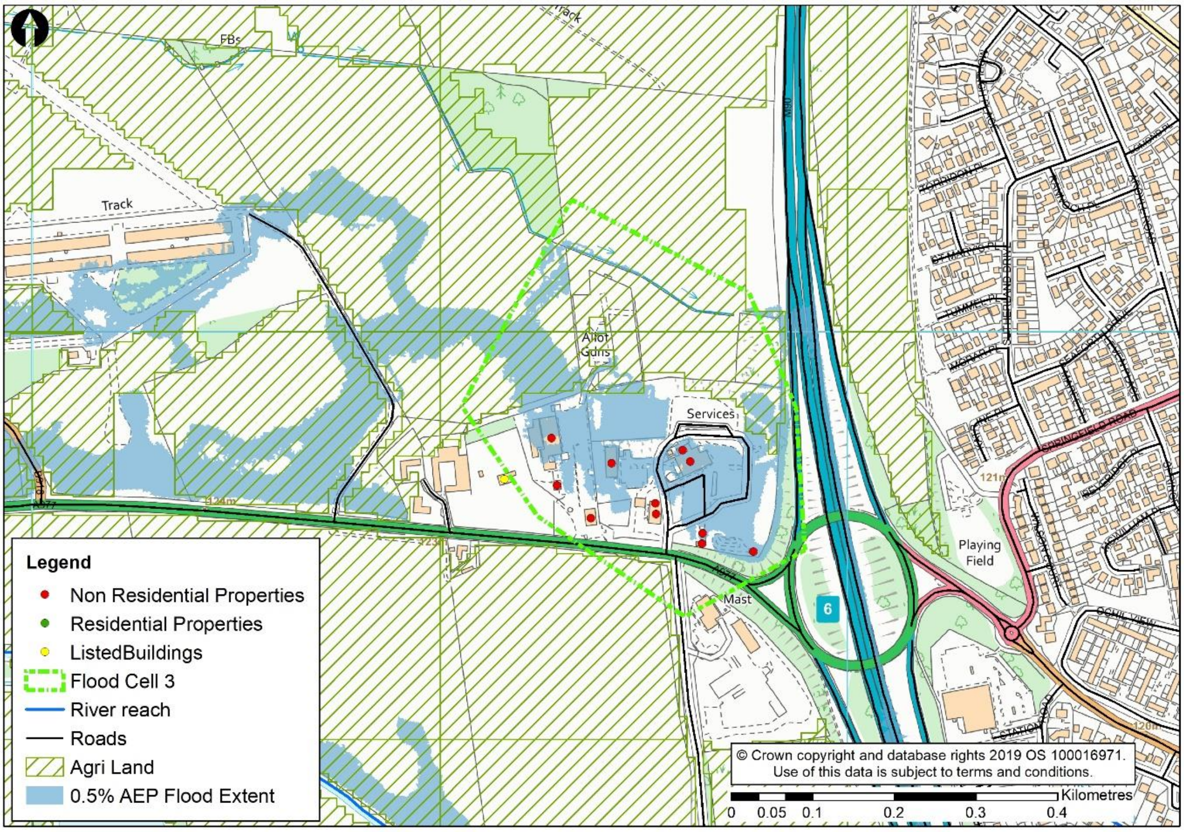

Figure 2.4: Overview of Flood Cell 3

2.5 Catchment Characterisation

The purpose of characterising the catchment area is to develop an understanding of how the catchment currently operates under flood conditions and the areas of the catchment that contribute most to flooding. The characterisation also investigates the catchment's potential to change in order to manage flood risk.

The study area catchments were characterised in accordance with the SEPA NFM handbook guidance. The hydrological, morphological, land use and historical characteristics were considered. The SEPA NFM maps were also used to help characterise the catchments. This assessment found a distinct character difference between the upper and lower catchment demarcated by the A91 road. The upper catchment is steeper, wetter and less permeable than the lower catchment. Its land use has been changed significantly by the plantation of commercial forest. The lower catchment has also been modified through the formation of agricultural fields and associated drainage network. The watercourses and in particular the South Queich have been modified by the mill industry with weirs, mill races and mill ponds. The South Queich has been straightened in places and the Killoch Burn and Gelly Burn have been formed along field boundaries. These conditions allow the land to drain quickly, contributing to an increased flood risk which may also carry soil into the watercourses.

A detailed catchment characterisation has been included within the accompanying Phase 1 NFM report provided in Appendix B, which details the catchment under the following headings:

- Hydrological Characteristics
- Morphological Characteristics
- Land Use Characteristics
- Historical Characteristics
- SEPA Natural Flood Management Maps

A number of recommendations were made in the Phase 1 report, including a proposal for a more detailed baseline assessment. A second phase assessment was commissioned, which included a walkover survey to verify the findings of the phase 1 report. This walkover was undertaken in early 2021 (Figure 2.5). The NFM Baseline Study was completed in March 2022, and has been included in Appendix G.

Figure 2.5: Image of South Queich upper catchment, taken during NFM Phase 2 walkover survey

2.6 Set Objectives

A Flood Protection Scheme for South Kinross (Action ID 100110006) has been included within the selected actions. The scheme description, coordination arrangements and potential impacts are fully described in the Forth Estuary Local FRM Plan. The South Kinross FPS is a Flood Risk Management cycle 1 scheme, which aims to reduce economic damages to residential and non-residential properties in the Kinross Potentially Vulnerable Area caused by river flooding. Any options should have the benefit of reducing overall flood risk and should avoid an overall increase in flood risk to other areas. The project specific objectives have been included in Section 1.2.

The Flood Risk Management (Scotland) Act requires a catchment-based approach and seeks to deliver multiple benefits in terms of reducing flood risk and water quality improvements through river basin management planning.

Flood protection schemes can have both positive and negative impacts on the ecological quality of the environment depending on how they are designed. A number of nationally and locally designated sites are present in the study area and could be positively or negatively impacted. The flood scheme must not have an adverse effect on the integrity of the Loch Leven Special Protection Area. Potential environmental impacts are to be considered in EIA screening and HRA screening reports, which are to be undertaken following the identification of a preferred option.

3 STAGE 2: DEVELOP, DESCRIBE AND VALUE

3.1 Overview

The South Kinross FPS aims to develop an outline design for a preferred scheme, as identified in the South Kinross Flood Study undertaken in 2010. This study reviewed a suite of flood alleviation actions and established an understanding of actions which were able to achieve the target standard of protection. Actions which were deemed technically inappropriate, technically impractical or had insurmountable constraints were screened out at the flood study stage.

The South Kinross FPS aimed to build upon the findings of the flood study through an Option Review. A brief description of the actions which were considered within the review have been included in Figure 3.1.

Table 3.1: List of flood defence actions considered for South Kinross Option Review

Action	Action Type	Description
Relocation / Managed Retreat	Avoid	While large scale relocation of properties would be considered an unsustainable approach, there may be specific properties or groups of properties that may be suitable for relocation out of flood risk areas.
Runoff Reduction	Reduce/Protect (NFM)	There may be suitable areas to alter land management practices in order to reduce runoff. This could reduce flood risk and promote environmental and biodiversity improvements.
Floodplain Storage	Reduce/Protect (NFM)	Rural areas and parks may be suitable to use as floodplain storage. This could reduce the peak flow during a flood event and therefore the flood risk. Wetland creation can also be created to enhance biodiversity.
Storage	Reduce/Protect (Engineering)	Storage areas may be available within the study river catchments which could reduce the peak flow and therefore flood risk.
Conveyance: Channel Capacity	Reduce/Protect (Engineering)	Lack of channel capacity has been identified as a contributing factor to flood risk. Improvement of channel conveyance could reduce this flood risk.
Conveyance: Control Structures	Reduce/Protect (Engineering)	Certain control structures may be modified to increase conveyance and reduce flood risk.
Direct Defences	Reduce/Protect (Engineering)	Flood walls and embankments could be used throughout the study area to reduce flood risk.
Diversion Channel	Reduce/Protect (Engineering)	A diversion channel or channels could be used to divert some of the flow from the watercourses in order to reduce the amount of river flooding in Kinross. These would divert excess flows away from areas at risk and direct them into the Loch or a watercourse that has enough capacity to take the excess flow.
Property Level Protection (PLP)	Reduce/Prepare	While PLP might not be able to provide the design SoP it can reduce the flood risk to suitable properties.
Property Level Resilience (PLR)	Prepare	PLR aims to make people and their property less vulnerable to the physical and mental impacts of flooding.

Further details on the actions which were shortlisted are provided in Section 3.3 for each flood cell. A summary of the options which were reviewed for each flood cell is presented in Table 3.2.

3.2 Short List of Actions

A number of actions were assessed in further detail utilising the hydraulic model which was developed for the FPS. The list of options formulated for each flood cell were based on the following rationale:

- Inclusion and further assessment of the preferred option identified in the previous flood study, which forms the core of the South Kinross FPS to be developed.
- Further assessment/modelling of actions requested by PKC and relevant stakeholders to have merit, or in response to comments received from local residents, to confirm actions which form the preferred option and provide further detail ahead of future consultation.
- Addressing any new areas of fluvial flood risk identified, following the updated hydrological and hydraulic analysis, based on the observed flooding mechanisms and taking constraints into account.

For the purposes of the option review report, all actions put forward for each flood cell were taken forward through the 'developing options' stage and were simulated in the hydraulic model to determine their effectiveness. These actions formed a short-list, from which viable options were developed that would meet the objectives set out in Section 2.6.

The following actions were identified for South Kinross. These are discussed in 3.3 of this report.

Table 3.2: Option review list actions investigated for each flood cell

Flood Cell 1	Flood Cell 2	Flood Cell 3
Improvement of Conveyance	Improving Channel Conveyance / Diversion	Storage
Diversion	PLP/PLR	
Direct Defences	Storage	
Storage		
Property Level Protection		
Property Level Resilience		
Relocation		

An NFM Study was also commissioned, to provide a long-term plan for the catchment to reduce flood risk on the South Queich catchment. This report was being developed to include more sustainable solutions which may improve biodiversity, recreation and water quality whilst simultaneously reducing the impacts of flooding to Kinross. However, at was not believed at the time of writing that the NFM options would provide a 0.5% AEP SoP for the study area as required in the project brief.

3.3 Shortlist of Actions: Developing Options

From this short-list, viable options were developed that would meet the objectives set out in Section 2.6. The options below are considered the most viable to reduce flood risk for each of the Flood Cells identified.

A separate NFM report has been developed to include more sustainable solutions which may improve biodiversity, recreation and water quality whilst simultaneously reducing the impacts of flooding to South Kinross. NFM was ruled out of the 2010 South Kinross Flood Study, following a high-level examination of floodplain storage and catchment land management.

A Phase 1 NFM report was carried out to assess the potential for NFM in the upper catchment. This report is provided in Appendix B. A NFM Baseline Study, which includes more detailed modelling and quantitative assessments, is due for completion in early 2022. However, at this stage it is not believed that the NFM options alone would provide a 0.5% AEP SoP for the study area as required in the brief.

3.3.1 Flood Cell 1 – South Queich / Loch Leven

The following actions were shortlisted for Flood Cell 1:

- Improvement of Conveyance: Channel / Structures
- Diversion
- Direct Defences
- Storage
- Property Level Protection (PLP)
- Property Level Resilience (PLR)
- Relocation

3.3.1.1 Improvement of Conveyance: Channel / Structures

An increase in channel capacity was simulated within the hydraulic model to alleviate flooding from the South Queich watercourse. This was achieved by altering the cross-section profiles in the model, to represent dredging / removal of material to achieve a greater cross-sectional area across a targeted section of the river reach.

The improvement of conveyance option for Flood Cell 1 assessed the impact of excavating approximately 4,731m^3 of bed material over a distance of 745m. The majority of this excavation would reduce the minimum channel bed level by 1m. This would also include increasing the width of some channel sections where possible. Excavation was required between the Old Railway Bridge and the footbridge near Loch Leven. The weir downstream of the High Street Road Bridge was also be removed in this scenario. An example of the change in cross section profile is shown in Figure 3.1.

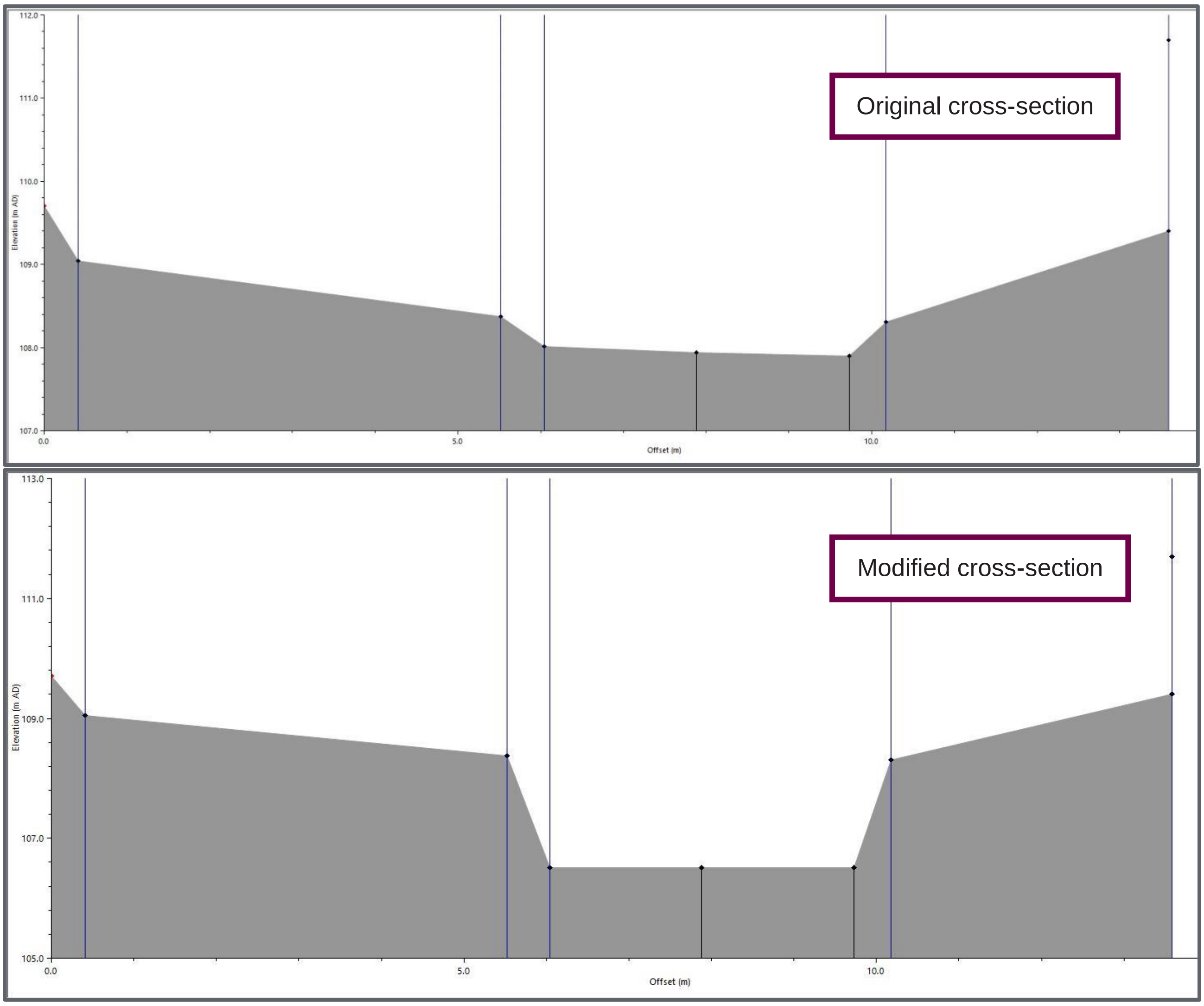

Figure 3.1: Example channel profile before and after excavation in improvement of conveyance model

The results of the channel reprofiling are shown in Figure 3.2. The hydraulic model indicates that this option is not able to fully alleviate the 0.5% AEP fluvial flood risk within Flood Cell 1. The main areas that remain at risk are the residential properties along Queich Place, the BCA buildings adjacent to the left bank of the South Queich and the commercial properties and sewage works near Loch Leven.

Some commercial properties near Loch Leven are also at risk from the rising water levels in the loch, therefore improving conveyance alone in the South Queich is unable to provide the target SoP for these properties. Another flood alleviation action would be required in combination to protect these properties, although provision of flood protection from Loch Leven is not an objective of this study. Conveyance would only be able to afford the target SoP if combined with other actions, such as direct defences or storage.

For the costing of this option, it has been assumed that works would have to be carried out every 10 years to remove the build-up of sediment that would occur after excavation has taken place. It is unknown at this stage how quickly sediment will accumulate along this section of the South Queich. This would have to be studied and monitored if this option was to be implemented. Despite its limitations this option has been carried forward to the options appraisal Section 3.5, to determine in more detail the costs and impacts of this action option.

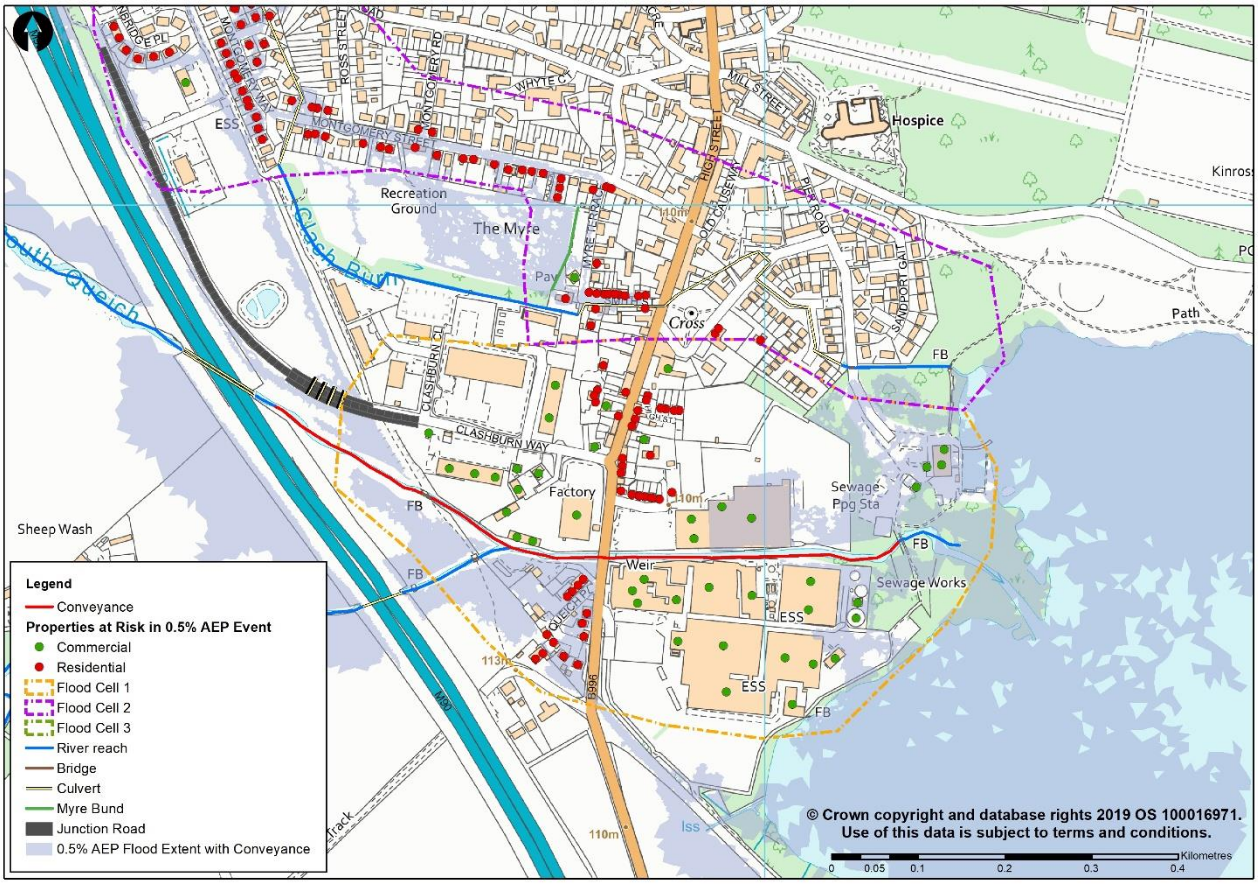

Figure 3.2: Flood Cell 1 Conveyance Solution

3.3.1.2 Diversion

The diversion solution aims to divert flow from the Gelly Burn along a new open channel, which would bypass Flood Cell 1.

The diversion solution would require a 15m wide channel that is 450m long. The channel bed would be 10m wide with banks with 1:1 slope. The depth of the channel ranges between 1.5m to 2.5m from the existing ground level, in order to maintain a steady decline in the gradient from upstream to downstream. The diversion on the Gelly Burn would start upstream of the M90 road bridge and divert flow out of the Gelly Burn into the new channel that would run parallel to the M90. The M90 culvert opening would be reduced by 50% and a spill structure would be added to encourage more flow to be directed into this channel from the right bank. Connecting the diversion channel under the M90 to allow it to discharge into Loch Leven could be achieved in different ways, such as a new culvert underneath the road, or taking a new culvert through an underpass road, approximately 500m to the south of the Gelly Burn. The route underneath the underpass was assessed in the model, through which a 3m diameter circular culvert was modelled. The results of this option are shown in Figure 3.3.

This option was unable to provide the required level of flood protection. The flows diverted from the Gelly Burn were not sufficient to prevent flooding from the South Queich, which poses the most risk to the properties within Flood Cell 1. Furthermore, this option would require excavation of approximately 18,000m³ of earth and technically would be difficult to achieve. It would be essential to ensure that no instability to the M90 banks would occur as a result of this diversion channel. This action, due to its inability to remove a significant portion of flood risk and the technical limitations associated, means this option was not carried forward to the options appraisal section 3.5.

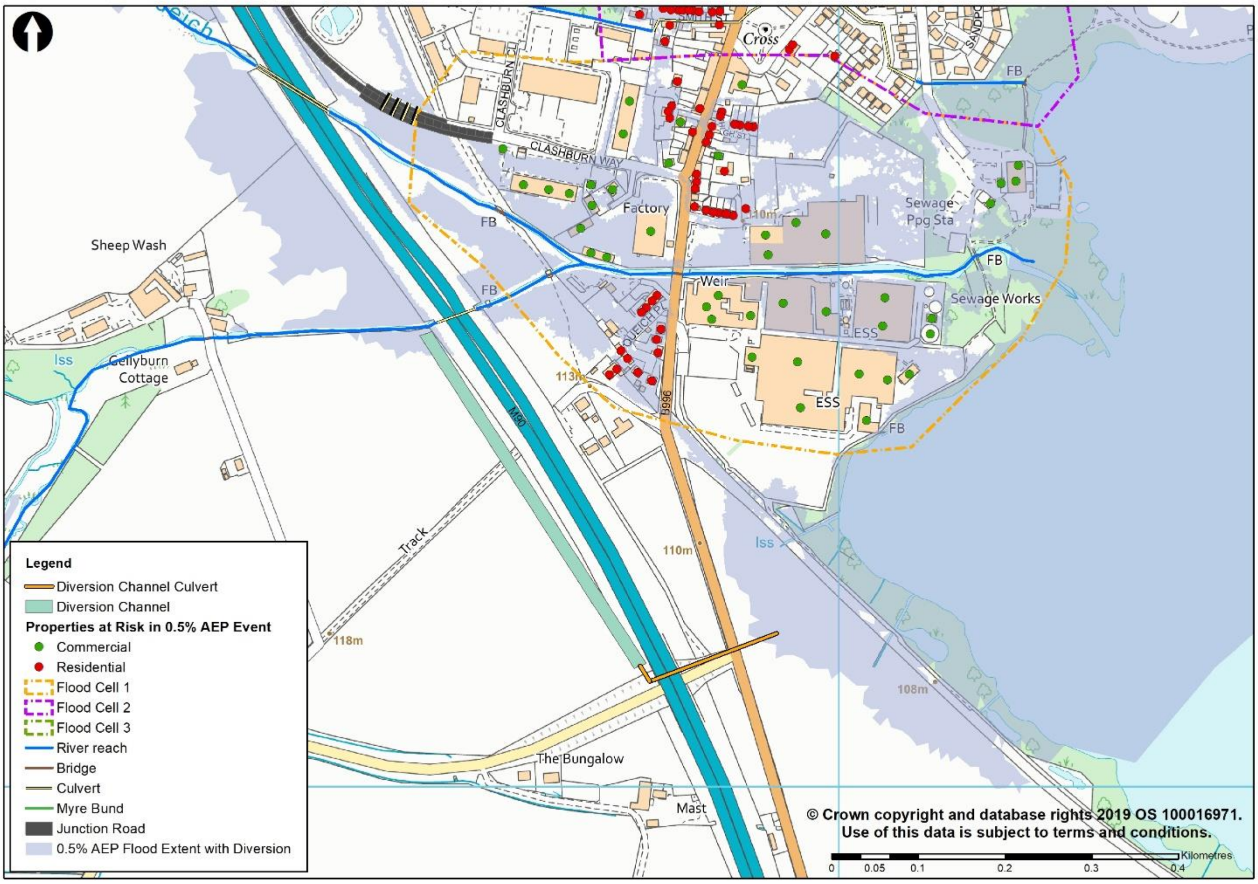

Figure 3.3: Flood Cell 1 Gelly Burn Diversion Solution

3.3.1.3 Direct Defence

The direct defence solution aims to prevent water from reaching the flood risk areas by containing water within the channels. Where possible these defences are set back from the bank to allow some use of existing floodplains. The direct defence solution considered for Flood Cell 1 included a mix of retaining walls, sheet pile walls and embankments, depending on the space available. These defences are summarised below in Table 3.3.

Table 3.3: Wall and Embankment Break Down

Defence Type	Length (m)	Average Height (m)	Max Height from Bed / Bank (m)	Max Protruding Height from Ground Level (m)
Embankment	287	1.22	1.96	1.96
Retaining Wall Type 1	692	0.95	1.36	1.36

Defence Type	Length (m)	Average Height (m)	Max Height from Bed / Bank (m)	Max Protruding Height from Ground Level (m)
Retaining Wall Type 2	201	2.43	3.19	2.14
Sheet Pile Wall	131	1.67	3.08	2.23

In total, there would be 1,311m of direct defences for Flood Cell 1.

Direct defences would provide protection to Flood Cell 1 from fluvial flood risk and would also reduce the flooding in Flood Cell 2 as the overland flow path from the South Queich to Smith Street would be avoided. However, four commercial buildings at Loch Leven would still be at risk as a direct result of increased levels in Loch Leven. These properties would therefore require some form of PLP or PLR to improve their resistance to flooding. Direct defences were not considered for these properties as they rely on access to the loch for social and economic reasons. To provide direct defences would require these properties to be ringfenced and cut off from the loch. The results of this option are shown below in Figure 3.4.

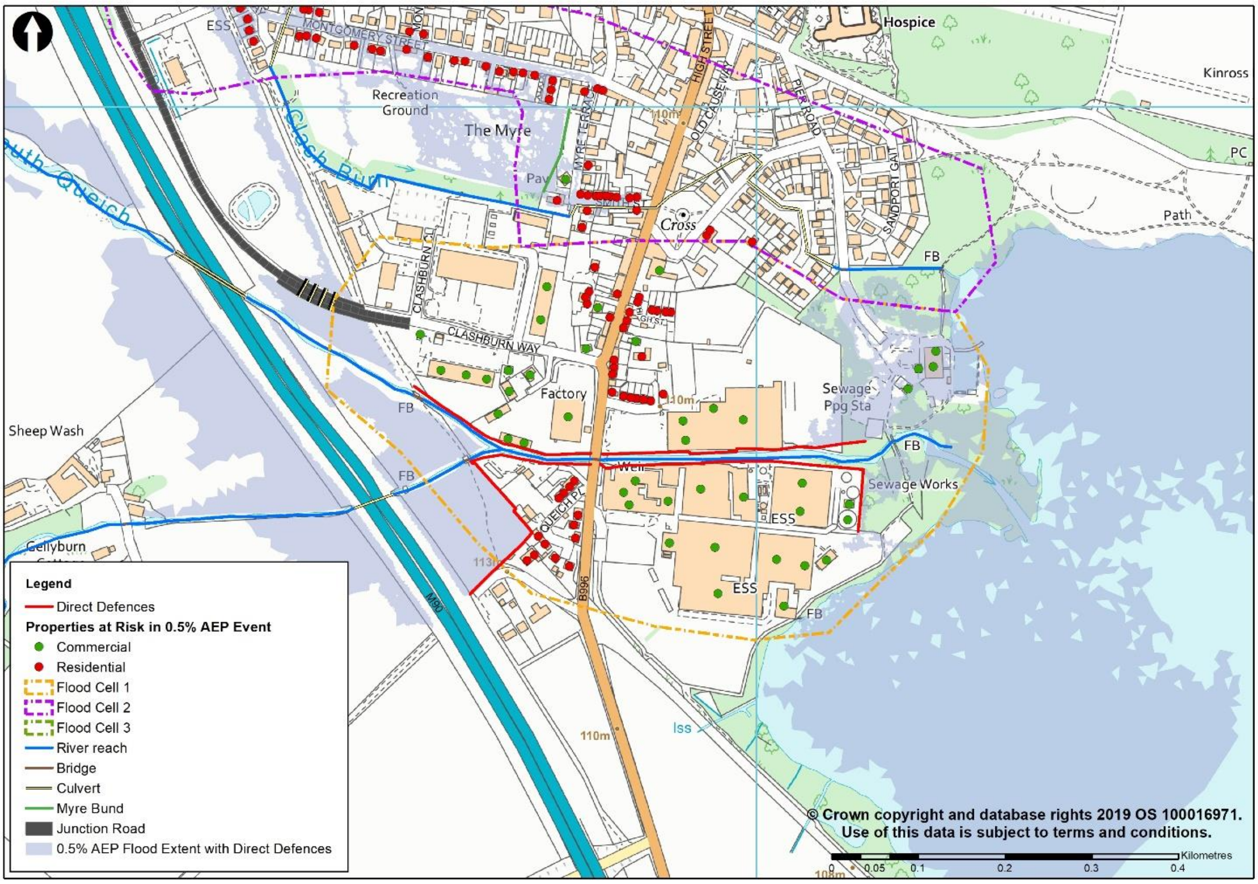

Figure 3.4: Flood Cell 1 Direct Defence Solution

3.3.1.4 Storage

For storage to be a feasible action, buildable storage features would be required that can store enough water to reduce the risk to downstream receptors. In order to assess its viability, the amount of storage required needs to be assessed against the amount of storage available. To determine the amount of storage required, a hydrological analysis was carried out at relevant HAPs throughout the study area showing the volume of water required to reduce any given flood event to the equivalent of any given smaller flood event. Despite the fact the hydraulic model indicates flooding to some properties in the 50% AEP fluvial event, this was the lowest magnitude event that was modelled, and therefore storage volumes were calculated to reduce the flows of larger magnitude events to the equivalent of a 50% AEP event. The summary of this analysis is shown in Table 3.4 below.

Table 3.4: Volume of stored water required to reduce flood risk (m^3)

Event Probability	Storage Required (m^3)
	FC1 South Queich
50% AEP	-
20% AEP	617,965
10% AEP	723,457
3.3% AEP	876,991
1.3% AEP	1,108,024
1% AEP	1,181,546
0.5% AEP	1,379,043
0.1% AEP	1,693,309

To determine the amount of storage available, a review of the topography was undertaken, initially within the modelled domain, to identify further areas of potential for storage. This was carried out by assuming buildability constraints (such as the height of an earthen dam) and testing within the hydraulic model. Other factors such as land use, location relative to properties and other infrastructure were also considered which may impact the feasibility, or how socially acceptable, a storage solution would be.

The potential areas assessed are highlighted in Figure 3.5.

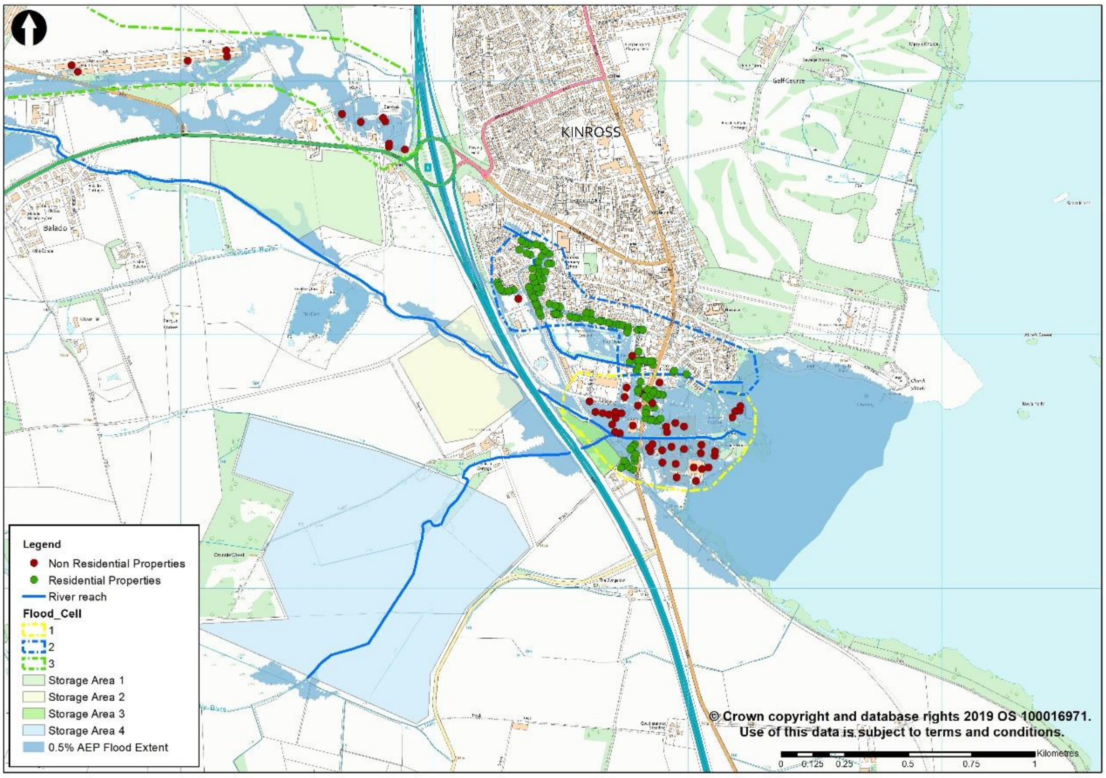

Figure 3.5: Potential storage areas for Flood Cell 1

Each of the storage areas assessed provided some reduction in flooding within Kinross, although these areas were unable to reduce the flood flows to the 50% AEP fluvial event, which was the lowest magnitude event considered in the hydrological analysis. An example of a storage area that was modelled is included in Figure 3.6. As can be seen, despite storing water across a large area there remained significant flood risk in Kinross from the South Queich.

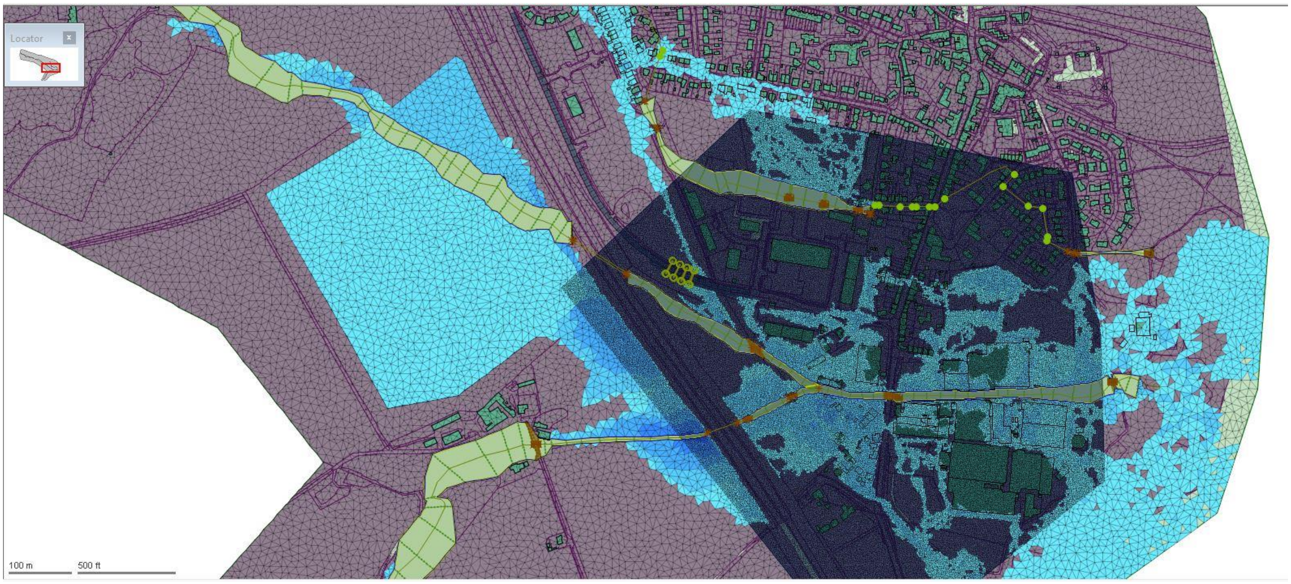

Figure 3.6: Modelling results of a flood storage area assessed on the South Queich, upstream of M90 motorway

Upstream of Flood Cell 1 & 3 there were areas identified by the client as having potential to store flood water from the South Queich. Storage here could have the potential to reduce flood risk in all three flood cells as it would reduce flows in the South Queich, and potentially reduce surface water runoff into the neighbouring Clash Burn catchment. The areas within which storage features were considered are shown in Figure 3.7. The viability of this action type was assessed to be limited, as it would require large volumes to be excavated with multiple large embankments across multiple storage features to achieve the storage volumes required to significantly reduce flood risk downstream. These storage features would be situated on areas of high-grade agricultural land, which may be considered too valuable to flood. Furthermore, two of the storage areas to the south in Figure 3.7 are disconnected and set a distance away from the main South Queich watercourse. This would require works to construct a new diversion feature to direct water to this area during flood events, and in addition construct a new flow route for stored water to be diverted back into the South Queich at a suitable location downstream. This action was ruled out as being technically unfeasible.

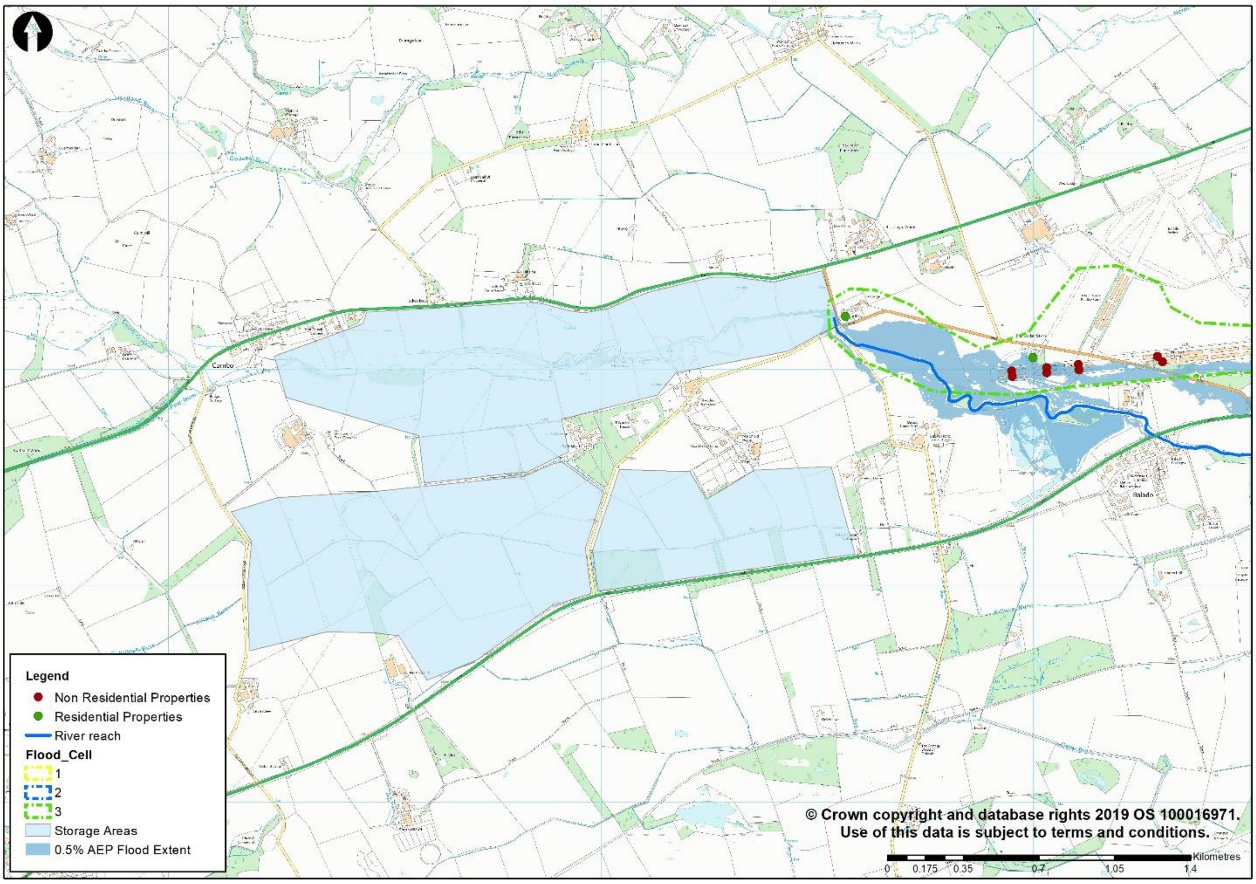

Figure 3.7: Potential storage areas for Flood Cell 1 & 3, upstream of modelled extent

3.3.1.5 PLP/PLR Solution

Property Level Protection

Property Level Protection (PLP) can be afforded to all at risk properties. This consists of a way to prevent water entering a property such as flood gates and air vent covers. PLP would provide protection up to a depth of 0.6m, beyond which water would be allowed to spill over the defence and into the house in order to limit the hydraulic pressure exerted on a building's walls and ensure its structural integrity. Some properties would therefore only be protected during lower flood event return periods. Some PLP measures rely on user intervention to erect them during times of flood, flood gates for example. This can lead to a reduced effectiveness, for example in circumstances where there is no-one available or able to erect the PLP measure.

The prime responsibility for the protection of properties against damage by flooding rests with the owner of the property as stated in the Local Flood Risk Management Plan (LFRMP) and Local Flood Risk Management (Scotland) Act 2009. The LFRMP states that 'Everyone is responsible for protecting themselves and their property from flooding. Property and business owners can take simple steps to reduce damage and disruption to their homes and businesses should flooding happen. This includes preparing a flood plan and flood kit, installing property level protection (PLP), signing up to Floodline and Resilient Communities initiatives, and ensuring that properties and businesses are insured against flood damage'. SEPA are not providing flood warning for the South Queich in Kinross. The SEPA FRM Cycle 1 set out an action to investigate the feasibility of a flood warning system, however it was concluded that it was not feasible for this watercourse.

Property Level Resilience

Property Level Resilience (PLR) can be afforded to all at risk properties. These measures are designed to make people and their property more resilient to the physical and emotional impacts of flooding, although cannot fully alleviate these impacts as it is not considered fully effective at stopping flood water reaching and entering a property. Implementation of these resilience measures will minimise the impact should water enter the house, speeding up the recovery process.

Examples of works which may be undertaken to improve a property's flood resilience include pointing or waterproofing brickwork, adding airbrick covers, waterproofing floors and substructures, installing non-return valves and moving vulnerable features such as wall plug sockets and wiring above the design standard of protection flood elevation level.

While PLR can make buildings more resilient the change required may not be suited to all buildings. Residential houses may be less suited to PLR and emotional impacts could remain high, while warehouses and other commercial premises may be more suited. PLR should therefore be considered on a case-by-case basis.

Conclusion

PLP and PLR, while not providing the full SoP, would be effective in reducing flood risk and was therefore considered as feasible. However, as there are a total of 39 residential properties and 42 commercial properties at risk of a 0.5% AEP fluvial flood event in Flood Cell 1, adopting PLP / PLR for all properties at risk is unlikely to be appropriate, given the lower SoP that would be afforded.

Therefore, this action is not one that should be considered to reduce flooding throughout Flood Cell 1, although this may be applicable for a small number of properties where there are no other viable solutions due to technical, economic, environmental or social reasons. This action should be considered as an addition to another solution where the target SoP is unable to be met through structural or non-structural methods.

3.3.1.6 Relocation

Relocation considers single or groups of receptors that can be relocated out of the risk area to a suitable location. When considering which receptors would be suitable for relocation the social, technical and economic factors were considered. Such factors included:

- Would removing properties have a detrimental impact on the local community;
- Are there other suitable areas zoned to accommodate the relocation;
- Would the cost be disproportionate to the present day damage from flooding;
- Public safety - especially in areas where there may be deep fast flowing water during a flood event;

- Potential to ease restrictions on development of other options e.g. to make space for defences or flood storage / conveyance improvements as part of structural solutions.

When assessing which properties may be suitable for relocation, the market value of the property was considered against the damage which the property may incur through flooding. Properties were considered suitable for relocation if the damage which they may incur through flooding was greater than their market value. Single isolated properties or isolated groups of properties are commonly only considered suitable.

In Flood Cell 1 there were no isolated properties identified where relocation may be preferred. Based on the 81 properties at risk within Flood Cell 1, the combined market value and estimate of relocation of these properties was calculated to be over £40m. This demonstrates that not only would such an option be socially unacceptable but would also be economically unviable.

3.3.2 Flood Cell 2 – Clash Burn / Loch Leven

The following actions were considered for Flood Cell 2:

- Improving Channel Conveyance / Diversion;
- Property level protection (PLP);
- Property level resilience (PLR);
- Storage.

3.3.2.1 Improving Channel Conveyance / Diversion Solution

The Clash Burn is located within a predominantly urban setting. This poses challenges in regard to increasing the capacity of existing culverts which are undersized, where sections of culvert are heavily constrained by existing structures. For this reason both upsizing and diversion where necessary were considered together, to achieve solutions that would address the observed flooding mechanisms and avoid constraints.

Following a review of relevant existing information and discussion with PKC, RPS investigated two diversion options; diversion of flow from the Clash Burn to the South Queich, and diversion of the existing culvert to follow more easily accessed locations regarding construction and maintenance, which avoided buildings and other receptors.

3.3.2.1.1 Diversion of Flow from the Clash Burn to the South Queich

At Hopefield Place there are three small culverts that would need to be upgraded to larger 500mm culverts to prevent these flooding out of their manholes. The main diversion to the South Queich considered a 1000mm diameter circular culvert, located between Hopefield Place and the old railway bridge on the South Queich. This would require the construction of a new culvert below Junction Road. Two manholes on Montgomery Street would also need sealed to prevent these smaller culverts from overflowing during the 0.5% AEP flood event. The results of the Clash Burn diversion to the South Queich are shown in Figure 3.8. With this option there would still be some flooding out of the culverts along Smith Street. Therefore, this option would need to be combined with another option set out in 3.3.2 to provide additional flood protection. In the simulation it was apparent that the present day 0.5% AEP fluvial flooding from the South Queich increase as a result of this diversion. It is assumed, however, that an action for Flood Cell 1 may be able to address this increase in flooding.

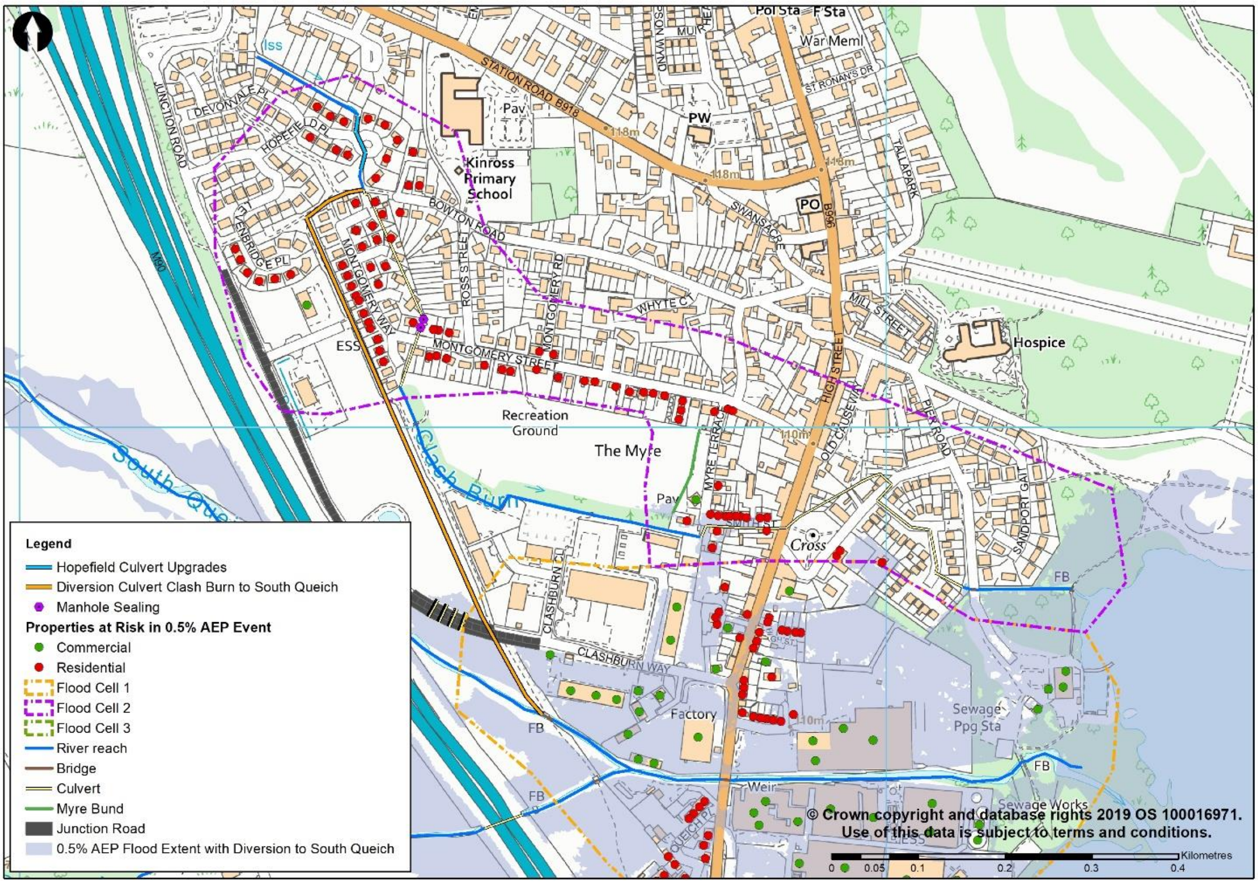

Figure 3.8: Flood Cell 2 Diversion to South Queich Solution

3.3.2.1.2 Diversion to Avoid Receptors

The second diversion option diverts the Clash Burn near Hopefield Place and conveys the flow along an alternative route to direct it into an open section of the Clash Burn at The Myre playing fields. An additional diversion route would be required from the junction of Smith Street and High Street and would divert flows away from the existing culverted section. This new section would divert along Nan Walker Wynd before re-joining the Clash Burn open channel at Sandport Close. Both of these diversion sections were modelled as 1000mm circular culverts. At Hopefield Place the existing culverts would have to be upgraded to 500mm culverts to take flow from the upstream channel and prevent flooding in this area. This option would also require the two manholes at Montgomery Street to be sealed to prevent the culverts from surcharging during a 0.5% AEP flood event. A storage pond to a depth of up to 400mm below existing ground levels would be included along the Clash Burn at the Myre playing fields to store a small amount of flooding. The results of these actions are shown below in Figure 3.9, which are capable of alleviating the 0.5% AEP fluvial flood risk in Flood Cell 2 from the Clash Burn. There would still be a flood risk to Flood Cell 2 from the South Queich. However it may be possible to adapt any suitable actions in Flood Cell 1 to accommodate the additional flow.

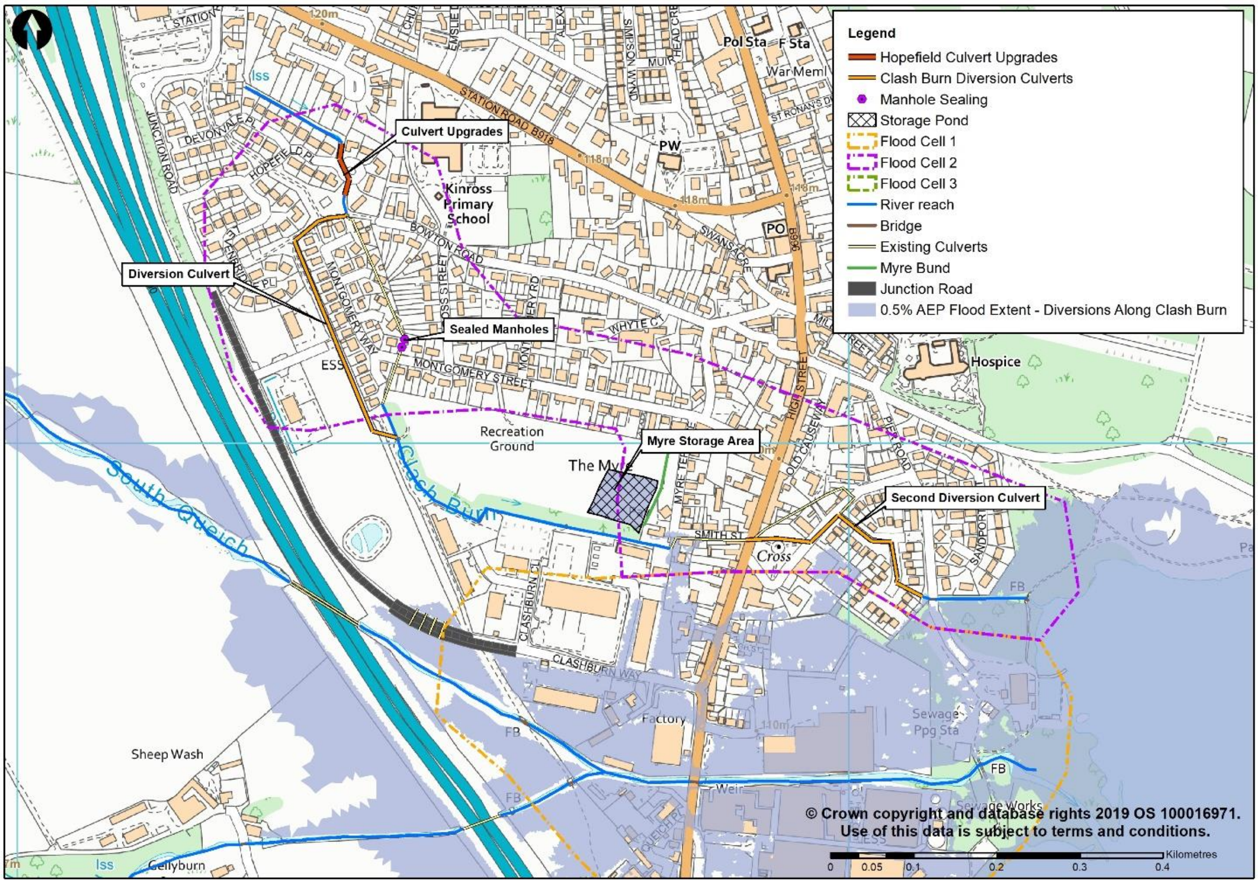

Figure 3.9: Flood Cell 2 Diversions along Clash Burn Solution

The 'diversion to avoid receptors' actions managed to keep fluvial flows within the same catchment, did not increase flood risk to the South Queich and provide the target 0.5% AEP fluvial SoP. Therefore, this diversion was favoured to directing from the Clash Burn to the South Queich.

3.3.2.2 PLP/PLR Solution

There are a total of 87 residential properties and 2 commercial properties at risk of a 0.5% AEP fluvial flood event within Flood Cell 2. It is not guaranteed that these properties would be protected to the standard required if they were all to be given PLP or PLR. Therefore, this action is not one that should be considered to reduce flooding throughout Flood Cell 2, but this may be applicable to a small number of properties where there are no other viable solutions. This action should be considered as an addition to another action if required.

3.3.2.3 Storage

Within Flood Cell 2 there is a potential area for storage at the Myre playing fields. To reduce the flow downstream of the Myre to that of a 50% AEP fluvial event, the storage volumes required are presented in Table 3.5.

Table 3.5: Storage volume required to reduce event probabilities to a 50% AEP event downstream of the Myre

Event Probability	Storage Required (m^3)
	FC2 Clash Burn
50% AEP	-
20% AEP	3,975
10% AEP	4,750
3.3% AEP	5,853
1.3% AEP	7,421
1% AEP	7,910
0.5% AEP	9,248
0.1% AEP	11,508

Assuming that the ground level could be reduced by 1m below existing ground levels across an approximately 27,000m^2 area, this would provide the required storage volume to reduce flood risk downstream. However, this would not be able to provide protection to properties upstream as flooding occurs in these locations due to out of channel flooding and a limited capacity within culverted sections. The potential storage area assessed is highlighted in Figure 3.10.

