Guide

“How to develop professional operators competences in Non Revenue Water loss reduction?”

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Water: the driving force of all nature

water supply & distribution

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1. Introduction

The aim of this brochure is to inform you about the results of the LLP partnership project "Water: the driving force of all nature; water supply and distribution".

This partnership concerning water supply and distribution is a follow-up of the ProWat project. This project aims to reduce water loss. The Leonardo da Vinci programme has funded the ProWat project. ProWat dealt with planning and implementing non-revenue water strategies to improve the performance of water supply and distribution systems. "Non-revenue water" is the difference between the volume of water put into a system and the volume of water paid by the customers. The ProWat project will help to reduce this water loss, through training modules and software tools to reduce the loss of drinking water and provide technical assistance to water authorities.

This first step, developing new protocols and discussing them with (utility) managers, is not enough. Utility personnel at all levels in the organisation must be trained in the new methods, but particularly at field operations level (technicians). The partnership brings (potential) utility employees up to date on new methods to improve the performance of water supply and distribution systems.

Water management can provide a wide range of professional challenges for people starting their career in this industry. There are many good reasons for choosing the water sector as the field in which one wants to work. Life on earth requires water. Water is a basic need of humans and a central element in all civilisations. With this in mind one should also remember that still billions of people have no access to clean water and that this is one of the main causes for diseases. Thus there is a great need for work in the field of water supply all over the world.

New career pathways for bright, talented professional operators are created and supplied with a certification program which gives credentials for their knowledge. These professionals are able to work all over Europe.

The timing is perfect for launching training initiatives in this field. The partnership recognize that this personnel shortage problem can be solved with suitable training programmes exclusively dedicate to the new methods developed for water loss evaluation and management. A new methodology offers a great opportunity to redesign the old network training programs and to create new career pathways for bright, talented professional operators. If coupled with a certification program which gives credentials for the knowledge, such training could help new employees enter into an area, where they are needed.

The water loss-issue will be addressed in Europe and worldwide. Water is a valuable asset and will play a more important role in the future. By training people and sharing experiences in European water distribution networks they will be prepared to deal with water in a more efficient and effective way.

This brochure is one of the ways in which the team of the partnership project intends to help to answer the question: "How do we bring utility employees up to date on new methods to improve the performance of water supply and distribution systems?".

The knowledge is developed! Now it is time to implement training tools further and train the utility personnel in the new methods at all levels in the supply and distribution companies. In the recent years water loss managers have faced a critical shortage of qualified, trained field crews skilled in material management, construction controls and proper leakage and repair.

This publication will help to trigger different target groups to put into practice the results of the ProWat project and other educational tools.

The targets groups for this guide consist of:

1. Students of vocational education institutes and universities (Bachelor/Master).
2. Employees who will develop their competences through formal and informal learning.
3. Companies which are working on quality security for craftsmanship.
4. Companies who will improve their performance in asset management.
5. Educational institutes who will organise education on water distribution.

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2. Questions & Answers

Many municipalities, regions and countries are struggling to ensure that customers receive a reasonable supply of safe drinking water, often via a pipe network that is inadequate, with poor record systems. Tariff systems and revenue collection policies often do not measure the true value of water supplied, which limits the utility's costs recovery and encourages customers to underestimate the service.

This section discusses questions connected with water loss reduction and gives you insight in the possibilities to improve water loss reduction, so that you have a view in the possibilities to improve water loss reduction.

2.1 Non-revenue Water loss reduction (NRW)

2.1.1 What is Non-revenue Water loss reduction?

Non-revenue water is water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred as physical losses) or apparent losses (for example through theft or metering inaccuracies). High levels of NRW are detrimental to the financial viability of water utilities, as well to the quality of water itself. NRW is typically measured as the volume of water "lost" as a share of net water produced. However, it is sometimes also expressed as the volume of water "lost" of water distribution network per day.

In other words: Non-revenue water is the difference between the volume of water put into a water distribution system and the volume that is billed to customers. NRW includes three components: physical (or real) losses, commercial (or apparent) losses, and unbilled authorized consumption.

- Physical losses comprise leakage from all parts of the system and overflows at the utility's storage tanks. They are caused by poor operations and maintenance, the lack of active leakage control and poor quality of underground assets.
- Commercial losses are caused by registered customer meter, data-handling errors, and theft of water in various forms.
- Unbilled authorized consumption includes water used by the utility for operational purposes, water used for fire fighting and water provided for free to certain consumer groups.

2.1.2 Why do utilities struggle with Water loss reduction?

In spite of the potential benefits, NRW reduction is not a simple matter to implement and this explains why so many water utilities fail to address this issue effectively. Not only do new technical approaches have to be adopted, but effective arrangements must be established in the managerial and institutional environment which often some fundamental challenges in the utility require attention

High levels of NRW are caused by huge volumes of water being lost through leaks not being invoiced to customers. It seriously affects the financial viability of water utilities through lost revenues and increased operational costs. Leakage can also trigger huge infrastructure costs and become a risk for the quality of water, namely on hygienic levels.

A high NRW level is normally a surrogate for a poorly run water utility that lacks the governance, the autonomy, the accountability and the technical and managerial skills necessary to provide reliable service to their customers The waste of resources resulting from high NRW levels varies between 2 and more than 70%..

2.1.3 What is the main reason for insufficient NRW reduction?

Not understanding the magnitude, sources and cost of NRW is one of the main reasons for insufficient NRW reduction efforts around the world. Only by quantifying NRW and its components, by calculating appropriate performance indicators, and turning volumes of lost water into monetary values can the NRW situation be properly understood and the required action taken. It is noteworthy that despite the fact that many utilities in the developing world have implemented NRW reduction programs with donor funding, it is rare that a comprehensive water balance, as described in 2.1.7 was actually developed and calculated. It is no wonder, therefore, that the end results often fail to match expectations.

2.1.4 Is NRW management technically difficult?

NRW management is not technically difficult, but it is complex. Understanding properly the baseline situation is a critical first step in moving toward an effective reduction program.

2.1.5 What capacity is needed for the employees for NRW?

NRW requires a range of skilled staff, including managers and professional engineers. Besides them you need also street crews, technicians and plumbers. “NRW reduction,” in its broadest sense, is neither taught at universities or technical colleges nor in many of the water industry training institutions around the world. As a consequence, staff with necessary skills are not widely available. Addressing this issue will require both an acceptance of the widespread challenges and consequences associated with NRW and then the development of appropriate training materials, methods and institutions. A major initiative is required to build such capacity.

2.1.6 Why is the management focus important in an effective NRW programme?

Establishing and maintaining an effective NRW program is, besides all other difficulties, a managerial problem. Physical loss reduction is an on-going, meticulous activity with few supporters among the following:

- Politicians: there is no “ribbon cutting” involved.
- Engineers: it is more “fun” to design treatment plants than to fix pipes buried under the road.
- Technicians and field staff: detection is done primarily at night, and pipe repairs often require working in hazardous traffic conditions.
- Managers: it needs time, constant dedication, staff and up-front funding.

Nor is the reduction of commercial losses very popular among the following:

- Politicians: unpopular decisions might have to be made (disconnection of illegal consumers or customers who don’t pay).
- Meter readers: fraudulent practices might generate a substantial additional income.
- Field staff: working on detecting illegal connections or on suspending service for those who don’t pay their bills is unpopular and can even be dangerous.
- Managers: it is easier to close any revenue gap by just spending less on asset rehabilitation (letting the system slowly deteriorate) or asking the government for more money.

Except for those customers who do pay their bills, it might appear that there is no support from any party. Given this situation, a utility manager trying to establish an NRW program to reduce high levels of losses may face frustrating responses from his or her own staff and from the utility owners. Engineers and operational staff will assure him or her that the levels relate solely to commercial losses (that is, there is no leakage problem), while the commercial staff will say that it is all leakage.

2.1.7 What are the technical reasons of Water losses?

The causes of water loss in water distribution networks, especially the metropolitan cities, could be summarized as follows:

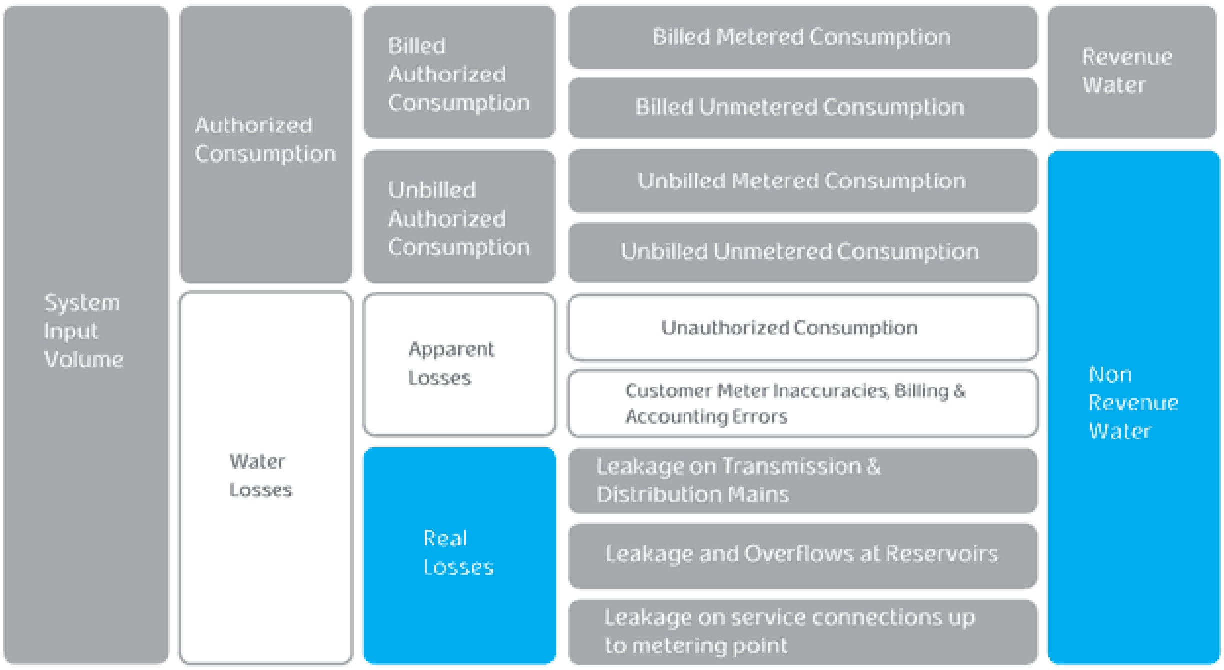
- Network pipes are very old (more than 50% of the network is 30 years old or older)
- Effective pressure management does not apply (water losses resulting from excessive pressures)
- Poor construction and maintenance of networks
- Water scheduling
- Costumer side leakage
- Illegal connections

The most important factor among those listed is the fact that the water distribution network is not separated into appropriate pressure zones. This results in a steep rise of technical losses due to the increase in water pressure in the lower parts of the city especially at night. Since SCADA-based pressure management is not applied even in the metropolitan cities the technical losses still account can be for more than 40% in some cities regardless of network pipe renewal.

2.1.8 What is a water balance?

Over the past decade, considerable work has been undertaken to develop a reliable set of tools and an internationally applicable methodology that allow water losses to be evaluated and managed in a scientific manner.

Preparing a baseline to establish current levels of water losses (by carrying out a water audit that leads to a water balance) is the first step for any utility wanting to reduce water losses. NRW reduction activities can then be planned using the baseline. Creating a baseline is therefore a first—and critical—step. Strangely enough, it is a step often overlooked in the development of many urban water supply projects. A standard template and terminology for categorizing and quantifying NRW, based on the initial version of the International Water Association (IWA), is shown in the figure.



The following is the situation faced by managers of water utilities: lack of water production and customer metering and limited knowledge of their distribution network ; this means that physical loss management, if carried out at all, is based more on a process of "estimation" than on an objective analysis and the application of proven technical solutions. Several basic issues are often overlooked:

- Most physical losses are caused by small leaks that are “invisible” (that is, they don’t come to the surface). A visible mains burst may cause a one-time water loss of several hundred cubic meters of water in a short period of time, but because it is visible, it will be quickly repaired. On the other hand, a small leak from a service connection (for example, leaking at a rate of, say, only 1 cubic meter per hour) that does not appear on the surface will continue to lose nearly 9,000 cubic meters of water each year—before it is eventually detected.

- Network pressure has a direct, approximately linear, relationship with physical losses (for example, 10 per cent more pressure translates into about 10 per cent more leakage in volume). Leak detection based only on pipe repairs often leads to increased pressures in other parts of the system, stimulating more leakage, much to the dismay of the utility managers. Pressure *management* (not necessarily reduction!) is of utmost importance, especially in low-pressure systems with poor infrastructure condition.

In the past decade, a comprehensive set of analytical tools, water-loss-reduction strategies and specialized equipment has been developed, but many water utilities are not aware of these. As a result, the gap between well-managed NRW reduction programs and the situation in most of the world’s water utilities is widening at a fast pace. Especially in developing countries, this is often compounded by a feeling of powerlessness (for example, that the network is so deteriorated that nothing can realistically be done about it and that there is no hope to move from intermittent supply of water to continuous service).

