



SAM Dissemination Conference 19 May 2009

Optimising risk-reduction
Dalmarnock case study

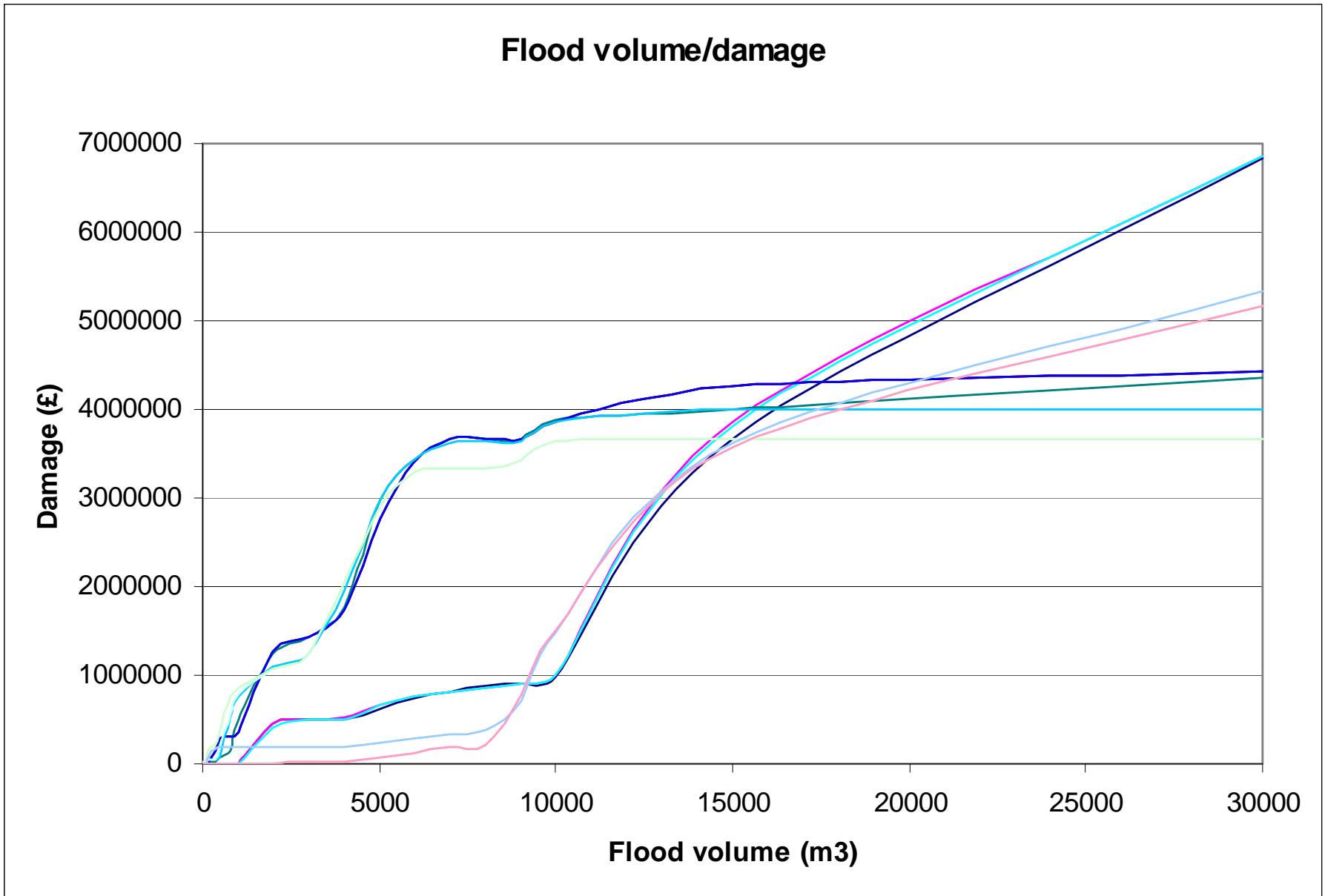
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Objective

- To demonstrate the development of a risk-based intervention strategy by adapting FastNett and applying the tools to a case study

Method

- HR used RFSM to produced flood/damage curves for each manhole for a range of flood volumes
- HR developed a range of options
- FastNett fast simulation and optimisation package adapted
 - Read flood volume/damage curves
 - Change groups of pipes as well as individual pipes during optimisation
 - Calculate EAD for every option
 - Optimise to minimise total EAD for a given spend
 - Avoid increases of EAD at individual manholes
- Dalmarnock network used as a case study
- Means of interpreting output considered.



Ewan Group FastNett Version 1.18

File Edit View Simulation Results Window Help

NS60646597.1

Graph Window for Pipe NS60646597.1

Time (s)	Infoworks DS (m³/s)	Infoworks US (m³/s)	FastNett (m³/s)
0	0.0000	0.0000	0.0000
2000	0.1000	0.1000	0.1000
4000	0.3000	0.3000	0.3000
6000	0.8000	0.8000	0.8000
8000	1.9000	1.9000	1.9000
10000	1.0000	1.0000	1.0000
12000	0.6000	0.6000	0.6000
14000	0.5000	0.5000	0.5000

Flood Volume Comparison Graph Window

FastNett (m³)	Infoworks (m³)
0	0
2000	2000
4000	4000
6000	6000
8000	8000
10000	10000
12000	12000
14000	14000
16000	16000
18000	18000
20000	20000
22000	22000
24000	24000
26000	26000
28000	28000
30000	30000

Network Map - YCE#4 - with orifice dwnstream.csv

Ready NUM

InfoWorks CS [8.5.1] - [GeoPlan - YCE#4_1 (R/O) [Target]]

