1 Inverurie & Port Elphinstone Flood Study

How is flood risk managed by the Aberdeenshire Council?

- The Flood Risk Management (Scotland) Act 2009 aims to prioritise flood mitigation across Scotland using a proactive and risk based process for assessing flood risk.
- This approach led to the preparation of SEPA's Flood Risk Management Strategies and the Local Flood Risk Management Plan for the North East Local Plan District developed by Aberdeenshire Council.

Study objectives

1. Develop a better understanding of flood risk in the community

- Create, update or develop a new flood model for flood mapping.
- Determine existing flood risk.

2. Engage partners and stakeholders

- Present the study to SEPA, Scottish Water and the Council.
- Present the study and the preferred option to the local community – the purpose of today's exhibition.

3. Develop recommendations for management of flood risk

- Appraise options to manage flood risk (consider the pros, cons and economic viability of the proposed options).
- Recommend options for the future management of flood risk.

4. Select a preferred approach that the Council can take forward

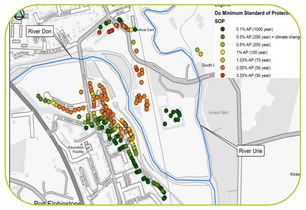
- SEPA (on behalf of Scottish Government) will prioritise nationally where funding should be allocated.
- The reports and findings of our study will inform this process. Preferred option from this report must be submitted by 31st Dec 2019.

What has been done so far?

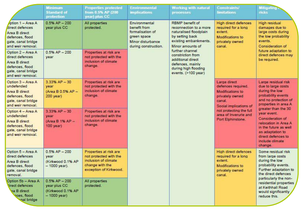
Flood review

River Surveys

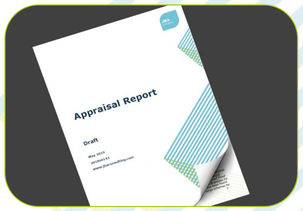
Modelling & mapping



Properties at risk and current standard of protection assessed



Options appraisal



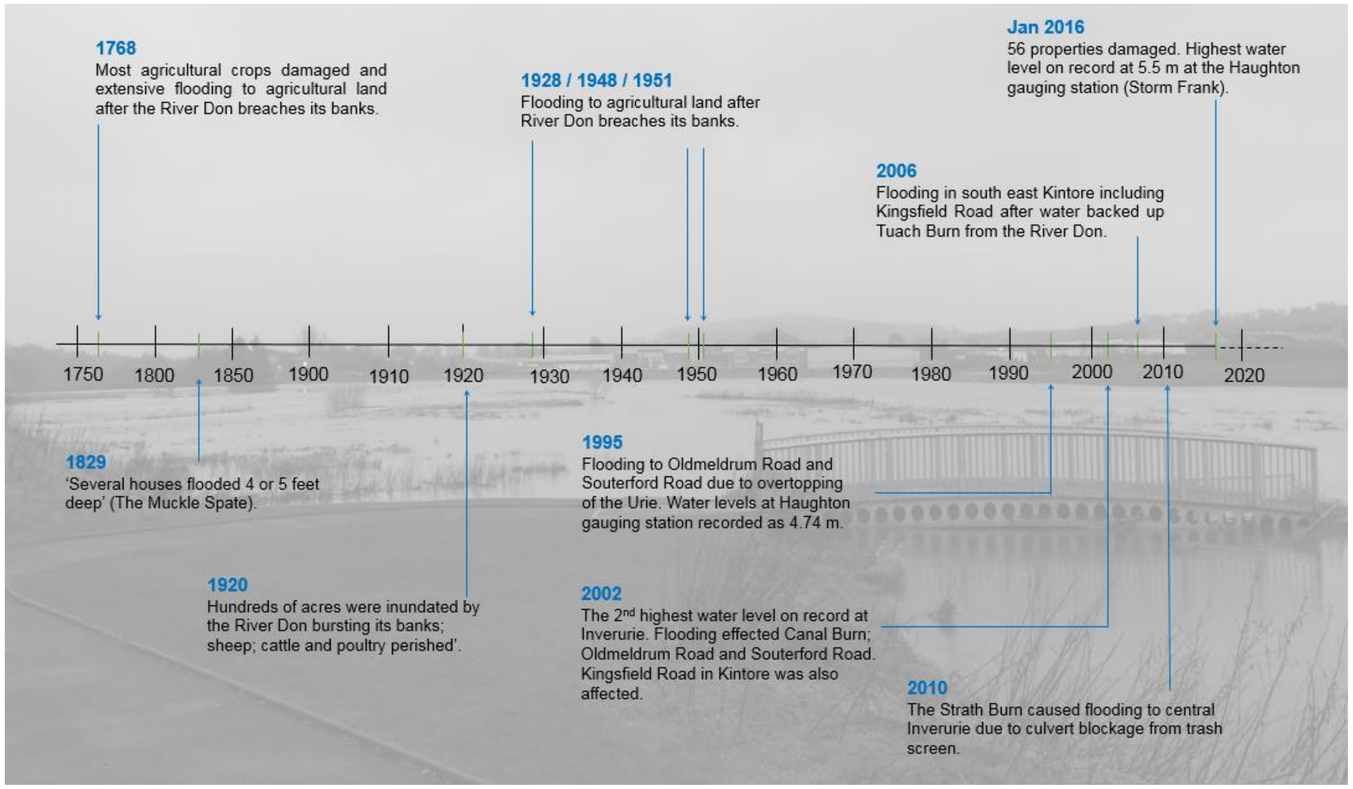
Reporting

What happens next?

Moving beyond this point is dependent on having government funding approved. At present there is no formal commitment by Scottish Government or Aberdeenshire Council for funding.

Public consultation (Today) → Council review flood study and decides strategy, Area Committee review → Schemes submitted to SEPA for prioritisation in national strategy by 31st Dec 2019 → More detailed design and consultation (e.g. site investigations) → Scheme construction

2 Flood History



- 2015/16 event estimated to be a 156 year event
- 200 year plus climate change estimated to be equivalent to a 406 year event

Return periods and annual probabilities

- When a river floods the severity of the flood is referred to as a '1 in *x* year' flood or as having a certain percentage chance of occurring in any one year.
- For example, a 1 in 200 year flood event is simply a flood of a size large enough that it has a probability of occurring once every 200 years, i.e. it has a 0.5% chance of occurring in any one year.
- Any given flood, such as the 1 in 200 year event, will not necessarily occur at all in a 200 year period, but a flood of this size could equally occur tomorrow and again next year - this is just statistically unlikely.

