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REPORT

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CARE-W WP1 Construction of a control panel of performance indicators for rehabilitation D1 – Preliminary Rehab PI System

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CARE

COMPUTER AIDED REHABILITATION OF WATER NETWORKS

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CARE – W

Computer Aided REhabilitation of Water networks. Decision Support Tools for Sustainable Water Network Management

WP1 - Construction of a control panel of performance indicators for rehabilitation

Report No. 1
Preliminary Rehab PI System

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Lisbon, December 2001

CARE – W

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WP1 - Construction of a control panel of performance indicators for rehabilitation

Preliminary selection of a listing of performance indicators for rehabilitation

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1 INTRODUCTION

CARE-W project is funded by the European community, and aims to develop methods and software that will enable engineers of the water undertakings to establish and maintain an effective management of their water supply networks, rehabilitating the right pipes at the right time. The results shall be disseminated as a manual on Best Management Practice (BMP) for water network rehabilitation.

This project is organised in the following Working Packages (WP):

- WP1: Construction of a control panel of performance indicators for rehabilitation;
- WP2: Description and validation of technical tools;
- WP3: Elaboration of a decision support system for annual rehabilitation programmes;
- WP4: Elaboration of long-term strategic planning and investment;
- WP5: Elaboration of CARE-W prototype;
- WP6: Testing and validation of CARE-W prototype;
- WP7: Dissemination;
- WP8: Project management.

LNEC is responsible for WP1. This report refers to the first Task of this Working Package.

2 METHODOLOGY

The WP1 is divided in three Tasks, each one with its specific objective, schedule, deliverables and methodology:

TASK 1.1 – CHOICE OF PERFORMANCE INDICATORS

Objective: Major research is currently being done in international programmes to define appropriate performance indicators for water systems. The objective of this Task is to select indicators to be used for the analyses of short term as well as long-term rehabilitation needs.

Schedule: 1 February - 30 April 2001.

Methodology:

a) Identification of CARE-W specific objectives with regard to the use of PI in the scope of rehabilitation of water distribution networks;

b) Discussion with partners of pre-selected rehab PI, based on the IWA[1]-PI system, including:
   - mailing to all partners of the questionnaire “CARE-W-Fev2001.doc” regarding the selection of relevant IWA PI [1] in the framework of CARE-W;
   - reception of replies from partners;

c) Identification of the specific requirements of the rehab models to be used within CARE-W framework, including:

[1] IWA – International Water Association

- mailing to all partners of questionnaire “CARE-W PI questionnaire.xls” regarding the input and output data of the existing rehab models, as well as the rehab PI and context information considered relevant for CARE-W prototype;
- reception of replies from partners;

d) Analysis of information collected, including:

- analysis of replies on relevant IWA PI (“CARE-W-Fev2001.doc”);
- analysis of input /output data of existing models (“CARE-W PI questionnaire.xls”, 2nd worksheet);
- analysis of partners suggestions for relevant rehab PI in the framework of CARE-W (“CARE-W PI questionnaire.xls”, 3rd worksheet);

e) Definition of a preliminary CARE-W rehab PI listing based on a cross-analysis of the above mentioned information;

f) Definition of a preliminary (definitive at this stage) CARE-W rehab PI listing, including:

- mailing of the PI-listing to partners, for feed-back;
- reception of replies from partners;
- refinement of PI listing.

Deliverables: Preliminary listing of rehab PI.

TASK 1.2 – TEST OF PERFORMANCE INDICATORS ON CITIES

Objective: The objectives of this Task are to held a rehab PI survey and create a database. Based on the PI selected in Task 1.1, a test program will be carried out towards the co-operating cities (the project end-users as well as other co-operating European cities). The program will include collection of information on failure records and management systems from the co-operating cities. Additionally, a questionnaire will be sent. This research will comprise questions on possible existing planning systems and additionally the same questions on rehabilitation planning. This information is necessary for the development of the succeeding project activities. Two major aspects in the test program will be the water network database and the condition of pipe materials.

Schedule: 1 June - 31 October 2001.