File Edit Network Selection Geo Results Tools Window Help

Optimisation events from YC 090415

- FEH Y50 D240
- FEH Y5 D90
- FEH Y5 D240
- FEH Y10 D90
- FEH Y10 D240
- FEH Y50 D90

Run Group

- YCE - orifices downstream outfall remov
- YCE - 21 mm downstream outfall remov
- YCE - orifices downstream outfall remov
- YCE - changed pipe sizes 21 mm to orif
- YCE - changed pipe sizes to 21 mm to :
- RJL#1
- RJL#2
- RJL#3
- 0.328649778072094
- YCE#4
- 0.328649778072094
- YCE#4_1 with trial rainfall
- 0.328649778072094
- YCE#4_1
- YCE#4_1 Opt000026

Selection List Group

- tank5
- change 7 - Groups allowed to change
- Group 1**
- Group 2
- Group 3
- Group 6
- Group 7
- Group 8
- Group 9
- Group 17

Ready - Press F1 for Help

259528, 665315

Zoom (m): 3661.29 [1:23941]

FastNett Options

FastNett Targets

FastNett Costs

Optimisation Options - YCE#4_1 options#1.fno

Manhole ID	Min Vol. (m ³)	Max Vol. (m ³)	Inc. Vol. (m ³)	Cost Factor
1 tank1_MHz	150.0	600.0	150.0	1.00
2 tank2_MHz	150.0	600.0	150.0	1.00
3 tank3_MHz	150.0	600.0	150.0	1.00
4 tank4_MHz	150.0	600.0	150.0	1.00
5 tanks5_MHz	150.0	600.0	150.0	1.00
6 tank6_MHz	150.0	600.0	150.0	1.00
7 tank7_MHz	150.0	600.0	150.0	1.00
8 tank8_MHz	150.0	600.0	150.0	1.00
9 tank9_MHz	150.0	600.0	150.0	1.00

Optimisation Targets - YCE#4_1 targets#1.fnt

No Flooding | CSOs | Risk

Minimum Capital £

Maximum Capital £

Damage Curve File

Cost Model - YCE#4_1 costs#1.fnc

Storage Volume (m ³)	Cost (£)
1 0.0	10000.00
2 1.0	10500.00
3 10000.0	5010000.00

Optimisation Options - YCE#4_1 options#1.fno

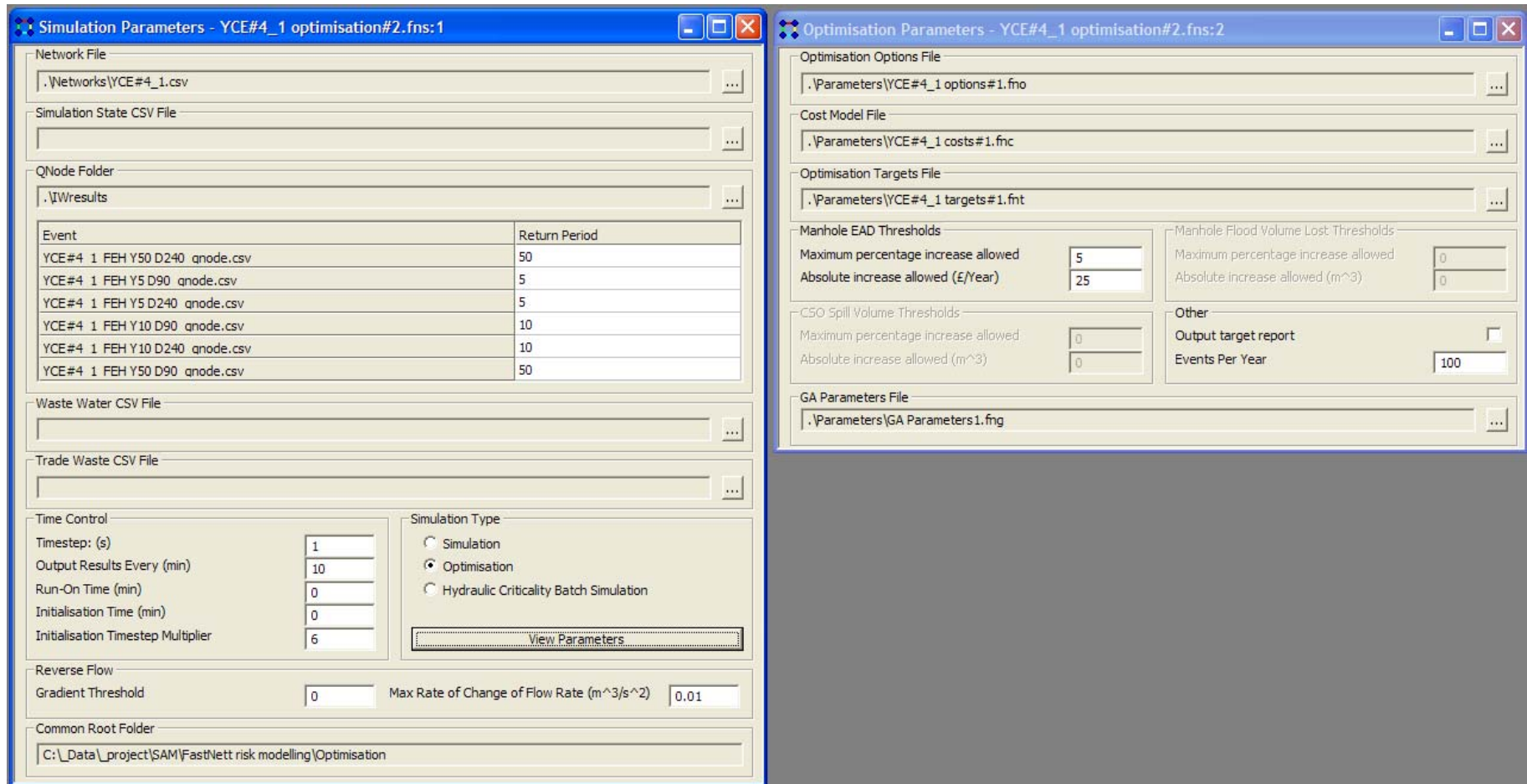
US Node ID	Suffix	Min Diam...	Max Dia...	Construc...	Soil Cost...	Surface Co...
1 pipegroup -901	1000	1000	Trench	1.00	1.00	
2 pipegroup -801	1000	1000	Trench	1.00	1.00	
3 pipegroup -702	750	750	Trench	1.00	1.00	
4 pipegroup -701	750	750	Trench	1.00	1.00	
5 pipegroup -602	1000	1000	Trench	1.00	1.00	
6 pipegroup -601	1000	1000	Trench	1.00	1.00	
7 pipegroup -501	750	750	Trench	1.00	1.00	
8 pipegroup -401	1000	1000	Trench	1.00	1.00	
9 pipegroup -301	400	400	Trench	1.00	1.00	
10 pipegroup -202	400	400	Trench	1.00	1.00	
11 pipegroup -201	400	400	Trench	1.00	1.00	
12 pipegroup -101	400	400	Trench	1.00	1.00	
13 pipegroup 1	2000	2000	Trench	1.00	1.00	
14 pipegroup 2	1200	1200	Trench	1.00	1.00	