2.1.9 How can you develop a strategy for non revenue water reduction?

The first, basic step to developing a strategy for management of NRW is to gain a better understanding of the amount and sources of NRW (calculating the water balance) and the factors that influence its components. These are the typical questions to be considered:

- How much water is being lost?
- Where is it being lost from?
- Why is it being lost?
- What strategies can be introduced to reduce losses and improve performance?
- How can the strategy be maintained and the achievements sustained?

This diagnostic approach, followed by the implementation of solutions that are practicable and achievable, can be applied to any water company to develop a strategy for NRW management. This approach will also provide a systematic basis for developing and monitoring any performance-based NRW reduction arrangement.

In practice, a tailor-made NRW reduction strategy might address only physical losses or only commercial losses, but in most cases it will be required to deal with both. A wide array of activities must typically be carried out.

It is often thought that dealing with physical losses mainly involves pipe repairs, but in reality a sustainable physical loss control strategy must include four basic elements:

1 Pipeline and asset management: managing network rehabilitation in an economical manner to reduce the need for corrective maintenance

2 Pressure management: regulating network pressure through the judicious use of pressure-reducing valves (often an underestimated option for leakage reduction)

3 Active leakage control: monitoring network flows on a regular basis to identify the occurrence of new leaks earlier so that they can be detected and repaired as soon as possible

4 Speed and quality of repairs: repairing leaks in a timely and efficient manner (often requiring a thorough shakeup of working practices, organization and stock keeping of repair materials)

The design of a commercial loss reduction strategy will very much depend on local circumstances, but is likely to comprise:

- Improving customer meter accuracy. Ensuring that customer meters are in appropriate working conditions and duly replaced at the end of their useful lives reduces under metering and recourse to estimated billing.

- Improving meter reading and billing. A significant portion of commercial losses comes from mistakes in the meter reading and billing chains, not only because of poor technology, antiquated cadastres, and data-handling errors in the office but also because of fraudulent practices on the part of utility staff.

- Detection of illegal connections and water pilferage. Contrary to common belief, a large portion of water stolen from public utilities does not come from poor, marginal urban areas, but rather from large industrial customers and those with political clout and enough resources to bribe utility staff and management. Allowing illegal connections and such fraudulent behaviour is unfair for the population who do pay their bills, especially the poor, and works against promoting a culture of good governance.

An important point to mention is that a precondition for *any* NRW reduction strategy is to provide incentives for management and staff of the water utility to deliver , and maintain, the reduction achieved. This has been the missing feature of most attempts to reduce NRW and is one of the main reasons why utilities, particularly in developing countries, have been unable to improve their performance.

2.2 Benefits

2.2.1 What are the benefits for the community?

The benefits of reducing NRW include:

- need for less water to be produced, treated, and pumped, translating into the postponement of the expansion of capacity—producing less water also translates immediately into cost savings, due to savings in energy and treatment costs;
- reduction in apparent losses, which will result in more water being billed and more revenue for utilities—it has also been shown that water metering and adequate rates reduce wasteful consumption, which will likely decrease total consumption;
- adequate understanding of consumption patterns, which will allow utilities to optimize distribution systems;
- better knowledge of real consumption, which will improve demand projections; and
- reduced sewage flows and pollution.

These benefits depend on adequate pricing of water resources and services. Subsidies for water extraction, discharge of wastewater, capital investment, and operation of water supply systems lower the cost of water as perceived by utilities and thus remove an incentive to reduce physical losses. Low water rates for consumers do not encourage utilities to meter their water consumption and detect unauthorized water use. Moreover, low rates fail to provide consumers with an incentive to deal with leaks and wastage beyond their meters.

2.2.2 What are the benefits for the environment?

Water scarcity is a growing worldwide problem that is not limited to developing countries. Many parts of Europe are suffering from dry conditions and dwindling water resources. It's essential that all water users focus on water efficiency and many communities have water conservation programs in place to encourage prudent use by consumers.

However water utilities also need to manage water efficiently in their day-to-day operations. Many water utilities lose tremendous volumes of water through leaks and destructive pipeline ruptures. Some utilities lose track of large quantities of water because they do not provide water meters for their customers or properly bill for water service.

Utilities not only provide us with the water we need, but they also move and consume large volumes of water and - without proper controls – they can waste or lose track of huge amounts of water. With pressures mounting on our limited water resources, we need to be water-efficient throughout the entire lifecycle of man's water use and water utilities need to regularly audit their supplies, contain losses and recoup needed revenues.

2.2.3 What are the benefits for the stakeholders?

The total cost to water utilities caused by NRW worldwide can be conservatively estimated at $141 billion per year, with a third of it occurring in the developing world. In developing countries, about 45 million cubic meters are lost daily through water leakage in the distribution networks—enough to serve nearly 200 million people. Similarly, close to 30 million cubic meters are delivered every day to customers, but are not invoiced because of pilferage, employees' corruption, and poor metering. All this directly affects the capacity of utilities in developing countries to become financially viable and fund necessary expansions of service, especially for the poor.

Although it is not feasible to eliminate all NRW in a water utility, reducing by half the current level of losses in developing countries appears a realistic target. This reduction could generate an estimated additional $2.9 billion in cash every year for the water sector (from both increased revenues and reduced costs) and potentially service an additional 90 million people without any new investments in production facilities nor drawing further on scarce water resources. Figures of such magnitude, even though they are based on a rough estimate, should obviously capture the attention of donors and developing-country governments alike.

2.2.5 What are the benefits for managers/employees/professionals on NRW?

Benefits for managers include awards from politicians and state officials when achieving NRW targets. This can be extended, for example, by getting bonuses when reducing loss levels from 7 to 5%.

This bonus scheme will also constitute a motivation for employees. Other benefits for these will be not having to work at inconvenient times (such as during the night or holiday periods), reduced exposure to work safety risks while repairing leaks (always performed in special circumstances), and also less time wasted on paper handling (by removing the need to report incidents when there are no leakages in the first place).

2.3 Asset management

2.3.1 What is asset management in infrastructure?

There are many terms and definitions on the subject of asset management. In the water environment, one will come across many terms such as Strategic Asset Management, Infrastructure Asset Management, Total Asset Management, Comprehensive Asset Management, etc. The reason for this is that the science and innovation on this subject is in an on-going development and though the approaches and definitions may vary, they all have a central objective being an integrated approach to the management and improvements in the management of water infrastructure.
The International Infrastructure Management Manual defines the asset management in terms of its goal to "meet a required level of service in the cost effective way through the management of assets to provide for present and future customers".
The US EPA defines asset management as managing infrastructure capital assets to minimize the total cost of owning and operating them, while delivering the service levels customer's desire. Lowest life cycle cost refers to the best appropriate cost for rehabilitating, repairing or replacing an asset.
The Department of Water and Environment Affairs of South Africa‘s definition is that Infrastructure Asset Management is an integrated process of decision-making, planning and control over the acquisition, use, safeguarding and disposal of assets to maximize their service delivery potential and benefits, and to minimize their related risks and costs over their entire life. Thus infrastructure asset management includes operation of infrastructure assets, and also planned maintenance and repair, refurbishment and renewal, and provision for replacement of the infrastructure. This definition indicates that infrastructure asset management:

- takes an organization-wide perspective and draws upon applicable principles and techniques in the management, engineering, accounting and social sciences (including human resources).
- has an outcome focus (i.e. a focus on outcomes such as maximization of service delivery potential, protection of the ability of the infrastructure network(s) to deliver services, cost effectiveness and efficiency).
- confers a guardianship role on the managers of infrastructures and their political leaders – i.e. that they are the "custodians", responsible for the lifelong sustainable operation of the infrastructure, and for service delivery not only to the current users of the infrastructure, but to future users as well.
- must take into account both consumer expectations (including levels of service, and cost of the service) and the legislative environment (e.g. financial and environmental legislation, including any regulatory regime (e.g. regulation of drinking water quality)).

Another useful infrastructure asset management definition has been created by the Office of Asset Management from Federal Highway Administration. It is defined as "a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines engineering principles with sound business practices and economic theory, and provides tools to facilitate a more organized, logical approach to decision making". A facilities asset management approach allows for both program-level management and project-level management and thereby supports both executive-level and field-level decision making.

The definition of 'proactive asset management' consists of;

1. knowing what you have (a systematic inventory of assets),
2. knowing what condition it is in (evaluated periodically on a consistent measurement scale or ranking system), and
3. knowing what the financial burden will be to sustain the assets (at a targeted condition on the measurement scale or ranking system). This knowledge enables a systematic approach to

setting objectives, managing capital investment and operations and maintenance costs, and providing the necessary information management to support those activities.

A new asset management concept for water utilities is the comprehensive asset management. At its most basic level, comprehensive asset management involves the systematic collection of key data and the application of analytical tools such as life-cycle cost analysis and risk assessment. This approach focuses on minimizing the total cost of acquiring, operating, maintaining, replacing, and disposing of capital assets over their life cycle and doing this in such a way that it achieves the level of customer service desired. Comprehensive asset management allows utility managers to obtain better information on the age and condition of existing assets, determine the level of maintenance needed to optimize asset performance and useful life, assess the risks associated with the failure of various assets and set priorities for their maintenance and replacement, understand the trade-offs and implications of management decisions about the assets and use information better to justify proposed rate increases or capital investments.

The intent of asset management is to ensure the long-term sustainability of the water or wastewater utility. By helping a utility manager make better decisions on when it is most appropriate to repair, replace, or rehabilitate particular assets and by developing a long-term funding strategy, the utility can ensure its ability to deliver the required level of service perpetually. Synthesizing the above mentioned definitions, it can be said that asset management procedures in water infrastructure can be defined as the process of managing the creation, acquisition, maintenance, operation, rehabilitation, extension and disposal of the assets of an organization in order to provide an acceptable level of service in a sustainable and long-term cost-effective manner. Thus from these various definitions from different parts and initiatives, it is evident that the outcome or the objective is the same being an integrated approach towards the maximization of services towards effectiveness and efficiency, as well as meeting expectations of consumer/customers towards affordable and reliable services.

2.3.2 What kind of efficiencies does asset management bring in the delivery of water supply?

There are many positive benefits of asset management. Systems that fully embrace asset management principals may achieve many or all of these benefits. However, systems may receive some of these benefits just by starting asset management. The benefits of asset management include, but are not limited to, the following:

- Better operational decisions
- Improved emergency response
- Greater ability to plan and pay for future repairs and replacements
- Increased knowledge of the location of the assets
- Increased knowledge of what assets are critical to the utility and which ones aren’t
- More efficient operation
- Better communication with customers
- Rates based on sound operational information
- Increased acceptance of rates
- Capital improvement projects that meet the true needs of the system

Systems should strive to achieve as many benefits as they can with their asset management program.

2.3.3 How can asset management help to optimize the water infrastructure?

Asset management refers to a strategy of operating, maintaining, rehabilitating, and replacing infrastructure in order to sustain a cost-effective level of service to customers. For a water utility, asset management requires collecting and analysing data and information about all functions of the utility, -i.e., customer service and support, financial, engineering, operations, maintenance- in order to make strategic decisions about the infrastructure. In order to do asset management, the water supplier needs to have condition assessment data and management tools, e.g., funding, planning and modelling tools. The goal of asset management is to determine the time to failure and vulnerability of individual components (like pipes) under varying scenarios. Determining the condition of in-use buried pipe is currently difficult and costly to accomplish because the pipe is usually still in use, the inside needs to be assessed, and the assessment can only look at one small area of one pipe out of many associated pipes. Thus, a water utility typically lumps pipes into classes and assigns to them average failure information by using statistics about the system, then predicts investment needs to maintain the assets. Beyond maintaining physical integrity, there are many important reasons for utilities to engage in asset management, including;

- to maintain assets at a predetermined level of service, which requires inspection and assessment in order to ascertain whether the assets are capable of providing this level of service;
- to uncover performance issues that might hinder a utility’s ability to meet customer service expectations, or potentially lead to a catastrophic failure endangering public health and safety;
- to control costs of rectifying or mitigating a problem, which are always much less just after inspection than after a rupture or other emergency event;
- to tailor maintenance practices to the actual condition of the asset and not merely base them on habit, resulting in an overall reduction in expenditure;
- to plan properly for the retirement and/or replacement of the asset, which, if done over a period of time, will avoid any unexpected surprises.

2.3.4 What should the expert do to supply a high degree of physical integrity?

It is impossible for a distribution system of any significant size to be managed in such a way as to prevent any loss of physical integrity over time. Hence, the procedures need to be in place to recover from a failure in a material and minimize the effects on water quality. There are several categories of recovery efforts. First, compromised materials can be cleaned, repaired, rehabilitated or replaced. Common types of repair activities include cutting and plugging the portion of pipe associated with a leak, installing a repair sleeve or clamp, eliminating dead end mains, replacing and repairing valves, adding ferrules and repairing or replacing hydrants. Rehabilitation of pipe involves the recycling and reinforcing of the existing infrastructure in order to prolong its useful life. For example, structural lining can be used to improve the structural integrity of existing pipes and involves placing a watertight structure in immediate contact with the inner surface of a cleaned pipe. Another form of restoration is to treat the contaminated water. Chlorine and other disinfectants have been used to protect pipes and storage facilities against external microbial contamination, prevent re-growth of nuisance organisms in response to intruded chemicals, prevent further contamination from the installation of a dirty main, and alleviate customer complaints. Both continuous disinfectant residual maintenance throughout the distribution system and dosing a section of the system with disinfectant are common. Third, recovery is often brought about by flushing the contaminated water from the system rather than treating it, generally using hydrant flushing. In those situations where the absence of a component was the cause for the lack of physical integrity, then simply installing the component is the recovery effort. For example, the installation of backflow prevention devices or changing covers on reservoirs should restore integrity. Finally, where operational failure is the problem, devices may also need to be entirely replaced, along with instituting inspections to ensure that failure does not recur. The table below summarizes some of the common methods used today to recover from a failure in a material barrier.