Methodology:

a) Questionnaire preparation and launching to the co-operating cities;

b) Assess data availability, reliability and accuracy for the rehab PI selected;

c) Reception of replies and report presentation;

d) Preparation of overall report with global trends and thresholds;

e) Extensive field-testing of the rehab PI in a selected group of end-users (e.g. Oeiras e Amadora, Brno, Ferrara, Codigoro and Regio Emilia);

f) Collect key context information;

g) Collect rehab PI data variables to assess reference rehab PI values;

h) Analysis of the results;

i) Preparation of a database with PI thresholds for the tested utilities.

Deliverables: Report, reference values and database.

TASK 1.3 – PREDICTABLE PERFORMANCE INDICATORS

Objectives: (i) Final refinement of the rehab PI listing; (ii) identification of the rehab PI that can be predicted by any of the other CARE-W modules, based on explanatory variables; (ii) preparation and use of a software for data collection and rehab PI assessment (or, if available, use of an existing software package will be adapted to the proposed goals).

Schedule: 1 June - 31 October 2001.

Methodology:

a) Identification of predictable rehab PI;

b) Refinement of the CARE-W rehab PI;

c) Refinement of the rehab PI reference thresholds;

d) Rehab PI module for CARE-W prototype: preparation, test and use of a software application for data collection and rehab PI assessment.

Deliverables: Report of control panel of rehab PI and software.

3 PARTNER CONTRIBUTIONS

According to the proposal, a total of 20 man-months are allocated to this WP1, 7 of them to LNEC´s team. Brno and Bologna/Ferrara/AGAC have 4 man-months each. SINTEF/NTNU, Dresden, INSA and CEMAGREF have 1-2 man-months each. Although WRc has no time allocated to this Task, has participated in this WP and LNEC would welcome their contribution in the coming activities.

The following activities have been planned for SINTEF/NTNU, Dresden, INSA, CEMAGREF, Brno and Bologna/Ferrara/AGAC:

- Reply to questionnaire “CARE-W-Fev2001.doc”;
- Reply to questionnaire “CARE-W PI questionnaire.xls”;
- Comment the preliminary listing of rehab PI;
- Support to the respective end-users in the response to the questionnaire regarding availability, reliability and accuracy of the data required to assess the selected rehab PI.

Added contribution is expected from Brno and Bologna/Ferrara/AGAC:

- Participation in the extensive field-testing of the rehab PI in a selected group of end-users (e.g. Brno, Ferrara, Codigoro and Regio Emilia, together with Oeiras e Amadora).

4 PERFORMANCE INDICATORS

4.1 The need

The systematic assessment and use of performance indicators (PI) is a widely disseminated practice in many industrial sectors. Any modern productive industry strives to maximise internal efficiency in order to improve profits, and monitors its customers’ views and attitudes, with regard to the services provided, in order to adapt them to the customers’ preferences. PI are an essential tool for those purposes and have for a long time been a central part of management procedures.

Due to its nature of public service and monopoly, the water industry is with this regard a step behind other industrial sectors, and only relatively recently started to realise the potential benefits of this tool.

In this context, many IWA[2] members expressed the view that the Association should define guidelines on the indicators to be adopted in the water supply field, and the information to be collected in order to evaluate them. This was a major challenge, and one that the newly created IWA was willing to tackle and win. It required the definition of a common reference for PI, as well as an adequate model of aggregation that would fit the basic common needs of the key types of users.

4.2 The IWA project

A Task Force was established in May 1997 under the Operations & Maintenance Committee, with the objective of preparing an IWSA/IWA proposal on PI, according to the guidance approved in the same year by the Association's Scientific and Technical Council: *"IWSA expects that a robust and well devised system of PI will emerge, able to attract water undertakings to use it as a routine management tool. IWSA aims to cover the basic needs of different types of users, with special emphasis on the undertakings themselves. The results should be applicable to undertakings with different levels of development, and different climatic, demographic and cultural characteristics."*

The project benefited from valuable contributions from experienced managers, practitioners and researchers from over 50 countries. The contributions focused mostly on the indicators' structure, on the listing of data and preliminary indicators proposed (completeness, practical relevance, feasibility of assessment), and on the terminology and definitions.

A first edition of the IWA system of performance indicators for water supply services [1] was published in July 2000. It is the first issue of the new IWA Publishing series of manuals of best practice. It comprises the text and a CD-ROM with the software SIGMA Lite, which incorporates the performance indicators assessment system, allowing any undertaking to try it out straight away. The output is a standardized PI language, covering: syntax (structure of the indicators); morphology/semantics (vocabulary and definitions); etymology (how to assess the indicators from the basic data).

