TECHNEAU D7.5.6
JUNE 2010

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Demonstration of Flushing

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Title
Cost Benefit Analysis of Water Quality Improvement in Riga Water Distribution: Demonstration of Flushing

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Deliverable Number
D7.5.6

This report is:

PU = Public

Contents

1 INTRODUCTION

Riga Water is a municipal water company which supplies water to about 700.000 inhabitants in Riga city. The quality of drinking water in Riga city generally meets regulatory standards. However, in some parts of the city discoloration events are common. The discoloration events have resulted in some customer complaints, a loss of customer goodwill, reduced revenue (as a result of increased consumption of bottled water) and fines when regulated standards are not met.

A flushing trial demonstrated the efficiency of unidirectional flushing (UDF) and Re-suspension Potential Measurement (RPM) in identifying and mitigating turbidity 'hotspots' in the distribution networks that could cause discoloration problems. As a result of the trial, Riga Water proposes to clean 1056 km of its network in order to reduce turbidity and discoloration in drinking water, hence reducing customer complaints. This intervention will involve the use of RPM to locate sedimentation 'hotspots' within a water supply zone, development of a flushing plan, subsequent flushing, disposal of waste water and monitoring of performance.

There is a need to assess the cost effectiveness of the programme before it commences. This will ensure that the company delivers good quality water to customers in a cost effective manner; saving money and time. TECHNEAU Partner WRc – working closely with RTU and Riga Water – has demonstrated the Cost-Benefit Analysis (CBA) tool developed as part of Work Package 5.1 to investigate the cost effectiveness of a range of flushing scenarios in the short and long term. This spreadsheet-based tool has been designed to help water suppliers demonstrate the cost effectiveness of operational and maintenance schemes by assessing the costs and benefits of various intervention options over a defined period of time.

2 COST BENEFIT ANALYSIS OF FLUSHING

Cost benefit analysis (CBA) is an economic tool for evaluating all the relevant costs and benefits of a proposed plan of action. This allows the comparison between alternative options as a common unit which is usually monetary[1]. This technique was used to assess the costs and benefits to determine the cost effectiveness of different flushing options for the Riga distribution network.

The CBA approach in this study is a financial CBA. The purpose of a financial CBA is to assess the financial viability of a proposed plan of action or project. It therefore focuses on the financial benefits and costs to the water utility attributable to the project in order to determine the least cost option.

It should be noted that the results of a CBA provide a guide to decision-making and should not be used as the sole basis to make operational decisions. It should however be used in conjunction with company's operational programme and objectives to make a sound decision.

2.1 Flushing scenarios

Different flushing scenarios were analysed in the short term (full flushing cycle of 1056 km of mains within 5 years) and in the long term (within 10 years). In the short term the following scenarios were analysed:

- Scenario 1: 'Do nothing' for 5 years - In this scenario, we assumed that no flushing is undertaken over the next ten (5) years. This will result in a rise in the number of discoloration-related customer complaints and fines.
- Scenario 2: Flush entire network within a period of three (3) years
- Scenario 3: Flush entire network within a period of five (5) years

In the long term, the following were analysed:

- Scenario 4: 'Do nothing' for 10 years.
- Scenario 5: Flush entire network within a period of ten (10) years
- Scenario 6: Delay flushing for 3 years and flush the entire network over a period of 7 years after that.

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[1] Framework for operational cost benefit analysis in water supply (2007) TECHNEAU report D5.1.2.
http://www.techneau.org/fileadmin/files/Publications/Publications/Deliverables/D5.1.2.frame.pdf

The TECHNEAU CBA tool was used to appraise the six (6) different scenarios to identify the most economic way of flushing the network. The CBA involves the following key elements:

- A base case or 'do nothing' option which represents existing levels of services and costs to Riga Water. The 'do nothing' option is implicit in the analysis since the costs and benefits will be measured as the difference between the 'do nothing' option and the intervention scenario.
- Costs and benefits of all proposed flushing scenarios over a defined flushing period.
- A discount rate to convert future values to present values.
- Decision rule – net present value (NPV) and benefit cost ratio (BCR).
- Criteria for assessing the benefits of flushing operations.

2.2 Evaluating the costs and benefits of flushing

A key step in the CBA process is the proper identification and estimation of all the costs and benefits of options. For the costs and benefits to be determined, the following were defined:

- the objective of the flushing,
- the type of flushing,
- benefits that the water supplier wants to achieve, and
- the performance parameters to measure these benefits.