Component	Mechanism of Integrity Loss	Recovery by
Pipe	Permeation	Reline or replace and conduct water quality testing
	Structural failure (leak)	Replace or repair or rehab
	Structural failure (break)	Replace or repair, flush or disinfect, conduct water quality testing
	Improper installation	Replace, reinstall
	Unsanitary activity	Disinfect, flush, and water quality testing
Fitting and appurtenance	Structural failure	Replace, repair, rehab and disinfect
	Improper installation	Reinstall
	Unsanitary activity	Disinfect and flush
Storage facility wall, roof, cover, vent, hatch	Structural failure (crack, hole)	Repair or rehab or replace, disinfect
	Absence of	Install
	Improper installation	Reinstall
	Unsanitary activity	Disinfect, flush, and water quality testing
Backflow prevention device	Absence of	Install
	Improper installation	Reinstall
	Operational failure	Replace or repair

2.3.5 What should an expert of a water supply utility do when faced with continuing deterioration concerning infrastructure condition?

In the face of continuing deterioration in infrastructure condition, the increasing costs to fix infrastructure problems and the inevitable competition for limited resources among competing needs, an expert should;

- do not wait for all the conditions and regulatory guidance to be in place. Most utilities have some means for collecting information on which to make current decisions on capital investment and operations and maintenance spending; most do not have ideal information or systems. Yet, decisions are made on the required schedule, ready or not.
- advocate improvement of processes, practices, and paradigms to support the obvious needs. For all the initiatives currently facing decision-makers, someone someplace had to be the first proponent and others rallied to the cause. Those who hold back hoping for someone else to lead the charge more strongly or to articulate the position more clearly, will finish back in the pack, if they finish at all.
- do not ignore the possible while expending energy on the impossible. In most management situations, a list of do-able action items can be developed readily; usually the reason they have not yet been done is that no one has yet made the needed commitment.

2.3.6 What is the approach of asset management programme for an expert with respect to optimal benefits of the assets?

In an urban water utility, experts are mainly responsible for the planning, design, construction or operation of a drinking water network system. These are already managing assets. However, managing assets is not the same as having an asset-management program. Though managing assets includes the complex decision-making process that the network system expert must use every day to set priorities, consider alternatives and make the most efficient use of available resources to accomplish program objectives, an asset-management program is a set of procedures and protocols that institutionalize, document, and preserve that decision-making process. The importance of documenting and preserving system knowledge and experience is crucial. An asset-management program has several benefits:

- Makes the decision-making process understandable and transparent to others;
- Provides consistent criteria for making those decisions and balancing competing needs and interests;
- Minimizes the long-term costs of system operations and maintenance;
- Defines acceptable levels of service to the customers;
- Creates data and information processes that improve future decision-making; and
- Establishes roles, goals, and metrics that can focus and motivate the entire organization toward more cost-effective operation.

An effective asset management program helps determine the funding needed to meet the service expectations of stakeholders, which comprise customers, elected officials, regulatory officials, the environmental community and any other entities having a stake in the performance of the drinking water network system. Though identifying and documenting service expectations can be difficult, not understanding those expectations can lead to longer-term difficulties. If the customer's level of service expectations is not met because of frequent system failures or lack of adequate performance, customer complaints may lead to undesirable political attention or, in some cases, regulatory enforcement actions. By exceeding customer expectations, the utility may increase the cost of service more than needed, also leading to complaints.

The key is to improve customers' understanding that the level of service is directly proportional to the cost. An asset-management program provides local experts with sound, understandable data illustrating the revenue that is needed to provide a given level of service and the consequences of not getting this revenue on a timely basis.

2.3.7 Why must utilities perform asset management?

Utilities must perform asset management if they are to stay in business. Mechanical system break, wear out and need to be adapted to changing patterns of customer demand. This can be done on an ad-hoc basis or can be organized and managed to achieve a higher return to the stockholder or taxpayer.

Maintenance and repair of a utility's assets is an on-going process. A basic electronic system assists the field crews by providing all of the documents needed to locate individual assets. The electronic document system allows the work planner to gather all the documents pertaining to the work order and put them into a work package helping the field crews to locate better the plant to work on. Emergency repairs are also facilitated by the ability to access location documents through the Internet using wireless connections from vehicle based computers. An outage management system can help determine the customers affected by an emergency and provide an easier method of locating customers that may have their service disrupted.

The planner can proactively eliminate system deficiencies before they show up as customer or regulator complaints by doing scans through the electronic database and selecting facilities due to age, location, trends or customer complaints to determine areas that need work. The hydraulic model allows the planner to determine when a particular part of the system can be taken out of service for repairs and what if any alternate means of serving the customers are needed. The document system conveniently provides details on the assets being analysed.

Electronic systems make planning for growth easier. The hydraulic model allows not only for correctly sizing the facilities in the planned development, but also allows for the identification of changes that will need to be made in the existing system to serve the new growth.

All of the above brings benefits to those financing the utility. A correctly sized new development reduces costs because oversized pipe or other assets are not installed just to be on safe side of inadequate analysis. Guess work is planned by figuring out the most effective way of fixing system deficiencies eliminating embarrassing rework when the initial fix wasn't sufficient to solve the problem. Time wasted driving back to the plant to look up paper records is eliminated with a wireless Internet based document management system. Faster emergency response is possible with a computerized outage management system.

2.3.8 What are the typical asset records?

Typical asset records are of;

- System maps of various scales and detail
- Documents detailing the installation of individual service taps, valves, mains, hydrants, pumps, wells, blow offs, etc.
- Customer information, which carries billing history
- SCADA data containing information about system operating parameters.

System maps are the basis for the hydraulic model and the asset database. An electronic map database can be used to provide maps of various scales and complexity and printed indexed map books as well as visual display over the Internet. The asset database provides the spatial hooks to maintain relationships between asset location, connectivity and various operations performed on these assets.

Documents show them as-built location, size and selected parameters of service taps, valves, mains, wells, pumps, hydrants, blow offs, etc. Linking these documents to a particular asset on the maps would be easy if there is a number both on the map and the document record, but in the real world this is rarely the case.

Customer consumption for virtually all utilities is being automated. The asset management system requires periodic downloads of consumption history so that demand can be placed on the hydraulic model. Automated daily downloads of new customers and changes to customer's ID and contact details are necessary if a current outage management system is desired. The daily downloads are generally inexpensive and should be considered for inclusion in the base system.

The SCADA system has the information necessary for the proper calibration of the hydraulic model. These systems have been automated almost as long as the customer information system. The SCADA information required to calibrate the hydraulic model is generally obtained on a periodic basis. Since the information required is limited a manual system transfer is sufficient for the base system. It would be nice to have selected daily readings transferred automatically to the asset management system so that a comparison can be made of the predictions versus the actual with exception reports e-mailed to the appropriate parties.

2.4 Body of Knowledge

2.4.1 What could the outcomes be in Body of Knowledge for NRW experts?

NRW expert must demonstrate the required level of competence in some outcomes.

Knowledge of mathematics, science and engineering

A technical core of knowledge in mathematics, science and water infrastructure engineering topics is stressed in this outcome. Underlying the professional role of the NRW expert as the technical leader is most of the following: mathematics, probability and statistics, calculus-based physics, chemistry, geomorphology, engineering economics, mechanics, hydraulics, water quality, material properties, network systems, geo-spatial representation, and information technology.

Design and execution of experiments and data analysis and interpretation

NRW experts frequently design and conduct field and laboratory studies, gather data, create numerical and other models, and then analyse and interpret the results. NRW experts should be able to do this in water infrastructure engineering areas.

Design of systems, components or processes to meet desired needs

Critical design methodology and process elements include problem definition, scope, analysis, risk assessment, environmental impact statements, creativity, synthesizing alternatives, iteration, regulations, codes, safety, security and constructability, sustainability and multiple objectives and various perspectives. Other important design or design procurement elements are bidding versus qualifications-based selection; estimating engineering costs; interaction between planning, design and construction; design review; owner-engineer relationships and life-cycle assessment. Understanding large-scale systems is important, including the need to integrate information, organizations, people, processes and technology. Design experiences should be integrated throughout the professional component of the curriculum.

Functioning on multi-disciplinary teams

NRW experts should be able to lead a design or other team as well as participate as a member of a team. This requires understanding team formation and evolution, personality profiles, team dynamics, collaboration among diverse disciplines, problem solving and time management and being able to foster and integrate diversity of perspectives, knowledge and experiences.

Identifying, formulating and solving water infrastructure engineering problems

Assessing situations in order to identify water resources engineering problems, formulate alternatives and recommend feasible solutions is an important aspect of the professional responsibilities of the NRW experts.

Professional and ethical responsibility

NWR expert is to hold paramount public safety, health and welfare. A thoughtful and careful weighing of alternatives when conflict values are crucial to the responsible conduct of engineering. Hence, NWR experts practicing at the professional level need to demonstrate an understanding of and a commitment to practice according to the international ethical rules.

Effective communication

Effective communication includes listening, observing, reading, speaking and writing. It requires understanding of the fundamentals of interacting effectively with technical and non-technical or lay individuals and audiences in a variety of settings. Professional NRW experts need to be versatile with mathematics, graphics, the worldwide web and other communication tools.

Impacts from engineering solutions in global and societal contexts

Professional NRW experts need to appreciate, from historical and contemporary perspectives, culture, human and organizational behaviour, aesthetics and ecology and their impacts on society including the history and heritage of the engineering profession.

Need for and commitment to engage in lifelong learning

Lifelong learning mechanisms include additional formal education, continuing education, professional practice experience, active involvement in professional societies, community service, coaching, mentoring and other learning and growth activities available for personal and professional development. Personal and professional development can include developing understanding of and competence in goal setting, personal time management, communication, delegation, personality types, networking, leadership, the socio-political process and effecting change.

Contemporary issues

NRW experts should appreciate the relationship of engineering to critical contemporary issues such as multicultural globalization of engineering practice; raising the quality of life around the globe; the growing diversity of society; and the technical, environmental, societal, political, legal, aesthetic, economic, and financial implications of engineering projects.

Techniques, skills and modern engineering tools necessary for engineering practice

This includes the role and use of appropriate information technology, contemporary analysis and design methods and applicable design codes and standards as practical problem-solving tools to complement knowledge of fundamental concepts. Also included is the ability to select the appropriate tools for solving different types and levels of problems.

Knowledge in a specialized area of water resources engineering

Specialized technical coursework is necessary for a NRW expert. Examples of specialized technical areas include hydrology, hydraulics, sediment transport, water quality management, water resources regulation, master planning, construction engineering and management, public works management, water resource protection, irrigation, water supply, numerical or physical modelling, system planning, operation and maintenance, etc.

Elements of project management and asset management

Efforts of the NRW experts often lead, in the context of projects, to construction of structures, facilities and systems that, in turn, must be operated and maintained. Project management essentials include project manager responsibilities, defining and meeting client requirements, risk assessment and management, project work plans, budget and schedule preparation and monitoring, interaction among water engineering disciplines, quality assurance and quality control and dispute resolution processes.

Asset management seeks effective and efficient long-term ownership of capital facilities via systematic acquisition, operation, maintenance, preservation, replacement and disposition. Goals include optimizing life-cycle performance, minimizing life-cycle costs and achieving maximum stakeholder benefit.

Business, public policy and administration fundamentals

NRW expert typically operate within both the public and private sectors. That requires at least an understanding of business, public policy and public administration fundamentals. Important business fundamentals topics as typically applied in the private, government and non-profit sectors include legal forms of ownership, organizational structure and design, income statements, balance sheets, budgets and procurement systems, decision economics, finance, marketing and sales, billable time, overhead and profit.

Role of the leader and leadership principles and attitudes

Leading requires broad motivation, direction and communication knowledge and skills. Attitudes generally accepted as being conducive to leadership include commitment, confidence, curiosity, high expectations, honesty, integrity, judgment, persistence, positivism and sensitivity.

2.4.2 What could be the levels of competence for individuals, who have intended to become certified as a NRW expert, in the Body of Knowledge?

The body of knowledge for NRW experts would be defined by the outcomes, which are knowledge, skills, and attitudes that are necessary to become a certified. Body of knowledge fulfilment begins with the premise that professional licensor, experience and ethics lays the foundation for all outcomes. Hence, all NRW experts must reach the minimum level recommended for licensing. Knowledge, skills and attitudes can exist at many different levels of capability and usefulness. The body of knowledge could distinguish the following broad levels of competence for individuals intending to become certified.

- Recognition: represents a reasonable level of familiarity with a concept. At this level, the expert is familiar with a concept, but lacks the knowledge to specify and procure solutions without additional expertise, e.g., an expert might recognize that a particular design plan poses significant construction difficulties without having the expertise to devise improved construction or to design alternative solutions.
- Understanding: implies a thorough mental grasp and comprehension of a concept or topic. Understanding typically requires more than abstract knowledge, e.g., an expert with an understanding of professional and ethical responsibility should be able to identify and to communicate ethical issues arising from a practical case study.
- Ability: is a capability to perform with competence. An expert with the ability to design a particular system can take responsibility for the system, identifying all the necessary aspects of the design, and match objectives with appropriate technological solutions. As the expert develops, his/her abilities also develop, so that more challenging and difficult problems can be solved.
- Mastery: shows that the expert has reached the level of advisor and that the more challenging, complex and difficult problems may be solved.