The goal

Protect against a 200 year plus climate change flood event. *Climate change is predicted to increase the scale of floods in Aberdeenshire by 24%.*

The long-list of options considered for appraisal to go to short list if deemed viable

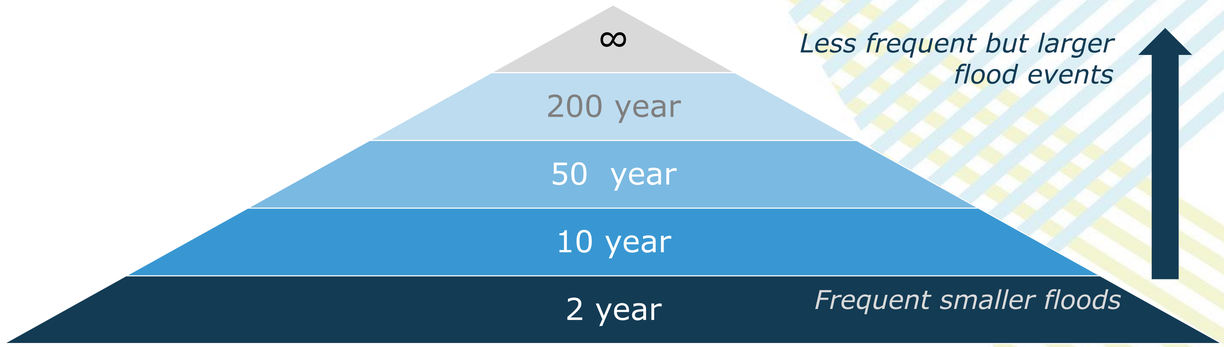
Engineering solutions:

- Storage (engineering)
- Conveyance (channel modification, diversion, realignment)
- Structure modification (enlarge culvert/bridge, trash screens)
- Control structures (weir, pumping station)
- Direct defences (wall, embankment, adaptable wall)
- Property Level Protection PLP (resistance and resilience measures)
- Sediment management (online/offline pond)

Non-structural options:

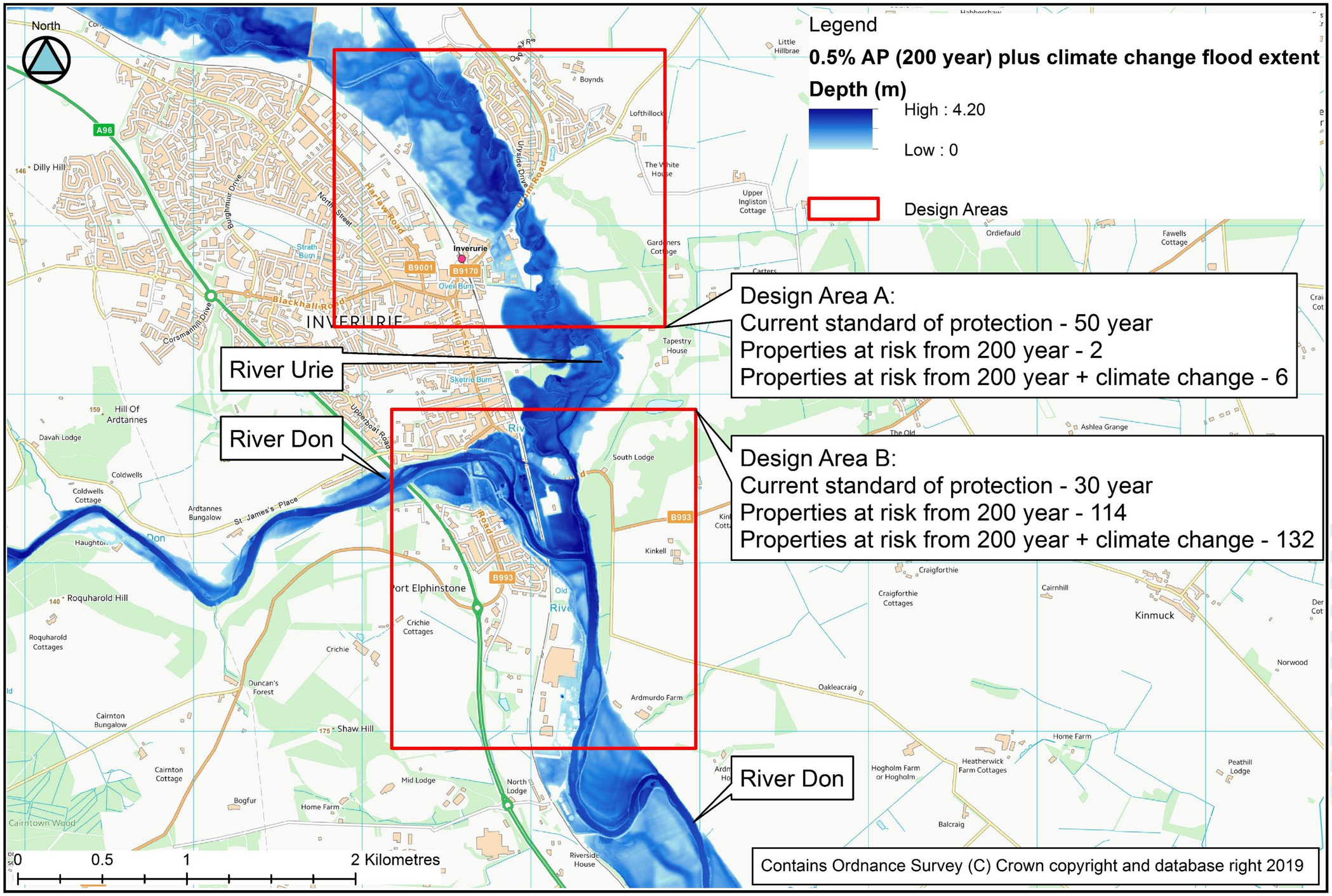
- Natural Flood Management NFM (runoff, sediment, floodplain)
- Watercourse maintenance
- Flood forecasting and warning
- Emergency planning & Local planning policies
- Self help

Non-structural options are expected to be carried forward alongside the engineering options.



Flood return periods

3 Watercourses & Design Areas



Inverurie and Port Elphinstone are at flood risk from the River Don and River Urie. Both watercourses have their own mechanism of flood risk and therefore to assess flood risk, two design areas have been identified.

The models produced flood maps which help us to work out where the greatest flood risk lies and how water flows out of the rivers and into properties.

These maps allowed us to plan where best to place flood defences or other solutions to reduce the flooding.

The following posters show the mitigation measures which have been considered within each design area. The best combination of options from each area is then presented and has been compared against social, environmental and economic benefits. This results in a preferred option, shown on poster 10.

