

Cost Benefit Methodology for Zonal Studies

Dŵr Cymru Welsh Water

1st December 2016

Report Reference: Cost Benefit Methodology for Zonal Studies V3



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1 Calculation of Whole Life Cost (or Net Present Cost)

The Whole Life Cost of a solution is calculated using the **tangible** costs associated with delivering a solution. The time span used varies depending on the scheme type. For civil schemes (such as renewals, valve installations and abandonments) a 60 year time span is used. For electrical schemes a 20 year time span is used and for cleaning schemes a 5 year time span is used.

1.1 Capital Cost

The latest best estimate of the capital cost is included and spread over the profile in which it will be delivered. Some items that make up the costs will need to be replaced in the determined time span in order to maintain the benefit. The costs of these replacements are included in the whole life calculation at the same value as the initial spend.

The unit cost models are allocated against a number of cost categories, with standard repeat cycles. The ones that are available to repeat are;

Category	Repeat year
Buildings, Road, Paths and Fences	15 years
Buildings, Road, Paths and Fences	60 years
Civils	60 years
IT & Systems	5 years
IT & Systems	10 years
M&E	10 years
M&E	15 years
M&E	20 years
M&E	25 years
M&E	30 years
M&E	40 years

1.2 Opex Cost Impact

The opex cost included is the change in opex associated with delivering the solution, which may be an increase (for example where we are increasing capacity) or a decrease (for example if we are constructing plant that is more energy efficient). We define this in relation to existing budgets so it tends to be changes in power consumption or chemical costs. Where a solution reduces staff time in dealing with problems we wouldn't tend to include it unless it would result in a clear reduction of at least one FTE.

1.3 Whole life cost calculation

The whole life cost is calculated using a net present value calculation using the combined capex and opex change values over the designated time window, discounted to the start year of the scheme. The discount factor used is the Cost of Capital (WACC), which is 3.6% for this AMP.

1.4 Examples

A project has an initial capex investment of £200k, 50% is civils, 50% is M&E with a 20 year life. The net present cost includes one repeat of the M&E cost and is £251k. Another project has the same capex profile but incurs an additional opex cost of £10k per year. The net present cost is £420k.

2 Calculation of Whole Life Benefit

The whole life benefit represents the *intangible* costs associated with the reduction in risk that will be realised by delivering the solution. This is the difference between the risk that would exist without any solution (the do nothing option) and the risk that would exist after the solution is delivered. This is monetised to reflect indicative costs should the risk occur.

Two methods of monetisation are used depending on the service measure that forms the risk.

2.1 Cost of consequence

The cost of consequence valuations represent the costs of Welsh Water dealing with a service failure and have been built up from expert knowledge and experience of real incidents. The list of activities were originally built up in workshops with a mix of operational and asset management colleagues to provide advice on the activities undertaken. As the costs have been added these have been through repeated validation to test the results.

The following table is an extract from the Drinking Water Bacteriological cost of consequence analysis showing the level of detail that has been used in the build-up.

	Resource type	Hourly Rate	Nr hours	Cost
Failure Notification Received				
Operator investigates	Band 3	£23.37	8	£186.96
Gang Investigates	Band 3	£23.37		£ -
Initial Investigation				
Sampling Costs R1		£69.37	4	£277.48
Additional Crypto Sampling		£200.52	2	£401.04

2.2 Social benefits

The social benefits valuations represent the intangible cost of a risk impact on customers or the environment. Typically this is based on Willingness to Pay figures. Not every measure has a social benefit applied.

During the PR14 Willingness to Pay research customers were asked about 12 different aspects of service and how much they were willing to pay to move the company performance between service levels. This was analysed to derive figures showing an average value for one customer to prevent one service failure. This was then multiplied by the total number of customers to derive a company level value to prevent one service failure. An example is discoloured water contacts, where we have a value of £1.8k per year to prevent one contact.

2.3 Whole life benefit calculation

In a similar way to the whole life cost the whole life benefit is calculated over a designated timeframe and discounted using the cost of capital.

