



Stranraer Flood Protection Scheme: A case Study



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Introduction

- Stranraer is located in South West Scotland, in the Dumfries and Galloway Council
- Population of around 13,000
- Ferry port connection
- Historical flooding issues
- October 2000 event
- Scottish Water and Council competences
- Drainage Area Plan



October 2000 flooding around the Sheuchan Burn

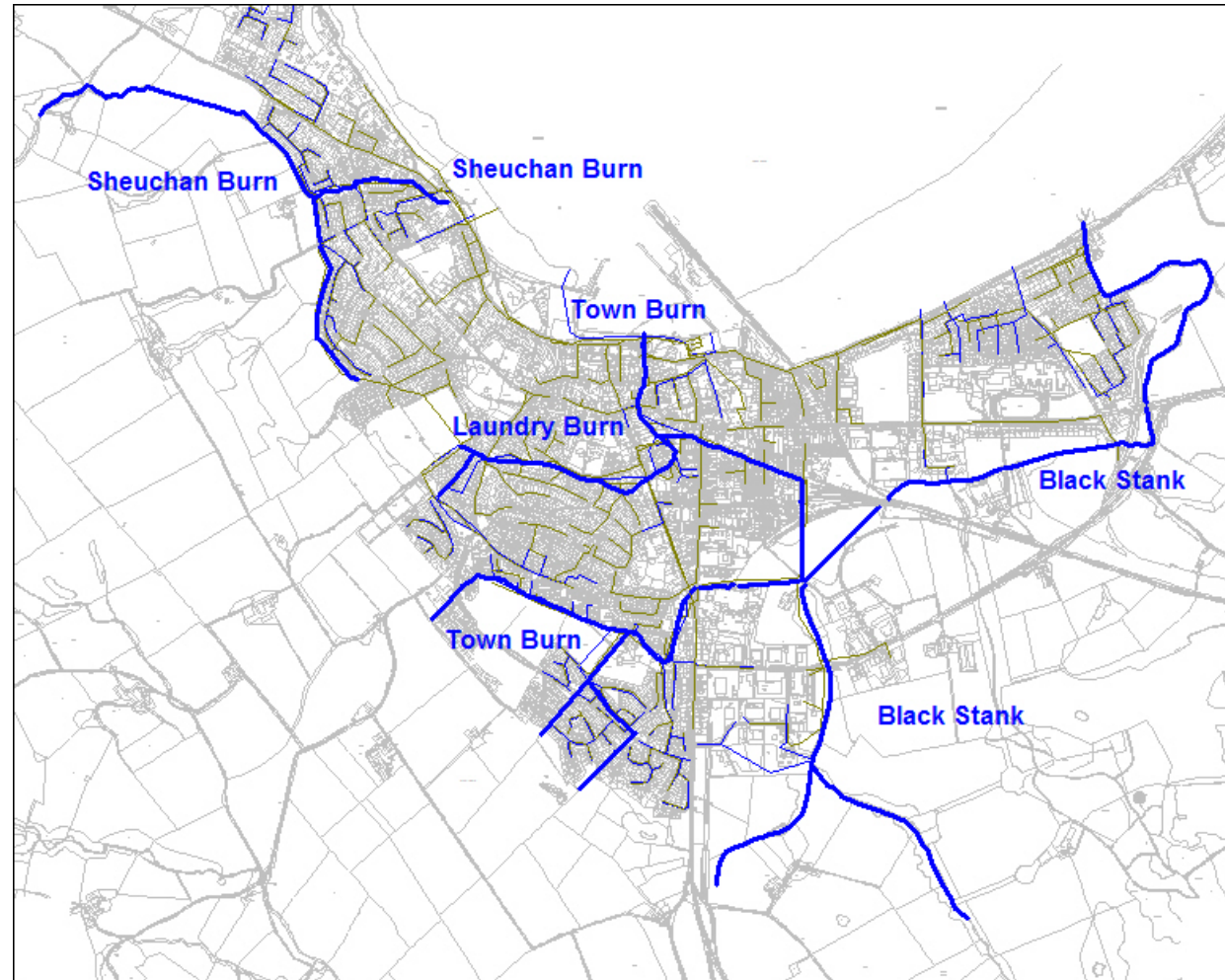


Stranraer Location



Stranraer Watercourses

- Black Stank
- Town Burn
- Laundry Burn
- Sheuchan Burn
- Surface water sewers

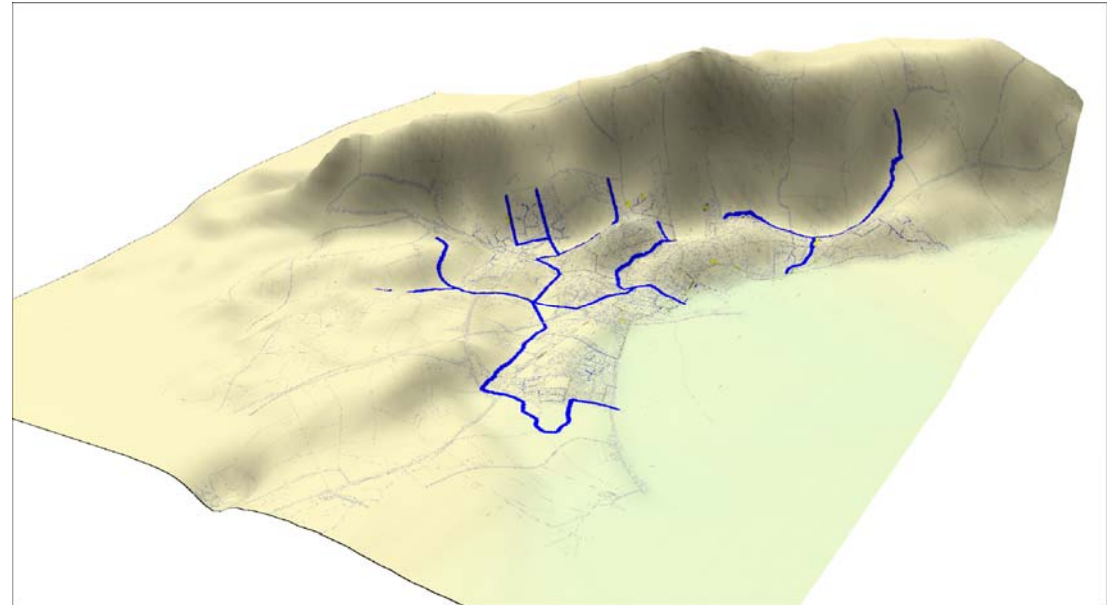


Stranraer watercourses



Data Gathering

- Site visits
- Topographic survey
 - Watercourse survey
 - Floodplain survey
 - Structural survey
 - 3D survey
- CCTV survey
- DAP survey
 - Manhole survey
 - Pumping Station survey
 - CCTV survey
 - CSO survey