Cost Model - YCE#4_1 costs#1.fnc

Depth (m)	Trench Pipe Costs	
	0.5	20.0
400	125.00	125.00
750	440.00	440.00
900	635.00	635.00
1000	785.00	785.00
1200	1130.00	1130.00
1600	2010.00	2010.00
2000	3140.00	3140.00



Setting up the Fastnett Optimisation



The image shows two windows from a software application. The left window is titled "Simulation Parameters - YCE#4_1 optimisation#2.fns:1" and the right window is titled "Optimisation Parameters - YCE#4_1 optimisation#2.fns:2".

Simulation Parameters - YCE#4_1 optimisation#2.fns:1

Network File: .\Networks\YCE#4_1.csv

Simulation State CSV File: [Empty]

QNode Folder: .\Wresults

Event	Return Period
YCE#4 1 FEH Y50 D240 qnode.csv	50
YCE#4 1 FEH Y5 D90 qnode.csv	5
YCE#4 1 FEH Y5 D240 qnode.csv	5
YCE#4 1 FEH Y10 D90 qnode.csv	10
YCE#4 1 FEH Y10 D240 qnode.csv	10
YCE#4 1 FEH Y50 D90 qnode.csv	50

Waste Water CSV File: [Empty]

Trade Waste CSV File: [Empty]

Time Control

Timestep: (s) [1]

Output Results Every (min) [10]

Run-On Time (min) [0]

Initialisation Time (min) [0]

Initialisation Timestep Multiplier [6]

Simulation Type

Simulation

Optimisation

Hydraulic Criticality Batch Simulation

View Parameters

Reverse Flow

Gradient Threshold [0] Max Rate of Change of Flow Rate (m³/s²) [0.01]

Common Root Folder: C:_Data_project\SAM\FastNett risk modelling\Optimisation

Optimisation Parameters - YCE#4_1 optimisation#2.fns:2

Optimisation Options File: .\Parameters\YCE#4_1 options#1.fno

Cost Model File: .\Parameters\YCE#4_1 costs#1.fnc

Optimisation Targets File: .\Parameters\YCE#4_1 targets#1.fnt

Manhole EAD Thresholds

Maximum percentage increase allowed [5]

Absolute increase allowed (£/Year) [25]

Manhole Flood Volume Lost Thresholds

Maximum percentage increase allowed [0]

Absolute increase allowed (m³) [0]

CSO Spill Volume Thresholds

Maximum percentage increase allowed [0]

Absolute increase allowed (m³) [0]

Other

Output target report

Events Per Year [100]

GA Parameters File: .\Parameters\GA Parameters1.fng

Fastnett Risk-Based Optimisation Approach

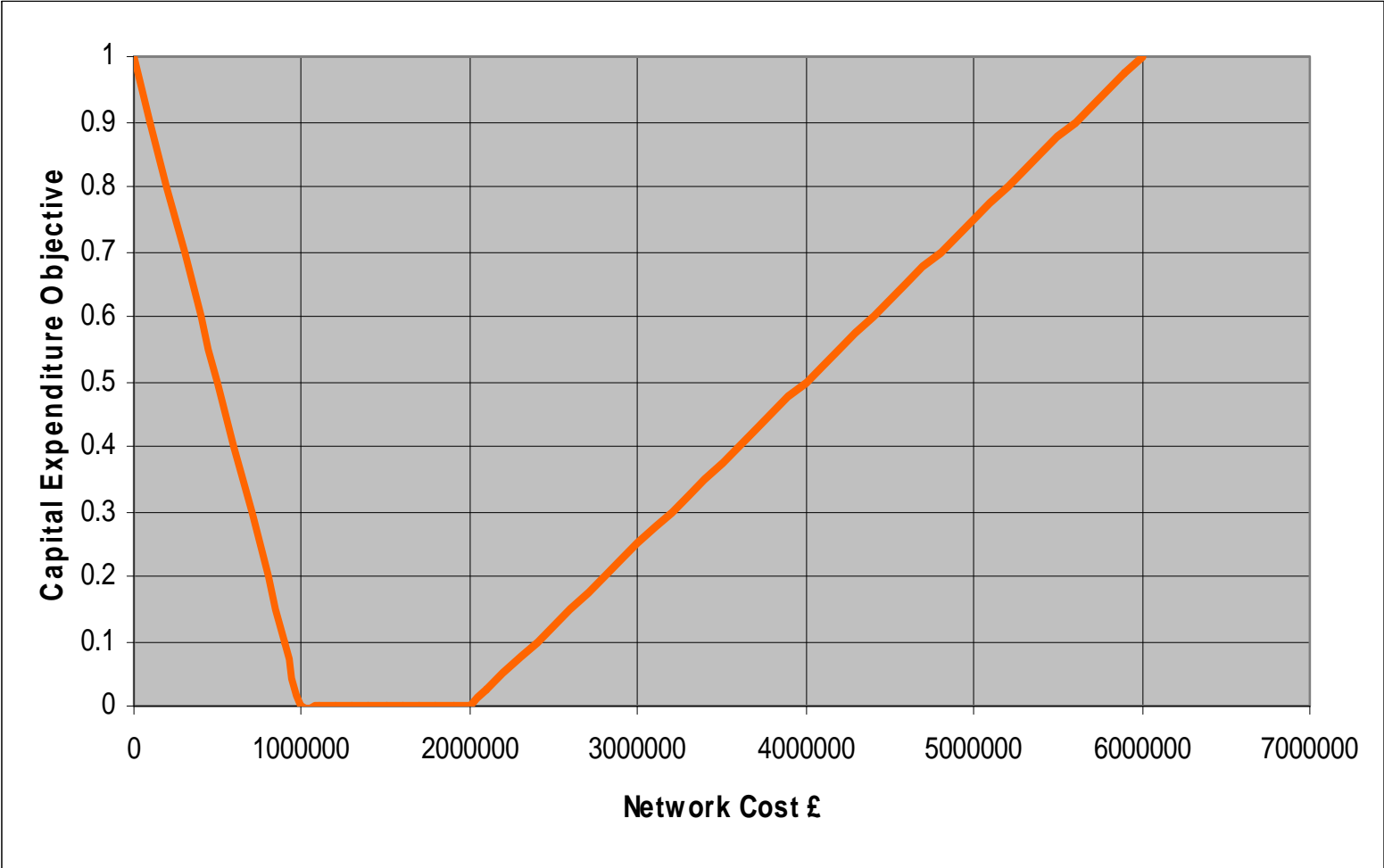
- Read data files
- Data validation
- Run event matrix on existing model
- Calculate current EAD
 - Damage (£) interpolated from flood volume/damage curves
 - For each return period calculate biggest damage for each duration
 - EAD for each note calculated accounting for probability of non-exceedance
- Optimisation loop
 - Generate population of networks with different combination of options
 - Simulate each network with each event in the matrix
 - Calculate cost of each network
 - Calculate EAD of each network
 - Identify the fittest networks and pass them on to the next generation
 - Export the fittest network to CSV for import to InfoWorks
 - Modify some networks and generate new ones to create a new population
 - Repeat the loop
- End when networks converge