2.3.1 Example Benefits Calculation

Risk of causing a 3-6 hour interruption to supply to 100 properties once in 10 years.

Annual risk score = $100 \times 0.1 = 10$ properties

Annual risk value (cost of consequence) = $10 \times £23.57 = £236$

60 year discounted risk value = £5,829.06

2.3.2 Worked Example: Taff Street, Pontypridd

A mains cleaning scheme is being proposed in Taff Street, Pontypridd. There are 250 properties that are affected 1 in 5 years by discoloured water.

The annual risk value is = $(250 \times 0.25) \times £29.58 = £1,848.75$

Over 5 years this risk is valued at = $£1,848.75 \times 4.652728 = £8,601.73$

Note that the 4.652728 is the discounted cost of capital (WACC) over a 5 year period.

The proposed solution will reduce the risk to 1 in 25 years so the post solution annual risk value is:

$(250 \times 0.04) \times £29.58 = £295.80 \times 4.652728 = £1,376.28$

Over 10 years the discounted benefit is £7,225.45

Note that:

- 4.652728 is the discounted cost of capital (WACC) over a 5 year period.
- 14.435248 is the discounted cost of capital (WACC) over a 20 year period.
- 24.699417 is the discounted cost of capital (WACC) over a 60 year period.

2.3.3 Benefit cost ratio

Once the total benefit figure has been derived it is then divided by the cost of the solution to give a '£1 spent = £x benefit' figure that can be used to assess the total financial benefit and cost of a solution.

3 Zonal Studies Specific Cost Benefit Equations

3.1 Water Quality

= (((properties impacted pre investment x pre investment annual frequency) x cost per failure type) x WACC) - (((properties impacted post investment x post investment annual frequency) x cost per failure type) x WACC)

3.2 Customer Acceptability

= (((properties impacted pre investment x pre investment annual frequency) x 29.58) x WACC) - (((properties impacted post investment x post investment annual frequency) x 29.58) x WACC)

3.3 Customer Minutes Lost

= (((properties impacted pre investment x pre investment annual frequency) x cost per duration) x WACC) - (((properties impacted post investment x post investment annual frequency) x cost per duration) x WACC)

3.4 Bursts

= ((Average cost of the bursts on the mains in question) x average number of bursts per year) x WACC

Note: when calculating the average burst cost ignore values that are £0 or less or have a value of #N/A. When calculating the average number of bursts per year include all relevant bursts regardless of cost. This is to eliminate spurious values that would reduce the average cost of a burst.