Stranraer topography



Stills from Millburn Court CCTV Survey (John Bunting, EEC - 7 July 2005)

Data Gathering

- Hydrology
 - Rainfall data from 4 raingauges (MET office, 2000)
 - Flood Estimation Handbook (FEH) methodology
- Climate Change (Price and McKenna, 2003)
- Extreme sea-water levels for Stranraer (HR Wallingford, 2002)
- Joint probability assessment (DEFRA, 2006)

Current Estimated Peak Flows (m ³ /s)									
Return Period (year)	2.33	5	10	25	50	100	200	500	
Black Stank	3.16	4.38	5.24	6.66	7.83	8.98	10.35	12.48	
Town Burn	1.26	1.62	1.88	2.22	2.4	2.53	2.65	2.81	
Sheuchan Burn	Reach B	1.09	1.58	1.89	2.34	2.81	3.27	3.82	4.68
	Reach A	1.06	1.57	1.89	2.36	2.75	3.21	3.77	4.63
	Whole	2.5	3.66	4.39	5.46	6.42	7.51	8.78	10.76
Laundry Burn	1.22	1.82	2.21	2.77	3.26	3.73	4.37	5.35	

Estimated Peak Flows (m³/s) for Stranraer Watercourses

Return Period (years)	Extreme water level (m AOD)
1	2.65
10	3.00
25	3.14
50	3.23
100	3.38
250	3.52

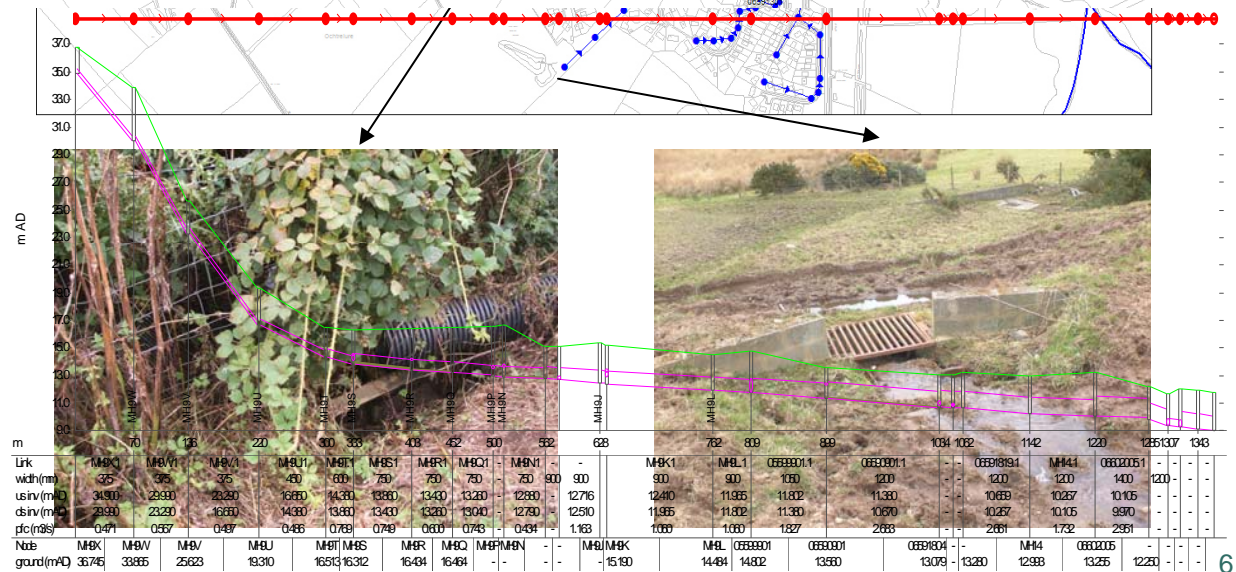
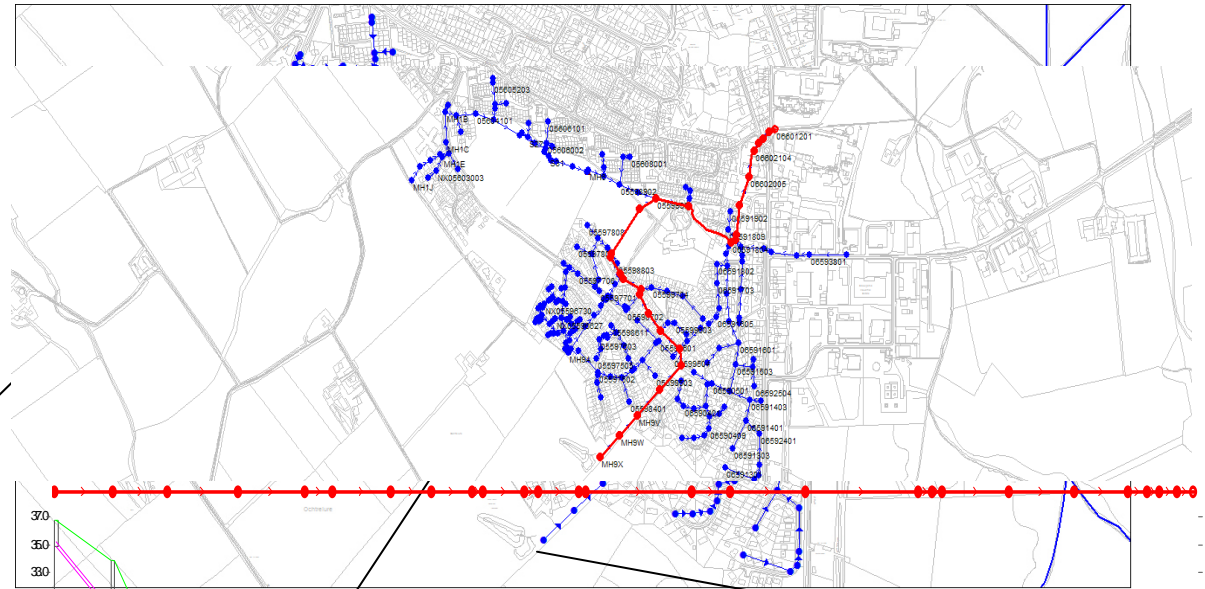
Extreme Water Levels for Stranraer