Costs and benefits data for the analysis were provided by Riga Water.

The cost elements included in the analysis were:

- Cost of undertaking RPM including labour, software development, travel and expenses.
- Equipment – flow meter, turbidity meter, vehicles, etc.
- Staff – labour, travel and expenses for developing flushing plan and the flushing itself.
- Cost of public notification – through local news advert, insert in monthly bills, tag on doors or flyers sent through the mail.
- Cost of disposal of waste water, i.e. charge for disposal to sewers or water bodies.
- Production cost of water flushed out – this value was estimated based on the total volume of water flushed out and the cost (chemicals and power) per cubic metre of water.

Intangible costs to the company such as the loss of public image as a result of perceived waste of water and traffic disruption during flushing were excluded from the analysis. This is because sufficient data were not available to assess the impact and subsequently quantify them in monetary terms. Thus the analysis focussed on the tangible or financial costs of flushing.

Benefits of flushing

The main measures of benefits used in the analysis were:

- Reduction in customer complaints – In 2007, Riga Water registered a total of 60 complaints from customers. This figure was used as a base figure in the analysis. It is assumed there is a linear relationship between time and the number of complaints received per year. This implies that there is a linear rise in the number of complaints with time if no flushing is done. This trend is compared with an assumed linear decline in complaints when flushing is done over a period of time. The reduction in complaints is estimated as the difference between the estimated number of complaints received in the 'do nothing' case and when an intervention is put in place.
- Reduction in claims / fines for discoloration.

2.3 Discounting costs and benefits

All the future costs and benefits were converted to their present values using a discount rate of 6%[2] , and the NPV and BCR calculated. Discounting is based on the principle that more importance is placed on costs and benefits that occur now than those that arise in the future. A company's cost of capital (or weighted average cost of capital, WACC) is usually the preferred rate for assessing the costs relevant to them. This is the private opportunity cost of capital and it is the rate of return on the most valuable alternative project given up. However, when evaluating projects which have broad impacts on society, the capital market is not always the best arbiter on which to make such a decision[3].

NPV of an option is the difference between the discounted total costs and benefits. It is therefore the amount that expresses the value of benefit that will result from an option. If it is positive then the project should be undertaken and if negative the proposed plan will not be worthwhile either in financial or economic terms.

Another way of deciding which options is the most attractive is to choose the option with the highest BCR. By placing monetary values on all benefits and costs, it is possible to rank options depending on their ratio of benefits to costs (i.e. the amount of benefits received for every pound spent). If the ratio is greater than 1, the benefits outweigh the costs and project delivers net social benefit.

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[2] This rate represents the interest rate as suggested by the Latvia Central Bank.

[3] TECHNEAU Report D5.1.2, *Framework for Operational Cost Benefit Analysis in Water Supply*.

2.4 Criteria for assessing benefits of flushing

Based on the costs and benefits listed above, the measurable performance of the benefits of flushing will be a reduction in the number of customer complaints after flushing has been done. This was measured in terms of amount of money spent per reduction in complaint (€/complaint) and the number of complaints reduced per each 1000 m^3 of water flushed.

3 RESULTS OF ANALYSIS

A comparison of the total costs of the flushing scenarios is given in Table 3.1:

Table 3.1 Comparison of costs and benefits

Scenarios	Cost (€) (Present Value)	Benefit (€) (Present Value)	NPV (€)	BCR
Scenario 1 'Do nothing' (5yrs)	388,557	0	-388,557	-
Scenario 2 (FFC 3 yrs)	198,720	337,726	139,006	1.7
Scenario 3 (FFC in 5yrs)	120,348	283,532	163,184	2.4
Scenario 4 'Do nothing' (10yrs)	691,472	0	-691,472	-
Scenario 5 (FFC 10 yrs)	105,494	365,385	250,891	3.4
Scenario 6 (FFC after 3yrs)	70,549	675,606	605,057	9.6

FFC- full flushing cycle

From Table 3.1, the total costs of the two 'do nothing' scenarios (i.e. Scenarios 1 and 4) are the highest. The company will incur greater cost in terms of handling increasing numbers of customer complaints and payment of claims if it does not put in interventions to resolve discoloration problems over the short and long term.