2.4.3 How does the body of knowledge provide critical competition in water loss management?

Body of Knowledge is a term used to represent the complete set of concepts, terms and activities that make up a professional domain. Competition for the water loss sector is a common prerequisite for efficient service delivery when dealing with challenging business settings. No doubt that infrastructure body of knowledge leads NRW experts to provide more competitive service quality levels. There are several approaches to facilitating competition in the water loss management market, i.e., competition in the sector, competition for the sector, competition between sectors. When all elements of body of knowledge can be competitive, then generally a primary job of the NRW expert is to remove barriers to entry or competition. The first approach is to have multiple water loss experts compete in the sector for customers, and examples include having multiple NRW service providers and multiple engineers of drinking water network system. The second approach is to have water loss experts compete on the market by having the experts bid for the right to be a service provider. Franchise bidding to operate and maintain a city drinking water system is an example of this approach. The third approach is to have experts in different sectors compete by comparing the efficiency and effectiveness of their operations and rewarding those experts that provide superior performance.

2.4.4 What is the importance of sustainable knowledge management by means of NRW expert skill improvement?

Determining knowledge needs, sharing information and implementing results of research are all part of the knowledge management applied by utilities to identify, create, share, store, present and disseminate knowledge. Knowledge management would start identifying the relevant social and technological trends and the way in which these trends will influence society. Water companies, water boards, etc. could be involved in analysing their ambitions and accomplishment strategies within the context of a continuously changing world. The knowledge required to deploy these strategies will then be determined, together with the extent to which this knowledge is already present within the organization. If vital knowledge is lacking, the method used to obtain in a timely fashion will be determined. Although research is a sound means to obtain knowledge, it is sometimes also possible to simply buy readily-available knowledge elsewhere. In such cases, some important points must be considered, e.g., how the knowledge can be preserved for the organization and for the future. Knowledge is more than just information and it also includes a range of competencies and experience to apply the information correctly. Effective dissemination of the knowledge also improves the experts' skills. Dissemination often means the transfer of knowledge from one organization (e.g., the knowledge institute) to another that will apply the knowledge. Knowledge management offers a variety of tools to facilitate this knowledge transfer. Digital tools are all too familiar, but they are not enough in transferring the knowledge to the end user. This nearly always involves bringing people physically together: researchers and experts. Ideally, the experts are already closely involved with the actual research. If this is the case, a process of continuous iteration can start between knowledge development and future application of this knowledge. This limits the risk that, despite a clear definition of the knowledge needs, knowledge is developed that is not sufficient to meet the needs of the expert. Only when knowledge is being implemented it becomes clear whether it is practically viable or not. Problems in applying the knowledge often emerges during the implementation phase. It is of utmost importance that experts can turn to the knowledge institutes for help at this point. Practical experience in the application of knowledge must be feed back to the researchers, so that the knowledge can be improved and adjusted to actual situations. Evaluation of the knowledge is the most important stage in the knowledge management, so that knowledge institutes and experts need to work together in improving the quality of the knowledge.

2.4.5 What is the role of information technology in effective knowledge application in water infrastructure sector?

The role of Information technology in the water infrastructure sector is very important in allowing the flow of knowledge, capturing knowledge, combining knowledge and developing knowledge communities. The management of the IT infrastructure for knowledge management is a critical success factor for a particular water company. Today, much of a water company's environment is determined by its IT infrastructure. Knowledge management and associated information technology initiatives are a result of several management misconceptions regarding knowledge work, business strategy and IT:

- Information technology and knowledge management are worth investing in the context of strategy.
- Knowledge work is fundamentally different in character from routine white-collar procedures resulting in the application of technology that does not fit knowledge work processes.
- Traditional organizational structure and human resources policy in a water company does not support the fact that knowledge work is cross-disciplinary and therefore knowledge work teams function in an ad hoc fashion and are completely immersed in a networked computing environment that is hindered by functional boundaries.
- Management has focused on capturing all operational knowledge on corporate databases. This is both impractical and impossible.

Designing an effective IT information architecture to support a knowledge management initiative is an important management challenge in water sector, particularly for monitoring. It is necessary to pay attention to the IT architecture and implement it in accordance with the operational functions that use knowledge and information to make decisions that realize objectives. IT systems must be comprehensive, highly integrated and that the electronic corporate memory must maximally contribute to the competitiveness of the organization. Furthermore, the KM IT architecture must improve competitive power by supporting three types of learning: individual learning, organizational learning through communication and continuous development of an electronic corporate knowledge repository. The advantage of new systems and efficiencies are more and more difficult to sustain. To remain competitive in the dynamic and complex environment of the new economy each water company should work hard to obsolete its own systems before competitors do. The key to this is continuous innovation. Some utilities have a SCADA system for the purpose of online system monitoring. Though SCADA system is an innovative high-tech system used in water infrastructure sector, many SCADA systems are designed to run the transmission level system and are not designed at distribution level, due to the cost involved. However, utilities are starting to cost-justify system optimization and SCADA should not be ruled out as an excellent, although costly, means of managing pressure within the distribution system. Generally speaking, this type of control is the most expensive to install but is the most efficient way to apply. It may not always however be necessary, and cost to benefit calculations may not justify, the installation of a full SCADA system, would absolutely improve the functionality of the drinking water distribution system. If a utility already has distribution level SCADA in place, then it may be very cost-effective to add on modules.

2.5 Personal development

2.5.1 What are the highlights of personnel development?

Personnel development strategies are targeting at:

- the individual and personal competences;
- the professional training and the relation with enterprises;
- the employability of people in Europe.

The emphasis lies on:

- lifelong learning;
- using new forms of information and communication technology;
- participation of the SME and enterprises in general;
- the promotion of equal chances for women and men;
- the prevention of exclusion and inequality;

The personnel development is not only directed to traditional group training, but has also a focus on training on the job and distant learning. The general idea is giving the current International NRW Engineer the ability to perform in his job as well as possible.

2.5.2 What about the professional development of NRW engineers?

Engineers qualify themselves in general terms, based on the engineering diploma, a degree obtained at a professional university, in combination with practical training and experience. However, the initial education forms the basis for further development of knowledge, skills and attitude; the on-going professional development.

In the past the knowledge acquired within the initial education proved to be most important and determinative. Extra-curricular education, for example in courses or workshops, was more or less an extra option.

The globalisation, the enormous development of knowledge and the increase of the availability of information, has a great impact on the importance of the professional development. Professional development became a vital component of lifelong learning and career development activities.

It's still not long ago that when a young engineer started his career in a company was considered to be a job for life.

His career path was quite clearly outlined by the company he worked for.

In many cases an engineer follows additional education or training randomly along certain personal interests, if only there was a budget available.

Nowadays engineers don’t have this strong long- term allegiances with the company. The engineer is mostly operating in divergent projects. For this he frequently works with various groups of people of other companies and operates from several locations.

Both the engineer and the networks, in which he participates, share the responsibility for the engineer’s well-functioning in his job. To stay employable, first the engineer must be responsible for his own career and therefore for on-going development of knowledge and skills.

2.5.3. Do development needs of International NRW Engineers have to be inventoried?

The existing and future needs for knowledge of an NRW engineer have to be inventoried in a Need Analyses (NA). A Delphi orientated design for the nearby future will be part of this NA. It is advised that around a hundred representatives of EU NRW companies and related universities will give their vision about the future and the career prospects of the International NRW Engineer. Besides the profession-specific technical NRW knowledge has to be inventoried and also see which other competences are essential to function successfully in the drink water companies. Entrepreneurship and cooperation can be important aspects in this respect.

Competences that are considered necessary by the industry have to be described. Demanded competences change and grow over time. Of course these changes are not distinctive for NRW technology. The initial education on universities intends to anticipate on the profile of the "new engineer".

Evolution of the demands has to be considered and this tendency has to be reflected in the post graduate training of the International NRW engineer.

2.5.4 What are the demands on the new expert in development perspective?

The profile of the new engineer differs on several points from the past. At this moment there is a need for broadly trained technicians. Mentioned is a shift towards a more process based direction of engineering. A good engineer has understanding of the whole design process and is capable to develop and control the processes of complex and multidisciplinary projects.

For this reason it is necessary that the engineer has knowledge not only on his profession (for example knowledge of NRW norms and water cleaning procedures) but also on other relevant disciplines for the design process (such as business administration and legal aspects). Moreover there are high demands regarding the capacity of engineers to be able to cooperate in multidisciplinary teams.

Desired knowledge and skill areas of the new engineer are divided in the following six components:

1. Knowledge of engineering techniques (basic knowledge, design and preparation, operations, production)
2. Knowledge of the design engineering process
3. Bachelor skills (analytically and critical capacity, examining attitude, devising capacity, multidisciplinary working, process targeting, insight in social context)
4. Management skills
5. Social- and communicative skills
6. Attitude (entrepreneurship, social insight, creativity, customer orientation, on demand)

During his career the NRW expert has to qualify himself on these six components. The degree to which he will qualify himself in each component depends also on his career.

2.5.5 What about the career planning of the NRW Experts?

The idea that a succeeding job must imply a promotion is a commonplace. Frequently this will be the case, certainly during the first 15 up to 20 years or up to 5 functions. However, in a career it will occur regularly that so-called "horizontal challenges" must be accepted consciously. This is the case if for example there is (temporarily) no place in the organisation for vertical promotion. On the other hand, this offers an employee the possibility to contemplate and “treat” the organisation from another perspective. Knowledge, skills and points of view acquired this way will make it possible to act in a better position later on.

To plan and control ones career implies that one must form an opinion about the following questions:

1. Which knowledge, skills and attitude are demanded, today and tomorrow?
2. How do I determine the lacks in my personal knowledge, skills and attitude?
3. After discovering the lacks; what are the options?
4. After considering the options; where do I start theaction?
5. What is within my capacities; what is feasible and desirable?

We live our life forwards and we understand our life backwards

Usually it is difficult to imagine the development of your career in the future. It is easier to look back to the path followed and indicate your career. Nevertheless, it seems very important to be aware of your career and make your plans systematically.

Although a young engineer decides in an early stage to follow a certain education course (administratively, commercially, technically etc.) the same choice has to be made after the graduation of the young engineer.

In common the expert chooses from the following career paths, with emphasis on:

- Technique: for example engineering design, production, maintenance
- Administration: for example planner, control of process and legislation norms

- Commerce: for example commercial engineer, sales
- Management: for example project coordination, consultant, manager, entrepreneur

Based on this classification it should be possible to formulate the basic set of competences, useful for the engineer to define his own career development plan. Of course it is still possible to introduce variations in those career paths.

From literature the next career path is confessed for technical engineers, from initial education to general management.

Character 1: career path[1]

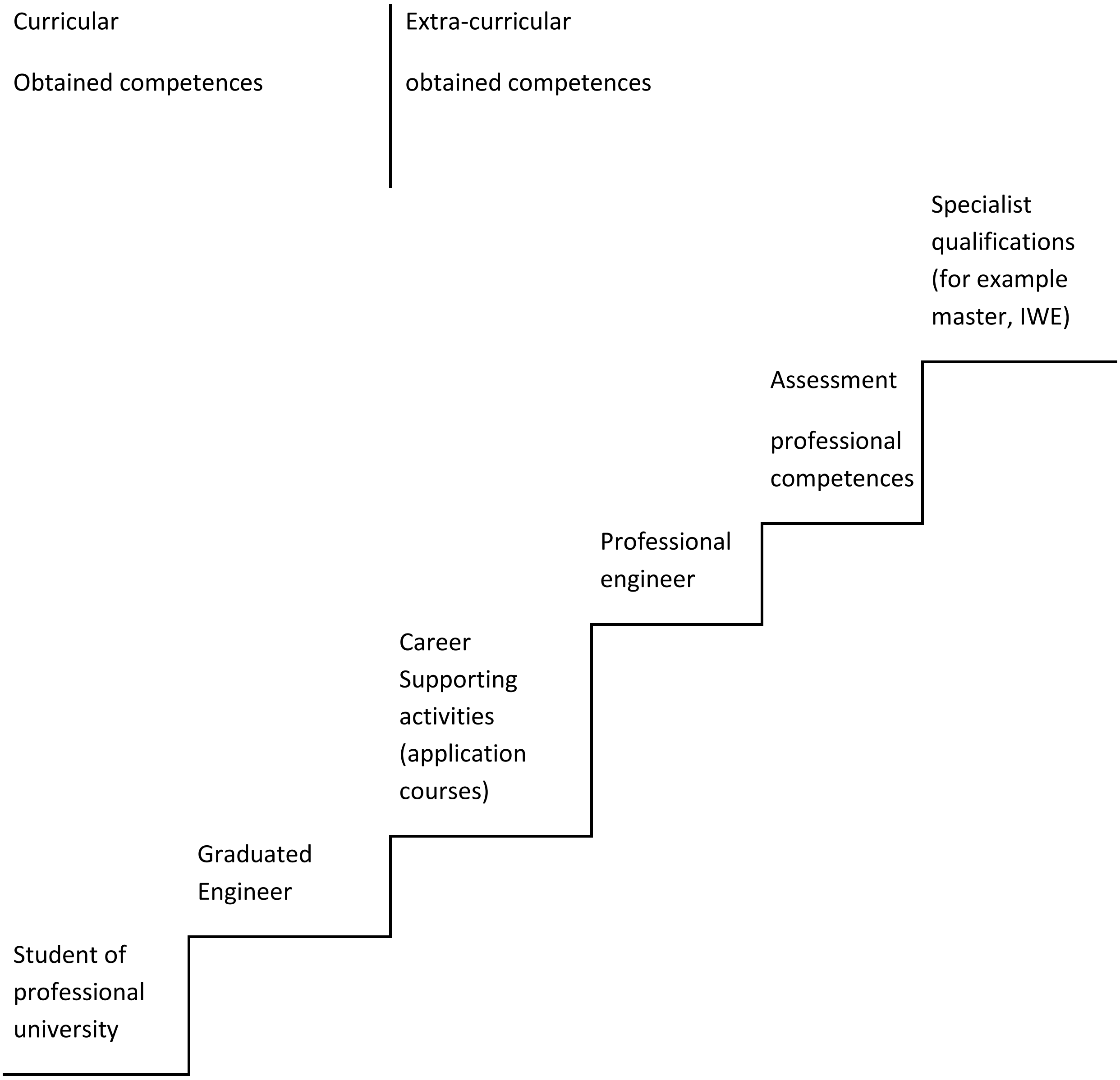
Character 1 shows us how the young graduated engineer has to be conscious, even after graduating, of the choices to be made to give his career a certain direction.