Hydraulic Modelling

- Combination of different hydraulic software packages
 - HEC-RAS (1D – open watercourses)
 - InfoWorks CS (1D – long culverts and drainage system)
 - MIKE21 (2D – overland flow)
- Watercourses and sewage system interactions
- Water depths were predicted at every single flooded property

Hydraulic Modelling – Upper Town Burn

- Highly modified
- Wholly culverted
- CCTV survey
- InfoWorks Modelling
- Draining assessment
- Outputs for 1D/2D

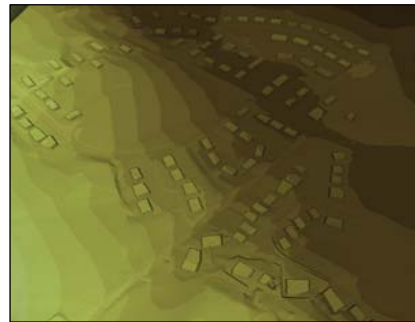
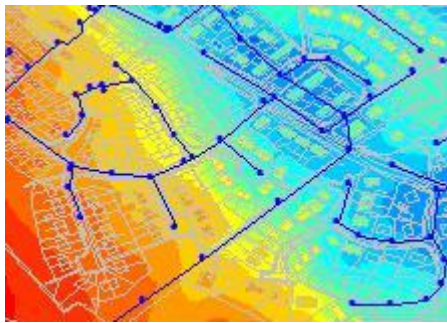


Upper Town Burn inlets and profile



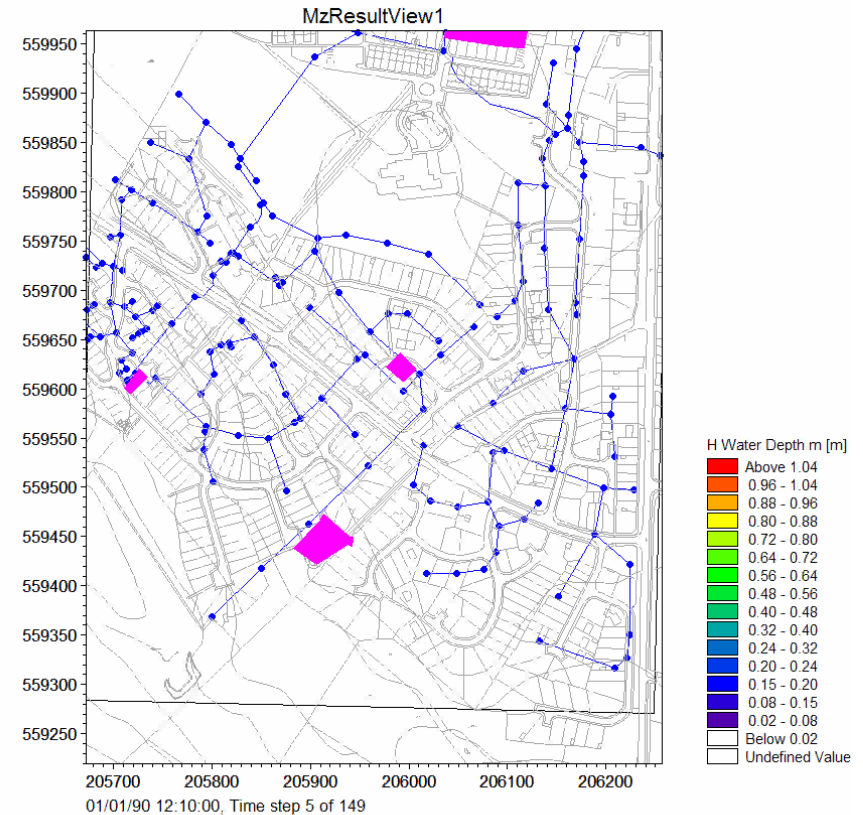
Hydraulic Modelling – Upper Town Burn 2D

- Detailed topographic survey
- Data Processing to get 3D model



3D model and survey data gathered for the Ochtralure area

- MIKE21 HD module
- Manhole spills (from InfoWorks)
- Assessment of several scenarios and return periods
- Appropriate Manning numbers and grid size



2D model Ochtralure 1:200 year results

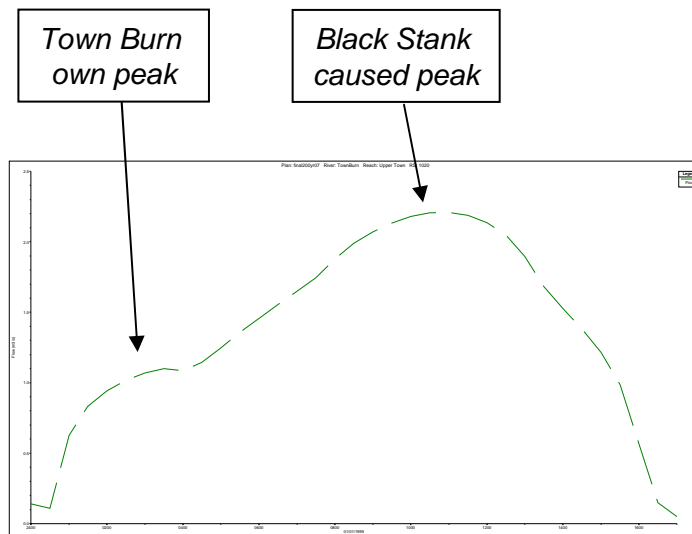


Hydraulic Modelling – Black Stank and Town Burn

- Topographic survey
- Structures survey
- Output from Upper Town Burn IW model
- HEC-RAS modelling of both watercourses
- Lateral structures definition
- Peak flow in Town Burn caused by the Black Stank



Black Stank Flowing Into Town Burn (B. Eriksen, 2/1/98).