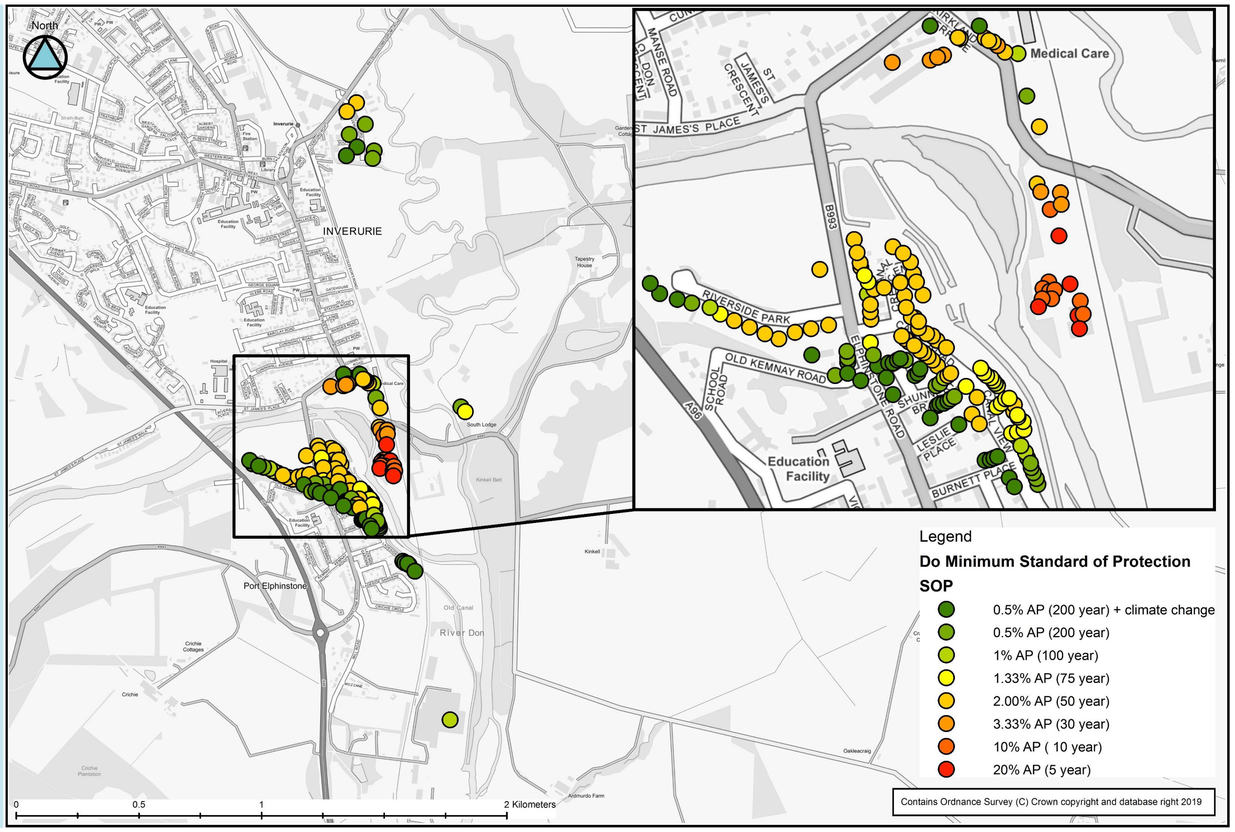
4 Coming up with the proposals

Aberdeenshire COUNCIL

Dougall Baillie Associates DBA civil. structural. transportation. water management

JBA consulting

Standard of Protection - 200 year plus climate change flood map



Prioritising the proposals

Option	Minimum Standard of protection	Properties protected from 0.5% AP (200 year) plus CC	Environmental implications	Working with natural processes	Constraints/ limitations	Mitigating residual risks	Improved public awareness	Best use of public money	Wider benefits
Option 1 – Area A direct defences Area B direct defences, flood gate, canal bridge and weir removal.	0.5% AP – 200 year plus CC	All properties protected.	Environmental benefit from formalisation of green space Minor disturbance during construction.	RBMP benefit of reconnection to a more naturalised floodplain by setting back existing embankments. Minor amounts of further channel constriction from additional direct defences, mainly during high flooding events. (>100 year)	High direct defences required for a long extent. Modifications to privately owned canal.	High residual damages due to large costs during the low probability events. Consideration of future adaptation to direct defences may be required.	Recommendations of continued work with action groups and the community. Ensure there is a good knowledge of the flood warning scheme that is already in place.	Not cost effective due to expense of defences and high residual risk, benefit cost ratio of 0.93.	Minimal impacts on community other than aesthetics from direct defences. Standard of protection against future increase in flows. Canal direct defences should be constructed so that reinstatement of the canal footpath results in a safer footpath with more difficult access to dangerous open water. Reconstruction of the existing embankments should result in a more robust defence where they have previously failed.
Option 2 – Area A direct defences Area B direct defences, flood gate, canal bridge and weir removal.	0.5% AP – 200 year	Properties at risk are not protected with the inclusion of climate change.						Not cost effective due to expense of defences and high residual risk, benefit cost ratio of 0.94.	
Option 3 – Area A undefended Area B direct defences, flood gate, canal bridge and weir removal.	3.33% AP – 30 year (Area B 0.5% AP – 200 year)	Properties at risk are not protected with the inclusion of climate change.			Large direct defences required. Modifications to privately owned canal. Social implications of not protecting the full area of Inverurie and Port Elphinstone.	Large residual risk due to large costs during the low probability events and no protection of properties in area A greater than the 30 year event. Consideration of relocation in Area A in the future as well as adaptation to direct defences to include climate change.		Benefit cost ratio of 1.05.	
Option 4 – Area A undefended Area B direct defences, flood gate, canal bridge and weir removal.	3.33% AP – 30 year (Area B 1% AP – 100 year)	Properties at risk are not protected with the inclusion of climate change.						Benefit cost ratio of 1.23.	
Option 5 – Area A direct defences Area B direct defences, flood gate, canal bridge removal.	0.5% AP – 200 year (Kirkwood 0.1% AP – 1000 year).	Properties at risk are not protected with the inclusion of climate change with the exception of Kirkwood.			High direct defences required for a long extent. Modifications to privately owned canal.	Some residual risk from large costs during the low probability events. Further adaptation to the direct defences particularly the non-residential properties at Keithhall Road would significantly reduce this.		Benefit cost ratio of 1.28.	
Option 5b – Area A direct defences Area B direct defences, flood gate, canal bridge removal.	0.5% AP – 200 year plus CC (Kirkwood 0.1% AP – 1000 year)	All properties protected.						Benefit cost ratio of 1.12.	
Option 6 – Area A direct defences Area B direct defences on existing alignment, flood gate, canal bridge removal. (SW WWTW unprotected)	0.5% AP – 200 year (Kirkwood 0.1% AP – 1000 year)	Properties at risk are not protected with the inclusion of climate change with the exception of Kirkwood.	No significant environmental benefit or impact from existing conditions.	RBMP impacts of channel constriction from direct defences on the banks.				Benefit cost ratio of 1.87.	
Option 6b – Area A direct defences Area B direct defences on offset alignment, flood gate, canal bridge removal. (SW WWTW unprotected)	0.5% AP – 200 year (Kirkwood 0.1% AP – 1000 year)	Properties at risk are not protected with the inclusion of climate change with the exception of Kirkwood.	Environmental benefit from formalisation of green space Minor disturbance during construction.	RBMP benefit of reconnection to a more naturalised floodplain by setting back existing embankments. Minor amounts of further channel constriction from additional direct defences, mainly during high flooding events. (>100 year)				Benefit cost ratio of 1.53.	

Negative | Neutral | Positive

The "standard of protection" map shows the maximum flood return period that each property is currently protected against. The properties shown would be expected to flood during larger floods. E.g. if a property is shown to have a Standard of Protection of 100 years, it would be expected to flood during a 200 year flood event.

The "prioritising the proposals" table summarises the pros and cons of each shortlisted option. The next few posters show these options in more detail.

