Purpose of this example: Demonstrate the application of condition analysis and optimization within a water network	
General information on the water utility or project	
Name of town/project/utility	Stadtwerke Bad Nauheim (public utility), Germany
Type of project	Asset Management
Scope of project	Condition analysis and optimization
Contact (optional)	Peter Drausnigg, General Manager
Asset manager/project manager	Mr. Peter Drausnigg / Dr.-Ing. Gerald Gangl
Service contractor	RBS wave GmbH
Population (people served)	31,000
Length of network and age of system	150 km supply pipe, middle net age 39 years
Number of service connections	6,000
Number of pumping stations	3
Special conditions	Diameter up to DN 500, 10 supply zones, 7 reservoirs, 11 wells
Project related ISO standard	ISO 24516-1
GIS in use, since when?	Yes, since 2001
Main methods and tools	Condition analysis by using an age-dependent model (software PiReM) by considering external factors like failure statistics, material, diameter, traffic, etc.…
Initiation and main features of the project (AM/water loss)	
Objectives and policy/regulation, if relevant?	
There is no regulatory requirement for the aspect. The idea is to define and optimize the CAPEX strategy, to invest more to avoid an investment backlog.	
What are the main actions in the recent past (lengths of rehabilitated network, acquisition of knowledge, active leakage control, pressure management, DMA…)?	
In the past the annual rehabilitation rate was in average 1.0%. The average failure rate of the last 5 years with 0.07 failures/km*a and the water loss indicator of 0.02m³/km*a shows a good condition of the network.	
What are the tools, criteria, performance indicators, technologies, used to implement the project (see e.g. ISO 24523 or ISO 24528)?	
Performance indicators according to ISO 24523 (regional benchmarking in the state of Baden-Württemberg), Performance indicators according to the German regulation DVGW. Software tool PiReM – Pipe Rehabilitation Management - for supporting the process of data analysis, model calibration and set up and analyze of scenarios.	
Project activities	
Main activities (leak repair, pipe renewal, special techniques, …): (include figures or volumes if available	
Security of supply, quality and reliability are the main aspects of maintenance planning. Demand-related recurring inspections in the plant system ensure the long-term maintenance of the technical standard in the pipe network. Information on the inspection and monitoring of networks and installations, remedial measures carried out to date and careful documentation form the basis for professional planning. Only the close connection of the experiences from the daily operation of the	

network with strategic approaches (quality goals, cost limitations) enables efficient rehabilitation planning (Strategic Asset Management).
The merging of the existing information makes it possible to define goals, map key figures and derive measures from them. If this information is available in digital form, this information can also be analyzed and evaluated with the help of suitable software products, and an asset management strategy derived from it.

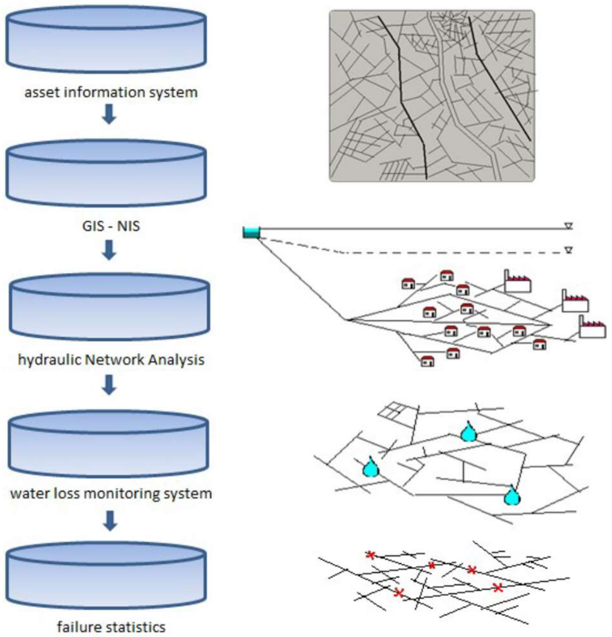

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Figure 1: Information sources in the supply network

If data is available digitally, this information can be merged and evaluated in an asset management system. In addition to the aging process of a pipe group and the associated probability of failure, several factors should be considered when developing an asset management strategy.
With the development of the rehabilitation strategy, the required amount of rehabilitation and the associated rehab budget are initially determined for a long-term observation period in order to achieve or maintain levels of quality or condition. For this purpose, cohorts with similar aging properties should be formed in order to be able to make an improved statement about the future failure behavior. Especially with older materials, the level of detail of the information (e.g., type of wrapping) is rather low, which is why attributes such as the year of construction can often be approximated to generations with / without improved wrapping. The adapted aging functions can be used to identify a strategic renewal requirement and to derive a necessary budget depending on the company goals.