3.5 Leakage

= ((Leakage in MI/d x 365) x £104.52) x WACC

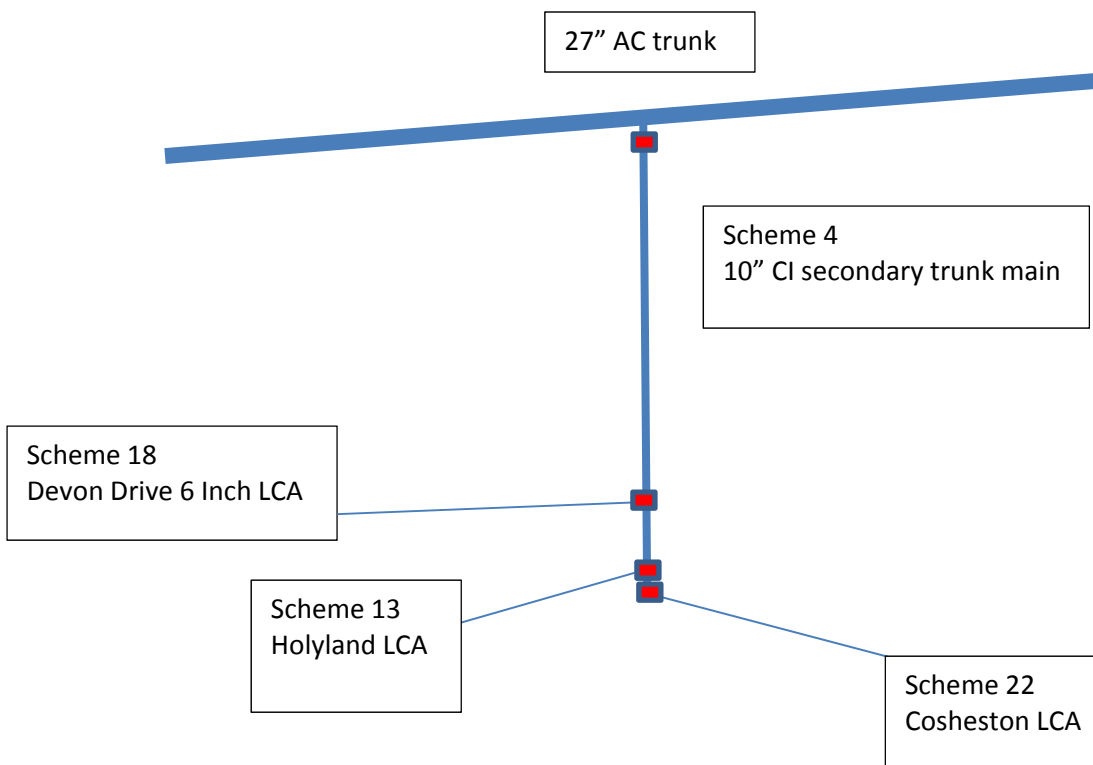
3.6 Low Pressure

= ((Pre investment no. of days per annum x cost per pressure complaint type) x WACC) - ((Post investment no. of days per annum x cost per pressure complaint type) x WACC)

3.7 Cost Benefit

= Total Benefit / Cost of the Solution

3.8 Assessing Benefits for Dependency Schemes.



3.8.1 Scenario

Holyland LCA, Devon Drive 6 inch and Coshleston LCAs have experienced repeated customer acceptability events over a 3 year period. These have not occurred in all LCAs at the same time but in each on separate occasions. The individual LCAs are all preferred materials and have not experienced any burst history in this time frame. The trunk is fed from a clean source, it operates at a suitable velocity, there have been no bursts and there are no widespread customer acceptability contacts in the area. The 10" CI secondary trunk main supplying the area has no direct fed customers, it operates at a decent but not ideal velocity and there have been no bursts on this main. Hydraulic modelling indicates that this main is slightly roughed up on the inside. The evidence suggests that this main is the likely cause of the customer acceptability issues.

The evidence indicates that everything from the 10" down requires cleaning. It is easy to justify the individual LCAs as each has a defined frequency and number of properties impacted. However, with no properties directly impacted and a varying frequency of events in the downstream areas, it is difficult to give a direct justification to the 10" main without double count MoS improvement figures. This is despite the knowledge that the schemes in the downstream area will never achieve their full benefit without this being cleaned first.

Scheme 13 – Holyland Mains Cleaning

791 properties currently impacted by 3 events per year. After cleaning the frequency is expected to reduce to 0.6 times a year. This will cost £241,405 to clean.

5 Year Risk Value = $((791 \times 3) \times 29.58) \times 4.652728 - ((791 \times 0.6) \times 29.58) \times 4.652728$
 5 Year Risk Value = £261,272.41
 Cost / Benefit = £261,272.41 / £241,405
 Cost / Benefit = £1.08

Scheme 18 – Devon Drive 6 Inch Mains Cleaning

908 properties currently impacted by 2 events per year. After cleaning the frequency is expected to reduce to 0.4 times a year. This will cost £253,430 to clean.

5 Year Risk Value = $((908 \times 2) \times 29.58) \times 4.652728 - ((908 \times 0.4) \times 29.58) \times 4.652728$
 5 Year Risk Value = £199,945.51
 Cost / Benefit = £199,945.51 / £253,430
 Cost / Benefit = £0.79

Scheme 22 – Coshaston Mains Cleaning

391 properties currently impacted by 4.67 events per year. After cleaning the frequency is expected to reduce to 0.93 times a year. This will cost £482,702 to clean.