Flood walls

Flood embankments (earth)

Typical examples of direct defences

Riparian buffer

Typical example of Natural Flood Management

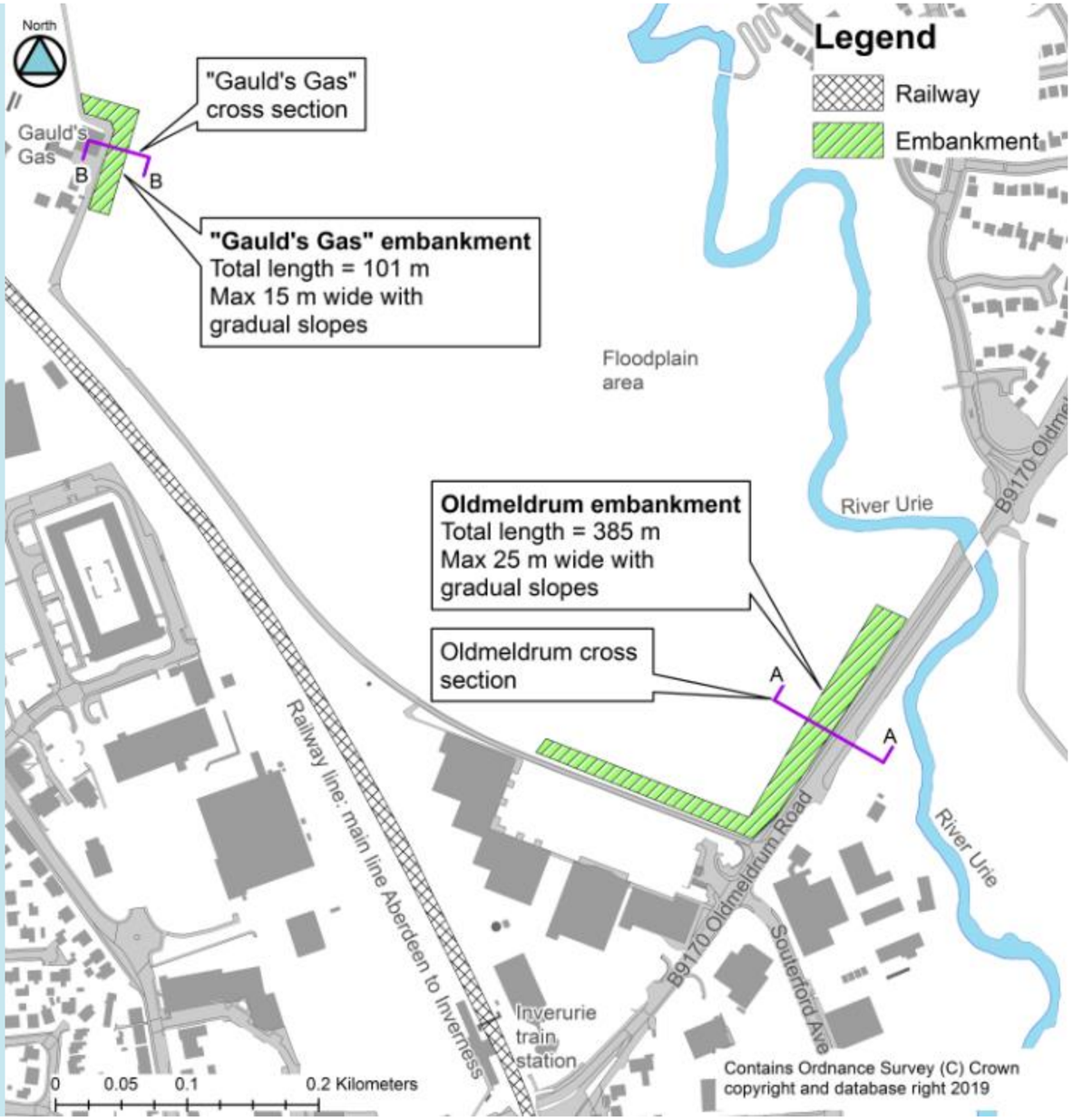
5 Oldmeldrum Road

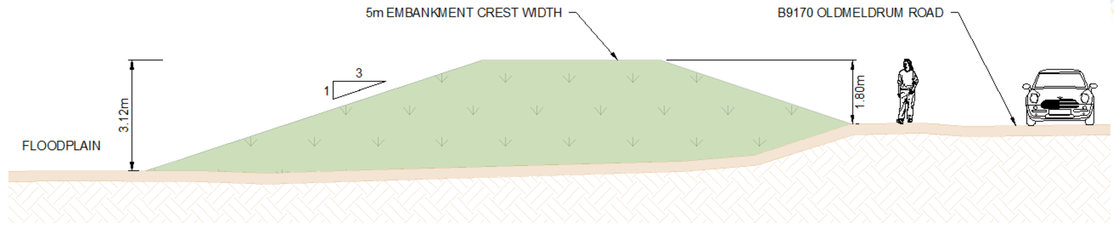
Area A (Oldmeldrum Road):

- Current standard of protection - **50 year**
- Properties at risk from the 200 year event - **2**
- Properties at risk from the 200 year plus climate change event - **6**

Flood risk from the River Urie

Area A – Oldmeldrum Road Options





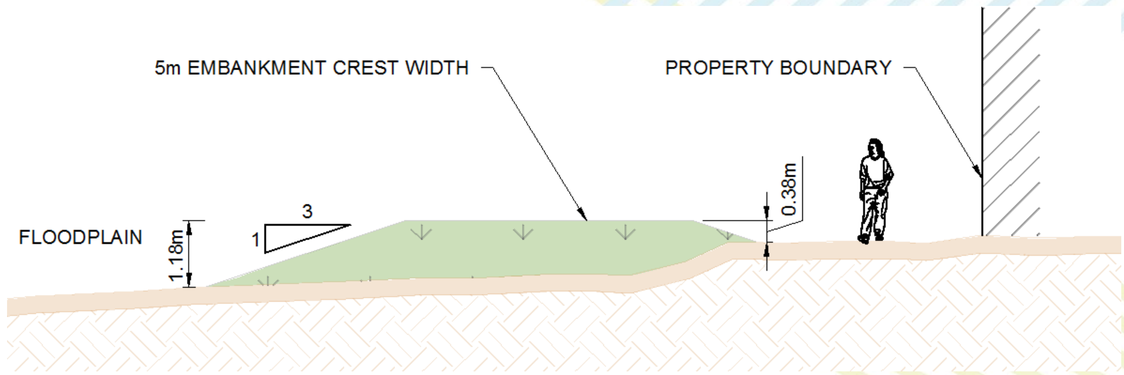
Section A-A: Oldmeldrum Road embankment cross section (sizing for 200 year plus climate change)

Sizing for 200 year plus climate change standard of protection:

- **Oldmeldrum Road embankment** –
  Maximum height from floodplain 3.76 m, maximum height from road 1.80 m
- **"Gauld's Gas" embankment** –
  Maximum height 1.43 m

Sizing for 200 year standard of protection:

- **Oldmeldrum Road embankment** –
  Maximum height from floodplain 3.38 m, maximum height from road 1.40 m
- **"Gauld's Gas" embankment** –
  Maximum height 1.43 m



Section B-B: "Gauld's Gas" embankment cross section (sizing for 200 year plus climate change)