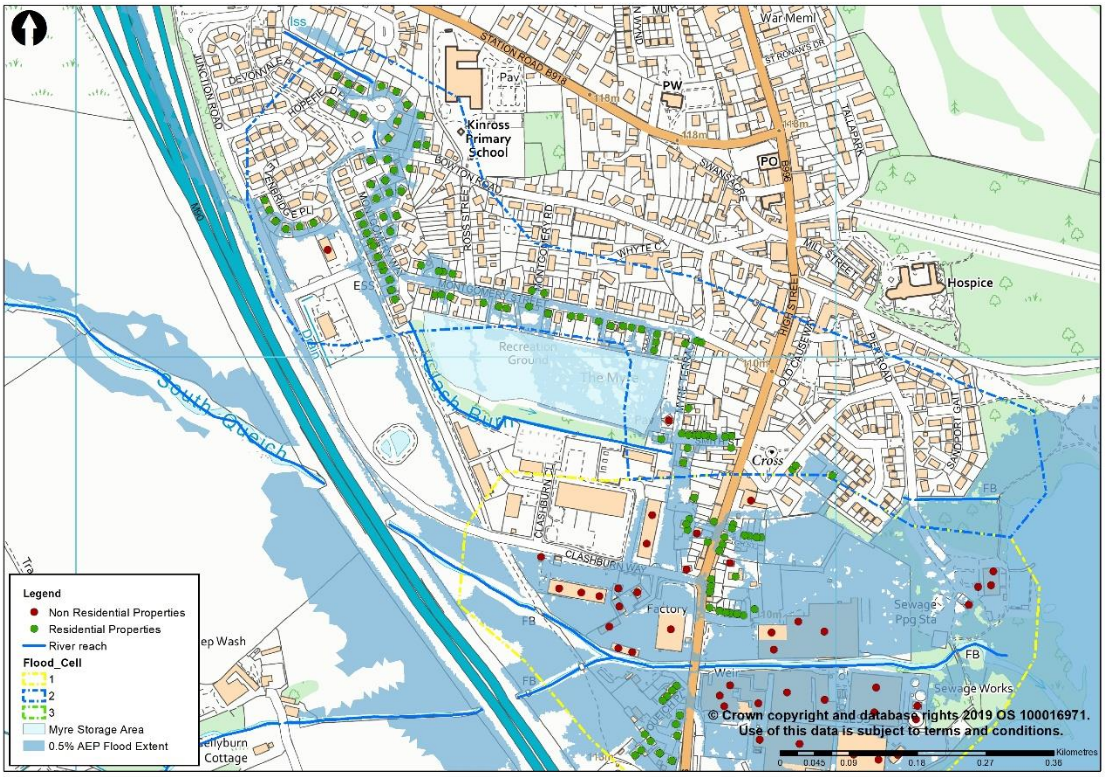

Figure 3.10: Potential storage area in Flood Cell 2

3.3.3 Flood Cell 3 – South Queich

The following actions were shortlisted for Flood Cell 3:

- Storage

3.3.3.1 Storage

Storage was proposed for Flood Cell 3 in order to protect flooding to the M90 services and the M90 motorway. This would be achieved by a flood embankment approximately 294m long and an average height of 1.05m. This embankment would also reduce flooding to Flood Cell 2 by preventing the flow path down the M90 and across Levenbridge Place. This option would prevent flooding to the M90 services but would not prevent flooding at the Balado Poultry Farm buildings. Flood depths at the Balado Poultry Farm buildings would not be increased due to the provision of flood storage. The simulated results of this option are shown below in Figure 3.11. As shown, there was no fluvial flooding identified to the commercial properties or the M90 motorway from the South Queich when the embankment was represented in the hydraulic model.

The Flood Cell 3 storage area is situated over 0.5km from the South Queich. Directly adjacent to the storage area is the Ury Burn, into which the stored water would most easily be discharged. The stored water should be discharged at a rate such that it does increase any potential flood risk downstream. This would be achieved through a control structure that would limit the rate at which water would be released from the storage area.

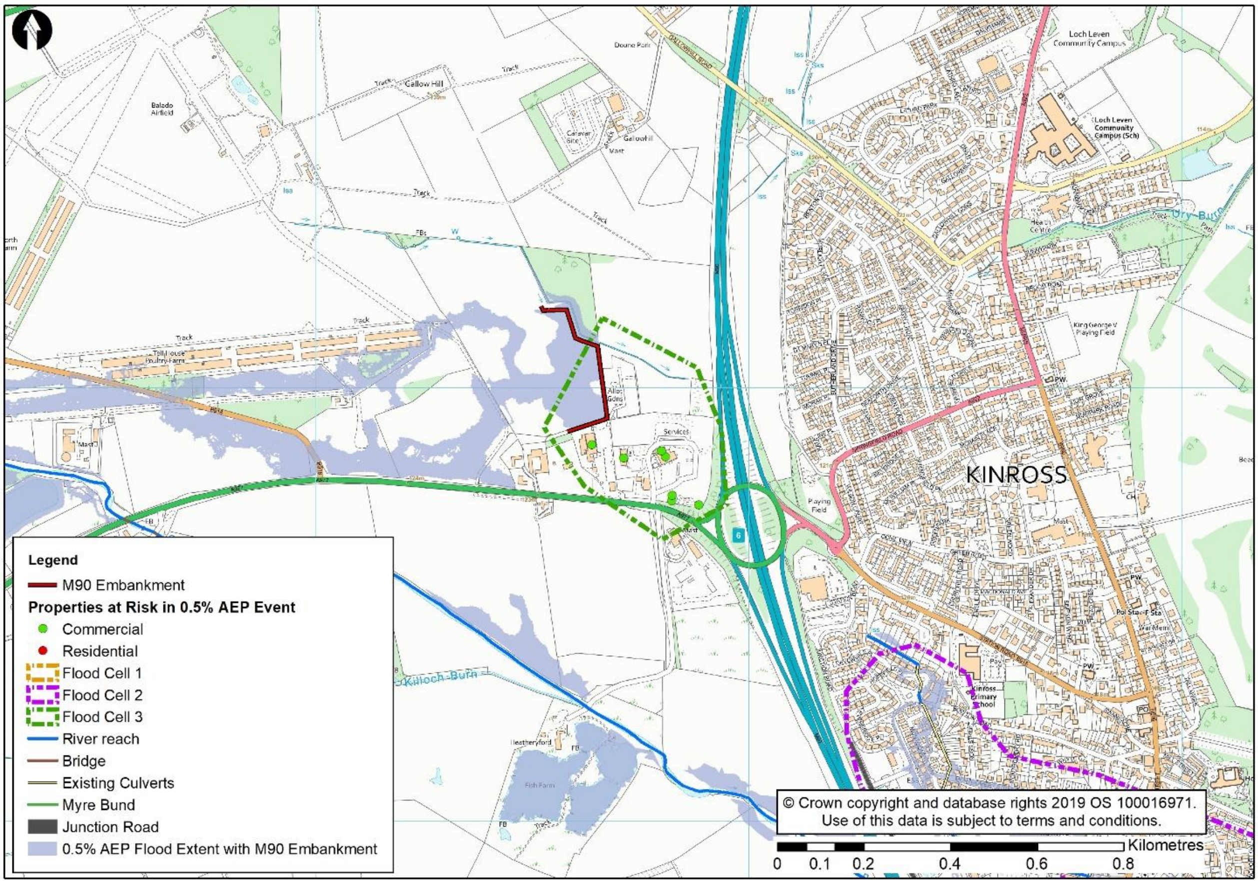

Figure 3.11: Flood Cell 3 Direct Defence Solution

A summary of the Flood Cell 3 flood embankment is shown below in Table 3.6.

Table 3.6: Summary of Flood Cell 3 Flood Embankment

Defence Type	Length (m)	Average Height (m)	Max Height (m)
Embankment	455	1.18	1.61

3.4 Stage 3 - Compare and Select the Most Sustainable Solution

The options described in Section 3.3 were appraised. Their effectiveness at reducing the 0.5% AEP flood risk and cost benefit to create the defence was investigated as part of the shortlisting of actions. These are listed for each Flood Cell and each action reviewed.

	Provides 0.5% AEP Fluvial Standard of Protection to majority of properties		
Action	**FC1** South Queich / Loch Leven	**FC2** Clash Burn	**FC3** South Queich
Improvement of Conveyance	-	-	
Diversion	×	✓	

Action	Provides 0.5% AEP Fluvial Standard of Protection to majority of properties		
	FC1 South Queich / Loch Leven	FC2 Clash Burn	FC3 South Queich
Direct Defences	✓		
Storage	-	-	✓
Property Level Protection	-		
Property Level Resilience	-		
Relocation	×		

✓ effective in protecting majority of properties at risk, - unable to protect majority of properties at risk but may be used in combination with other actions, × screened out based on shortlist action screening

RPS undertook a benefit-cost analysis to demonstrate the economic case for the identified options. This involved an assessment of the benefits (i.e., reducing flood impact) and the costs of the options over a 100-year design life span. This approach ensures that Perth and Kinross Council has a robust economic argument which shows that the preferred option provides best value for money. A breakdown of costs for those actions which were capable of removing the majority of flooding to a given Flood Cell have been included.

A cost benefit cannot be attributed to any of the individual options as there is interaction between all three Flood Cells, as detailed in Sections 2.1 to 2.3. To compare these individually would either double count some properties or not include others when totalling the costs and benefits associated with each option. Therefore, the cost benefit of the options is listed below for the preferred option in Section 4.

Full details of the Economic Appraisal including damage assessment assumptions and option costing are presented in Appendix C, D and E. Table 4.2 summarises the results of the Economic Appraisal.

3.4.1 Flood Cell 1

Through the shortlisting of actions and testing in the hydraulic model it was identified that the Direct Defences action provided the target SoP to the majority of properties, with only 4 commercial properties at Loch Leven at risk of extreme water levels in the Loch. To afford some protection to the properties at risk whilst cutting off access to the Loch, PLR would provide resilience to flooding and greatly reduce any potential damage caused by flooding from the Loch.

Table 3.7: Summary of Economic Appraisal for FC1

	Costs (£)		
	Baseline	Direct Defence	PLP/PLR (4 commercial properties)
Enabling	-	£181,409	£9,174
Preliminaries	-	£164,917	£8,340

	Costs (£)		
Construction	-	£1,593,402	£80,580
Maintenance (NPV over 100 years)	-	£37,816	£46,448
Optimism Bias Adjustment (60%)	-	£1,186,526	£86,725
Total Present Value Costs	-	**£3,164,069**	**£231,266**

Although not considered within the preferred actions for Flood Cell 1, a costing exercise was undertaken for conveyance as it was found to provide some protection to properties. The total Present Value Cost was calculated to be £1.09m, which is less than the cost of direct defences. For this action to be feasible it would need to be combined with another action, such as direct defences, which would increase the costs. There would also be negative environmental impacts associated with dredging the South Queich, which would be required periodically over the 100-year design life of the scheme. This has the potential to negatively impact the ecological status of the South Queich, as well as Loch Leven immediately downstream.

In Flood Cell 1 the actions brought forward to form part of the preferred option are Direct Defences, in combination with Property Level Resilience.

3.4.2 Flood Cell 2

Through the shortlisting of actions and testing in the hydraulic model it was identified that a combination of diversion and upgrading of the culvert network would be required to provide the 0.5% fluvial Standard of Protection to the majority of properties at risk. A number of the actions included were costed to demonstrate those which offer good value for money. Those actions costed are presented in Table 3.8.

Table 3.8: Summary of Economic Appraisal for FC2

	Costs (£)			
	Baseline	Diversion to South Queich	Diversions on Clash Burn	PLP/PLR
Enabling Costs	-	£576,142	£548,315	£299,343
Preliminary Costs	-	£418,565	£398,348	£272,130
Construction Costs	-	£2,378,884	£2,263,985	£2,629,275
Maintenance Costs (NPV over 100 years)	-	£657,143	£465,463	£1,515,566
Optimism Bias Adjustment (60%)	-	£2,418,439	£2,205,667	£2,829,789
Total Present Value Costs	-	**£6,449,172**	**£5,881,778**	**£7,546,103**

At the shortlisting of actions stage the hydraulic modelling identified the diversions on the Clash Burn as providing the greatest standard of protection to properties within Flood Cell 2, while not increasing the flood risk on the South Queich / Flood Cell 1. As can be seen in Table 3.8 this option is also cheaper compared with the diversion to the South Queich. PLP / PLR was also costed for all properties in Flood Cell 2. This action does not provide the target SoP and is also shown to be more expensive compared to the diversion and upgrade actions.

In Flood Cell 2 the actions brought forward to form part of the preferred option are diversions on the Clash Burn and upgrades on the Clash Burn. To provide the target SoP to all properties at risk a small temporary storage area at The Myre and manhole sealing at two properties would also be required. The preferred option is described in further detail later in Table 4.1.

3.4.3 Flood Cell 3

Flooding observed in Flood Cell 3 is caused by a lack of channel capacity further upstream of the South Queich, which was outside of the study area. To intercept the flowpaths observed immediately upstream of the area of risk, storage was investigated to protect within Flood Cell 3. To allow an economic comparison with another action, PLP / PLR was also costed, which could provide some protection to the commercial properties at risk Flood Cell 3.

Table 3.9: Summary of Economic Appraisal for FC3

	Baseline	FC3 Storage Embankment	PLP/PLR
	Costs (£)		
Enabling Costs	-	£21,511	£16,055
Preliminary Costs	-	£19,556	£14,595
Construction Costs	-	£188,945	£141,014
Maintenance Costs (NPV over 100 years)	-	£34,513	£81,284
Optimism Bias Adjustment (60%)	-	£119,036	£151,769
Total Present Value Costs	-	**£383,561**	**£404,716**

4 PREFERRED OPTION

The preferred option was identified through the findings of cost, levels of protection, impact upon the natural environment and any potential impact on social receptors.

4.1 Description of Preferred Option

A summary of the solutions chosen for the preferred option are listed below in Table 4.1 for each of the Flood Cells.

Table 4.1: Description of Preferred Option

Flood Cell	Preferred Option	
	Solution	**Description**
FC1 South Queich/Gelly Burn	Direct Defences	Direct Defences including embankments, retaining walls and sheet pile walls. These would be situated predominantly along the banks of the South Queich from the Old Railway Bridge to the Loch Leven Heritage Trail footbridge. Embankments would be placed between the M90 and Queich Place to utilise an existing area of floodplain while preventing a flow path through to Queich Place and the surrounding areas. A small stretch of embankment would also be placed near the woollen mill's wastewater treatment plant at the right bank of the South Queich close to Loch Leven to prevent this area from flooding.
FC2 Clash Burn	Culvert Upgrades/Diversions	Culverts would be upgraded at Hopefield Place. Immediately downstream of this at Bowtown Road a diversion culvert would divert the flow from the Clash Burn behind the properties on Montgomery Way before discharging back into the Clash Burn at the Myre playing fields. Two manholes would be sealed at Montgomery Street to prevent these from overflowing. A small temporary flood storage area would be placed on the Myre playing fields adjacent to the Clash Burn close to Smith Street to reduce overland flows from impacting on some properties along Smith Street. Downstream at the junction of Smith Street and High Street a second diversion culvert would take more flow along the Sandport Road, then along Nan Walker Wynd and directed between two properties and back into the Clash Burn at Sandport Close.
FC3 South Queich	Storage	An embankment would be constructed close to the M90 services to protect commercial properties, intercepting an overland flow path that is shown to impact the M90, before travelling along the road and into Flood Cell 2.

A summary of the preferred option's CBA is presented in the table below.

Table 4.2: Summary of Economic Appraisal for the Preferred Option

	Preferred Option
	Costs (£)
Capital costs	£5,007,518
Optimism Bias Adjustment (60%)	£3,405,932
Maintenance Costs (NPV over 100 years)	£669,035
Total Present Value Costs	£9,082,485
	Benefits (£)
Present Value Damage	£85,593,630

Present Value Damage Avoided (Benefit, Capped)	£ 12,947,372
Intangible Benefit	£ 402,361
Total Present Value Benefit	£13,349,733
	Benefit Cost Ratio
Benefit / Cost Ratio (BCR)	1.47

A breakdown of the geometry of alleviation actions, quantities of materials and costs are detailed in the Appendices (Costing Sheets).

5 UPDATE TO PREFERRED OPTION

5.1 Historic Flooding Information

Following engagement with local residents and businesses at the Loch front by PKC there were reports of a flooding mechanism which had been observed in previous flood events. This information was supplied after the preferred option had been identified. Subsequently RPS investigated the model to identify whether the model was replicating the flooding mechanisms observed, and whether and update to the preferred option would be required. Photos provided have been included in Appendix F.

5.2 South Queich FPS Updated Preferred Option

Following the receipt of new historical evidence, a small alteration to the preferred option was required. The additional historical flood evidence highlighted that there was a flow path which occurs across the left bank of the South Queich downstream of the BCA buildings. Following this new information, the model was tested to determine if this mechanism was being replicated. This flow path was correctly picked up however the levels in Loch Leven were masking it, due to interaction between the two sources. Following sensitivity runs where the loch levels were reduced it was determined that the flow path was present and would need a solution to prevent additional fluvial flood risk to properties along the pier in Flood Cell 1. The flooding mechanism across the left bank was addressed by extending the direct defences already proposed on the South Queich. These direct defences would be extended alongside the pumping station just upstream of the Loch Leven Heritage Trial footbridge. From here the defences would travel northwards to the back of a storage shed before travelling east and stopping close to the edge of the quay on Loch Leven. The extended defences are shown below in Figure 5.1.

An Environmental Impact Assessment (EIA) Screening Report was undertaken in July 2021 based on the preferred option presented. It was recommended that an EIA Report be undertaken for the South Kinross FPS. An EIA scoping exercise was being undertaken at the time of writing to inform the main chapters of an Environmental Impact Assessment report.

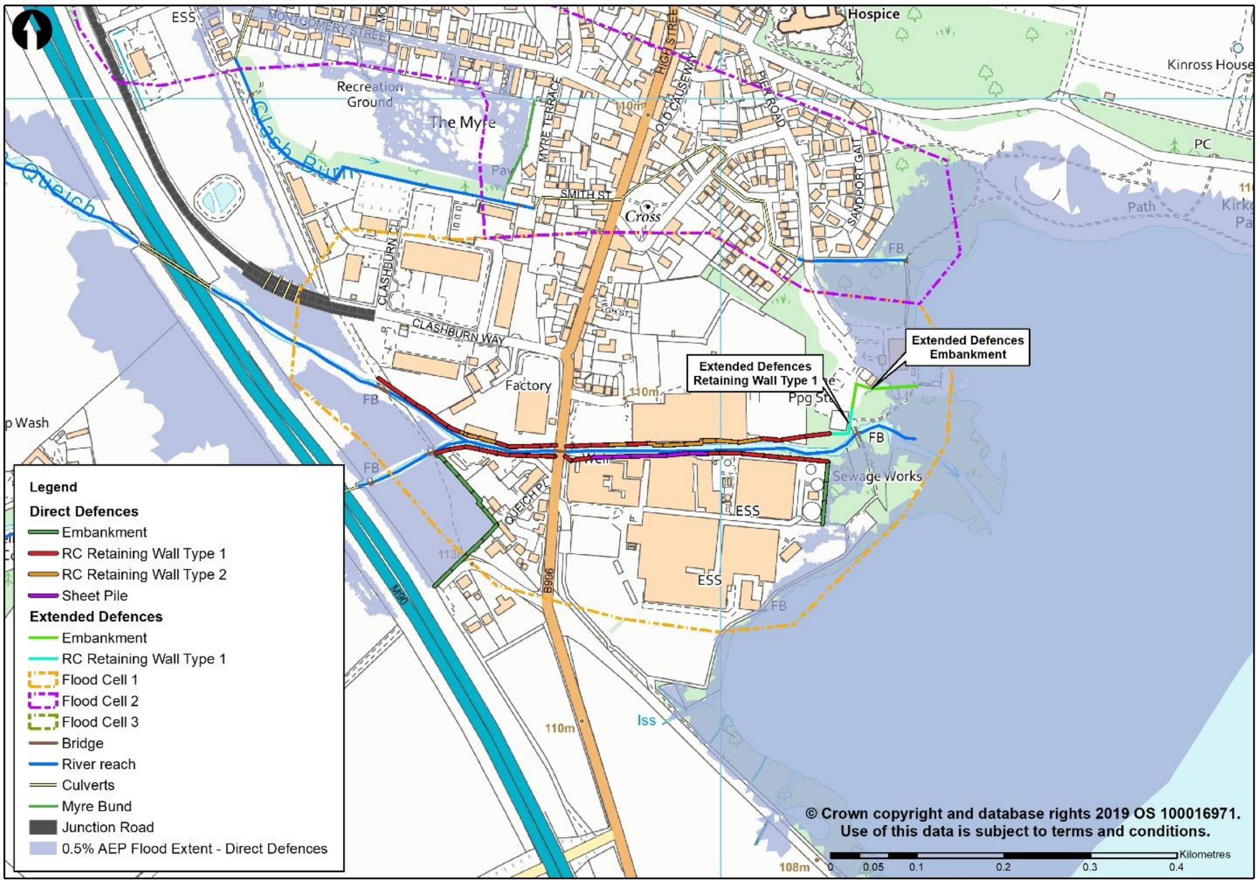

Figure 5.1: Updated Preferred Option for Flood Cell 1

The cost of the preferred option was updated, and the cost-benefit ratio revised. This information is presented in Table 5.1 benefit was developed for this preferred option and is listed in Table 5.1.

Table 5.1: Updated Preferred Option Cost Benefit Ratio

	Updated Preferred Option
	Costs (£)
Capital costs	£5,167,176
Optimism Bias Adjustment (60%)	£3,506,506
Maintenance Costs (NPV over 100 years)	£677,000
Total Present Value Costs	£9,350,681
	Benefits (£)
Present Value Damage (uncapped)	£ 79,485,139
Present Value Damage Avoided (Benefit, Capped)	£ 12,761,953
Intangible Benefit	£ 402,361
Total Present Value Benefit	£ 13,164,314
	Benefit Cost Ratio
Average benefit/cost ratio	1.41

The updated preferred option was found to still be cost beneficial. An updated MCA was also created to take into account that the extended direct defences would be close to the SPA and RAMSAR sites of the Loch Leven.

Figures showing the final preferred option for the South Kinross FPS have been included in Figure 5.2 and Figure 5.3. The costing breakdown has been included in Appendix E.

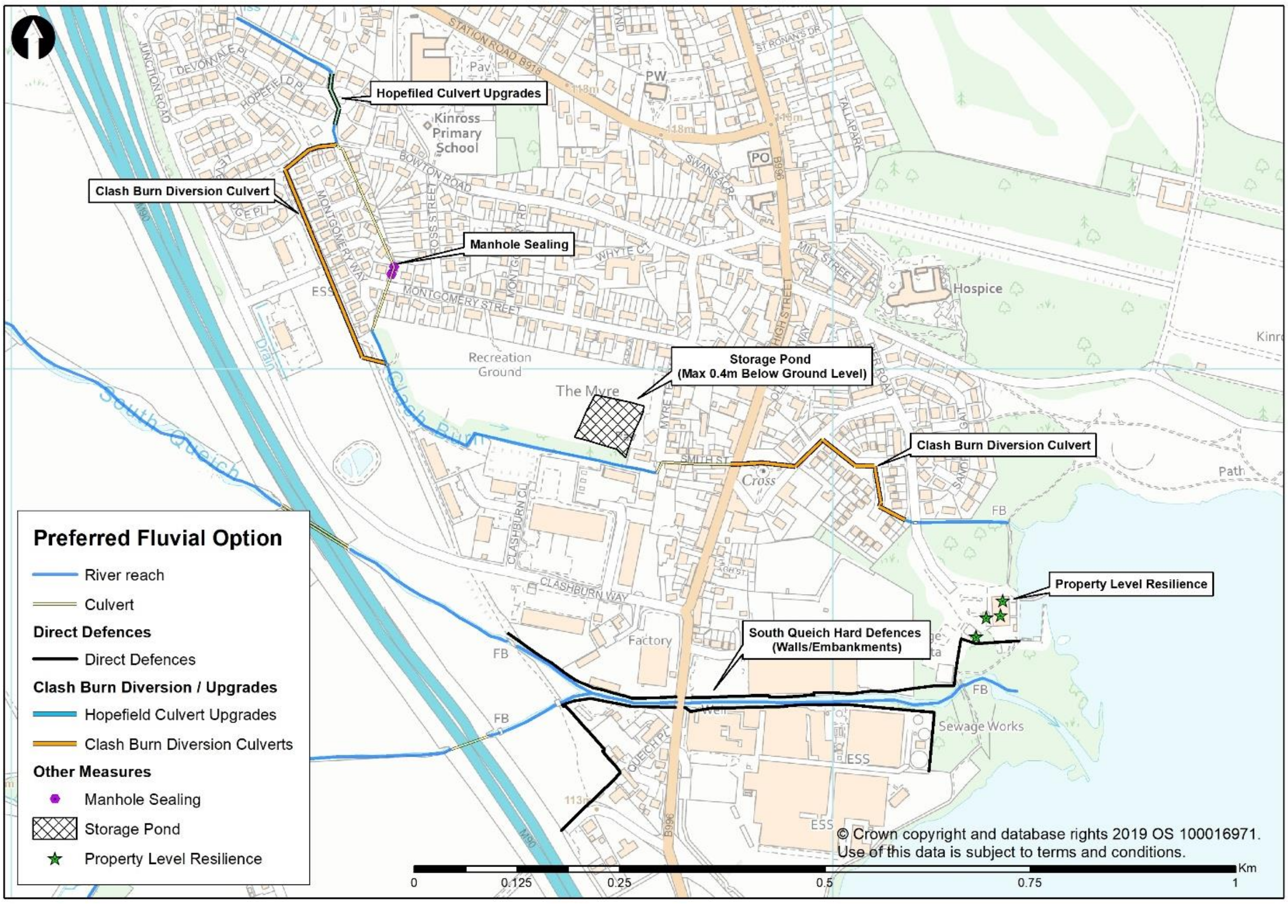

Figure 5.2: South Kinross FPS Preferred Option (Flood Cells 1 & 2)

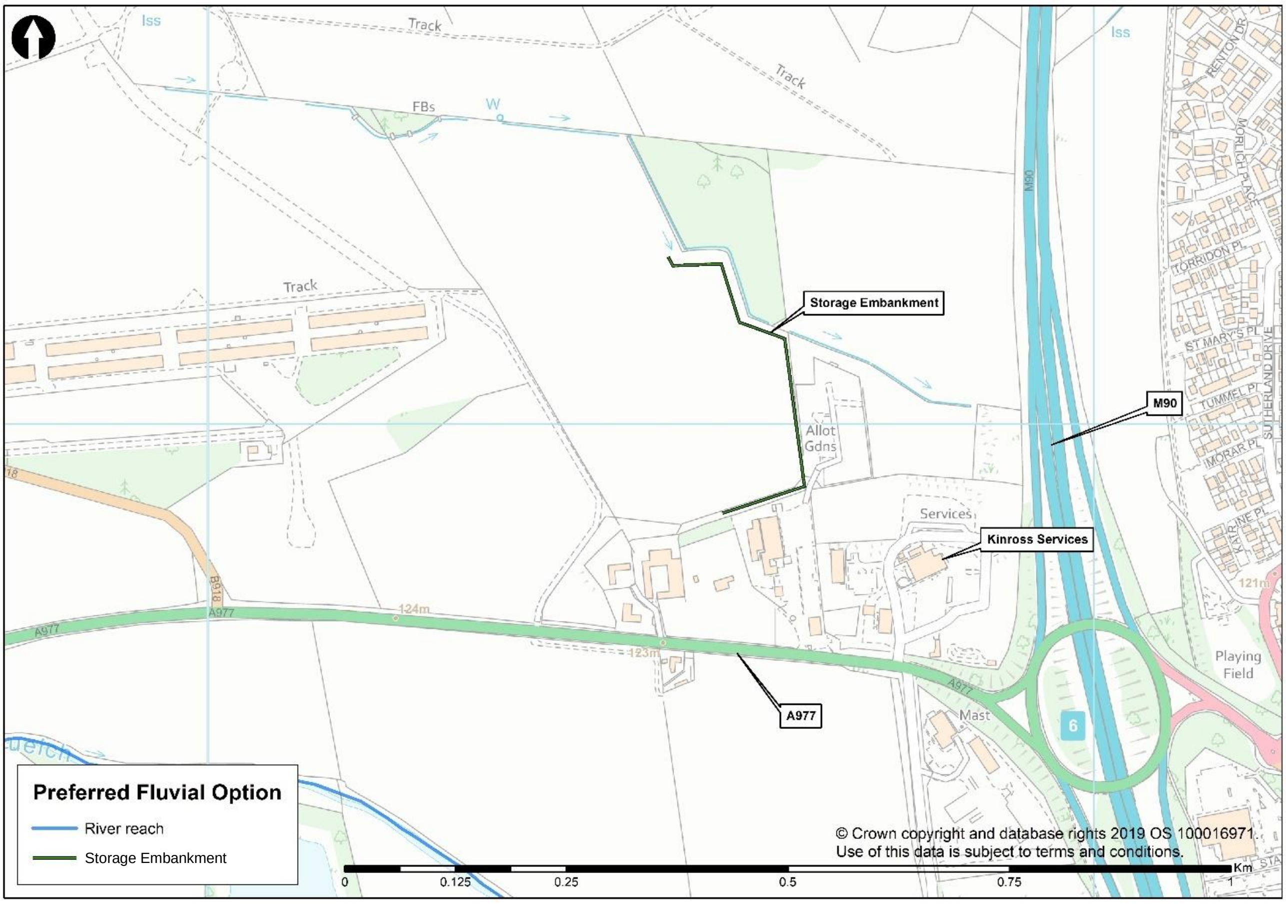

Figure 5.3: South Kinross FPS Preferred Option (Flood Cell 3)

6 CLIMATE CHANGE ADAPTABILITY

The impact of climate change has estimated flows within the study area to increase by 40%. Consequently, climate change is expected to affect the area significantly over the lifespan of the preferred option. The increase in flood extents associated with climate change in the vicinity of the preferred options are presented in Figure 6.1 and Figure 6.2.

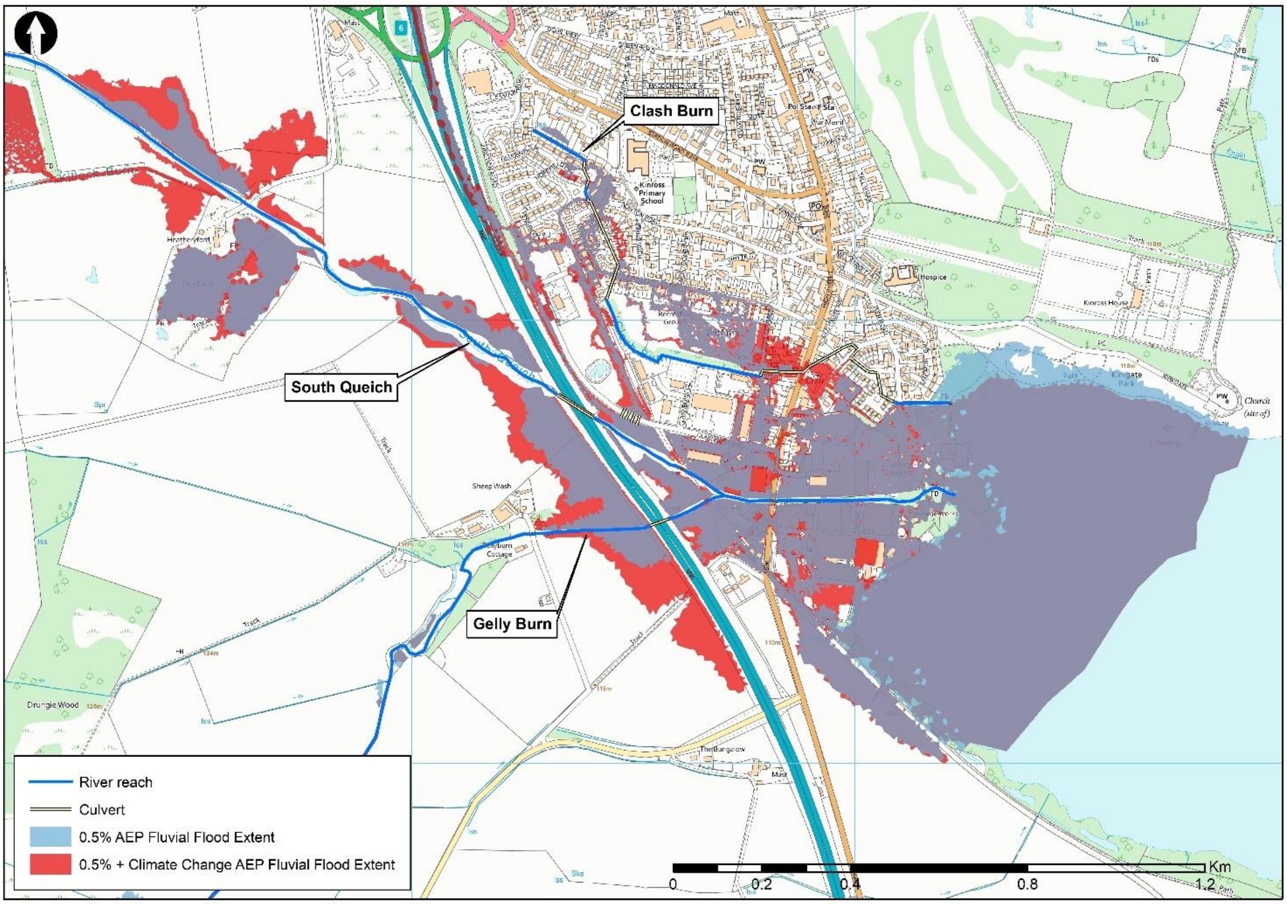

Figure 6.1: 0.5% AEP + Climate change extents comparison with 0.5% present day extents (downstream)

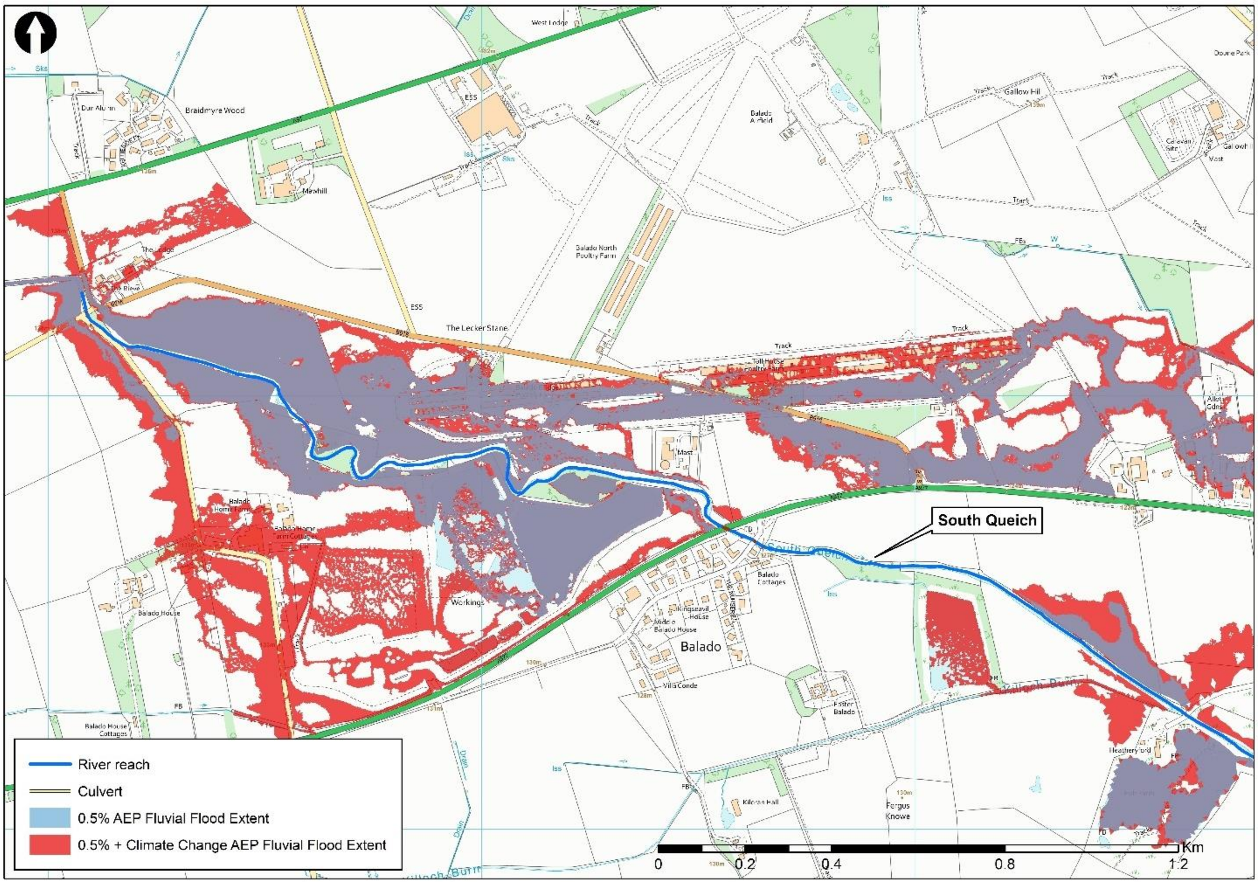

Figure 6.2: 0.5% AEP + Climate change extents comparison with 0.5% present day extents (upstream)

While NFM is not recommended to form part of the preferred option works, it was recommended to be developed through a longer-term plan for the catchment.

It is recommended that a long-term risk strategy form part of the preferred option and should include the following:

- Adaptation of the proposed defences to maintain the 0.5% AEP fluvial SoP across the design life of the scheme.
- Future relocation of risk receptors where current FRM action will become ineffective.
- NFM implementation plan across the catchment where possible.

6.1 Provision of Full 0.5% AEP plus Climate Change Standard of Protection

A 0.5% AEP plus Climate Change Standard of Protection could be afforded to the majority of properties at risk within the study area, through a combination of hard defences (walls and embankments) proposed along the South Queich and Gelly Burn, while on the Clash Burn a combination of culvert upgrades, culvert diversions, storage and manhole sealing has been identified. A number of non-residential properties situated near the

Loch Leven pier at Kinross are to be afforded property level protection, to reduce the impact of flooding from the Loch whilst maintaining access to the pier.

Culvert upgrades were required along Smith Street to provide the adequate capacity for the 0.5% AEP + climate change flows. A small hard defence behind a property on Smith Street was also required to address a flooding mechanism which was observed when the 0.5% AEP preferred option measures (with no climate change provision) were tested with the 0.5% AEP + climate change flows. In other areas hard defences have increased in height and length. The maximum protruding height of the retaining wall type 2 increased by maximum of 330mm, while the sheet pile section increased by a maximum of 262mm.

The details of the adapted 0.5% plus climate change AEP is included within the costing presented in Appendix E.

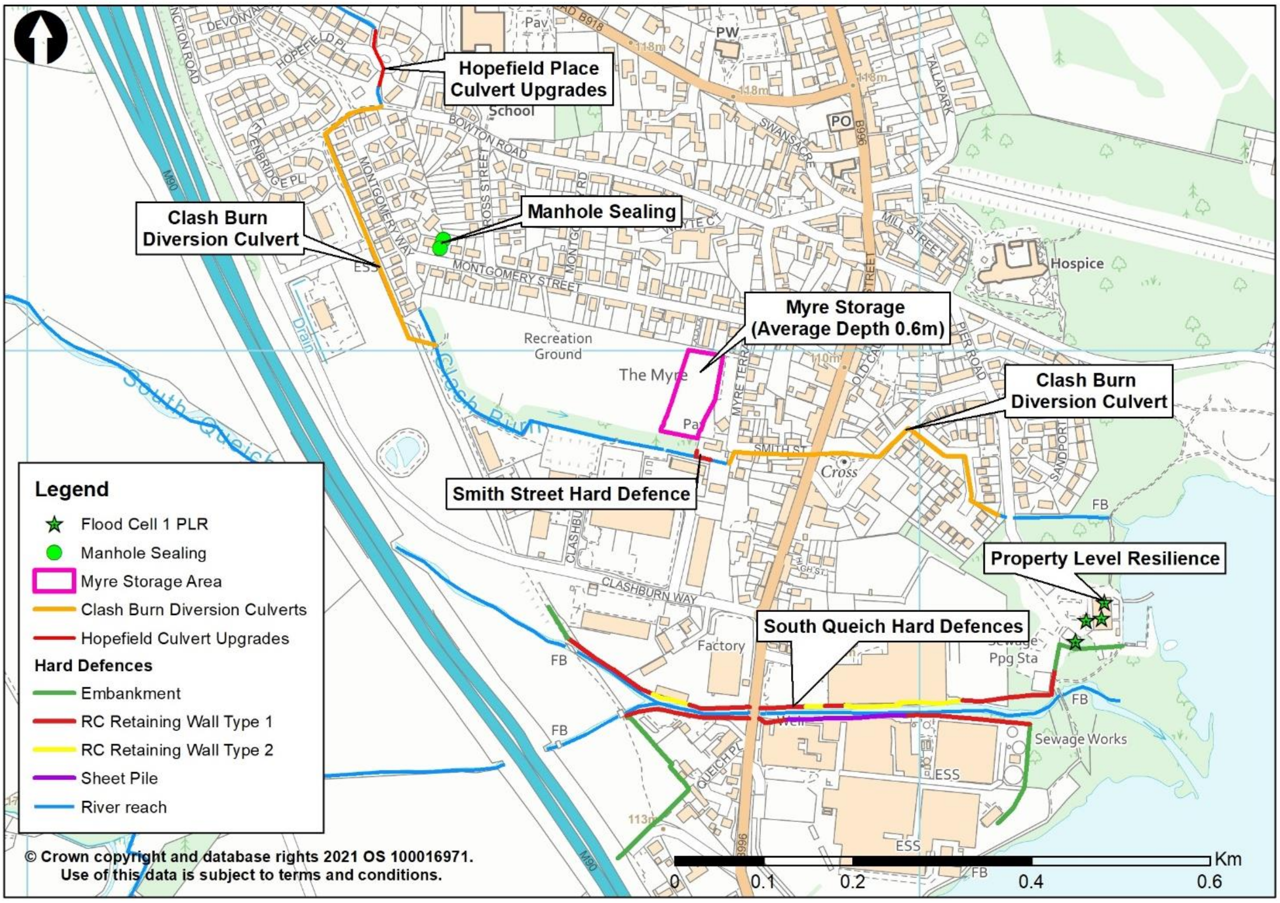

Figure 6.3: South Kinross FPS preferred option, adapted to provide 0.5% plus climate change AEP standard of protection (Flood Cells 1 & 2)

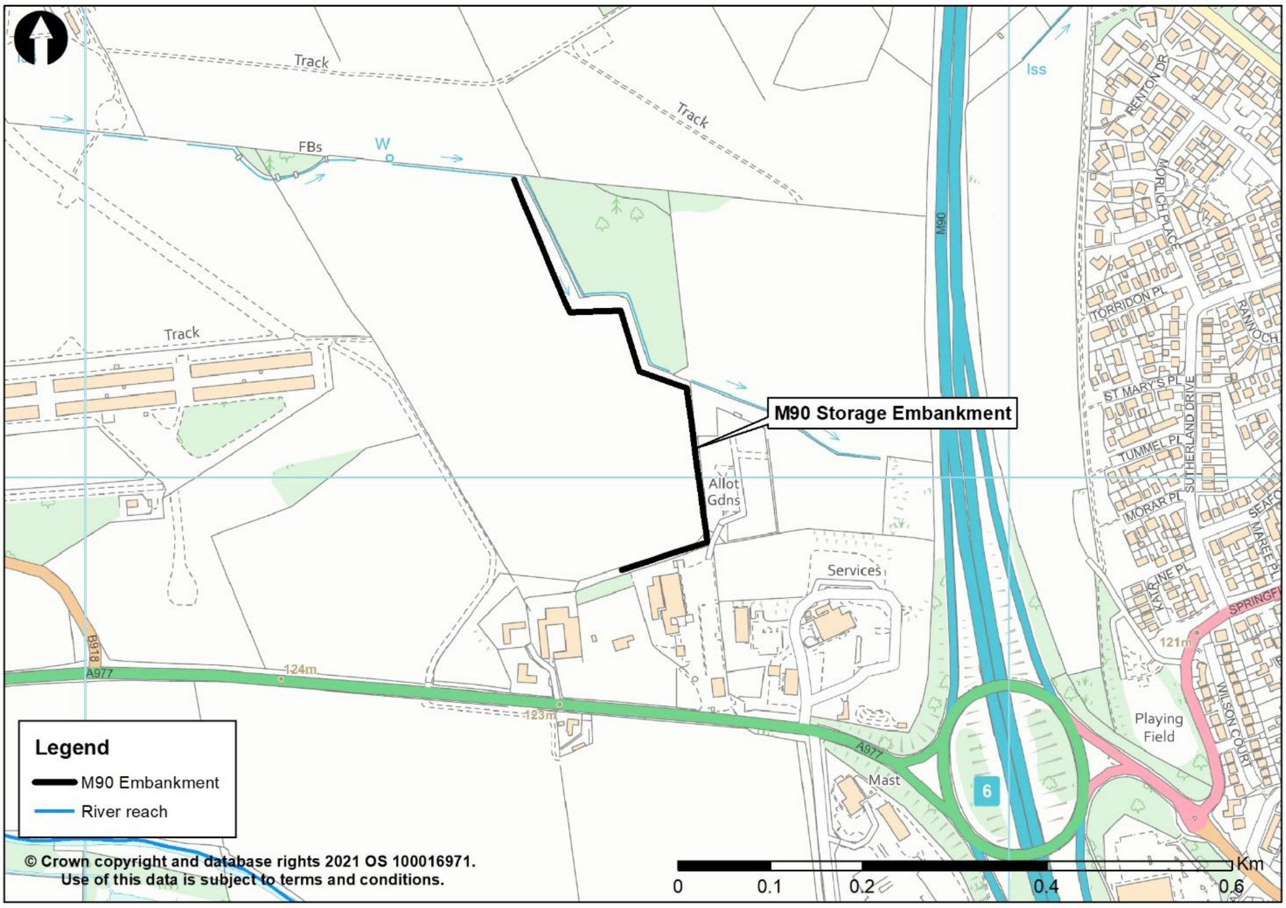

Figure 6.4: South Kinross FPS preferred option, adapted to provide 0.5% plus climate change AEP standard of protection (Flood Cells 1 & 2)

The costing of the adapted preferred option has been presented in Table 6.1. As can be seen, the analysis indicates that the climate change option would maintain a positive cost-benefit ratio.

Table 6.1: Summary of Economic Appraisal for the modified Preferred Option to provide a 0.5% AEP plus climate change standard of protection

	Preferred Option
	Costs (£)
Capital costs	£5,892,841
Optimism Bias Adjustment (60%)	£4,002,895
Maintenance Costs (NPV over 100 years)	£778,650
Total Present Value Costs	£10,674,386
	Benefits (£)
Present Value Damage	£85,593,630
Present Value Damage Avoided	£17,173,129
Intangible Benefit	£403,125
Total Present Value Benefit	£13,349,733
	Benefit Cost Ratio

Average benefit/cost ratio	1.25

6.2 Adaptability to Provide 0.5% AEP plus Climate Change Standard of Protection

It may be possible to construct some of the proposed measures for the 0.5% AEP (present day) standard of protection with allowance for increasing allowance for climate change in the future. One example would be to construct a flood wall with foundations with additional capacity, such that the wall height could be increased in the future, with the original foundations able to cope with the additional loading.

Some options, such as culvert upgrades do not offer the same flexibility as flood walls, as the capacity of culverts are fixed. These measures do not offer adaptability for climate change. Similarly if there are extended portions or additional separate hard defences required these would require additional works beyond the adaptability of measures proposed in the present-day scenario.

For the South Kinross FPS, a scenario was costed where a 0.5% present day standard of protection was afforded for adaptable measures, with increased capacity considered for future adaptation. Where options were not adaptable for the 0.5% AEP plus climate change, such as culvert upgrades, these features were sized and costed to provide the 0.5% AEP plus climate change standard of protection from year 0.

The details of the adapted 0.5% plus climate change AEP is included within the costing presented in Appendix E.

Table 6.2: Summary of Economic Appraisal for the modified Preferred Option to provide a 0.5% AEP present day standard of protection, with 0.5% AEP plus climate change adaptability

	Preferred Option
	Costs (£)
Capital costs	£5,495,125
Optimism Bias Adjustment (60%)	£3,745,195
Maintenance Costs (NPV over 100 years)	£746,866
Total Present Value Costs	£9,987,186
	Benefits (£)
Present Value Damage	£85,593,630
Present Value Damage Avoided	£17,173,129
Intangible Benefit	£403,125
Total Present Value Benefit	£13,349,733
	Benefit Cost Ratio
Average benefit/cost ratio	1.33

6.3 Findings

The modelling and costing exercise carried out to assess the potential climate change adaptability shows that it may be possible to design a flood scheme which accounts for climate change whilst maintaining a favourable benefit-cost ratio. The increased water level brought about by climate change will however have a range of impacts, notably on the visual aspect within an urban setting and on the existing control structures, such as the South Queich Bridge. The maximum water level in the 0.5% AEP plus climate change event at South Queich bridge is 110.668m AOD, which is 372mm higher than the 0.5% AEP event. When compared to the soffit level of the bridge at 111.249m AOD, this is likely to increase the loading on the bridge abutments of the arch bridge. The impact of the maximum water level and any modifications required at South Queich bridge will be assessed during the design stage.

There are however a number of work areas which are to be assessed through the subsequent design stages and environmental assessments, where analysis may identify the requirement to change the form and / or position of proposed measures. This has the potential to drive up costs, and at present there is no accepted methodology for deriving additional present value benefits from climate change impacts to properties. The minimum target standard of protection for the 0.5% AEP fluvial event set out for the project is to be assessed going forward.

7 STANDARD OF PROTECTION RECOMMENDATION

7.1 Background

Following the completion of the draft Option Review Report, RPS were commissioned to recommend the standard of protection (SoP) for the South Kinross Flood Protection Scheme. To allow a recommendation to be made on the SoP, RPS appraised various options, which were included in an addendum to the Option Review Report (see Appendix H). This report focussed on options relating to the following standards of protection of the scheme, as instructed by Perth & Kinross Council.

Standards of Protection

Option 1: 0.5% (Present Day) Fluvial AEP

Option 2: 0.5% + Climate Change Fluvial AEP

Option 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

Option 4: 0.5% (Present Day) Fluvial AEP with NFM Strategy

The assessment built upon the analysis and findings presented in the D02 version of the South Kinross FPS Option Review report, which presented a scheme that provides a 0.5% AEP fluvial Standard of Protection (SoP) as the preferred option. A recommendation on the SoP was later considered per flood cell, to allow the economic, social, and environmental merits of any methods to be considered, alongside the specific flooding mechanisms, constraints, and opportunities within each area.

7.2 Recommendation

A recommendation per Flood Cell was proposed by RPS, based on the outcomes of the Multi-Criteria Analysis and Benefit-Cost Ratios presented in the report in Appendix H, which captured a broad range of technical, economic, social, and environmental criteria. The recommended SoP per flood cell, as agreed with PKC, were as follows:

Flood Cell 1: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

Flood Cell 2: 0.5% + Climate Change Fluvial AEP

Flood Cell 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

8 RECOMMENDATIONS TO SUPPORT OPTION DEVELOPMENT

To support the option development, there were a number of recommendations set out which may assist in providing further confidence of the feasibility of the preferred option identified. These activities were taken forward for the stages following to the completion of the option review report, informing both the outline and detailed design stages.

- Further topographical surveys would be required to inform outline and detailed design. This will facilitate the production of long section drawings along option routes, more detailed quantification of volumes of materials to be costed, identification of access issues etc. These surveys had progressed at the time of writing.
- Additional Ground Investigation may be required to inform design of the option identified.
- Costs for utility asset diversions to be investigated through discussion with relevant utility companies.
- Seepage analysis will help inform the best suited type of hard defences, where an acceptable amount of seepage will be determined which can be incorporated within the capacity of back drainage behind any flood defences.
- A pluvial assessment will assess any ponding of surface water behind any proposed defences. From this assessment the requirements for back drainage and potential need for auxiliary pumps can be calculated.
- An Environmental Impact Assessment (EIA) Screening Report was undertaken in July 2021 based on the preferred option presented. It was recommended that an EIA Report be undertaken for the South Kinross FPS. An EIA scoping exercise was being undertaken at the time of writing to inform the main chapters of an Environmental Impact Assessment Report (EIAR). The EIAR will inform and support the option development stages.
- A Natural Flood Management study report was completed in March 2022. This report investigates how NFM may be incorporated into a longer-term catchment management plan for the South Queich catchment, which could improve the robustness of the preferred scheme presented in the Option Review Report, as well as provide some resilience against the impacts of climate change. Implementing NFM measures throughout the South Queich catchment may also lead to improvements across several ecosystem service categories. The final report has been included in Appendix G. It is not proposed to include NFM into the preferred options, but that the NFM study would inform a South Queich Natural Flood Management plan, in order to achieve NFM implementation over a long time period.

9 REFERENCES

Accounting for residual uncertainty: updating the freeboard guide (Report – SC120014), Environment Agency, (February 2017)

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Options appraisal for flood risk management: Guidance to support SEPA and the responsible authorities (May 2016), The Scottish Government.

Rateable values for a non-residential property, Scottish Assessors Association (2017). Available at http://www.saa.gov.uk.