4.3 The PI concept

To achieve its management goals, the water undertaking needs to strive for high degrees of efficiency and effectiveness. *Efficiency* means the extent to which the resources of a water undertaking are utilised optimally to produce the service. *Effectiveness* means the extent to which declared objectives (specifically and realistically defined) are achieved.

A *performance indicator* is a quantitative measure of a particular aspect of the undertaking's performance or standard of service, for instance its rehabilitation activities. It assists in the monitoring and evaluation of the efficiency and effectiveness of the undertakings, thus simplifying an otherwise complex evaluation [1].

In the context of this project, a *performance indicator* is a ratio between values of identical or different nature, expressing the performance of the undertaking regarding a given point of view relevant in the rehabilitation framework and reflecting its decisions.

4.4 The PI users

Performance indicators can be of use to several entities, having the following potential benefits and uses [1]:

[2] The International Water Association (IWA) was created from the merge of the International Association of Water Quality (IAWQ) and the International Water Services Association (IWSA). The PI Task Force was established before the merger, by IWSA.

- For water undertakings: facilitates better quality and more timely response from managers; allows for an easier monitoring of the effects of management decisions; provides key information that supports a pro-active approach to management, with less reliance on apparent system malfunctions (reactive approach); highlights strengths and weaknesses of departments, identifying the need for corrective measures to improve productivity, procedures and routines; assists with implementation of a Total Quality Management regime, as a way of emphasising all-round quality and efficiency throughout the organisation; facilitates the implementation of benchmarking routines, both internally, for comparing the performance at different locations or systems, and externally, for comparison with other similar undertakings, thus promoting performance improvements; provides a sound technical basis for auditing the organisation's workings and predicting the effect of any recommendations made as a result of an audit.
- For consumers and pro-active stakeholders: provides the means of translating complex processes into simple-to-understand information and of transmitting a measure of the quality of service provided.
- For the national or regional policy-making bodies: provides a common basis for comparing the performance of water undertakings and identifying possible corrective measures; supports the formulation of policies for the water sector, within the integrated management of water resources, including resource allocations, investments, and the development of new regulating tools.
- For regulatory agencies: provides key monitoring tools to help safeguard consumer interests in a monopoly service supplier situation and monitor compliance with contracted goals, thus being a key element of yardstick regulation.
- For financing bodies: assistance in assessing investment priorities, project selection and follow-up.

4.5 The PI requirements

The rehab indicators to be selected in the framework of the CARE-W project should comply with the following requirements [1]:

a) to represent all the relevant mains rehabilitation aspects of a water undertaking's performance, allowing for a global representation of the system by a reduced number of performance indicators;

b) to be suitable for representing those aspects in a true and unbiased way;

c) to be clearly defined, with a concise meaning and a unique interpretation for each indicator;

d) to include only non-overlapping performance indicators;

e) to require only measuring equipment that is affordable, the need for sophisticated and expensive equipment being avoided;

f) to be auditable, which is specially important when the performance indicators are to be used by regulatory bodies that may need to check the results reported;

g) to be easy to understand, even by non-specialists e.g. consumers, wherever possible;

h) to refer to a well-defined period of time;

i) to refer to well-defined geographical areas;

j) to be applicable to undertakings with different characteristics and stages of development;

k) to be as few as possible, avoiding the inclusion of non-essential aspects.

5 IDENTIFICATION OF CARE-W SPECIFIC OBJECTIVES

According to the methodology, the WP1 activities start with the identification of CARE-W specific objectives with regard to the use of PI in the scope of rehabilitation of water distribution networks.

The selection of performance indicators to use in the scope of CARE-W prototype requires a careful analysis of its aimed capabilities. WP1 being developed in an early stage of the project may be used as a catalyser for partner's discussion and preliminary agreement of this issue. End-users must play an important role in this discussion, as well as model providers. Also the contribution of WRc, responsible for the development of the prototype shell (WP5), is essential.