2.5.6 Is there an EU model to career development plans?

At present there are no EU qualification standard for engineers. It will be a challenge to try to formulate such standard.

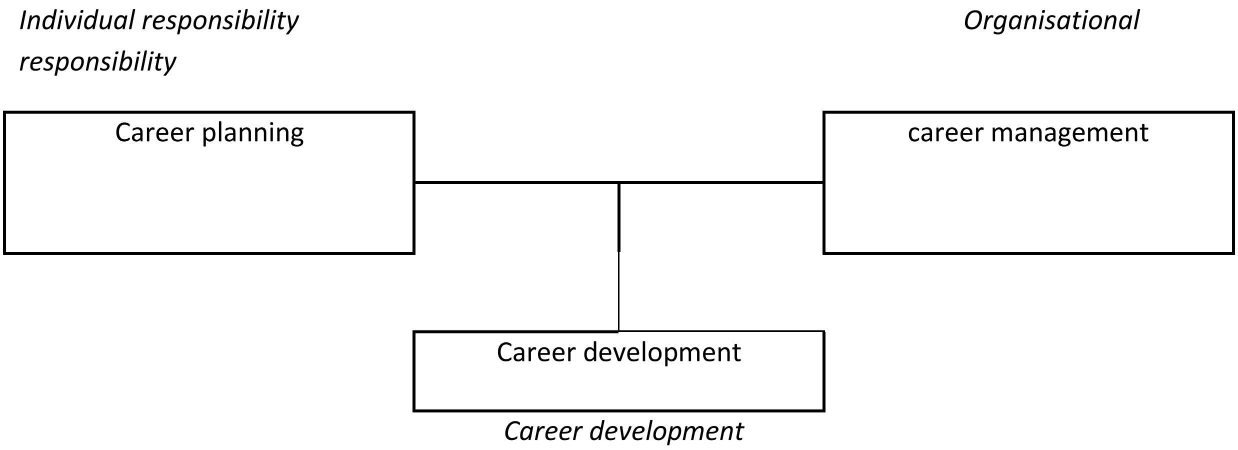
Within the Dutch higher technical education a lot of attention is given on the competent HTNO[3]”.

In character 2 the professional development is reflected schematically. Acquiring extra-curricular competences is a cycle, which can repeat again and again.



Character 2: Career student of a Dutch professional university study

We could distinguish career planning, career management and career development as below:



Character 3: Distinction career planning, career management and career development

The responsibility for the development of the career of the individual employee within the company or organisation is shared by the employee himself as well as his employer.

2.5.7 Are life phase & career planning connected?

Every employer has certain needs that he /she likes to realise. Those needs depend on the phase in which an individual finds oneself and could be related with his/her career prospect.

At the start, the first wish is to establish a position. At that stage one needs role models, training, coaching, feedback, protection and acceptance. The stage of progress follows. One desires challenges in his/her work, wants to be seen and to prove oneself. Beside that counselling is often required.

From the progressing stage follows the stage of maintaining. In this stage autonomy is important and mostly there is a need to help others to develop themselves. Finally, approaching the end of the career comes the moment to reduce the work, to step back. In this stage one searches the role of consultant and is more inclined to transfer knowledge and experience.

2.5.8. How to obtain Extra-curricular competences?

Concerning the demanded competences of the engineer, only a part of it could be covered by initial education. Many competences are obtained via work experience and by other means of non formal methods of learning.

So a career planning and the acquiring extra-curricular competences has to be done by the company where the engineer is working and the engineer him/herself.

Milestones are:

1. Making the NRW career paths more transparent
2. Having tools for self- assessment
3. Developing Competence scans for engineers and companies
4. Setting up a system of counselling and coaching

How to handle internationally with career development and lifelong learning for the NRW Expert is a big challenge for a TOI or Innovative Life Project.

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[1] From: Careers or engineers in General management, thesis Dr. P. To puff, UTwente 1998
[2] UK Standard for professional engineering Competence, Chartered Engineer and Incorporated Engineer Standard
[3] Competent HTNO (2000), guide for describing national qualifications in the HTNO, pine
Hedge: Competent HTNO (by means of www.hbo-raad.Netherlands).

2.6 Qualification and certification

2.6.1 What kind of qualification system is suitable for the NRW experts?

Qualification is the formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards. The tasks of the qualification are defined as statements of what a learner should know, understand and be able to do upon completion of a learning process. The tasks are therefore defined in terms of knowledge, skills and competence. Knowledge is the body of facts, principles, theories and practices related to a field of work or study. Skills mean the ability to apply knowledge and use know-how to complete tasks and solve problems. Competence means the proven ability to use knowledge, skills and personal, social and methodological abilities in work or study situations and in professional and/or personal development. The descriptions of the tasks would be both a "holistic" as well as a "component". The component description separately examines the knowledge, skills and competence that are acquired as part of the education/ training. The holistic description examines these three components together as a whole. The holistic description is to be seen as a kind of summary of the three descriptors knowledge, skills and competence. In order to determine the tasks in the qualification, workshops with experts should be conducted. Experts may be lecturers in master schools, specialists with professional qualifications from companies, people from social partnership institutions (i.e. IWA), etc. To keep the labour market up-to-date, it is important to know what people being awarded with this qualification do in the labour market and what they are qualified for. The following questions may be asked:

- What tasks should an individual possess when (s)he has completed the bachelor/ master training program in NRW subject?
- What tasks help the individual achieve a successful professional career?
- What knowledge, skills and competence have to be listed in an international call (e.g., a call for NRW projects) for candidates with a master qualification in NRW?
- What knowledge, skills and competence must he/she possess in order to be accepted for the position?
- What theories, principles, formulas, etc. is an individual expected to have? How can the extent of the knowledge be described?
- What skills are connected to the master qualification? What professional abilities does someone with a master qualification have to possess?
- What competence is connected to the master qualification?
- What degree of responsibility and what level of autonomy correspond to the master qualification?

2.6.2 How is certification of leakage management organized in Europe?

At this moment there is no existing general certification of leakage management in Europe .

2.6.3 What is needed to organize certification?

It is important to take commitment of all the national water distribution companies to organize a European system of certification. This partnership is not able to organize that independently from the water distribution sector itself. It is suggested to the International Water Association to take the lead.

2.6.4 What are the developments in the EU in relation to national qualification?

The qualifications frameworks have turned into key instruments for the restructuring and reform of education, training and qualifications systems in Europe. While very few countries had considered this approach prior to 2005, the majority of EU and EEA countries (as well as candidate countries to the EU) are currently working actively on the development and implementation of national qualification frameworks. While the number of countries having fully implemented a national qualification framework is still low (e.g., Ireland, France, Malta and the UK), almost all EU and EEA countries are now signalling that they will introduce comprehensive, overarching national qualification frameworks covering all parts of their education, training and qualifications systems. The key explanation to this rapid development of comprehensive, overarching national qualification frameworks is the European qualifications framework for lifelong learning. Adopted in 2008 by the European Parliament and Council, the European qualification framework is as a common device to 'translate' and compare qualifications across Europe. The recommendation invites countries to relate their qualifications systems to the EQF by 2010 by:

• referencing, in transparent manner, their qualification levels to the levels set out by EQF and, where appropriate;

• developing national qualifications frameworks (NQFs) in accordance with national legislation and practice.

The rapid development of NQFs confirms that the EQF is seen as a relevant and important reference for countries. The impact of the EQF can be also seen in the way countries are structuring their NQFs. While NQFs are important to reach the European objectives, they are increasingly seen as instruments for addressing national objectives. While given a regulatory role in some countries (e.g., the UK), NQFs are mainly seen as communication or transparency tools whose main task is to clarify the relations – vertically as well as horizontally – between the different parts of the national system. Frameworks provide a new platform for dialogue – across sectors and institutions – facilitating discussion on how to improve current practices and how to remove barriers to education, training and learning.

2.6.5 What are the benefits for certification?

Professional certifications would be very important to the whole water sector. The main points addressed should be quality, cost efficiency, competent employees, and customer satisfaction.

Certification demonstrates that every employer has a general competence to perform due diligence in supervising the personnel providing services at public facilities. Certification provides employers with evidence that the certificate holder has demonstrated a certain level of job-related knowledge, skills and abilities. It provides a documented level of assurance that employees are competent in safe work practices. Certification provides concrete evidence to board members and citizens that the agency is staffed with people who know what they are doing and is competitive in any comparison for quality of service.

The water sector is a very large professional area where there are no general certifications, only certifications coming from universities and polytechnic institutes, which often do not take into consideration the operational needs.

Benefits from certification of non-revenue water loss reduction are different according to the different target groups, such as society in general, water companies and employers or employees. The benefits for the society are better quality of water network, cost savings and less damages to the infrastructure. The benefits for water companies (and their employees) are better quality of network, improved financials, better image and competent proactive employees. Benefits to employees are higher competence level, the possibility to work in a more wide professional area, and help their mobility between EU countries—made possible by a more transparent body of competencies.

3. Best Practises

3.1 Working in Water Services

It is important to form proper conditions about your professional life for your own professional development. First you should ask yourself more personal questions such as:

'Does my choice reflect my talents and can I find personal happiness and satisfaction in it?'

And concerning the financial side, you should ask yourself:

'Can I earn a living that will fulfil my own and my family's needs and wishes?'

This is an example of the varying skills required and the rewards gained from working in water services and the motivation to develop the required skills.

The Ruhrverband (Germany) as a concrete example for professional challenges

The Ruhrverband is responsible for the water quality and water quantity management in the catchment area of the River Ruhr. Its duties comprise the planning, financing, operating and maintaining of around 800 different assets (reservoirs, wastewater treatment plants, storm water tanks, pumping stations, gauging stations and impounding lakes).These assets are operated in an area of 4500 km² by around 1100 employees. The yearly turnover amounts to around €280 million ($435 million).

Since the establishment in 1913 Ruhrverband has been a self-governing and non-profit corporation that was created by a special law. Its members (about 450) are the communities and districts, the wastewater discharging and water consuming industries and the waterworks in the catchment area of the River Ruhr.

In the past it has been mainly civil and sanitary engineers which have played the key role in developing the local infrastructures for water management and they are still expected to continue to play such a role in the future. During the last years though there has been a change towards a more multi- and interdisciplinary approach which involves more natural scientists, economists, lawyers, etc. Nowadays the water sector is thus open for many different disciplines.

In the foreseeable future the professionals of Ruhrverband have to face several significant challenges:

The members of Ruhrverband are very interested in minimizing costs, of course. This leads to a combined technical and economical evaluation of all activities. Modern instruments of controlling have to be used by both engineers and economists to achieve the optimum balance between operation performance and operation costs.

A focus for at least the next decade will be on the relevance and possible removal of trace pollutants and manmade compounds in Germany, a country with an abundance of water. The availability of new large scale membrane technologies for drinking water purification and wastewater treatment might in some cases lead to an additional treatment step in both of these processes. One key aspect of every new process is its cost benefit ratio. To improve our public image we have to work harder to communicate the necessity of our work, the efficiency of the measures proposed and the reliability of our expertise.

The water industry has to define its role between obtaining cost effectiveness (public owned companies), respectively optimising the shareholder value (private companies) on the one hand and the definition of aims and approaches for a sustainable development on the other hand. Although many people think and feel that water belongs to everybody there is the danger of having to deal with a mostly local water monopoly. Therefore water is not a normal commodity. In this context it seems that non-profit institutions owned by the public and controlled by the customers are very good means by itself to balance out the questions of economics and sustainability. Environmental successes and the costs to achieve these, are often compared from country to country, in our globalised world. Working in the field of water also means dealing with these comparisons and explaining complex systems to the public.