Supplementary Green Book Guidance on the treatment of optimism bias, HM Treasury (2002)

Technical Flood Risk Guidance for Stakeholders, SEPA, Version 10, (July 2018)

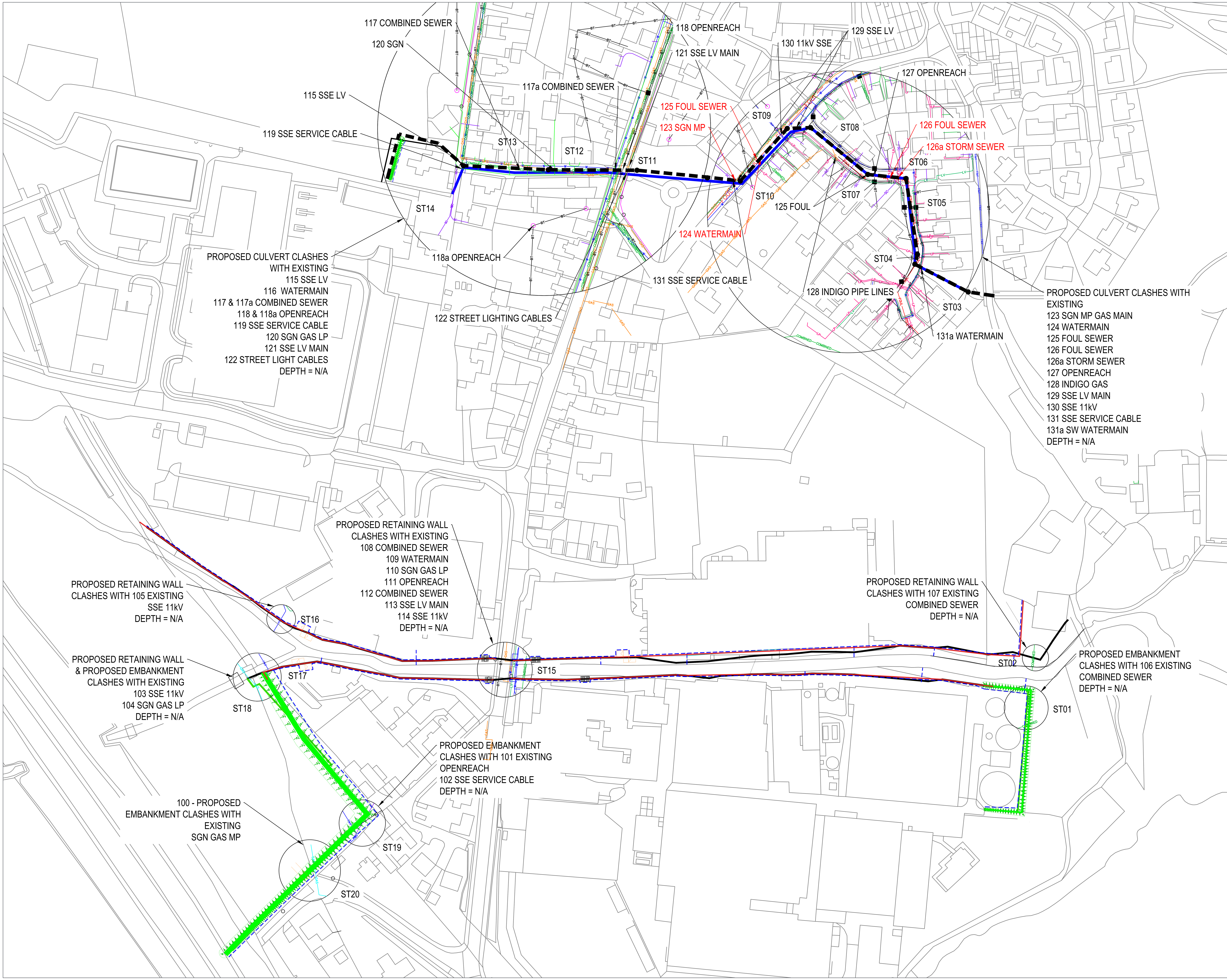
Appendix C

Utility Register

Drawing Reference	Service Ref	Provider Affected	Service	Action	Element of scheme impacted	Location	Cost	Link to correspondence	Additional comment
IBE_1585_002	100	SGN Gas	Underground Medium Pressure Gas Line running through flooded area and crossing Gelly Burn at existing footbridge location	Re-position embankment and allow SGN to divert 445m of gas pipe to rear	Direct Defences	Old Cleish Road	£ 194,020.00	2424029 - Job 2 - South Kinross Flood Protection Scheme Queich Bridge Kinross Kinross Shire KY13 8EN..msg	2424029 - Job 2 - no real possible diversion route which allows us ease of access and suitable servitude. I've been asked if you would reposition your flood defensive embankment to allow for SGN to divert around the rear, providing us with servitude
IBE_1585_002	101	Open Reach	Overhead Telecommunication (BT) line runs along east side of the Old Cleish Road embankment	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Direct Defences	Old Cleish Road	£2,838.87	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Open reach\kinross plan 6.pdf	No diversion flagged in C3 quote
IBE_1585_002	102	SSE Service Cable	Underground 11kV power line running perpendicular to east side of the Old Cleish Road embankment	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 40m of 3c 240mm XLPE HV Cable **(Diversion)**	Direct Defences	Old Cleish Road	£ 8,354.03	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 1 in SSE quote
IBE_1585_002	103	SSE 11kV	Underground 11kV power line running perpendicular to Gelly Burn	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 205m of 3c 240mm XLPE HV Cable **(Diversion)**	Direct Defences	Gelly Burn Crossir	£ 42,814.38	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 2 in SSE quote
IBE_1585_002	104	SGN GAS LP	Underground Medium Pressure Gas Line running through flooded area and crossing Gelly Burn at existing footbridge location	Covered by diversion in service ref 100	Direct Defences	Gelly Burn Crossir	£ -	2424029 - Job 2 - South Kinross Flood Protection Scheme Queich Bridge Kinross Kinross Shire KY13 8EN..msg	Linked to diversion 100. Covered here
IBE_1585_002	105	SSE 11kV	Underground 11kV power line running perpendicular to South Queich adjacent to Korkora Manufacturing	Cut and abandon Existing Cable. Lay Approx. 205m of new cable **(Diversion)**	Direct Defences	Korkora Manufactu	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Covered in 105
IBE_1585_002	106	SW Combined Sewer	450 mm dia. Concrete Combined Sewer intersecting proposed flood embankment at treatment works	Cover of 0.9m, therefore no clash expected. Depending on depth of clay core may need to wrap around pipe. This has been costed assuming excavation, disposal and fill of clay around pipe. **(Protection)**	Direct Defences	Sewage Works	£ 530.27	Meeting with WSP 25/04/23	No mechanical compaction allowed above and either side of sewer. Sewer to protected from construction traffic. MH surveys required to confirm location and cover level
IBE_1585_002	107	SW Combined Sewer	450 mm dia. Concrete Combined Sewer under river intersecting proposed flood wall	Wall has been realigned to avoid this clash **(Protection)**	Direct Defences	Pumping Station	£ -	No longer needed based on update	Sewer Ils and location to be surveyed prior to construction
IBE_1585_002	108	SW Combined Sewer	375 mm dia. VC Combined Sewer under river intersecting proposed flood wall at High Street Bridge	Main Contractor to carry out works. Temporary overpumping to be provided during construction. Sewer to be re-laid with PE pipe passed each bank walls per existing levels through sheet piling or flood wall. Penetration detail required for approval. 375 VC outfall from MH ref 4373 on BCA side to be abandoned. Site inspection to confirm. **(Temp diversion)**	Direct Defences	High Street Bridge	£ 28,000.00	Meeting with WSP 25/04/23	Sewer Ils and location to be surveyed prior to construction. MH ref 4373 Site inspection required for abandonment of part of existing sewer
IBE_1585_002	109	SW Watermain	7in CI watermain under river intersecting proposed flood wall at High Street Bridge	Temporary water main to be provided during construction, over or along bridge. Permanent diversion to be re-laid PE pipe passed each bank walls per existing levels through sheet piling or flood wall. Penetration detail required. **(Temp diversion)**	Direct Defences	High Street Bridge	£ 6,710.53	Meeting with WSP 25/04/23	Main Ils and location to be surveyed by contractor prior to construction. Permanent diversion not possible through bridge
IBE_1585_002	110	SGN GAS LP	Low Pressure Gas Line running across High Street Bridge	SGN do not consider that diversions will be required. Protection measures agreed by SGN appears to be the most suitable solution **(Protect)**	Direct Defences	High Street Bridge	£ -	2424029 - Job 2 - South Kinross Flood Protection Scheme Queich Bridge Kinross Kinross Shire KY13 8EN..msg	100 diversion will now cross High Street bridge
IBE_1585_002	111	Open Reach	Underground telecoms ducting passing across High Street Bridge	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Direct Defences	High Street Bridge	£2,838.87	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Open reach\kinross plan 5.pdf	No diversion flagged in C3 quote
IBE_1585_002	112	SW Combined Sewer	375 mm dia. VC Combined Sewer outfall to river intersecting proposed flood wall BCA Carpark	375 VC outfall from MH ref 4373 on BCA side to be abandoned. Site inspection to confirm. (Temp diversion)	Direct Defences	High Street Bridge	£ 439.20	Meeting with WSP 25/04/23	SPONS 23 removal of redundant 400mm dia sewer p182. No need to removal manhole chamber
IBE_1585_002	113	SSE LV Main	Underground power line passing across High Street Bridge intersecting flood wall at joint with bridge	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Direct Defences	High Street Bridge	£ 1,002.48	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	
IBE_1585_002	114	SSE 11kV	Underground power line passing across High Street Bridge towards BCA Site/Nan Walker Wynd intersecting flood wall at joint with bridge	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Direct Defences	High Street Bridge	£ 1,002.48	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	
IBE_1585_002	115	SSE LV	Underground Low Voltage power line which new Smith Street Diversion culvert will cross at Myre Terrace	LV cable clashing with crown of new culvert. Assume cable can be raised 100mm still having 500mm cover based on slit trenching depth of 650mm recorded . Assume this would happen between domestic connection points so 30m length assumed **(Diversion)**	Smith Street Culvert	Smith Street	£ 6,265.52	New clash no quote sitting just at pipe crown. Assume we can move up because there is no diversion route that doesn't cross culvert. Rate from SSE quote used per m	Altered based on new route
IBE_1585_002	116	SW Watermain	4in CI watermain running parallel to new culvert along Smith Street	Culvert to be moved to south side of road and watermain diverted to north side to provide suitable clearance **(Diversion)**	Smith Street Culvert	Smith Street	£ 40,263.16	Meeting with WSP 25/04/23	
IBE_1585_002	117	SW Combined Sewer	300 dia. VC Sewer running parallel to culvert along Smith Street clash with sewer and manhole	Culvert to be moved to south side of road and combined sewer to be diverted with 300 mm dia. PE pipe and new 1050 manhole **(Diversion)**	Smith Street Culvert	Smith Street	£ 100,000.00	Meeting with WSP 25/04/23	Trench for new culvert to be 300mm clear from diverted 300mm dia. Sewer
IBE_1585_002	117a	SW Combined Sewer	Clash with existing MH (1800mm dia. MH) Culvert to be moved to south side of Smith Street. Combined VC 525mm dia. sewer intersecting culvert at High Street.	MH14 moved out of road to avoid clash. Sewer to be replaced with twin 225mm dia. Pipes. Will require hydraulic modelling ahead of C4 as this would reduce capacity. Risk of blockage and flooding would not be accepted by SW. **(Diversion)**	Smith Street Culvert	Smith Street	£ 50,000.00	Meeting with WSP 25/04/23	
IBE_1585_002	118	Open Reach	75mm duct crossing proposed culvert at High Street.	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Smith Street Culvert	Smith Street	£2,838.87	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Open reach\kinross plan 7.pdf	Cable sits above pipe - no clash identified based on likely 350mm depth of cable and BT check
IBE_1585_002	118a	Open Reach	BT require new aerial from Smith Street to existing BT pole to rear of 164 High Street	30m of new 46mm aerial cabling required **(Diversion)**	Smith Street Culvert	Smith Street	£ 25,994.50	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Open reach\kinross plan 7.pdf	Cable sits above pipe - no clash identified based on likely 350mm depth of cable and BT check
IBE_1585_002	119	SSE LV	Underground Low Voltage power line running parallel to new culvert along Smith Street	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Smith Street Culvert	Smith Street	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	
IBE_1585_002	120	SGN GAS LP	Underground Low Pressure Gas Line running parallel to proposed culvert.	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Smith Street Culvert	Smith Street	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SGN\2422452 - Job 1 - South Kinross Flood Protection Scheme Smith Street The Cross Sandport Kinross Kinross Shire KY13 8EN..msg	Whilst there is apparatus in the vicinity of your proposed works SGN do not consider that diversions will be required and therefore are not going to provide C3 Budget Cost on this occasion. Protection measures agreed by SGN appears to be the most suitable solution. Appears to sit 200mm above pipe. this will improve with box culvert arrangement
IBE_1585_002	121	SSE LV Main	Underground Low Voltage power line running parallel to new culvert along Smith Street	Cut and abandon Existing Cable. Pot end existing cable where required Excavate, Lay and Blind approximately 140m of 3c 300mm XLPE LV Cable and approximately 240m of 3c 95mm XLPE LV Connect any services that require reconnecting to network. **(Diversion)**	Smith Street Culvert	Smith Street	£ 29,239.09	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 9 in SSE quote
IBE_1585_002	122	Street Lighting	Underground Street Lighting Cable. Proposed Culvert inserts cable at east edge of High Street and parkland	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from PKC. **(Protection)**	Smith Street Culvert	Sandport	£ 1,253.10	N/A	Based on standard assumed depth of 650mm cable below ground in carriageway, cable should be above proposed pipe requiring work around during construction
IBE_1585_002	123	SGN GAS LP	Underground Medium Pressure Gas Line running parallel to proposed culvert.	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. **(Protection)**	Smith Street Culvert	Sandport	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SGN\2422452 - Job 1 - South Kinross Flood Protection Scheme Smith Street The Cross Sandport Kinross Kinross Shire KY13 8EN..msg	Whilst there is apparatus in the vicinity of your proposed works SGN do not consider that diversions will be required and therefore are not going to provide C3 Budget Cost on this occasion. Protection measures agreed by SGN appears to be the most suitable solution. Appears to sit 200mm above pipe. this will improve with box culvert arrangement

IBE_1585_002	124	SW Watermain	4in UPVC watermain running parallel to proposed Culvert at Sandport and Nan Walker Wynd	Watermain to be moved to north side of road, Culvert moved to south (**Diversion**)	Smith Street Culvert	Sandport	£ 33,552.63	Meeting with WSP 25/04/23	
IBE_1585_002	125	SW Foul	200mm Dia. VC Foul sewer running running parallel to proposed Culvert at Sandport	Foul sewer to be moved to north side of road, Culvert moved to south (**Diversion**)	Smith Street Culvert	Sandport	£ 75,000.00	Meeting with WSP 25/04/23	
IBE_1585_002	126	SW Foul	150mm dia. VC Foul sewer running parallel to proposed culvert at Nan Walker Wynd	Culvert to be moved west and foul sewer diverted east. Crossing at end of Nan Walker Wynd but no conflict **(Diversion)**	Smith Street Culvert	Nan Walker Wynd	£ 96,000.00	Meeting with WSP 25/04/23	
IBE_1585_002	126a	SW Surface Water	150mm dia. PVC storm sewer running parallel to proposed culvert at Nan Walker Wynd	Surface water pipe to be removed and connection made to new culvert. (**Diversion**)	Smith Street Culvert	Nan Walker Wynd	£ 42,947.37	Meeting with WSP 25/04/23	
IBE_1585_002	127	Open Reach	3 crossings of underground telecoms cables with proposed culvert at Nan Walker Wynd	219m new ducting diverted from Sandport along Sandport Close to tie in with existing BT cabling at green space south of Clash Burn outlet to Loch Leven **(Diversion)**	Smith Street Culvert	Sandport	£ 189,759.88	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Open reach\Kinross Plan 1.pdf	
IBE_1585_002	128	Indigo Gas	165m X 90mm PE Low Pressure gas main running parallel to culvert at Nan Walker Wynd	Move/ lower existing 165m X 90mm PE LP at grid ref E311965 N701887 to E312060 N701829. **(Diversion)**	Smith Street Culvert	Sandport	£19,228.94	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Indigo Pipelines\Received\P148110 Kinross Diversion 2.pdf	Diversion 2 in quote
IBE_1585_002	129	SSE LV Main	2 crossings of SSE LV cable running parallel at with proposed culvert at Sandport	Cut and abandon Existing Cable. Approx. 140mm of new LV cable and approx. 240m of 3c 95mm XLPE LV Cable - Covered by diversion 121	Smith Street Culvert	Sandport	£ 50,124.15	IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 9 in SSE quote
IBE_1585_002	130	SSE 11kV	Underground electric cable crossing perpendicular and parallel to proposed culvert at Sandport	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 45m of 3c 240mm XLPE HV Cable **(Diversion)**	Smith Street Culvert	Sandport	£ 9,398.28	IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspon	Diversion 10 in SSE quote
IBE_1585_002	131	SSE Service Cable	Underground electric cable crossing perpendicular to proposed culvert at Sandport	Abandon - Covered by diversion 121	Smith Street Culvert	Sandport	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 9 in SSE quote. Covered in 121 and 129
IBE_1585_002	131a	SW Watermain	4in UPVC crossing perpendicular to proposed culvert end of Nan Walker Wynd	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. (**Protection**)	Smith Street Culvert	Nan Walker Wynd	£ -	Meeting with WSP 25/04/23	Assumes no clash on basis watermain is 0.75m below ground and box culvert is being adopted here
IBE_1585_003	132	SW Watermain	90mm HPPE watermain crossing proposed culvert clashing with new pipe	15m of 90mm HPPE pipe to be diverted under proposed culvert (**Diversion)**	Hopefield Place Culvert	Hopefield Place	£ 6,710.53	Meeting with WSP 25/04/23	
IBE_1585_003	133	SW Foul	150mm dia. UPVC foul sewer	Foul sewer already below new culvert. Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. (**Protection**)	Hopefield Place Culvert	Hopefield Place	£ -	Meeting with WSP 25/04/23	
IBE_1585_003	134	Open Reach	Underground telecoms cable running perpendicular to proposed culvert at Hopefield Place turning circle	Cable is above proposed culvert, no diversion anticipated. Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from utility company. (**Protection**)	Hopefield Place Culvert	Hopefield Place	£2,838.87	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Open reach\C3 Letter_170723.pdf	
IBE_1585_003	135	Indigo Gas	Underground LP gas main running perpendicular to proposed culvert at Hopefield Place turning circle	Divert/ install 165m X 90mm PE LP main with 3 X connections to existing 90mm PE LP mains. (Existing main sections to be cut back, capped, purged and abandoned). Existing LP connection to SGN up stream network to be managed and kept live by SGN (**Diversion**)	Hopefield Place Culvert	Hopefield Place	£ 3,920.17	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\Indigo Pipelines\Received\P148110 Kinross Diversion 2.pdf	Diversion 1 in quote
IBE_1585_003	136	SSE Service Cable	Underground electric cable running perpendicular to proposed culvert at Hopefield Place turning circle	Connect existing service to new 3c 95mm XLPE LV Cable from 137 (**Diversion**)	Hopefield Place Culvert	Hopefield Place	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 8 in SSE quote. Cost covered in action 137
IBE_1585_003	137	SSE LV Main	Underground LV electric cable running perpendicular to proposed culvert at Hopefield Place turning circle	Cut and abandon Existing Cable. Pot end existing cable in close. Excavate, Lay and Blind approximately 100m of 3c 300mm XLPE LV Cable. Breech onto new cable and Lay approximately 40m of 3c 95mm XLPE LV Cable (**Diversion**)	Hopefield Place Culvert	Hopefield Place	£ 29,239.09	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 8 in SSE quote
IBE_1585_003	138	Street Lighting	Underground street lighting cable running perpendicular to proposed culverted at pedestrian path	Cable is above proposed culvert, no diversion anticipated. Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from PKC. (**Protection**)	Clash Burn Diversion Culvert	Bowton Road	£ 1,044.25	Liaison required with PKC	Assuming streetlighting is laid 450mm below ground in footway, cable should be above proposed pipe requiring work around during construction
IBE_1585_003	139	SGN GAS MP	Underground MP gas main running parallel to proposed culvert - minimum clearance between routes.	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from SGN. (**Protection**)	Clash Burn Diversion Culvert	Bowton Road	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SGN\2424074 - Job 5 - South Kinross Flood Protection Scheme Montgomery Way Kinross Kinross Shire KY13 8EN..msg	Although the route follows our Medium Pressure main there is little opportunity for SGN to divert this main – greater care should be taken when conducting your proposed works in this area…
IBE_1585_003	140	SW Foul	150mm dia. UPVC sewer running parallel to proposed culvert - clash of manhole and limited clearance between lines	Divert Foul Sewer Manhole north out of line of proposed culvert (Diversion) Modelling required to ensure no change in capacity (**Diversion**)	Clash Burn Diversion Culvert	Bowton Road	£ 15,000.00	Meeting with WSP 25/04/23	Add bend to foul pipe to move Foul MH further north and avoid clash with new culvert. TBC at C4
IBE_1585_003	141	SW Foul	Rising main identified by SW 175mm dia. HDPE foul rising main identified by SW running parallel to proposed culvert	Divert Rising Main 1m away from new culvert **(Diversion)**	Clash Burn Diversion Culvert	Bowton Road	£ 78,000.00	Meeting with WSP 25/04/23	Slit trenching should confirm. TBC at C4. Model indicates rising mains going north east direction - may be simplified
IBE_1585_003	142	SSE LV Main	Underground LV electric cable running perpendicular to proposed culvert Bowton Road pedestrian walkway	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 130m of 3c 240mm XLPE HV Cable **(Diversion)**	Clash Burn Diversion Culvert	Bowton Road	£ 27,150.58	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 7 in SSE quote
IBE_1585_003	143	SSE 11kV	Underground 11kV electric cable running perpendicular to proposed culvert Bowton Road pedestrian walkway	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 170m of 3c 240mm XLPE HV Cable **(Diversion)**	Clash Burn Diversion Culvert	Bowton Road	£ 35,504.61	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 6 in SSE quote
IBE_1585_003	144	Street Lighting	Underground street lighting cable running perpendicular to proposed culverted at pedestrian path	Cable is above proposed culvert, no diversion anticipated. Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from PKC. (**Protection**)	Clash Burn Diversion Culvert	Unnamed Road	£ 417.70	Liaison required with PKC	Assuming streetlighting is laid 600mm below ground in road, cable should be above proposed pipe requiring work around during construction
IBE_1585_003	145	SGN GAS MI	Underground MP gas main running parallel to proposed culvert - minimum clearance between routes.	Operations will be carried out to ensure the necessary protection requirement to the cable duct. Seek guidance from SGN. (**Protection**)	Clash Burn Diversion Culvert	Unnamed Road	£ -	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SGN\2424074 - Job 5 - South Kinross Flood Protection Scheme Montgomery Way Kinross Kinross Shire KY13 8EN..msg	Although the route follows our Medium Pressure main there is little opportunity for SGN to divert this main – greater care should be taken when conducting your proposed works in this area…
IBE_1585_003	146	SW Foul	125 dia. UPVC Foul Rising Main identified crossing perpendicular proposed culvert entering Myre Playing Fields	Rising Main is be re-laid under culvert **(Diversion)**	Clash Burn Diversion Culvert	Myre Playing Fields entrance	£ 35,000.00	Meeting with WSP 25/04/23	
IBE_1585_003	147	SW Watermain	90mm BPBU watermain identified crossing perpendicular proposed culvert entering Myre Playing Fields	Watermain is be re-laid under culvert **(Diversion)**	Clash Burn Diversion Culvert	Myre Playing Fields entrance	£ 15,500.00	Meeting with WSP 25/04/23	
IBE_1585_003	148	SSE 11kV	Underground 11kV electric cable running parallel to proposed culvert at Bowton Road pedestrian walkway	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 160m of 3c 240mm XLPE HV Cable **(Diversion)**	Clash Burn Diversion Culvert	Unnamed Road	£ 33,416.10	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 5 in SSE quote

IBE_1585_003	149	SSE 11kV	Underground 11kV electric cable running parallel to proposed culvert at Bowton Road pedestrian walkway	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 60m of 3c 240mm XLPE HV Cable **(Diversion)**	Clash Burn Diversion Culvert	Unnamed Road	£ 12,531.04	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 3 in SSE quote
IBE_1585_003	150	SSE 11kV	Underground 11kV electric cable running parallel to proposed culvert at Myre Playing Fields	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 240m of 3c 240mm XLPE HV Cable **(Diversion)**	Clash Burn Diversion Culvert	Unnamed Road	£ 50,124.15	\\belf-eh-fs-02\40\Section 40\Job No IBE1500 -\IBE1585 - South Kinross Flood Protection Scheme\3_Communications\3_Correspondence\SSE	Diversion 4 in SSE quote



NOTES

1. Verifying Dimensions.
   The contractor shall verify dimensions against such other drawings or site conditions as pertain to this part of the work.

2. Existing Services.
   Any information concerning the location of existing services indicated on this drawing is intended for general guidance only. It shall be the responsibility of the contractor to determine and verify the exact horizontal and vertical alignment of all cables, pipes, etc. (both underground and overhead) before work commences.

3. Issue of Drawings.
   Hard copies, dwf and pdf will form a controlled issue of the drawing. All other formats (dwg, dxf etc.) are deemed to be an uncontrolled issue and any work carried out based on these files is at the recipients own risk. RPS will not accept any responsibility for any errors arising from the use of these files, either by human error by the recipient, listing of un-dimensioned measurements, compatibility issues with the recipient's software, and any errors arising when these files are used to aid the recipients drawing production, or setting out on site.

4. Legend

- Proposed Embankment
- Proposed Retaining Wall
- Proposed Culvert
- SGN Gas LP
- SGN Gas MP
- Main Water
- Natural Water
- Foul Sewer
- Combined Sewer
- Clean Water
- Indigo Pipelines (SSE) LP Main
- SSE Service Cable
- SSE 11kV
- SSE LV Main
- Openreach BT
- Openreach BT Pole
- Openreach BT Jointbox
- Street Light Cables
- Street Light
- Slit Trenches

rev	amendments	check	date
B	Proposed Defences Updated & Slit Trenches Added	NM	20/10/2022
A	Utilities for SSE added	NM	09/08/2021

rps
Elmwood House
74 Boucher Road
Belfast
BT12 6RZ
T +44 (0) 28 90 667914
F +44 (0) 28 90 668286
W www.rpsgroup.com/ireland
E ireland@rpsgroup.com

Client

..\perth-and-kinross-council-2910_275x0x.png

Project
South Kinross Flood Protection Scheme

Title
Proposed Trial Pit Locations

Project Number	Sheet Size	Drawing Scale
IBE1585	A1	1:1000

Drawing Number
IBE1585_002

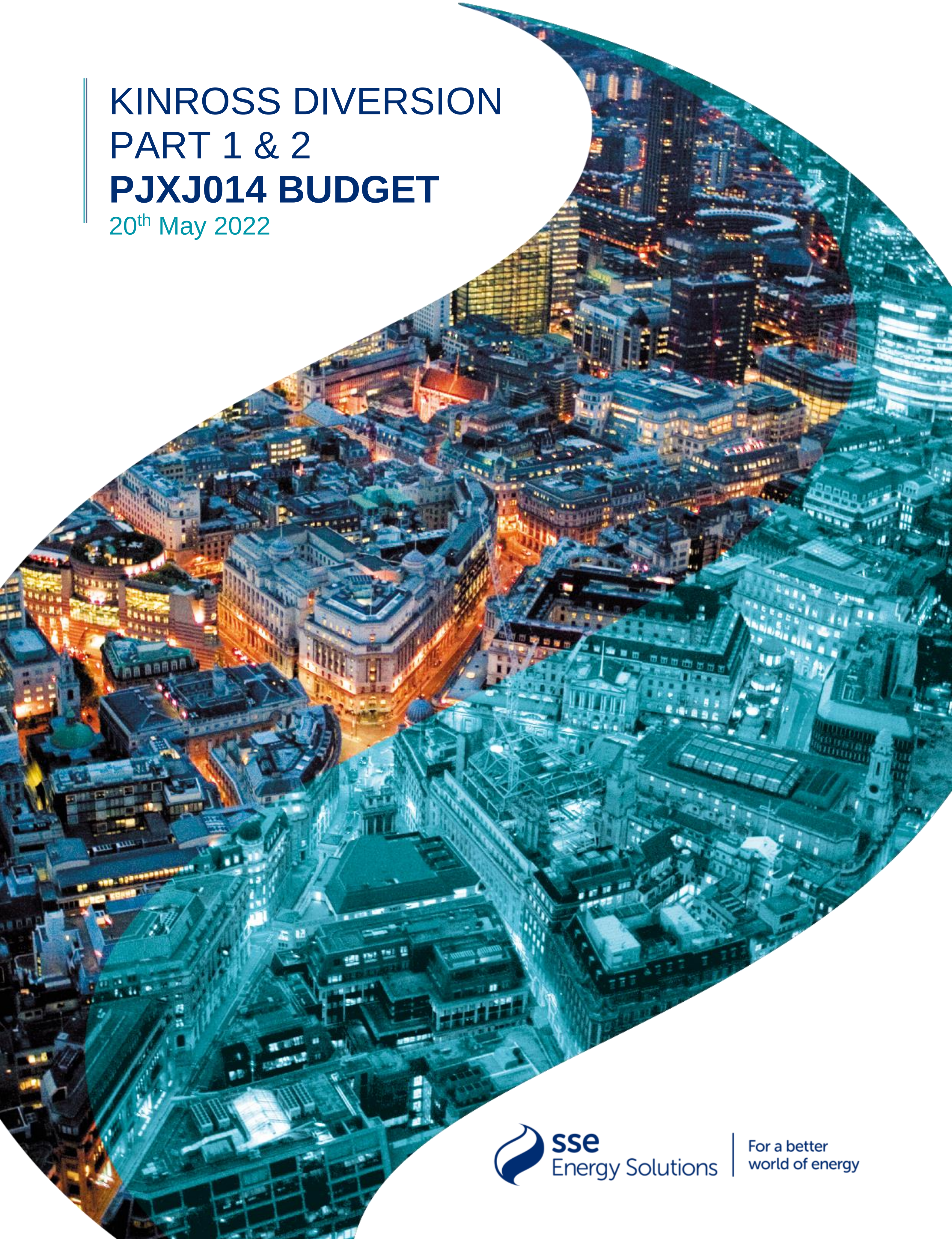
Drawn By	Status	Revision
NM	Draft	B

Checked By	Approved By	Date
JD	SP	06/07/2021

INDIGO PIPLINES

KINROSS DIVERSION
PART 1 & 2
PJXJ014 BUDGET

20th May 2022



sse Energy Solutions | For a better world of energy

CONTENTS

INTRODUCTION

Thank you for your enquiry to divert existing Indigo Pipelines mains assets on 2 existing networks P148110 at Nan Walker Wynd (Part 1) and PJCB646 at Montgomery Way (Part 2), Kinross, Kinross-shire. SSE Utility Solutions Limited (SSEUSL) trading as SSE Energy Solutions has pleasure in submitting this bespoke BUDGET quotation PJXJ014 based on a recent site visit.

YOUR REQUIREMENTS

This quotation has been put together in accordance with your requirements. When comparing our quotation please be aware that it is firm and includes:

PART 1

- Cost to divert / install 165m X 90mm PE LP main with 3 X connections to existing 90mm PE LP mains. (Existing main sections to be cut back, capped, purged and abandoned)
- **Existing LP connection to SGN up stream network to be managed and kept live by SGN**
- All traffic management & road opening notices*
- Project Management & first-class delivery
- RPS Group to include for all excavation and reinstatement **

PART 2

- Cost to divert / install 3m & 5m X 63mm PE LP main with connections to existing 63mm PE LP mains. (Existing main sections to be cut back, capped, purged and abandoned)
- **Existing MP connection to SGN up stream network to be managed and kept live by SGN**
- All traffic management & road opening notices*
- Project Management & first-class delivery
- RPS Group to include for all excavation and reinstatement **

***This does not include costs for specific lane rental charges that may be enforced by the Local Authority in some areas. This quotation may be subject to additional costs once the Local Authority has been contacted by our appointed contractors.**

Not Included

- **All excavation and reinstatement by client**

Please note that SGN will need to manage the connection points at both sites to keep assets live so that no customer is without supply if this quotation is accepted.

Please also note that a BUDGET quotation has been provided, for firm costs this request will need further investigation at both site locations. For further advice please contact our Field Asset Engineer John Kiczynski on 07876 837134.

PROPOSED COST PLAN

PART 1 Client Contribution of **£3,266.81 Plus VAT (£3,920.17 inc. VAT)**

PART 2 Client Contribution of **£16,024.12 Plus VAT (£19,228.94 inc. VAT)**

To be paid in advance of works commencing

To accept this quotation please complete the attached Quotation Acceptance Form and return it with any required payment in full.

All prices quoted are net of any allowances. This quotation is open for acceptance for 90 calendar days and is subject to the enclosed SSEUSL terms and conditions.

Please note: If work does not physically start within 180 days of the acceptance date, SSEUSL reserves the right to review the quotation and pass any additional costs SSEUSL may incur onto the Developer.

Any change to the requirements of the works described above and issued on the attached plan will require the quotation to be re quoted, and if accepted a variation charge will be issued to be paid by the client.

PROPOSED APPROACH & ASSUMPTIONS

Our proposals and this quotation depend on us receiving all necessary consents and permissions from any third parties. The terms and conditions set out your obligations in respect of these consents. Where SSEUSL are responsible for obtaining these rights, the cost of obtaining the legal rights and easements to divert this pipework will be passed on to the customer.

Please also note that as per our contractor quote that any aborted programmed works will be charged at £280 per day chargeable to the client if site is not ready.

SSEUS reserves the right to withdraw or amend this Proposal at any stage prior to acceptance.

RESPONSIBILITIES CHECKLIST

This quotation is based upon the following, this is a generic list, all do not apply to this quotation.

		SSEUSL	Customer
1	Drawings are made available to SSEUSL in suitable electronic format, for the preparation of necessary project drawings at no cost to SSEUSL		✓
2	The provision to SSEUSL of the Pre-Construction Health and Safety Plan prior to producing the design.		✓
3	Temporary Site Electricity and Festoon Lighting, Fixed Scaffolding, Skips, General builders' works in connection, including chasing and making good to surfaces, Congestion charges, Ground and Excavation work		✓
4	Welfare facilities consisting of toilets, water, mess rooms, drying rooms		✓
5	Provision of temporary and hard standing roads required to enable suitable working platform		✓
6	Provision of sufficient space for office and storage accommodation		✓
7	Provision of office and storage accommodation, excluding any provision for the payment of rates	✓	
8	Electrical Supply to SSEUSL site accommodation, including connection costs F.O.C		✓
9	Electrical Supply (110V) for power tools and lighting to within 30 metres of any working position		✓
10	Provision of temporary safety lighting		✓
11	Provision of temporary task lighting	✓	
12	Site Security		✓
13	Hoisting, distribution and placing into position items of equipment	✓	
14	Provision of skips and removal of rubbish from site		✓

15	Clearing of rubbish to an agreed location	✓	
16	Protection of fixed and installed materials	✓	✓
17	Setting out - i.e. datums, levels, grid references		✓
18	Power for testing and commission F.O.C		✓
19	Preparation of on-site trenches (including joint holes) conforming to NJUG/SSEUSL specifications unless otherwise stated		✓
20	All on site digging, trenching, backfilling and reinstatement to be carried out on an agreed schedule. All materials to be supplied		✓
21	All on site mains and services to be installed on an agreed schedule	✓	
22	Provision and installation of suitable fine fill material to bed and surround to cover		✓
23	Supply and installation of any required road crossing and service ducts		✓
24	Provision of suitable easements, wayleaves or land transfers for all on site works as necessary		✓
25	Marker tapes to be installed for all utilities	✓	
26	Provision for removing and controlling surface water e.g. de watering trenches		✓
27	Ensure that kerb races are in place prior to installation of new infrastructures		✓
28	Forming of enclosures, foundations, plinths and bases		✓
29	Any power, fuel and water charges etc. required for the installation, testing or commissioning by our Sub-Contractors or ourselves		✓
30	Coring of walls for services		✓
31	All off site digging trenching and reinstatement to be carried out to an agreed schedule	✓	
32	250m of open trench for mains lay in private land to be made available on each visit		✓
33	4x house/flat service connections available on each visit		✓
34	All off site mains to be installed on an agreed schedule	✓	
35	Movement of materials including pipes, etc.		✓
36	CAD drawings and utility designs		✓
37	Gas Infrastructure design before meters	✓	
38	Gas Infrastructure design beyond meters		✓

39	Gas CSEP	✓	
40	Provision of PRI	✓	
41	Provision of PRI location and base		✓
42	Domestic gas services to external meter boxes	✓	
43	Provision of domestic gas meter boxes	✓	
44	Provision and installation of domestic gas meters		✓
45	Commercial gas service to external meter kiosk	✓	
46	Provision and installation of commercial meter kiosks		✓
47	Provision and installation of commercial meters		✓

CONTACT US

Jason Burton
Gas Connections Designer
E: Jason.burton@sse.com
T: 0345 078 6739
sseenergysolutions.co.uk

For a better world of energy

Gas Network

22/03/2022 08:55:20

1:1,126

0 0.01 0.03 0.05 mi

0 0.02 0.04 0.08 km

Gas Junction

End Closure

Gas Supply Point

Cavity Wall Meter Box

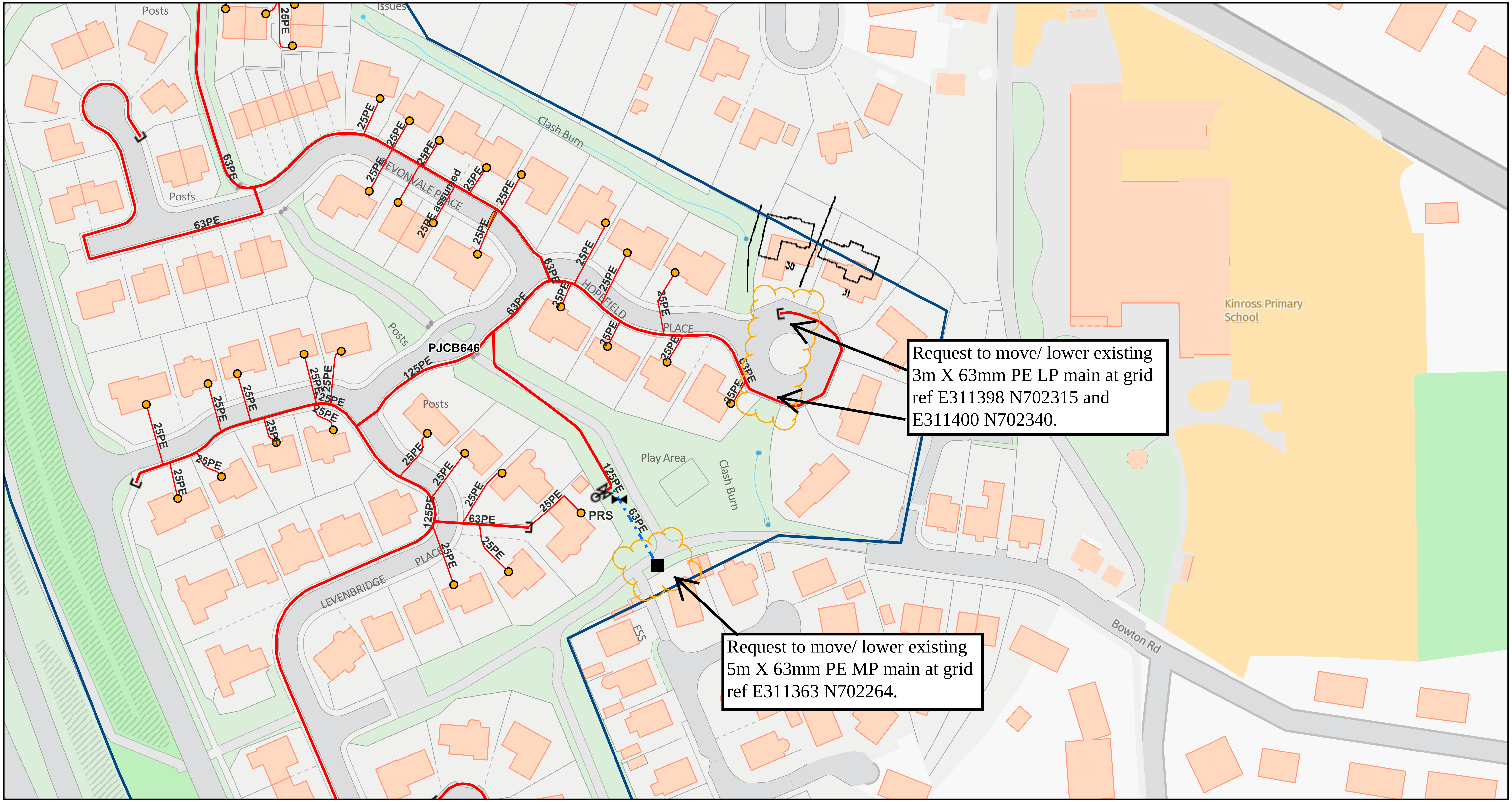
Gas Pipe

LP Main

LP Service

Gas Site

Gas Network



22/03/2022 08:48:37

1:1,126

Gas Device
- Valve,Closed
- CSEP

Gas Junction
- End Closure
- Pressure Reduction Station

Gas Supply Point
- Cavity Wall Meter Box

Gas Pipe
- LP Main
- LP Service
- MP Main
- Ducting
- Gas Site

0 0.01 0.03 0.05 mi
0 0.02 0.04 0.08 km

SSE

Scottish & Southern Electricity Networks

North of Scotland 0800 048 3515
Central Southern England 0800 048 3516

Our reference: EVZ383/2
Your reference:

Connections and Engineering
Walton Park
Walton Road
Cosham
PO6 1UJ

RPS Consulting Uk & Ireland
FAO Joshua Deery
74 Boucher Road
Belfast
BT12 6RZ

07384 454 411
James.McNeish@sse.com
www.ssen.co.uk

FAO First Name Second Name

19th August 2022

Dear Joshua Deery,

Diversion works for – South Kinross Flood Protection Scheme

Thank you for your recent enquiry. I am pleased to provide you with my quotation for electricity network diversion works at the above locations, along with a plan illustrating the proposed works. My proposals are subject to our obtaining all necessary legal consents to carry out the work as planned, including any consent required from third parties.

£ **327,895.50** This charge includes VAT and is valid for 90 days from the date of this letter.

! The quotation has been calculated based on the information provided to date but please be aware that we will charge for any additional work required that has not been included in the described works. Therefore, it's really important to make sure you check the quote thoroughly to avoid incurring any further charges. In addition to this, it is important to note that the price stated in this offer is valid for acceptance for 90 days. This price will then be valid for twelve months from the date of acceptance. All work must be completed within twelve months, at which point we will reserve the right to revise the terms of our contract with you, unless any delays to the completion of work have been within our control.

! I have calculated this quotation on the assumption that you will carry out/ organise all of the excavation and backfilling of the cable trenches required, on the land in your or your clients' ownership.

I have enclosed with this letter an information pack, which I hope will prove useful. I trust the information I have provided is of assistance and if I can help further please do not hesitate to contact me. Alternatively, you may find answers to any questions you may have on our web site www.ssepd.co.uk.

Yours sincerely,

James McNeish

Connections

Description of works and assumptions

Diversion 1
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 40m of 3c 240mm XLPE HV Cable

Diversion 2
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 205m of 3c 240mm XLPE HV Cable

Diversion 3
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 60m of 3c 240mm XLPE HV Cable

Diversion 4
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 240m of 3c 240mm XLPE HV Cable

Diversion 5
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 160m of 3c 240mm XLPE HV Cable

Diversion 6
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 170m of 3c 240mm XLPE HV Cable

Diversion 7
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 130m of 3c 240mm XLPE HV Cable

Diversion 8
Cut and abandon Existing Cable.
Pot end existing cable in close
Excavate, Lay and Blind approximately 100m of 3c 300mm XLPE LV Cable. Breech onto new cable and Lay approximately 40m of 3c 95mm XLPE LV Cable and connect existing service to this cable.

Diversion 9
Cut and abandon Existing Cable.
Pot end existing cable where required
Excavate, Lay and Blind approximately 140m of 3c 300mm XLPE LV Cable and approximately 240m of 3c 95mm XLPE LV Cable as indicated on plan. Connect any services that require reconnecting to network.

Diversion 10
Cut and abandon Existing Cable.
Excavate, Lay and Blind approximately 45m of 3c 240mm XLPE HV Cable

We have assumed that if third party consents are required to deliver these works, they will be granted without dispute or attached conditions. Where we are unable to gain necessary consents, we will need to revise our design and the terms of our contract with you. Where necessary to gain consents, you will need to meet any associated additional expenses that we may incur, arising from but not limited to:

We have assumed that if third party consents are required to deliver these works, they will be granted without dispute or attached conditions. Where we are unable to gain necessary consents, we will need to revise our design and the terms of our contract with you. Where necessary to gain consents, you will need to meet any associated additional expenses that we may incur, arising from but not limited to:

- Planning application fees where permitted development rights do not apply
- Consenting charges imposed by government departments and statutory bodies
- Legal and other fees and expenses of any third party in connection with land transactions
- Wayleave fees levied by third parties to process wayleave agreements
- Specialist ecology surveys
- Tree cutting compensation and sterilisation
- Archaeology investigations including watching briefs
- Damage claims and any associated surveyors fees where the damage is over and above what is reasonably necessary to undertake the works

What happens next

Please enclose either a cheque or, if paying by Bank Transfer, make payment before acceptance.

When we have received your acceptance and provided we have received the appropriate payment, we will start to make arrangements to carry out the works. Our Team Manager will contact you to discuss the programming of our works to meet your requirements, and provide guidance on the excavations you are required to carry out before we can deliver our works.

Job reference: EVZ383/2

Quotation for Diversion works for South Kinross Flood Protection Scheme

You can pay for your quotation by credit or debit card, cheque, or bank transfer. Please note that we only accept card payments for charges up to £5,000 in value (including VAT).

To pay by **credit or debit card** please call: 0800 197 5528

If paying by cheque, please make it payable to Scottish Hydro Electric Power Distribution plc. Please complete this form and return it with your cheque to the following address:

Connections and Engineering
Scottish and Southern Energy Power Distribution
Walton Road
Cosham
PO6 1UJ

If paying by bank transfer, you must instruct your bank to transfer funds **before** returning this form to the above address, or by email to quote.acceptance@sse.com. Please ask your bank to label your payment with the job reference as given above. Our bank account details are:

Account name:	Scottish Hydro Electric Power Distribution plc
Bank:	NatWest
Sort code:	60-17-21
Account number:	89543130
IBAN code:	GB41 NWBK 601721 89543130
UTR:	85621 10776
VAT registration number:	553 7696 03

Amount paid: £

Choose your method of payment:

O Cheque O Bank Transfer O Card payment

Please sign the acceptance below.

- A receipt will be issued to the party who has requested and received this quotation unless you specify different details to us.
- If we receive your payment without this completed acceptance form, we will assume that you have accepted our terms and conditions, enclosed herewith.
- If you cancel your project before commencement we will return any monies due minus administration costs.

I accept your quotation and the terms and conditions enclosed.

Signed: ______________________ **Date:** ______________

Information pack

For your information, we have attached this pack which we hope you will find useful. This pack contains all of the information you should need relevant to the work for which you have been quoted. However, if you have any further questions at all, please don't hesitate to contact us.

Contents

Safety

When we carry out any job, Safety is our first priority. Our motto is, "We do it safely, or not at all". Please read the enclosed information carefully and if in any doubt, please ask us to explain.

Your site requirements schedule

This gives details of any site works you will need to complete for us to meet your requirements. It includes what you need to know about cable routes and trenching.

Safety

We ask you to take note of the following.

In accordance with the Health and Safety Executive Guidance Note GS6, you are required to take every precaution to ensure that cranes, tipper lorries, scaffolding, ladders and other plant employed on your works are kept at a safe distance from overhead electric lines and their supports and that such supports are not disturbed by excavations. Goal posts with height restriction will need to be placed at appropriate locations for vehicles passing underneath Scottish and Southern Electricity Networks' overhead lines.

In accordance with Health and Safety Executive Guidance Note HSG47 care will also be necessary when digging in proximity to underground cables, particular if mechanical excavators are used.

Overhead lines, underground cables and other electrical plant must be regarded as being "live". Before commencing work in proximity to such plant written notification must be given to Scottish and Southern Electricity Networks.

If during the course of your works, any cable should be damaged by you/or your contractors, then this fact must be reported to our Emergency Service Centre on 0800 300 999 (Scottish Hydro Electric Power Distribution plc) immediately. The cost of any repairs will be fully rechargeable.

Locating cables on site

The drawings that I have enclosed with this quotation are not suitable for locating cables on site. To obtain the latest copies of our cable records please send a plan of the area in question together with your contact details to:

Mapping Services
Scottish and Southern Energy Power Distribution
P O Box 6206
BASINGSTOKE
RG24 8BW

Tel: 01256 337294
Fax: 01256 337295

requesting details of any Scottish and Southern Electricity Networks' plant and cables in the area. You must excavate hand-dug trial holes to establish the actual positions of all cables before any mechanical excavation works commence.

Scottish & Southern Electricity Networks

North of Scotland 0800 048 3515
Central Southern England 0800 048 3516

Your site requirements schedule

This schedule gives details of the site works you will need to complete for us to meet your requirements. Please read this document carefully as any problems with these works may result in additional charges and/or delays. If you need any assistance please contact me.

When we attend to undertake our works you must ensure that any substation site/s, cable routes and any associated overhead line positions are clear of all encumbrances and ready for on site construction.

Cable routes and ducts

Before we can lay our cables you will need to set out kerb lines, establish levels where roads or footpaths are not yet being constructed and, provide routes clear of obstructions or building materials. We will charge you for any subsequent alterations to our cables because of changes to the site layout.

You will need to install road crossing ducts. These must be twin walled black polyethylene ducting such as Ridgiduct, complying with the current edition of the ENATS specification 12-24.

Duct crossings must be laid at a depth of not less than 600mm and not more than 800mm below the finished road surface. The crossings should extend approximately 150mm beyond the kerb line on either side of the road and the ends should be blanked off to prevent ingress of spoil.

Please ensure that ducts provided for our use are spaced at least 1.0m clear of inspection pits and other duct lines to ensure working clearance at the ends of the ducts.

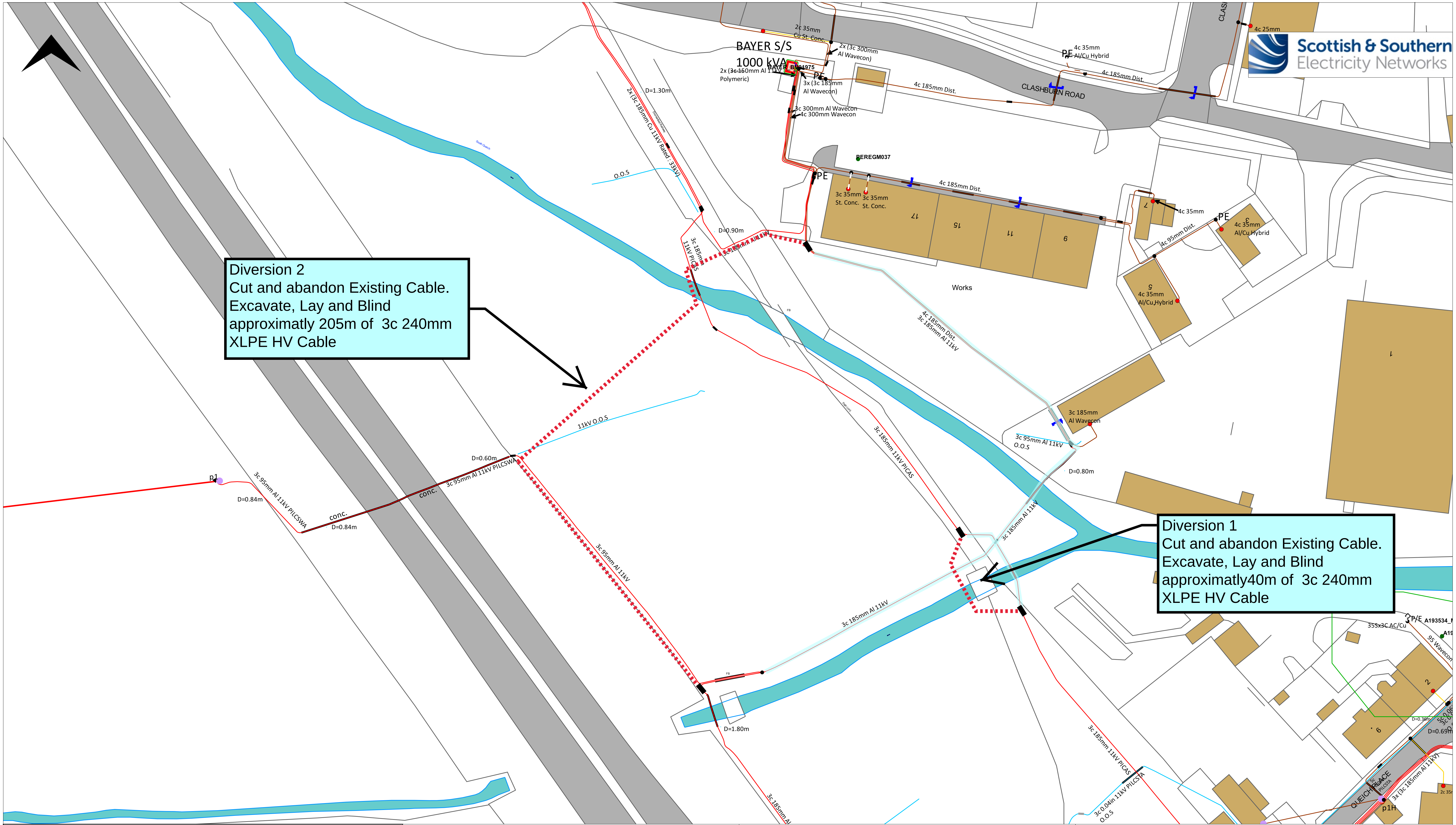
Trenching and inspection of cables

Where you are trenching for our cables, further information is available in our 'Mains Trenching Guide'. Please ask our Team Manager for a copy. This will ensure you meet our requirements and comply with the NJUG recommendations.

We will blind our cables using suitable material - which must be free of sharp stones and rocks etc. Where the excavated material is not suitable, you will need to provide us, free of charge, an alternative material for this purpose, typically sand. You will be responsible for backfilling and reinstatement of the trenches. Please contact our Team Manager a few days before you start works on site and he will visit and advise you on any additional requirements.

Removal of Scottish and Southern Electricity Networks equipment

Any equipment disconnected from our network is still our property. You may not remove any disconnected plant or cables without our prior agreement.



WARNING	
There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depths of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE GS6 SHOULD BE CONSULTED (AVAILABLE FROM THE HSE WEBSITE)	

Map Centre: 311594, 701640		Grid Ref: NO11590164
Scale: 1:1000	Page Size: A3	Plot Date: 16/08/2022
Designer Name: McNeish, James		Job Number: EVZ383/2

UNCONTROLLED COPY
Subject to revision
Master held by SSEN Asset Data Team - Asset.Data@sse.com

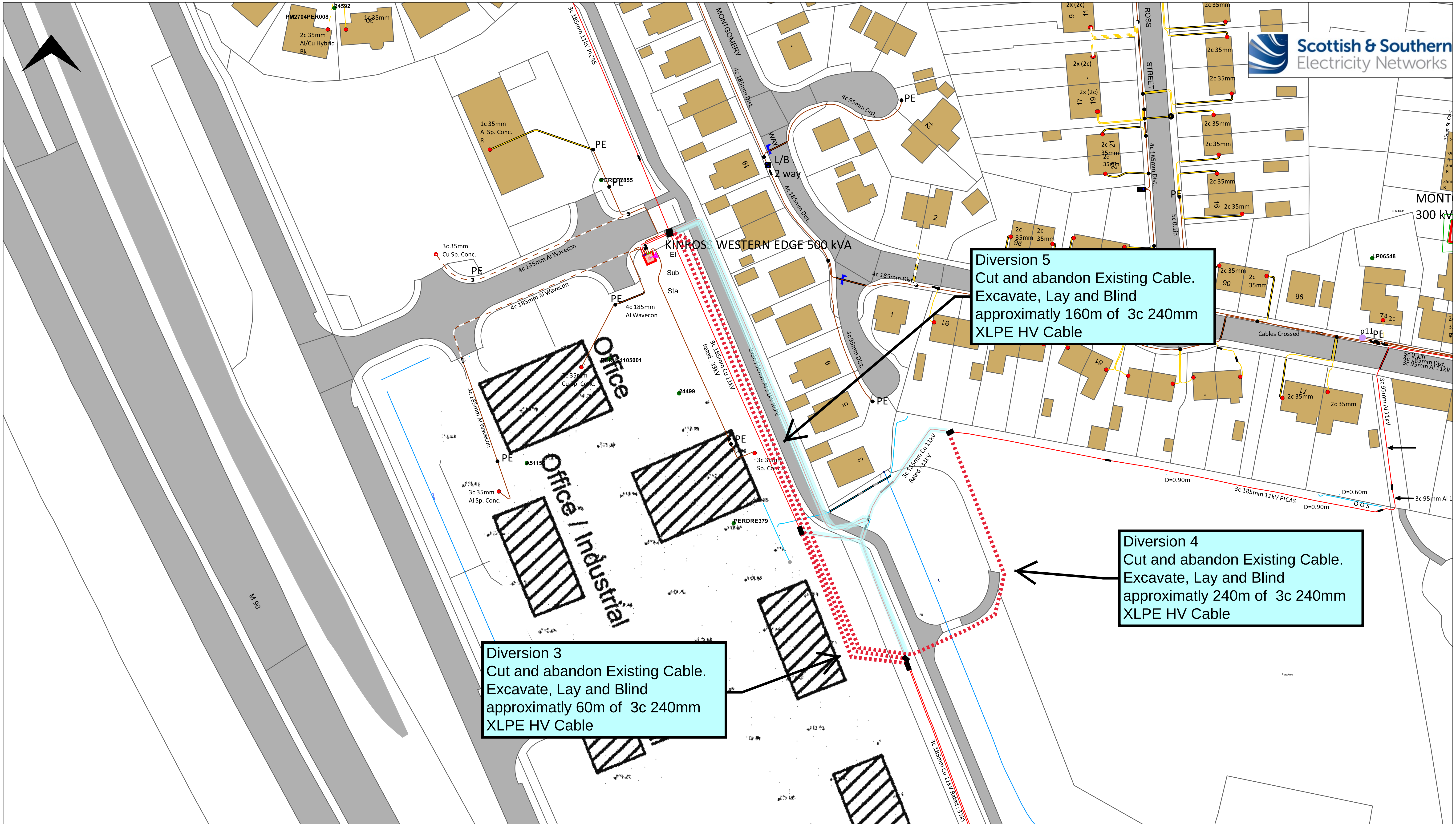
If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries	0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID

	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend



WARNING	Map Centre: 311395, 702064		Grid Ref: NO11390206			
	Scale: 1:1000	Page Size: A3	Plot Date: 19/08/2022			
	Designer Name: McNeish, James		Job Number: EVZ383/2			

UNCONTROLLED COPY
Subject to revision
Master held by SSEN Asset Data Team - Asset.Data@sse.com

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	Services	LV	HV	EHV
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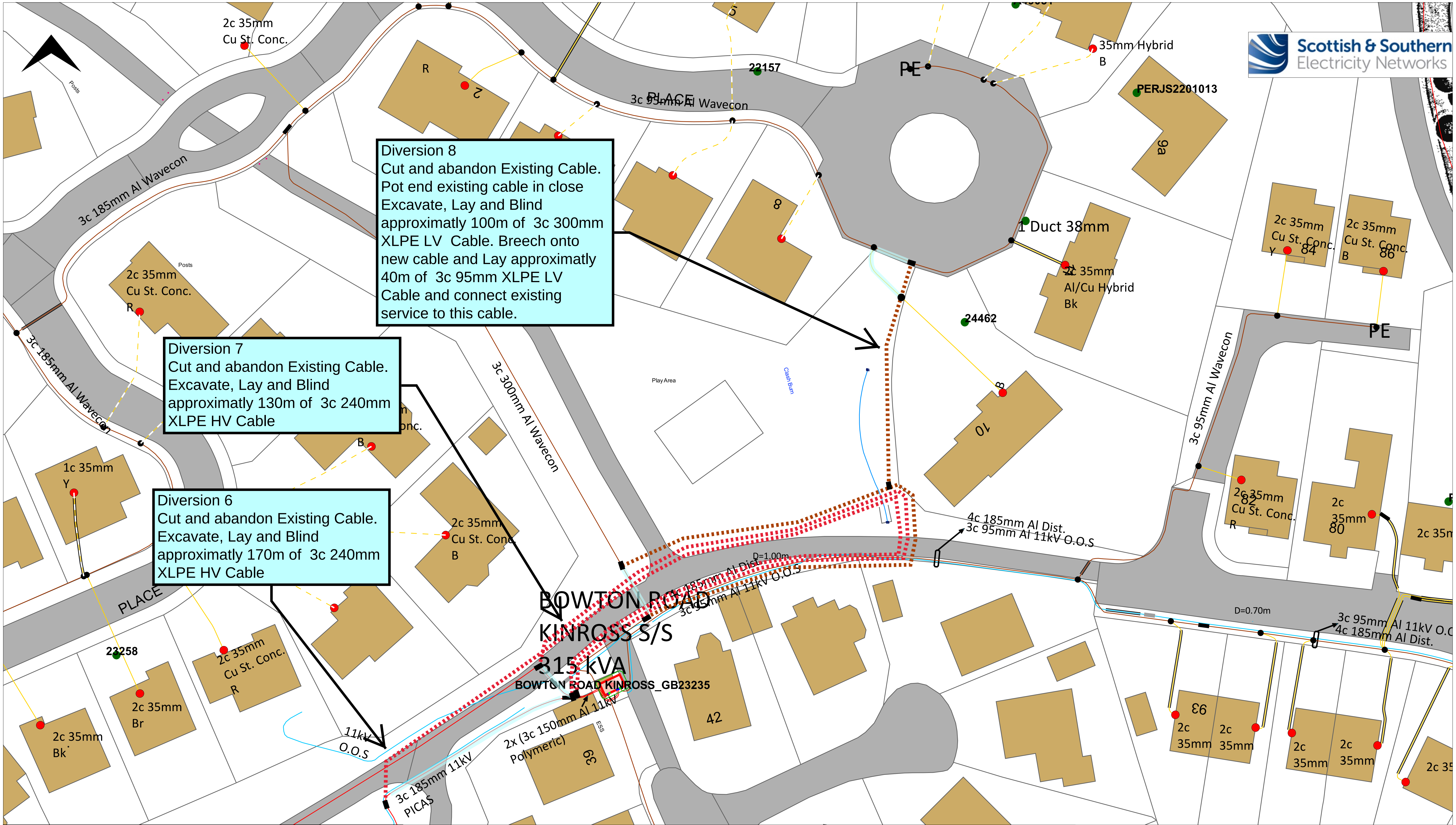
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend



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Map Centre: 311374, 702292
Grid Ref: NO11370229
Scale: 1:500
Page Size: A3
Plot Date: 19/08/2022
Designer Name: McNeish, James
Job Number: EVZ383/2

UNCONTROLLED COPY
Subject to revision
Master held by SSEN Asset Data Team - Asset.Data@sse.com

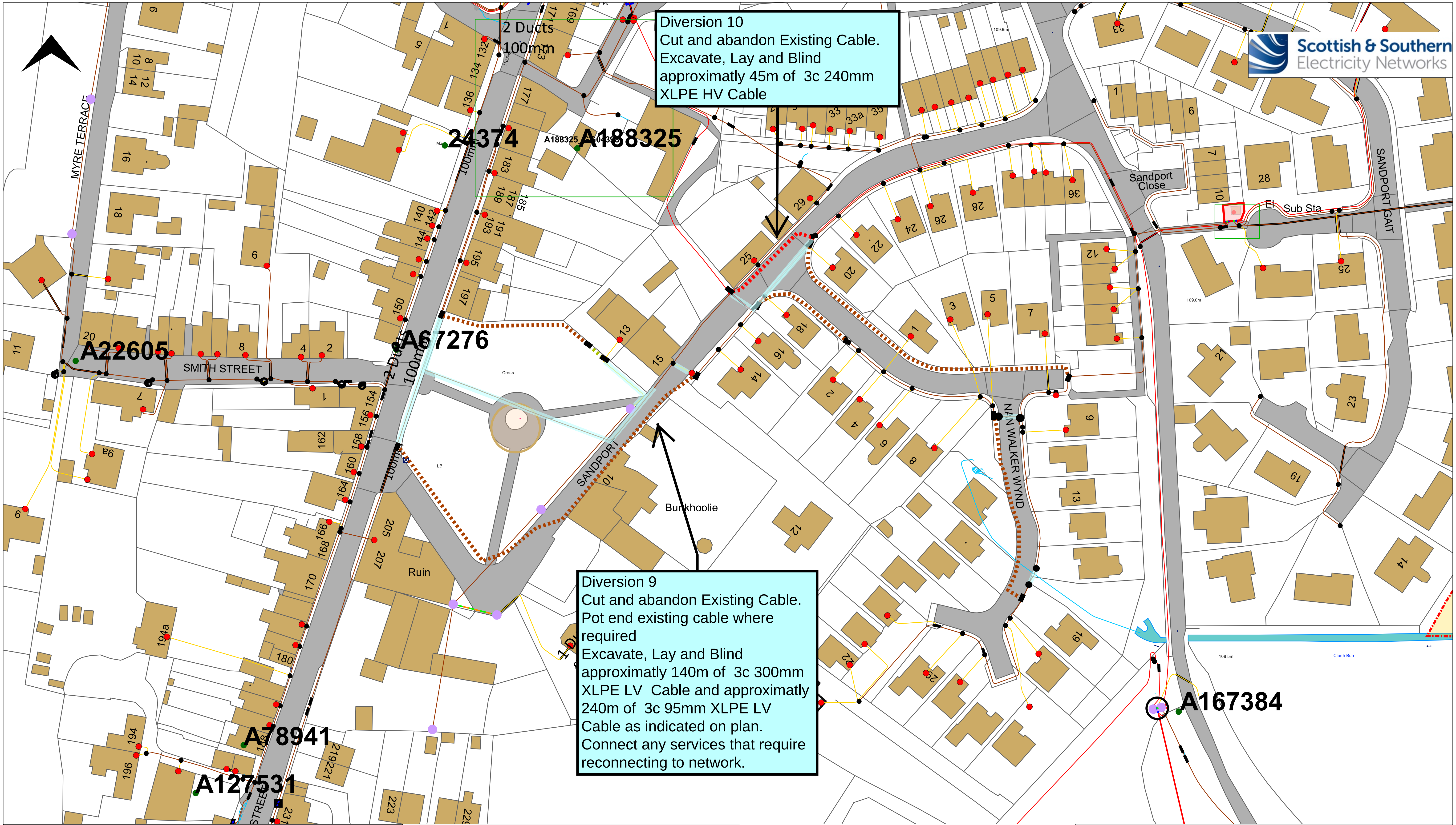
If you are unsure & need to seek advice before commencing excavations please contact;

General Enquiries 0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID

	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend



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Map Centre: 311974, 701876	Grid Ref: NO11970187
Scale: 1:1000 Page Size: A3	Plot Date: 19/08/2022
Designer Name: McNeish, James	Job Number: EVZ383/2

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Subject to revision
Master held by SSEN Asset Data Team - Asset.Data@sse.com

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General Enquiries 0800 048 3516

NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID

	Services	LV	HV	EHV
FOOTPATH/UNMADE	0.45m	0.45m	0.6m	0.8m
ROAD CROSSING	0.6m	0.6m	0.75m	0.9m
AGRICULTURAL	1m	1m	1m	1.1m

Legend

OPEN REACH

openreach

RPS Group
Phoenix House
Newhall Street
Birmingham
B3 3NH

FAO: Aisling McGilloway

Our Ref: 890704
17th July 2023 **Your Ref:**

Dear Sir

NEW ROADS AND STREET WORKS ACT 1991
DRAFT SCHEME AND BUDGET ESTIMATES

Appendix C3 of the Code of Practice
'Measures Necessary Where Apparatus Is Affected By Major Works (Diversionary Works)'

Scheme Title	South Kinross Flood Scheme
Location of Works	Kinross, Kinross Shire
OS Grid Ref	
Road No/Street Name	Various locations South Kinross
From	
To	
Description of Works	Diversion and alterations to facilitate flood prevention works
Expected Start Date	TBA
Expected Completion	TBA

Thank you for your draft scheme dated 17th July 2023 and copies of your drawings numbered IBE1585_OD_2001, IBE1585_OD_2002, IBE1585_OD_2006 & IBE1585_OD_2008.
It would appear from your proposals that alterations to our existing Openreach apparatus may be necessary.
I am returning our preliminary assessment of diversionary works necessary as a consequence of the scheme.