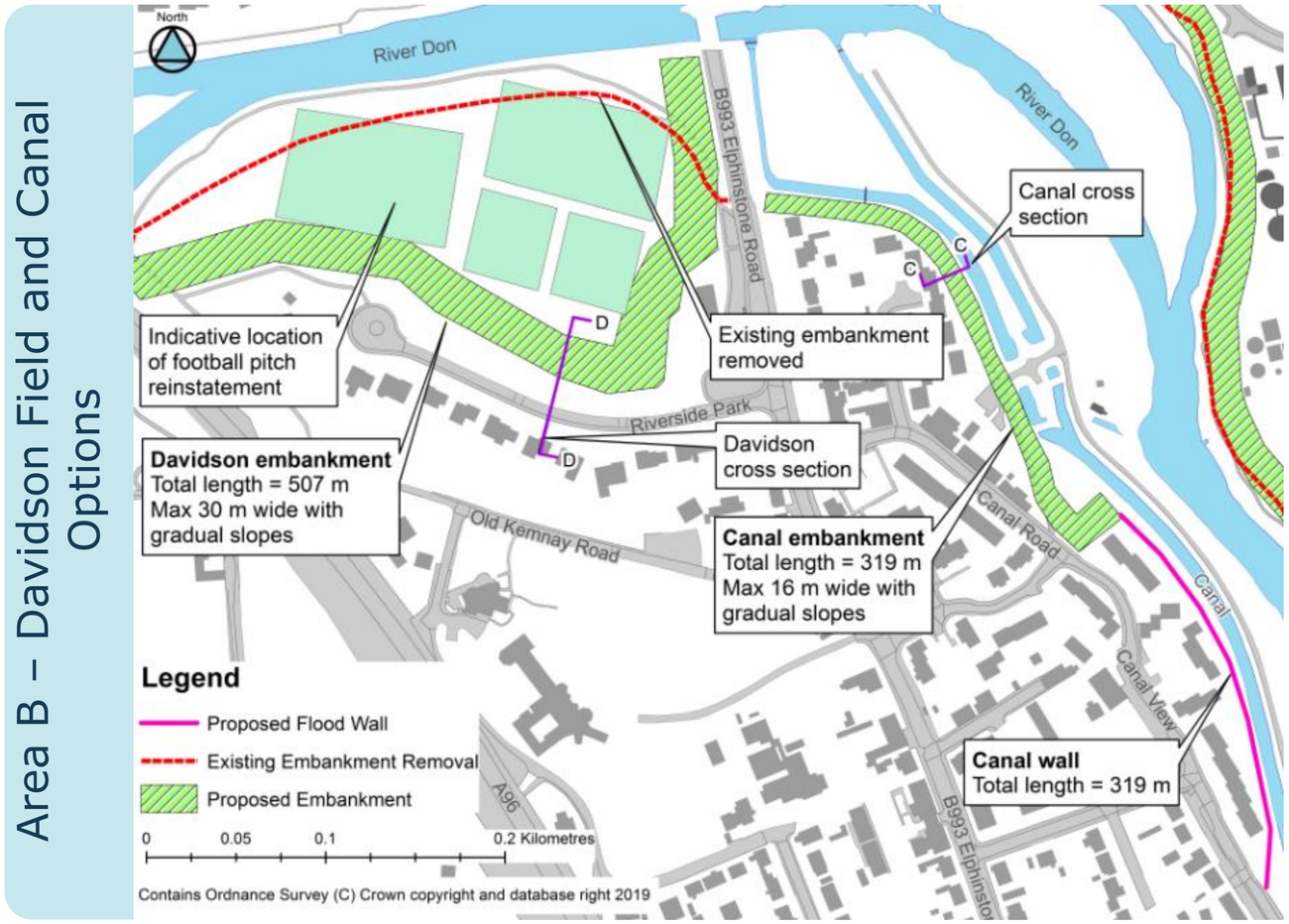
6 Port Elphinstone

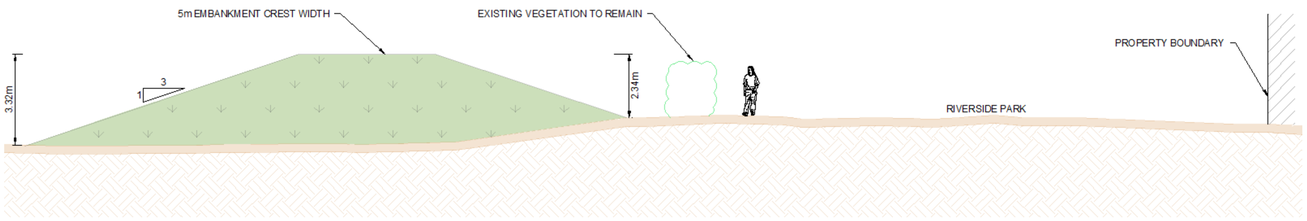
Area B (South Inverurie & Port Elphinstone):

- Current standard of protection - **30 year**
- Properties at risk from the 200 year event - **114**
- Properties at risk from the 200 year plus climate change event - **132**

Flood risk from the River Don & Old Canal

Area B – Davidson Field and Canal Options





Section D-D: Davidson Field embankment cross section (sizing for 200 year plus climate change)

Sizing for 200 year plus climate change standard of protection:*

- **Davidson Field embankment** – Maximum height from field 3.94 m, maximum height from Riverside Park 2.55 m
- **Canal embankment** – Maximum height 2.08 m
- **Canal wall** – Maximum height 2.05 m

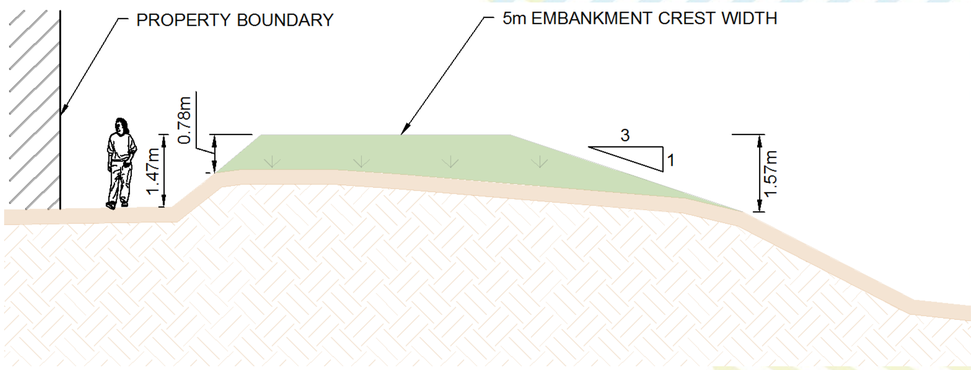
Sizing for 200 year standard of protection:*

- **Davidson Field embankment** – Maximum height from field 3.35 m, maximum height from Riverside Park 1.96 m
- **Canal embankment** – Maximum height 1.67 m
- **Canal wall** – Maximum height 1.64 m

Sizing for 100 year standard of protection:*

- **Davidson Field embankment** – Maximum height from field 2.35 m, maximum height from Riverside Park 0.96 m
- **Canal wall** – Maximum height 1.79 m (embankment not required, wall continues for 50 m further upstream than shown on drawing)

**Additional recommendation of drainage within Port Elphinstone to be reassessed with all proposed options*



Section C-C: Canal embankment cross section (sizing for 200 year plus climate change)

Aberdeenshire COUNCIL

7 Keithhall Road

Dougall Baillie Associates DBA civil. structural. transportation. water management