Conclusions for other parts of the world

Today's systems for water supply and wastewater disposal have been engineered, upgraded and optimized in the developed parts of the world over a long time. A hundred years ago the conditions in the Ruhr region were as poor as they still are in many parts of the world today, which suffer from heavy pollution. Although it was the water supply source for millions of people, the River Ruhr fell dry during some summers. In some of these years there were epidemics of cholera and typhus along with other diseases due to very bad hygienic conditions and heavy industrial pollution. It took a hundred years to reach the conditions we have today.

Fortunately, we have now mastered many of the problems, other parts of the world are still struggling with.

In regions of the world where the water related situation is bad, the starting conditions are different from those we had 100 years ago when proper technical solutions were often missing. Today there is little which cannot be achieved technically. What is needed is political will, effective governance and financing and, of course, professionals who are able to implement the solutions.

The variety of tasks is enormous: the future water management must not only answer questions about various kinds of pollution but also other water related hazards such as floods, droughts, desertification, tropical storms and erosion. Solutions are mostly of local or regional nature.

And so the work in all parts of the world will continue and require new generations of highly qualified and motivated people. Water management is an essential element of infrastructure, environmental protection and sustainable development on a local, regional and global scale.

Resume: Skills and Earnings

The skills of young professionals need for their career in the water sector do not differ so much from those of other technically and / or economically oriented branches.

First of all, one certainly should have a deep knowledge of many facets of his/ her discipline. Additionally, he/she needs a good portion of the so called soft skills. These are:

- The skill to communicate – to speak with representatives of other disciplines and the involved stakeholders, to get an understanding of their motivations and to cross-link different ideas and approaches. The solution of water problems requires the interaction of many spheres and sectors. This interaction must take the objectives of safe drinking water, sanitation and food security for all into account.
- The ability to solve problems by analytical and logical thinking is also very important – for example by structuring engineering projects and fairly weighing their costs and benefits, both over the short-term and long-term.

The amount of money someone can earn in a field might also influence the choice of profession. We will mention two points:

- Water in the western world is one of the products which will continue to be needed, demanded and paid for in the long run. In the last years nations have invested a significant amount of their yearly GDP to guarantee this basis of existence.
- As far as salaries go, people in the water business seem to be paid fairly and they earn slightly above average in most regions of the world. Measured on a materialistic scale one earns enough for a good living. But don't forget that, besides money, there are many other important criteria to choose the profession in which one works for a life time.

Water is a major factor within each of the three pillars of sustainable development –economic, social and environmental. Someone who works 'for the water' has a more basic and satisfying quality than creating products like electronic devices or other consumer goods. It is also fascinating to be working with one of the basic forces of nature.

There is a global need for improved water and wastewater services – the challenge of delivering these services falls upon the managers of the water sector to a great extent. As an engineer or a natural or social scientist, every young professional can find challenging responsibilities in planning, constructing and operating very different water facilities today. Whether the future of local water issues decisions are for the better or for the worse it will depend on the decisions made by these future professionals.

3.2 Non revenue water in master education

Scope and Objectives

Leuven is situated in Belgium at the very heart of Europe, a 20 minute drive from Brussels. The KatholiekeUniversiteit Leuven (K.U.Leuven) is Belgium's largest university, consisting of 14 faculties, covering the complete range of scientific disciplines in the humanities, natural science and technology, bioscience and medicine, supported by about 8,000 staff members, teaching to more than 35,000 students, 12% of them are international students from more than 120 countries.

A wide range of water related research can be found at the K.U.Leuven in different faculties, departments and research units. The Master on Water Resources Engineering is taught at Faculty Bioscience Engineering - a two year MSc degree course, especially for students and graduates who want to develop their knowledge and understanding of water resources engineering. In addition they are or expected to be involved in the design &operation or day-to-day management of water resources schemes in developing countries or anywhere in the world. The main goal is to offer comprehensive training in water resources engineering to engineers and scientists from developing as well as industrialized countries.

ProWat's results as Materials source for Master Course

Although 'Water' is as a research topic disparate organized over different units such as Department of Chemical Engineering, Department of Earth and Environmental Sciences, Department of Civil Engineering, Biology Department, etc. Many cooperate closely on the educational level in the Master in Water Resources Engineering. The ProWat's results are widely distributed by both visual objects and on-line sources; its Know-how is made available to the (international) community, Master degree and other water related research topics as well:

- From *ProWat Book* (in English and French*)* and *ProWat Website*.


- Cooperative research by preference *focuses on ProWat case-studies*.

- In *Parabolic Interface*, obvious relations are presented between the topic of 'Water' and other aspects:
  - *Climate:* climate and meteorological variables as rainfall, temperature and evaporation (transpiration) are key elements in the water cycle; interactions between the atmospheric and the hydrological processes.
  - *Soil and land:* soil and land use affect catchment hydrology (peak flows, flood risks, infiltration, etc.); surface and soil water availability affect vegetation, water courses are important elements in structuring the landscape and in spatial land management; interactions between soil and (ground)water contamination.

- *Ecosystems and sustainability in using natural resources:* exploitation and management of water resources.
- *Biodiversity and ecosystem services:* surface and soil water quantities and qualities affect biodiversity and ecosystem services; water storage by green roofs.
- *Sustainable food production, sustainable agriculture and biomass production:* surface and soil water availability affect food production, agricultural activities and biomass production; efficient agricultural water consumption, i.e. through efficient irrigation schemes, takes part of sustainable agricultural management.
- *Society and environment:* population centres, industrial activities, tourism, etc. often developed around rivers and coastal areas, reciprocal interaction between the water systems (surface- and groundwater) and the society; (public) participation in water management; multidirectional interactions between different stakeholders involved in water use and management.
- *Energy:* hydropower energy production, energy consumption and greenhouse gas emissions indirectly affect the hydrological cycle through anthropogenic climate change (influence on floods, drought risks, water temperature and water quality).

Parabolic Interface

At the scale of these river basins, multidisciplinary research collaborations can be set up to integrate meteorological, hydrological, hydraulic, morphological, physic-chemical, ecological, socio-economical, etc. processes. This should lead to a scientifically based methodology for integrated water system related problem solving. Examples are:

- development of water engineering decision support systems integrating rural and urban catchment hydrology, wastewater treatment infrastructure with sewer systems and receiving rivers…
- treatment and re-use of wastewater for agriculture
- impact investigation, mitigation and adaptation of climate and land use change on floods and low flows, groundwater, agriculture, water quality, ecology, society.

Best Practices

The water related research and Master education involve the following effective teaching practices: it is designed to help accelerate student achievement in vocabulary development, comprehensive strategies, higher level questioning, differentiated and targeted instruction, student engagement strategies, cooperative grouping patterns and standard-based instruction. Along with learning the strategies listed above, candidates are aimed at seeking to start or expand water resource engineering education programs; policy-makers and economic developers seeking to meet workforce needs; and students, scientists & business professionals looking to enter the industry or upgrade their existing skills.

The water research/teaching topics are advertised from high school through Ph.D. and International programs with clear guidance on key issues such as curriculum planning, student recruitment, funding, connecting with workforce needs, measuring performance and efficacy, and developing student clubs. There is also strong international representation from 120 countries ranging from Asia, Australia, Canada, New-Zealand, North Europe to the United States, South America and Africa at K.U.Leuven which is a wide variety range of student source.

The Master education and research topics exploit widely and profoundly the knowledge and know-how from many on-line sources: ProWat/ProWat2 websites as well as ProWat Parabolic Interface on the MTM Dept. server which is easy and access always available for public and students.So long as the Internet is connected the end-user or learner can view/activate the program on any corner of the world, at any time, at any moment.

3.3 Non revenue water & competence based qualifications

Competence-based qualifications of water management systems in Finland

Finland has been developing competence-based qualifications since 1994. This system is intended to enable working-age adults to gain qualifications without necessarily attending formal training. It is possible to take competence-based vocational qualifications, further vocational qualifications and special vocational qualifications or only parts of them. The competence-based qualifications are set and supervised by field-specific education and training committees. The committees agree on the organization of the tests with providers of education and other communities. About 95% of candidates attend some training before taking a competence-based test.

Some 36,000 vocational qualifications are awarded annually, from which 6,670 are competence-based qualifications. The annual number of further and specialist qualifications is 12,450.

Apprenticeship training

Apprenticeship training is hands-on learning at a workplace, complemented by theoretical studies. A contract of temporary employment (apprenticeship contract) is signed by the parties of the apprenticeship training.

In apprenticeship training it is possible to study for initial vocational qualifications and for further and specialist qualifications. It is a training track chosen by some 9% of vocational students each year.

Apprenticeship training is based on a fixed-term agreement which a prospective trainee, aged 15 or more, concludes with the employer. Each student is given a personal study plan based on a core curriculum issued by the National Board of Education or on the requirements of the competence-based qualification in the field.

About 70 to 80% of the training takes place at the workplace under the guidance and supervision of an on-the-job instructor. The supplementary theoretical instruction is given by vocational institutions.

The employer pays wages according to the collective agreement for the duration of the training. During theoretical training, the trainee is entitled to a daily allowance and subsidised travel and accommodation. The employer is reimbursed for the cost of the training.

There are three levels in the competence tests:

- Those who have a vocational upper secondary qualification can switch to jobs in the relevant field.
- Those who have a further vocational qualification have the vocational skills required of professionals in the field.
- Those who have a specialist vocational qualification are competent in the most demanding tasks in the field.

Obtaining a competence-based qualification requires competence on field skills. The skill requirements have been set, in collaboration with the trade and industry, on the basis of work modules in working life.

The competence-based qualifications for adults in Water Management consist of:

FURTHER QUALIFICATION IN WATER SUPPLY AND SEWERAGE
OBLIGATORY MODULES
1 § Knowledge of the processes of the water supply and sewerage 2 § Knowledge of the industry (water supply branch)
OPTIONAL MODULES **one of which must be taken**
3 § Water abstraction and purification 4 § Wastewater treatment 5 § Water supply and sewerage networks
VOLUNTARY MODULE
6 § Entrepreneurship

Candidates must be able to independently, as a member of a working team, undertake typical tasks of water supply, sewerage and drainage networks, such as management and investigation, operation and maintenance, construction and rehabilitation, as well as works of house connection and water meters. One of the topics is water loss management in networks.

- The professional competence is demonstrated in the real life working environment by undertaking typical tasks required by the process
- If necessary, the performance can be additionally assessed by interviews, discussions, simulated assignments or other methods

Example: Preparatory training in Environmental School of Finland SYKLI

- Education and training consists of 3 different parts :
  - on-the-job training (approximately 80 % of the total),
  - contact teaching (learning at Sykli) and
  - distant and multiform learning (homework)
- Workplaces and good workplace instructors play a great role in our training system.
  - SYKLI assists instructors in planning each student's on-the-job-training
- The course consists of approximately 14 days of contact teaching within 1 ½ years; From these, 1 day is occupied with NRW management:

  Implementation of NRW Reduction strategy , Assessing water loss , Water balance

  Pipeline and asset management: managing network rehabilitation in an economical manner to reduce the need for corrective maintenance

  Pressure management: regulating network pressure through the judicious use of pressure-reducing valves (often an underestimated option for leakage reduction)

  Active leakage control: monitoring network flows on a regular basis to identify the occurrence of new leaks earlier so that they can be detected and repaired as soon as possible

  Speed and quality of repairs: repairing leaks in a timely and efficient manner (often requiring a thorough shakeup of working practices, organization and stock keeping of repair materials)
- The number of contact teaching depends on the student's existing skills
- **An individual learning plan** is done for every student (personalization: interviews, tests)

Water Hygiene Passport (certification test 2007)

Due to some quality problems with the distributed drinking water in Finland, an obligatory water hygiene passport test for all people working in the field of drinking water was instituted in 2008.

Normally it consists of one day training followed by an exam. The test area is water hygiene issues in:

- Surface water treatment
- Ground water treatment
- The water cycle
- Network management
- Understanding a basic water distribution system
- Water quality
- Water hygiene issues

3.4 Non revenue water, maintenance and Asset Management

Sustainable Solutions

The strategic challenge of infrastructure management

Strategic asset management is necessary for the provision of a safe and reliable water supply.

Introduction

Planning, designing, constructing, maintaining and operating the infrastructures required to guarantee a high level of drinking water service, are activities technically and financially rather demanding and complex. These activities are strongly supported on physical assets of high value, representing an intensive capital sector.

Additionally, they are long living assets, built up for many decades. Consequently, they are designed for peak situations within the assets' lifetime, which generate idle capabilities, not used for long periods. The infrastructures show a high degree of immobilization, as they are intended for a specific purpose and therefore their transaction is difficult.

It is a challenge to keep a sustainable use of water sources in growing economies, raw water tends to require increasing complex treatment processes due to emerging pollutants and to a better knowledge of their effects on human health.