5 Year Risk Value = $((391 \times 4.67) \times 29.58) \times 4.652728 - ((391 \times 0.93) \times 29.58) \times 4.652728$
 5 Year Risk Value = £201,258.48
 Cost / Benefit = £201,258.48 / £482,702
 Cost / Benefit = £0.42

Scheme 4 – Bush Cross to Holyland Mains Cleaning

0 properties currently impacted by 0 events per year. After cleaning the frequency is expected to reduce to 0 times a year. This will cost £200,015 to clean.

Dependency Schemes: 13, 18, 22

5 Year Risk Value = $((0 \times 0) \times 29.58) \times 4.652728 - ((0 \times 0) \times 29.58) \times 4.652728$
 5 Year Risk Value = £0 + £261,272.41 + £199,945.51 + £201,258.48
 10 Year Risk Value = £662,476.40
 Cost / Benefit = £662,476.40 / £200,015
 Cost / Benefit = £3.31

Schemes	Report and Scheme Book MoS Impacts				
	A1 Safety of Water	A2. Customer Acceptability	A3. Reliability of Supply	F1. Asset Serviceability	F2. Leakage
Scheme 4					
Scheme 13		0.003456			
Scheme 18		0.001037			
Scheme 22		0.001728			

As scheme 4 has no direct customer impact therefore it doesn't attribute to any Measure of Success improvement. The addition of the risk values of the dependant schemes to Scheme 4, as a predecessor scheme, just highlights the importance of carrying out this potential solution in respect to its dependencies. The additional risk value of the dependency schemes ensures that the preceding scheme has a good cost benefit figure.

4 Current Cost of Consequence Figures

Clean / Waste	Service Measure Driver	Severity	Cost of Consequence	Social Valuation	
Clean Water	Drinking Water Quality - Aesthetic and T&O	Threshold Value Failure (e.g. Turbidity levels)	£927.00		<i>Per failure</i>
	Drinking Water Quality - Aesthetic and T&O	PCV Failure	£2,743.00		<i>Per failure</i>
	Drinking Water Quality - Aesthetic and T&O	Internal Event - Water Quality Related	£29.75		<i>Per property</i>
	Drinking Water Quality - Aesthetic and T&O	DWI Event Classification - Water Quality Related	£68.33		<i>Per property</i>
Clean Water	Drinking Water Quality - Chemical	Threshold Value Failure	£732.00	£0.00	<i>Per failure</i>
	Drinking Water Quality - Chemical	PCV Failure	£2,643.00	£0.00	<i>Per failure</i>
	Drinking Water Quality - Chemical	Internal Event - Water Quality Related	£68.86	£0.00	<i>Per property</i>
	Drinking Water Quality - Chemical	DWI Event Classification - Water Quality Related	£129.19	£42.04	<i>Per property</i>
Clean Water	Drinking Water Quality - Bacti Failure	Threshold Value Failure - Colony counts	£732.00	£0.76	<i>Per failure</i>
	Drinking Water Quality - Bacti Failure	PCV Failure - Coliform	£4,680.00	£7.57	<i>Per failure</i>
	Drinking Water Quality - Bacti Failure	Internal Event - Water Quality Related - Ecoli / Crypto	£69.51	£75.72	<i>Per property</i>
	Drinking Water Quality - Bacti Failure	DWI Event Classification - Water Quality Related	£131.79	£378.58	<i>Per property</i>