All the flushing options (Scenarios 2, 3, 5 and 6) are cost beneficial, i.e. they have a positive NPV implying that they will deliver more benefits than the costs the company will incur to flush the pipes. However, the most cost effective flushing plan is to defer flushing for the next 3 years and then flush over a period of 7 years. This reflects the low number of discoloration-related complaints that Riga Water is currently receiving per year, so there is no economic justification to flush until after three (3) years when the level of complaints received becomes significant. A graphical comparison of the costs of all the scenarios is shown in the Figure 3.1 below.

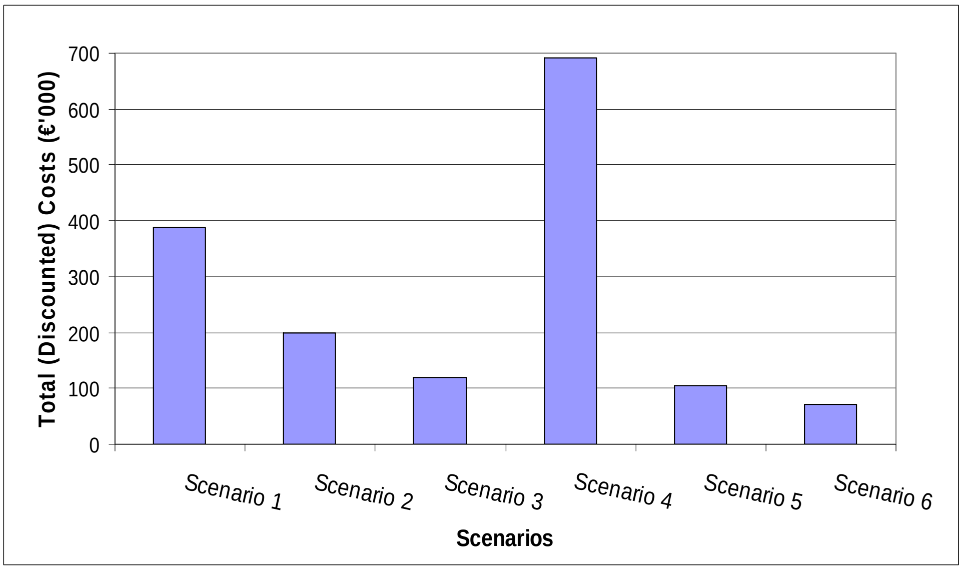

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Figure 3.1 Comparison of costs of different flushing scenarios

Figures 3.2 and 3.3 show the cash flow of options over a period of 5 years (i.e. short term) and 10 years (i.e. long term) respectively.

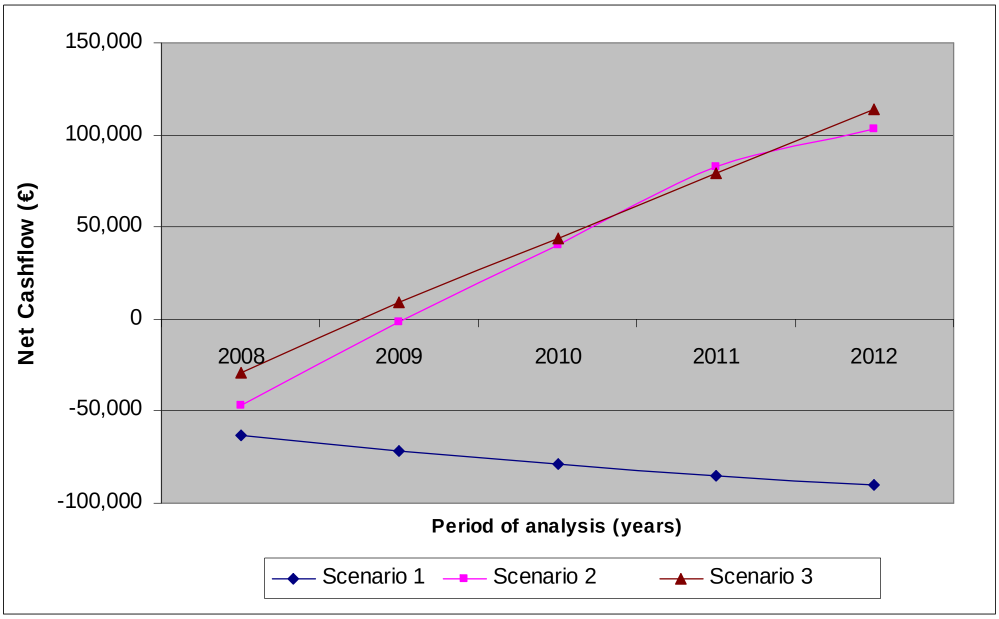

Figure 3.2 Net cashflow of flushing scenarios over 5 years (short term)

The results of the analysis show that in the short term, it is more 'profitable' for the Company to flush their pipes within the first 3 years than to do so over 5 years. It will cost them more not to flush at all in the next 5 years i.e. 'do nothing' option (refer to Table 1).