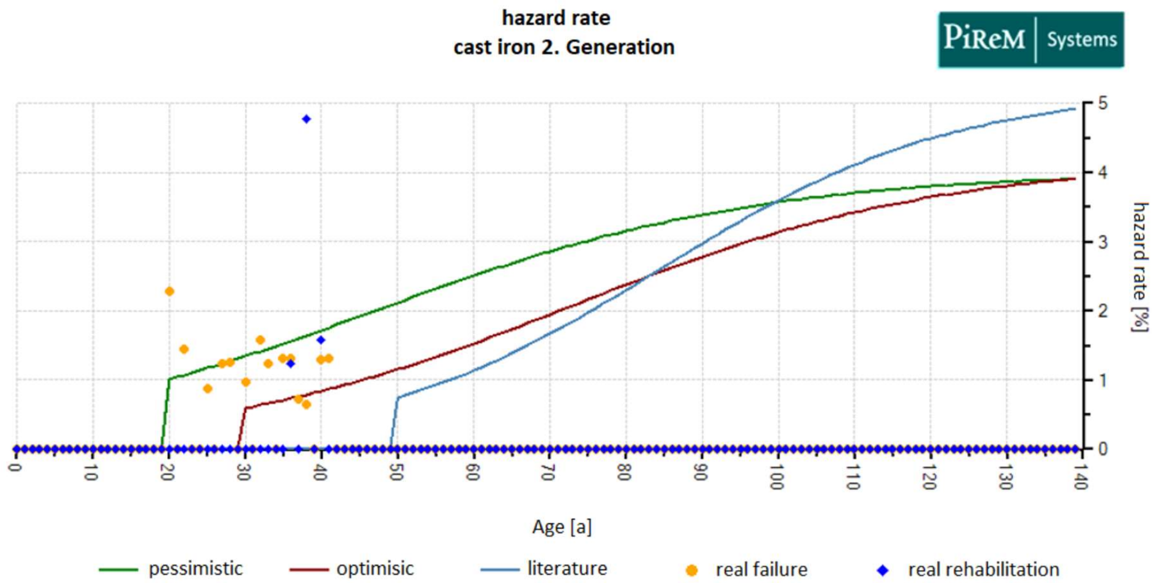

Figure 2: calibrated age function of a pipe group

By jointly analyzing the existing information from the various systems (GIS, hydraulic network calculation, water loss monitoring) in an asset management system, the different boundary conditions can be weighted, combined and an informed decision for renewal or repair can be made which meets budgetary and performance requirements. Where possible an overall strategic plan for drinking water networks should be combined with that for other utility networks such as sewer, district heating, electricity, gas such that construction costs and , road works are minimized,