Risk-Based Optimisation Objectives

- Objective is comprised of three parts
- Each objective is tackled in turn
 - Capital expenditure objective.
 - Local per manhole EAD objective (Avoid moving EAD from one area to another)
 - Global network EAD objective. Minimise total network EAD.

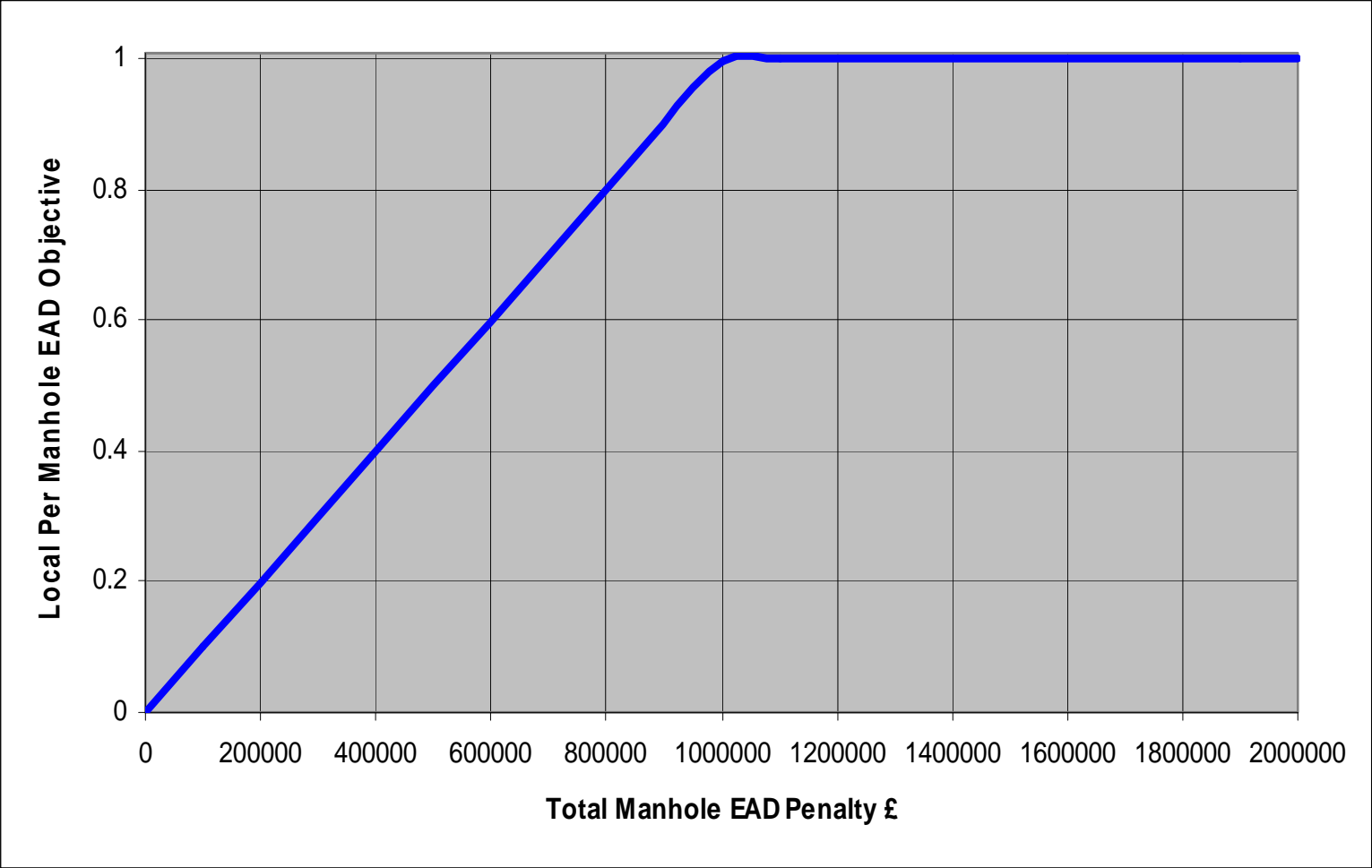


Capital Expenditure Objective



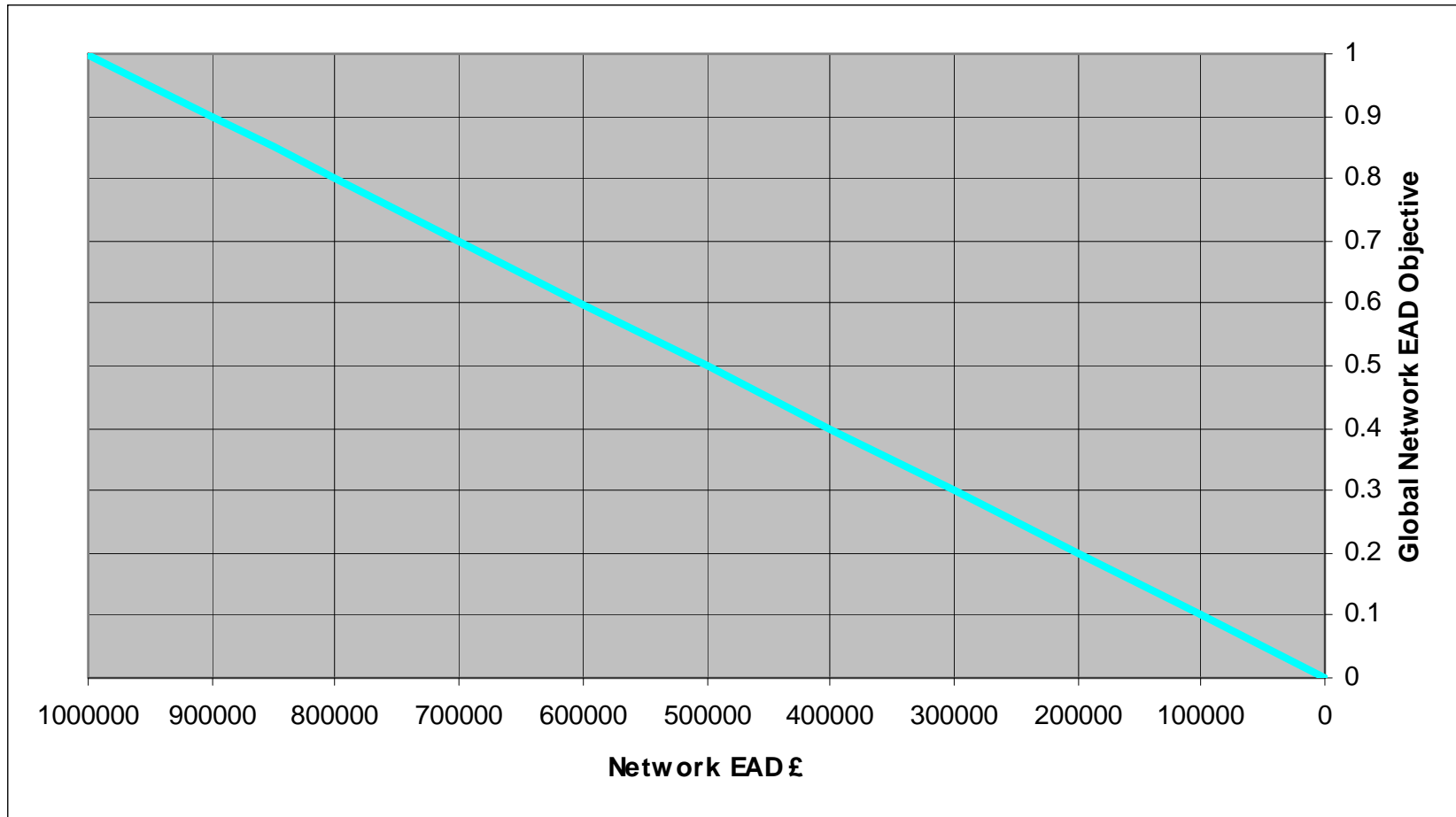


Local Per Manhole EAD Objective





Global Network EAD Objective



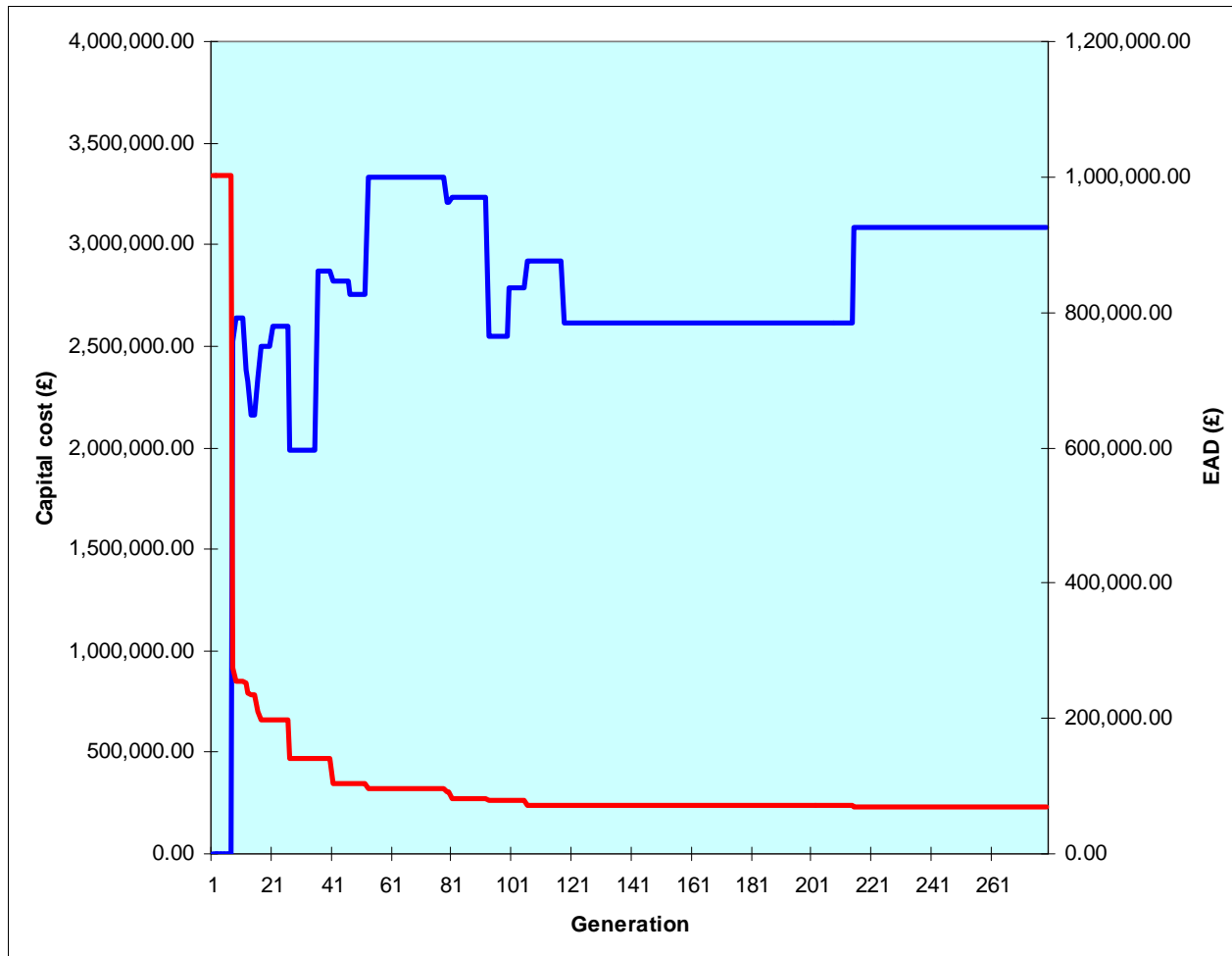
Fastnett Optimisation

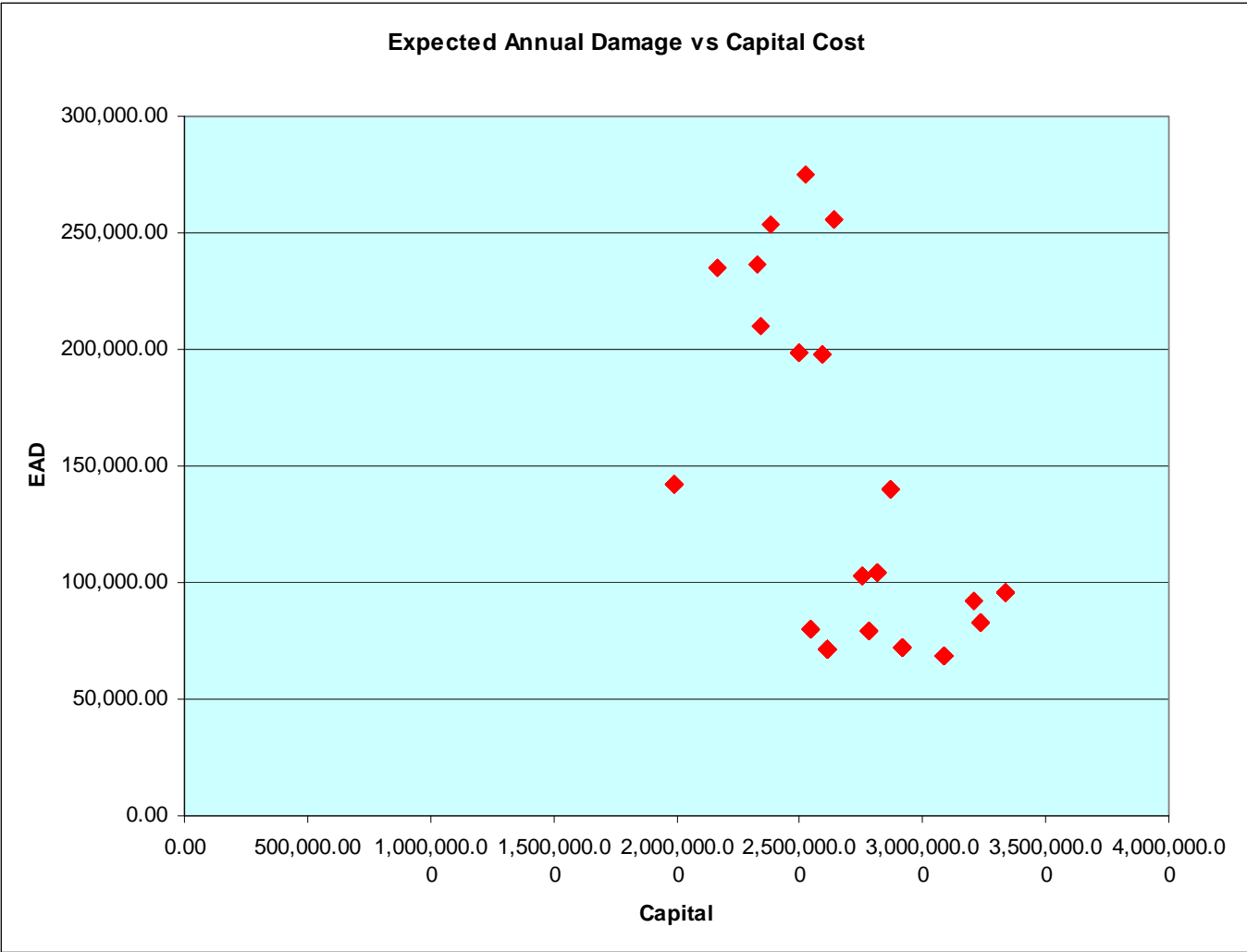
Example report on one generation

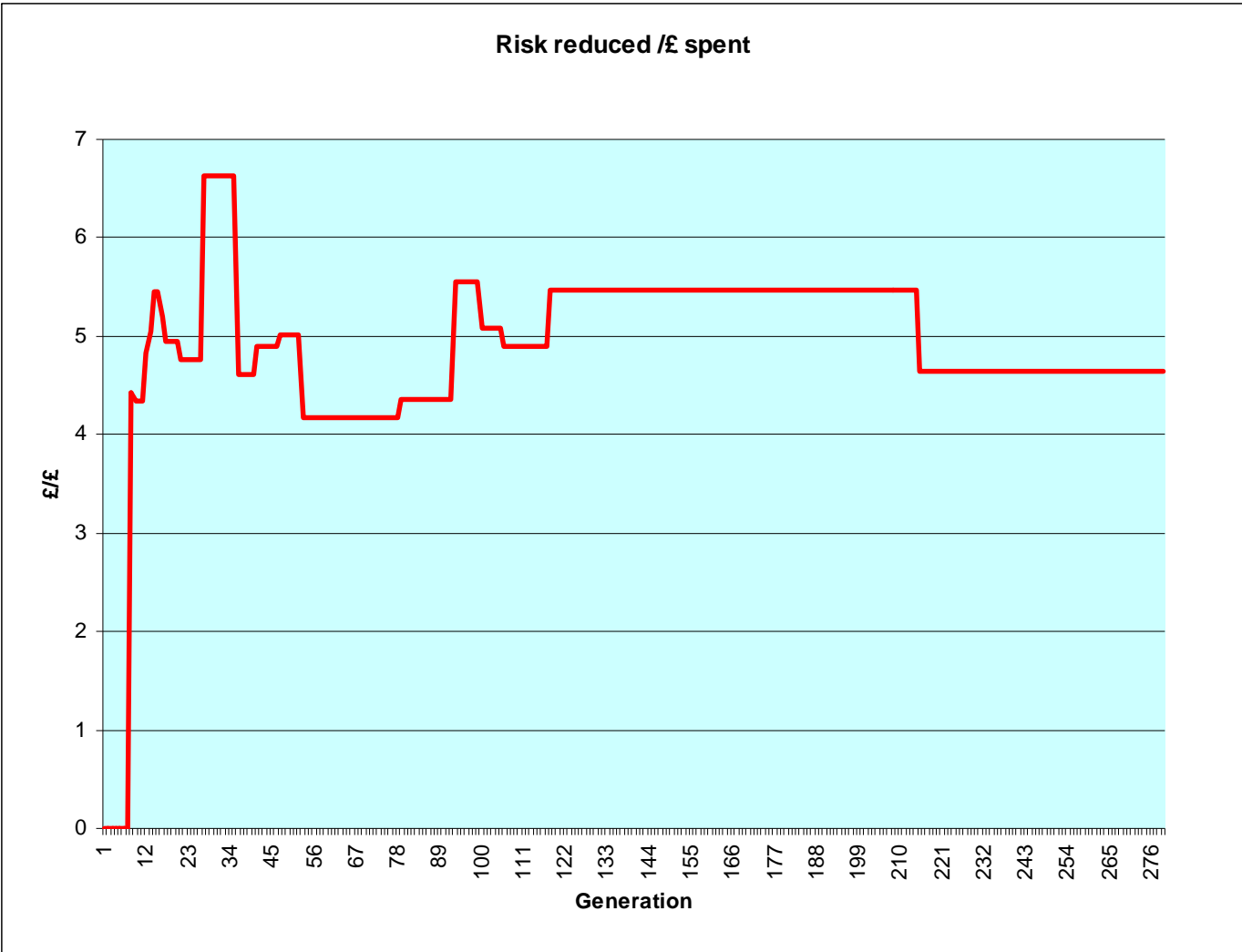
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Report Window
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Optimisation stats for population 277 min=0.0106 mean=0.0118 maximum=0.0124 - At least one solution found
Current Best Network
Pipe group PipeGroup.-901 is unchanged costing £0.00