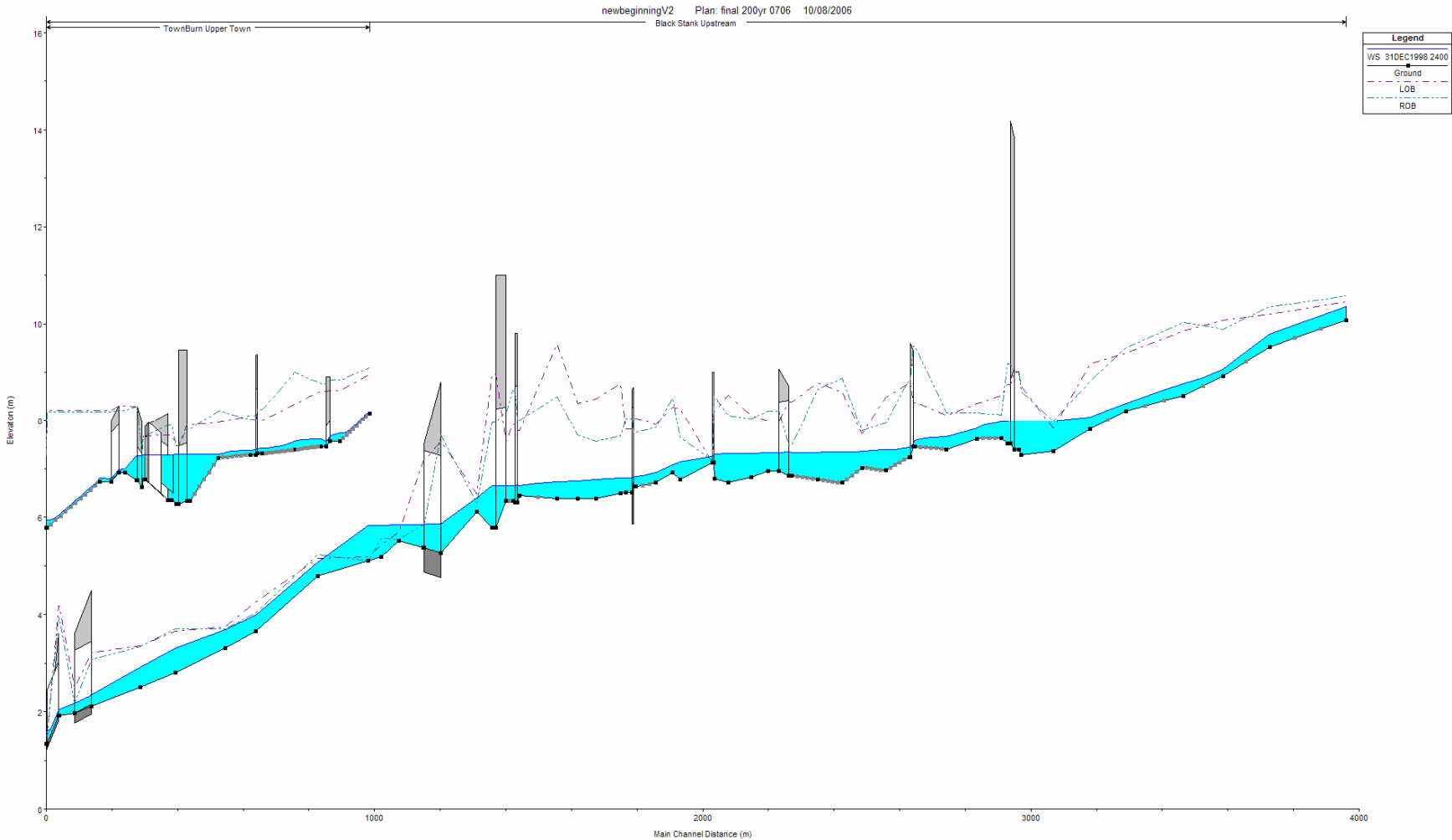


Town Burn 1:200 year predicted hydrograph



Town Burn culvert

Hydraulic Modelling – Black Stank and Town Burn



1:200 year Town Burn and Black Stank combined model results

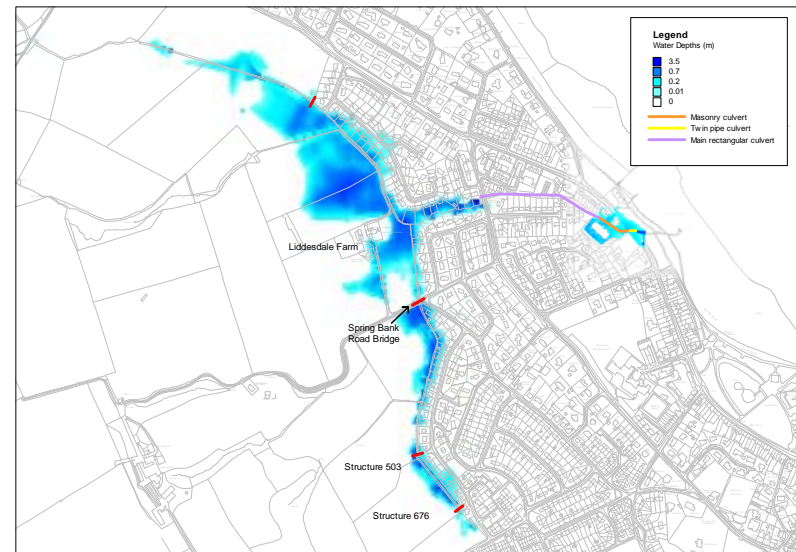


Hydraulic Modelling – Sheuchan Burn

- Topographic survey
- CCTV survey
- HEC-RAS modelling of Sheuchan A and B
- InfoWorks CS modelling of Sheuchan culvert
- MIKE21 modelling of Millburn Court manhole spills