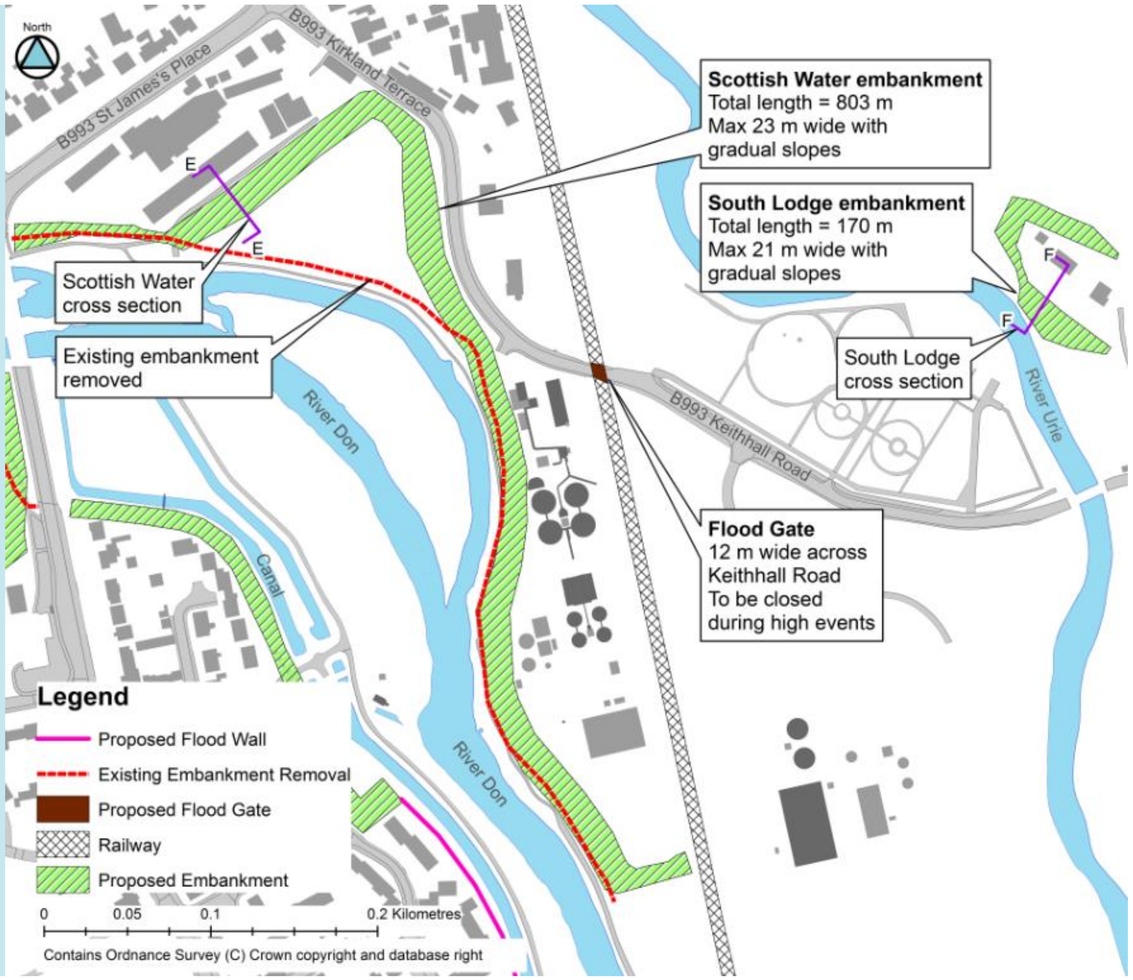
JBA consulting

Area B (South Inverurie & Port Elphinstone):

- Current standard of protection - **30 year**
- Properties at risk from the 200 year event - **114**
- Properties at risk from the 200 year plus climate change event - **132**

Flood risk from the River Don & River Urie

Area B – Keithhall Road Options



Sizing for 200 year plus climate change standard of protection :

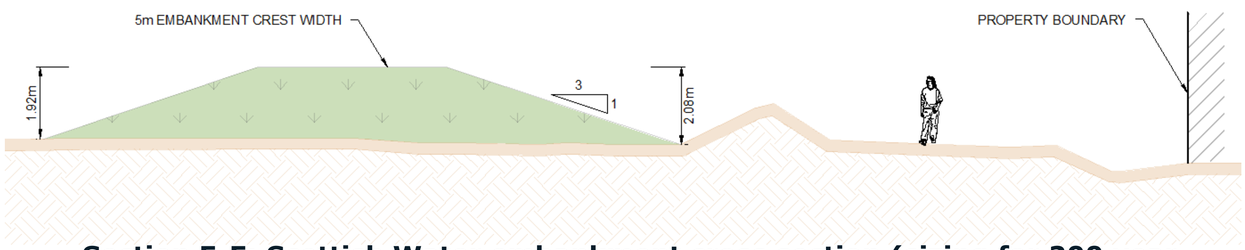
- **Scottish Water embankment** – Maximum height 3.24 m, average height 2.22 m
- **South Lodge embankment** – Maximum height 3.28 m, average height 1.71 m
- **Keithhall flood gate** – 1.80 m high

Sizing for 200 year standard of protection:

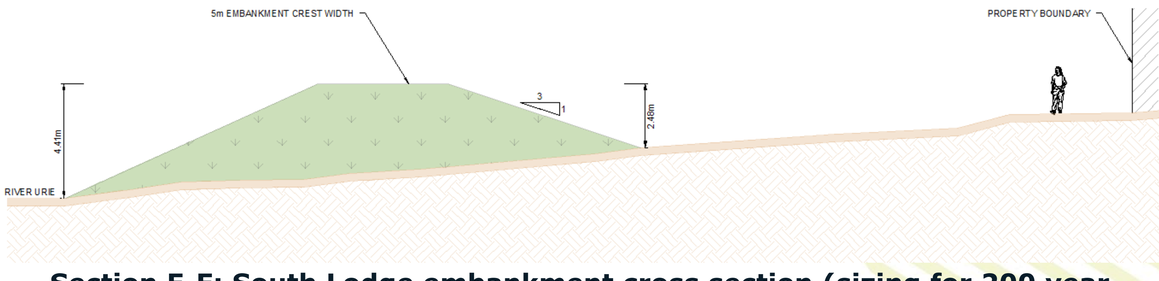
- **Scottish Water embankment** – Maximum height 2.85 m, average height 1.80 m
- **South Lodge embankment** – Maximum height 2.98 m, average height 1.66 m
- **Keithhall flood gate** – 1.80 m high

Sizing for 100 year standard of protection :

- **Scottish Water embankment** – Maximum height 2.00 m, average height 1.62 m
- **South Lodge embankment** – Maximum height 2.78 m, average height 1.44 m
- **Keithhall flood gate** – 1.20 m high



Section E-E: Scottish Water embankment cross section (sizing for 200 year plus climate change)



Section F-F: South Lodge embankment cross section (sizing for 200 year plus climate change)