PP GBTD
Telephone House
21 Ward Road
Dundee
rpeAdd

email: douglas.borthwick@openreach.co.uk
tele: 0+443316261274
mob: 0+447743843233

Openreach Limited
Registered Office: Kelvin House
123 Judd Street, London WC1H 9NP
Registered in England and Wales no. 10690039

As requested a budget estimate of the possible cost of diverting our apparatus is attached. It includes all direct costs and overheads likely to arise. It is stressed that this is a budgetary figure and only intended as a guide, the actual amount could be significantly different. (see form C3 Appendix G).

Prior to any works involving Openreach apparatus, we must agree a Specification and provide a Detailed Estimate of costs to the Principal or Promoter of this project. The costs incurred in producing the Specification and Detailed Estimate are chargeable and for this scheme are estimated to be £3,442.00 excluding VAT. The charge applies whether or not your works proceed to execution. Your payment in advance, for the estimated cost of the design work, will be required before any works proceed on this scheme.

None of the materials required has a lead time of greater than three months and therefore advance ordering should not be required.

Notification to Openreach customers of circuit downtime will be required. The normal arrangement period for this notification is 3 months.

We offer a free site visit service to locate and mark the position of Openreach apparatus within your work area. To arrange a site visit from a Plant Protection Officer call Fax: Email: cbyd@openreach.co.uk

For further information on this service please visit the following URL:
https://www.openreach.com/network-services/locating-our-network

Please be aware that any duct and poles owned and controlled by Openreach can be used by third party Communications Providers (CP) for the installation of their cables and apparatus if they have a contract with us for our Physical Infrastructure Access (PIA) product. The CP must, however, place an order with us for PIA before they install their cables or apparatus. If such CP cables or apparatus are identified in our network within your area of interest, I will identify a contact for the affected CP and advise them of your proposals. I will pass these contact details on to you and liaise with the CP so that they are aware of any diversionary requirements relating to your proposals. You will be contacted directly by the affected third party CP - they will advise you of any associated chargeable costs relating to their cable and apparatus diversions. If you have any queries or concerns relating to this aspect of the Openreach operated network, please don't hesitate in contacting me. Please note Openreach Limited will not be held liable for any delays, costs, losses or damage caused by the third party CP.

Please note that no further action will be taken on this enquiry until we receive the appropriate notification of the Detailed Scheme from the promoting authority in accordance with Appendix C4 of the Code of Practice. If you are not the promoting authority but will be acting as his Agent and deal with notices etc., then confirmation of this will be required, in writing, from the promoting authority (see Section 2.1).

Yours faithfully

D. Borthwick

Douglas Borthwick
Network Rearrangement Project Engineer

C3 BUDGET ESTIMATE

NRSWA 1991: A CODE OF PRACTICE	**HA Ref No**	
'MEASURES NECESSARY WHERE APPARATUS IS AFFECTED BY MAJOR WORKS (DIVERSIONARY WORKS)'	(to be quoted in all correspondence)	
	Undertaker Ref	890704
HA Name and Address	(to be quoted in all correspondence)	
RPS Group Phoenix House Newhall Street Birmingham B3 3nh	**Date of Estimate**	17th July 2023

Undertaker	Openreach
Scheme	South Kinross Flood Scheme
Diversion Description	Diverting Openreach apparatus

Budget Estimate Summary (Net of any discount/s)	
Direct Labour Inc overheads @ 92.68%	£123,181.97
Contract Costs Inc overheads @ 53.37%	£49,447.29
Materials Inc overheads @ 43.32%	£13,186.97
Budget Estimate Project Cost	£185,816.23 excluding VAT

Anticipated Duration	8 months
Lead Times (Refer to Code)	10 weeks
Is Design/Survey Work Required	Yes
Anticipated cost of Design/Survey Work	£3,442.00 excluding VAT

Possibility of	
Deferment of Renewal	No
Betterment	No
Materials Recovered	Yes

Legend

CAUTION_AREA

BT.CAUTION_AREA

EQUIPMENT

TABCD FIBRE, TCODE

COPPER, CABINET

476R COPPER, DP

DUCT

A/C AERIAL

TUNNEL

DUCT

PROPOSED

A/C AERIAL

DUCT

STRUCTURE

YCODE

CABINET SHELL

SPLIT COUPLING

POLE

KIOSKS

MANHOLE

JOINTBOX

CHANGE OF STATE

DUCT TEE

PROPOSED

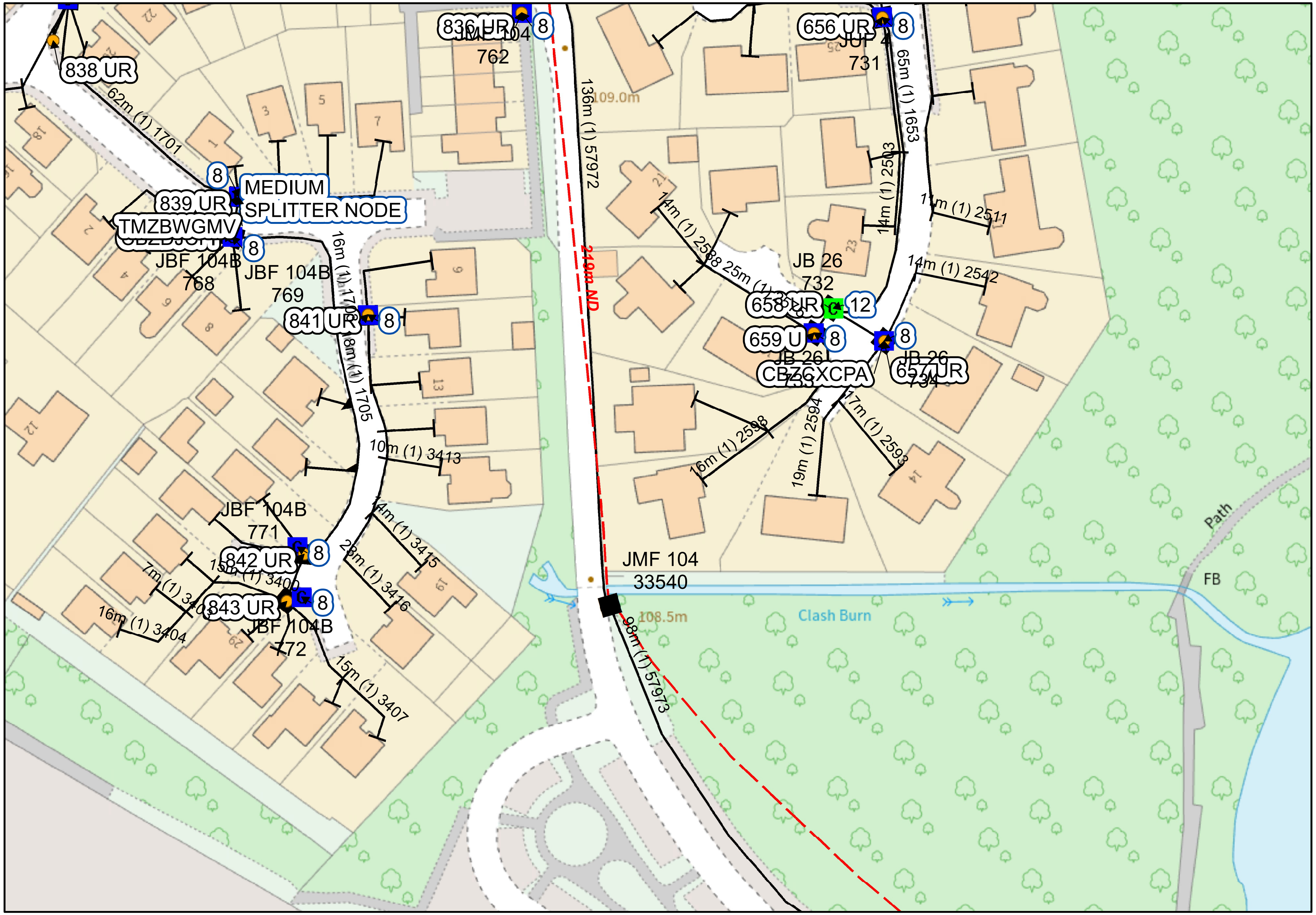
MANHOLE

JOINTBOX

DUCT TEE

Other proposed plant is shown using dashed lines.

BT symbols not listed above may be disregarded.



IMPORTANT WARNING:
Information regarding the location of BT apparatus is given for your assistance and is intend for general guidance only. No guarantee is given of its accuracy. It should not be relied upon in the event of excavations or other works being made near to BT apparatus, which may exist at various depths and may deviate from the marked route.

Exisiting BT plant may not be recorded.
Information valid at time of preparation.

CLICK BEFORE YOU DIG

FOR PROFESSIONAL FREE ON SITE ASSISTANCE PRIOR TO COMMENCEMENT OF EXCAVATION WORKS INCLUDING LOCATE AND MARKING SERVICE

email cbyd@openreach.co.uk

ADVANCE NOTICE REQUIRED
(Office hours:Monday -Friday 08.00 to 17.00)

N

PLANT INFORMATION REPLY

Grid Ref 312103,701813

<Double-Click to add Text>

openreach

Legend

CAUTION_AREA

BT.CAUTION_AREA

EQUIPMENT

TABCD FIBRE, TCODE

COPPER, CABINET

476R COPPER, DP

DUCT

A/C AERIAL

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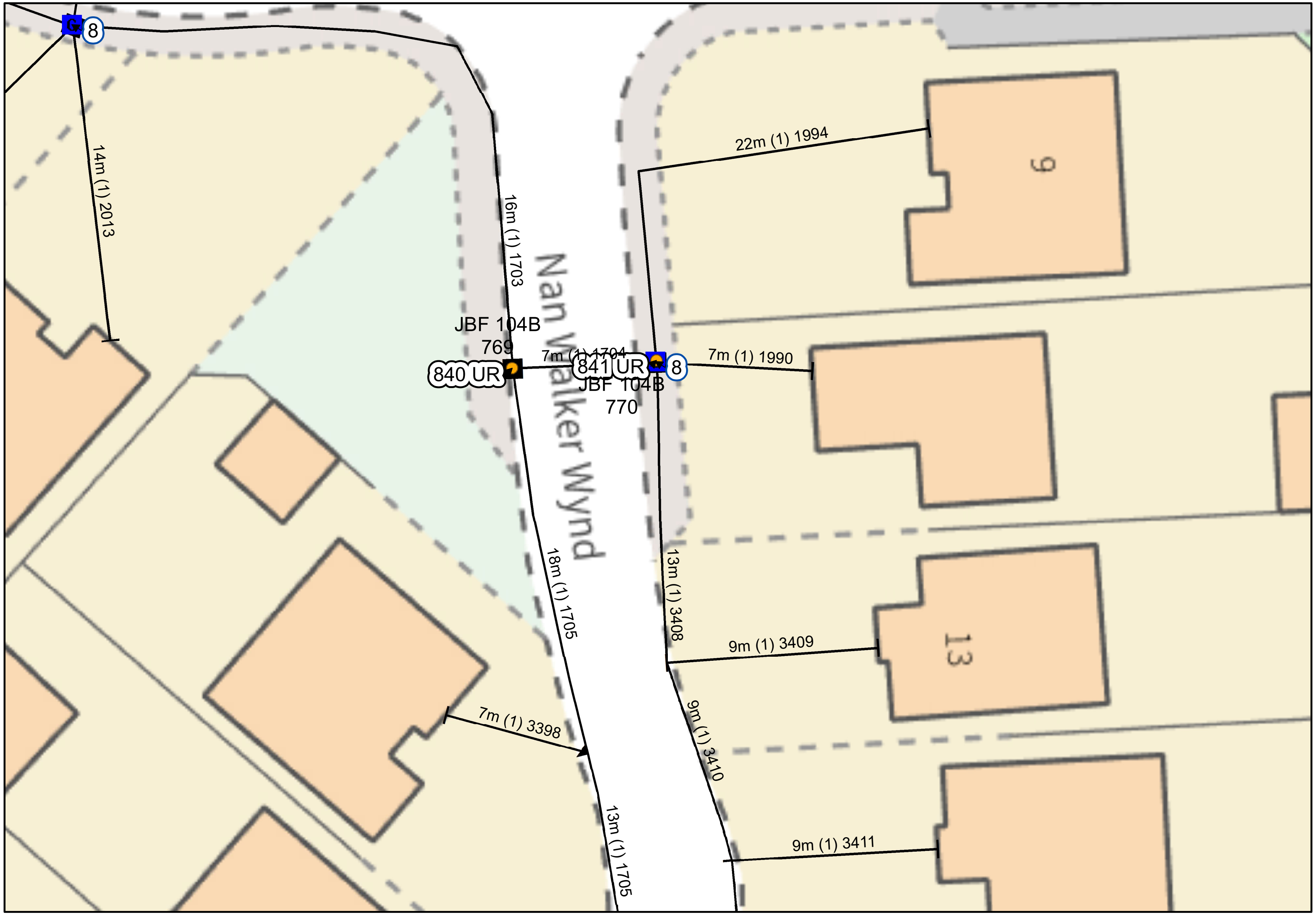

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N

PLANT INFORMATION REPLY

Grid Ref 312054,701866

<Double-Click to add Text>

openreach

Legend

CAUTION AREA
BT.CAUTION_AREA

EQUIPMENT
TABCD FIBRE, TCODE
COPPER, CABINET
476R COPPER, DP

DUCT
A/C AERIAL
TUNNEL
DUCT

PROPOSED
A/C AERIAL
DUCT

STRUCTURE
YCODE
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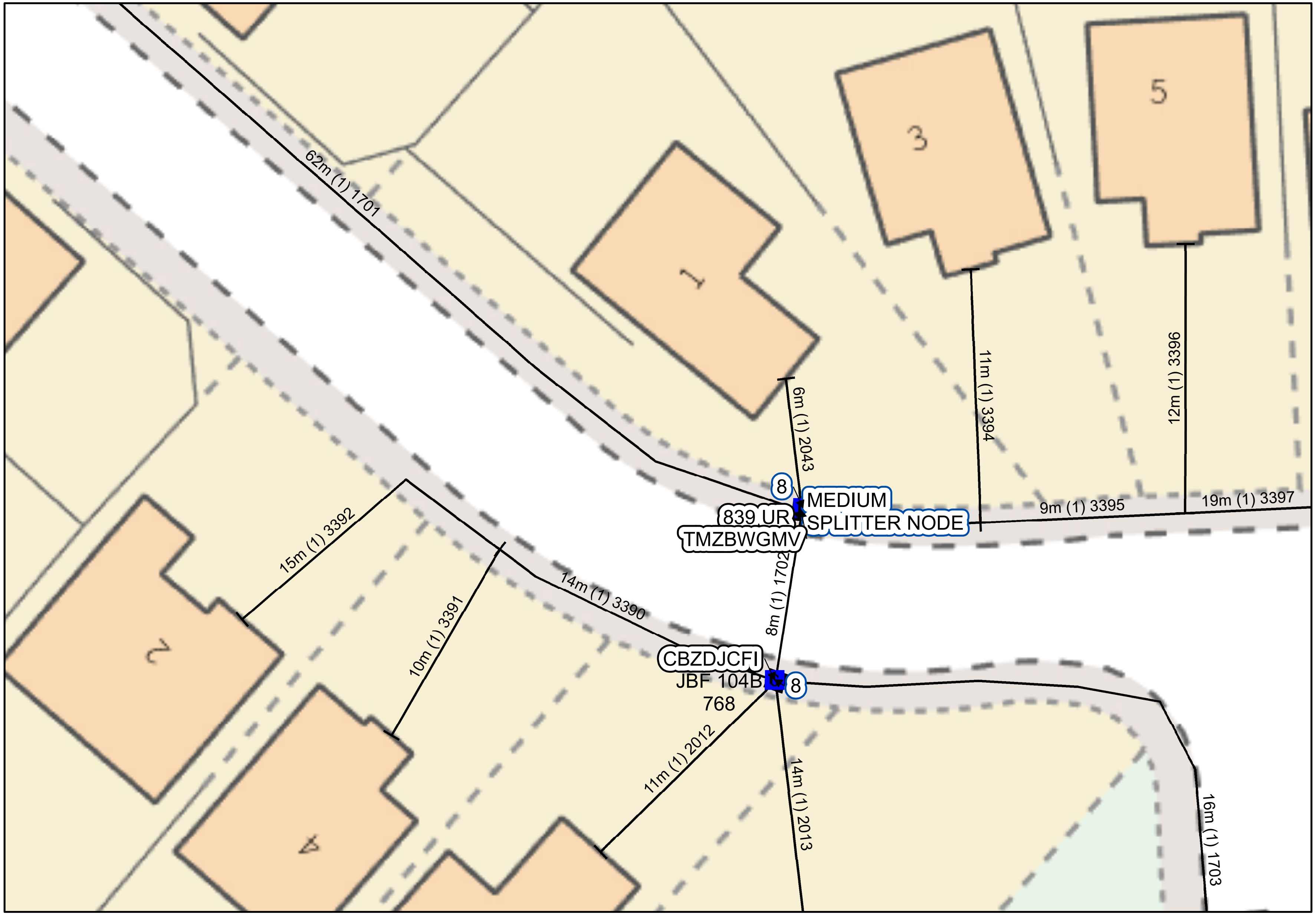

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N

PLANT INFORMATION REPLY
Grid Ref 312032,701886
<Double-Click to add Text>

openreach

Legend

CAUTION_AREA

BT.CAUTION_AREA

EQUIPMENT

TABCD FIBRE, TCODE

COPPER, CABINET

476R COPPER, DP

DUCT

A/C AERIAL

TUNNEL

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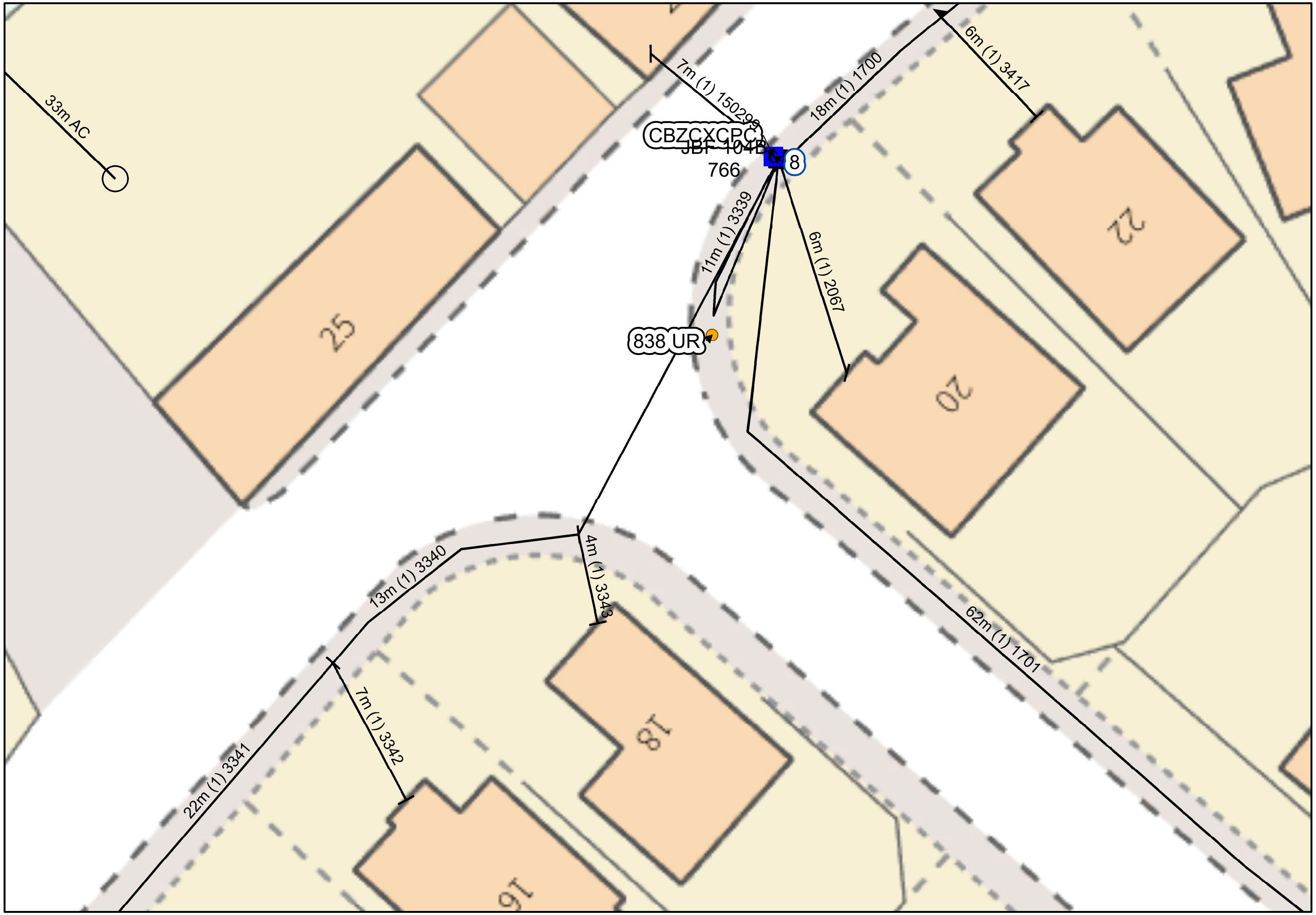

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N

PLANT INFORMATION REPLY

Grid Ref 311994,701917

<Double-Click to add Text>

openreach

Legend

CAUTION AREA
BT.CAUTION_AREA

EQUIPMENT
TABCD FIBRE, TCODE
COPPER, CABINET
476R COPPER, DP

DUCT
A/C AERIAL
TUNNEL
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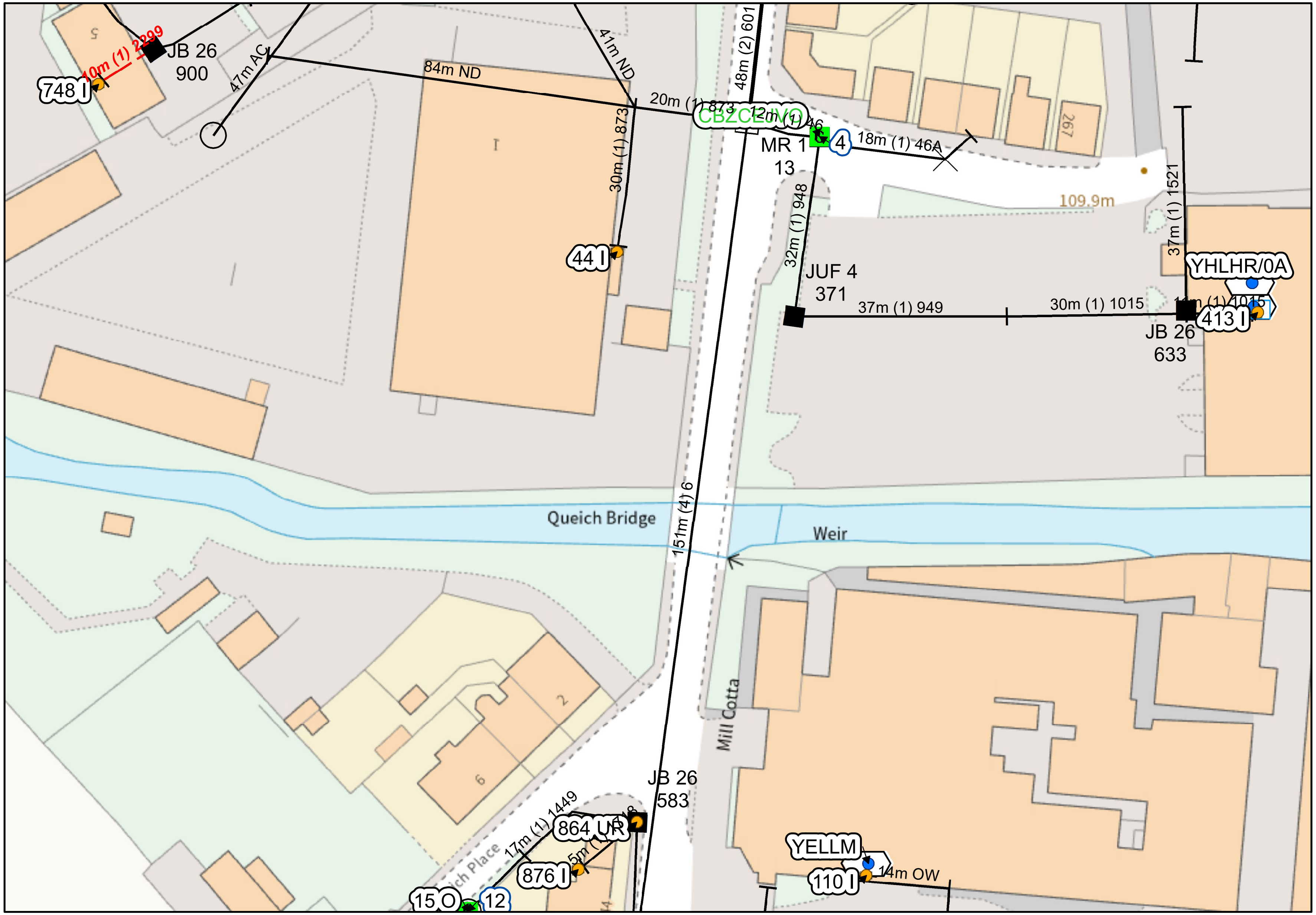

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PLANT INFORMATION REPLY
Grid Ref 311813,701594
<Double-Click to add Text>

openreach

Legend

CAUTION_AREA

BT.CAUTION_AREA

EQUIPMENT

TABCD FIBRE, TCODE

COPPER, CABINET

476R COPPER, DP

DUCT

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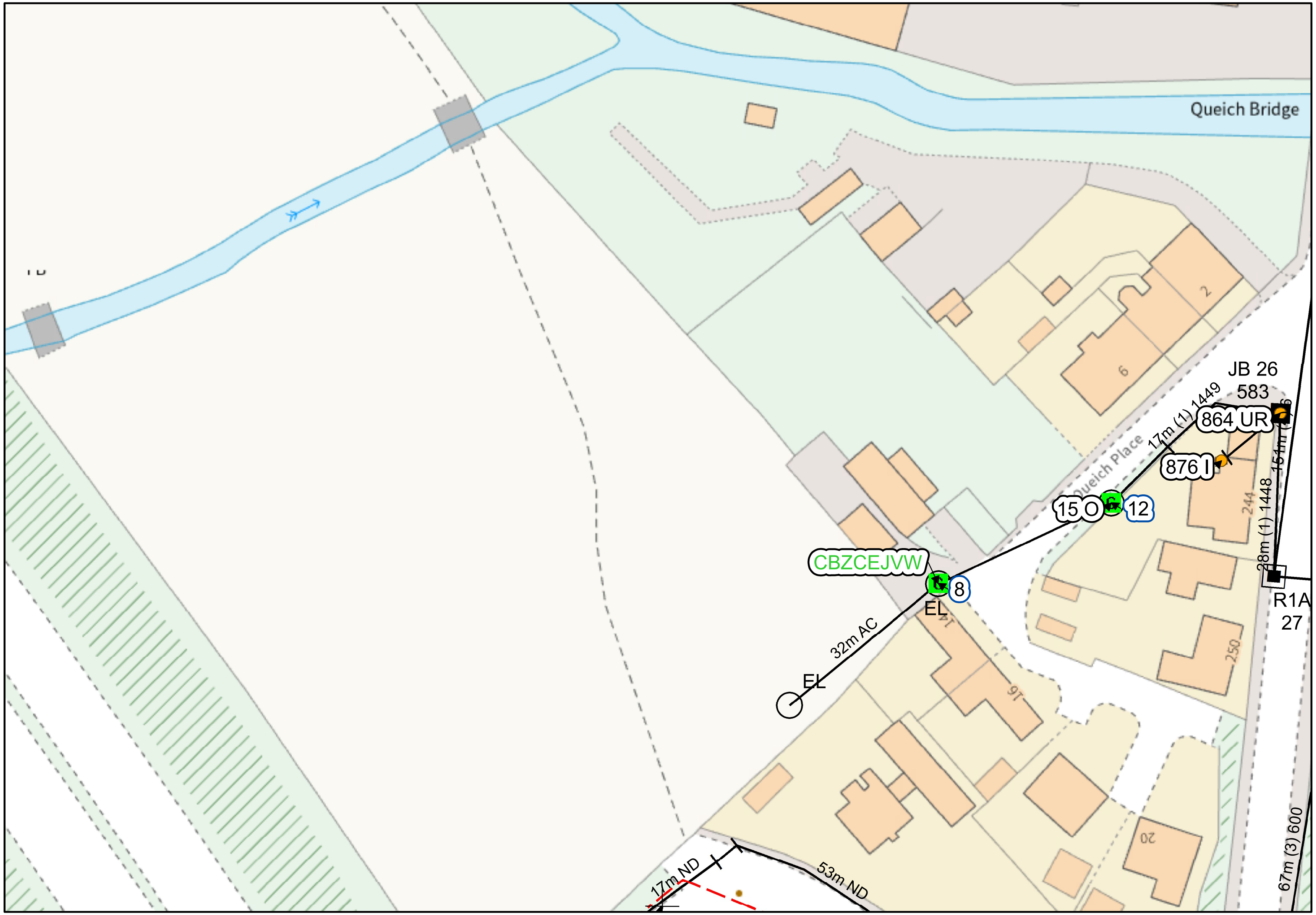

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PLANT INFORMATION REPLY

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<Double-Click to add Text>

openreach

Legend

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476R COPPER, DP

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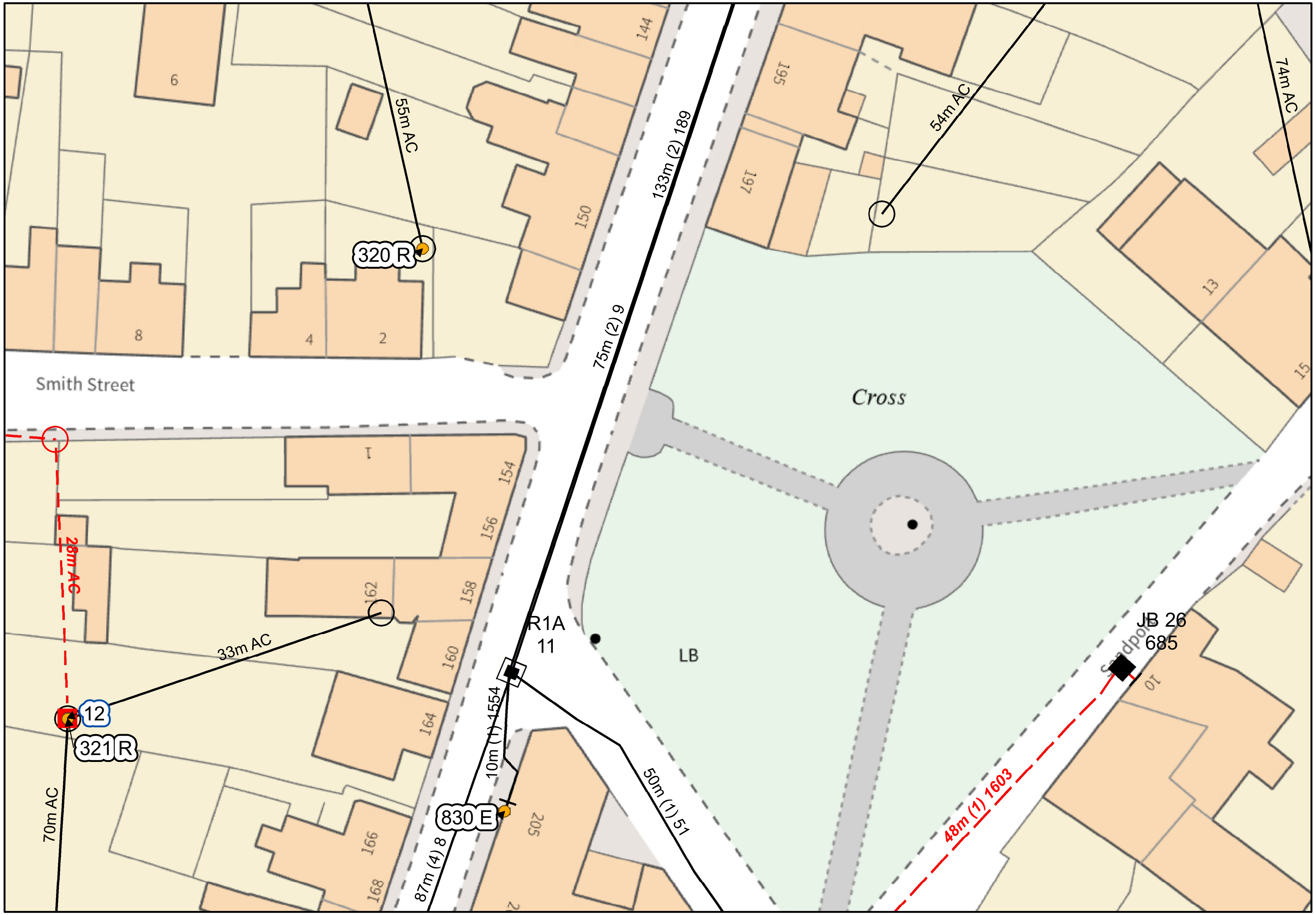

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ADVANCE NOTICE REQUIRED
(Office hours Monday -Friday 08.00 to 17.00)

N

PLANT INFORMATION REPLY

Grid Ref 311886,710914

<Double-Click to add Text>

openreach

SGN

Aisling McGilloway

From:	Spiers, John <john.spiers@sgn.co.uk> on behalf of Quotations/SGN <quotations@sgn.co.uk>
Sent:	31 May 2023 14:13
To:	Aisling McGilloway
Subject:	2422452 - Job 1 - South Kinross Flood Protection Scheme, Smith Street, The Cross, Sandport, Kinross, Kinross Shire, KY13 8EN.
Attachments:	1.1000_overlay_a3.pdf; 1.1000.pdf; Dig Safely-Measures to avoid injury and damage to gas pipes.pdf

Classified as Confidential

Further to previous correspondence.

- **Although the route follows our Medium Pressure main there is little opportunity for SGN to divert this main – greater care should be taken when conducting your proposed works in this area…**

Please find attached extract from GEOfield (SGN digitised asset record) of current Gas pipes in the area of your proposed infrastructure improvements.

Whilst there is apparatus in the vicinity of your proposed works SGN do not consider that diversions will be required and therefore are not going to provide C3 Budget Cost on this occasion. Protection measures agreed by SGN appears to be the most suitable solution.

Safe digging practices in accordance with HS(G)47 must be used to verify and establish the actual position of mains pipes, services and other apparatus on site prior to any mechanical plant being used. It is your responsibility to ensure that up to date plant location information is provided to all persons working for you on or near gas apparatus. Information included on Gas Map extracts should not be referred to beyond a period of 28 days from date of issue.

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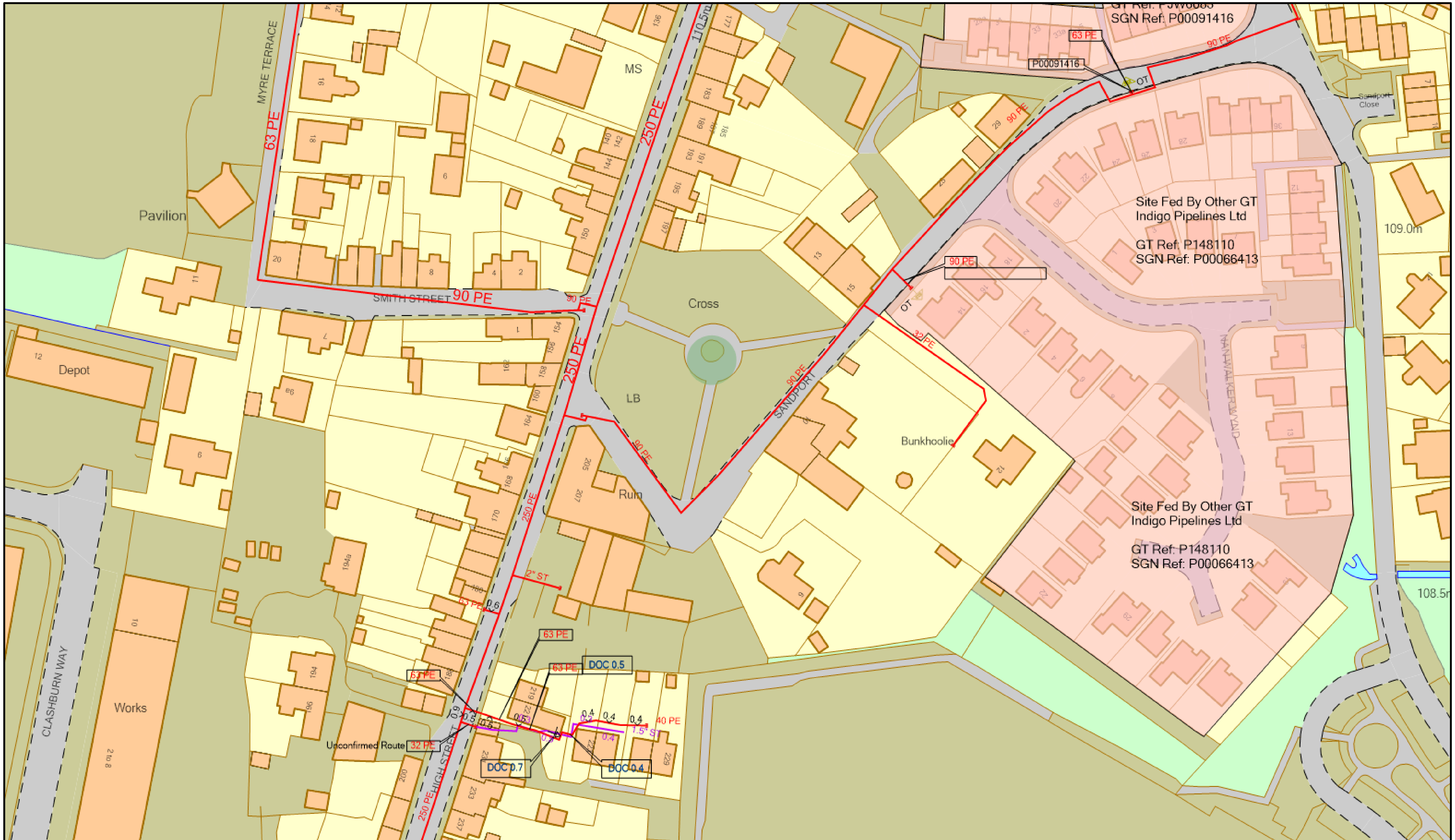
Further, additional information for working in the vicinity of gas plant is detailed in the Dig Safely Measures booklet attached.

Should you require to discuss any aspects of your works in more detail then please do not hesitate to contact me.

Regards,

John Spiers
Design Assistant
Scotland Quotation Team

sgn.co.uk
Find us on Facebook and follow us on Twitter: @SGNgas



SCALE: 1 : 1000

USER ID: js61672

DATE: 31/05/2023

GRID REFERENCE:
E311919, N701855, NO119018

LP MAINS

MP MAINS

IP MAINS

LHP MAINS

IGTs

SSSIs

Some examples of Plant Items

Valve | Syphon | Depth of Cover | Diameter Change | Material Change

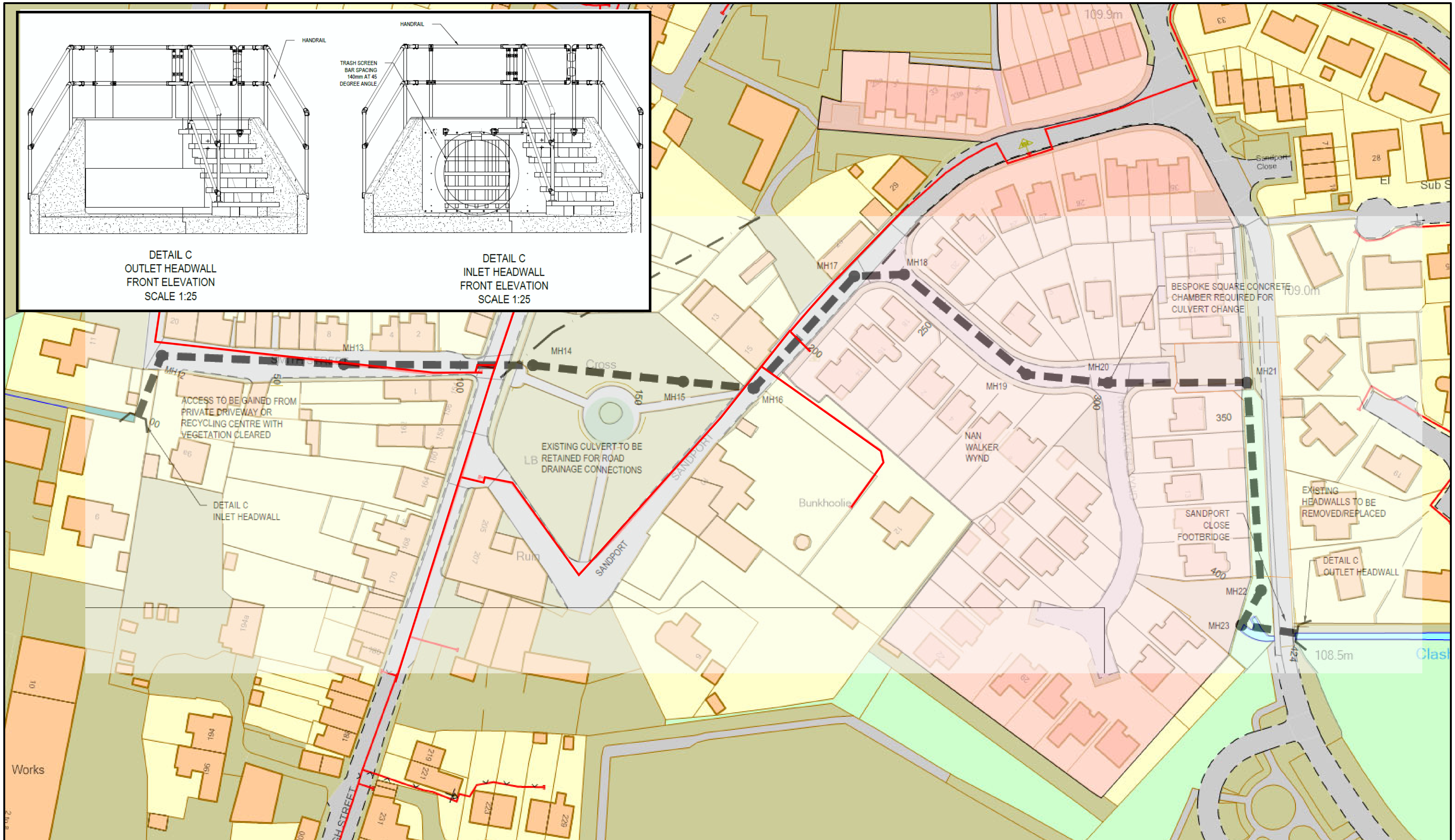
This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes /assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 08009121722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G) 47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

SMELL GAS? CALL 0800 111 999

Map version: 2.12.2

Issued by: Scotia Gas Networks Ltd

SGN



SCALE: 1 : 1000

2422452

GRID REFERENCE:
E311947, N701872, NO119018

LP MAINS	
MP MAINS	
IP MAINS	
LHP MAINS	
IGTs	SSSIs

Some examples of Plant Items

Valve | Syphon | Depth of Cover | Diameter Change | Material Change

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SMELL GAS? CALL 0800 111 999

Map version: 2.12.2

Issued by: Scotia Gas Networks Ltd

SGN

Aisling McGilloway

From: Spiers, John <john.spiers@sgn.co.uk> on behalf of Quotations/SGN <quotations@sgn.co.uk>

Sent: 20 July 2023 15:17

To: Aisling McGilloway

Subject: 2424029 - Job 2 - South Kinross Flood Protection Scheme, Queich Bridge, Kinross, Kinross Shire, KY13 8EN.

Attachments: 1.1500_Overlay_A3.pdf; 1.1000_overlay_a3.pdf

Follow Up Flag: Follow up

Flag Status: Flagged

CAUTION: This email originated from outside of RPS.

Classified as Confidential

Good Afternoon

This is the last response to you flood Protection Scheme at the above location which needs addressing…

- For this section of the proposal, after careful consideration we feel there is no real possible diversion route which allows us ease of access and suitable servitude.

- I've been asked if you would reposition your flood defensive embankment to allow for SGN to divert around the rear, providing us with servitude rights and sufficient proximity for ease of access to maintain, replace and repair where required.

- **Trench Depths of Cover**

The minimum depth of cover for mains in open fields and agricultural land is 1100mm; in carriageways and verges 750mm; and in paved footpaths and private ground 600mm.

- Proximity from the defence would also need to be insured for working in the event of a gas emergency when a flood had occurred.

Regards

John Spiers
Design Assistant

Scotland Quotation Team
☎: +44 800 912 1700
✉: quotations@sgn.co.uk

SGN, Axis House, 5 Lonehead Drive, Newbridge, EH28 8TG
Visit our website: www.sgn.co.uk
Find us on Facebook and follow us on Twitter: @SGNgas
Smell gas? Call 0800 111 999

SCALE: 1 : 1000

2424029

GRID REFERENCE:
E311708, N701559, NO117015

LP MAINS
MP MAINS
IP MAINS
LHP MAINS
IGTs SSSIs

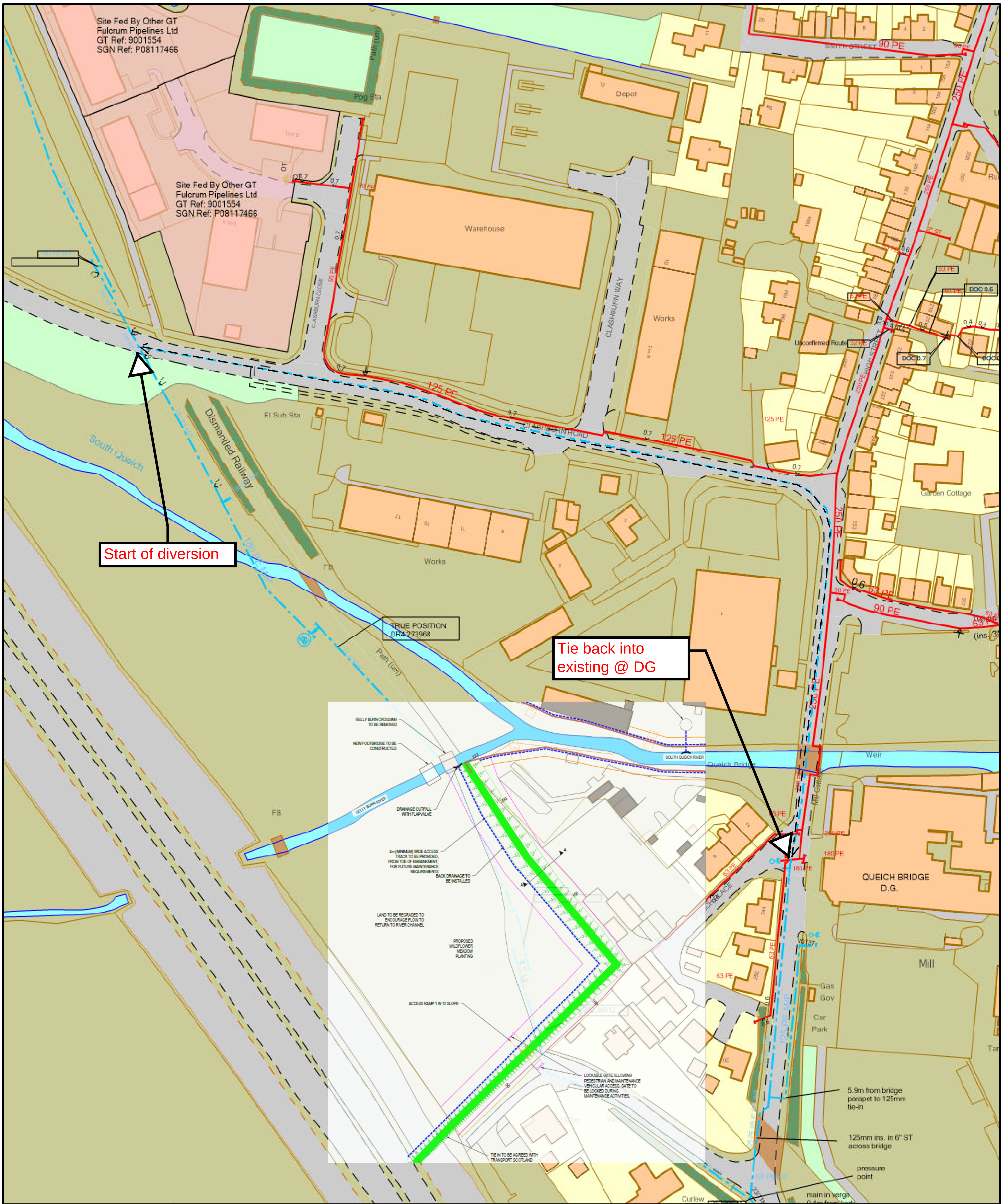
Some examples of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Map version: 2.12.2

Issued by: Scotia Gas Networks Ltd

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes /assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 08009121722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G) 47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

SMELL GAS? CALL 0800 111 999



SCALE: 1 : 1500 2424029 GRID REFERENCE: E311688, N701658, NO116016	LP MAINS MP MAINS IP MAINS LHP MAINS IGTs SSSIs	Some examples of Plant Items Valve Syphon Depth of Cover Diameter Change Material Change © Crown copyright and database rights 2023 OS 7142104 & 7261731 Background data © OpenStreetMap contributors via the Open Database License. Map version: 2.12.2 Issued by: Scotia Gas Networks Ltd

SMELL GAS? CALL 0800 111 999

Aisling McGilloway

From: Spiers, John <john.spiers@sgn.co.uk> on behalf of Quotations/SGN <quotations@sgn.co.uk>
Sent: 18 May 2023 14:37
To: Aisling McGilloway
Subject: 2424042 - Job 3 - South Kinross Flood Protection Scheme, Sewage Works And Pavilion, Kinross, Kinross Shire, KY13 8EN.
Attachments: 1.1000_overlay_a3.pdf; 1.500_overlay_a4.pdf; Dig Safely-Measures to avoid injury and damage to gas pipes.pdf

Further to previous correspondence.

Please find attached extract from GEOfield (SGN digitised asset record) of current Gas pipes in the area of your proposed infrastructure improvements.

Whilst there is apparatus in the vicinity of your proposed works SGN do not consider that diversions will be required and therefore are not going to provide C3 Budget Cost on this occasion. Protection measures agreed by SGN appears to be the most suitable solution.

Safe digging practices in accordance with HS(G)47 must be used to verify and establish the actual position of mains pipes, services and other apparatus on site prior to any mechanical plant being used. It is your responsibility to ensure that up to date plant location information is provided to all persons working for you on or near gas apparatus. Information included on Gas Map extracts should not be referred to beyond a period of 28 days from date of issue.

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Further, additional information for working in the vicinity of gas plant is detailed in the Dig Safely Measures booklet attached.

Should you require to discuss any aspects of your works in more detail then please do not hesitate to contact me.