Pipe group PipeGroup.-801 has 1000mm diameter costing £8371.17
Pipe group PipeGroup.-702 is unchanged costing £0.00
Pipe group PipeGroup.-701 is unchanged costing £0.00
Pipe group PipeGroup.-602 has 1000mm diameter costing £7850.00
Pipe group PipeGroup.-601 has 1000mm diameter costing £8054.96
Pipe group PipeGroup.-501 has 750mm diameter costing £4362.22
Pipe group PipeGroup.-401 has 1000mm diameter costing £4964.78
Pipe group PipeGroup.-301 is unchanged costing £0.00
Pipe group PipeGroup.-202 is unchanged costing £0.00
Pipe group PipeGroup.-201 has 400mm diameter costing £750.00
Pipe group PipeGroup.-101 has 400mm diameter costing £1286.29
Pipe group PipeGroup.1 is unchanged costing £0.00
Pipe group PipeGroup.2 has 1200mm diameter costing £69132.09
Pipe group PipeGroup.3 has 900mm diameter costing £60517.92
Pipe group PipeGroup.6 has 1600mm diameter costing £60535.85
Pipe group PipeGroup.7 has 1600mm diameter costing £30747.09
Pipe group PipeGroup.9 is unchanged costing £0.00
Pipe group PipeGroup.46 is unchanged costing £0.00
Pipe group PipeGroup.48 has 1600mm diameter costing £240788.02
Pipe group PipeGroup.70 has 1200mm diameter costing £83857.26
Pipe group PipeGroup.78 has 900mm diameter costing £37363.81
Pipe group PipeGroup.83 is unchanged costing £0.00
Pipe group PipeGroup.86 is unchanged costing £0.00
Pipe group PipeGroup.87 is unchanged costing £0.00
Pipe group PipeGroup.88 is unchanged costing £0.00
Pipe group PipeGroup.89 is unchanged costing £0.00
Pipe group PipeGroup.90 has 1200mm diameter costing £86941.70
Pipe group PipeGroup.91 is unchanged costing £0.00
Pipe group PipeGroup.92 has 900mm diameter costing £55916.07
Pipe group PipeGroup.98 has 900mm diameter costing £10472.69
Pipe group PipeGroup.101 is unchanged costing £0.00
Pipe group PipeGroup.107 is unchanged costing £0.00
Pipe group PipeGroup.111 is unchanged costing £0.00
Pipe group PipeGroup.128 has 1600mm diameter costing £48172.32
Pipe group PipeGroup.1001 is unchanged costing £0.00
Pipe group PipeGroup.1002 has 2000mm diameter costing £288349.75
Pipe group PipeGroup.1003 is unchanged costing £0.00
Pipe group PipeGroup.6003 is unchanged costing £0.00
Pipe group PipeGroup.9001 has 1600mm diameter costing £169901.48
Node tank1_MHz has 450.00m^3 of storage costing £235000.00
Node tank2_MHz has 300.00m^3 of storage costing £160000.00
Node tank3_MHz has 600.00m^3 of storage costing £310000.00
Node tank4_MHz has 600.00m^3 of storage costing £310000.00
Node tank5_MHz has 600.00m^3 of storage costing £310000.00
Node tank6_MHz has 150.00m^3 of storage costing £85000.00
Node tank7_MHz has 600.00m^3 of storage costing £310000.00
Node tank8_MHz has 150.00m^3 of storage costing £85000.00
Node tank9-MHz has 0.00m^3 of storage costing £0.00
Capital: £3083335.50
Penalty: 0.00 £/Year
EAD: 68640.23 £/Year
EAS: 932474.25 £/Year
    