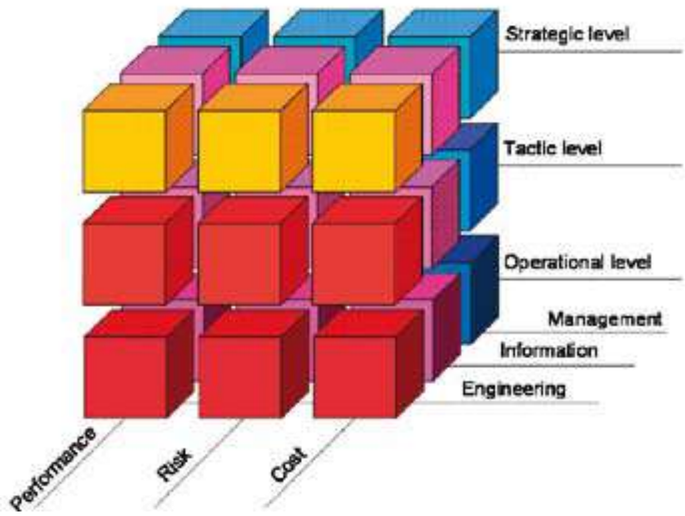
However, the more reliable and good the provided service is, the less this 'behind the curtain' effort is duly perceived by the population. For modern developed societies it is so normal to have safe water out of consumers' taps that the service is taken for granted. Communities assume this is so obvious that they do not even think of it unless some extraordinary event occurs. The fact that water supply infrastructures have very little visibility (mostly buried), and the service is easily accessible contribute to this general societal behaviour, which causes consumers and politicians to tend to under-valuate this service. Consumers' willingness to pay is often below reasonable and the budget allocated to capital maintenance of the infrastructures is below needs, putting the service into risk in the medium and long term. This is currently a major problem that must not be ignored.

For instance, in the United States of America, the American Society of Civil Engineers carries out periodic reviews on the condition and performance of the main public infrastructure services. ASCE estimates that $1.6 trillion is needed over a five-year period to bring the nation's infrastructure to good condition (ref. 2008). As regards drinking water, the 2005 'Report card for America's infrastructure' states that 'America faces a shortfall of $11 billion annually to replace aging facilities and comply with safe drinking water regulations'. In these reports, grades are assigned on the basis of condition and capacity and funding versus need. The drinking water service, as well as the wastewater service, decreased from grade D (poor) in 2001, to D- in 2005, being at the bottom of the ranking 14 infrastructure services analysed. Similar results are found in many other developed countries.

It is therefore a shared responsibility of utility staff, administration, regulators, consumers and society at large to change this situation and manage the drinking water infrastructures in a strategic and sustainable way. A long term approach to the problem is required in the process of optimising available resources while assuring a good level of service in a sustainable way. In short, there is a need for strategic asset management of the water supply infrastructure.

Concept of strategic asset management

Strategic asset management is a multidimensional approach (see Figure 1) that may be defined as the corporate strategy and the corresponding planning as well as the systematic and coordinated activities and practices through which an organization optimally manages its assets and their associated performance, risks and expenditures over their lifecycle.



Strategic (infrastructure) asset management should be planned and implemented at strategic, tactical and operational levels, in a coherent way, in order to involve all the organization in achieving the corporate objectives. In an ideal world, the performance of the infrastructure, assessed in terms of system condition and quality of the service it provides, should be excellent at all times, with no risk of failure, and with negligible cost. As these objectives conflict with each other, the challenge is to set up and reach a balance between them. This is why STRATEGIC ASSET MANAGEMENT is sometimes referred to as the art of consensus. For this, three main fields of competence are required: engineering, information and management. Information and management are key domains for managing any type of asset. Since water supply is an activity sector centred on the use of expensive and long endurance built infrastructures, engineering gains a great relative importance. Particularly, it is the engineer’s role to plan, design and construct the systems, to define and implement optimized operation strategies, to establish maintenance procedures, to establish diagnosis of the systems condition and functional performance, to establish rehabilitation policies and to develop the corresponding supporting methods, algorithms, software tools and technologies.

Levels of intervention

Strategic infrastructure asset management may be seen at two main levels: the administration and policy making level and the utility level.

At the administration and policy making level there is a need for:

- improving awareness on the importance of STRATEGIC ASSET MANAGEMENT;
- establishing legal and institutional mechanisms and creating incentives that promote STRATEGIC ASSET MANAGEMENT;
- setting up regulatory systems (including the promotion of self-regulation mechanisms) that incorporate a long-term perspective and do not confine their aim to higher economic efficiencies in the short term;
- promoting research and Development on STRATEGIC ASSET MANAGEMENT;
- promoting best practices and show cases.

At the utility level, there is a need for:

- having the CEO commitment for a gradual implementation of STRATEGIC ASSET MANAGEMENT;
- creating a STRATEGIC ASSET MANAGEMENT culture within the organisation;
- networking with other utilities and learning from their better practices;
- improving the information structures and current information management practices;
- improving the organisational structure;
- adopting effective engineering decision support tools and solutions to the
- utilities;
- improving multidisciplinary and multi-departmental collaboration and communication between stakeholders;
- implementing STRATEGIC ASSET MANAGEMENT approaches.

These are fundamental steps for a successful implementation of a STRATEGIC ASSET MANAGEMENT approach, which includes:

- analysing the internal and external contexts, including stakeholders requirements, needs and expectations, and establishing target levels of service and acceptable levels of risk in the short, medium and long terms;

- characterising the condition and the levels of the service provided by the existing infrastructure assets;
- identifying critical infrastructures, assess corresponding levels of risk for the status quo scenario and compare with acceptable levels of risk;
- estimating expected residual life of the assets, taking into account condition, performance and risk of failure;
- estimating the deferred Maintenance (i.e., deficit of capital maintenance in the system to bring it to an acceptable level of performance and risk);
- identifying and comparing alternative intervention solutions, compare the corresponding performance, risk and cost over the assets lifetime and define intervention priorities;
- preparing the investment plan and specifying funding sources;
- preparing an asset management plan;
- implementing, monitoring and revising the AM plan;
- consulting stakeholders in key stages of the process, such as context characterisation and establishment/ revision of target levels of service and of acceptable levels of risk.

Best Practises

Australia and New Zealand are probably the countries where STRATEGIC ASSET MANAGEMENT, seen as a formal and integrated approach, is currently more broadly implemented. However, many other successful stories might be referred.

In Europe, the research projects CARE-W and CARE-S are successful stories on the development of computer-aided tools for the rehabilitation of water and wastewater networks. Above all, these projects significantly contributed to change the installed culture in many utilities, creating awareness for the need for good quality historical data and for the adoption of integrated and multi-criteria decision making processes.

But STRATEGIC ASSET MANAGEMENT is all about people and people's organization and motivation. An example of a successful story that clearly demonstrates this statement may be found in Uganda. The creation of a national strategy for the improvement of the water supply service, supported by incentives to the workers who achieve pre-defined objectives, made the difference shown in Table 1.

Table 1: Evolution of the water supply service in Uganda

Uganda indicators	**1998**	**2006**
Service coverage	48%	70%
Non-revenue water	51%	29%
Metered water	65%	99.6%
Active service connections	63%	94%
New connections	3317 /year	23,312 /per year
Total connections	50,826	148,312

Total revenues US$	11 million US$	34 million US$

Does STRATEGIC ASSET MANAGEMENT provide attractive opportunities to young engineering professionals?

A professional career, to be attractive, should have a market, should bring innovation, should have challenges, require creative solutions and be rewarding in terms of results of the work for the society and for the own individual. Strategic asset management of water supply infrastructure has this and much more. Given the wide spectrum of activities involved, it requires the contribution from professionals with different backgrounds. For engineers, it accommodates may different profiles of people: those who like to understand the causes of the problems and create new knowledge, as well as those who prefer to solve them in practice; those who prefer the indoors office work as well as those who prefer to implement the solutions on the field; those who prefer the purely engineering activities, as well as those who feel also attracted by complementary managerial activities. Key requirements for success are to feel motivated, to be technically well prepared, to feel motivated for a multidisciplinary team work, and to be convinced of the vital role of STRATEGIC ASSET MANAGEMENT for the sustainability of the society.

3.5 Non revenue water and practises in a water distribution form

Vitens is the largest water company in the Netherlands, providing water in many departments with 5,400,000 consumers, with 1.500 employees. In the report, information on the company profile, the water consumption and the water quality as well as the current maintenance practice are given. The annual water consumption is about 350 M m3. Vitens has a high-tech laboratory for drinking water, where the quality from source to tap is closely monitored. Every day 3,000 bottles of samples are collected, out of which 750 samples are processed. Vitens sends daily more than one hundred engineers on the road for preventive and curative maintenance to the pipelines and connections. Vitens has a mobile data system with connections to the GIS and the mobile work order system and uses the SAP application in conjunction with a GIS.

Objectives and Tasks

Vitens is very customer oriented. The customers can rely on drinking water quality at the lowest price possible (2009: € 0,90 - € 1,50 p.m3) and comes with an excellent service. Vitens provides sufficient water, a well-maintained distribution system and a back-up for major production. Therefore customers are never without drinking water. Through their Customer Service websites Vitens makes sure that customers can reach Vitens support units easily and quickly and ask for help. Vitens has an innovative character. Through continuous innovation and development, the quality of water is increased by providing good, fresh and safe drinking water and at the same time with respect of environment.

Also, to protect water resources, Vitens is working with water boards, conservation organizations, municipalities and provinces. Challenging global water issue: Vitens looks across national boundaries. Huge numbers of people around the World do not have clean drinking water available for them. Together with a different water company organization - Evides - Vitens contributes to challenge global water issues. With several projects Vitens helps to build a better water supply for millions of people in developing countries. Vitens can help them through the Water for Life Fund.

Trends

- Sustainable Water extraction.
- Although water is generally sufficient, the government tries to reduce water consumption, to save the environment. Water saving solutions have ensured that the (relative) water consumption has slowly decreased. The decrease is mainly caused by new toilets and washing machines with water efficient practices. In 2007, there was a slight increase in water use, caused by an increase in the use of showers.
- Experiments were done with two kinds of water: household water (for the toilets) and drinking water. It all ended because the risk of cross connections between drinking water pipelines and household water supply proved to be too big.

Current Maintenance Practices

To provide the services at a high level to the customers, Vitens sends more than one hundred engineers everyday on the road for preventive maintenance and repairs of the pipelines and connections. To increase efficiency and customer satisfaction Vitens has a mobile data system developed with connections to the GIS (Geographic Information System) and the mobile work order system.

For preventive and corrective maintenance of the infrastructure (pipes and connections) Vitens uses the SAP application (software for Enterprise Resource Planning) in conjunction with a GIS. In a later stage, the process is improved for automated meter reading, collection and control.

In addition to the need to streamline and optimize the internal processes to continually improve the quality of service to its customers Vitens continues to improve services. The “mobile workflow” plays a crucial role and provides the mobile staff of all essential information such as location, mission and GIS information around pipes and house connections.

The Vitens mobile work order system is controlled through a planning and reporting office. The mechanics/repair men have in their bus service a laptop or a PDA with an integrated modem so that they constantly have the most current information. The various work orders are automatically transmitted to the planning system in which the planner assigns a technician to a certain function. The mechanic gets his job assignment and associated information sent. After performing his work the mechanic fills an electronic "form" where they store all the information about the order, including the materials used. The data are all sent back to office via SAP. Thus Vitens has a constant overview of the work and the list of specific tasks/orders performed. The customer can also be kept fully informed. Moreover, the mechanics are directly traceable in case of emergency orders. In addition the Mobile GIS staff has the full up-to-date GIS information on pipelines and household connections.

Risk Management

The water distribution companies want a more structural approach to handle risk management of external effects of pipe leakage. This desire has resulted in a contract of VEWIN at Kiwa Water Research to carry out an initial exploration of this issue via a survey. The aim of this survey is to create a more structural approach to risks of external effects of pipe leakage, with support from the industry.The main goal (on the longer-term) is to find public support for that approach from external stakeholders (governments, license and customers).

With regards to external impacts by pipeline leakage below you could find some conclusions of this survey.

1. The Dutch transport and distribution is in a relatively good state. There are only very limited incidents involving pipe leakage leading to damage to third parties (externalities). This is thanks to the management measures taken in the past.

2. Currently there is a legal obligation to maintain a management system for new pipelines covered by the standard NEN3650 (released in July 2003). Also for all primary dams there is an obligation to a five year test of the dam capacity, to be implemented by the administrator of the dams. It may be that in the future the pressure on water distribution companies will increase further to become more accountable, so they avoid risky situations. (In general decrease the pressure.).

3. There may arise a large number of risky situations, such as pipes in the vicinity, among others: primary water barriers, bosom quays, other dike, railways, highways, provincial and municipal roads and buildings.

4. Although the water distribution companies have a broad focus to keep the water and the pipelines in good condition they are not aware of which pipes are located in the vicinity of hazardous objects. Most companies do not explicitly focus on pipes with leaks that can lead to large external effects.

5. To set up a management system for leaking pipes that can lead to large external effects, the following is needed:

a. a table to identify pipes which are located in the vicinity of hazardous objects;

b. expertise so that a development tool available in the form of a checklist to estimate whether in a given situation there is a need for a additional structural or managerial measures ;

c. a system recording incidents that have led to external effects.

4. Glossary

- Active Leakage Control (ALC): The process by which unreported leaks are detected and repaired. This contrasts with Passive Leakage Control. Invisible leaks account for more than 90% of the total volume of real losses. Small hidden leaks, which often run for years, lose more water than even the most dramatic surface bursts. Active Leakage Control is comprised for well-targeted and properly-managed leak detection activities in order to locate hidden leaks, communication strategies to encourage the customers to report immediately visible leaks and effective work management to ensure speedy and good quality repairs.