Regards,

John Spiers
Design Assistant
Scotland Quotation Team

sgn.co.uk
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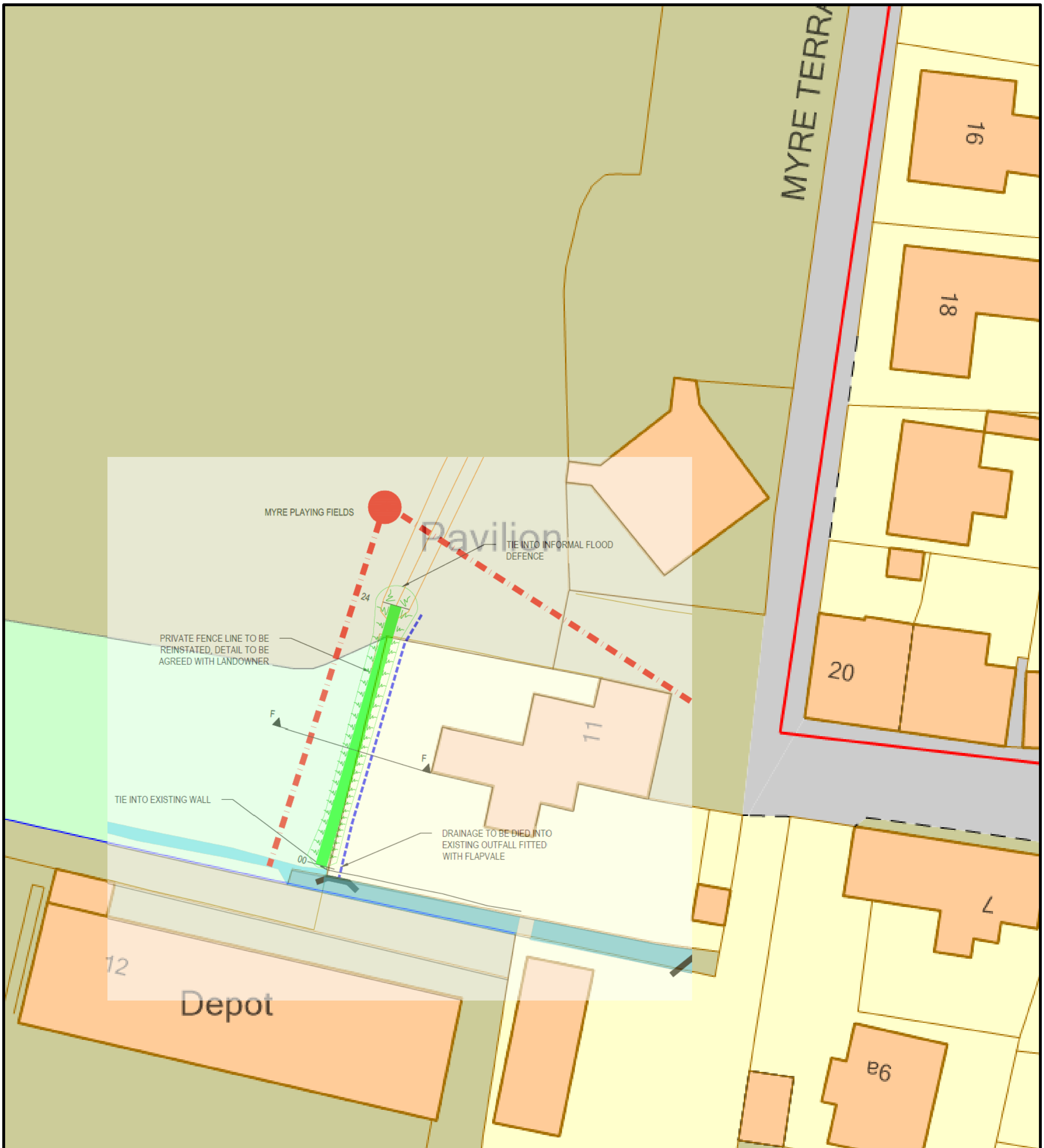
Smell gas? Call 0800 111 999
Find out how to protect your home from carbon monoxide



SCALE: 1 : 500

GRID REFERENCE:
E311766, N701908, NO117019

LP MAINS

MP MAINS

IP MAINS

LHP MAINS

IGTs SSSIs

Some examples of Plant Items

Valve Syphon Depth of Cover Diameter Change Material Change

Map version: 2.12.2

Issued by: Scotia Gas Networks Ltd

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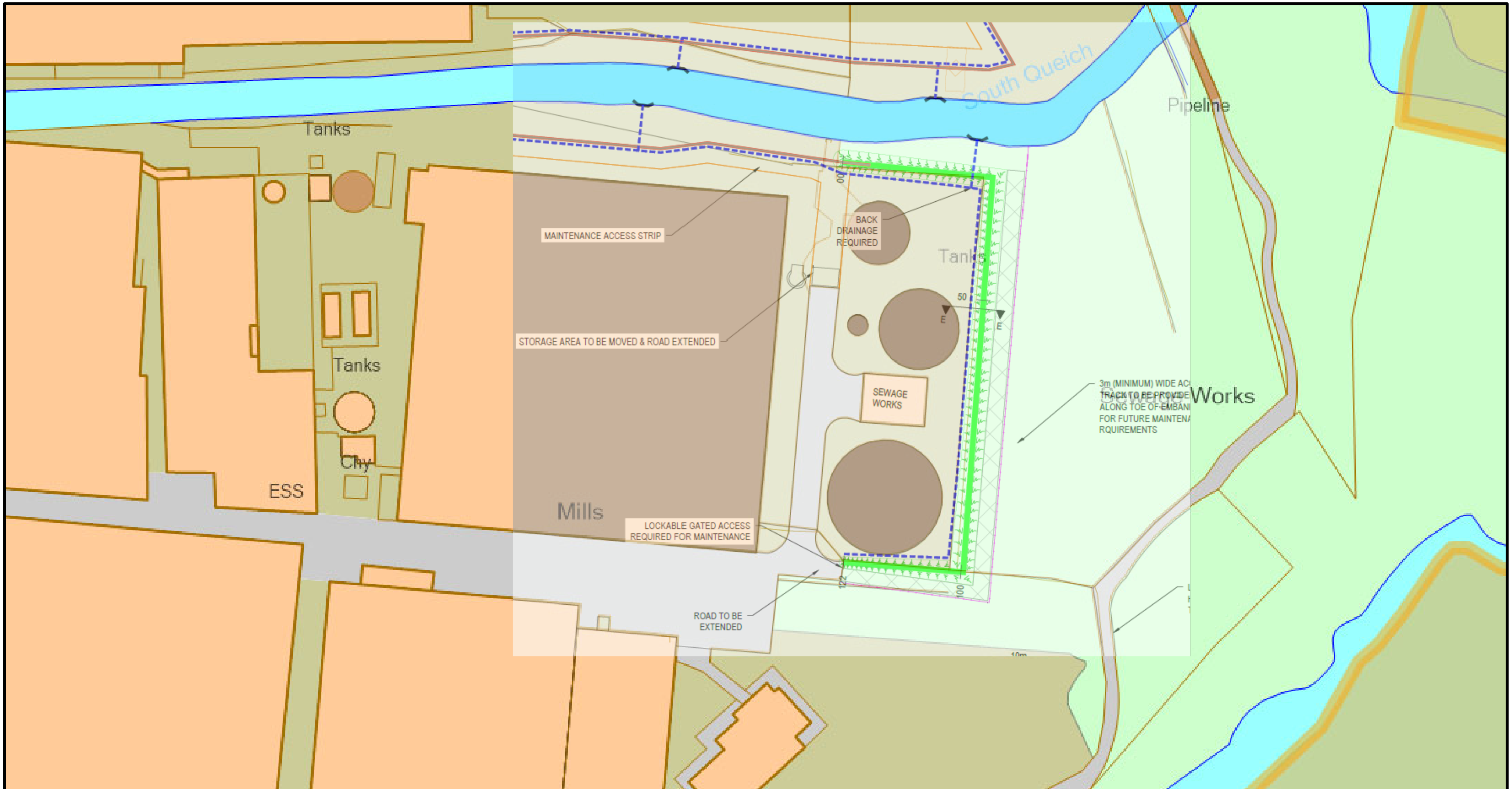
SMELL GAS? CALL 0800 111 999



SCALE: 1 : 1000

2424042

GRID REFERENCE:
E312082, N701542, NO120015

LP MAINS

MP MAINS

IP MAINS

LHP MAINS

IGTs SSSIs

Some examples of Plant Items

Valve Syphon Depth of Cover Diameter Change Material Change

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SMELL GAS? CALL 0800 111 999

Map version: 2.12.2

Issued by: Scotia Gas Networks Ltd

Aisling McGilloway

From:	Spiers, John <john.spiers@sgn.co.uk> on behalf of Quotations/SGN <quotations@sgn.co.uk>
Sent:	31 May 2023 12:25
To:	Aisling McGilloway
Subject:	2424074 - Job 5 - South Kinross Flood Protection Scheme, Montgomery Way, Kinross, Kinross Shire, KY13 8EN.
Attachments:	Dig Safely-Measures to avoid injury and damage to gas pipes.pdf; 1.1500_A3 _Overlay.pdf

CAUTION: This email originated from outside of RPS.

Classified as Confidential

Further to previous correspondence.

- **Althought the route follows our Medium Pressure main there is little opertunity for SGN to divert this main – greater care should be taken when conducting your proposed works in this area…**

Please find attached extract from GEOfield (SGN digitised asset record) of current Gas pipes in the area of your proposed infrastructure improvements.

Whilst there is apparatus in the vicinity of your proposed works SGN do not consider that diversions will be required and therefore are not going to provide C3 Budget Cost on this occasion. Protection measures agreed by SGN appears to be the most suitable solution.

Safe digging practices in accordance with HS(G)47 must be used to verify and establish the actual position of mains pipes, services and other apparatus on site prior to any mechanical plant being used. It is your responsibility to ensure that up to date plant location information is provided to all persons working for you on or near gas apparatus. Information included on Gas Map extracts should not be referred to beyond a period of 28 days from date of issue.

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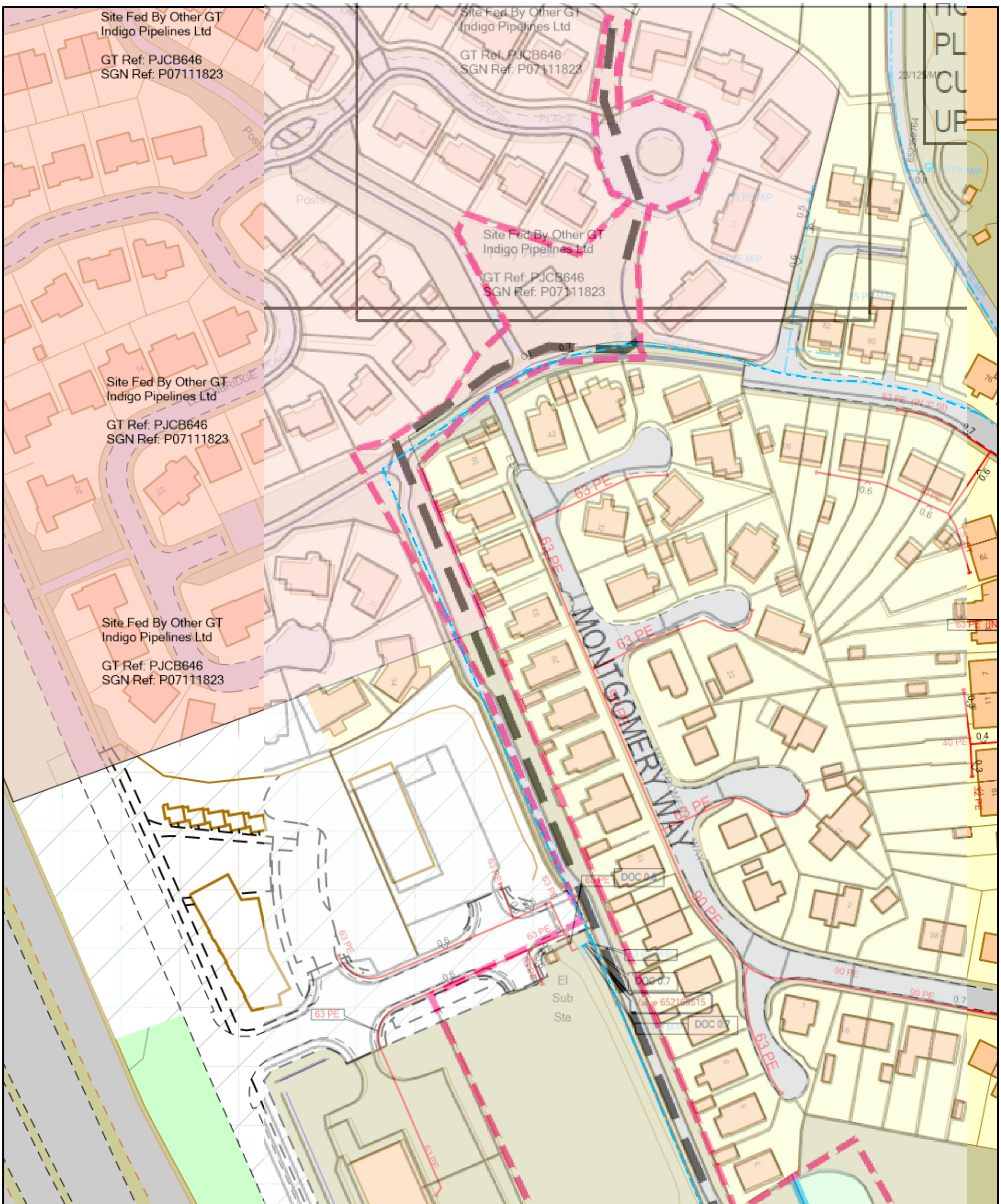
Further, additional information for working in the vicinity of gas plant is detailed in the Dig Safely Measures booklet attached.

Should you require to discuss any aspects of your works in more detail then please do not hesitate to contact me.

Regards,

John Spiers
Design Assistant
Scotland Quotation Team

sgn.co.uk
Find us on Facebook and follow us on Twitter: @SGNgas



SCALE: 1 : 1000	LP MAINS	Some examples of Plant Items: Valve, Syphon, Depth of Cover, Diameter Change, Material Change
2424254	MP MAINS	© Crown copyright and database rights 2023 OS 7142104 & 7261731 Background data © OpenStreetMap contributors via the Open Database License.
GRID REFERENCE: E311359, N702204, NO113022	IP MAINS LHP MAINS IGTs SSSIs	Map version: 2.12.2 Issued by: Scotia Gas Networks Ltd

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SMELL GAS? CALL 0800 111 999

Aisling McGilloway

From:	Spiers, John <john.spiers@sgn.co.uk> on behalf of Quotations/SGN <quotations@sgn.co.uk>
Sent:	18 May 2023 14:46
To:	Aisling McGilloway
Subject:	2424101 - Job 6 - South Kinross Flood Protection Scheme, North Of Roundabout, Kinross, Kinross Shire, KY13 8EN.
Attachments:	Dig Safely-Measures to avoid injury and damage to gas pipes.pdf; 1.1000 _Overlay_A3.pdf

CAUTION: This email originated from outside of RPS.

Classified as Confidential

Further to previous correspondence.

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Regards,

John Spiers
Design Assistant
Scotland Quotation Team

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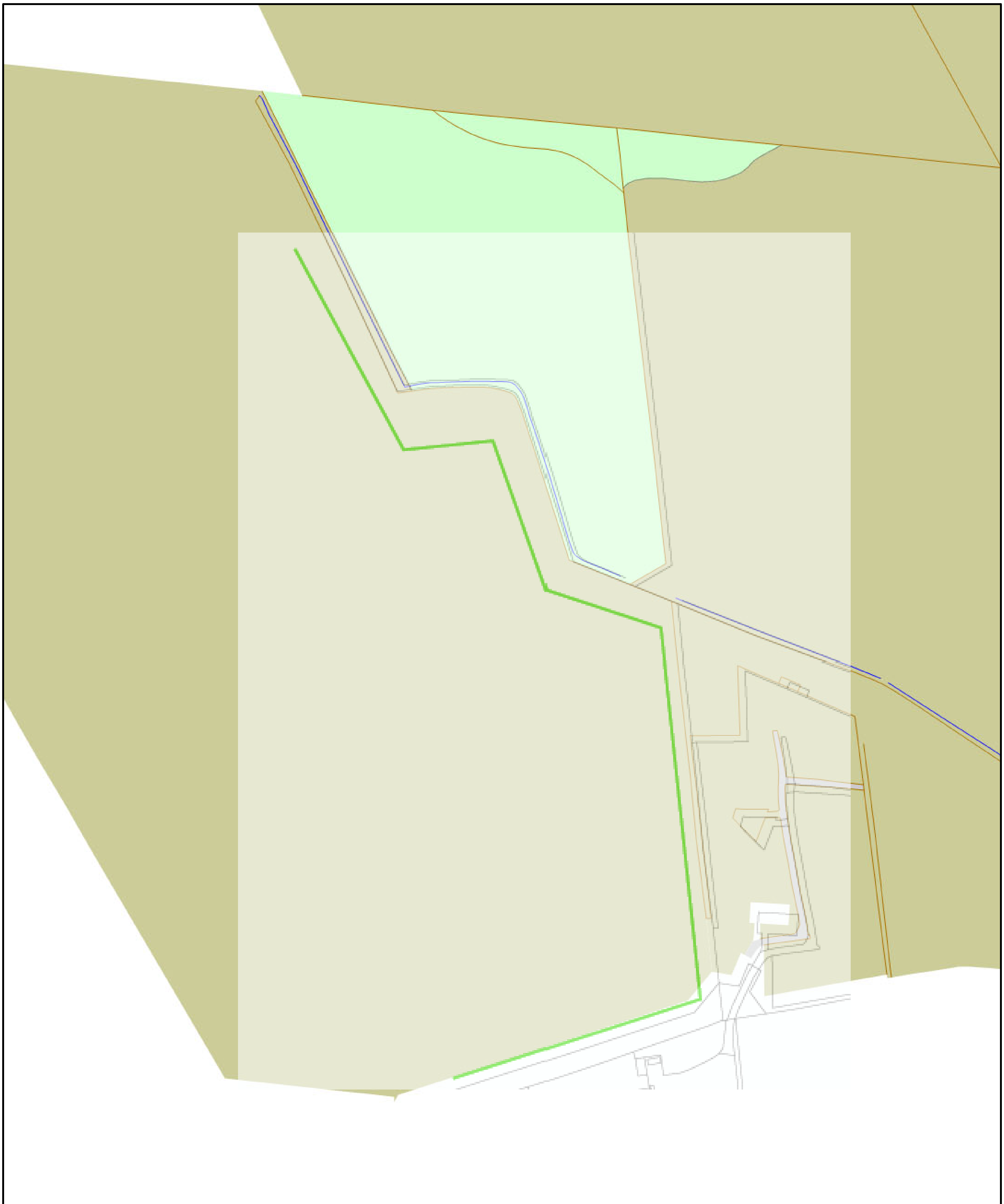

SCALE: 1 : 1587 2424101 GRID REFERENCE: E310581, N703102, NO105031	LP MAINS MP MAINS IP MAINS LHP MAINS IGTs SSSIs	Some examples of Plant Items Valve Syphon Depth of Cover Diameter Change Material Change	

Map version: 2.12.2

Issued by: Scotia Gas Networks Ltd

SGN

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SMELL GAS? CALL 0800 111 999

20th September 2023

For the Attention of Aisling McGilloway

RPS Consulting UK & Ireland
Elmwood House
74 Boucher Road
Belfast
Co. Antrim

BT12 6RZ

SCOTTISH WATER

The Bridge
Buchanan Gate Business Park
Cumbernauld Road
Stepps
Glasgow
G33 6FB

T: 0787 587 9907
F: N/A
W: www.scottishwater.co.uk
E: hauc.diversions@scottishwater.co.uk

Our Ref: - HAUC/CW/C3/ 5139752393
Your Ref: - N/A

Dear Aisling,

NRSWA:-C3 Draft Design and Budget Estimate
South Kinross C3 Water
Scottish Water Apparatus – Water Main

I refer to your NRSWA C3 request dated 08th December 2022 regarding the proposed South Kinross C3 Water – Water Replacement

I now attach the C3 Estimate including 8 drawings.

You will see that the total estimated cost is £429,451.22. Taking into account the NRSWA Advance Payment Discount of £75,598.54, the estimated cost to the Client is £353,852.69 not including VAT.

Please also note that these are estimated costs and that the Council shall pay the actual costs of any works undertaken, whether greater or less than any estimate provided. The Estimate is valid for a period of six months. This estimate is based on benchmark prices and will be subject to review by our Framework Delivery Contractor prior to construction, should you instruct Scottish Water to carry out the diversion works.

If you require any further assistance, please do not hesitate to contact me.

Yours faithfully,

Robin Gallacher
Hauc Diversions Team
Hauc.diversions@scottishwater.co.uk

South Kinross C3 Water - Water Main Diversions
C3 Water Project ID 5139752393
NRSWA Appendix C3:- Draft Designs and Draft Estimates

Date: 20 September 2023

Our Ref: HAUC/CW/C3/5139752393

Client Ref: N/A

Agent Ref:

Contact: Chris Wood — T:-0787587 9907 F:N/A

Contact: T:-N/A F:-N/A

Contact: Aisling McGilloway — T:- +44 2890 667 914 F:-N/A

Our Address:

Scottish Water HAUC Diversions Team
The Bridge, Buchanan Gate Business Park
Cumbernauld Road
Stepps
Glasgow G33 6FB

Clients Address:

Agent Address:

RPS Consulting UK & Ireland
Elmwood House
74 Boucher Road
Belfast, Co. Antrim
BT12 6RZ

Location:

South Kinross C3 Water - Water Main Diversions

Details of existing apparatus:

90mm HPPE, 4in CI, 7in CI, 4in uPVC, 90mm HPPE and 7in CI Water mains

Clients Drawings which estimate based upon:

Description of Diversions (Necessary Measures):

All of the water mains have to be abandoned and re-laid below the proposed culvert.

Details of proposed apparatus:

Approx 15m of Permanent 90mm SDR11 PE pipe. Approx 65m of Permanent 110mm SDR11 PE pipe. Approx 30m of Permanent 125mm SDR11 PE pipe. Approx 13m of Permanent 90mm SDR11 PE pipe. Approx 8m of Permanent 200mm SDR11 PE pipe. Approx 6m of Permanent 90mm SDR11 PE pipe. Approx 42m of Permanent 200mm SDR11 DI pipe.

Applicable legislation:

New Roads & Street Works Act 1991

Cost Sharing Percentage (0%, 7.5%, 18%):

18% where applicable.

Lead in Time (months):

Approximately 8 weeks.

Construction Time:

Temporary: TBA

Permanent: TBA

Total length of existing apparatus to be diverted:

Approx 15m of 90mm HPPE pipe. Approx 65m of 4in CI pipe. Approx 30m of 4in uPVC pipe. Approx 13m of Unknown pipe. Approx 8m of 7in CI pipe. Approx 6m of 90mm HPPE pipe. Approx 68m of 7in CI pipe.

South Kinross C3 Water - Water Main Diversions

C3 Water Project ID 5139752393

				Existing Apparatus												Proposed Apparatus									
Diversion Number	**Drawing Number**	**Location**	**Coordinates**	**Existing Apparatus**	**Year**	**Actual Age (Years)**	**Design Age (Years)**	**NRSWA Status**	**Deferment of Renewal Factor**	**Deferment of Renewal?**	**Length to be Diverted**	**Length of Main in Road (m)**	**Length Not in Road (m)**	**% of Length in Road**	**% of Length Not in Road**	**Proposal**	**Material**	**Length of New Main (m)**	**Total Est. Cost of Diversion**	**Deferment of Renewal Value**	**Total Cost Less DoR:- Amount Payable by Client**	**Advance Payment Discount Applicable**	**Advance Payment Discount**	**Total Cost Less DoR & AP Discount (Client Contribution)**	**Scottish Water Contribution**
SWW1	5139752393-DRG-001	Hopefield Place	311399.207, 702313.286	90mm HPPE	2019	4	120	Yes	0	No	15	15	0	100%	0%	90mm	SDR11 PE	15	£19,777.40	£0.00	£19,777.40	Yes	£3,559.93	£16,217.47	£3,559.93
SWW2	5139752393-DRG-002	Back of No3 Montgomery way	311421.980, 702034.905	Unknown	2014	9	120	Yes	0	No	13	6	7	46%	54%	90mm	SDR11 PE	13	£17,567.36	£0.00	£17,567.36	Yes	£1,459.44	£16,107.92	£1,459.44
SWW3	5139752393-DRG-003	Smith Street	311800.552 701893.742	4in CI	1955	68	120	Yes	0	No	65	65	0	100%	0%	110mm	SDR11 PE	65	£95,663.88	£0.00	£95,663.88	Yes	£17,219.50	£78,444.38	£17,219.50
SWW4	5139752393-DRG-003	Jct of Smith Street & High Street	311880.114 701889.193	7in CI	1910	113	120	Yes	0	No	8	8	0	100%	0%	200mm	SDR11 PE	8	£23,076.61	£0.00	£23,076.61	Yes	£4,153.79	£18,922.82	£4,153.79
SWW5	5139752393-DRG-003	Sandport	311962.319, 701889.701	4in uPVC	1975	48	120	Yes	0	No	30	30	0	100%	0%	125mm	SDR11 PE	30	£45,617.20	£0.00	£45,617.20	Yes	£8,211.10	£37,406.11	£8,211.10
SWW6	5139752393-DRG-003	Nan Walker Wynd	312057.987, 701832.577	90mm HPPE	2005	18	120	Yes	0	No	6	6	0	100%	0%	90mm	SDR11 PE	6	£11,472.30	£0.00	£11,472.30	Yes	£2,065.01	£9,407.29	£2,065.01
SWW7(Temp)	5139752393-DRG-004 Temp	B996 / High Street	311820.237, 701595.363	7in CI	1910	113	120	Yes	0	No	68	68	0	100%	0%	200mm	SDR11 PE	55	£127,552.94	£0.00	£127,552.94	Yes	£22,959.53	£104,593.41	£22,959.53
SWW7(Perm)	5139752393-DRG-004 Perm	B996 / High Street	311820.237, 701595.363	Temp removed	2023	0	120	Yes	0	No	55	55	0	100%	0%	200mm	SDR11 DI	42	£88,723.53	£0.00	£88,723.53	Yes	£15,970.23	£72,753.29	£15,970.23
											1) Total Estimated Costs of Water Mains Diversions: **2) All Deferment of Renewal calculations to be reviewed on completion of works.**								**£429,451.22**	**£0.00**	**£429,451.22**	**£0.00**	**£75,598.54**	**£353,852.69**	**£75,598.54**
																			Total Estimated Cost	**Total Deferment of Renewal**	**Costs Less DoR (Adv. Payment not Made)**			**Costs Less DoR (Advance Payment Made)**	

South Kinross C3 Water - Water Main Diversions
C3 Water Project ID 5139752393
Cost Summary

Total Construction & Resource Cost	£	380,991.91
Add 9.97% Capital Investment & Delivery (CID) Overhead	£	37,984.89
Sub Total	£	418,976.80
Add 2.5% SW Corporate Overhead	£	10,474.42
Total Estimated Cost	**£**	**429,451.22**

Allowance for Deferment of Renewal

(calculated using Bacon and Woodrow Formula, see Appendix E2 of CoP)

Item	Estimated Cost	Total Length to be Diverted (m)	Length to be Diverted Within Existing Road	Length to be Diverted Outwith Existing Road	Dia Mat	Age (Expired life) of existing Apparatus	Notional full Life of Apparatus	Factor	Cost of Diversion	Deferment of Renewal	Advance Payment Discount
SWW1-SWW4	£ 429,451.22	Refer to separate Deferment of Renewal and Advance Payment Discount Detailed Summary Sheet							£ 429,451.22	£0.00	£75,598.54

Total Allowance for Deferment of Renewal (N/A)		£0.00
Estimated rechargeable cost (Allowable Costs)	£	429,451.22
Advance Payment Cost Share Discount applicable to sections of water main to be diverted within existing road.		£75,598.54
Estimated Rechargeable Cost (Exc VAT)		£353,852.69

South Kinross C3 Water - Water Main Diversions

C3 Water Project ID 5139752393

NRSWA Appendix C3:- Draft Designs and Draft Estimates

Terms and Conditions

In these conditions "Authority" includes a Roads, Transport or Bridge Authority within the meaning of the New Roads and Street Works Act (NRSWA) and also the		
Ref	**Section A; Scope of Works**	**Applicable**
1	This C3 does not include for necessary protection works to existing Scottish Water apparatus. The Authority shall ensure that sufficient measures are taken to protect Scottish Water's apparatus. Details of proposals shall be submitted to Scottish Water at an early stage for consideration. The contractor shall be liable for damage caused to SW apparatus during the project.	Yes
2	This C3 estimate is prepared in accordance with Appendix C3 of the HAUC Code of Practice 'Measures Necessary where Apparatus is Affected by Major Works (Diversionary Works', under the 'New Roads and Street Works Act 1991.	Yes
3	This estimate is intended to fulfil any obligations, which may arise for Scottish Water to provide a C3 (detailed) estimate under the New Roads and Street Works Act 1991.	Yes
4	This is a qualified C3 in that it is not possible to produce a final C3 due to lack of information on the final road scheme. (See Section C below).	Yes
5	No allowances have been made for night or weekend working, lack of continuous (end to end) work, traffic management and contaminated or other unusual ground conditions, for temporary road diversions, exceptional obstructions or other services or for secondary diversions thus necessitated.	Yes
6	The Final Detailed C3 Scheme and Detailed Estimates (Appendix C3 of the CoP) will be provided once advance payment has been deposited and once detailed final detailed roads scheme proposals have been received from the Authority.	Yes
7	The nominal depth of cover to Scottish Water's water mains is 0.9 metres but may be variable. Please note that records are not kept of the position of communication pipes but some of the larger ones may be shown. Normally, communication pipes and fire supply connections are laid with 0.75 metres cover but this cannot be guaranteed.	Yes
8	The HAUC Code of Practice for "Diversion Works" provides a recommendation for progressing utility diversions between a undertaker and a authority. These estimate conditions are provided to supplement those recommendations and encourage a partnership approach between the parties.	Yes
9	No allowances are included in the estimates for special requirements of the Authority or of third parties. These parties include those with an interest in, but not limited to, other diversionary works, traffic management (including road closures), special protection measures, etc. The authority should make appropriate provision to cover any such costs.	Yes
10	All works are assumed to be undertaken during normal working hours and no allowance has been made for any special noise or nuisance abatement measures.	Yes
11	All works are assumed to be undertaken in a single visit unless otherwise stated. (i.e. continuous working).	Yes
12	No allowances for dealing with exceptional ground or surface water including specialist dewatering are included unless stated otherwise.	Yes
13	No allowances are included for diversions of other utility services. It is assumed that other utilities' apparatus does not obstruct works.	Yes
14	No specific allowances have been made for the removal and disposal of contaminated materials, asbestos cement pipes etc unless specifically stated.	Yes
15	No costs have been included for accommodating any archaeological watches or investigations.	Yes
16	Unless otherwise noted, this estimate is based on the type, size and position of apparatus shown on the public sewer and water main records. The accuracy of such records cannot be guaranteed and Scottish Water reserve the right to change the C3 proposals in the light of additional information being available. Any costs associated with those changes shall be an allowable cost.	Yes
17	The scope of works identified to provide this estimate is based on the information made available to Scottish Water. The Authority will need to satisfy themselves that the necessary measures can be constructed in the position and manner proposed. This applies particularly where water mains/sewers are constructed on road structures e.g. bridges.	Yes
18	As a consequence of detailed information from any source, Scottish Water may be required to amend the scope of works to fulfil their obligations under the Scheme and maintain Statutory and regulatory demands. An amended C3 estimate will be provided if required by the Authority but costs associated with this will be considered to be "allowable" costs.	Yes
Section B; C3 Finance		
19	A charge will apply to the Authority for the preparation of this C3 Estimate. No discount will apply since this project is a flood scheme. No discount shall be permitted if payment is not received in advance of the design work proceeding.	Yes
20	Scottish Water will only give a discount on one C3 estimate. If additional and/or revised C3 estimates are required then the full costs of that C3 will be chargeable to the Authority by Scottish Water.	No
21	The Authority's attention is drawn to the choice of contract, particularly if the Authority adopts a Design and Build Contract. In this situation, the Final C3 design and estimate will not be deemed available until the road contractor's final design has been completed and submitted to the Undertaker. Interim C3's can be issued at the request of the Authority but these shall be 'Qualified' in that they are not produced in response to the Final Detailed Roads Scheme.	No
22	It is required that the Authority agrees in writing, and in advance of the works, to the undertaker that they will be liable for the actual costs of the diversionary works, whether greater or less than the estimate, all in accordance with the NRSWA Code of Practice. In the absence of such a statement it will be assumed that actual costs will be paid by the authority unless specific alternative arrangements are in place.	Yes
23	The C3 estimate is referenced to a baseline period and subject to a validity period of 180 days. Scottish Water reserves the right to amend any estimate if the validity period is exceeded.	Yes
24	The estimate is exclusive of VAT unless specifically stated otherwise.	Yes
Section C Qualifications to C3		
25	This C3 is qualified and will remain qualified by Scottish Water until Scottish Water receives the final detailed roads scheme from the Authority or from his agent. Hence Scottish Water reserves the right to change the C3 in any way that may be deemed necessary as more information becomes available. Any costs incurred through having to change or amend the C3 will be deemed an allowable cost under NRSWA.	Yes
26	The Final C3 will be agreed between the parties once full information is available and this will supersede any qualified C3 estimates.	Yes
27	The C3 estimate assumes that apparatus on site is found to be as described in this estimate. This can not be guaranteed.	Yes
28	The diversion works are admeasureable and the authority shall be liable for the actual costs of any diversionary works as allowed in the New Roads and Street Works Act Code of Practice.	Yes
29	Scottish Water shall issue a final account on completion of the works to the Authority, all in accordance with the NRSWA.	Yes
Section D- Project Specific issues		
30	Require to work alongside other Contractors.	Yes
31	This C3 Estimate does not include any sums for Traffic Management that may be required. It is anticipated that the Scottish Water Contractor would utilise the Main Roads Contractors Traffic Management if required.	Yes

20th September 2023

For the Attention of Aisling McGilloway

RPS Consulting UK & Ireland
Elmwood House
74 Boucher Road
Belfast
Co. Antrim

BT12 6RZ

SCOTTISH SEWER

The Bridge
Buchanan Gate Business Park
Cumbernauld Road
Stepps
Glasgow
G33 6FB

T: 0787 587 9907
F: N/A
W: www.scottishSewer.co.uk
E: hauc.diversions@scottishSewer.co.uk

Our Ref: - HAUC/CW/C3/ 5139812296
Your Ref: - N/A

Dear Aisling,

NRSWA:-C3 Draft Design and Budget Estimate
South Kinross C3 Sewer
Scottish Sewer Apparatus – Sewer

I refer to your NRSWA C3 request dated 08th December 2022 regarding the proposed South Kinross C3 Sewer – Sewer Replacement

I now attach the C3 Estimate including 8 drawings.

You will see that the total estimated cost is £445,811.28. Taking into account the NRSWA Advance Payment Discount of £21,561.34 and the Deferment of Renewal of £496.24, the estimated cost to the Client is £423,753.70 not including VAT.

Please also note that these are estimated costs and that the Council shall pay the actual costs of any works undertaken, whether greater or less than any estimate provided. The Estimate is valid for a period of six months. This estimate is based on benchmark prices and will be subject to review by our Framework Delivery Contractor prior to construction, should you instruct Scottish Sewer to carry out the diversion works.

If you require any further assistance, please do not hesitate to contact me.

Yours faithfully,

Robin Gallacher
Hauc Diversions Team
Hauc.diversions@scottishwater.co.uk

South Kinross C3 Sewer - Sewer Diversions
C3 Sewer Project ID 5139812296
NRSWA Appendix C3:- Draft Designs and Draft Estimates

Date: 20 September 2023

Our Ref: HAUC/CW/C3/5139812296

Client Ref: N/A

Agent Ref:

Contact: Chris Wood T:-0787587 9907 F:N/A

Contact: T:-N/A F:-N/A

Contact: Aisling McGilloway T:- +44 2890 667 914 F:-N/A

Our Address:

Scottish Sewer HAUC Diversions Team

The Bridge, Buchanan Gate Business Park

Cumbernauld Road

Stepps

Glasgow G33 6FB

Clients Address:

Agent Address:

RPS Consulting UK & Ireland

Elmwood House

74 Boucher Road

Belfast, Co. Antrim

BT12 6RZ

Location:

South Kinross C3 Sewer - Sewer Diversions

Details of existing apparatus:

125mm PE pipe.
300mm PE pipe.
150mm uPVC pipe.
450mm DI pipe.
300mm PE pipe.
150mm uPVC pipe.
375mm DI pipe.

Clients Drawings which estimate based upon:

Description of Diversions (Necessary Measures):

All of the Sewer mains have to be abandoned and re-laid below the proposed culvert.

Details of proposed apparatus:

Approx 35m of Permanent 125mm PE pipe.
Approx 10m of Permanent 300mm PE pipe.
Approx 6m of Permanent 150mm uPVC pipe.
Approx 80m of Permanent 300mm PE pipe.
Approx 50m of Permanent 150mm uPVC pipe.
Approx 50m of Permanent 375mm DI pipe.
Approx 50m of Permanent 450mm DI pipe.

Applicable legislation:

New Roads & Street Works Act 1991

Cost Sharing Percentage (0%, 7.5%, 18%):

18% where applicable.

Lead in Time (months):

Approximately 8 weeks.

Construction Time:

Temporary: TBA

Permanent: TBA

Total length of existing apparatus to be diverted:

Approx 35m of 125mm uPVC pipe.
Approx 5m of 525mm VC pipe.
Approx 40m of 225mm uPVC pipe.
Approx 80m of 300mm VC pipe.
Approx 121m of 150mm uPVC pipe.
Approx 50m of 375mm VC pipe.
Approx 50m of 450mm Conc pipe.

Scottish Water
Always serving Scotland

South Kinross C3 Sewer - Sewer Diversions

C3 Sewer Project ID 5139812296

				Existing Apparatus												Proposed Apparatus									
Diversion Number	**Drawing Number**	**Location**	**Coordinates**	**Existing Apparatus**	**Year**	**Actual Age (Years)**	**Design Age (Years)**	**NRSWA Status**	**Deferment of Renewal Factor**	**Deferment of Renewal?**	**Length to be Diverted**	**Length of Main in Road (m)**	**Length Not in Road (m)**	**% of Length in Road**	**% of Length Not in Road**	**Proposal**	**Material**	**Length of New Main (m)**	**Total Est. Cost of Diversion**	**Deferment of Renewal Value**	**Total Cost Less DoR:- Amount Payable by Client**	**Advance Payment Discount Applicable**	**Advance Payment Discount**	**Total Cost Less DoR & AP Discount (Client Contribution)**	**Scottish Water Contribution**
SWD1	5139752393-DRG-002	Back of No3 Montgomery way	311421.980, 702034.905	125mm uPVC	2018	5	120	Yes	0	No	35	5	30	14%	86%	125mm	PE	35	£19,825.26	£0.00	£19,825.26	Yes	£509.79	£19,315.47	£509.79
SWD2	5139752393-DRG-003	Smith Street	311800.552, 701893.742	300mm VC	1955	68	120	Yes	0	No	80	80	0	100%	0%	300mm	PE	80	£70,511.91	£0.00	£70,511.91	Yes	£12,692.14	£57,819.77	£12,692.14
SWD3	5139752393-DRG-003	Jct of Smith Street & High Street	311800.552, 701893.742	525mm VC	1955	68	120	Yes	0	No	5	5	0	100%	0%	Twin 300mm either side of culvert	PE	5	£11,019.95	£0.00	£11,019.95	Yes	£1,983.59	£9,036.36	£1,983.59
SWD4	5139752393-DRG-003	Nan Walker Wynd	311800.552, 701893.742	150mm uPVC	2005	18	120	Yes	0.013816139	No	121	121	0	100%	0%	150mm	uPVC	50	£35,917.44	£496.24	£35,421.20	Yes	£6,375.82	£29,045.38	£6,872.06
SWD5	5139752393-DRG-003	Nan Walker Wynd	311800.552, 701893.742	225mm uPVC	2005	18	120	Yes	0	No	40	0	40	0%	100%	150mm	uPVC	6	£5,008.50	£0.00	£5,008.50	No	£0.00	£5,008.50	£0.00
SWD6(Temp)	5139752393-DRG-004 Temp	B996 / High Street	311820.237, 701595.363	375mm VC	0	0	119	Yes	0	No	50	0	50	0%	100%	375mm	PE	74	£97,087.72	£0.00	£97,087.72	No	£0.00	£97,087.72	£0.00
SWD6(Perm)	5139752393-DRG-004 Perm	B996 / High Street	311820.237, 701595.363	Temp removed	2023	0	120	Yes	0	No	74	0	74	0%	100%	375mm	DI	50	£34,626.76	£0.00	£34,626.76	No	£0.00	£34,626.76	£0.00
SWW7(Temp)	5139752393-DRG-005 Temp	Grassland south of Kinross ferry landing	312124.606, 701582.501	450mm Concrete	0	0	120	Yes	0	No	50	0	50	0%	100%	450mm	PE	82	£60,836.64	£0.00	£60,836.64	No	£0.00	£60,836.64	£0.00
SWW7(Perm)	5139752393-DRG-005 Perm	B996 / High Street	312124.606, 701582.501	Temp removed	2023	0	120	Yes	0	No	82	0	82	0%	100%	450mm	DI	50	£110,977.11	£0.00	£110,977.11	No	£0.00	£110,977.11	£0.00
											1) Total Estimated Costs of Water Mains Diversions: **2) All Deferment of Renewal calculations to be reviewed on completion of works.**								**£445,811.28**	**£496.24**	**£445,315.04**	**£0.00**	**£21,561.34**	**£423,753.70**	**£22,057.58**
																			Total Estimated Cost	**Total Deferment of Renewal**	**Costs Less DoR (Adv. Payment not Made)**			**Costs Less DoR (Advance Payment Made)**	

South Kinross C3 Sewer - Sewer Diversions

C3 Sewer Project ID 5139812296

Cost Summary

Total Construction & Resource Cost	£	395,505.90
Add 9.97% Capital Investment & Delivery (CID) Overhead	£	39,431.94
Sub Total	£	434,937.83
Add 2.5% SW Corporate Overhead	£	10,873.45
Total Estimated Cost	**£**	**445,811.28**

Allowance for Deferment of Renewal

(calculated using Bacon and Woodrow Formula, see Appendix E2 of CoP)

Item	Estimated Cost	Total Length to be Diverted (m)	Length to be Diverted Within Existing Road	Length to be Diverted Outwith Existing Road	Dia Mat	Age (Expired life) of existing Apparatus	Notional full Life of Apparatus	Factor	Cost of Diversion	Deferment of Renewal	Advance Payment Discount
SWW1-SWW4	£ 445,811.28	Refer to separate Deferment of Renewal and Advance Payment Discount Detailed Summary Sheet							£ 445,811.28	£496.24	£21,561.34

Total Allowance for Deferment of Renewal (N/A)		£496.24
Estimated rechargeable cost (Allowable Costs)	£	445,811.28
Advance Payment Cost Share Discount applicable to sections of water main to be diverted within existing road.		£21,561.34
Estimated Rechargeable Cost (Exc VAT)		£423,753.70

South Kinross C3 Sewer - Sewer Diversions

C3 Sewer Project ID 5139812296

NRSWA Appendix C3:- Draft Designs and Draft Estimates

Terms and Conditions

Ref	In these conditions "Authority" includes a Roads, Transport or Bridge Authority within the meaning of the New Roads and Street Works Act (NRSWA) and also the Section A; Scope of Works	Applicable
1	This C3 does not include for necessary protection works to existing Scottish Water apparatus. The Authority shall ensure that sufficient measures are taken to protect Scottish Water's apparatus. Details of proposals shall be submitted to Scottish Water at an early stage for consideration. The contractor shall be liable for damage caused to SW apparatus during the project.	Yes
2	This C3 estimate is prepared in accordance with Appendix C3 of the HAUC Code of Practice 'Measures Necessary where Apparatus is Affected by Major Works (Diversionary Works', under the 'New Roads and Street Works Act 1991.	Yes
3	This estimate is intended to fulfil any obligations, which may arise for Scottish Water to provide a C3 (detailed) estimate under the New Roads and Street Works Act 1991.	Yes
4	This is a qualified C3 in that it is not possible to produce a final C3 due to lack of information on the final road scheme. (See Section C below).	Yes
5	No allowances have been made for night or weekend working, lack of continuous (end to end) work, traffic management and contaminated or other unusual ground conditions, for temporary road diversions, exceptional obstructions or other services or for secondary diversions thus necessitated.	Yes
6	The Final Detailed C3 Scheme and Detailed Estimates (Appendix C3 of the CoP) will be provided once advance payment has been deposited and once detailed final detailed roads scheme proposals have been received from the Authority.	Yes
7	The nominal depth of cover to Scottish Water's water mains is 0.9 metres but may be variable. Please note that records are not kept of the position of communication pipes but some of the larger ones may be shown. Normally, communication pipes and fire supply connections are laid with 0.75 metres cover but this cannot be guaranteed.	Yes
8	The HAUC Code of Practice for “Diversion Works” provides a recommendation for progressing utility diversions between a undertaker and a authority. These estimate conditions are provided to supplement those recommendations and encourage a partnership approach between the parties.	Yes
9	No allowances are included in the estimates for special requirements of the Authority or of third parties. These parties include those with an interest in, but not limited to, other diversionary works, traffic management (including road closures), special protection measures, etc. The authority should make appropriate provision to cover any such costs.	Yes
10	All works are assumed to be undertaken during normal working hours and no allowance has been made for any special noise or nuisance abatement measures.	Yes
11	All works are assumed to be undertaken in a single visit unless otherwise stated. (i.e. continuous working).	Yes
12	No allowances for dealing with exceptional ground or surface water including specialist dewatering are included unless stated otherwise.	Yes
13	No allowances are included for diversions of other utility services. It is assumed that other utilities' apparatus does not obstruct works.	Yes
14	No specific allowances have been made for the removal and disposal of contaminated materials, asbestos cement pipes etc unless specifically stated.	Yes
15	No costs have been included for accommodating any archaeological watches or investigations.	Yes
16	Unless otherwise noted, this estimate is based on the type, size and position of apparatus shown on the public sewer and water main records. The accuracy of such records cannot be guaranteed and Scottish Water reserve the right to change the C3 proposals in the light of additional information being available. Any costs associated with those changes shall be an allowable cost.	Yes
17	The scope of works identified to provide this estimate is based on the information made available to Scottish Water. The Authority will need to satisfy themselves that the necessary measures can be constructed in the position and manner proposed. This applies particularly where water mains/sewers are constructed on road structures e.g. bridges.	Yes
18	As a consequence of detailed information from any source, Scottish Water may be required to amend the scope of works to fulfil their obligations under the Scheme and maintain Statutory and regulatory demands. An amended C3 estimate will be provided if required by the Authority but costs associated with this will be considered to be “allowable” costs.	Yes
Section B; C3 Finance		
19	A charge will apply to the Authority for the preparation of this C3 Estimate. No discount will apply since this project is a flood scheme. No discount shall be permitted if payment is not received in advance of the design work proceeding.	Yes
20	Scottish Water will only give a discount on one C3 estimate. If additional and/or revised C3 estimates are required then the full costs of that C3 will be chargeable to the Authority by Scottish Water.	No
21	The Authority's attention is drawn to the choice of contract, particularly if the Authority adopts a Design and Build Contract. In this situation, the Final C3 design and estimate will not be deemed available until the road contractor's final design has been completed and submitted to the Undertaker. Interim C3's can be issued at the request of the Authority but these shall be 'Qualified' in that they are not produced in response to the Final Detailed Roads Scheme.	No
22	It is required that the Authority agrees in writing, and in advance of the works, to the undertaker that they will be liable for the actual costs of the diversionary works, whether greater or less than the estimate, all in accordance with the NRSWA Code of Practice. In the absence of such a statement it will be assumed that actual costs will be paid by the authority unless specific alternative arrangements are in place.	Yes
23	The C3 estimate is referenced to a baseline period and subject to a validity period of 180 days. Scottish Water reserves the right to amend any estimate if the validity period is exceeded.	Yes
24	The estimate is exclusive of VAT unless specifically stated otherwise.	Yes
Section C Qualifications to C3		
25	This C3 is qualified and will remain qualified by Scottish Water until Scottish Water receives the final detailed roads scheme from the Authority or from his agent. Hence Scottish Water reserves the right to change the C3 in any way that may be deemed necessary as more information becomes available. Any costs incurred through having to change or amend the C3 will be deemed an allowable cost under NRSWA.	Yes
26	The Final C3 will be agreed between the parties once full information is available and this will supersede any qualified C3 estimates.	Yes
27	The C3 estimate assumes that apparatus on site is found to be as described in this estimate. This can not be guaranteed.	Yes
28	The diversion works are admeasureable and the authority shall be liable for the actual costs of any diversionary works as allowed in the New Roads and Street Works Act Code of Practice.	Yes
29	Scottish Water shall issue a final account on completion of the works to the Authority, all in accordance with the NRSWA.	Yes
Section D- Project Specific issues		
30	Require to work alongside other Contractors.	Yes
31	This C3 Estimate does not include any sums for Traffic Management that may be required. It is anticipated that the Scottish Water Contractor would utilise the Main Roads Contractors Traffic Management if required.	Yes

Appendix D

Designers Risk Assessment

DESIGN RISK MANAGEMENT LOG

Project Title:	South Kinross Flood Protection Scheme	**Project Number:**		**Designer :**	RPS
Package or Element:	**Outline Design Report**	**Design Stage:**	OUTLINE	**Date Completed:**	05/04/2023
Revision:	0				
Originator: AMG		**Reviewer:**	AJ	**Approver:**	SP

No	Activity [1]	Design Risk Identified [2]	Design Measures taken to Eliminate or Reduce the Risks [3]	Solutions considered not Reasonably Practicable [4] and/or Presumed Methods of Construction [5] and/or Designers Assumptions [6]	Information provided about the Residual Risks [7] Information to be provided to other Designers [8]
1	Direct Defences	Retaining walls and precast concrete walls identified as form of direct defences	Form of wall changed to sheet pile so access can be gained from BCA site with demolishing of building – less risk of work in water required	Based on ECI discussion with Balfour Beatty believe its is practical to get a suitable sheet piling approach. Temporary bridges for access to water have been shown on access drawings as worst case	Detailed topo obtained to show fence lines boundary walls for clarity on working area. Commentary provided in outline design report on design decision
2	Direct Defences	Potential for contaminated land	Form of wall changed to sheet pile so access can be gained from BCA site with demolishing of building – less requirement for open excavation	Based on ECI discussion with Balfour Beatty believe its is practical to get a suitable sheet piling approach.	GI and Geo-Environmental reports to be provided
3	Direct Defences	Vibration risk to existing property	Realigned defences where space allows to set back from property lines where possible. Redundant buildings to be demolished based on agreement with Landowner	Flood walls cannot be pushed further into watercourse as this would create issues with constructability, access, scour, loss of channel capacity and risk of passing forward flood risk. Assumes pre and post structural surveys will be carried out to inform selection of construction method	Detailed topo to be provided to show building footprints in comparison to working footprint

DESIGN RISK MANAGEMENT LOG

No	Activity [1]	Design Risk Identified [2]	Design Measures taken to Eliminate or Reduce the Risks [3]	Solutions considered not Reasonably Practicable [4] and/or Presumed Methods of Construction [5] and/or Designers Assumptions [6]	Information provided about the Residual Risks [7] Information to be provided to other Designers [8]
3	Construction of all elements of the scheme	Potential extreme weather events during construction creating risk to people, programme and cost	Temporary works to be put in place to create dry working areas where required. This will require inputs from hydraulic model to design based on agreed magnitude of flooding to prepare for	Assume working in water will be minimal but temporary works. Assumes sequencing such that culvert upgrades are construction downstream to upstream so that pass forward flows can be managed to reduce over pumping to diversion culverts and that new culvert route at Montgomery Way would be in place before works at Hopefield Place	Prepare section in contract using modelling to work out likelihood of flooding during programme and contractors responsibilities to protect working areas and existing areas
4	Culverts	New culverts will require new headwalls for inlet and outlets. These will require visual inspection and clearance in future	Trash screens have been included on new inlets to reduce risk of blockage and entry of unauthorised persons. Catwalk access and handrails to culvert inlet and outlet provided for safe inspection	Considering access from top of headwall with some fencing for security that would be within acceptable length for manual raking however this does leave some risk of fall compared to stepped solution	Details provided on drawings
5	South Queich embankment	Area will become informal flood storage during extreme events and is used as an informal path by dog walkers potential for someone to become trapped during flood	Gated access to be provided at either end of field which can be locked during flood event and maintenance activities. Signage to advice on flood risk.	Completely cut off access – likely to be unpopular locally and area will not be flooded frequently enough for this to be a balanced approach	Note on drawings
6	SEPA Gauging Station	Blocking of access to flow monitoring equipment by defence	Locked flood gate – locked at all times except when SEPA require access	Steps up and over flood wall would require greater land take.	Note on drawings

DESIGN RISK MANAGEMENT LOG

No	Activity [1]	Design Risk Identified [2]	Design Measures taken to Eliminate or Reduce the Risks [3]	Solutions considered not Reasonably Practicable [4] and/or Presumed Methods of Construction [5] and/or Designers Assumptions [6]	Information provided about the Residual Risks [7] Information to be provided to other Designers [8]
7	Maintenance access to upstream storage area	During flood event flood access to culvert may be impeded	Crest of embankment width increased so that an operative can safely walk along crest well above flooding to visually inspect or clear culvert inlet. Culvert outlet would be access from dry side via new access at garden centre		
8	Utilities	Unexpected location and path	Slot trenching of critical services to confirm routes and depths, early C3 engagement with utility providers	Assumes surveys enable reasonable degree of derisking	Services drawings to be provided with design packs and disclaimer regarding check before dig
9	Ecology	Accommodate/mitigate for species leading to design changes – potential extra surveys also	Early PEA and Phase 1 Habitat surveys so awareness of constraints has been considered in outline stage	Assumes no significant changes since time of survey 2020	Section in outline design and coverage in EIA
10	Ecology	Invasive species in working area – may lead to design changes or changes in construction approaches	Early PEA and Phase 1 Habitat surveys so awareness of constraints has been considered in outline stage	Assumes no significant changes since time of survey 2020	Section in outline design and coverage in EIA
11	Utilities	Substantial amount of utilities requiring diversion or protection – unclear based on current level of info the level of impact this will have on design complexity	Early engagement with utility providers and request for C3 quotations after identifying clashes.	This will need to be an early action item in detail design. Assume utilities works would be carried out first as part of enabling works	Services drawings to be provided with design packs and disclaimer regarding check before dig

DESIGN RISK MANAGEMENT LOG

No	Activity [1]	Design Risk Identified [2]	Design Measures taken to Eliminate or Reduce the Risks [3]	Solutions considered not Reasonably Practicable [4] and/or Presumed Methods of Construction [5] and/or Designers Assumptions [6]	Information provided about the Residual Risks [7] Information to be provided to other Designers [8]
12	Ground Conditions	GI may produce unfavourable results	Desktop analysis and use of existing GI records in the area to ascertain risk before developing outline design further	GI planned early well before commencement of detail design to avoid rework based on findings	GI Factual and interpretive report to be developed
13	Access	Risk access is not available through BCA demolished building	Discussion with contractor indicated access should still be achievable either from water or carpark areas if building remained but safer option would be to remove building	Assumes sheet piling approach accepted	Note on drawing regarding demolishing of BCA
14	Utilities	Work near high voltage power lines	Overhead lines to be moved away from site.	Assumes utility diversion carried out as enabling works	Services drawings to be provided with construction drawings with hazard symbols and in PCI
15	Access	Work exposing workers to the risk of drowning.	Access is to be gained from riverbank where practicable – where works in watercourse are required temp works such as overpumping required to create dry working area. Suitable PPE to be worn including life jackers when working around water.	Assumes sheet piling is carried out mainly from bank with suitable temporary access platform	Work around water risk to be highlight in drawing notes
16	Scheme approach	Model Inaccuracy	Hydraulic modelling inherently is based off hydraulically theory and assumptions. Therefore there is a risk that flows and capacity may be under estimated and that flooding may be worse that calculated.	Modelling is carried out by suitably skilled, knowledgeable and experience modellers. Model is reviewed and check to ensure all assumptions and hydraulic performance occur as close to	No other method of design would be considered suitable for such a scheme.

No	Activity [1]	Design Risk Identified [2]	Design Measures taken to Eliminate or Reduce the Risks [3]	Solutions considered not Reasonably Practicable [4] and/or Presumed Methods of Construction [5] and/or Designers Assumptions [6]	Information provided about the Residual Risks [7] Information to be provided to other Designers [8]
				reality as can be simulated. Calibration/sensitivity analysis also incorporated as part of the model verification process.	
17	General design	Some small gaps in detailed topo	Supplemented with LIDAR data which had been sense checked against detailed topo and reasonable variation indicating limited risk	Detailed topo to be carried out in gaps	

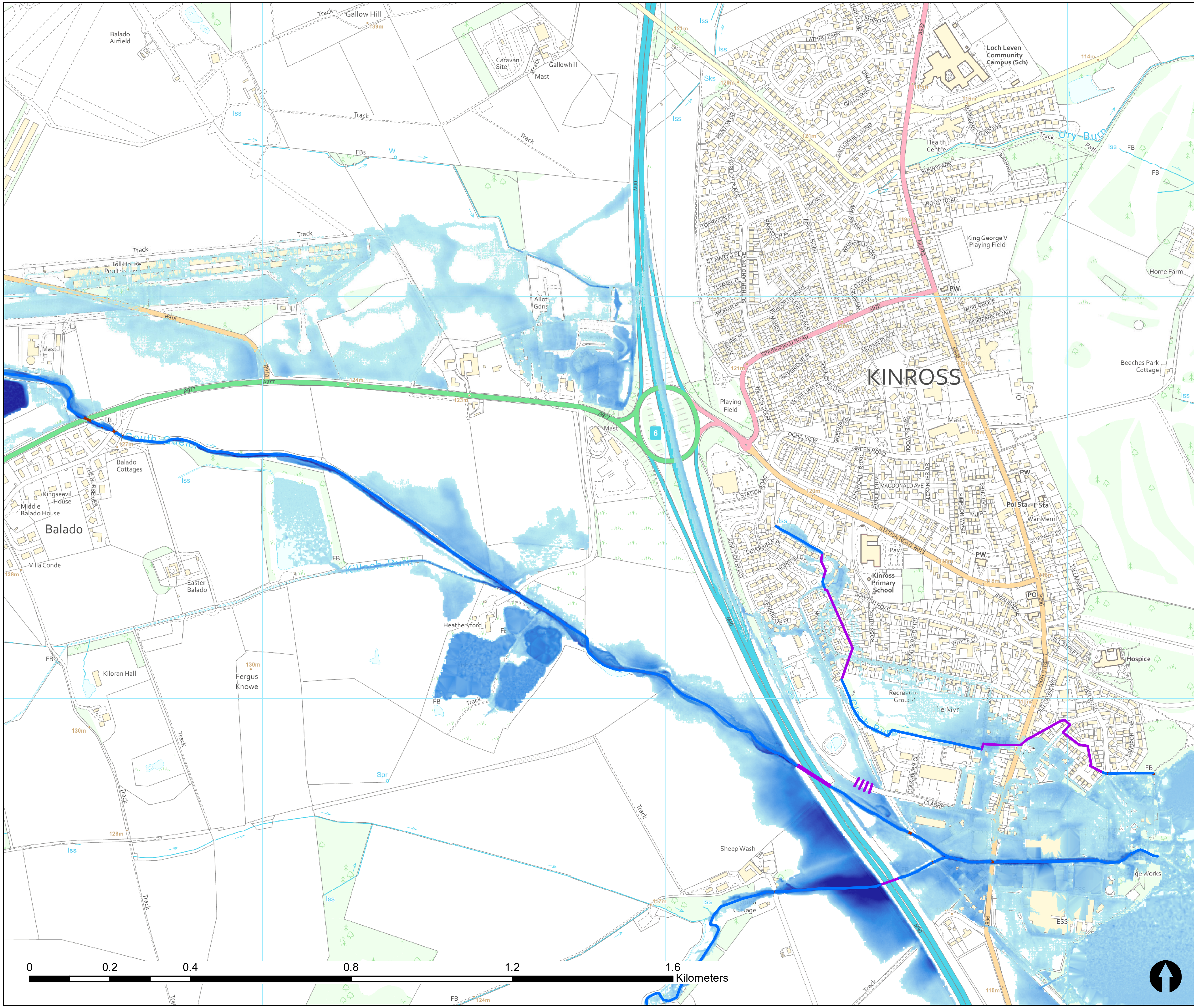
NOTE: These are designer's risk evaluations of design options carried out in-house for the purpose of our complying with designers' duties under the Construction (Design and Management) Regulations. The evaluations relate only to those aspects/elements of the project which we are responsible for designing under the terms of our appointment by our client. Other parties should not rely on these evaluations for their own purposes; in particular, contractors, who must deal with and control all risks arising during construction, must carry out their own definitive risk assessments or that purpose.