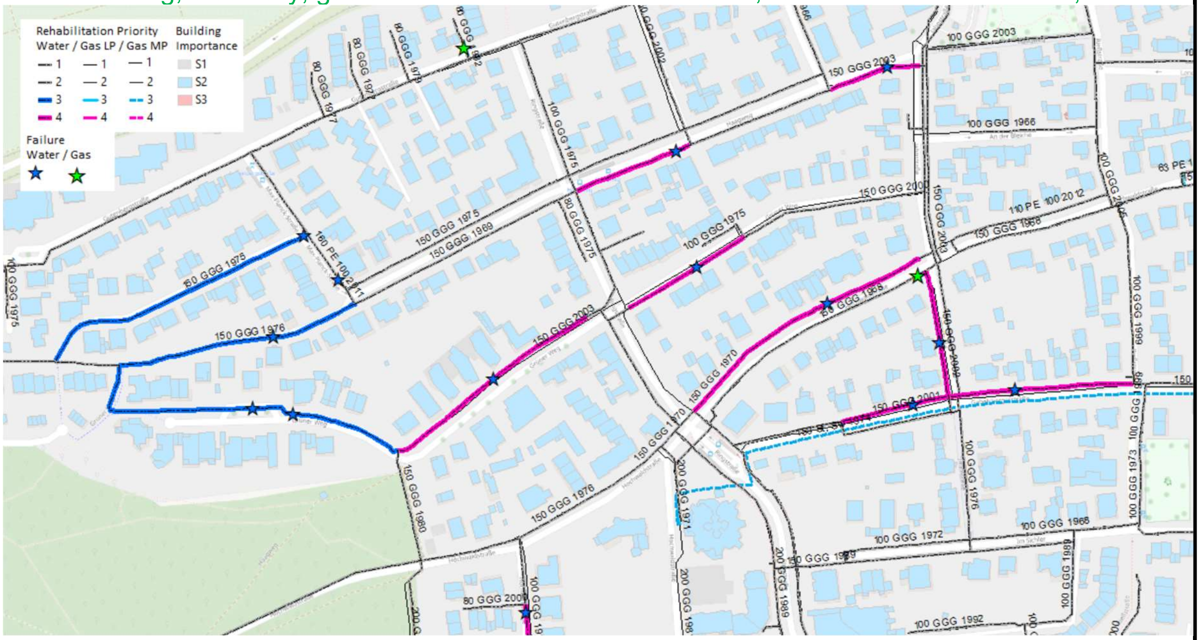

Figure 3: pipes with rehabilitation priority (combination of water and Gas network)

Outcomes of the asset management policy

Results. What are the main outcomes in terms of impact on the assets, the operation, the planning of works, etc.?

By using an age-depend models and a calibrated hydraulic model of the pipe network, a strategy for optimizing the network was developed. The optimization had a focus on the optimal failure rate (supply interruptions) and condition as well as the flow velocity, the retention time in the network or the supply for firefighting These were optimized within financial constraints.
Additionally, the condition of the related assets (reservoirs, wells, pumping station) was analyzed for a strategic reconstruction of the trunk network.
Parallel to the rehabilitation strategy and hydraulic analysis of the water supply network, the same procedure was also elaborated for the gas supply network. So, it is possible to use synergy effects at a construction site when renewing a water and a gas pipe.

Setbacks, failures, upcoming activities (optional):

Financial aspects

How is the project budget defined? What are the constraints? What is the impact on tariff? Is there a specific budget dedicated to asset management policy, on top or instead of usual budgets (OPEX and CAPEX)? For what duration?

The approach is to help define a CAPEX budget and furthermore to help prioritize works within a given CAPEX envelop. There is a cost for the method itself, that is part of OPEX

Impact on the operational costs quantified or analyzed and which method is used?
Reduction of operational cost (cost for repairing leaks) was part of the cost value comparison

Indicate financial criteria (e.g. return on investment), give figures

The calculation of the cost value comparison was made for the next 25 years using a failure forecast model.

Method for the estimation of the value of assets (optional)? Depreciation method used

The financial department of the utility estimated the value of assets using the depreciation method.

Recommendations for a good management of assets
Conclusions, return of experience (lessons learned)
For evaluating the actual rehabilitation condition, a risk-based method was used. The importance of a pipe segment was defined by using a calibrated using failure statistics. One main conclusion was that standard parameters for an aging model are helpful but may differ a lot from specific influencing factors within individual networks. A good database will therefore help by calibrating a model. Another conclusion is, that a risk-based method leads to a better result than a priority ranking based on a separated condition-based analysis and a separate hydraulic analysis.
Possible improvements
Upgrade of documentation of historic failures (digital instead of analog).
Outlook and suggested improvements
Parallel to the asset management strategy a hydraulic analysis was elaborated to define the relevance of pipes in the network. Thus, the results of a hydraulic analysis in combination with an age-depending strategy will lead to a risk-based method.