-	-	-	-	-	-
Clean Water	Drinking Water Quality - Complaints	Water Quality Complaint - Other	£29.58		<i>Per Contact</i>
	Drinking Water Quality - Complaints	Water Quality Complaint - Taste and Odour	£29.58		<i>Per Contact</i>
	Drinking Water Quality - Complaints	Water Quality Complaint - Discolouration	£29.58		<i>Per Contact</i>
-	-	-	-	-	-
Clean Water	Interruption to Supply	0 to 3 Hour Interruption to Supply	£14.38		<i>Per Property</i>
	Interruption to Supply	>3 to 6 Hour Interruption to Supply	£23.57		<i>Per Property</i>
	Interruption to Supply	>6 to 12 Hour Interruption to Supply	£62.46		<i>Per Property</i>
	Interruption to Supply	>12 to 24 Hour Interruption to Supply	£62.46		<i>Per Property</i>
	Interruption to Supply	>24 Hour Interruption to Supply	£109.96		<i>Per Property</i>
-	-	-	-	-	-
Clean Water	Pressure	Low pressure noticed by customer but above or at acceptable level	£179.88		<i>Per Incident</i>
	Pressure	High Pressure (customer complaints)	£205.92		<i>Per Incident</i>
	Pressure	Pressure below acceptable level (<9l/min; 9m head)	£254.64		<i>Per Incident</i>
-	-	-	-	-	-
Clean Water	Loss of production / resource	MI/d loss into supply	£104.52		<i>Per MI lost</i>
-	-	-	-	-	-
Clean Water	Water Use Restrictions	Drought trigger level 1: Issue of customer communication	£674,822.27		<i>Per incident</i>

	Water Use Restrictions	Drought trigger level 2: Implementation of hosepipe ban	£992,385.70		<i>Per incident</i>
	Water Use Restrictions	Drought trigger level 3: Implementation of drought order	£10,600,000.00		<i>Per incident</i>
	Water Use Restrictions	Emergency Measures	£10,600,000.00		<i>Per incident</i>
-	-	-	-	-	-
Clean Water	Flooding - Internal	No permanent damage, area easily cleaned and disinfected.- Low	£1,570.09		<i>Per incident</i>
	Flooding - Internal	Fittings - Repairable damage caused, replacement of household goods / carpet required. - Medium	£10,744.02		<i>Per incident</i>
	Flooding - Internal	Fixtures - Irreparable damage caused (e.g. Re-plastering, re-wiring required) - High	£21,951.43		<i>Per incident</i>
	Flooding - Internal	House destruction	£318,332.41		<i>Per incident</i>
-	-	-	-	-	-
Clean Water	Flooding - External	Public amenity	£354.46		<i>Per Area</i>
	Flooding - External	Roads or public access / Footpath	£354.46		<i>Per Area</i>
	Flooding - External	Non curtilage private	£755.12		<i>Per Area</i>
	Flooding - External	Curtilage not inhibiting access	£2,828.66		<i>Per Area</i>
	Flooding - External	Curtilage inhibiting access	£13,031.68		<i>Per Area</i>
-	-	-	-	-	-
Clean Water	Breach of EA Licence conditions	Failure of measurement instrumentation	£532.17		<i>Per failure</i>
	Breach of EA Licence conditions	Failure of recording / reporting requirements	£709.70		<i>Per failure</i>
	Breach of EA Licence conditions	Over Abstraction - Annual	£32,268.88		<i>Per failure</i>
	Breach of EA Licence conditions	Over Abstraction - Daily	£49,738.30		<i>Per failure</i>
-	-	-	-	-	-

Clean Water	Leakage		£38,146.15		<i>Per Mld</i>
Clean Water	Burst		Not currently used		
General	Unplanned Maintenance		Not currently used		-
-	-	-	-	-	-
General	Sludge Treatment and Disposal	Sludge Compliance Failure leading to dewatering	£117.11		<i>Per tonne</i>
	Sludge Treatment and Disposal	Sludge Compliance Failure leading to re-treatment	£119.51		<i>Per tonne</i>
	Sludge Treatment and Disposal	Sludge Compliance Failure leading to re-treatment TTA	£127.58		<i>Per tonne</i>
	Sludge Treatment and Disposal	Sludge Compliance Failure leading to Tankering	£161.36		<i>Per tonne</i>
	Sludge Treatment and Disposal	Sludge Disposed of through Landfill	£186.36		<i>Per tonne</i>
-	-	-	-	-	-
General	Nuisance - Noise, Flies, Pest, Other	Customer Complaint	£35.05		<i>Per incident</i>
	Nuisance - Noise, Flies, Pest, Other	Pressure group involvement	£893.84		<i>Per incident</i>
	Nuisance - Noise, Flies, Pest, Other	Environmental Health Involvement	£14,875.37		<i>Per incident</i>
	Nuisance - Noise, Flies, Pest, Other	Statutory Nuisance Abatement Notice	£29,061.63		<i>Per incident</i>
-	-	-	-	-	-
General	Pollution Incidents (Land, Aquatic)	Category 4: Has no potential to have an environmental impact	£183.10		<i>Per incident</i>
	Pollution Incidents (Land, Aquatic)	Category 3: Has the potential to have a minor environmental impact e.g. small spills with little visual impact	£5,595.30		<i>Per incident</i>