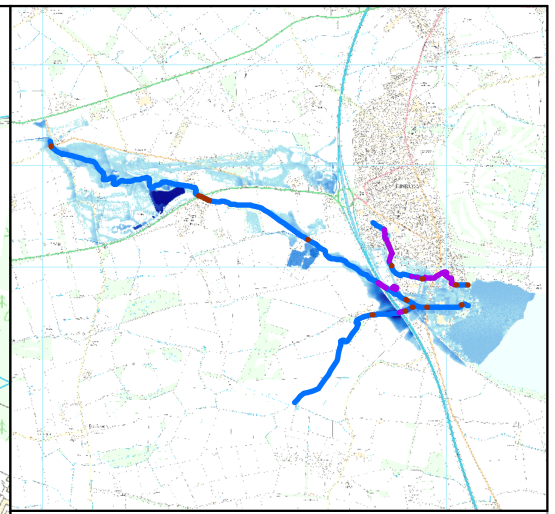
	Particular Risks (Schedule 4 of the CDM Regulations lists Particular Risks as follows	Element of activity identified which includes Particular Risks
1	Work which puts workers at risk of burial under earthfalls, engulfment in swampland or falling from a height, where the risk is particularly aggravated by the nature of the work or processes used or by the environment at the place of work or site.	N
2	Work which puts workers at risk from chemical or biological substances constituting a particular danger to the health or safety of workers or involving a legal requirement for health monitoring.	N
3	Work with ionising radiation requiring the designation of controlled or supervised areas under regulation 16 of the Ionising Radiations Regulations (Northern Ireland) 2000	N
4	Work near high voltage power lines.	Y

5	Work exposing workers to the risk of drowning.	Y – work around water
6	Work on wells, underground earthworks and tunnels.	N
7	Work carried out by divers having a system of air supply.	N
8	Work carried out by workers in caissons with a compressed air atmosphere.	N
9	Work involving the assembly or dismantling of heavy prefabricated components.	N

Appendix E

Flood Maps





Legend

River reach

Bridge

Culvert

0.5%+CC AEP Fluvial Flood Depth (m)

High : 3.873

Low : 0

REV:	NOTE:	DATE:

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Perth and Kinross Council

PROJECT

South Kinross Flood Protection Scheme

TITLE

0.5%+CC AEP Flood Depth - Page 2 of 3

Drawing Status	Sheet Size	Drawing Scale
Draft	A3	1:9000

Drawing Number	Datum
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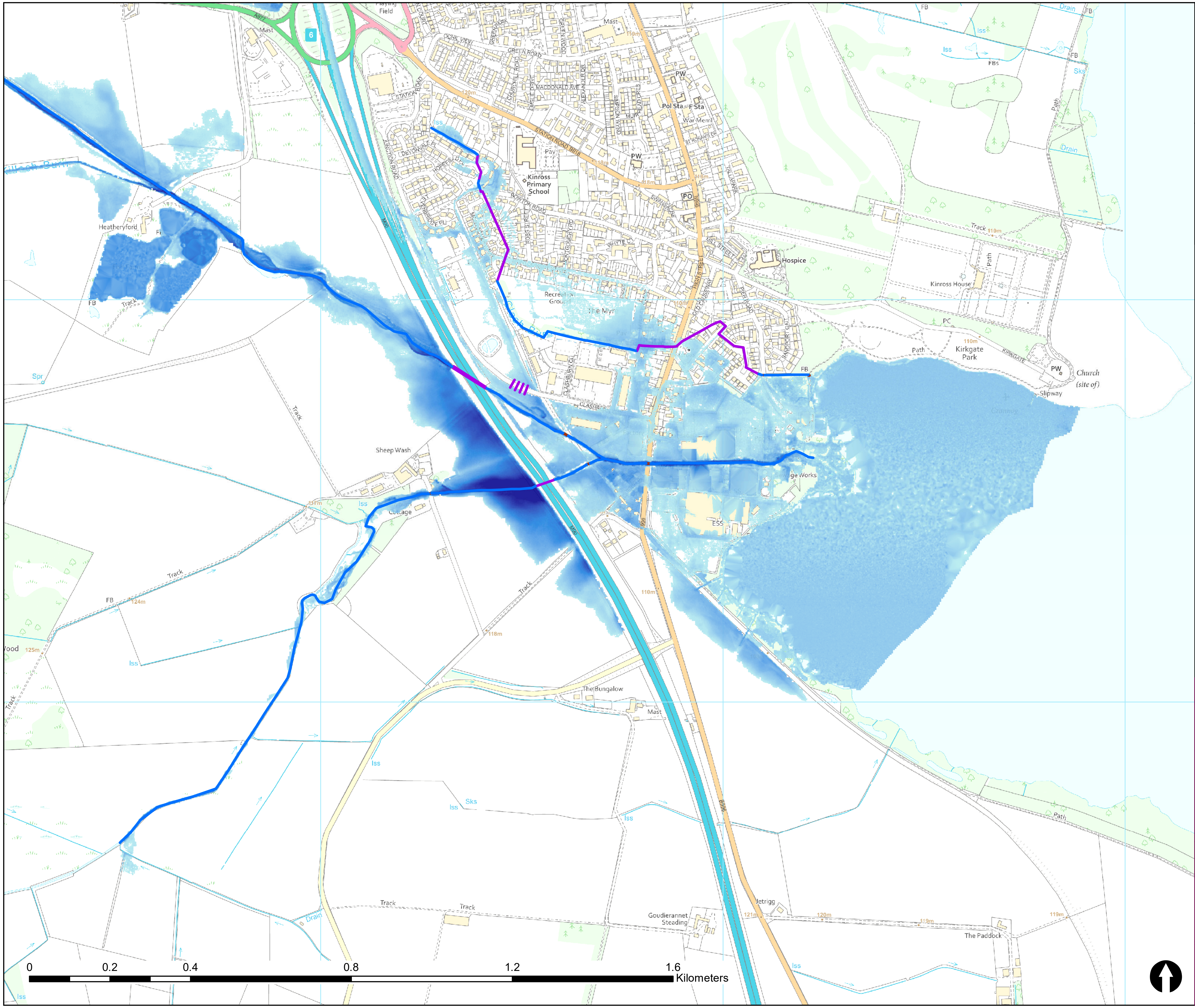
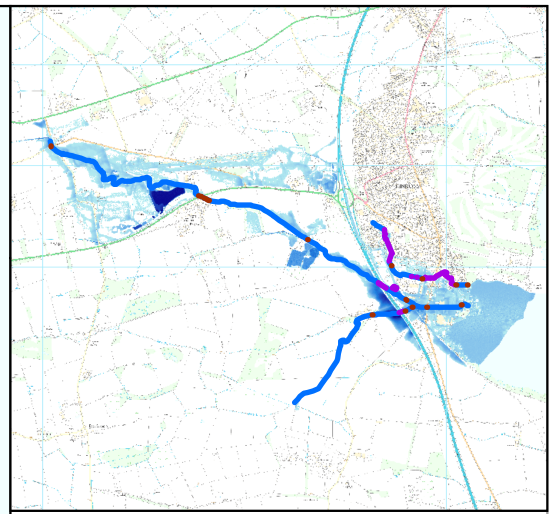
Project Leader	Drawn By	Date	Initial Review
J.D.	C.M.G	12/04/2021	J.D.





Legend

River reach

Bridge

Culvert

0.5%+CC AEP Fluvial Flood Depth (m)

High : 3.873

Low : 0

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South Kinross Flood Protection Scheme

TITLE
0.5%+CC AEP Flood Depth - Page 3 of 3

Drawing Status	Sheet Size	Drawing Scale
Draft	A3	1:9000

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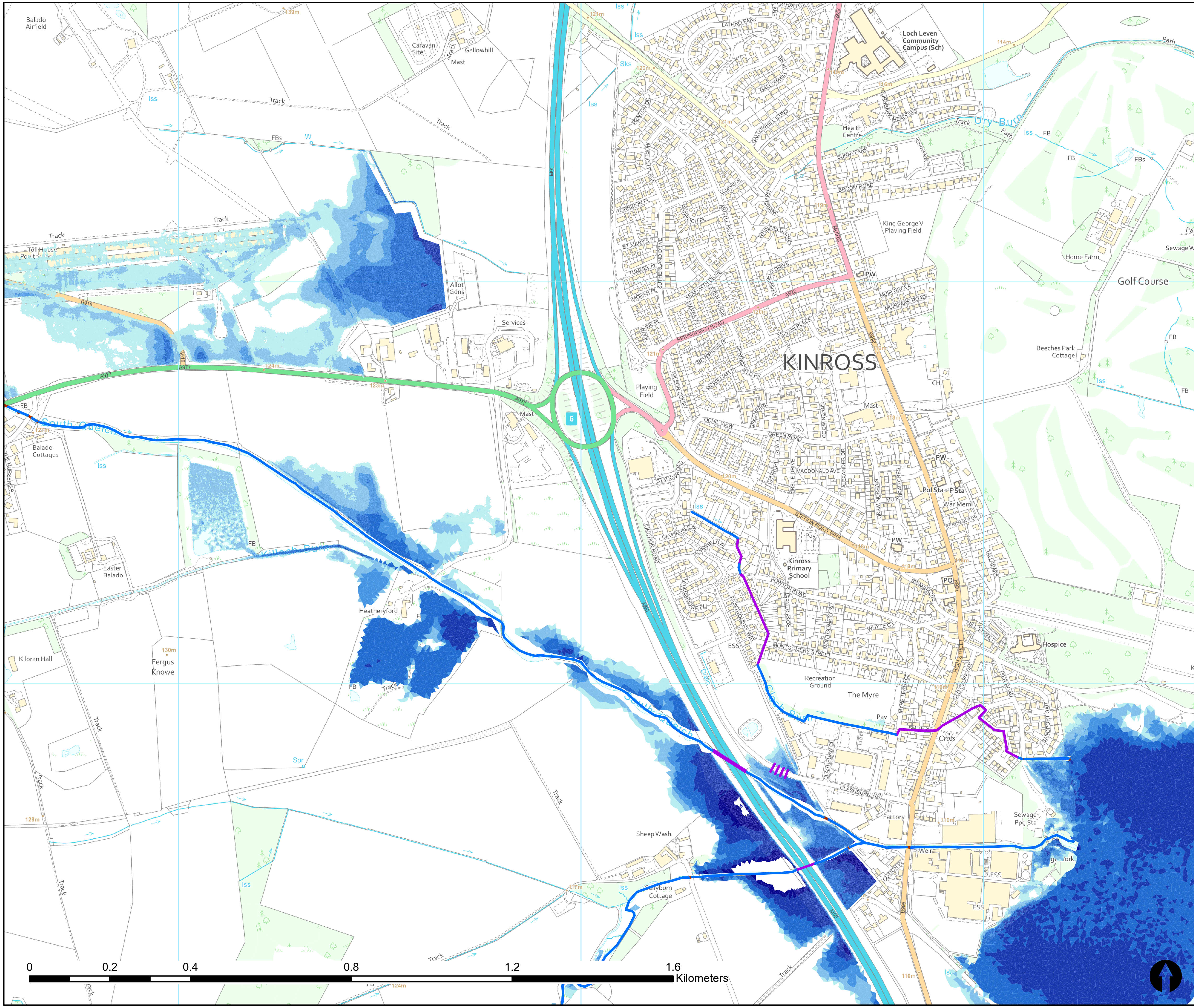
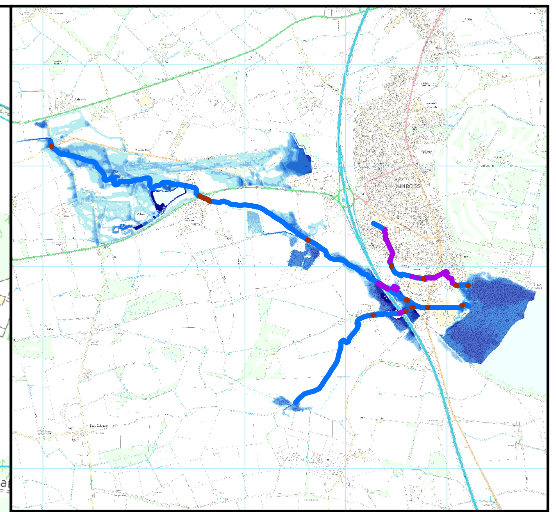
Project Leader	Drawn By	Date	Initial Review
J.D.	C.M.G	12/04/2021	J.D.





Legend

- River reach
- Bridge
- Culvert

0.5%+CC AEP- Scheme Fluvial Flood Depth (m)

- 0.001 - 0.100
- 0.101 - 0.300
- 0.301 - 0.500
- 0.501 - 1.000
- 1.001 - 1.500
- 1.501 - 1.891

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PROJECT
South Kinross Flood Protection Scheme

TITLE
0.5%+CC AEP Flood Depth - Scheme

Drawing Status	Sheet Size	Drawing Scale
Draft	A3	1:9000

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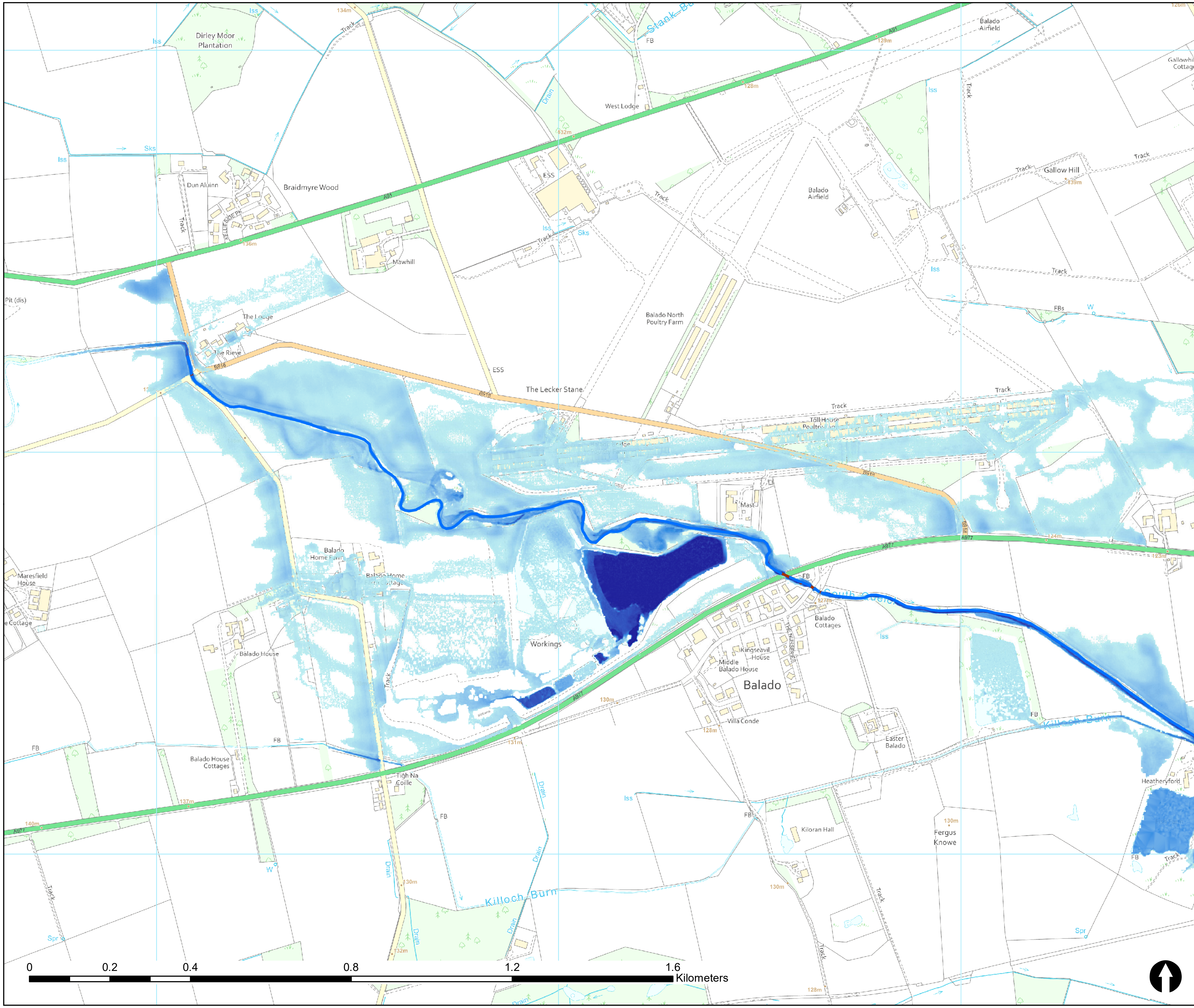
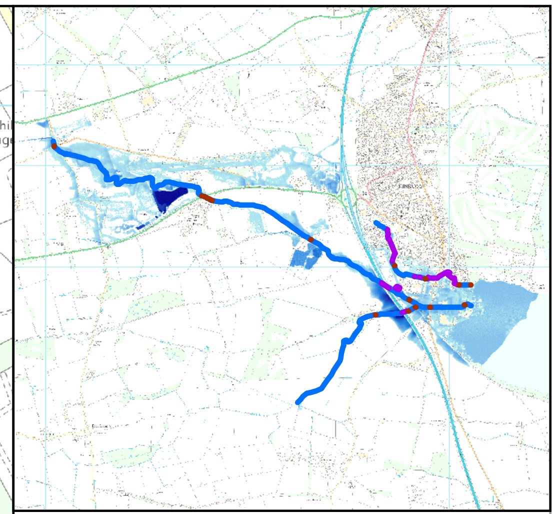
Project Leader	Drawn By	Date	Initial Review
S.P	C.M.G	15/03/23	AMG





Legend

- River reach
- Bridge
- Culvert

0.5%+CC AEP Fluvial Flood Depth (m)

High : 3.873

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South Kinross Flood Protection Scheme

TITLE

0.5%+CC AEP Flood Depth - Page 1 of 3

Drawing Status	Sheet Size	Drawing Scale
Draft	A3	1:9000

Drawing Number	Datum
IBE1585_Depth_D02	-

Project Leader	Drawn By	Date	Initial Review
J.D.	C.M.G	12/04/2021	J.D.

Appendix F

Outline Design Drawings

Appendix G

SoP Recommendation Report

SOUTH KINROSS FPS

Standard of Protection Recommendation

IBE1585
F01
9 September 2022

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D01	Review/comment	JD/JH	MW/RB	AJ	05/07/2022
F01	Review/comment	JD/JH	MW/RB	AJ	09/09/2022

Approval for issue

AJ	9 September 2022

Prepared by:

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Contents

Tables

Figures

Appendices

1 INTRODUCTION

RPS were commissioned to recommend the standard of protection for the South Kinross Flood Protection Scheme. To allow a recommendation to be made on the SoP, RPS have presented the various options in this addendum to the optioneering report. This report focusses on options relating to the standards of protection of the scheme, as instructed by Perth & Kinross Council.

This assessment builds upon the analysis and findings presented in the South Kinross FPS Option Review report, which presented a scheme that provides a 0.5% AEP fluvial Standard of Protection (SoP) as the preferred option. A recommendation on the SoP was later considered per flood cell, to allow the economic, social, and environmental merits of any methods to be considered, alongside the specific flooding mechanisms, constraints, and opportunities within each area.

2 STANDARDS OF PROTECTION CONSIDERED

The options for Standard of Protection assessed have been listed below and described in detail in Sections 2.1 to 2.4. These options were compared against a 'Maintain Existing' baseline, to help compare the impact each option had from the current arrangement, with no flood scheme or formal flood defences in place. A recommendation was made based on a multi-criteria and BCR analysis undertaken for each flood cell.

Standards of Protection

Option 1: 0.5% (Present Day) Fluvial AEP

Option 2: 0.5% + Climate Change Fluvial AEP

Option 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

Option 4: 0.5% (Present Day) Fluvial AEP with NFM Strategy

2.1 Option 1: 0.5% (Present Day) Fluvial AEP

This standard of protection was considered in the main Option Review Report undertaken by RPS, based on the requirements of the South Kinross Flood Protection Scheme brief. This option is described in Section 5.2 of the Option Review Report. Maps of the measures for each flood cell have been provided in Figure 2.1 and Figure 2.2.

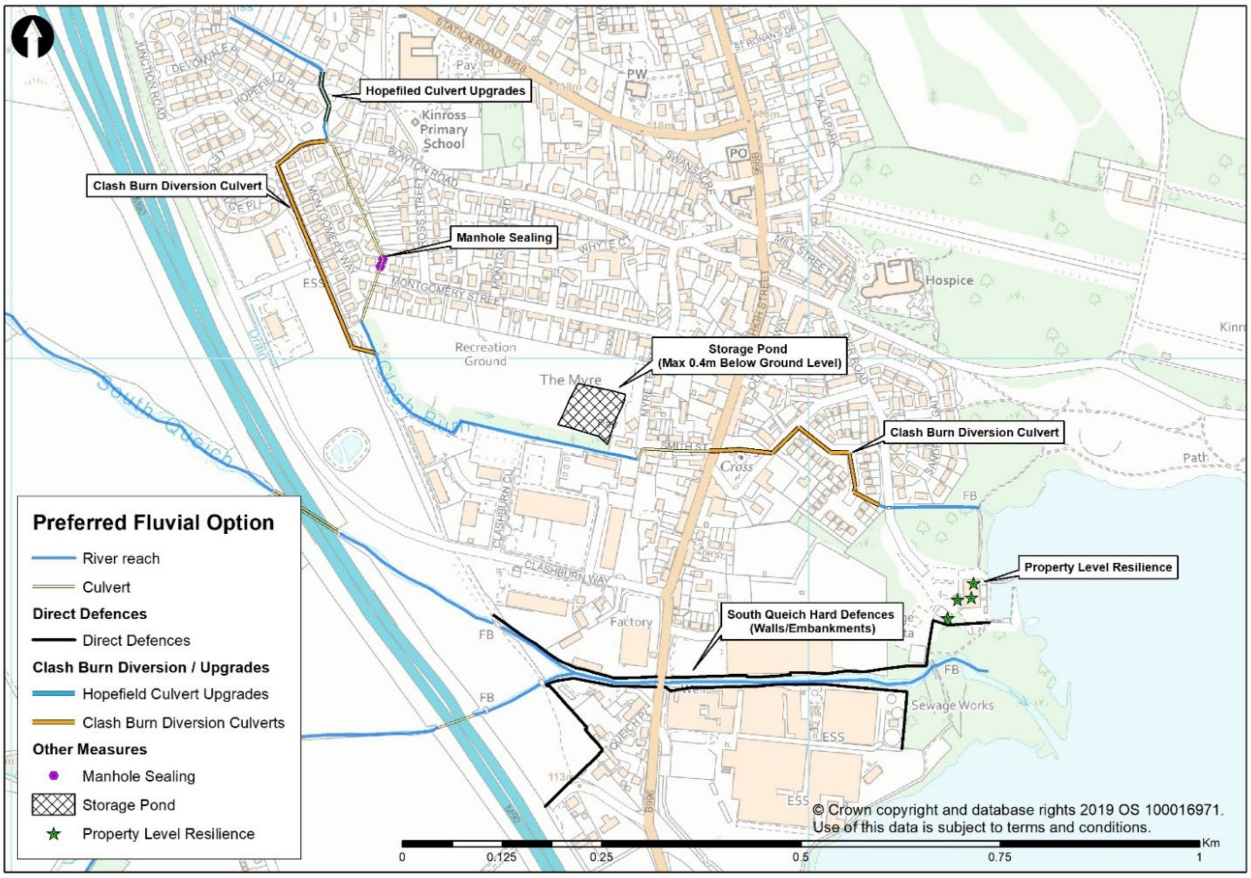


Figure 2.1: Option 1 (Flood Cell 1 & 2)

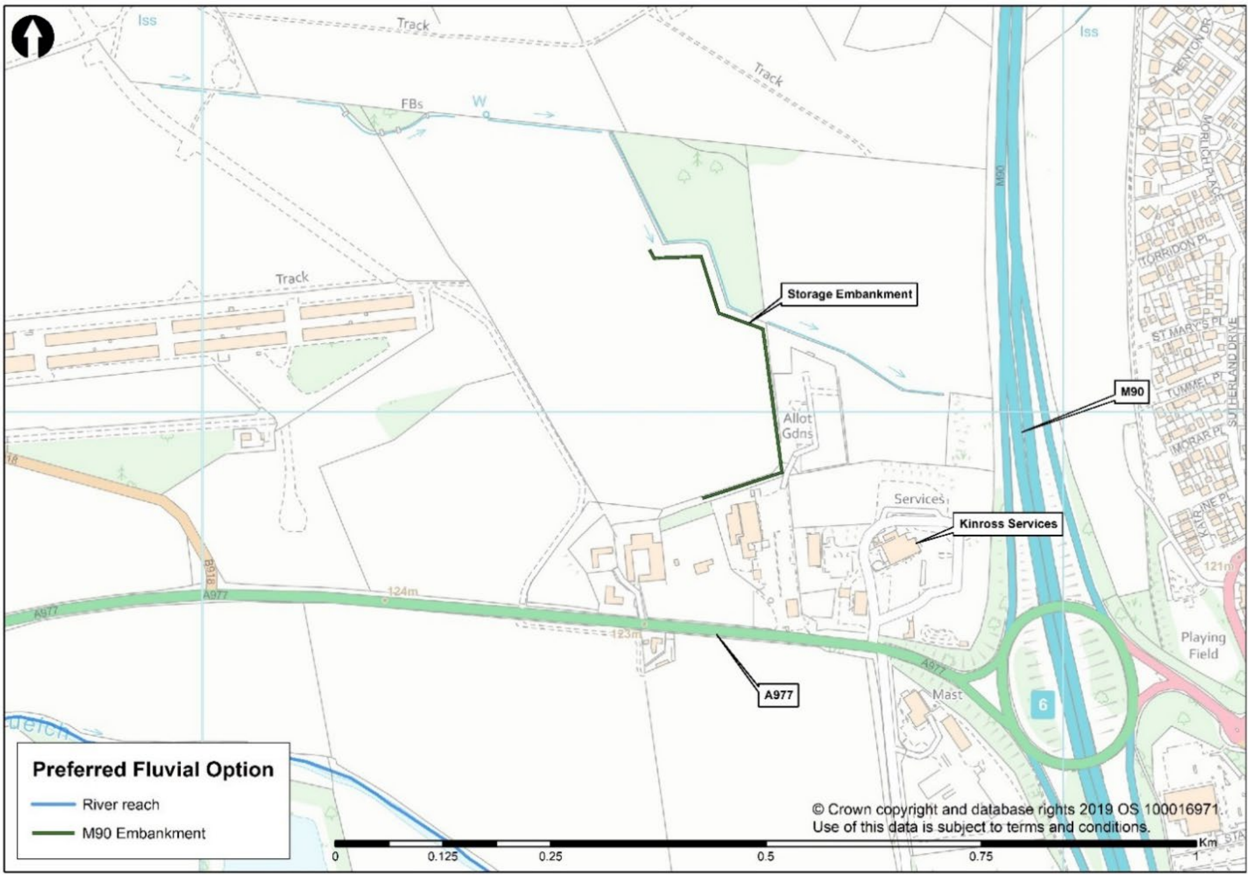


Figure 2.2: Option 1 (Flood Cell 3)

2.2 Option 2: 0.5% + Climate Change Fluvial AEP SoP i.e. build higher now

Building to this SoP considers designing the Flood Protection Scheme to account for future increases in flow, generally resulting in building hard defences higher, upsizing culverts and storage areas. This option is described in Section 6.1 of the Option Review Report. Hard defences are approximately 300mm higher than Option 1. Natural Flood Management was not considered as part of this option. The measures proposed in Option 2 are presented in Figure 2.3 and Figure 2.4.

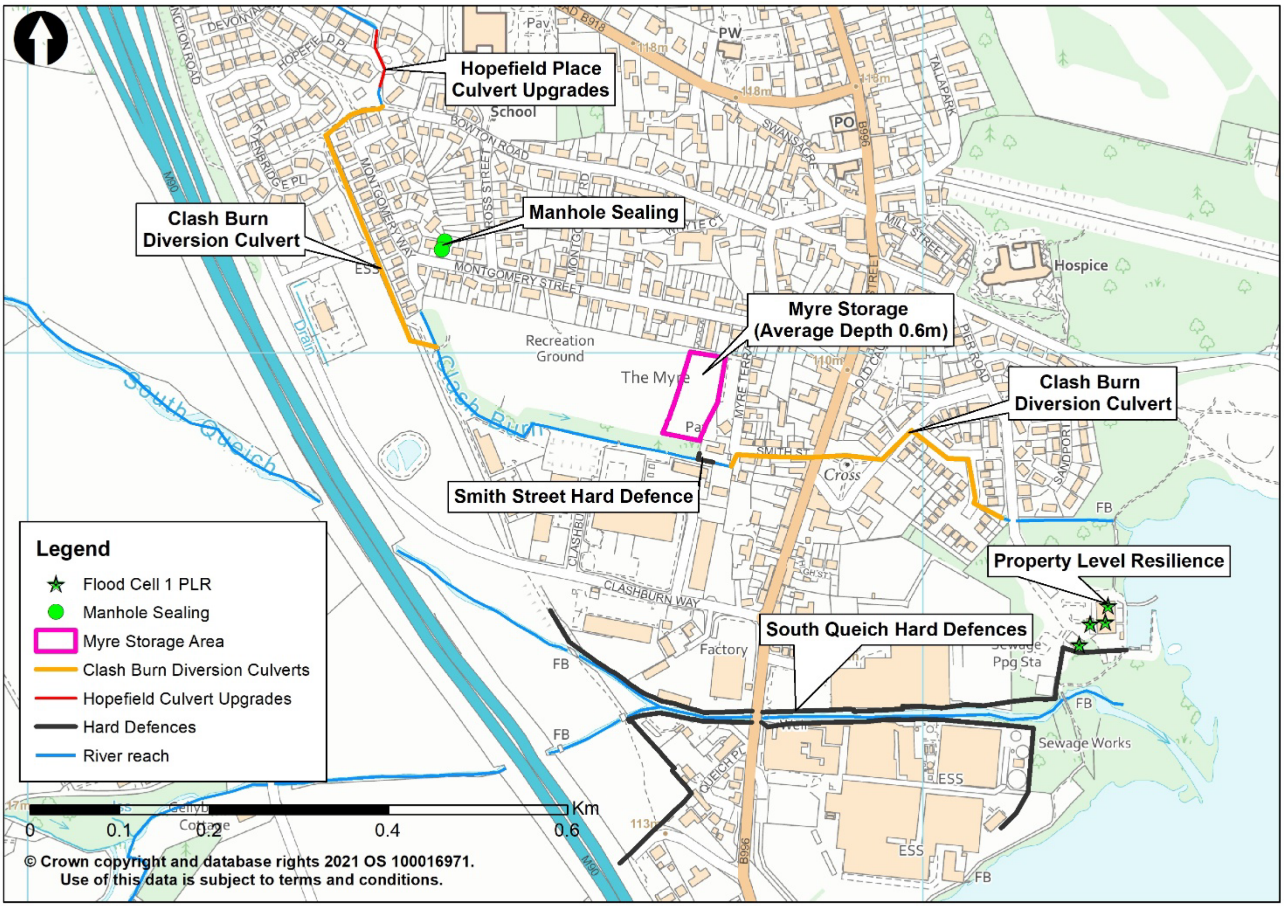


Figure 2.3: Option 2 (Flood Cell 1 & 2)

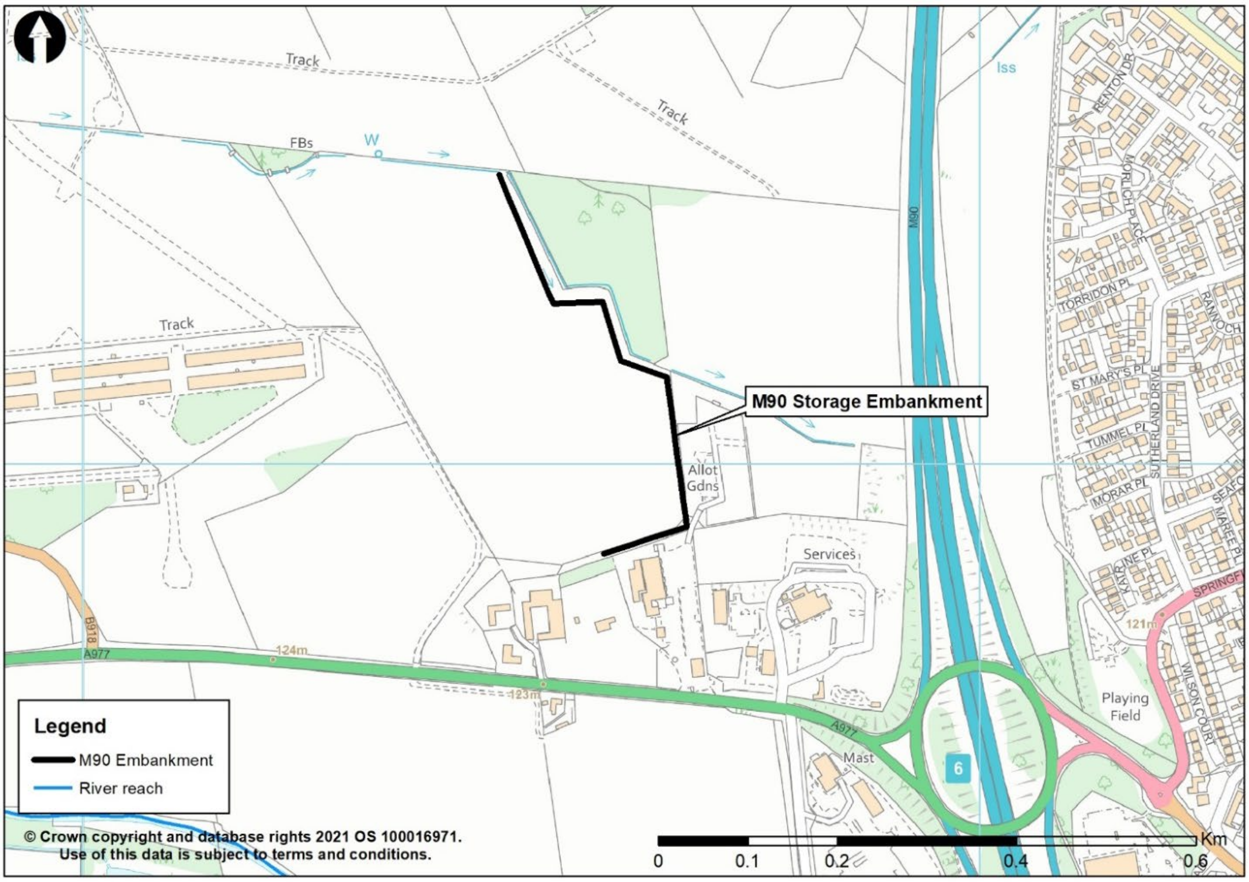


Figure 2.4: Option 2 (Flood Cell 3)

2.3 Option 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation

This approach would provide the 0.5% AEP Fluvial SoP after construction. This differs from Option 1, in that the measures constructed may be adapted in the future, without having to replace those constructed initially. A common example of allowing for future climate change adaptation is where the foundations hard defences are upsized now, to allow the defence to be made taller in the future. This option is described in Section 6.2 of the Option Review Report. Flow monitoring would also be proposed for this option (hourly rainfall gauges and hydrometric gauging), as this would allow hydrological analysis to be undertaken in the future which could help inform when adaptation for climate change protection would be most effective.

Any increase to the potential benefits from adaptation of any defences in the future were not considered as part of the economic analysis. This is due to the high uncertainty regarding when the scheme would be adapted.

Culverts are not considered to be adaptive, as upsizing to increase flow capacity would require full replacement. As this type of measure was not considered to be adaptable, Option 3 considers upsizing culverts now rather than in the future. Maps of the proposed options are presented in Figure 2.5 and Figure 2.6.

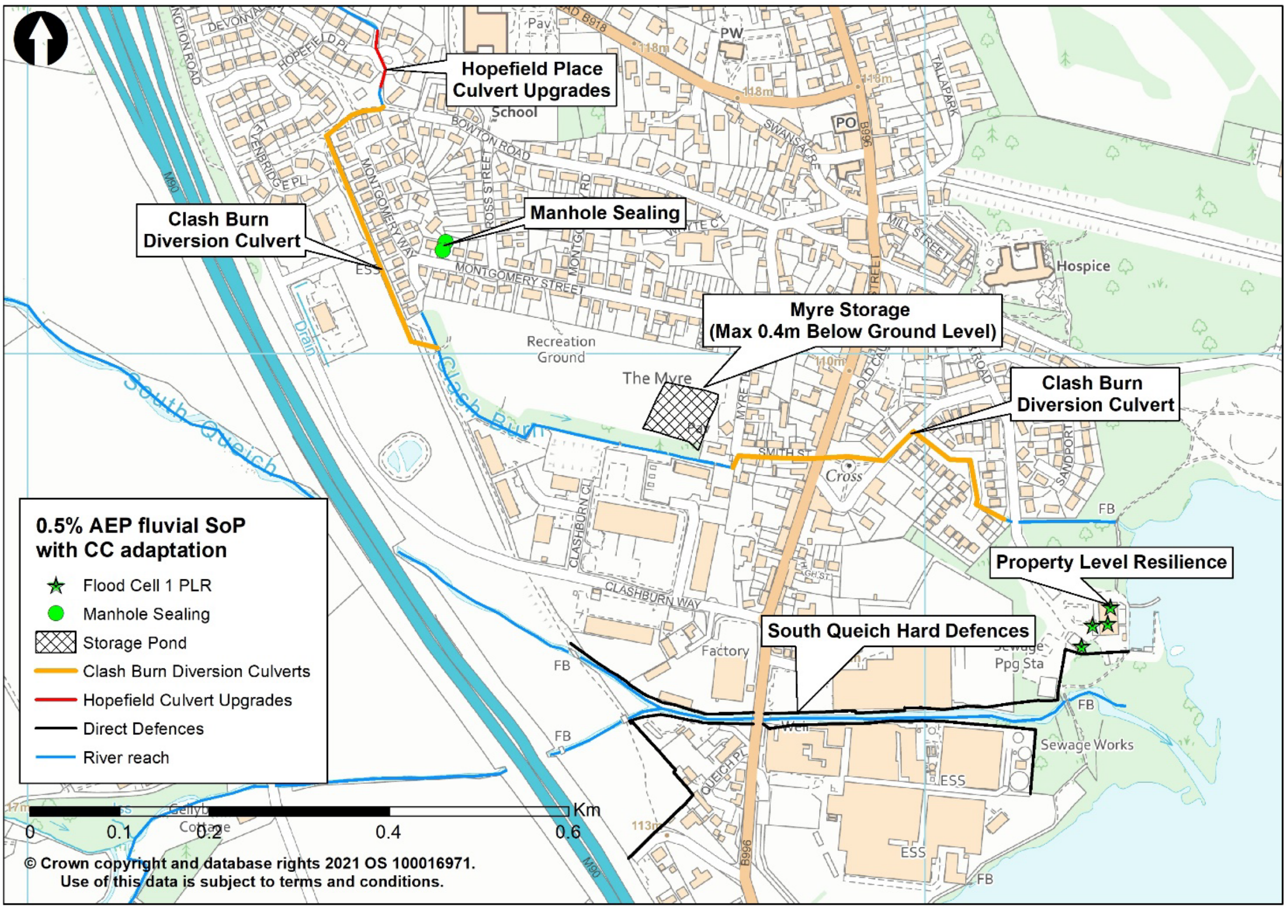


Figure 2.5: Option 3 (Flood Cell 1 & 2)

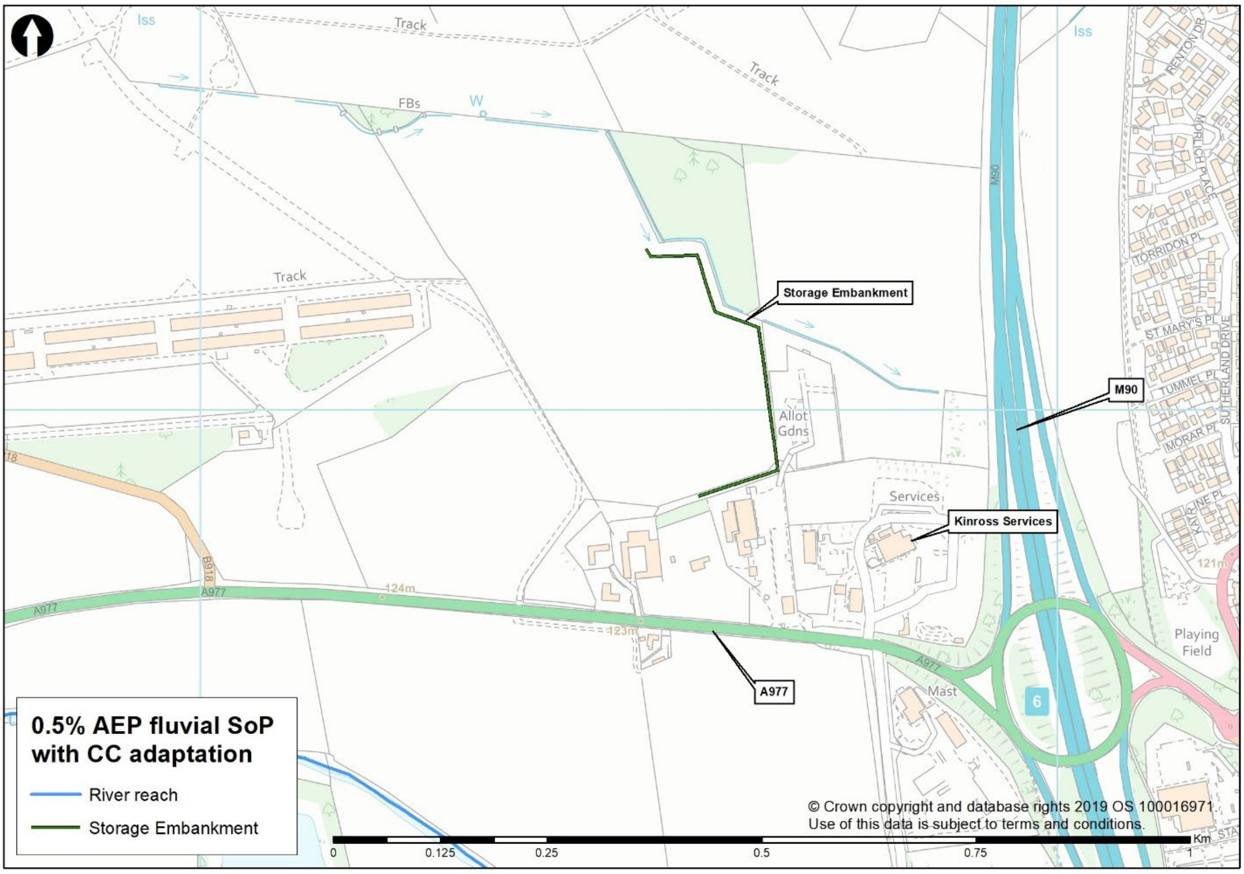


Figure 2.6: Option 3 (Flood Cell 3)

2.4 Option 4: 0.5% (Present Day) Fluvial AEP with NFM Strategy

This option allows the recommendation for more natural measures to be investigated in the future, to provide additional protection against the increase in flows brought about by climate change. There are many uncertainties surrounding NFM, such as effectiveness at reducing flows, construction type (landowner vs contractor led), and costs to implement and maintain features. In addition, the effectiveness of NFM measures may not be fully realised for many years, such is the case for carbon sequestration by planting trees. Option 4 allows for NFM to be recommended as part of a longer-term aspirational strategy. Any provision of NFM would not be included as part of the flood scheme, as without the appropriate landowner engagement, ecological surveys and resources to lead the development, there is not the necessary level of detail required to include for scheme publication.

Flow monitoring (hourly rainfall gauges and hydrometric gauging) would play an important role alongside any NFM measures, allowing analysis to be undertaken in the future to assess their effectiveness of any measures over time.

The South Kinross FPS NFM Study, included in Appendix G of the South Kinross FPS Option Review Report, presented an NFM opportunity map, which is shown in Figure 2.7. As presented in this report, the costs to implement these measures were estimated to vary significantly, predominantly based on whether the work is undertaken by the landowner or by a separate contractor, and the scale at which fencing is required. The upper and lower whole life cost range was calculated to be £9.3m and £1.9m respectively. This also assumed that all features identified could be constructed, the feasibility of which was unknown at the time of writing.

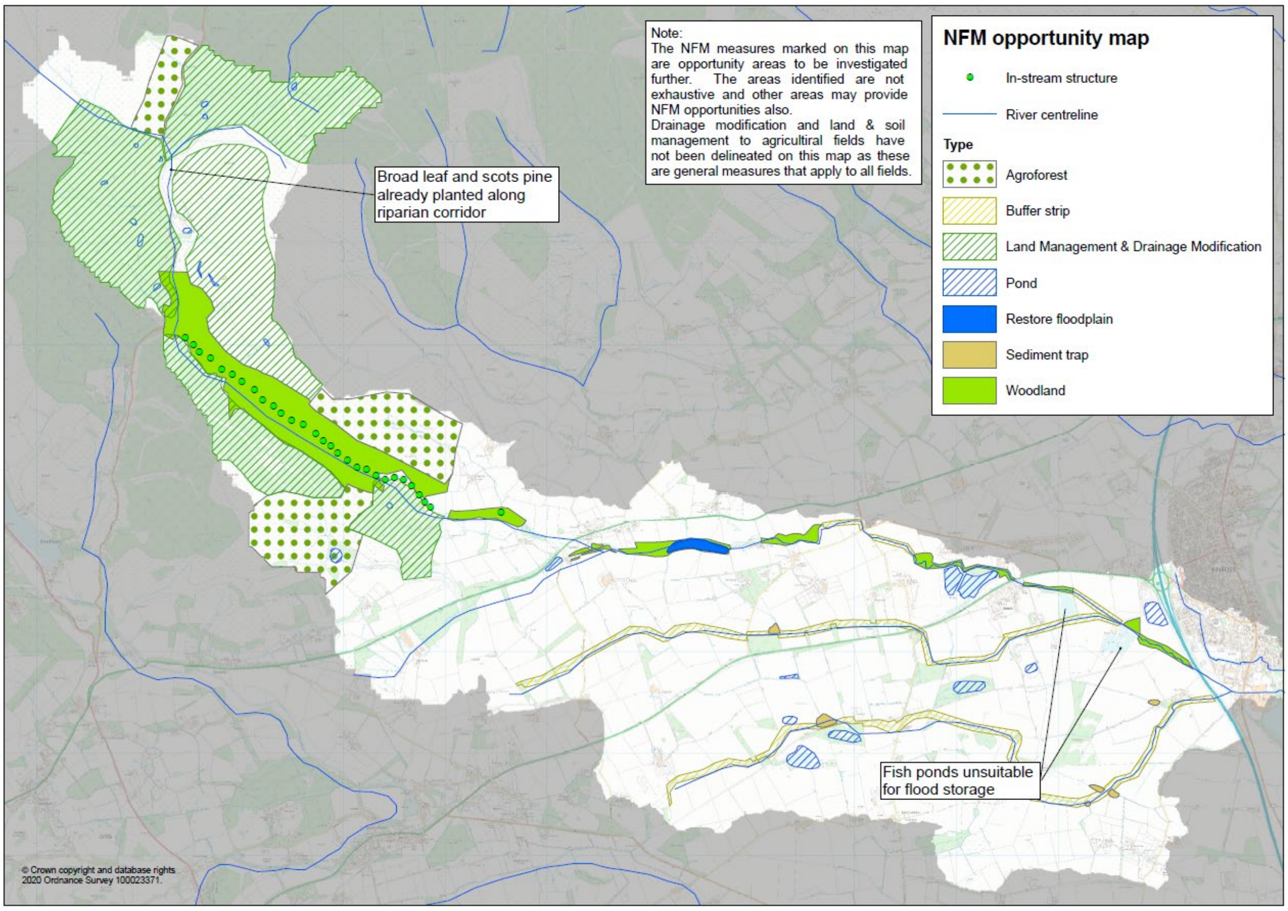


Figure 2.7: NFM Opportunity Map for South Queich Catchment

It was requested as part of the NFM Study that RPS make a recommendation for measures which could be prioritised. The measures proposed in the report are included in Figure 2.8. The whole life costs for the NFM were based on a contractor led scheme.

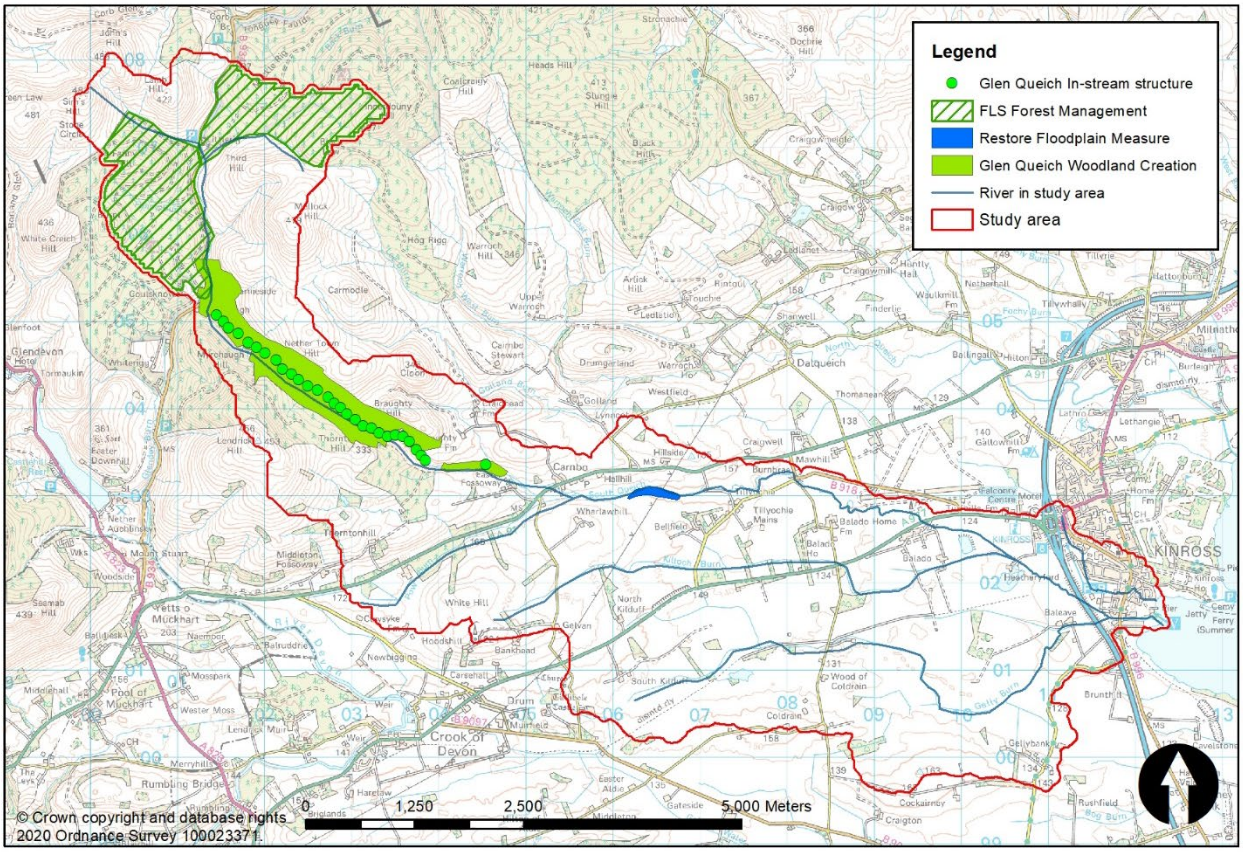


Figure 2.8: Option 4 South Queich Upper Catchment

3 BENEFIT COST RATIO COMPARISON

Provided below is a summary of the whole life costs associated with each of the options presented in this report. These costs have been sourced from the South Kinross FPS Option Review Report and the NFM Study. The whole life costs include for enabling, preliminaries, construction, operation, and maintenance across a design life of 100 years. The detailed breakdown of costs is provided within the appendices for these reports.

All the options were found to be cost beneficial at the Scheme Area scale, based on the costing undertaken to date. The summary of BCRs is provided in Table 3.1. The Present Value Benefit associated with protecting residential and non-residential properties for the were assessed to the present-day scenario in the Option Review Report. It would be expected that any provision of climate change protection would increase the potential benefits, although for both adaptation (Option 3) and NFM (Option 4) there is low confidence in when the additional benefits will be realised in the future. For this reason, the present value benefit (PVB) has been maintained at the 0.5% AEP Standard of Protection benefit. The PVB is therefore considered to be conservative for Options 3 & 4 which may provide some additional protection against climate change impacts in the future.

For Flood Cell 1, a comparison of peak flows found a 2.6% difference between the 0.5% plus climate change and present day 0.1% AEP flows. In Flood Cell 3, the difference in peak flow on the South Queich was found to be <1%. RPS were instructed to assess what the benefit would be for a Q1000 Standard of Protection, which could be used to quantify some of the additional benefits provided by the Q200+CC SoP. For this reason, the PVB for Option 2 is higher than that for the other options. The percentage difference in flows for the Clash Burn indicated that 0.1% AEP peak flows were ~9% higher than the 0.5% plus climate change peak flow, therefore the PVB for Option 2 was not altered for Flood Cell 2.

Table 3.1: Summary Benefit Cost Ratios for Options 1, 2, 3 & 4 at Scheme Area Scale

	Option 1	Option 2	Option 3	Option 4
Whole Life Cost	£9,350,681	£10,671,187	£9,987,186	£11,492,955
Present Value Benefit	£13,164,315	£14,574,567	£13,164,315	£13,164,315
Benefit Cost Ratio	**1.41**	**1.37**	**1.32**	**1.15**

To facilitate the comparison of the preferable option per Flood Cell, the costed elements within Flood Cells 1, 2 & 3 were separated.

3.1 Flood Cell 1

A summary of the BCRs for Flood Cell 1 are provided in Table 3.2. In Flood Cell 1 the BCRs of all options were identified to be cost beneficial at Flood Cell scale. The most cost beneficial was Option 1 (0.5% AEP Fluvial Present Day SoP). It is expected Options 2 and 3 would provide greater protection, but the PVB estimates are conservative and have not included a detailed assessment of additional protection afforded against the impacts of climate change.

Table 3.2: Benefit Cost Ratios for Flood Cell 1

	Option 1	Option 2	Option 3	Option 4
Whole Life Cost	£3,637,327	£4,216,185	£3,784,246	£5,779,601*
Present Value Benefit	£10,415,641	£11,544,954	£10,415,641	£10,415,641
Benefit Cost Ratio	**2.86**	**2.74**	**2.75**	**1.80***

*High uncertainty over costs relating to any potential NFM, concerning feasibility, costs and potential benefit cost ratios

3.2 Flood Cell 2

A summary of the BCRs for Flood Cell 2 are provided in Table 3.3. For Flood Cell 2, none of the options considered have been calculated to be cost beneficial at Flood Cell scale. As discussed earlier, all options are calculated to be cost beneficial for the South Kinross FPS at the Scheme Area scale. Option 1 provides the greatest cost benefit at 0.46. NFM focussed on the South Queich catchment and the additional protection that could be afforded to Flood Cell 1, therefore would not be considered to benefit Flood Cell 2, therefore Option 4 has been greyed out in Table 3.3.

Table 3.3: Benefit Cost Ratios for Flood Cell 2

	Option 1	Option 2	Option 3	Option 4
Whole Life Cost	£5,290,114	£5,712,195	£5,673,926	N/A
Present Value Benefit	£2,425,347	£2,425,347	£2,425,347	N/A
Benefit Cost Ratio	**0.46**	**0.42**	**0.43**	N/A

3.3 Flood Cell 3

A summary of the BCRs for Flood Cell 3 are provided in Table 3.4. For Flood Cell 2, none of the options considered have been calculated to be cost beneficial at Flood Cell scale. As discussed earlier, all options are calculated to be cost beneficial for the South Kinross FPS at the Scheme Area scale. Option 3 provides the greatest cost benefit at 0.76. NFM focussed on the South Queich catchment and the additional protection that could be afforded to Flood Cell 1, therefore would not be considered to benefit Flood Cell 3, therefore Option 4 has been greyed out in Table 3.4.

Table 3.4: Benefit Cost Ratios for Flood Cell 3

	Option 1	Option 2	Option 3	Option 4
Whole Life Cost	£423,240	£742,808	£529,014	£423,240
Present Value Benefit	£323,327	£443,270	£323,327	£323,327
Benefit Cost Ratio	**0.76**	**0.60**	**0.61**	**0.76**

4 MULTI-CRITERIA ANALYSIS

RPS proposed undertaking a multi-criteria analysis in order to aid in understanding and comparing various social, economic, environmental impacts as well as the technical feasibility of the proposed South Kinross FPS options, regarding the different Standards of Protection set out in Section 2.

The objectives within the MCA set out aims that each option should be seeking to achieve, if possible. The degree to which an option achieves an objective is an indication of the 'success' of the option, and equally, the more an option achieves across all of the objectives, then the greater the preference that will be given to that option relative to others, while taking account the cost of each of the options.

4.1 Guidance & Legislation

The MCA scoring matrix developed to assess South Kinross FPS options was developed based on the following guidance:

- The Office of Public Works (OPW) Technical Methodology Note – Option Appraisal and the Multi-Criteria Analysis (MCA) Framework (September 2018)
- The Environment Agency's Flood and Coastal Erosion Risk Management Appraisal Guidance (March 2010 & March 2022)

4.2 MCA Scoring Rationale and Justification

The OPW developed robust MCA guidance for the Republic of Ireland, which RPS has adapted for a Scottish context in order to assess the different Standards of Protection for the South Kinross FPS. Aspects of the Environment Agency's approach have been considered to assist this process and frame the MCA in a UK context. The MCA scoring system uses a scale of -3 (very negative) to 3 (very positive) for each of the objectives. The scoring matrix, which sets out each of the MCA objectives with scoring justification details are provided in Table 4.1. The MCA scores for each Flood Cell have been summarised in Section 4.3.1 to 4.3.3, with the detailed justification provided in Appendix A.

Each objective has a Basic Requirement and an Aspirational Target associated with it. The Basic Requirement represents a neutral status or '*no change'*, whereby if an option has no impact on the matter the objective relates to or meets what might be termed for some objectives as minimum requirements for acceptability, then that option will have met the Basic Requirement. If an option performs worse than the Basic Requirement, i.e., has a negative impact (a dis-benefit) or does not meet the minimum requirements for acceptability, it will score a negative-value score for that objective, but might still be considered further, depending on the degree of the dis-benefit or failure to meet the requirements.

The aim is defined as an Aspirational Target, whereby an option would be deemed as perfect with respect to the given objective if it were to meet the Aspirational Target. Typically, this will represent complete removal of a risk, or the full achievement of another benefit.