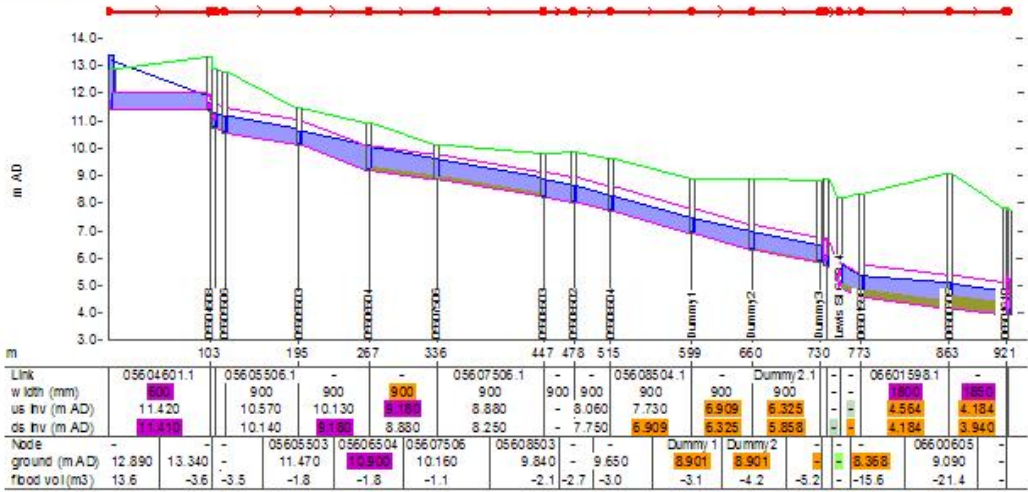
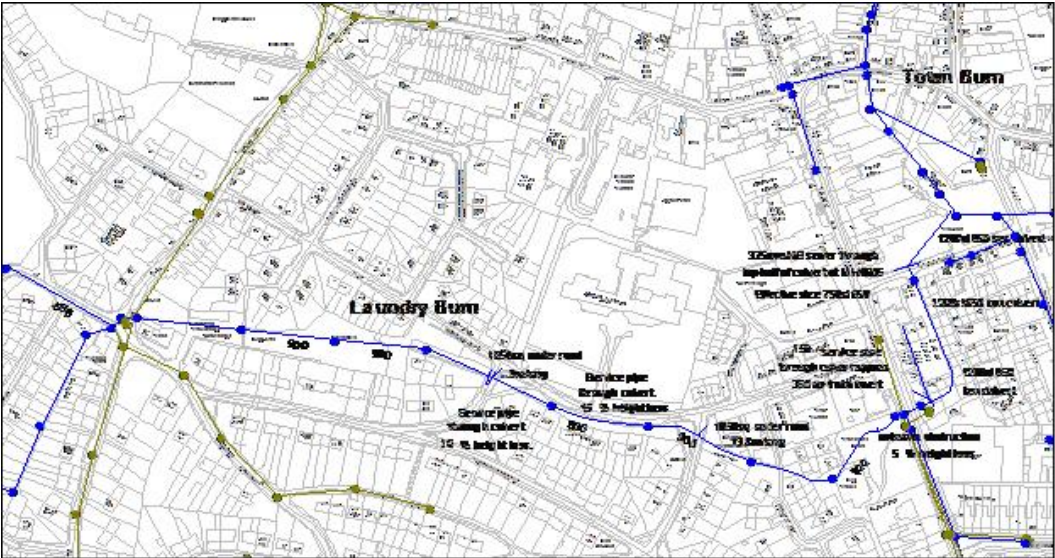
Sheuchan Burn area



Sheuchan Burn 1:200 year results

Hydraulic Modelling – Laundry Burn

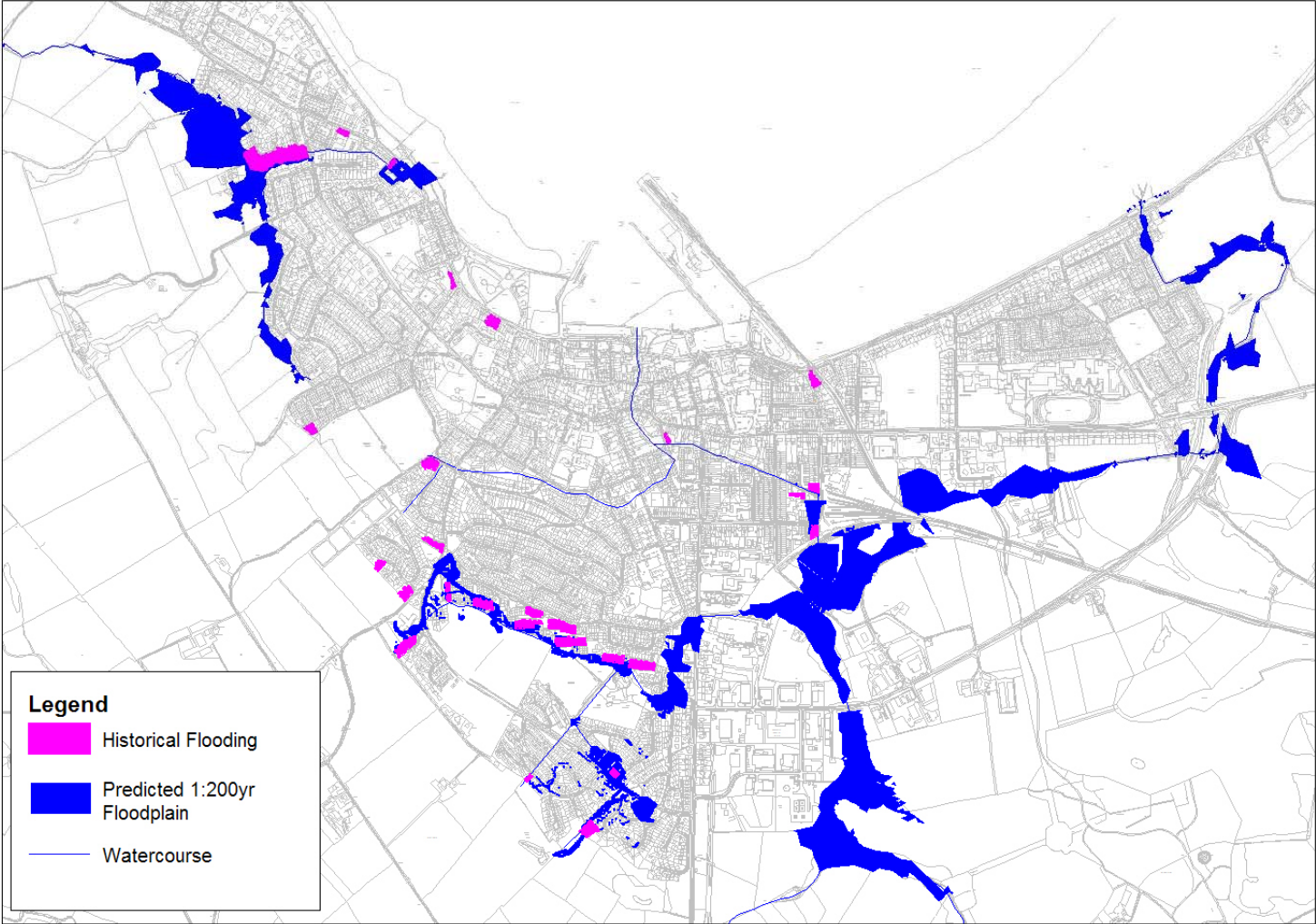
- CCTV survey
- Totally culverted
- Discharging into the Town Burn
- Reported capacity issues
- No flooding predicted
- Blockage issues