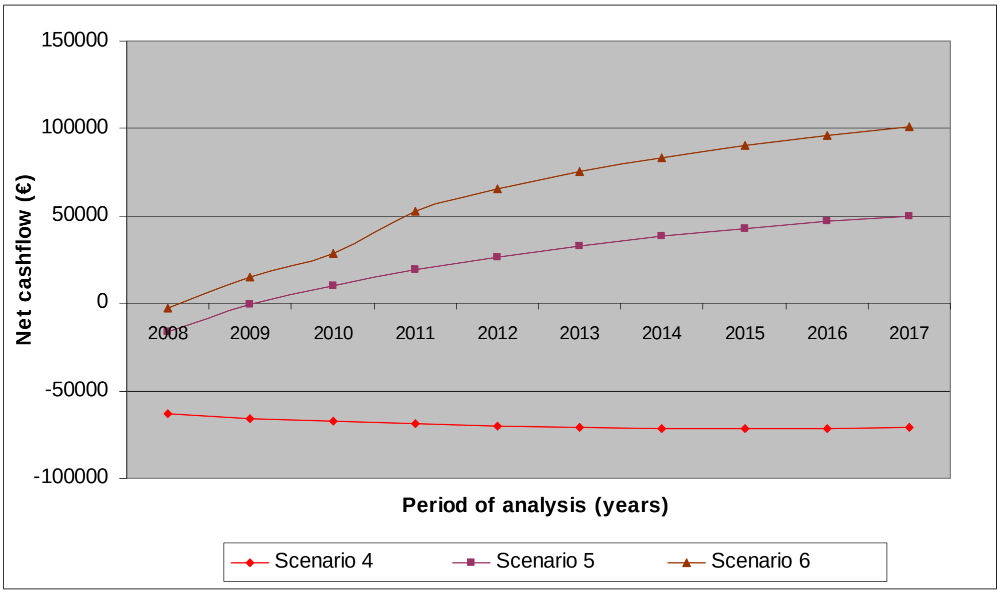

Figure 3.3 Net cashflow of scenarios over 10 years (Long term)

Figure 3.3 shows that the net cash flow of Scenario 6 (i.e. defer cleaning of pipes until 2012 and then flush over 7 years) is most cost beneficial over a period of 10 years.

3.1 Sensitivity analysis

A sensitivity analysis was undertaken to assess the robustness of the expected NPV to changes in the number of registered complaints received per year and changes in the cost of complaints. This analysis was also based on earlier assumption about the linear relationship between the number of complaints received and time.

This sensitivity was applied to only Scenarios 2, 3, 5 and 6. The result of the analysis is shown in Tables 3.2 and 3.3.

Table 3.2 NPV as a function of changes in the number of registered complaints per year

Performance Criteria	Net Present Value (€)			
	n=60 (base)	n=100	n=200	n=300
Scenario 2	139,006	227,386	444,837	663,288
Scenario 3	163,184	304,758	419,939	603,335
Scenario 5	250,891	353,524	610,106	866,687
Scenario 6	605,057	761,266	1,151,787	1,542,308

n=number of registered complaints per year

Generally, there is an increase in the NPV with increase in the number of complaints registered per year. This implies flushing becomes more cost effective as the number of discoloration-related complaints from customers increase, i.e. the higher the number of complaints received, the more important it is for the company to put in interventions to deal with the problem.

Table 3.3 NPV as a function of changes to the average cost of handling each complaint

Performance Criteria	Net Present Value (€)		
	x=€100	x=€408.85 (base)	x=€600
Scenario 2	39,994	139,006	200,286
Scenario 3	80,060	163,184	214,630
Scenario 5	134,596	250,891	322,867
Scenario 6	428,055	605,057	714,606

x=cost of handling each complaint

The results from Table 3.3 show that the higher the cost incurred to handle each customer complaint, the more benefits will accrue to the company when they put in measures to reduce the number of complaints.

3.2 Measuring the performance of flushing options

Table 3.4 provides a summary of the quantitative measures of performance for each of the scenarios.