Table 4.1: MCA Scoring Matrix

Score	Degree of Impact	Scoring Justification			
		Social	Economic	Environmental	Technical
+3	Very Positive	100% reduction in number of residential properties at present day flood risk with climate change protection	Potential to minimise present day economic risk (i.e. 100% reduction in AAD), with climate change protection	Potential to enhance conditions for internationally protected species and their key habitats, in line with conservation objectives.	No/negligible operational risk (i.e. no reliance on systems or intervention, with no/some limited maintenance and monitoring required)
		100% reduction in number of high vulnerability properties at present day flood risk with climate change protection	Reduce present day risk to transport infrastructure to zero, with climate change protection	Potential to significantly improve water quality and significantly contribute to improving water status. Significantly improved hydromorphology.	Negligible risk to health and safety during construction, maintenance or operation
		100% reduction in number of social infrastructure assets at present day flood risk with climate change protection	Reduce present day risk to utility infrastructure to zero, with climate change protection	-	Option is adaptable at no/negligible/limited cost and provides no impediment to future interventions to address new potential future risk areas
		100% reduction in number of non-residential properties at present day flood risk with climate change protection	Potential to minimise risk to agriculture and provide the potential for enhanced agricultural production with climate change protection	-	-
+2	Positive	Significant decrease in number of residential properties at present day flood risk	Significant decrease in present day economic risk (i.e. 50-100% reduction), no climate change allowance	Potential to enhance conditions for national and/or local nature conservation sites and priority / protected species, or other known species of conservation concern.	Low/very low operational risk (i.e. requirement for systems or interventions to operate, with regular monitoring and maintenance, and a very low/low likelihood of system/operational failure)
		Significant decrease in number of high vulnerability properties at present day flood risk	Significant decrease in transport infrastructure at risk, no climate change allowance	Potential to improve water quality and contribute to improving water status. Moderately improved hydromorphology.	Low acceptable and manageable, level of health and safety risk during construction, maintenance or operation
		Significant decrease in number of social infrastructure assets at present day flood risk	Significant decrease in utility infrastructure at risk, no climate change allowance	Potential for protection to national heritage sites. Multi-benefit potential for incorporation of national heritage features / trails into solution.	Option is adaptable at moderate / significant cost, difficulty and impact, and provides no impediment to future interventions to address new potential future risk areas
		Significant decrease in number of non-residential properties at present day flood risk	Significant decrease in agricultural assets at present day flow risk, no climate change allowance	Multi-benefit scheme providing amenity and recreation potential, improving the landscape and local views.	-
+1	Slightly Positive	Slight decrease in number of residential properties at risk	Slight decrease in economic risk (i.e. 0-49% reduction)	Potential for long term biodiversity net gain.	Low/moderate operational risk (i.e. options that are fully reliant on systems or interventions to operate, with regular monitoring and maintenance, and a low to moderate likelihood of system/operational failure)

Score	Degree of Impact	Scoring Justification: Social	Economic	Environmental	Technical
		Slight decrease in number of high vulnerability properties at risk	Slight decrease in transport infrastructure at risk	Potential to contribute towards improving water quality or water status. Slightly improved hydromorphology.	Moderate, but acceptable and manageable, level of health and safety risk during construction, maintenance or operation
		Slight decrease in number of social infrastructure assets at risk	Slight decrease in utility infrastructure at risk	Potential for protection to local heritage sites. Multi-benefit potential for incorporation of local heritage features / trails into solution.	Option is adaptable only at significant cost, difficulty and impact, and provides no impediment to future interventions to address new potential future risk areas
		Slight decrease in number of non-residential properties at risk	Slight decrease in agricultural assets at risk	Potential to improve the landscape and local views.	-
0	**Neutral**	Number of residential properties at risk not increased	No increase in economic risk (i.e. AAD is not increased)	No impacts on international, national and local nature conservation sites and priority / protected species, or other know species of conservation concern.	Moderate but manageable operational risk (i.e. options that are fully reliant on systems or interventions to operate, with regular monitoring and maintenance, and a moderate likelihood of system/operational failure)
		Number of high vulnerability properties at risk not increased	No increase in risk to transport infrastructure	No impact on water quality, water status or hydromorphology.	Moderate to high, but acceptable and manageable, level of health and safety risk during construction, maintenance or operation
		Number of social infrastructure assets at risk not increased	No increase in risk to utility infrastructure	No impacts on known heritage sites.	Option is not adaptable, but provides no impediment to future interventions to address new potential future risk areas
		Number of non-residential properties at risk not increased	No increase on the negative impact of flooding on agriculture	No impacts on landscape, views or amenity.	-
-1	**Slightly Negative**	Slight increase in number of residential properties at risk	Slight increase in economic risk	Potential for short / long term biodiversity net loss.	Moderate/high operational risk (i.e. options that are fully reliant on systems or interventions to operate, with regular monitoring and maintenance, and a moderate/high likelihood of system/operational failure)
		Slight increase in number of high vulnerability properties at risk	Slight increase in transport infrastructure at risk	Potential for slight (temporary) reductions in water quality. Potential for slight negative impacts on hydromorphology.	High level risk to health and safety during construction, maintenance or operation for which there are challenges to manage and mitigate
		Slight increase in number of social infrastructure assets at risk	Slight increase in utility infrastructure at risk	Potential for damage to or partial loss of local heritage site, or permanent impacts on the setting of national heritage site.	Option is not adaptable, and will create a minor / moderate interference or impediment to with potential future measures
		Slight increase in number of non-residential properties at risk	Slight increase in agricultural assets at risk	Potential for short term (temporary) / long term (permanent) negative impacts on local views and access to amenities.	-

Score	Degree of Impact	Scoring Justification			
		Social	Economic	Environmental	Technical
-2	Negative	Significant increase in number of residential properties at risk	Significant increase in economic risk	Potential for permanent or recurring loss of or disturbance to national and local nature conservation sites and priority / protected species, or other know species of conservation concern.	High operational risk (i.e. options that are fully reliant on systems or interventions to operate, with regular monitoring and maintenance, and a moderate/high likelihood of system/operational failure) OR Foreseeable likelihood that failure would render measure ineffective
		Significant increase in number of high vulnerability properties at risk	Significant increase in transport infrastructure at risk	Potential for recurring reductions in water quality, potentially contributing to stalling improvement in water status. Potential for moderate impacts on hydromorphology.	Very high level risk to health and safety during construction, maintenance or operation for which there are challenges to manage and mitigate
		Significant increase in number of social infrastructure assets at risk	Significant increase in utility infrastructure at risk	Potential for damage to or partial loss of national heritage site.	Option is not adaptable, and will create a major interference with or impediment to potential future measures
		Significant increase in number of non-residential properties at risk	Significant increase in agricultural assets at risk	Potential for short term (temporary) / long term (permanent) negative impacts on the landscape and access to amenities.	-
-3	Very Negative	Unacceptable increase in number of residential properties at risk	Unacceptable increase in economic risk	Potential for permanent or recurring loss of or disturbance to internationally protected species and their key habitats.	Unacceptable operational risk (i.e. options that are fully reliant on systems or interventions to operate that will be difficult to achieve, and for which failure of the system/intervention is likely and would have unacceptable consequences)
		Unacceptable increase in number of high vulnerability properties at risk	Unacceptable increase in transport infrastructure at risk	Potential for recurring significant reductions in water quality, potentially contributing to deterioration in water status. Potential for significant impacts on hydromorphology.	Unacceptable risk to health and safety during construction, maintenance or operation for which there are no options for management and mitigation
		Unacceptable increase in number of social infrastructure assets at risk	Unacceptable increase in utility infrastructure at risk	-	Unacceptable interference with potential future measures
		Unacceptable increase in number of non-residential properties at risk	Unacceptable increase in agricultural assets at risk	-	-

Once all the objectives were analysed, the 'Technical Criteria Score', 'MCA Benefit Score', MCA Option Selection Score, MCA BCR and Economic BCR could be calculated. Further details on how each of these are calculated can be found in Section 5.

4.3 MCA Tables

The effectiveness of the options for each Flood Cell were considered against the scoring justification. Detailed explanations for the scoring have been included in Appendix A. A summary of the scores has been provided below.

4.3.1 Flood Cell 1

The outcomes of the MCA have been summarised for Flood Cell 1 in Table 4.2.

Table 4.2: Multi-Criteria Analysis (Flood Cell 1)

Criteria	Objective	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
Social	Residential properties at risk	2	3	2.5	2.1
	High vulnerability properties at risk	-	-	-	-
	Social infrastructure and amenity at risk	-	-	-	-
	Local employment at risk	2	3	2.5	2.1
	SOCIAL CRITERA SCORE	**4**	**6**	**5**	**4.2**
Economic	Economic risk	2	3	2.5	2.1
	Risk to transport infrastructure	2	3	2.5	2.1
	Risk to utility infrastructure	3	3	3	3
	Risk to agriculture	-	-	-	-
	ECONOMIC CRITERA SCORE	**7**	**9**	**8.3**	**7.1**
Environmental	Biodiversity, Flora, Fauna	-1	-1	-2	0
	Water Quality & Hydromorphology.	-2	-2	-2	-1.5
	Cultural, Architectural & Archaeological Value	1	1	1	1
	Landscape & Amenity	-1	-1	-1	0
	ENVIRONMENTAL CRITERA SCORE	**-3**	**-3**	**-5**	**-0.5**
Technical	Operational risk	2	2	2	2
	Health and safety risks	1	1	0.5	1
	Adaptability to future flood risk and climate change	-2	2	3	1
	TECHNICAL CRITERA SCORE	**0**	**5**	**5.5**	**4**
	MCA OPTION SELECTION SCORE	**2.20**	**2.85**	**2.46**	**1.87**
	MCA BENEFIT SCORE	**2.86**	**2.74**	**2.75**	**1.80**

4.3.2 Flood Cell 2

The outcomes of the MCA have been summarised for Flood Cell 2 in Table 4.3. Note that Option 4 has been greyed out as NFM measures do not directly affect this flood cell.

Table 4.3: Multi-Criteria Analysis (Flood Cell 2)

Criteria	Objective	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
Social	Residential properties at risk	2	3	2.5	N/A
	High vulnerability properties at risk	-	-	-	N/A
	Social infrastructure and amenity at risk	-	-	-	N/A
	Local employment at risk	2	3	2.5	N/A
	SOCIAL CRITERA SCORE	**4**	**6**	**5**	N/A
Economic	Economic risk	2	3	2.5	N/A
	Risk to transport infrastructure	2	3	2.8	N/A
	Risk to utility infrastructure	-	-	-	N/A
	Risk to agriculture	-	-	-	N/A
	ECONOMIC CRITERA SCORE	**4**	**6**	**5.3**	N/A
Environmental	Biodiversity, Flora, Fauna	0	0	0	N/A
	Water Quality & Hydromorphology.	0	0	0	N/A
	Cultural, Architectural & Archaeological Value	0	0	0	N/A
	Landscape & Amenity	-1	-1	-2	N/A
	ENVIRONMENTAL CRITERA SCORE	**-1**	**-1**	**-2**	N/A
Technical	Operational risk	1	1	1	N/A
	Health and safety risks	1	1	0	N/A
	Adaptability to future flood risk and climate change	-2	2	-1	N/A
	TECHNICAL CRITERA SCORE	**0**	**4**	**0**	N/A
	MCA OPTION SELECTION SCORE	**1.32**	**1.93**	**1.46**	N/A
	MCA BENEFIT SCORE	**0.46**	**0.42**	**0.43**	N/A

4.3.3 Flood Cell 3

The outcomes of the MCA have been summarised for Flood Cell 3 in Table 4.4. Note that Option 4 has considered the NFM measures, although the cost has been included solely in Flood Cell 1, as the NFM study considered all areas directly upstream of the original South Kinross FPS study area, which is situated downstream of the M90 motorway.

Table 4.4: Multi-Criteria Analysis (Flood Cell 3)

Criteria	Objective	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
Social	Residential properties at risk	-	-	-	-
	High vulnerability properties at risk	-	-	-	-

Criteria	Objective	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
	Social infrastructure and amenity at risk	-	-	-	-
	Local employment at risk	2	3	2.5	2.1
	SOCIAL CRITERA SCORE	**2**	**3**	**2.5**	**2.1**
Economic	Economic risk	2	3	2.5	2.1
	Risk to transport infrastructure	2	3	2.5	2.1
	Risk to utility infrastructure	-	-	-	-
	Risk to agriculture	-1	-1	-1	-2
	ECONOMIC CRITERA SCORE	**3**	**5**	**4**	**2.2**
Environmental	Biodiversity, Flora, Fauna	0	0	-1	2
	Water Quality & Hydromorphology.	0	0	0	1
	Cultural, Architectural & Archaeological Value	0	0	0	1
	Landscape & Amenity	0	0	0	1
	ENVIRONMENTAL SCORE	**0**	**0**	**-1**	**5**
Technical	Operational risk	2	2	2	2
	Health and safety risks	2	2	1.5	2
	Adaptability to future flood risk and climate change	-2	2	3	1
	TECHNICAL CRITERA SCORE	**2**	**6**	**6.5**	**5**
	MCA OPTION SELECTION SCORE	**11.81**	**10.77**	**10.44**	***21.97**
	MCA BENEFIT SCORE	**0.76**	**0.60**	**0.61**	***0.76**

*Costs for NFM measures included in Flood Cell 1

5 MCA & BCR OUTCOMES

A suite of different scores presents the findings of the MCA. These are compiled of different elements of the MCA to demonstrate how each option delivers against the objectives. The scores are as follows:

- **Criteria Scores** – For each option in each Flood Cell, the scores for each of the technical, economic, social, and environmental criteria was summed to provide the Criteria Scores.
- **MCA Benefit Score** – To derive the MCA Benefit Score, the scores for the economic, social and environmental Criteria Scores were summed. This score represents the net benefits of the option.
- **Option Selection MCA Score** - This is the sum of all scores for all four of the criteria. This score compliments the MCA Benefit Score with the Technical Criteria Score, and hence includes all of the aspects that should be taken into account when considering a preferred option for each Flood Cell.
- **MCA Benefit-Cost Ratio** - This score is calculated by dividing the MCA Benefit Score by the cost of the option, giving a numerical, but non-monetarised, MCA Benefit - Cost Ratio, that provides an indication of the overall benefits that can be delivered per pound invested.
- **The Economic BCR** - This is the comparison of the reduction in damages expected against the cost of the scheme. This was calculated using the more traditional techniques, i.e., the FHRC Multi-Coloured Manual.

The results of the MCA process were used to inform, providing a recommendation for the Standard of Protection to be considered for each Flood Cell. It should be recognised that whilst a numeric scheme is used in the MCA process, the selection of scores and overall recommendation of preferred option is subjective and based on professional judgement.

5.1 Flood Cell 1

Table 5.1 shows the Criteria, MCA Benefit and Option Selection Scores for Flood Cell 1.

Table 5.1: Criteria Scores (Flood Cell 1)

Criteria	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
Social	4	6	5	4.2
Economic	7	9	8.3	7.1
Environmental	-3	-3	-4	-0.5
Technical	0	5	5.5	4
MCA BENEFIT SCORE (*sum of scores for the economic, social & environmental criteria*)	**2.20**	**2.85**	**2.46**	**1.87**
OPTION SELECTION MCA SCORE (*sum of all 4 criteria scores*)	**2.86**	**2.74**	**2.75**	**1.8**

5.2 Flood Cell 2

Table 5.2 shows the Criteria, MCA Benefit and Option Selection Scores for Flood Cell 2. Note that Option 4 has been greyed out as NFM measures do not directly affect this flood cell.

Table 5.2: Criteria Scores (Flood Cell 2)

Criteria	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
Social	4	6	5	N/A
Economic	4	6	5.3	N/A
Environmental	-1	-1	-2	N/A
Technical	0	4	0	N/A
MCA BENEFIT SCORE (*sum of scores for the economic, social & environmental criteria*)	**1.32**	**1.93**	**1.46**	N/A
OPTION SELECTION MCA SCORE (*sum of all 4 criteria scores*)	**0.46**	**0.42**	**0.43**	N/A

5.3 Flood Cell 3

Table 5.3 shows the Criteria, MCA Benefit and Option Selection Scores for the five Options for Flood Cell 3.

Table 5.3: Criteria Scores (Flood Cell 3)

Criteria	Score (Option 1)	Score (Option 2)	Score (Option 3)	Score (Option 4)
Social	2	3	2.5	2.1
Economic	3	5	4	2.2
Environmental	0	0	-1	5
Technical	2	6	6.5	5
MCA BENEFIT SCORE (*sum of scores for the economic, social & environmental criteria*)	11.81	10.77	10.40	*21.97
OPTION SELECTION MCA SCORE (*sum of all 4 criteria scores*)	0.76	0.60	0.61	*0.76

*Costs for NFM measures captured in Flood Cell 1, although some benefits may be afforded for Flood Cell 3 also

6 RECOMMENDATION

A recommendation per Flood Cell was proposed by RPS, based on the outcomes of the Multi-Criteria Analysis and Benefit-Cost Ratios, which captured a broad range of technical, economic, social, and environmental criteria.

6.1 Flood Cell 1

For Flood Cell 1, Option 4 was found to have the lowest MCA Benefit-Cost Ratio, as well as the lowest Economic BCR out of all the options. Despite the potential benefits that could be afforded through aspirational NFM measures, unfortunately there are too many variables surrounding which, if any, NFM measures could be implemented across the upper catchment, and the impacts and benefits that would be associated with these measures over time. These uncertainties were considered within the MCA scoring. This option was not considered further, although the benefits associated with a long term NFM Study could be investigated further in the future, building upon the findings and recommendations presented in the NFM Study report.

The MCA benefit-cost ratio and economic BCRs were similar for Options 1 to 3, which range between 2.20 and 2.85. There was no clear Option identified with the best ratio for both categories. Some wider considerations were accounted for when choosing the recommended SoP, in combination with the findings of the MCA. As set out in the Natural Flood Management (Scotland) Act 2009, due to the uncertainties in projections of future flood risk, a managed adaptive approach is preferable wherever possible, as opposed to a precautionary approach[1]. In addition, a recommendation made by Convention of Scottish Local Authorities (COSLA), to pause and review any flood protection schemes which are not yet “legally committed”, may apply additional pressure to demonstrate that flood schemes demonstrate value for money for the nation. The adaptive approach is recommended to provide the most sustainable solution for the future, which avoids increased capital costs initially and provides a ‘no-regrets’ approach in regard to providing climate change protection in the future.

The adaptation approach for Flood Cell 1, set out by Option 3, has been determined to be feasible, and draws a compromise with both the MCA Benefit-Cost Ratio and the Economic BCR. The preferred option proposed for Flood Cell 1 is **Option 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation.**

6.2 Flood Cell 2

For Flood Cell 2 it was found that the Economic BCR was similar across Options 1, 2 and 3, although the adaptation approach (Option 3) would require additional works be undertaken in the future to replace many of the culverts already proposed to be upgraded to achieve the 0.5% AEP present day flows. Option 2 was found to have the best MCA Benefit-Cost Ratio, scoring highly on the social and economic criteria. As the flood alleviation options for Flood Cell 2, which are primarily related to culvert upgrades, are not by nature easily adapted without full replacement, it is recommended that climate change be accounted for in the South Kinross

[1] Flood Risk Management (Scotland) Act 2009, Options appraisal for flood risk management: Guidance to support SEPA and the responsible authorities (May 2016)

FRS. This is also aligned with the Flood Risk Management (Scotland) Act 2009, which takes into consideration whether flood alleviation options proposed are adaptable or not.

The preferred option proposed for Flood Cell 2 is **Option 2: 0.5% 0.5% + Climate Change Fluvial AEP SoP**

6.3 Flood Cell 3

For Flood Cell 3, as it is impacted by flooding from the South Queich, the NFM measures in the upper catchment were considered to have the potential to benefit this flood cell. As documented in Section 6.1, it was decided to park any potential NFM due to the uncertainties surrounding this option.

The MCA found both the MCA benefit-cost ratio and economic BCR to be highest for Option 1, for the 0.5% AEP Standard of protection. It is noted that the Option 2 and 3 scored significantly higher across the technical criteria, particularly relating to the adaptability to future flood risk and climate change. As the cost of the options for this Flood Cell were significantly lower compared to the other flood cells, the variation between them appears more exaggerated, which has had an adverse impact on the ratios calculated. Despite Option 1 having a lower cost, RPS recommends that climate change be considered, to ensure a ‘no regrets’ approach, and to bring forward the potential positive social, environmental, and technical impacts identified in the MCA.

Taking into consideration the findings of the MCA, as well as the Natural Flood Management (Scotland) Act 2009 recommendation to take forward managed adaptation wherever possible, RPS have determined that Option 3 would be preferable to Option 2.

The preferred option proposed for Flood Cell 3 is **Option 3: 0.5% (Present Day) Fluvial AEP with Climate Change Adaptation.**

Appendix A

MCA Tables

Table A1: MCA Results (Flood Cell 1)

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
Social	Residential properties at risk	53 residential properties at risk in 0.5% AEP event.	**Score: 2** All properties at risk protected to 0.5% AEP fluvial event.	**Score: 3** All properties at risk protected to 0.5% +CC AEP fluvial event.	**Score: 2.5** All properties at risk protected to 0.5% AEP fluvial event initially, with possibility of adaptation in the future.	**Score: 2.1** All properties at risk protected to 0.5% AEP fluvial event. Resilience against climate change afforded through aspirational measures, though not possible to quantify impacts at present. Score accounts for significant uncertainties, regarding a lack of baseline hydrological data and the length of time NFM measures such as woodland areas take to provide benefits to flooding, ecological habitats, and carbon sequestration.	**Option 1, 2, 3 & 4** All options provide at a minimum 0.5% AEP fluvial protection to all properties at risk
	High vulnerability properties at risk	None at risk	-	-	-	-	-
	Social infrastructure and amenity at risk	None at risk	-	-	-	-	-
	Local employment at risk	43 commercial properties	**Score: 2** All properties at risk protected to 0.5% AEP fluvial event.	**Score: 3** All properties at risk protected to 0.5% +CC AEP fluvial event.	**Score: 2.5** All properties at risk protected to 0.5% AEP fluvial event initially, with possibility of adaptation in the future.	**Score: 2.1** All properties at risk protected to 0.5% AEP fluvial event. Resilience against climate change may be afforded through aspirational measures.	**Option 1, 2, 3 & 4** Protection to industrial units provides opportunity for expansion or new development on benefiting lands. This would lead to a positive social impact.
	SOCIAL (*criteria score*)		**4**	**6**	**5**	**4.2**	
Economic	Economic risk	AAD = £2,503,143 Annual Average Damage (AAD) fluvial risk assessed up to 0.1% AEP fluvial event.	**Score: 2** Residual AAD = £46,070 Residual AAD is calculated up to the 0.1% AEP present day scenario.	**Score: 3** Residual AAD = £0 Residual AAD would be less than that calculated for the present day scenario, providing full 0.5% AEP climate change protection. Peak flow of Q200+CC is comparable to the Q1000 event.	**Score: 2.5** Residual AAD = <£46,070 Assuming the scheme would be adapted in the future this has the potential to reduce the residual AAD further.	**Score: 2.1** Residual AAD = <£46,070 The AAD may be reduced through the installation of aspirational measures. In addition to the uncertainty regarding what NFM measures may be implemented is the lack of confidence in the flow reduction that NFM measures may provide.	**Option 1, 2, 3 & 4** Present value benefits associated with climate change not available. Uncertainty regarding what year climate change adaptation would be undertaken. Uncertainty over effectiveness of any proposed NFM measures and how the effectiveness would change over time.
	Risk to transport infrastructure	Approximately 6 roads at risk, including the B996	**Score: 2** Present day 0.5% fluvial protection provided to all roads at risk.	**Score: 3** Present day 0.5% fluvial protection provided to all roads at risk. Protection against climate change (approx. 60m additional road at climate change risk).	**Score: 2.5** Present day 0.5% fluvial protection provided to all roads at risk. Some additional protection would be afforded to the approx. 60m additional road at climate change risk.	**Score: 2.1** Present day 0.5% fluvial protection provided to all roads at risk. Some of the additional road infrastructure at climate change risk may be afforded some protection over time, but the confidence in this level of protection is extremely low.	
	Risk to utility infrastructure	1 electricity substation	**Score: 3** Present day 0.5% fluvial protection provided to substation. Substation is unlikely to be impacted by climate change when present day flood alleviation scheme is in place.	**Score: 3** Equivalent of present day 0.1% fluvial protection provided to substation. Substation is unlikely to be impacted by climate change	**Score: 3** Present day 0.5% fluvial protection provided to substation. Substation is unlikely to be impacted by climate change when present day flood alleviation scheme is in place.	**Score: 3** Present day 0.5% fluvial protection provided to substation. Substation is unlikely to be impacted by climate change when present day flood alleviation scheme is in place.	

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
				when present day flood alleviation scheme is in place.			
	Risk to agriculture	No agricultural land present in Flood Cell 1	-	-	-	-	-
	ENVIRONMENTAL (*criteria score*)		7	9	8.3	7.1	
Environmental	Biodiversity, Flora, Fauna	There is unlikely to be any major long term biodiversity loss or any impact on Loch Leven SPA, Ramsar Site, NNR or SSSI. However, if flooding occurs, there may be short term impacts on terrestrial biodiversity.	**Score: -1** There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of hard defences. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Tree removal may also be required in order to construct walls, which may result in loss of biodiversity along the river corridor and result in loss of habitat for bat roosting. Overall, it is expected that there will be a slightly negative impact on biodiversity, flora or fauna as a result of **Option 1.**	**Score: -1** There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of hard defences. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Tree removal may also be required in order to construct walls, which may result in loss of biodiversity along the river corridor and result in loss of habitat for bat roosting. Overall, it is expected that there will be a slightly negative impact on biodiversity, flora or fauna as a result of **Option 2**.	**Score: -2** There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of hard defences. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Tree removal may also be required in order to construct walls, which may result in loss of biodiversity along the river corridor and result in loss of habitat for bat roosting. There may be two construction phases required for this option as the walls may need to be built higher to account for climate change, so any construction phase impacts will likely occur again. Overall, it is expected that there will be a negative impact on biodiversity, flora, or fauna as a result of **Option 3**.	**Score: 0** The aspirational Glen Queich woodland creation has the potential to directly impact the Glen Queich SSSI. While this will provide new habitats and increase biodiversity, creating a continuous corridor down Glen Queich, it may also cause changes in vegetation succession in the area. (See Section 5 of NFM Report in Appendix G). As the SSSI is designated for non-montane rock habitats and lowland grassland habitats, this may encroach on these existing habitats. However, with appropriate planning this can be avoided. Woodland creation may also provide carbon sequestration (See Section 5 of NFM Report in Appendix G). There is uncertainty associated with the benefit woodland creation would provide over time. The installation of in-stream structures in Glen Queich and the restoration of the floodplain near Carnbo are unlikely to have any direct impact on the SSSI and may also create more varied river habitats for flora and fauna (See Section 5 of NFM Report in Appendix G). FLS forest management in the upper catchment may have a positive impact on designated sites within the South Queich catchment, providing additional habitats for wildlife and sequestering carbon from the environment See Section 5 of NFM Report in Appendix G). There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of hard defences. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Tree removal may also be required in order to construct walls, which may result in loss of biodiversity	**Option 1, 2, 3 & 4** No direct impacts on designated sites are expected as a result of option implementation and it assumed that suitable mitigation measures during the construction phase will reduce indirect impacts. It is assumed that NFM measures in the Queich upper catchment will have an overall benefit to biodiversity, flora and fauna and help offset negative impacts from construction of flood walls downstream. Further details can be found in the NFM Report (appendix G).

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
						along the river corridor and result in loss of habitat for bat roosting. Overall, it is expected that there will be no impact on biodiversity, flora, or fauna as a result of the **Option 4**.	
	Water Quality & Hydromorphology.	There is unlikely to be any improvements or reductions in water quality.	**Score: -2** The current water quality of the South Queich is 'High'. Hard defences may potentially have temporary impacts on water quality, which would not contribute to improving water quality. The construction of walls may also have impacts on the hydromorphology of the river and may reduce overall status from poor to bad. Overall, it is expected that there would be short term impacts to water quality, and potential for moderate impacts on hydromorphology.	**Score: -2** The current water quality of the South Queich is 'High'. Hard defences may potentially have temporary impacts on water quality, which would not contribute to improving water quality. The construction of walls may also have impacts on the hydromorphology of the river and may reduce overall status from poor to bad. Overall, it is expected that there would be short term impacts to water quality, and potential for moderate impacts on hydromorphology.	**Score: -2** The current water quality of the South Queich is 'High'. Hard defences may potentially have temporary impacts on water quality, which would not contribute to improving water quality. The construction of walls may also have impacts on the hydromorphology of the river and may reduce overall status from poor to bad. The construction phase for **Option 3** will likely be repeated in the future to build walls higher to account for climate change. Appropriate mitigation through the construction phased could limit any impacts to hydromorphology and water quality. Overall, it is expected that there would be short term impacts to water quality, and potential for moderate impacts on hydromorphology.	**Score: -1.5** It is likely that NFM measures proposed in the South Queich catchment would have a positive impact on water quality, especially stream structures (See Section 5 of NFM Report in Appendix G). Water quality for the South Queich is already 'High', however there may be additional benefits to the river and Loch Leven and River Leven downstream which are currently classified as 'Moderate' water quality. The current water quality of the South Queich is 'High'. Hard defences may potentially have temporary impacts on water quality, which would not contribute to improving water quality. The construction of walls may also have impacts on the hydromorphology of the river and may reduce overall status from poor to bad. Overall, it is expected that there would be short term impacts to water quality, and potential for moderate impacts on hydromorphology. These impacts may be somewhat offset under this objective through potential improvements to water quality through aspirational NFM measures implemented upstream of Kinross.	**Option 1, 2, 3 & 4** All options have the potential to impact upon water quality in the short-term and hydromorphology in the long-term. It is assumed that NFM measures in the Queich upper catchment will help offset negative impacts from construction of flood walls downstream. Further details can be found in the NFM Report.
	Cultural, Architectural & Archaeological Value	Flooding may impact the settings of a number of listed buildings in Kinross as well as Kinross Conservation Area	**Score: 1** There are several listed buildings in the vicinity of the hard defences that may be impacted in the short-term by construction. The construction of hard defences may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Overall, it is expected that **Option 1** will have a slightly positive impact on heritage assets in the area as flood protection will be provided.	**Score: 1** There are several listed buildings in the vicinity of the hard defences that may be impacted in the short-term by construction. The construction of hard defences may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Overall, it is expected that **Option 2** will have a slightly positive impact on heritage assets in the area as flood protection will be provided.	**Score: 1** There are several listed buildings in the vicinity of the hard defences that may be impacted in the short-term by construction. The construction phase for **Option 3** will likely be repeated in the future to build walls higher to account for climate change. This means repeated impacts on cultural, architectural, and archaeological assets. The construction of hard defences may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Overall, it is expected that **Option 3** will have a slightly positive impact	**Score: 1** The category B listed Burnbrae Farmhouse, Dairy and Walled Garden is located approximately 1.5km downstream of proposed floodplain restoration works. It is unlikely that NFM measures will impact this building, however it is important to consider before work commences. A scheduled monument (Braughty, unenclosed settlement) of prehistoric origin and national importance is located approximately 250m from proposed Glen Queich Woodland Creation. It is unlikely that NFM measures would impact this monument, however it is important to consider before work commences.	**Option 1, 2, 3 & 4** All options are likely to have a positive impact on cultural, architectural, and archaeological value by providing flood protection to listed buildings and conservation areas.

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
					on heritage assets in the area as flood protection will be provided.	NFM measures may provide protection for heritage sites downstream in Kinross when implemented alongside other measures. There are a number of listed buildings in the vicinity of the hard defences that may be impacted in the short-term by construction. The construction of hard defences may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Overall, it is expected that **Option 4** will have a slightly positive impact on heritage assets in the area as flood protection will be provided	
	Landscape & Amenity	There may be flooding to the Loch Leven Heritage Trail, temporarily restricting access for the public during times of flood.	**Score: -1** There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed hard defences which may be impacted, however it is unlikely the construction would have a negative impact on this. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. Overall, it is expected that **Option 1** will have a slightly negative impact on landscape and amenity in the area.	**Score: -1** There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed hard defences which may be impacted, however it is unlikely the construction would have a negative impact on this. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. Overall, it is expected that **Option 2** will have a slightly negative impact on landscape and amenity in the area.	**Score: -1** There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed hard defences which may be impacted, however it is unlikely the construction would have a negative impact on this. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. The construction phase for **Option 3** will likely be repeated in the future to build walls higher to account for climate change. This means repeated impacts on landscape and amenity. Overall, it is expected that **Option 3** will have a slightly negative impact on landscape and amenity in the area.	**Score: 0** Proposed NFM measures have the potential to increase local landscape value and create amenity / recreational value for the public, especially with the creation of new woodland in Glen Queich. There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed hard defences which may be impacted, however it is unlikely the construction would have a negative impact on this. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. Overall, it is expected that **Option 4** will have a neutral impact on landscape and amenity in the area, with the slightly negative impact in the town offset by aspirational NFM measures.	-
	TECHNICAL (*criteria score*)		-3	-3	-4	-0.5	
Technical	Operational risk	Currently no operational interventions, outside general maintenance. Observations and watercourse assessments are undertaken by PKC and reported upon biannually. These reports set out proposed maintenance works.	**Score: 2** Some operational risk maintaining existing culverts and bridges, access to which may be made more difficult by hard defences	**Score: 2** Some operational risk maintaining existing culverts and bridges, access to which may be made more difficult by hard defences. This risk is unlikely to be significantly different when defences are higher due to climate change provision.	**Score: 2** Some operational risk maintaining existing culverts and bridges, access to which may be made more difficult by hard defences. This risk is unlikely to be significantly different when defences are higher due to climate change provision.	**Score: 2** Some operational risk maintaining existing culverts and bridges, access to which may be made more difficult by hard defences. Any potential climate change provision in the future could reduce siltation and debris transported from the other catchment, but uncertainties surrounding potential implementation of NFM prohibit altering the score.	**Option 1, 2, 3 & 4** No reliance on systems or any other intervention as part of the options, for example pumps or manually deployed flood gates.

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
	Health and safety risks during construction, maintenance, and operation.	Clearance of vegetation is undertaken at times along the South Queich as required. Erosion has been identified further upstream along the South Queich, which is outside the area	**Score: 1** All phases require working near / in water, and involve the use of heavy machinery (excavators, piling rigs etc.). Construction phase will require working in areas with limited access, due to the presence of existing buildings in close proximity to riverbanks, where hard defences are proposed. At this early stage it is assumed that the level of health and safety risk during construction, maintenance, and operation would be moderate, but acceptable and manageable.	**Score: 1** All phases require working near / in water, and involve the use of heavy machinery (excavators, piling rigs etc.). Construction phase will require working in areas with limited access, due to the presence of existing buildings in close proximity to riverbanks, where hard defences are proposed. It is not expected the higher wall heights will increase the health and safety risks significantly during any stage across the design life of the scheme. At this early stage it is assumed that the level of health and safety risk during construction, maintenance, and operation would be moderate, but acceptable and manageable.	**Score: 0.5** All phases require working near / in water. Construction phase will require working in areas with limited access, due to the presence of existing buildings in close proximity to riverbanks, where hard defences are proposed. At this early stage it is assumed that the level of health and safety risk during construction, maintenance, and operation would be moderate, but acceptable and manageable. This option has been scored lower than options 1 & 2 as there would be two construction phases required. The scale of the second stage of construction is likely to be of lower impact than the first, likely avoiding any working in water or disturbing riverbanks.	**Score: 1** All phases require working near / in water. Construction phase will require working in areas with limited access, due to the presence of existing buildings in close proximity to riverbanks, where hard defences are proposed. At this early stage it is assumed that the level of health and safety risk for the structural measures during construction, maintenance, and operation would be moderate, but acceptable and manageable. Any implementation of an NFM plan would.	**Option 1, 2, 3 & 4** Risk scores assume health and safety risks are considered and managed to a high level by the successful contractor, as well as any operatives on site during the operation and maintenance phase.
	Adaptability to future flood risk and climate change	Currently no measures in place providing appropriate present day or climate change protection.	**Score: -3** No allowance for climate change and adaptation not considered. This would lead to unacceptable interference with potential future measures, requiring replacement of measures at significant cost and disruption. It is also extremely unlikely that any upgrades for climate change in the future would be cost-beneficial.	**Score: 2** Climate change provision provided across full design life, based on climate change projections at the time of writing. As these projections are subject to change over time, this option is not adaptable to future river flow and rainfall projections changes.	**Score: 3** Adaptation possible in future. Making a strong economic case for adaptation measures in the future may prove difficult as majority of protection is provided by main scheme, however this would allow for flow monitoring and review of very latest climate change policies, increasing confidence.	**Score: 1** NFM may offer some protection from, or resilience to, climate change uplifts due to attenuation provided in the upper catchment of the South Queich. Due to the uncertainties over what potential for NFM to be deployed, as well as the scale, timeframes and other uncertainties this has been scored lower than the structural options	
	TECHNICAL (*criteria score*)		**0**	**5**	**5.5**	**4**	
	MCA OPTION SELECTION SCORE (*sum of all 4 criteria scores*)		8	17	14.8	14.8	
	MCA BENEFIT SCORE (*sum of scores for the economic, social & environmental criteria*)		8	12	9.3	10.8	
	COST (£Million)		£3,637,327	£4,216,185	£3,784,246	£5,779,601	
	BENEFIT OF OPTION (£Million)		£10,415,641	£11,544,954	£10,415,641	£10,415,641	
	MCA Benefit-Cost Ratio		2.20	2.85	2.46	1.87	
	ECONOMIC BCR		**2.86**	**2.74**	**2.75**	**1.80**	

Table A2: MCA Results (Flood Cell 2)

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
Social	Residential properties at risk	87 residential properties at risk in 0.5% AEP event.	**Score: 2** All properties at risk protected to 0.5% AEP fluvial event	**Score: 3** All properties at risk protected to 0.5% +CC AEP fluvial event	**Score: 2.5** All properties at risk protected to 0.5% AEP fluvial event initially, with possibility of adaptation in the future	N/A	**Option 1, 2, 3 & 4** All options provide at a minimum 0.5% AEP fluvial protection to all properties at risk
	High vulnerability properties at risk	None at risk	-	-	-	N/A	
	Social infrastructure and amenity at risk	None at risk	-	-	-	N/A	
	Local employment at risk	2 commercial properties	**Score: 2** All properties at risk protected to 0.5% AEP fluvial event	**Score: 3** All properties at risk protected to 0.5% +CC AEP fluvial event	**Score: 2.5** All properties at risk protected to 0.5% AEP fluvial event initially, with possibility of adaptation in the future	N/A	**Option 1, 2, 3 & 4** Protection to industrial units provides opportunity for expansion or new development on benefiting lands. This may have a positive
	SOCIAL (*criteria score*)		4	6	5	N/A	
Economic	Economic risk	AAD = £150,143 Annual Average Damage (AAD) fluvial risk assessed up to 0.1% AEP fluvial event.	**Score: 2** Residual AAD = £5,400 Residual AAD is calculated up to the 0.1% AEP present day scenario.	**Score: 3** Residual AAD = <£5,400 Residual AAD would be less than that calculated for the present day scenario, providing full 0.5% AEP climate change protection.	**Score: 2.5** Residual AAD = <£5,400 Assuming the scheme would be adapted in the future this has the potential to reduce the residual AAD further. The measures predominantly	N/A	
	Risk to transport infrastructure	Approximately 7 roads at risk, including significant sections of Smith Street, Myre Terrace and Montgomery Street	**Score: 2** Present day 0.5% fluvial protection provided to all roads at risk.	**Score: 3** Present day 0.5% fluvial protection provided to all roads at risk. Protection against climate change (approx. 60m of the B996 / High Street at risk in the climate change scenario)	**Score: 2.8** Present day 0.5% fluvial protection provided to all roads at risk. Protection against climate change (approx. 60m of the B996 / High Street at risk in the climate change scenario)	N/A	
	Risk to utility infrastructure	No utility infrastructure identified at risk in damage assessment for Flood Cell 2	**-**	**-**	**-**	N/A	
	Risk to agriculture	No agricultural land present in Flood Cell 2	-	-	-	N/A	
	ECONOMIC (*criteria score*)		4	6	5.3	N/A	
Environmental	Biodiversity, Flora, Fauna	There is unlikely to be any major long term biodiversity loss or any impact on Loch Leven SPA, Ramsar Site, NNR or SSSI. However, if flooding occurs, there may be short term impacts on terrestrial biodiversity.	**Score: 0** There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of culvert upgrades / diversions. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on any designated sites in the area.	**Score: 0** There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of culvert upgrades / diversions. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Construction of a 0.6m average depth storage area at The Myre is unlikely to impact directly on any designated sites in the area.	**Score: 0** There is no direct impact on the Loch Leven SPA, Ramsar Site, NNR or SSSI as a result of culvert upgrades / diversions. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on any designated sites in the area.	N/A	**Option 1, 2, 3 & 4** No direct impacts on designated sites are expected as a result of option implementation and it assumed that suitable mitigation measures during the construction phase will reduce indirect impacts.

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
			Overall, it is expected that **Option 1** will have no impact on biodiversity, flora and fauna in the area	Overall, it is expected that **Option 2** will have no impact on biodiversity, flora and fauna in the area	There may be two construction phases required for **Option 3** as the culverts and storage area may need to be upgraded to account for climate change, so any construction phase impacts will likely occur again. Overall, it is expected that **Option 3** will have no impact on biodiversity, flora and fauna in the area		
	Water Quality & Hydromorphology.	There is unlikely to be any improvements or reductions in water quality.	**Score: 0** The Clash Burn is not assessed under WFD and is a heavily modified, culverted channel already. Therefore, there will be no impacts on water quality or hydromorphology in the Clash Burn. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on water quality or hydromorphology in the area. Overall, it is expected that **Option 1** will have no impact on water quality and hydromorphology in the area	**Score: 0** The Clash Burn is not assessed under WFD and is a heavily modified, culverted channel already. Therefore, there will be no impacts on water quality or hydromorphology in the Clash Burn. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Construction of a 0.6m average depth storage area at The Myre is unlikely to impact directly on water quality or hydromorphology in the area. Overall, it is expected that **Option 2** will have no impact on water quality and hydromorphology in the area	**Score: 0** The Clash Burn is not assessed under WFD and is a heavily modified, culverted channel already. Therefore, there will be no impacts on water quality or hydromorphology in the Clash Burn. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on water quality or hydromorphology in the area. There may be two construction phases required for **Option 3** as the culverts and storage area may need to be upgraded to account for climate change, so any construction phase impacts will likely occur again. Overall, it is expected that **Option 3** will have no impact on water quality and hydromorphology in the area	N/A	**Option 1, 2, 3 & 4** No direct impacts on water quality or hydromorphology are expected as a result of option implementation and it assumed that suitable mitigation measures during the construction phase will reduce indirect impacts. It is assumed that the Clash Burn is not an important water body in terms of its water quality and hydromorphological characteristics due to its small size and heavy modification.
	Cultural, Architectural & Archaeological Value	Flooding may impact the settings of a number of listed buildings in Kinross as well as Kinross Conservation Area	**Score: 0** There are a number of listed buildings in the vicinity of culvert upgrades / diversions. There may be a temporary, construction phase impact on the setting of these buildings. In the long-term culvert upgrades / diversions may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on the setting of any cultural heritage assets or the Kinross Conservation Area. Overall, it is expected that **Option 1** will have no impact on heritage	**Score: 0** There are a number of listed buildings in the vicinity of culvert upgrades / diversions. There may be a temporary, construction phase impact on the setting of these buildings. In the long-term culvert upgrades / diversions may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Construction of a 0.6m average depth storage area at The Myre is unlikely to impact directly on the setting of any cultural heritage assets or the Kinross Conservation Area. Construction of hard defences at Smith Street may have a short-term	**Score: 0** There are a number of listed buildings in the vicinity of culvert upgrades / diversions. There may be a temporary, construction phase impact on the setting of these buildings. In the long-term culvert upgrades / diversions may potentially reduce the impact of flooding to a number of listed buildings and the Kinross Conservation area. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on the setting of any cultural heritage assets or the Kinross Conservation Area. There may be two construction phases required for **Option 3** as the	N/A	**Option 1, 2, 3 & 4** It is expected that the long-term benefits of flood protection will offset the short-term impact to the settings of cultural, architectural, and archaeological assets. It is assumed that NFM measures that are proposed nearby scheduled monuments and listed buildings will be sympathetic to the settings of these assets.

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
			assets in the area as the flood protection offsets any short-term construction disruption	impact on heritage during construction, however, is unlikely to impact upon any heritage assets or the Kinross Conservation Area after construction is complete. Overall, it is expected that **Option 2** will have no impact on heritage assets in the area as the flood protection offsets any short-term construction disruption	culverts and storage area may need to be upgraded to account for climate change, so any construction phase impacts will likely occur again. Overall, it is expected that **Option 3** will have no impact on heritage assets in the area as the flood protection offsets any short-term construction disruption		
	Landscape & Amenity	There may be flooding to the Loch Leven Heritage Trail, temporarily restricting access for the public during times of flood.	**Score: -1** There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed culvert upgrades and diversions which may be impacted, however it is unlikely the construction would have a negative impact on this as work is below ground and the area will not be visually modified. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on any views or landscapes in the area. However, there may be a short-term construction phase impact on use of the playing fields for recreational activities. The change in ground level may make the area unsuitable for playing fields in the long term. However, this storage area will be dry most of the time so may still be used for other purposes. Overall, it is expected that **Option 1** will have a slightly negative impact on landscape and amenity due to short term construction impacts experienced at the Myre.	**Score: -1** There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed culvert upgrades and diversions which may be impacted, however it is unlikely the construction would have a negative impact on this as work is below ground and the area will not be visually modified. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. Construction of a 0.6m average depth storage area at The Myre is unlikely to impact directly on any views or landscapes in the area. However, there may be a short-term construction phase impact on use of the playing fields for recreational activities. The change in ground level may make the area unsuitable for playing fields in the long term. However, this storage area will be dry most of the time so may still be used for other purposes. Overall, it is expected that **Option 2** will have a slightly negative impact on landscape and amenity due to short term construction impacts experienced at the Myre.	**Score: -2** There is one Local Landscape Area (Loch Leven and Lomond Hills) at the downstream end of the proposed culvert upgrades and diversions which may be impacted, however it is unlikely the construction would have a negative impact on this as work is below ground and the area will not be visually modified. There may be short-term construction phase impacts to the Loch Leven Heritage Trail, temporarily restricting access for the public. Construction of a 0.4m average depth storage area at The Myre is unlikely to impact directly on any views or landscapes in the area. However, there may be a short-term construction phase impact on use of the playing fields for recreational activities. There may be two construction phases required for **Option 3** as the culverts and storage area may need to be upgraded to account for climate change, so any construction phase impacts will likely occur again. The change in ground level may make the area unsuitable for playing fields in the long term. However, this storage area will be dry most of the time so may still be used for other purposes. Overall, it is expected that **Option 3** will have a negative impact on landscape and access to amenity due to short term construction impacts experienced at the Myre across two construction phases.	N/A	**Option 1, 2, 3 & 4**
	ENVIRONMENTAL (*criteria score*)		-1	-1	-2	N/A	
Technical	Operational risk	Works have been undertaken in the Smith Street area in recent years, to clear a blockage in the culvert network.	**Score: 1** Some operational risk involved in maintenance of upgrades, including clearing debris from any screens	**Score: 1** Some operational risk involved in maintenance of upgrades, including clearing debris from any screens	**Score: 1** Some operational risk involved in maintenance of upgrades, including clearing debris from any screens	N/A	

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
			and ensuring culverts are free from sediment and any blockages.	and ensuring culverts are free from sediment and any blockages. The climate change option requires some pipes be upsized beyond that proposed in Option 1, and some additional sections are replaced. This will not have any significant impact beyond Option 1.	and ensuring culverts are free from sediment and any blockages. The climate change option requires some pipes be upsized further during a second construction phase, and some additional sections are replaced. This will not have any significant impact beyond Option 1.		
	Health and safety risks during construction, maintenance, and operation.		**Score: 1** Assuming the contractor sets out and adheres to suitable risk assessments and method statements in regard to mitigating any health and safety risks, then the degree of impact could be categorised as slightly positive. Refer to comments for all options.	**Score: 1** Assuming the contractor sets out and adheres to suitable risk assessments and method statements in regard to mitigating any health and safety risks, then the degree of impact could be categorised as slightly positive. Refer to comments for all options. It is not expected that the impacts will be significantly greater to protect against climate change uplifts.	**Score: 0** Assuming the contractor sets out and adheres to suitable risk assessments and method statements in regard to mitigating any health and safety risks, then the degree of impact could be categorised as slightly positive. Refer to comments for all options. It is not expected that the impacts from construction, maintenance and operation will be significantly greater to protect against climate change uplifts, although as a second construction phase would be required, this option has been scored as neutral.	N/A	**Option 1, 2, 3 & 4** All options involve working in proximity to various utilities, both above and below ground. Traffic management will need considered during the construction phase, as all options require culvert upgrades along roads.
	Adaptability to future flood risk and climate change		**Score: -2** No allowance for climate change and adaptation not considered adaptable. This will create a major interference with or impediment to potentially future measures.	**Score: 2** Climate change provision provided across full design life, based on climate change projections at the time of writing. As these projections are subject to change over time, this option is not adaptable to future river flow and rainfall projections changes.	**Score: -1** Adaptation is not possible in the future for many of the measures proposed for Flood Cell 2. As features such as pipe sizes cannot be upsized without full replacement, which would be required in the future. Due to the significant amount of utility clashes identified, a second construction phase in the future would be disruptive and expensive.	N/A	
	TECHNICAL (*criteria score*)		**0**	**4**	**0**	N/A	
	MCA OPTION SELECTION SCORE (*sum of all 4 criteria scores*)		7	15	8.3	N/A	
	MCA BENEFIT SCORE (*sum of scores for the economic, social & environmental criteria*)		7	11	8.3	N/A	
	COST (£Million)		£5,290,114	£5,712,195	£5,673,926	N/A	
	BENEFIT OF OPTION (£Million)		£2,425,347	£2,425,347	£2,425,347	N/A	
	MCA Benefit-Cost Ratio		1.32	1.93	1.46		
	ECONOMIC BCR		**0.46**	**0.42**	**0.43**	N/A	

Table A3: MCA Results (Flood Cell 3)

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
Social	Residential properties at risk	0 residential properties at risk	-	-	-	-	-
	High vulnerability properties at risk	0 high vulnerability properties at risk	-	-	-	-	-
	Social infrastructure and amenity at risk	0 social infrastructure and amenity at risk	-	-	-	-	-
	Local employment at risk	7 commercial properties at risk	**Score: 2** All properties at risk protected to 0.5% AEP fluvial event	**Score: 3** All properties at risk protected to 0.5% +CC AEP fluvial event	**Score: 2.5** All properties at risk protected to 0.5% AEP fluvial event initially, with possibility of adaptation in the future	**Score: 2.1** All properties at risk protected to 0.5% AEP fluvial event. Some resilience against climate change may be afforded through aspirational measures. Score accounts for significant uncertainties, regarding a lack of baseline hydrological data and the length of time NFM measures such as woodland areas take to provide benefits to flooding, ecological habitats, and carbon sequestration.	**Option 1, 2, 3 & 4** All options provide at a minimum 0.5% AEP fluvial protection to all properties at risk
	SOCIAL (*criteria score*)		2	3	2.5	2.1	
Economic	Economic risk	AAD = £14,868 Annual Average Damage (AAD) fluvial risk assessed up to 0.1% AEP fluvial event.	**Score: 2** Residual AAD = £4,023 Residual AAD is calculated up to the 0.1% AEP present day scenario.	**Score: 3** Residual AAD = £0 Residual AAD would be less than that calculated for the present day scenario, providing full 0.5% AEP climate change protection. Peak flow of Q200+CC is comparable to the Q1000 event.	**Score: 2.5** Residual AAD = <£4,023 Assuming the scheme would be adapted in the future this has the potential to reduce the residual AAD further.	**Score: 2.1** Residual AAD = <£4,023 The AAD may be reduced through the installation of aspirational measures. In addition to the uncertainty regarding what NFM measures may be implemented is the lack of confidence in the flow reduction that NFM measures provide over time. Score accounts for significant uncertainties, regarding a lack of baseline hydrological data and the length of time NFM measures such as woodland areas take to provide benefits to flooding, ecological habitats, and carbon sequestration.	**Option 1, 2, 3 & 4** Present value benefits associated with climate change not available. Uncertainty regarding what year climate change adaptation would be undertaken. Uncertainty over effectiveness of any proposed NFM measures and how the effectiveness would change over time.
	Risk to transport infrastructure	Approximately 3 roads at risk, including the M90 motorway	**Score: 2** Present day 0.5% fluvial protection provided to all roads at risk.	**Score: 3** Present day 0.5% fluvial protection provided to all roads at risk. Protection against climate change (approx. 180m additional section of M90 carriageway climate change risk)	**Score: 2.5** Present day 0.5% fluvial protection provided to all roads at risk. Additional road infrastructure may be afforded protection after adaptation in the future.	**Score: 2.1** Present day 0.5% fluvial protection provided to all roads at risk. Any effective NFM measures in the upper catchment may have a reduction in the overland flowpath identified, impacting Flood Cell 3. Some of the additional road infrastructure at climate change risk may be afforded some protection over time, but the confidence in this level of protection is low.	
	Risk to utility infrastructure	No utility infrastructure identified at risk in damage assessment for Flood Cell 3	-	-	-	-	-
	Risk to agriculture	Approximately 50/50 split of urban land use at services and agricultural improved grassland surrounding this area. Flood storage measure proposed in area of	**Score: -1** Storage area proposed in agricultural land. Expected to only store water during extreme events,	**Score: -1** Storage area proposed in agricultural land. Expected to only store water during extreme events,	**Score: -1** Storage area proposed in agricultural land. Expected to only store water during extreme events,	**Score: -2** Storage area proposed in agricultural land. Expected to only store water during extreme events,	**Option 1, 2, 3 & 4** Land take associated with footprint of storage embankment would

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
		agricultural improved grassland.	and on a temporary basis. Nevertheless, there would be a short term impact during the construction phase, as well as a permanent land-take across the footprint of the embankment.	and on a temporary basis. Climate change protection will increase the height of storage embankment and have a minor impact on the length of the storage area. This is unlikely to add significant impact beyond that identified in option 1.	and on a temporary basis. Adaptation of defences will require additional disruption to agricultural land during construction. This is balanced by the uncertainty of climate change, which could be reduced on the availability of flow monitoring data.	and on a temporary basis. There may be some impact to agricultural land through aspirational NFM measures, although there is high uncertainty surrounding this.	reduce the agricultural yield from this land. Significant portion of field to be flooded in extreme flood events, though temporary in nature
	ENVIRONMENTAL (*criteria score*)		**3**	**5**	**4**	**2.2**	
Environmental	Biodiversity, Flora, Fauna	**Score: 0** There is unlikely to be any major long term biodiversity loss. However, if flooding occurs, there may be short term impacts on terrestrial biodiversity.	**Score: 0** There is no direct or indirect impact on any designated sites as a result of construction of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to be an issue. Tree removal may also be required in order to construct the storage embankment, which may result in loss of biodiversity and result in loss of habitat for bat roosting. Overall, it is expected that **Option 1** will have no impact on biodiversity, flora and fauna in the area	**Score: 0** There is no direct or indirect impact on any designated sites as a result of construction of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to be an issue. Tree removal may also be required in order to construct the storage embankment, which may result in loss of biodiversity and result in loss of habitat for bat roosting. Overall, it is expected that **Option 2** will have no impact on biodiversity, flora and fauna in the area	**Score: -1** There is no direct or indirect impact on any designated sites as a result of construction of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to be an issue. Tree removal may also be required in order to construct the storage embankment, which may result in loss of biodiversity and result in loss of habitat for bat roosting. There may be two construction phases required for **Option 3** as the storage embankment may need to be extended to account for climate change, so any construction phase impacts will likely occur again. Overall, it is expected that **Option 3** will have a slightly negative impact on biodiversity, flora and fauna in the area.	**Score: 2** The proposed Glen Queich woodland creation would directly impact the Glen Queich SSSI. While this would provide new habitats and increase biodiversity, creating a continuous corridor down Glen Queich, it may also cause changes in vegetation succession in the area. (See Section 5 of NFM Report in Appendix G). As the SSSI is designated for non-montane rock habitats and lowland grassland habitats, this may encroach on these existing habitats. However, with appropriate planning this can be avoided. Woodland creation may also provide carbon sequestration (See Section 5 of NFM Report in Appendix G). There is uncertainty associated with the benefit woodland creation would provide over time. The installation of in-stream structures in Glen Queich and the restoration of the floodplain near Carnbo are unlikely to have any direct impact on the SSSI and may also create more varied river habitats for flora and fauna (See Section 5 of NFM Report in Appendix G). FLS forest management in the upper catchment may have a positive impact on designated sites within the South Queich catchment, providing additional habitats for wildlife and sequestering carbon from the environment (See Section 5 of NFM Report in Appendix G). There is no direct or indirect impact on any designated sites as a result of construction of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to be an issue.	**Option 1, 2, 3 & 4** No direct impacts on designated sites are expected as a result of option implementation and it assumed that suitable mitigation measures during the construction phase will reduce indirect impacts. It is assumed that trees that have 'moderate' bat roosting potential can be retained, or their removal will not have a major impact on bats in the area. It is assumed that NFM measures in the Queich upper catchment will have an overall benefit to biodiversity, flora and fauna and help offset negative impacts from construction of flood walls downstream. Further details can be found in the NFM Report in Appendix G.