```

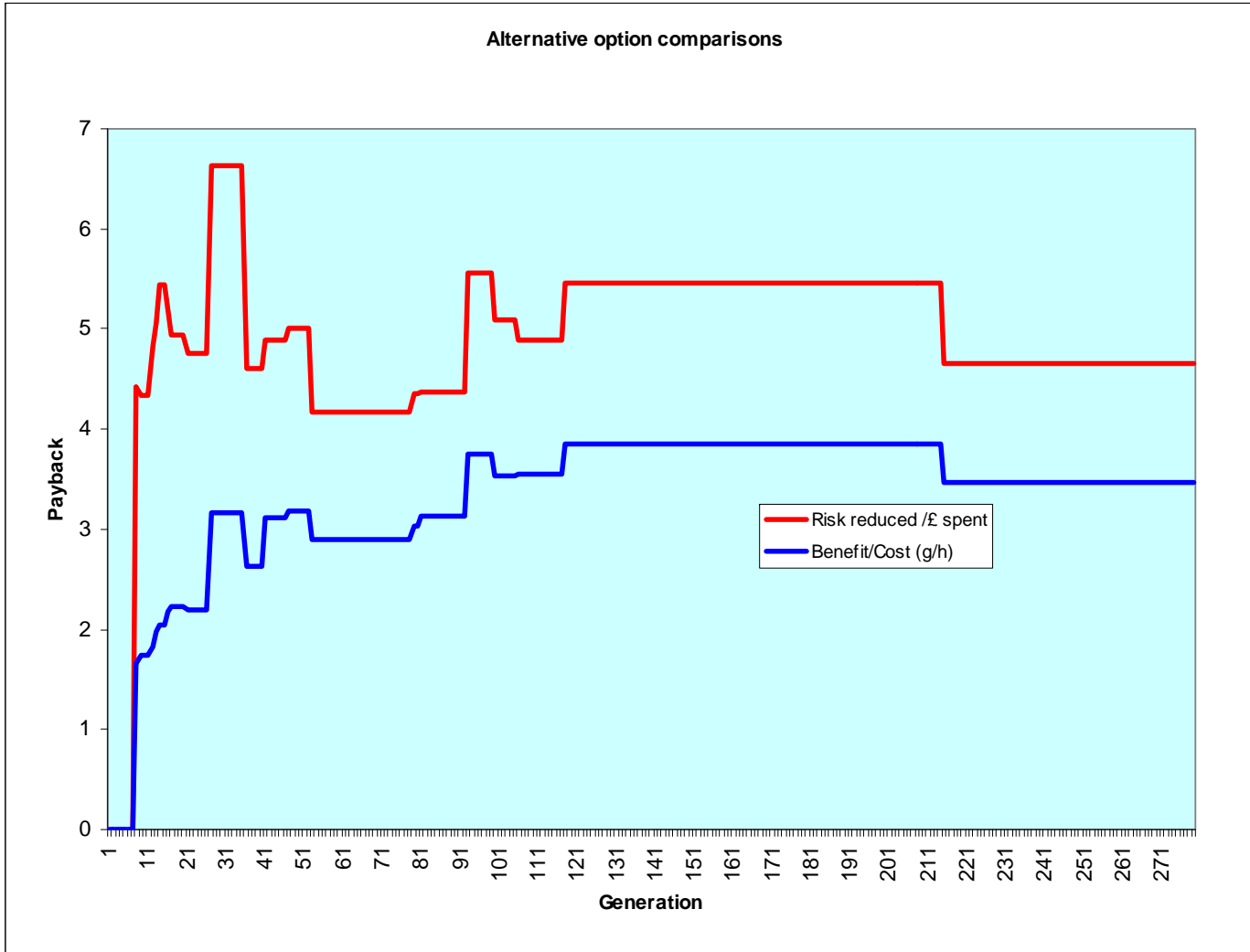
Fastnett Risk-Based Optimisation Results







Alternative option comparisons



Fastnett Risk-Based Optimisation Summary

- FastNett has been developed to perform risk-based optimisation
- RFSM has been used to produce flood volume/damage curves
- A risk-based optimisation has been carried out for the Dalmarnock sewer network
- Different ways of interpreting the results have been considered.