Table 3.4 Summary of performance criteria of flushing options

Performance Criteria	Scenario 2	Scenario 3	Scenario 5	Scenario 6
Period of evaluation of option (years)	5	5	10	10
Total volume of water flushed ('000 m^3)	165.88	165.88	165.88	165.88
Total cost of flushing (Present Value) (€)	198,720	120,348	105,494	70,549
Total number of complaints reduced	380	320	540	840
Cost per complaint reduced (€/complaint)	523	376	195	84
Number of customer complaints reduced/1000 m^3 of water flushed (no./'000m^3)	2	2	3	5

Table 3.4 shows that apart from Scenario 2, the cost to reduce a complaint through flushing the network is less than the cost incurred dealing with a complaint of turbid/discoloured water (estimated as 408.85 € per complaint).

This implies that it will cost the company less to clean their network through flushing than to deal with turbidity-related complaints using Scenarios 3, 5 and 6. However, based on the assumptions made and data available for this analysis, the CBA identifies Scenario 6 as the most cost-effective option as it provides more benefits than all the other scenarios. This is illustrated in Figure 3.4 below.

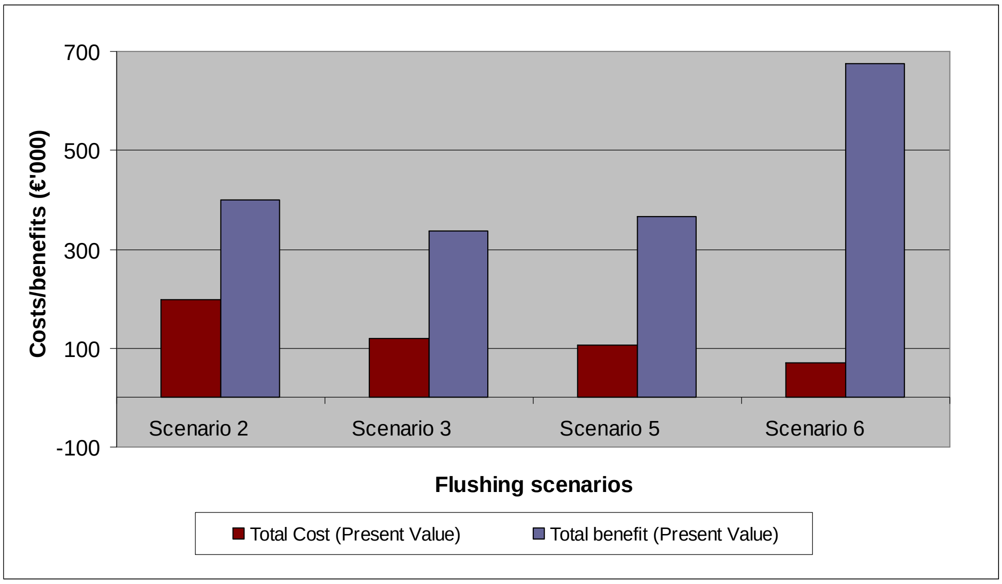

Figure 3.4 Comparison of the costs and benefits of different flushing scenarios

4 CONCLUSIONS

CBA seeks to provide the necessary information (in terms of costs and benefits) to evaluate the cost effectiveness of operation and maintenance schemes to improve water quality. The analysis of the different flushing scenarios shows that the most cost effective flushing plan is for Riga Water to defer flushing for three (3) years, and then carry out a full flushing cycle within a period of 7 years. This outcome has been based on only the financial or measurable cost and benefits of flushing provided by Riga Water within the limit of assumptions that has been used in the analysis. Other intangible cost to the company and the public at large such as street flooding, perceived waste of water etc. were not included in the analysis due to lack of appropriate data. Also the analysis did not take into consideration the layout of the network which might affect how flushing is done.

The analysis uses the quantitative measure such as number of complaints reduced per € spent and the number of complaints reduced per cubic meter of water flushed to measure the performance of flushing scenarios. There are other quantitative measures of performance such as a reduction in turbidity and colour, reduction in iron levels etc. before and after flushing for each scenario which were not assessed as a performance indicator. With the availability of adequate trial data, these should be determined so that the selection of a flushing plan is not based on the financial impacts but also how a particular flushing plan achieves the target water quality levels.

Performing a CBA does require time and effort, however, the information gained from a good quality CBA can provide significant pay-backs by improving the decision making process. It should be noted that the results of a CBA provide a guide to decision-making and should not be used as the sole basis to make operational decisions.