Laundry Burn location and 1:200 year profile



Wide Stranraer Results

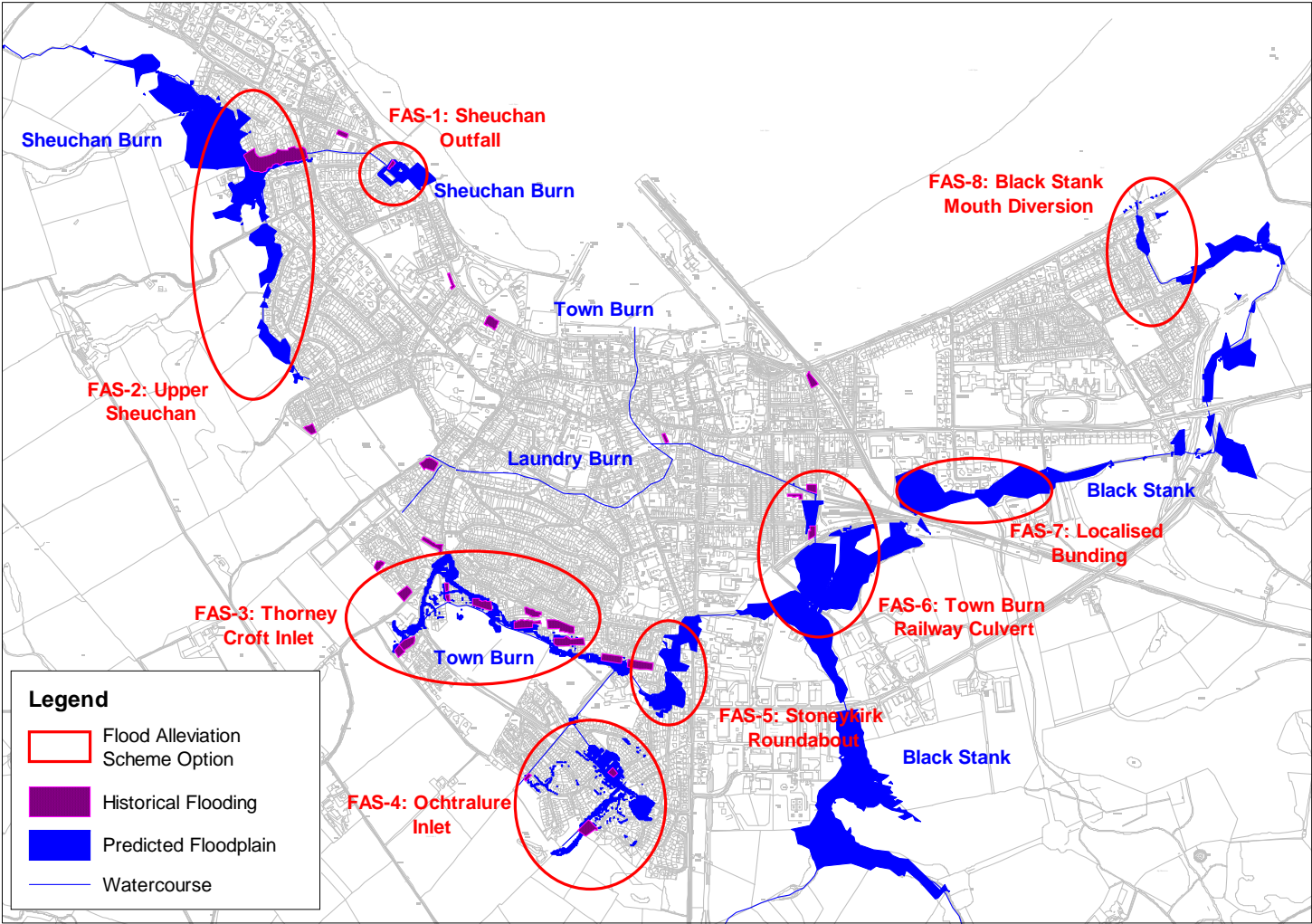


Stranraer 1:200 year floodplain outline

Benefit / cost analysis

- Economic performance of flood protections schemes
- Benefits are measured in terms of the present value of damages avoided over the life of the scheme.
- Eight Flood Alleviation Schemes (FAS) identified through Stranraer Flood Study.
- For each FAS the following was considered in the modelling exercise:
 - Do nothing (current situation modelling results)
 - Do minimum
 - Do something (option modelling)

Stranraer Flood Alleviation Schemes (FAS)



Stranraer FAS areas

Stranraer Main Causes of Flooding

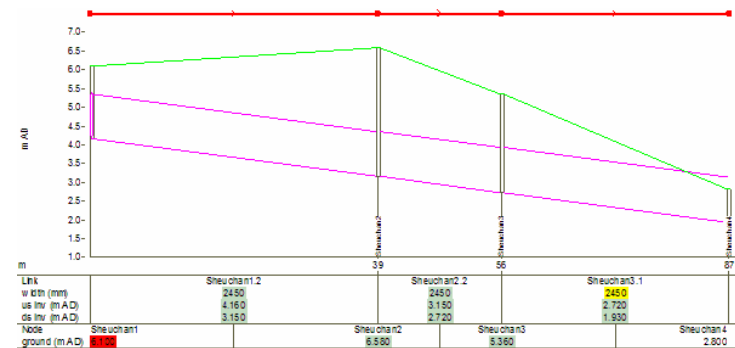
- Insufficient hydraulic capacity of culverts and inlets
- Blocking issues in culverts and inlets.
- Overland flow
- Structural issues
- Highly modified watercourses



Town Burn Downstream of Railway Culvert

FAS 1 and 2 – Sheuchan Outfall and Upper Sheuchan Burn

- FAS 1 associated with flooding in lower Sheuchan due to lack of capacity
- Structural issues
- New Outfall designed.