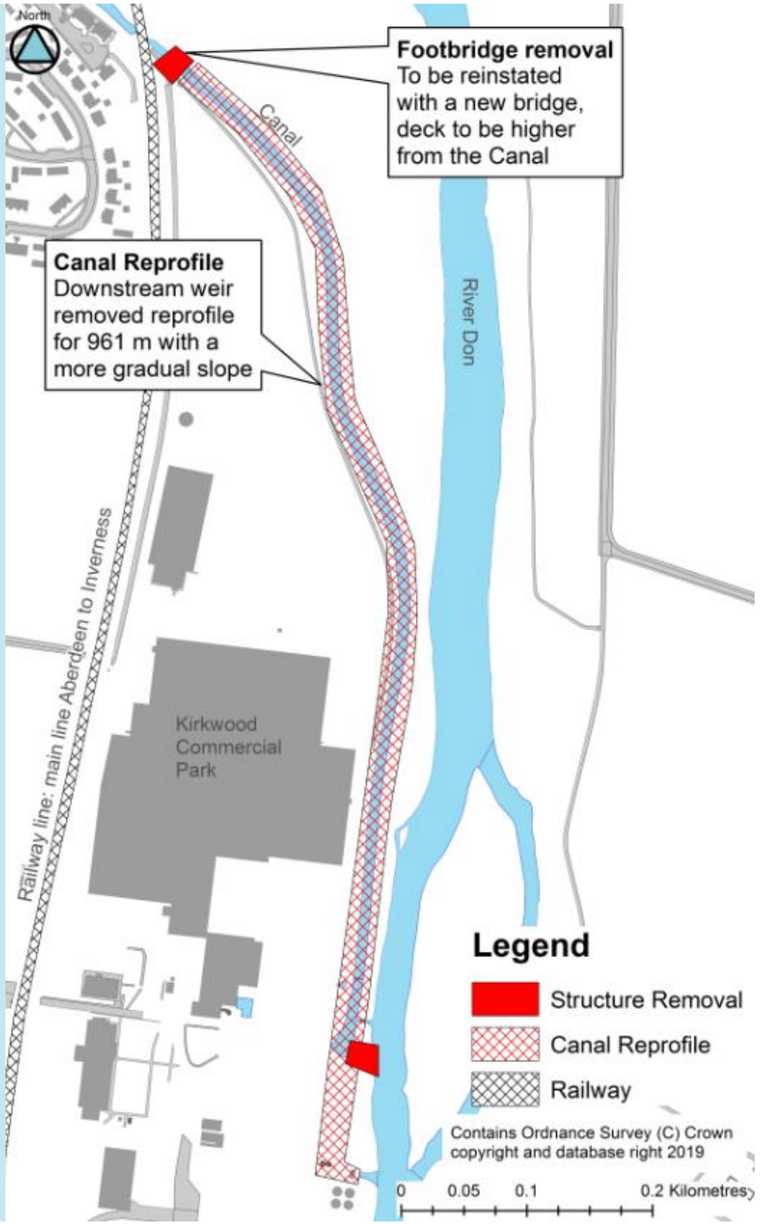
8 Old Canal

Area B (South Inverurie & Port Elphinstone):

- Current standard of protection - **30 year**
- Properties at risk from the 200 year event - **114**
- Properties at risk from the 200 year plus climate change event - **132**

Flood risk from the River Don & Old Canal

Area B – Old Canal Reprofile Option



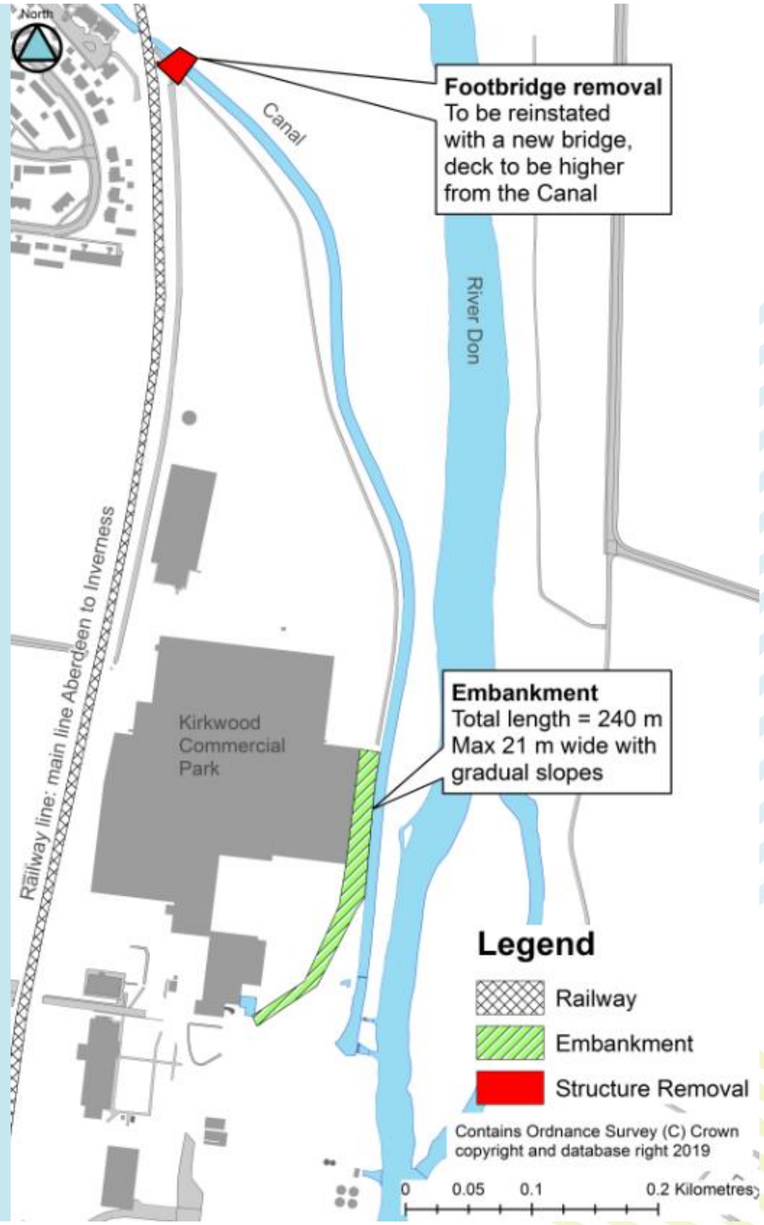
Old Canal reprofile option:

- **Reprofile** 961 m of Canal, new invert at channel level 10 m downstream of existing weir. Reprofile at a gradual constant gradient to the footbridge.
- Existing **footbridge removal**, **reinstatement of new footbridge** with higher bridge deck level to allow for more conveyance and maintain footpath access.
- Demolish existing weir.

Old Canal embankment option:

- Construction of **embankment**:
  - Total length = 240 m
  - Maximum height = 2.63 m
  - Average height = 1.80 m
- Existing **footbridge removal**, **reinstatement of new footbridge** with higher bridge deck level to allow for more conveyance and maintain footpath access.

Area B – Old Canal Embankment Option



9 Option Combinations

Area A – Oldmeldrum Road **Area B – South Inverurie & Port Elphinstone**

Option 1

Area A – Embankments protecting 200 year plus climate change

Area B – Embankments protecting 200 year plus climate change. Canal reprofiling and structure removal

Damages avoided = £10,956,000

Cost = £11,836,000

BCR = 0.9

Option 2

Area A – Embankments protecting 200 year

Area B – Embankments protecting 200 year. Canal reprofiling and structure removal

Damages avoided = £9,359,000

Cost = £9,984,000

BCR = 0.9

Option 3

Area A – Undefended

Area B – Embankments protecting 200 year plus climate change. Canal reprofiling and structure removal

Damages avoided = £9,318,000

Cost = £8,843,000

BCR = 1.1

Preferred option

Option 5b

Area A – Embankments protecting 200 year plus climate change

Area B – Embankments protecting 200 year plus climate change. Bridge removal and Canal embankment to the 1000 year

Option 5b damages avoided = £12,724,000

Option 5b cost = £11,332,000

BCR = 1.1

Option 4

Area A – Undefended

Area B – Embankments protecting 100 year. Canal reprofiling and structure removal

Option 4 damages avoided = £9,318,000

Option 4 cost = £7,656,000

BCR = 1.2

Option 5

Area A – Embankments protecting 200 year

Area B – Embankments protecting 200 year. Bridge removal and Old Canal embankment to the 1000 year

Option 5 damages avoided = £12,112,000

Option 5 cost = £9,465,000

BCR = 1.3

Future option*

Option 6

Area A – Embankments protecting 200 year

Area B – Embankments protecting 200 year clipped to Keithhall Road rail bridge. Bridge removal and Old Canal embankment to the 1000 year. Further assumptions listed below

Option 6 damages avoided = £12,188,000

Option 6 cost = £6,503,000

BCR = 1.9

Future option*

Option 6b

Area A – Embankments protecting 200 year

Area B – Embankments protecting 200 year on existing alignments for the Scottish Water and Davidson defences. Bridge removal and Old Canal embankment to the 1000 year. Further assumptions listed below

Option 6b damages avoided = £12,188,000

Option 6b cost = £7,985,000

BCR = 1.5

How the options have been assessed

Damages to all properties over 100 years ÷ Full cost of the scheme = Benefit Cost Ratio (BCR)

Each option has been assessed economically where if the damages over 100 years exceeds the cost of the scheme it is deemed to be economically viable (BCR > 1).