	Pollution Incidents (Land, Aquatic)	Category 2: Has the potential to have a significant environmental impact e.g. cancellation of a local water sport event due to discharge of sewage	£23,493.17		<i>Per incident</i>
	Pollution Incidents (Land, Aquatic)	Category 1: Has the potential to have a major environmental impact e.g. >100 dead fish	£42,625.00		<i>Per incident</i>
-	-	-	-	-	-
General	Environmental Impact	River Waters		£3,727.95	<i>Per km per year</i>
	Environmental Impact	Bathing Waters		£239,715.00	<i>Per area per year</i>
	Environmental Impact	Shellfish Water		£456,000.00	<i>Per area per year</i>
	Environmental Impact	Special Protection Areas		£100,000.00	<i>Per area per year</i>
-	-	-	-	-	-
General	Traffic and Transport Disruption	B roads or non commuting roads		£378.00	<i>Per day</i>
	Traffic and Transport Disruption	A roads and main commute roads		£3,163.00	<i>Per day</i>
	Traffic and Transport Disruption	Motorway		£205,653.00	<i>Per day</i>
	Traffic and Transport Disruption	Railway		£4,380.00	<i>Per day</i>
-	-	-	-	-	-
	Health & Safety	Near Hit		Not currently used	<i>Per incident</i>
General	Health & Safety	Minor Injury		£322.00	<i>Per incident</i>
	Health & Safety	Serious Injury / Serious Work Related Illness		£19,332.00	<i>Per incident</i>
	Health & Safety	Permanently Incapacitating Injury / Permanently Incapacitating Illness		£333,303.00	<i>Per incident</i>

	Health & Safety	Fatality		£1,668,738.00	<i>Per incident</i>
-	-	-	-	-	-
General	Legal Compliance	Failure to comply with legislation	£1,995.92		<i>Per incident</i>
	Legal Compliance	Enforcement Notice issued	£12,061.41		<i>Per incident</i>
	Legal Compliance	Court case	£25,658.71		<i>Per incident</i>
-	-	-	-	-	-
General	Other costs of failure (tankering, call outs, hiring of additional equipment, Ex Gratia GSS compensation...)	Other cost of failure	At cost		
-	-	-	-	-	-
General	Staff Productivity	0 - 4 Hours lost productivity	£117.28		<i>Per incident</i>
	Staff Productivity	>4 - 8 hours lost productivity	£234.56		<i>Per incident</i>
	Staff Productivity	>8-24 hours lost productivity	£703.68		<i>Per incident</i>
	Staff Productivity	> 24hours lost productivity	£1,407.36		<i>Per incident</i>
-	-	-	-	-	-
General	Buildings / Aesthetics	Welfare issues	Not currently used		
	Buildings / Aesthetics	Signs of damage - cracks, crumbling or lack of amenities	Not currently used		
	Buildings / Aesthetics	Process impacted by structural building damage	Not currently used		
-	-	-	-	-	-

General	Customer Contacts (others)	Customer Contact by Telephone	£265.92		<i>Per incident</i>
	Customer Contacts (others)	Customer Contact in Writing / Email	£303.42		<i>Per incident</i>
	Customer Contacts (others)	Contact Escalated to Director Level	£985.90		<i>Per incident</i>
	Customer Contacts (others)	Issue Escalated to CC Water / OFWAT / DWI / EA	£1,724.68		<i>Per incident</i>