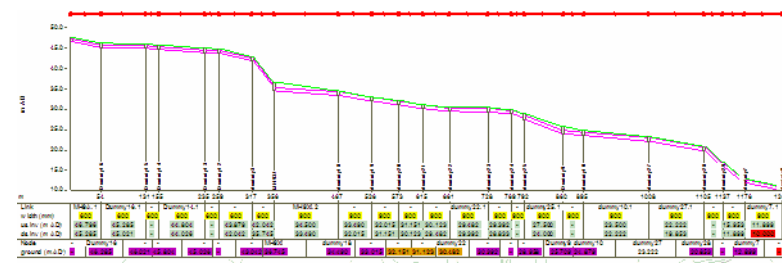


Sheuchan Outfall location and profile

- FAS 2 concerned with flooding along properties in Upper Sheuchan
- Localised protection is the preferable option.

FAS 3, 4 and 5 – Upper Town Burn

- FAS 3 is associated with flooding in Thorney Croft Inlet whereas FAS 4 is associated with Gallowhill Rise and Highcroft inlets
- Inlets improvements is FAS 3 most practical solutions
- Channel diversion is FAS 4 preferable option



FAS 4 diversion location and profile

- FAS 5 concerned with flooding in StoneyKirk Roundabout
- Structural and hydraulic capacity issues.
- Replacement not viable

FAS 6 - Town Burn Railway Culvert (Black Stank and Lower Town Burn)

- FAS 6 associated with flooding in the Station Road area (Town Burn)
- Flooding caused by the Black Stank and Town Burn interaction
- Poor culvert condition – Flow restriction

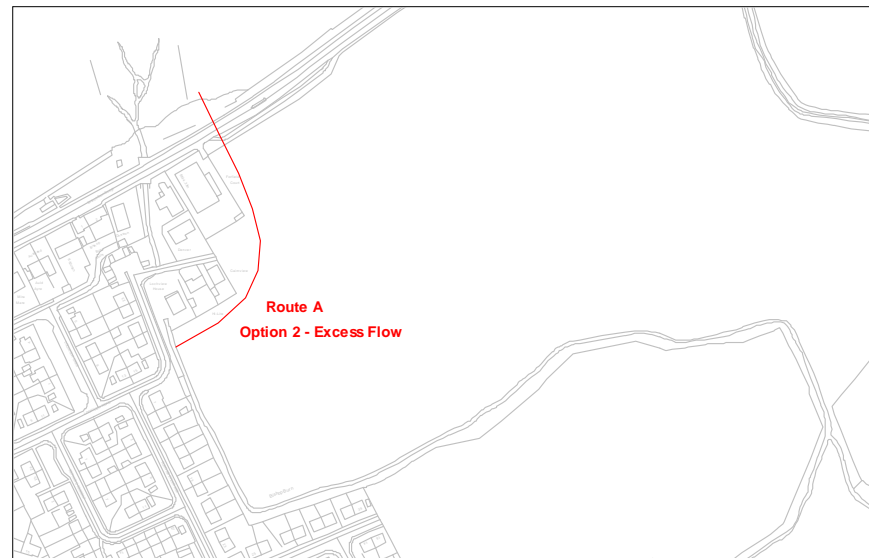


Town Burn Railway Culvert

- Replacement of the railway culvert by a 750mm flow control
- Modifications further downstream