- Auto Meter Reading (AMR): AMR enables frequent and accurate data transfer of metered information. It enables improved analysis of the status of individual meters, customer leaks and frauds. At the network level, AMR provides tools for enhanced Water Loss analysis, on-going water balance and identification and localization of bursts. Consequently, AMR improves NRW management at all levels.

- Apparent Losses/Commercial Losses: Includes all types of inaccuracies associated with customer metering as well as data handling errors (meter reading and billing) plus unauthorized consumption (theft or illegal use). Apparent Losses are called "Commercial Losses" by the World Bank and in some countries the misleading term "Non- Technical Losses" is used.

- Authorized Consumption: The volume of metered and/or unmetered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial and industrial purposes. It also includes water exported across operational boundaries. Authorized consumption may include items such as fire fighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or unmetered.

- Average Zone Night Pressure (AZNP): The property-weighted average pressure in a zone during the minimum night flow period.

- Awareness Time: The time between the occurrence of an unreported leak and the water undertaking becoming aware of its existence.

- Background Leakage: The component of leakage that is not affected by ALC. This usually consists of very small leaks.

- Billed Authorized Consumption: Those components of Authorized Consumption which are billed and produce revenue (also known as Revenue Water). Equal to Billed Metered Consumption plus Billed Unmetered Consumption.

- Billed Metered Consumption: All metered consumption which is also billed. This includes all groups of customers such as domestic, commercial, industrial or institutional and also includes water transferred across operational boundaries (water exported) which is metered and billed.

- Billed Unmetered Consumption: All billed consumption which is calculated based on estimates or norms but is not metered. This might be a very small component in fully metered systems (for example billing based on estimates for the period a customer meter is out of order) but can be the key consumption component in systems without universal metering. This component might also include water transferred across operational boundaries (water exported) which is unmetered but billed.

- Bottom-up: This term refers to assessments of leakage made from night flows measured in DMAs and added together to produce an area leakage level.
- Burst: A failure of a pipe or service leading to leakage. This term is interchangeable with leak.
- Bursts And Background Estimates (BABE): Component-based estimate of annual losses in different parts of the distribution system for any particular combination of local circumstances, i.e. pressure, burst frequency, burst flow rate, number of properties, length of mains, method of leakage control, standards of service and waste notice service/enforcement policy.
- CARL: Current Annual Real Loss
- Cascade: A method of supplying DMAs where water flows through one DMA into another . This makes more than one meter on some DMAs necessary; a situation where best can be avoided.
- Commercial Losses: see "Apparent Losses"
- Current Annual Real Losses (CARL): CARL always tends to increase as the distribution networks grow older. This increase can be constrained by a successful leakage management policy.
- Customer Metering Inaccuracies and Data Handling Errors: Commercial water losses caused by customer meter inaccuracies and data handling errors in the meter reading and billing system.
- Customer Night Use: The water used by customers during the minimum night flow period.
- DM: District Meter
- District Metered Area (DMA): A small metered area within the distribution network.
- Economic Level of Leakage: The level of leakage at which the net present cost of operation of the network is a minimum.
- Energy Management: Miya's holistic program of energy efficiency improvements addresses shortcomings and minimizes the carbon footprint of water. Energy efficiency is achieved by physical improvement of the network, reducing physical losses (leakage) in the system and optimizing the operation of the network.
- Flushing: The induction of flows in pipes by opening hydrants or washouts.
- GIS: Geographic Information System
- Hydraulic Balance Point: In a complicated network fed by several trunk mains, there will be points within the distribution mains network where the net flow is close to zero at a given time, as flows from different routes feed the customers on either side. These hydraulic balance points are often suitable for sector or DMA boundaries as the closure of a valve here will cause little disruption.

- ILI (Infrastructure Leakage Index): The ILI is a measure of how well a distribution network is managed (maintained, repaired and rehabilitated) for the control of real losses, at the current operating pressure. It is the ratio of current annual volume of real losses (CARL) to unavoidable annual real losses (UARL). This is how it is calculated: ILI = CARL/UARL.
- Leak: See Burst
- Leakage and Overflows at Utility's Storage Tanks: Water lost from leaking storage tank structures or overflows of such tanks caused by e.g. operational or technical problems.
- Leakage on Service Connections up to point of Customer Metering: Water lost from leaks and breaks of service connections from (and including) the tapping point until the point of customer use. Leakage on service connections might be reported breaks but will predominately be small leaks which do not surface and which run for long periods (often years).
- Leakage on Transmission and/or Distribution Mains: Water lost from leaks and breaks on transmission and distribution pipelines. These might either be small leaks which are still unreported (e.g. leaking joints) or large bursts which were reported and repaired but did obviously leak for a certain period before that.
- Leakage: The water lost through holes in the pipes and tanks forming the network.
- Location Time: The time taken from the point where the Water Undertaking is aware of the existence of a leak to the point when the undertaking is aware of the exact location of the leak.
- Losses: Losses can be divided into apparent losses (meter errors and unauthorised consumption) and real losses. Real losses are equivalent to leakage.
- Meter Management: Active involvement of utilities in meter testing, maintenance and replacement which ensures that meters , that register less water, will be kept to a minimum and consequently the utility's revenues will be maximized.
- Minimum Achievable Annual Physical Losses (MAAPL): Physical Losses cannot be totally eliminated. The volume of Minimum Achievable Annual Physical Losses represent the lowest technically achievable annual volume of Physical Losses for a well-maintained and well-managed system. The standard equation for calculating MAAPL for individual systems was developed and tested by the IWA Water Losses Task Force. It allows for:
    - background leakage - small leaks with flow rates too low for sonic detection
    - reported leaks and breaks - based on average frequencies, typical flow rates, target average durations
    - unreported leaks and breaks - based on average frequencies, typical flow rates, target average durations
    - pressure/leakage rate relationships (a linear relationship being assumed)
    - The MAAPL equation requires data on four key system-specific factors:

        - Length of mains (all pipelines except service connections)
        - Number of service connections
        - Length of service connection between property boundary and customer meter. (Note: this is not the same as the total length of the service connection. Losses on the service connection between the tapping point at the main pipeline are included in the allowance per service connection. The additional allowance for length of connections on private land was included to take the longer leak run-times in situations where visible leaks would not be seen by public into account. In most urban situations, if the customer meter is inside the building, the length of service connection between property boundary and customer meter is obviously nil.)
        - Average operating pressure
    - Minimum Achievable Annual Physical Losses (MAAPL) is called “Unavoidable Annual Real Losses (UARL)” by the International Water Association.

- Minimum Night Flow (MNF): The net flow into a metered area during the period of minimum flow: this period is usually one hour.
- Night Day Factor (NDF): The factor by which night flow losses, (calculated from the Minimum Night Flow over a one hour period), should be multiplied to obtain the daily leakage. The NDF is usually less than 24, due to lower pressures during the day.
- Night Line: See Minimum Night Flow
- Non-Revenue Water (NRW): The gap between the amount of water put into the distribution system and the amount of water for which customers are actually billed. The major challenge facing water utilities and municipalities is how to deal with high levels of NRW. High levels of NRW reflect huge volumes of water being lost through leaks (real/physical losses), water not being invoiced or not being accurately measured (apparent/commercial losses) or a combination of them.
- NRR: Natural Rate of Rise
- NRW Management Software: NRW management software provides tools to effectively manage NRW operations. The software tools enable:
    - Top down and bottom up analysis of DMA data
    - IWA Water balances at the DMA and higher levels
    - Prioritizing and managing of leak detection activities
    - Area performance reporting and thematic mapping tools
    - An asset performance tool for analysing network asset performance

    - A rehabilitation planning tool
    - Building and maintaining hydraulic models
    - Recording and viewing the status of events occurring in the network.

  These software packages interface with a wide range of existing systems including SCADA, logger databases, GIS, CSS, Work Management and billing systems. Miya's experts have developed leading water audit software tools.

- Passive Leakage Control: Leakage control carried out by repairing only those leaks that become and are reported to the Water Undertaking.
- PCC: Per Capita Consumption
- Physical Losses: See "Real Losses"
- Pipe Repair: Invisible leaks account for more than 90% of the total volume of water losses. Small hidden leaks, which often run for years, lose more water than surface bursts. Good quality repairs, as part of an Active Leakage Control program, are an economic and practical way to contend with leakage.
- Pressure Correction Factor (PCF): If leakage (L0) is either measured, or estimated, at one pressure (P0), then in order to estimate the leakage (L1) at another pressure (P1), a relationship of the formula: can be used. The PCF is a function of the two pressures P1 and P0. This method is frequently used to translate leakage estimated at 50m head into leakage at the actual pressure experienced in a zone.
- Pressure Management: Pressure management involves reducing excess pressures and avoiding pressure fluctuations. It is the most beneficial leakage reduction activity because of the direct pressure/leakage relationship. It helps reduce burst frequency and therefore extends an asset's lifetime. Miya group companies have developed and implemented the most advanced pressure management systems available today and Miya regularly invests in on-going research and development to improve pressure management solutions and technology.
- Pressure Reducing Valve (PRV): A control valve within the network which reduces the downstream pressure using various types of control method.
- Pressure Zero Test (PZT): See zero pressure test.
- Rate of Rise of Leakage: The rate at which leakage increases with time between periods of active leakage control. This can be measured by analysing long-term flow and repair records. It is usually expressed in litres per connection per day per year.
- Real Losses: Real losses involve leakage and overflows at reservoirs, leakage on service connections up to metering point and leakage on transmission and distribution mains, up to the point of customer use. Real losses are called "Physical Losses" by the World Bank and in some countries the misleading term "Technical Losses" is used.

- Repair Time: The time taken from the point when the undertaking is aware of the exact location of the leak to the point when the repair is completed.
- Reported Burst: A leak that the water undertaking becomes aware of, without any detection activity. The reasons for this are typically that the water becomes visible on the surface or the burst leads to loss of supply to customers.
- Revenue Water: Those components of Authorized Consumption which are billed and produce revenue (also known as Billed Authorized Consumption). Equal to Billed Metered Consumption plus Billed Unmetered Consumption.
- SCADA (Supervisory Control and Data Acquisition). A computer system for gathering and analysing real time data.
- Sector: A section of the distribution network, usually much larger than a DMA and often defined by clear natural or manmade boundaries, such as rivers or railways.
- Step Test: A test to find the location of a leak. Parts of an area fed through a meter are progressively isolated while the flow is monitored. The drop in flow after each isolation is used to identify the amount of leakage in that isolated section.
- System Input Volume: The volume of treated water input to that part of the water supply system to which the water balance calculation relates.
- Top-down: Refers to assessment of leakage levels through a water balance.
- Training: It is Miya's mission to propagate knowledge to water utility practitioners, in order to ensure the continuation of best practice Water Loss Management during the project period and even after Miya's service term comes to an end. The sharing and transfer of knowledge is carried out by training the water utility management and staff, maintaining high involvement throughout the process and even integrating with the work teams to ensure that the know-how is used optimally by the utility.
- TWL: Top Water Level
- UARL: Unavoidable Annual Real Losses
- Unaccounted-for Water: Because of the widely varying interpretations and definitions of the term "Unaccounted for Water", it is strongly recommend that this term be no longer used.
- Unauthorized Consumption: Any unauthorized use of water. This may include illegal water withdrawal from hydrants (for example for construction purposes), illegal connections, bypasses to consumption meters or meter tampering.
- Unbilled Authorized Consumption: Those components of Authorized Consumption which are legitimate but not billed and therefore do not produce revenue. Equal to Unbilled Metered Consumption plus Unbilled Unmetered Consumption.

- Unbilled Metered Consumption: Metered Consumption which is for any reason unbilled. This might for example include metered consumption by the utility itself or water provided to institutions free of charge, including water transferred across operational boundaries (water exported) which is metered but unbilled.

- Unbilled Unmetered Consumption: Any kind of Authorized Consumption which is neither billed nor metered. This component typically includes items such as fire fighting, flushing of mains and sewers, street cleaning, frost protection, etc. In a well-run utility it is a small component which is very often substantially overestimated. Theoretically this might also include water transferred across operational boundaries (water exported) which is unmetered and unbilled - although this is an unlikely case.

- Unreported Burst: A burst which can be found by active leakage control but not by passive leakage control.

- Water Audit: An accurate and detailed water audit details how much of each type of water loss is occurring and how much it is costing the water utility. The key concept behind this approach is that water should not be “unaccounted-for”. In conducting a water balance audit, a quantity is determined for the major components of water consumption and water loss and subsequently a price is placed on each component in order to assess its financial impact on the water utility. A detailed and accurate water balance forms the basis for an effective NRW management strategy.

- Water Conservation: A complimentary activity which is important to decrease water demand. Miya can train utilities staff and communities to develop water conservation strategies with programs such as:

    - Water use profiling
    - ICI water audits
    - Residential end use analysis
    - Verifications of pre/post-replacement savings
    - Toilet replacement programs
    - Outdoor / peak day assessment
    - Other appliances - flow control
    - Grey water recycling

- Water Loss: The difference between System Input and Authorized Consumption. Water losses can be considered as a total volume for partial systems such as transmission or distribution schemes, for the whole system or for individual zones. Water Losses consist of Physical Losses and Commercial Losses.

- Water Undertaking: A general term for the organisation responsible for operation of the water supply and distribution system.
- Zero Pressure Test: A test to identify whether the boundary to a zone is watertight. An area of the distribution system is isolated by closing boundary valves. The pressure is monitored and if it drops to zero this indicates that the boundary is watertight.

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