Economical benefit (options with a BCR > 1) is the main driver though sustainability and environmental benefit has also been strongly considered when evaluating options.

*Future option assessed if other options are not deemed feasible by the Scottish Government. Assumptions of over the next 100 years if the western waste water treatment works is demolished this site could be allowed to flood, dramatically reducing the required embankment length. Further assumption of soil reuse from the existing embankments made.

10 Preferred Option

Option 5b
Area A – Embankments protecting 200 year plus climate change

Area B – Embankments protecting 200 year plus climate change. Bridge removal and Canal embankment to the 1000 year

Why is this the preferred option?

- *Option is economically viable with a benefit cost ratio of 1.1.*
- *Option achieves a full standard of protection of 200 year with the inclusion of climate change.*
- *Option is sustainable with the inclusion of offsetting the existing embankments to allow for a more natural floodplain*

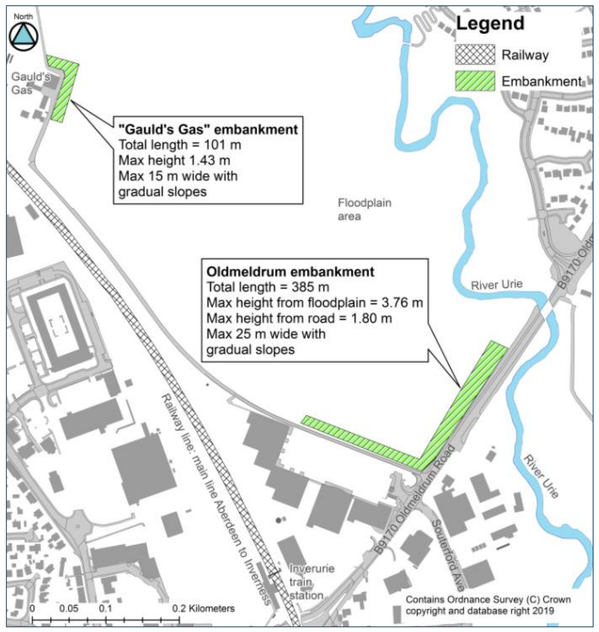
Additional Option for Consideration

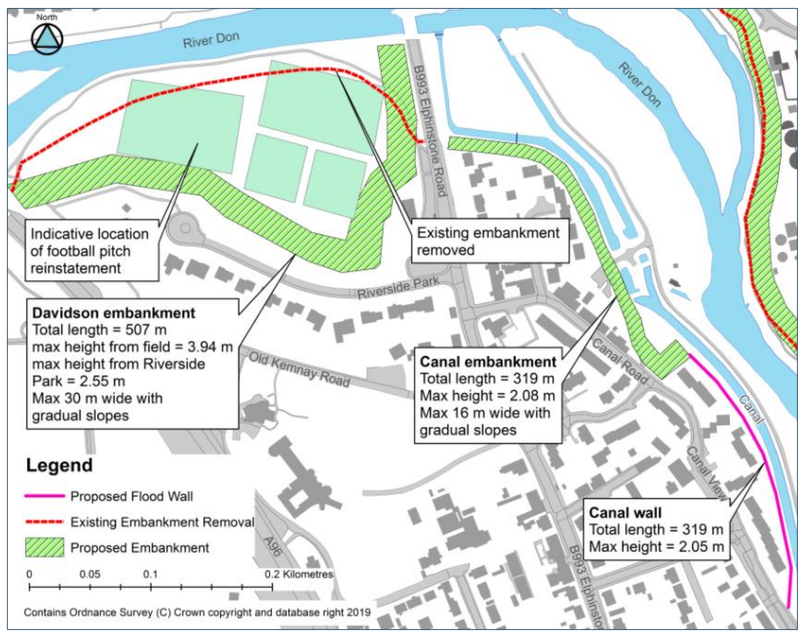
There is no formal commitment for Scottish Government funding. Should a scheme achieve funding and hence move forward to detailed design Option 5 would also be considered further due to the following:

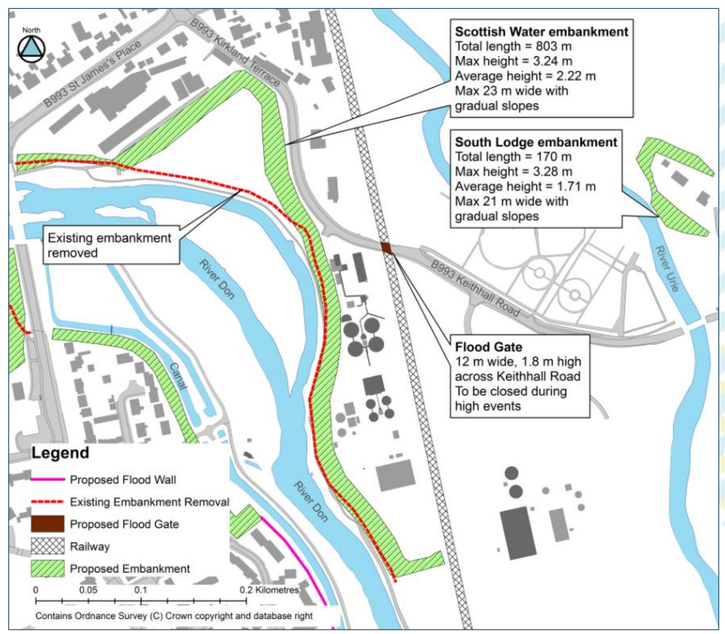
- Option 5 – more economically viable though less sustainable as it does not protect all areas against climate change

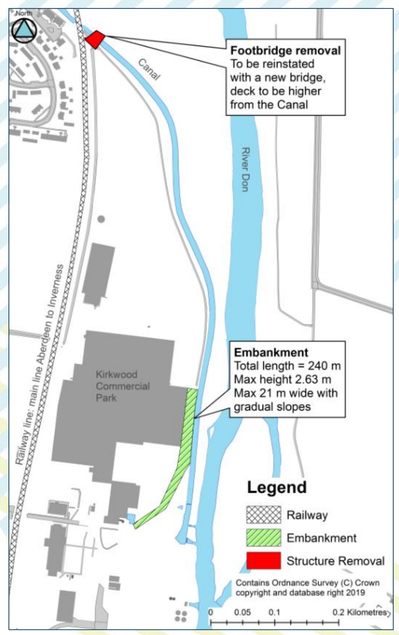
Option 5
Area A – Embankments protecting 200 year
Area B – Embankments protecting 200 year. Bridge removal and Old Canal embankment to the 1000 year

BCR = 1.3









Further information please visit the study website: www.inverurieflоodstudy.com