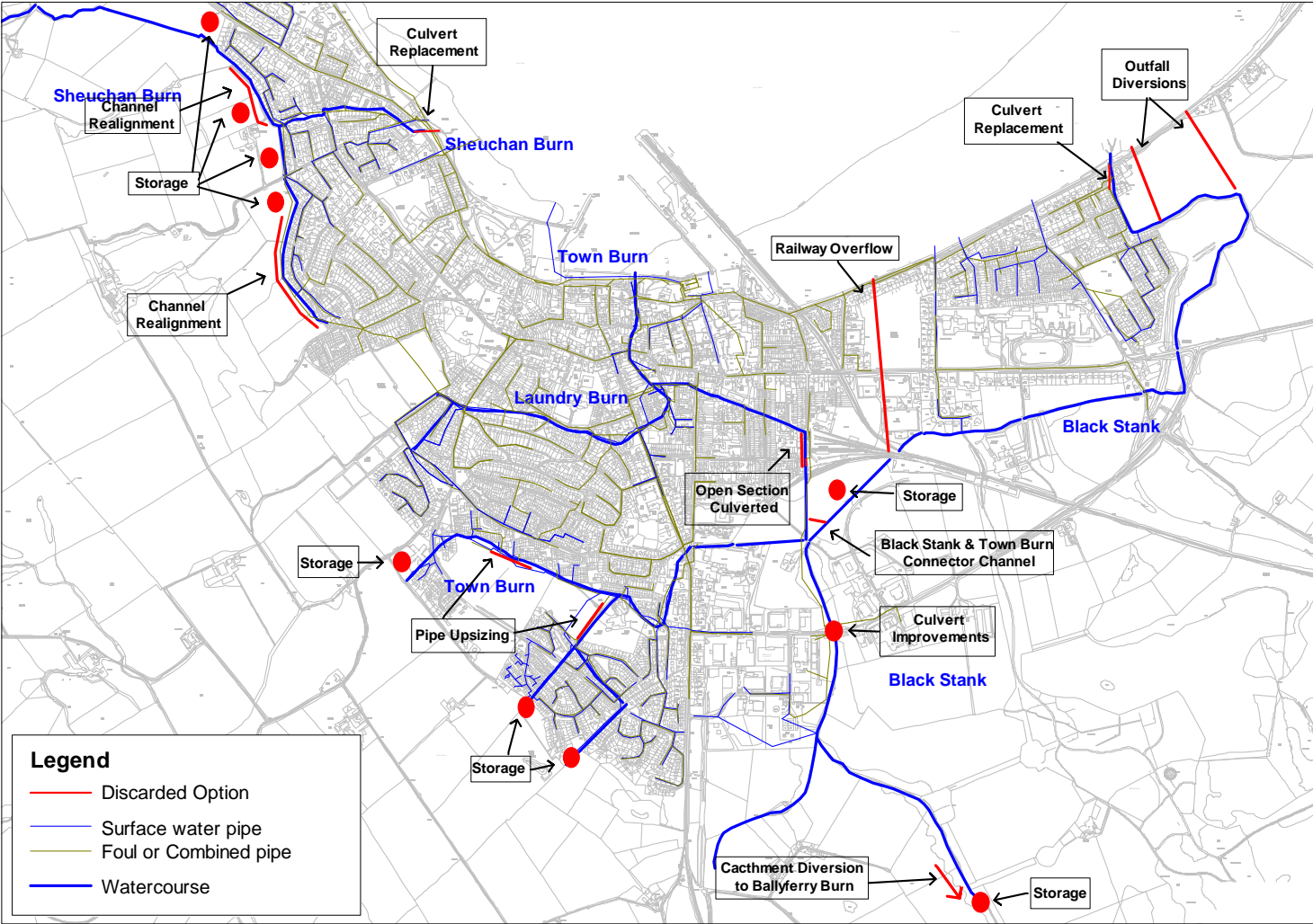
FAS 7 and 8

- FAS 7 associated with flooding in properties along the Black Stank
- Localised protection proved to be the preferable option
- FAS 8 concerned with alleviating flooding in the vicinity of properties at the downstream end of the Black Stank
- Diversion of the Black Stank peak flows

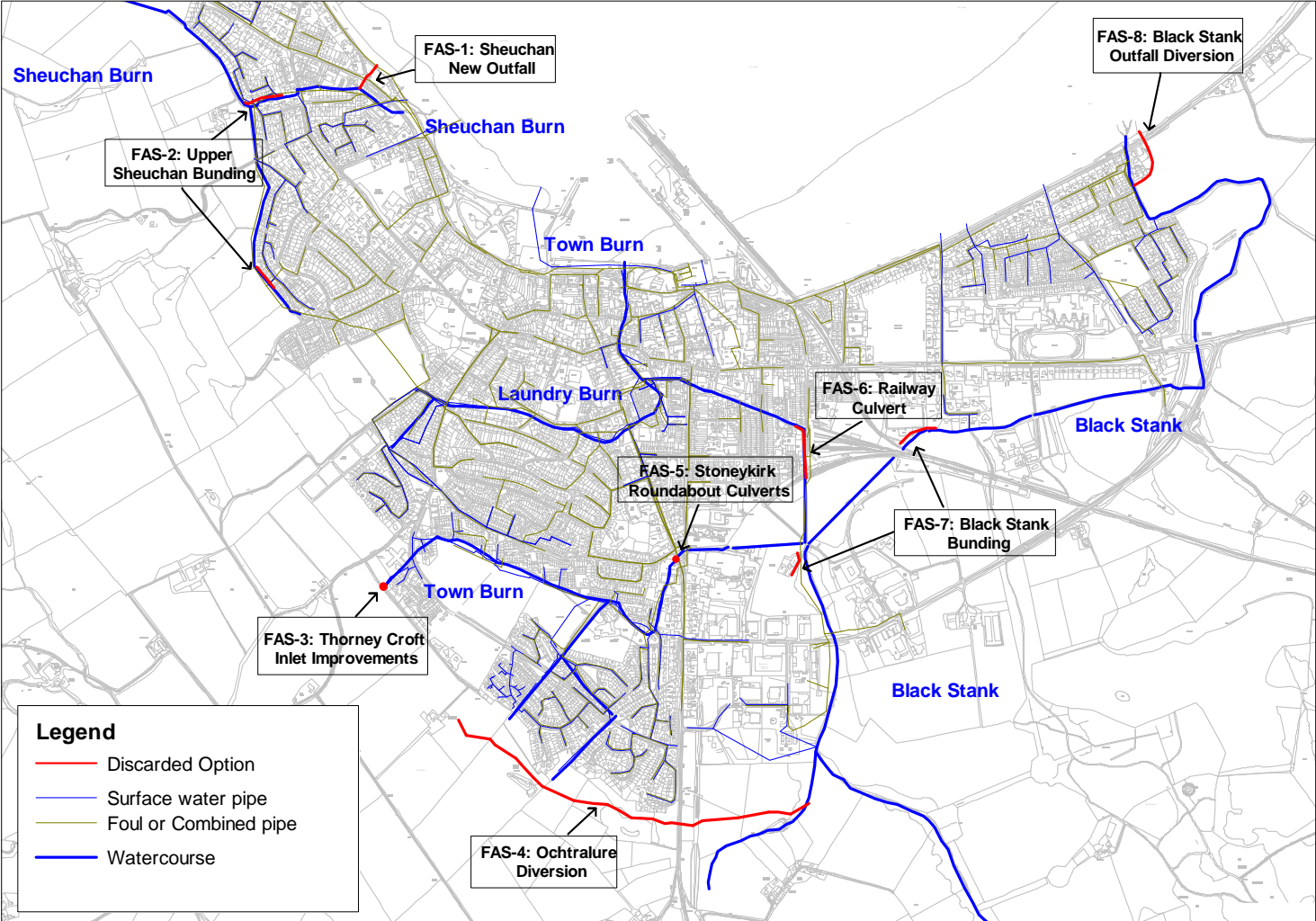


FAS 8 diversion option

Stranraer Discarded Options



Stranraer Preferable Options



Summary and Conclusions

- A high level detail modelling identified properties at risk in Stranraer
- Water depths were predicted at those properties
- Eight flood alleviation schemes were assessed
- Potential mitigation options were tested
- A benefit/cost analysis approach was used
- The diversion type option was the most viable for three FAS
- Culvert or inlet improvements was the preferable options for other three FAS
- Local bunding was the option chosen for two FAS