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
						Tree removal may also be required in order to construct the storage embankment, which may result in loss of biodiversity and result in loss of habitat for bat roosting. Overall, it is expected that **Option 4** will have a positive impact on biodiversity, flora and fauna in the area due to creation of new and protection of existing habitats	
	Water Quality & Hydromorphology.	There is unlikely to be any improvements or reductions in water quality.	**Score: 0** There are no watercourses in the vicinity of the storage embankment that are assessed under the WFD. Therefore, there will be no impacts on water quality or hydromorphology resulting from construction or operation of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Overall, it is expected that **Option 1** will have no impact on water quality & hydromorphology as there are no WFD watercourses nearby to the proposed embankment.	**Score: 0** There are no watercourses in the vicinity of the storage embankment that are assessed under the WFD. Therefore, there will be no impacts on water quality or hydromorphology resulting from construction or operation of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Overall, it is expected that **Option 2** will have no impact on water quality & hydromorphology as there are no WFD watercourses nearby to the proposed embankment.	**Score: 0** There are no watercourses in the vicinity of the storage embankment that are assessed under the WFD. Therefore, there will be no impacts on water quality or hydromorphology resulting from construction or operation of the storage embankment. There is potential for short-term downstream sedimentation during the construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. There may be two construction phases required for **Option 3** as the storage embankment may need to be extended to account for climate change, so any construction phase impacts will likely occur again. Overall, it is expected that **Option 3** will have no impact on water quality & hydromorphology as there are no WFD watercourses nearby to the proposed embankment.	**Score: 1** It is likely that aspiration NFM measures in the Queich catchment could have a positive impact on water quality, especially stream structures (See Section 5 of NFM Report in Appendix G). Water quality for the South Queich is already 'High', however there may be additional benefits to the river, as well as Loch Leven and River Leven downstream, which are currently classified as 'Moderate' water quality. There are no watercourses in the vicinity of the storage embankment that are assessed under the WFD. Therefore, there will be no impacts on water quality or hydromorphology resulting from construction or operation of the storage embankment. There is potential for short-term downstream sedimentation during any construction phase, however with appropriate mitigation and construction methodology, this is unlikely to impact on Loch Leven. Overall, it is expected that water quality & hydromorphology could be impacted positively by **Option 4,** however due to the uncertainties surrounding whether measures could be implemented in the future, the option has been scored as having the potential to contribute towards improving water quality or water status.	**Option 1, 2, 3 & 4** No direct impacts on water quality or hydromorphology are expected as a result of option implementation and it assumed that suitable mitigation measures during the construction phase will reduce indirect impacts. It is assumed that the Ury Burn is not an important water body in terms of its water quality and hydromorphological characteristics due to its small size and heavy modification.
	Cultural, Architectural & Archaeological Value	Flooding may impact the setting of Turfhills House	**Score: 0** There is only one category B listed building (Turfhills House) nearby the proposed storage embankment, however this is unlikely to be directly impacted by construction and operation of the scheme. The storage embankment is being constructed along a field boundary and may encroach on some of the field. This field is located to the north of Turfhills category B listed	**Score: 0** There is only one category B listed building (Turfhills House) nearby the proposed storage embankment, however this is unlikely to be directly impacted by construction and operation of the scheme. The storage embankment is being constructed along a field boundary and may encroach on some of the field. This field is located to the north of Turfhills category B listed	**Score: 0** There is only one category B listed building (Turfhills House) nearby the proposed storage embankment, however this is unlikely to be directly impacted by construction and operation of the scheme. There may be two construction phases required for **Option 3** as the storage embankment may need to be extended to account for climate	**Score: 1** The category B listed Burnbrae Farmhouse, Dairy and Walled Garden is located approximately 1.5km downstream of proposed floodplain restoration works. It is unlikely that NFM measures will impact this building, however it is important to consider before work commences. A scheduled monument (Braughty, unenclosed settlement) of	It is assumed that fields that may be impacted by construction are not of any significant cultural value. It is assumed that the construction and operation of the storage embankment and storage area will not impact upon any nearby listed buildings. It is assumed that NFM measures that are proposed nearby scheduled monuments and listed

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
			building and may be culturally linked to this building. However, the field is not listed or designated. Overall, it is expected that **Option 1** will have no impact on heritage assets in the area as the flood protection offsets any short-term construction disruption	building and may be culturally linked to this building. However, the field is not listed or designated. Overall, it is expected that **Option 2** will have no impact on heritage assets in the area as the flood protection offsets any short-term construction disruption	change, so any construction phase impacts will likely occur again. The storage embankment is being constructed along a field boundary and may encroach on some of the field. This field is located to the north of Turfhills category B listed building and may be culturally linked to this building. However, the field is not listed or designated. Overall, it is expected that **Options 3** will have no impact on heritage assets in the area as the flood protection offsets any short-term construction disruption	prehistoric origin and national importance is located approximately 250m from proposed Glen Queich Woodland Creation. It is unlikely that NFM measures will impact this monument, however it is important to consider before work commences. There is only one category B listed building (Turfhills House) nearby the proposed storage embankment, however this is unlikely to be directly impacted by construction and operation of the scheme. The storage embankment is being constructed along a field boundary and may encroach on some of the field. This field is located to the north of Turfhills category B listed building and may be culturally linked to this building. However, the field is not listed or designated. Overall, it is expected that **Option 4** will have a slightly positive impact on heritage assets in the area as the flood protection offered by the scheme outweighs any short-term construction disruption	buildings will be sympathetic to the settings of these assets.
	Landscape & Amenity	There is unlikely to be any impacts on landscape and amenity in the area currently.	**Score: 0** There are no National Scenic Areas or Local Landscape Areas in the vicinity of the proposed storage embankment and the embankment will be constructed along a field boundary. The construction of the embankment will change the visual characteristics of surrounding farmland and may encroach on fields. However, there is no designations associated with any farmland in the area. Overall, **Option 1** is expected to have no impact on landscape and amenity in the area as no important landscapes or recreational areas will be affected	**Score: 0** There are no National Scenic Areas or Local Landscape Areas in the vicinity of the proposed storage embankment and the embankment will be constructed along a field boundary. The construction of the embankment will change the visual characteristics of surrounding farmland and may encroach on fields. However, there is no designations associated with any farmland in the area. Overall, **Option 2** is expected to have no impact on landscape and amenity in the area as no important landscapes or recreational areas will be affected	**Score: 0** There are no National Scenic Areas or Local Landscape Areas in the vicinity of the proposed storage embankment and the embankment will be constructed along a field boundary. The construction of the embankment will change the visual characteristics of surrounding farmland and may encroach on fields. However, there is no designations associated with any farmland in the area. There may be two construction phases required for **Option 3** as the storage embankment may need to be extended to account for climate change, so any construction phase impacts will likely occur again. Overall, **Option 3** is expected to have no impact on landscape and amenity in the area as no important landscapes or recreational areas will be affected	**Score: 1** Proposed NFM measures would have the potential to increase local landscape value and create amenity / recreational value for the public, especially through the aspirational creation of new woodland in Glen Queich. There are no National Scenic Areas or Local Landscape Areas in the vicinity of the proposed storage embankment and the embankment will be constructed along a field boundary. The construction of the embankment will change the visual characteristics of surrounding farmland and may encroach on fields. However, there is no designations associated with any farmland in the area. Overall, it is expected that **Option 4** could have a positive impact on landscape and amenity in the area as construction impacts will only be short term. It is possible that aspirational NFM measures could also increase recreational and amenity value of landscapes along the South Queich.	It is assumed that fields that may be impacted by construction are not important landscape or amenity features.
	ECONOMIC (*criteria score*)	**-1**	**0**	**0**	**-1**	**5**	

Criteria	Objective	Maintain Existing	MCA Score (Option 1)	MCA Score (Option 2)	MCA Score (Option 3)	MCA Score (Option 4)	Comment (All options)
Technical	Operational risk	No operational risks in this area, outside general agricultural practices.	**Score: 2** Some operational risk maintaining flood storage embankment, though this is expected to be acceptable, low risk. The embankment is expected to have a very low likelihood of failure if designed and constructed adequately.	**Score: 2** Some operational risk maintaining flood storage embankment, though this is expected to be acceptable, low risk. No additional operational risk is expected from providing the climate change level of protection.	**Score: 2** Some operational risk maintaining flood storage embankment, though this is expected to be acceptable, low risk. No additional operational risk is expected from adapting the storage embankment in the future to provide the climate change level of protection	**Score: 2** Some operational risk maintaining flood storage embankment, though this is expected to be acceptable, low risk. Operational risk within Flood Cell 3 is unlikely to be impacted by any aspirational NFM measures upstream. Maintenance of any proposed NFM measures is expected to be low and acceptable.	
	Health and safety risks during construction, maintenance, and operation		**Score: 2** The construction phase will involve the use of heavy machinery and some limited working near water. At this early stage it is assumed that the level of health and safety risk during construction, maintenance, and operation would be low, acceptable and manageable.	**Score: 2** The construction phase will involve the use of heavy machinery and some limited working near water. At this early stage it is assumed that the level of health and safety risk during construction, maintenance, and operation would be low, acceptable and manageable. It is not expected the higher wall heights will increase the health and safety risks significantly during any stage across the design life of the scheme.	**Score: 1.5** The construction phase will involve the use of heavy machinery and some limited working near water. At this early stage it is assumed that the level of health and safety risk during construction, maintenance, and operation would be low, acceptable and manageable. It is not expected the higher wall heights will increase the health and safety risks significantly during any stage across the design life of the scheme. This option has been scored lower than options 1 & 2 as there would be two construction phases required.	**Score: 2** The construction phase will involve the use of heavy machinery and some limited working near water. Aspirational NFM measures are unlikely to bring about risks beyond that expected for the construction and maintenance of the storage embankment, and if managed appropriately would be considered low risk.	
	Adaptability to future flood risk and climate change	Currently no flood risk measures in place.	**Score: -2** No allowance for climate change and adaptation not considered. Proposed measures would provide an impediment to future interventions to address new potential flood risk areas.	**Score: 2** Climate change provision provided across full design life, based on climate change projections at the time of writing. As these projections are subject to change over time, this option does not offer any flexibility for future river flow and rainfall projections changes.	**Score: 3** Adaptation would be incorporated into the design of the flood embankment. Making a strong economic case for adaptation measures in the future may prove difficult as majority of protection is provided by main scheme, however this would allow the timing of adaptation to incorporate findings the findings flow monitoring and the review of very latest climate change policies.	**Score: 1** NFM may offer some protection from, or resilience to, climate change uplifts due to attenuation provided in the upper catchment of the South Queich. Due to the uncertainties over what potential for NFM to be deployed, as well as the scale, timeframes and other uncertainties this has been scored lower than the structural options	
	TECHNICAL (*criteria score*)		**2**	**6**	**6.5**	**5**	
	MCA OPTION SELECTION SCORE (*sum of all 4 criteria scores*)		7	14	12	14.3	
	MCA BENEFIT SCORE (*sum of scores for the economic, social & environmental criteria*)		5	8	5.5	9.3	
	COST (£Million)		£423,240	£742,808	£529,014	*£423,240	
	BENEFIT OF OPTION (£Million)		£323,327	£443,270	£323,327	*£323,327	
	ECONOMIC BCR		**0.76**	**0.60**	**0.61**	***0.76**	

Appendix H

Cost Estimation

Scheme Description

Works Summary

A 0.5% AEP Standard of Protection is afforded to the majority of properties at risk within the study area. The study area is comprised of 3 Flood Cells:

Flood Cell 1
A combination of hard defences (walls and embankments) are proposed along the South Queich and Gelly Burn watercourses. A number of non-residential properties situated near the Loch Leven pier at Kinross are to be afforded property level protection, to reduce the impact of flooding from the Loch whilst maintaining access to the pier.

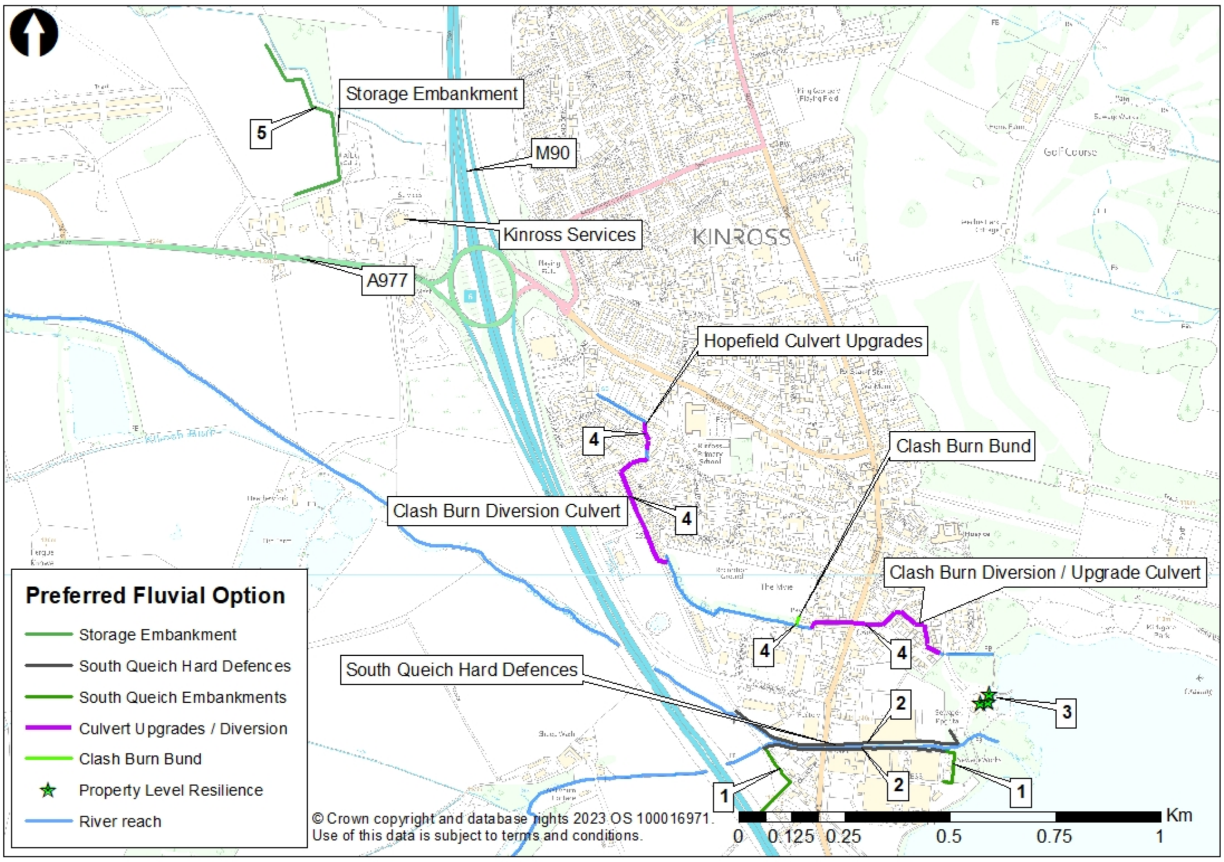
Flood Cell 2
On the Clash Burn a combination of culvert upgrades, culvert diversions, storage and manhole sealing are proposed, which will require reinstatement of the local road network post-construction.

Flood Cell 3
West of the M90 motorway, a storage embankment is proposed to intercept an overland flow path which affects commercial properties and the motorway.

List of Elements

Number	Description	Location
Element 1	Flood Earth Embankments	FC1 - South Queich
Element 2	Flood Walls	FC1 - South Queich
Element 3	Property Level Resilience	FC1 - Loch Leven
Element 4	Culvert Upgrades	FC2 - Clash Burn
Element 5	Flood Storage Embankment	FC3 - West of M90

Sketch of Option



Element 1 Construction Costs - Flood Earth Embankments

Works Description

Direct defences are proposed within Flood Cell 1 at South Queich / Gelly Burn. Embankments are proposed at the western and eastern ends of the direct defences on the southern bank of the South Queich watercourse. To the west, an embankment will be located between the M90 and Queich Place to utilise an existing floodplain zone and to block an existing flow path through to Queich Place and surrounding areas. To the east, an embankment will be placed near the woollen mill's Wastewater Treatment Plant, close to Loch Leven to prevent flooding in this area.

Quantities have been generated from Civils 3D AutoCAD software. Rates have been generated from previous jobs, SPONS 2023, quotes and EA unit rates, as indicated below.

Quantities

Defence

Embankment Location	Length (m)	Slope (1:X)	Crest Width (m)	Surface Area (m^2)	Cut Volume (m^3)	Fill Volume (m^3)	Length of Back Drainage (m)
Queich Place	221.86	3.00	3.00	2662.30	49.01	1013.76	440.63
WwTP	121.54	2.50	1.00	516.52	1.86	107.24	120.94

Utilities

Ref	Type	Action	Source	Total
100	SGN LP gas main	Re-position embankment and allow SGN to divert 445m of gas pipe to rear	Rate from prev job	£194,020
101	BT electric cable	No diversion required based on C3, Protection of plant	Quote	£2,839
102	SSE service cable	Protect cable at Old Cleish Road	Quote	£8,354
103	SSE 11kV electric cable	Abandon existing and lay new cable at Gelly Burn crossing	Quote	£42,814
104	SGN LP gas main	Cover by ref 100 diversion	Quote	£0
106	Scottish Water combined sewer	Protect combined sewer below embankment with suitable cover	SPONS 23	£530

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Vegetation removal	1.50	ha	£1,592.00	SPONS 2023	£2,388
2	Invasive species removal	0.15	ha	£4,387.93	SPONS 2023	£5,924
3	Tree removal	25.00	no.	£99.90	SPONS 2023	£2,498
4	Topsoil stripping & stockpile	392.72	m^3	£3.00	Previous Job	£1,178
5	Temporary site security fencing	300.00	m	£18.00	Previous Job	£5,400
6	Relocation of existing fence at WwTP	205.00	m	£19.70	SPONS 2023	£4,039
7	Temporary relocation of Gelly Burn footbridge for construction phase	25.18	m^3	£70.31	SPONS 2023	£1,770
14	Excavation - cutting for embankments	50.87	m^3	£8.10	SPONS 2023	£412
15	Disposal - cutting for embankments	36.16	m^3	£33.86	SPONS 2023	£1,225
16	Asbestos removal from southwest corner of proposed embankment location	134.51	m^3	£46.62	SPONS 2023	£6,271
17	Importing clay fill for embankments	333.67	m^3	£33.11	SPONS 2023	£11,048
18	Importing granular fill for embankments	787.33	m^3	£31.52	SPONS 2023	£24,817
19	Placing fill for embankments	1121.00	m^3	£8.50	Previous Job	£9,528
20	Allowance for encountering soft spots and replacement fill	5.09	m^3	£40.87	SPONS 2023	£208

	Description	Quantity	Unit	Rate	Source	Total
21	Placing of biodegradable geotextile layer	3178.82	m^2	£4.59	SPONS 2023	£14,591
22	Placing of topsoil for embankments (100mm layer)	317.88	m^3	£8.50	Previous Job	£2,702
23	Seeding of embankments	3178.82	m^2	£0.32	SPONS 2023	£1,003
24	Excavation, support and backfilling of 160mm back drainage pipework	561.58	m	£34.77	SPONS 2023	£19,526
25	150mm non-return flap valve	2.00	no.	£495.20	SPONS 2023	£990
26	150mm precast concrete headwall	2.00	no.	£570.00	EA Unit Rate	£1,140
27	Installation of new fence at Queich Place	376.00	m	£19.89	SPONS 2023	£7,479
28	Subbase Vehicle and pedestrian access ramp over defence at Queich Place	12.00	m^3	£52.33	SPONS 2023	£628
29	Base course Vehicle and pedestrian access ramp over defence at Queich Place	60.00	m^2	£37.59	SPONS 2023	£2,255
30	Binder course Vehicle and pedestrian access ramp over defence at Queich Place	60.00	m^2	£39.19	SPONS 2023	£2,351
28	Surface course Vehicle and pedestrian access ramp over defence at Queich	60.00	m^2	£26.35	SPONS 2023	£1,581
29	Locked gates	4.00	no.	£519.28	SPONS 2023	£2,077
30	Installation of new bridge for vehicle and pedestrian over Gelly Burn - Reinforced concrete bridge with precast beams	48.00	no.	£2,996.97	SPONS 2018	£143,855
31	Light duty Pedestrian Pavement 150mm thick Subbase permanent pedestrian access route at Queich Place	591.00	m^3	£7.00	SPONS 2023	£4,137
34	Installation of permanent pedestrian access route at Queich Place	591.00	m^2	£23.53	SPONS 2023	£13,906
35	Topsoil reinstatement at Queich Place	39.93	m^3	£8.92	SPONS 2023	£356
36	Regrading of ground levels and wildflower meadow planting at Queich Place	9500.00	m^2	£0.48	Quote	£4,560
37	Regrading of ground levels at Queich Place - assume 100mm acceptable material is disposed of in regrade	950.00	m^3	£2.29	SPONS 2023	£2,176
38	Re-planting of trees	40.00	no.	£212.38	SPONS 2023	£8,495
39	Installation of new fence at WwTP - Timber post and wire	111.00	m	£19.89	SPONS 2023	£2,208
41	Installation of new fence at WwTP - Timber post and wire	9.00	days	£200.00	Quote	£1,800
42	Relocation of WwTP storage area	35.00	m^3	£8.29	SPONS 2023	£290
43	Subbase Extension of WwTP road	24.00	m3	£52.33	SPONS 2023	£1,256
44	Base course Extension of WwTP road	120.00	m2	£37.59	SPONS 2023	£4,511
45	Binder course Extension of WwTP road	120.00	m2	£39.19	SPONS 2023	£4,703
46	Surface course Extension of WwTP road	120.00	m2	£26.35	SPONS 2023	£3,162
47	Topsoil reinstatement at WwTP	70.75	m^3	£8.92	SPONS 2023	£631
48	Removal of excess material	162.24	m^3	£25.64	Previous Job	£4,160
49	De-watering of excavations with submersible pump	20.00	days	£135.00	SPONS 2023	£2,700
					Total construction cost:	**£584,491**

Element 2 Construction Costs - Flood Walls

Works Description

A series of flood walls are proposed along the left and right banks of South Queich, from the Old Railway Bridge to the Loch Leven Heritage Trail footbridge. This will protect from river overtopping.

Quantities have been generated from Civils 3D AutoCAD software. Rates have been generated from previous jobs, SPONS 2023, quotes and EA unit rates, as indicated below.

Quantities

Wall	Length (m)	Clad Length (m)	Capping Beam Volume (m^3)	Average existing ground level (m)	Average crest level (m)	Average stem height (m)	Stem volume (m^3)	Length of Back Drainage (m)
LHB	557.00	344.797	557.00	109.62	110.56	0.98	219.01	609.52
RHB	426.00	426.00	426.00	109.24	110.57	1.39	236.86	427.35

Utilities

Ref	Type	Action	Source	Total
105	SSE 11kV	Cut and abandon Existing Cable. Lay Approx. 205m of new cable (Diversion). Cost covered in Ref 103	C3 Quote	£0
107	SW Combined Sewer	Protection	Rate from prev job	£0
108	SW Combined Sewer	Sewer to be re-laid with PE pipe	Rate from prev job	£28,000
109	SW Watermain	Temporary water main to be provided during construction, over or along bridge. Permanent diversion to be re	Rate from prev job	£6,711
110	SGN GAS LP	Protection	C3 Quote	£0
111	Open Reach	Protection	Rate from prev job	£2,839
112	SW Combined Sewer	375 VC to be abandoned. (Temp diversion)	Rate from prev job	£439
113	SSE LV Main	Protection	C3 Quote	£0
114	SSE 11kV	Protection	C3 Quote	£0

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Vegetation removal	0.65	ha	£1,592.00	SPONS 2023	£1,035
2	Invasive species removal	0.31	ha	£4,387.93	SPONS 2023	£6,716
3	Tree removal	15.00	no.	£99.90	SPONS 2023	£1,499
4	Topsoil stripping & stockpile	442.35	m^3	£3.00	Previous Job	£1,327
5	Temporary site security fencing	250.00	m	£18.00	Previous Job	£4,500
6	Demolition & removal of fences	250.00	m	£19.70	SPONS 2023	£4,925
7	Creation of temporary stoned haul road	200.00	m	£24.50	SPONS 2023	£4,900
8	Demolition of BCA building on LHS bank to facilitate construction & maintenance	5935.04	m^3	£8.29	SPONS 2023	£49,202
9	Demolition of derelict buildings on RHS bank to facilitate construction & maintenance	528.00	m^3	£8.29	SPONS 2023	£4,377
10	Temporary access along South Queich channel below bridge - assumes temp culverting providing access for plant	300.00	m	£176.61	Previous Job	£52,983
11	Installation of sheet-piled flood wall	983.00	m	£2,633.00	EA Unit Rate	£2,588,239

12	Excavation and removal of material for R.C capping beam and wall	983.00	m^3	£8.93	SPONS 2023	£8,778
13	Disposal of material for R.C capping beam and wall	983.00	m3	£10.00	Previous Job	£9,830
14	Construction, placement and removal of temporary formwork for capping beam and stem walls	4245.34	m^2	£69.82	SPONS 2023	£296,410
15	Construction of concrete capping beam	983.00	m^3	£142.66	SPONS 2023	£140,235
16	Construction of concrete stem wall	455.87	m^3	£142.66	SPONS 2023	£65,034
17	Steel reinforcement for capping beam and stem walls	359.72	T	£1,543.01	SPONS 2023	£555,047
18	Hydrophilic strip & sealant between existing bridge wall and flood wall	40.00	m	£31.72	Previous Job	£1,269
19	Strengthening works to existing road bridge at High Street	20.00	m	£5,040.00	Previous Job	£100,800
20	Cladding of flood walls	931.08	m^2	£300.00	Previous Job	£279,323
21	Copings to top of flood walls	983.00	m	£75.08	Previous Job	£73,804
22	Excavation, support and backfilling of 160mm back drainage pipework	1036.87	m	£34.77	SPONS 2023	£36,052
23	150mm non-return flap valve	10.00	no.	£495.20	SPONS 2023	£4,952
24	150mm precast concrete headwall	10.00	no.	£570.00	EA Unit Rate	£5,700
25	Excavation for pumping station	100.00	m^3	£8.93	SPONS 2023	£893
26	Disposal of pumping station excavated material	100.00	m3	£10.00	Previous Job	£1,000
27	Pumping station at LHS bank (5m X 5m X 2m tank)	1.00	no.	£60,000.00	Previous Job	£60,000
28	Vehicle access ramps over defence - compacted stone	46.20	m^3	£90.66	SPONS 2023	£4,188
29	Vehicle access ramps over defence - boulder clay	4.62	m^3	£52.12	SPONS 2023	£241
30	Maintenance access steps over defence	72.00	m^3	£123.66	SPONS 2023	£8,904
31	Handrail for access steps	80.00	m	£172.36	SPONS 2023	£13,789
32	Proposed fence	150.00	m	£19.89	Quote	£2,984
33	Locked gates	9.00	no.	£519.28	SPONS 2023	£4,674
34	In-channel scour protection - rip-rap	600.00	m^3	£80.40	Previous Job	£48,240
35	Removal of excess material	492.35	m^3	£25.64	Previous Job	£12,624
35	Dewatering / diversion using diesel pump	200.00	days	£135.00	SPONS 2023	£27,000
36	Install of 6 hydrostatic level sensors, staff gauges and telemetry (1 Pumping station, 1 us storage, 4 defences)	6.00	nr	£4,119.91	EA Unit Rate	£24,719
					Total construction cost:	**£4,544,178**

Element 3 Construction Costs - Property Level Resilience

Works Description

Property level resilience is proposed to provide resilience to 4no properties affected by high water levels in Loch Leven.

Rates have been generated from the Environment Agency's "Cost estimation for household flood resistance and resilience measures - summary of evidence" as indicated below.

Cost Breakdown

	Description	Quantity	Rate	Source	Total
PLP & Resilience Type: House with suspended floor and where flood level is greater than threshold level					
1	PVC flood door	2	£1,500	EA Unit Rate	£3,000
2	Non-return valve	5	£50	EA Unit Rate	£250
3	Toilet bung	1	£50	EA Unit Rate	£50
4	Waterproofing bricks	1	£500	EA Unit Rate	£500
5	Puddle pump	1	£500	EA Unit Rate	£500
6	Flood air bricks	5	£100	EA Unit Rate	£500
7	Re-plaster walls	1	£3,000	EA Unit Rate	£3,000
8	Solid flooring	1	£7,500	EA Unit Rate	£7,500
9	Raise electrics	1	£5,000	EA Unit Rate	£5,000
10	Replace fixed furniture	1	£10,000	EA Unit Rate	£10,000
				Total:	**£30,300**
PLP & Resilience Type: NRP (non-residential properties) with suspended floor and where flood level is greater than threshold level					
1	PVC flood door	2	£1,500	EA Unit Rate	£3,000
2	Non-return valve	5	£50	EA Unit Rate	£250
3	Toilet bung	2	£50	EA Unit Rate	£100
4	Waterproofing bricks	1	£1,000	EA Unit Rate	£1,000
5	Puddle pump	2	£500	EA Unit Rate	£1,000
6	Flood air bricks	5	£100	EA Unit Rate	£500
7	Raise electrics	1	£5,000	EA Unit Rate	£5,000
8	Replace fixed furniture	1	£10,000	EA Unit Rate	£10,000
				Total:	**£20,850**

Quantities

Number of residential properties at risk	0
Cost of PLP & PLR	£0
Number of NRP properties at risk	4
Cost of PLP & PLR	£83,400
Inflation - from 2021 to Mar 2023 uplift of 15.6%	1.1556
Total construction cost:	**£96,377**

Element 4 Construction Costs - Culvert Upgrades

Works Description

Flood Cell 2 proposed works include the following:

• Culvert upgrade at Hopefield Place to increase capacity.
• Sealing of 2 manholes at Montgomery Way.
• Diversion culvert for the Clash Burn immediately downstream of Hopefield Place at Bowton Road to divert flow away from the Clash Burn behind properties on Montgomery Way before re-joining the Clash Burn at Myre playing fields.
• Small bund at Myre playing fields as a resilience measure to direct surplus water away from properties on Smith Street and onto the playing fields.
• Diversion culvert downstream of Smith Street and High Street junction, routing through Sandport Road, along Nan Walker Wynd and back into the Clash Burn at Sandport Close.
• Reinstatement of roads, etc disturbed by the proposed works.

Quantities have been generated from Civils 3D AutoCAD software. Rates have been generated from previous jobs, quotes, SPONS 2023 and EA unit rates, as indicated below.

Quantities

Culverts

Location	Section Length (m)	Diameter (m)	Average Depth to Invert (m)	No. of Manholes	Manhole Diameter (m)	Manhole Depth to Invert (m)	No. of inlet / outlet structures
Hopefield Place	99.1	0.6	1.4	2	1.5	1.32	2
Clash Burn	329.173	0.9	1.8	9	1.8	1.5	2
Smith Street	404.448	1.05	1.8	12	1.8	2	2

Embankment

Embankment Location	Length (m)	Slope (1:X)	Crest Width (m)	Surface Area (m^2)	Cut Volume (m^3)	Fill Volume (m^3)	Length of Back Drainage (m)
Clash Burn	24.42	2.50	1.00	97.69	0.23	13.12	25.00

Utilities

Ref	Type	Action	Source	Total
115	SSE LV	LV cable clashing with crown of new culvert. Assume length assumed for diversion	Assumed from services quoted for	£6,266
116	SW Watermain	Culvert to be moved to south side of road and watermain diverted to north side to provide suitable clearance (Diversion)	Rate from prev job	£40,263
117	SW Combined Sewer	Culvert to be moved to south side of road and combined sewer to be diverted with 300 mm dia. PE pipe and new 1050 manhole (Diversion)	Rate from prev job	£100,000
117a	SW Combined Sewer	Sewer to be replaced with twin 225mm dia. Pipes.	C3 Quote	£50,000
118	Open Reach	Protection	C3 Quote	£2,839
118a	Open Reach	30m of new 46mm aerial cabling required (Diversion)	C3 Quote	£25,995
119	SSE LV	Protection	C3 Quote	£0
120	SGN GAS LP	Protection	C3 Quote	£0
121	SSE LV Main	Cut and abandon Existing Cable. Pot end existing cable where required	C3 Quote	£29,239
122	Street Lighting	Protection	Rate from prev job	£0
123	SGN GAS LP	Protection	C3 Quote	£0
124	SW Watermain	Watermain to be moved to north side of road, Culvert moved to south (Diversion)	Rate from prev job	£33,553
125	SW Foul	Foul sewer to be moved to north side of road, Culvert moved to south (Diversion)	Rate from prev job	£75,000
126	SW Foul	Culvert to be moved west and foul sewer diverted east. Crossing at end of Nan Walker Wynd but no conflict	Rate from prev job	£96,000
126a	SW Surface Water	Surface water pipe to be removed and connection made to new culvert. (Diversion)	Rate from prev job	£42,947
127	Open Reach	219m new ducting diverted from Sandport along Sandport Close to tie in with existing BT cabling	C3 Quote	£189,760
128	Indigo Gas	Move/ lower existing 165m X 90mm PE LP	C3 Quote	£19,229
129	SSE LV Main	Covered by diversion 121	C3 Quote	£50,124
130	SSE 11kV	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 45m of 3c 240mm XLPE HV Cable	C3 Quote	£9,398
131	SSE Service Cable	Abandon - Covered by diversion 121	C3 Quote	£0

Ref	Type	Action	Source	Total
131a	SW Watermain	Protection	Rate from prev job	£0
132	SW Watermain	15m of 90mm HPPE pipe to be diverted under proposed culvert (Diversion)	Rate from prev job	£6,711
133	SW Foul	Foul sewer already below new culvert. (Protection)	Rate from prev job	£0
134	Open Reach	Cable is above proposed culvert, no diversion anticipated. (Protection)	C3 Quote	£2,839
135	Indigo Gas	Divert/ install 165m X 90mm PE LP main with 3 X connections to existing 90mm PE LP mains.	C3 Quote	£3,920
136	SSE Service Cable	Covered in diversion 137	C3 Quote	£0
137	SSE LV Main	Cut and abandon Existing Cable. Pot end existing cable in close. Excavate, Lay and Blind approximately 100m of 3c 300mm XLPE LV Cable. Breech onto new	C3 Quote	£29,239
138	Street Lighting	Cable is above proposed culvert, no diversion anticipated. Protection	Rate from prev job	£1,044
139	SGN GAS MP	Protection	C3 Quote	£0
140	SW Foul	Divert Foul Sewer Manhole north of line of new culvert	Rate from prev job	£15,000
141	SW Foul	Divert Rising Main 1m away from new culvert	Rate from prev job	£78,000
142	SSE LV Main	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 130m of 3c 240mm XLPE HV	C3 Quote	£27,151
143	SSE 11kV	Cut and abandon Existing Cable. Excavate, Lay and Blind approximately 170m of 3c 240mm XLPE HV	C3 Quote	£35,505
144	Street Lighting	Cable is above proposed culvert, no diversion anticipated. Protection	Rate from prev job	£418
145	SGN GAS MP	Protection	C3 Quote	£0
146	SW Foul	Rising Main is be re-laid under culvert (Diversion)	Rate from prev job	£35,000
147	SW Watermain	Watermain is be re-laid under culvert (Diversion)	Rate from prev job	£15,500
148	SSE 11kV	Excavate, Lay and Blind approximately 160m of 3c 240mm XLPE HV Cable (Diversion)	C3 Quote	£33,416
149	SSE 11kV	Excavate, Lay and Blind approximately 60m of 3c 240mm XLPE HV Cable	C3 Quote	£12,531
150	SSE 11kV	Excavate, Lay and Blind approximately 240m of 3c 240mm XLPE HV Cable (Diversion)	C3 Quote	£50,124

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Vegetation removal	0.21	ha	£3,184.00	SPONS 2023	£677
2	Invasive species removal	0.00	ha	£4,387.93	SPONS 2023	£0
3	Tree removal	15.00	no.	£99.90	SPONS 2023	£1,499
4	Topsoil stripping & stockpile	407.25	m^3	£3.00	Previous Job	£1,222
5	Temporary site security fencing	450.00	m	£18.00	Previous Job	£8,100
6	Creation of temporary stoned haul road	100.00	m^3	£24.50	SPONS 2023	£2,450
7	Cold milling of roads and footpaths	350.00	m^3	£160.39	SPONS 2023	£56,137
8	Excavation - cutting for embankments	0.23	m^3	£40.50	SPONS 2023	£9
9	Disposal - cutting for embankments	0.23	m^3	£169.30	SPONS 2023	£39
10	Importing clay fill for embankments	9.19	m^3	£165.55	SPONS 2023	£1,521
11	Importing granular fill for embankments	3.94	m^3	£157.60	SPONS 2023	£620
12	Placing fill for embankments	13.12	m^3	£42.50	Previous Job	£558
13	Placing clay fill for Myre bund	9.19	m^3	£42.50	Previous Job	£390
14	Placing of biodegradable geotextile layer for Myre bund	97.69	m^2	£22.95	SPONS 2023	£2,242
15	Placing of topsoil for Myre bund (100mm layer)	9.77	m^3	£42.50	Previous Job	£415
16	Seeding of Myre bund	97.69	m^2	£1.58	SPONS 2023	£154
17	Excavation, support and backfilling of 160mm back drainage pipework	25.00	m	£34.77	SPONS 2023	£869
18	150mm non-return flap valve	1.00	no.	£495.20	SPONS 2023	£495
19	150mm precast concrete headwall	1.00	no.	£570.00	EA Unit Rate	£570
20	Sealing of manholes on Montgomery Way	2.00	no.	£2,590.44	SPONS 2023	£5,181
21	100mm reinforcement concrete layer above culverts	74.50	m^3	£140.03	SPONS 2023	£10,432
22	Trash screens at Myre	2.00	no.	£8,600.00	Previous Job	£17,200
23	Permanent access route at Junction Road	437.50	m^3	£28.75	SPONS 2023	£12,578
24	Locked gate	1.00	no.	£519.28	Prev Job	£519
25	600mm headwalls with screens at Hopefield Place	1.00	no.	£3,670.10	Previous Job	£3,670
26	Removal of existing 225mm culvert at Hopefield Place	99.10	m	£51.62	SPONS 2023	£5,116
27	Removal of existing 1200mm manholes at Hopefield Place	2.99	m^3	£1,277.88	SPONS 2023	£3,815

	Description	Quantity	Unit	Rate	Source	Total
28	Excavation, support and backfilling of 600mm culvert at Hopefield Place	99.10	m	£246.81	SPONS 2023	£24,459
29	Excavation, support, backfilling & disposal of Hopefield Place manholes	2.00	no.	£204.08	SPONS 2023	£408
30	Hopefield Place 1500mm manhole concrete base and surround	2.00	no.	£80.30	SPONS 2023	£161
31	Hopefield Place 1500mm manhole chamber rings	2.00	no.	£497.81	SPONS 2023	£996
32	Hopefield Place 1500mm manhole biscuit cover slab	2.00	no.	£277.86	SPONS 2023	£556
33	Hopefield Place 1500mm manhole surround	2.00	no.	£152.43	SPONS 2023	£305
34	Hopefield Place 1500mm manhole benching	2.00	no.	£292.96	SPONS 2023	£586
35	Hopefield Place 1500mm manhole step rungs	2.00	no.	£87.23	SPONS 2023	£174
36	Hopefield Place 1500mm manhole access cover and frame	2.00	no.	£307.89	SPONS 2023	£616
37	900mm headwall with screens at Clash Burn inlet	1.00	no.	£4,193.26	Previous Job	£4,193
38	1050mm headwall with screen at Smith Street inlet	1.00	no.	£4,892.13	Previous Job	£4,892
39	1050mm headwalls with screen at Smith Street	1.00	no.	£4,892.13	Previous Job	£4,892
40	Install of 4 hydrostatic level sensors, staff gauges and telemetry one at each headwall	4.00	no.	£4,119.91	EA Unit Rate	£16,480
41	Excavation, support and backfilling of new 900mm culvert at Clash Burn	329.17	m	£280.56	SPONS 2023	£92,353
42	Excavation, support and backfilling of new 1050mm culvert at Smith Street	404.45	m	£363.40	SPONS 2023	£146,976
43	Excavation, support, backfilling & disposal of Clash Burn & Smith Street manholes	21.00	no.	£299.37	SPONS 2023	£6,287
44	Clash Burn & Smith Street 1800mm manhole concrete base and surround	21.00	no.	£80.30	SPONS 2023	£1,686
45	Clash Burn & Smith Street 1800mm manhole chamber rings	21.00	no.	£633.75	SPONS 2023	£13,309
46	Clash Burn & Smith Street 1800mm manhole biscuit cover slab	21.00	no.	£277.86	SPONS 2023	£5,835
47	Clash Burn & Smith Street 1800mm manhole surround	21.00	no.	£202.64	SPONS 2023	£4,255
48	Clash Burn & Smith Street 1800mm manhole benching	21.00	no.	£292.96	SPONS 2023	£6,152
49	Clash Burn & Smith Street 1800mm manhole step rungs	21.00	no.	£130.85	SPONS 2023	£2,748
50	Clash Burn & Smith Street 1800mm manhole access cover and frame	21.00	no.	£307.89	SPONS 2023	£6,466
51	Allowance for encountering soft spots and replacement fill	218.91	m^3	£40.87	SPONS 2023	£8,947
52	Dewatering / diversion using diesel pump	200.00	days	£135.00	SPONS 2023	£27,000
53	Relocation of fences	685.00	m	£19.70	SPONS 2023	£13,495
54	250mm capping layer for culvert road reinstatement	550.00	m^3	£25.00	SPONS 2023	£13,750
55	350mm granular sub-base for culvert road reinstatement	770.00	m^3	£25.00	SPONS 2023	£19,250
56	120mm base course for culvert road reinstatement	264.00	m^3	£30.00	SPONS 2023	£7,920
57	50mm binder course for culvert road reinstatement	110.00	m^3	£35.00	SPONS 2023	£3,850
58	50mm surface course for culvert road reinstatement	110.00	m^3	£35.00	SPONS 2023	£3,850
59	150mm granular sub-base for carrier pipe footpath reinstatement	195.00	m^3	£25.00	SPONS 2023	£4,875
60	50mm binder course for carrier pipe footpath reinstatement	65.00	m^3	£35.00	SPONS 2023	£2,275
61	30mm surface course for carrier pipe footpath reinstatement	39.00	m^3	£35.00	SPONS 2023	£1,365
62	Raising of ground profile in grass areas	155.00	m^3	£8.92	SPONS 2023	£1,383
63	Replanting of trees	30.00	no.	£1,000.00	SPONS 2023	£30,000
64	Topsoil reinstatement	155.00	m^3	£8.92	SPONS 2023	£1,383
65	Seeding of grass areas	0.21	ha	£3,156.53	SPONS 2023	£671
					Total construction cost:	**£1,738,285**

Element 5 Construction Costs - Flood Storage Embankment

Works Description

In Flood Cell 3, an embankment would be constructed close to the M90 services to protect commercial properties. This would intercept an overland flow path that is shown to impact the M90, before travelling along the road and into South Kinross. A culvert with inlet and outlet headwall arrangement would convey flow from the storage area to the Ury Burn watercourse.

Quantities have been generated from Civils 3D AutoCAD software. Rates have been generated from previous jobs, quotes, SPONS 2023 and EA unit rates, as indicated below.

Quantities

Embankment Location	Length (m)	Slope (1:X)	Crest Width (m)	Surface Area (m^2)	Cut Volume (m^3)	Fill Volume (m^3)	Length of Back Drainage (m)
M90	526.13	3.00	1.00	6313.61	0.70	892.33	526.13

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Vegetation removal	3.60	ha	£230.00	SPONS 2023	£828
2	Invasive species removal	0.25	ha	£4,387.93	SPONS 2023	£5,551
3	Topsoil stripping & stockpile	1054.35	m^3	£3.00	Previous Job	£3,163
4	Temporary site security fencing	250.00	m	£18.00	Previous Job	£4,500
5	Excavation - cutting for embankments	0.70	m^3	£8.10	SPONS 2023	£1,000
6	Disposal - cutting for embankments	0.70	m^3	£33.86	SPONS 2023	£1,000
7	Importing clay fill for embankments	267.70	m^3	£33.11	SPONS 2023	£8,864
8	Importing granular fill for embankments	633.56	m^3	£31.52	SPONS 2023	£19,970
9	Placing fill for embankments	901.26	m^3	£8.50	Previous Job	£7,661
10	Allowance for encountering soft spots and replacement fill	0.07	m^3	£40.87	SPONS 2023	£1,000
11	Excavation, support and backfilling of 450mm storm culvert pipe	30.00	m	£96.60	SPONS 2023	£2,898
12	450mm non-return flap valve	1.00	no.	£1,130.20	SPONS 2023	£1,130
13	450mm precast concrete headwall	2.00	no.	£2,920.94	Previous Job	£5,842
14	Placing of biodegradable geotextile layer	6313.61	m^2	£4.59	SPONS 2023	£28,979
15	Placing of topsoil for embankments (100mm layer)	631.36	m^3	£8.50	Previous Job	£5,367
16	Seeding of embankments	6313.61	m^2	£0.32	SPONS 2023	£1,993
17	Excavation, support and backfilling of 160mm back drainage pipework	526.13	m	£34.77	SPONS 2023	£18,294
18	Maintenance access steps over embankment	15.00	m^3	£123.66	SPONS 2023	£1,855
19	Handrail for access steps	20.00	m	£172.36	SPONS 2023	£3,447
	Subbase Maintenance strip	437.50	m3	£52.33	SPONS 2023	£22,894
	Base course Maintenance strip	2187.50	m2	£37.59	SPONS 2023	£82,228
	Binder course Maintenance strip	2187.50	m2	£39.19	SPONS 2023	
	Surface course Maintenance strip	2187.50	m2	£26.35	SPONS 2023	
21	Locked gate	1.00	no.	£519.28	Prev Job	£519
22	Topsoil reinstatement	47.51	m^3	£8.92	SPONS 2023	£424
24	Removal of excess material	1006.84	m^3	£25.64	Previous Job	£25,815
26	De-watering of excavations with submersible pump	30.00	days	£135.00	SPONS 2023	£4,050
					Total construction cost:	**£259,271**

Enabling and Preliminary Costs

Preliminary costs include for work required before construction takes place. Examples include setting up site compound areas, surveys (structural, environmental, etc.), traffic management, provision of temporary access, watercourse management, etc. A percentage of the construction costs is assumed as previous schemes have shown a relationship between the size of scheme's construction costs and the preliminary costs, with a range of 10% - 30% being typical.

The percentage assumed has also been based on factors such as the remoteness of the works, if there are known environmental and technical restrictions, whether the site is situated within a heavily urbanised area, etc.

Enabling costs cover items required before the construction and preliminary works can take place. This includes items such as professional fees, design, consultation, modelling, licence / planning fees, etc. SEPA costing guidance recommends use of a percentage of the capital costs (construction & preliminary) isto estimate relationship the enabling costs. Based on recent experience of flood schemes in Scotland and information on early actions required to develop the project from outline stage specific big ticket items have been costed in the enabling cost calculation.

Preliminary Costs

Construction Costs	£7,222,602
Preliminary Cost Percentage	n/a
Preliminary Costs (£)	£2,663,645
Assumptions	Based on Balfour ECI cost estimate and comparison with other projects.

Enabling Costs

Enabling Costs (£)	£1,846,355
Assumptions	Items costed include: Ecology surveys General surveys - Precondition surveys, CCTV pre and post , Topo Survey, Drainage Survey, Ground Investigation, Council PM fees – Engineering admin, Consultants detailed design fees, Site supervision fees, Consultant, Project Management, Compensation Claims , Land Costs

Enabling Task	Estimate	Assumption in costing
Ecology surveys	£18,058	Assumed based on recent projects and likely preconstruction work required
General surveys - Precondition surveys, CCTV pre and post	£59,840	Assumed about 80 assets based on rough count, rate from recently completed scheme
Topo Survey	£10,000	Assumed based on recent projects
Drainage Survey	£15,000	Assumed based on recent projects
Ground Invesitgaition	£209,351	recent GI for simillar scheme around 135K, National Research Council recommends that a minimum of 3% of the project value should be dedicated to ground investigation.
Agency PM fees	£187,200	Agency PM for 2 years
Council Engineering Admin fees	£186,000	Council staff fees Senior Eng/Engineer/Technician
Consultants detailed design fees	£348,918	5% of project cost
Site supervision fees	£194,400	Based on Site manager/Site Supervisor/RPS graduate Engineer
Consultant Project Management	£66,312	
Misc	£5,000	
Licences	£10,000	
Compensation Claims	£40,000	Almondbank
Land Costs	£278,000	Refer to Land Cost breakdown
PKC legal fees	£10,000	
District Valuer and PKC Estate Fees	£50,000	
current outstanding consultants fees including publication	£158,276	
Estimated Enabling Costs	**£1,846,355**	

Operation and Maintenance

The various elements of the scheme will have associated operation and maintenance (O&M) costs. Costs are dependent on the responsible body (e.g., local authority, government body, private party), the complexity of the element (e.g., moving parts, high precision tolerances), and the robustness of the element (e.g., rate of degradation, risk of collapse).

Element 1 - Flood Earth Embankments	
Annual O&M cost	£2,504
Assumptions	Cost based on a rate of £2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control and back drainage improvements. 2 monthly grass cutting taking 4 hours a time at rate of £30 per hour. Annual cost of fiter drain maintenance £2.47 per m filter drain made up of £8.65 cost per m of removal every 5yrs and £0.67 per m monthly visits/litter clearance from Cambridge SuDS Maintenance Guidance
Telemetry	
Annual O&M cost	£5,172
Assumptions	Cost based on rate of £517 per monitor location for annual maintenance. Cost based on Blackwater Mallow Flood Forecasting System used in EA Flood Monitoring Cost Estimation Guidance. Converted from Eur to GBP and uplifted to 2023 rates for inflation
Element 2 - Flood Walls	
Annual O&M cost	£5,983
Assumptions	Cost based on a rate of £0.565/m/year. The O&M costs provide for inspection, vegetation clearance from the wall base, minor concrete repairs and wall repair works. Pumping Station will need inspection and maintenance in 6 monthly time frames. This is gernerally expected to be between 5-10% of the capital cost of the asset. Annual cost of fiter drain maintenance £2.47 per m filter drain made up of £8.65 cost per m of removal every 5yrs and £0.67 per m monthly visits/litter clearance from Cambridge SuDS Maintenance Guidance
Element 3 - Property Level Resilience	
Annual O&M cost	£0
Assumptions	Asset to be transferred to owner therefore not included in WLC for SG and PKC Funding
Element 4 - Culvert Upgrades	
Annual O&M cost	£21,640
Assumptions	CCTV - 5 yearly (£1,700), De-silting operation - every 10 years (36,000), annual general inspection (£2,100), monthly inspection (£300) and blockage clearance (£1,000). 100yr cost of 2,164,000 divided over 100yrs. Rates from EA Cost Estimation for Culverts
Element 5 - Flood Storage Embankment	
Annual O&M cost	£2,733
Assumptions	Cost based on a rate of £2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control and back drainage improvements. Annual cost of fiter drain maintenance £2.47 per m filter drain made up of £8.65 cost per m of removal every 5yrs and £0.67 per m monthly visits/litter clearance from Cambridge SuDS Maintenance Guidance
Total O&M Annual Costs	
O&M costs per year	**£38,032**

Whole Life Cost

Design Life

No.	Element	Design Life (years)
1	Flood Earth Embankments	100
2	Flood Walls	100
3	Property Level Resilience	35
4	Culvert Upgrades	100
5	Flood Storage Embankment	100

Financial Assumptions

Financial period	100 years
Discount rate	3.5% for year 0-30, 3% for year 31-75, 2.5% for year 76-99

Year	Discount factor	E&P	Construction	O&M	PV E&P	PV Construction	PV O&M
0	1.000	4,510,000			4,510,000	-	-
1	0.966		7,222,602		-	6,978,359	-
2	0.934			38,032	-	-	35,503
3	0.902			38,032	-	-	34,303
4	0.871			38,032	-	-	33,143
5	0.842			38,032	-	-	32,022
6	0.814			38,032	-	-	30,939
7	0.786			38,032	-	-	29,893
8	0.759			38,032	-	-	28,882
9	0.734			38,032	-	-	27,905
10	0.709			38,032	-	-	26,962
11	0.685			38,032	-	-	26,050
12	0.662			38,032	-	-	25,169
13	0.639			38,032	-	-	24,318
14	0.618			38,032	-	-	23,496
15	0.597			38,032	-	-	22,701
16	0.577			38,032	-	-	21,933
17	0.557			38,032	-	-	21,192
18	0.538			38,032	-	-	20,475
19	0.520			38,032	-	-	19,783
20	0.503			38,032	-	-	19,114
21	0.486			38,032	-	-	18,467
22	0.469			38,032	-	-	17,843
23	0.453			38,032	-	-	17,239
24	0.438			38,032	-	-	16,656
25	0.423			38,032	-	-	16,093
26	0.409			38,032	-	-	15,549
27	0.395			38,032	-	-	15,023
28	0.382			38,032	-	-	14,515
29	0.369			38,032	-	-	14,024
30	0.356			38,032	-	-	13,550
31	0.346			38,032	-	-	13,155
32	0.336			38,032	-	-	12,772
33	0.326			38,032	-	-	12,400
34	0.317			38,032	-	-	12,039
35	0.307			38,032	-	-	11,688
36	0.298	96,377		38,032	28,757	-	11,348
37	0.290			38,032	-	-	11,017
38	0.281			38,032	-	-	10,697
39	0.273			38,032	-	-	10,385
40	0.265			38,032	-	-	10,083
41	0.257			38,032	-	-	9,789
42	0.250			38,032	-	-	9,504
43	0.243			38,032	-	-	9,227

Year	Discount factor	E&P	Construction	O&M	PV E&P	PV Construction	PV O&M
44	0.236			38,032	-	-	8,958
45	0.229			38,032	-	-	8,697
46	0.222			38,032	-	-	8,444
47	0.216			38,032	-	-	8,198
48	0.209			38,032	-	-	7,959
49	0.203			38,032	-	-	7,727
50	0.197			38,032	-	-	7,502
51	0.192	60,000		38,032	11,491	-	7,284
52	0.186			38,032	-	-	7,072
53	0.181			38,032	-	-	6,866
54	0.175			38,032	-	-	6,666
55	0.170			38,032	-	-	6,472
56	0.165			38,032	-	-	6,283
57	0.160			38,032	-	-	6,100
58	0.156			38,032	-	-	5,922
59	0.151			38,032	-	-	5,750
60	0.147			38,032	-	-	5,582
61	0.143			38,032	-	-	5,420
62	0.138			38,032	-	-	5,262
63	0.134			38,032	-	-	5,109
64	0.130			38,032	-	-	4,960
65	0.127			38,032	-	-	4,815
66	0.123			38,032	-	-	4,675
67	0.119			38,032	-	-	4,539
68	0.116			38,032	-	-	4,407
69	0.112			38,032	-	-	4,278
70	0.109			38,032	-	-	4,154
71	0.106			38,032	-	-	4,033
72	0.103			38,032	-	-	3,915
73	0.100			38,032	-	-	3,801
74	0.097			38,032	-	-	3,691
75	0.094			38,032	-	-	3,583
76	0.092	96,377		38,032	8,859	-	3,496
77	0.090			38,032	-	-	3,411
78	0.087			38,032	-	-	3,327
79	0.085			38,032	-	-	3,246
80	0.083			38,032	-	-	3,167
81	0.081			38,032	-	-	3,090
82	0.079			38,032	-	-	3,014
83	0.077			38,032	-	-	2,941
84	0.075			38,032	-	-	2,869
85	0.074			38,032	-	-	2,799
86	0.072			38,032	-	-	2,731
87	0.070			38,032	-	-	2,664
88	0.068			38,032	-	-	2,599
89	0.067			38,032	-	-	2,536
90	0.065			38,032	-	-	2,474
91	0.063			38,032	-	-	2,414
92	0.062			38,032	-	-	2,355
93	0.060			38,032	-	-	2,297
94	0.059			38,032	-	-	2,241
95	0.057			38,032	-	-	2,187
96	0.056			38,032	-	-	2,133
97	0.055			38,032	-	-	2,081
98	0.053			38,032	-	-	2,031
99	0.052			38,032	-	-	1,981
				Totals:	**£4,559,106**	**£6,978,359**	**£1,059,058**

Optimism Bias

The starting (upper bound) Optimism Bias for scheme costs at the design stage is 60%. The Optimism Bias (OB) consists of risk components, with each contributing a pre-defined percentage of the overall OB factor. These risk components can be reduced for individual strategies or schemes if demonstrable action to minimise risks has been taken, or other evidence is provided that risks are not applicable to the degree indicated. For schemes with a high degree of risk or uncertainty, risk components can also be increased. In any case, the revised sum of risk components is divided by 100 and multiplied by 60 to obtain the new OB factor.

Risk Component		Definition	%	Adjustment Comment	%
Procurement	Late contractor involvement in design	Late involvement of the contractor in the design leads to redesign or problems during construction.	1	Adjusted as ECI has been brough forward from detailed to outline stage, reducing risks in construction.	0
	Dispute and claims occurred	Disputes and claims occur where no mechanisms exist to manage effectively adversarial relationships between project stakeholders.	11	Experienced client in efffective management in dealing with disputes through Flood Act. Potential to go to public enquiry but already been through process with Comrie.	6
	Other	Other factors that relate to procurement which affect the final project cost.	1	No adjustment.	1
Project-specific	Design complexity	The complexity of design (including requirements, specifications and detailed design) requires significant management, impacting on final project costs.	4	No adjustment. Issues with seepage until GI phase 2 complete. Proximity to existing buildings but BCA and T&D sites now to be demolished.	2
	Degree of innovation	The degree of innovation required due to the nature of the project requires unproven methods to be used.	4	Limited innovation as design elements are well established and proven to work based on previous schemes.	1
	Environmental impact	The project has a major impact on its adjacent area leading to objection from neighbours and the general public.	13	Reduced by over 50% due to limited environmental impact. But factoring in potential redo of envi surveys if timed out	10
	Other	Other project-specific factors which affect the final project cost.	9	ECI of outline design	5
Client-specific	Inadequacy of business case	The project scope changes as a result of the poor quality of requirement specifications and inadequate project scope definition.	23	Reduced due to Scoping exercise, re-optioneering and redefining Scope and independent check by Contractor on construction costs. CBR very low.	15
	Funding availability	Project delays or changes in scope occur as a result of the availability of funding (e.g. departmental budget spent or insufficient contingency funds).	2	No adjustment.	2
	Project management team	The project management team's capabilities and / or experience impact on final project costs.	1	Experience with Almondbank/Comrie and will appoitment qualified persons to site roles during construction	0.5

Risk Component		Definition	%	Adjustment Comment	%
	Poor project intelligence	The quality of initial project intelligence (e.g. preliminary site investigation, user requirements, surveys etc.) impacts on the occurrence of unforeseen problems and costs.	8	Reduced due to some intial GI available, detailled topo in most locations and slit trenching information. A few issues to resolve with a stakeholder and still to contact some landowners.	6
Environment	Public relations	A high level of effort is required to address public concern about the project, which impacts on the final project cost.	5	Public consulation complete and very positive feedback. It is thought only 2 landowners may object at publication	3
	Site characteristics	The characteristics of the proposed environment for the project are highly sensitive to the project's environmental impacts (e.g. greenfield site with badger setts, or contaminated brownfield site).	4	EIA complete and minimal impact anticipated but some surveys almost out of date	3
External influences	Economic	The project costs are sensitive to economic influences such as higher-than-expected construction cost inflation, oil price shocks, etc.	5	No adjustment.	5
	Legislation / regulations	The project costs are sensitive to legislation and regulation changes, e.g. health and safety and building regulations.	4	No adjustment.	4
	Technology	The project costs are sensitive to technological advancements, e.g. the effects of obsolescence.	4	No issues anticipated.	0
	Other	Other external influencing factors which affect the final project cost.	1	No adjustment.	1
Total:			100		64.5
Optimism Bias:		**Upper Bound**	60	**Adjusted**	38.7

Option Summary			
PV Enabling Costs		**£**	**1,846,355**
PV Preliminary Costs		**£**	**2,663,645**
PV Construction Costs		**£**	**6,978,359**
Element 1	£584,491		
Element 2	£4,544,178		
Element 3	£96,377		
Element 4	£1,738,285		
Element 5	£259,271		
PV Operation and Maintenance Costs		**£1,059,058**	
Contractor Profit Margin (assume 10%)		**£0**	
Optimism Bias		**£2,700,625**	
Total Cost		**£15,248,042**	