In general, the implementation of a rehabilitation procedure includes the following stages:

1. **System preliminary characterisation and understanding**
2. **Problem(s) identification**
3. **Diagnosis**
   - 3.1. **System detailed characterisation focused on the existing problem(s)**
   - 3.2. **Identification of the causes of malfunctions or shortcomings**
   - 3.3. **Prediction of future trends of the symptoms and system reliability**
4. **Decision making**
   - 4.1. **Assessment of additional decision factors**
   - 4.2. **Rehab strategy definition (where to rehabilitate? when to rehabilitate? what / how much to rehabilitate?** how to rehabilitate/technologies?**)**
5. Solution implementation
6. **Monitoring**

The objective of CARE-W is to contribute to establish a method for estimating the vulnerability of water network systems, i.e. the reliability of delivering enough water of acceptable quality to every customer; establish improved systems for forecasting water pipe breaks and leaks; establish improved systems for decision-making aid (multi-criteria analysis for priority setting and technology selection); test different available analytical methods in representative cities; evaluate alternative rehabilitation strategies.

According to these initial ideas, it is thought that CARE-W prototype will cover the items in boldface (which means all the issues but not how to rehabilitate/technologies and the solution implementation) and the definition of the set of rehab PI must have this procedure into account.

6 DISCUSSION WITH PARTNERS OF PRE-SELECTED REHAB PI BASED ON THE IWA-PI SYSTEM

According to the CARE-W methodology, a mailing to all partners with a questionnaire entitled "CARE-W-Fev2001.doc" was prepared, regarding the selection of relevant IWA PI.

The questionnaire presented a listing with the whole set of indicators (133) included in the system of performance indicators for water supply services of the International Water Association [1]. In the first column of each table a code of colours has been used to express LNEC's preliminary view about the importance of each indicator for rehabilitation (based on

the classification: essential, important, useful or irrelevant), in the scope of CARE-W. Each partner was requested to fill-in the second column of the tables with his own view, using the same grading scheme.

Replies have been received from SINTEF/NTNU, Dresden, INSA, CEMAGREF, Brno, Bologna/Ferrara/AGAC and WRc and are synthesized in Appendix 1. A detailed analysis is presented in item 8.1.

7 IDENTIFICATION OF THE SPECIFIC REQUIREMENTS OF THE REHAB MODELS TO BE USED

According to the methodology, a mailing to all partners has been prepared and issued with a questionnaire “CARE-W PI questionnaire.xls”, regarding the input and output data of the existing rehab models, as well as the rehab PI and context information considered relevant for CARE-W prototype.

The questionnaire (in Excel) was split into three worksheets:

- Worksheet “Instructions” contained the partner’s identification and the questionnaire instructions;
- Worksheet "Models inputs & output" was directed to the partners who have rehab models (Utilnets, NHPP and Aquarel, from NTNU-SINTEF, Failnet Reliab and Failnet Stat from CEMAGREF, Poisson Regression and Stochastic models from INSA, Kanew, from Dresden University, and RelNet model from BRNO University). It aimed to synthesize all input and output variables of the current versions of the existing models;
- Worksheet “PI & context information” was asked to be replied by every partner. It aimed to collect the participants' views about the performance indicators and context information that shall be included in the decision making process of CARE-W prototype, regardless of being already included or not in the existing models. Those who full-filled worksheet model inputs and outputs should include in this sheet only new aspects that either are planned for the future model development or are deemed to be relevant for the new decision support modules of CARE-W prototype.

Replies have been received from SINTEF/NTNU, Dresden, INSA, CEMAGREF and Bologna/Ferrara/AGAC and a detailed analysis is presented in items 8.2 and 8.3.

8 ANALYSIS OF THE INFORMATION COLLECTED

8.1 Analysis of replies on relevant IWA-PI

The results of the questionnaire “CARE-W-Fev2001.doc” are presented in Appendix 1. Note that all the performance indicators graded as irrelevant (68) by most partners has been removed from the initial listing. For each of the remaining performance indicators (65) the grades obtained (essential, important, useful or irrelevant) are indicated and the dominant opinion is highlighted (in red).

The following preliminary conclusions arise from the results:

Water resources indicators: None of the 2 IWA PI is considered essential from the rehab point of view. The opinions are mainly split into useful and important for both indicators (inefficiency of use of water resources WR1 and resources availability ratio WR2).

Personnel indicators: None of the IWA PI is considered essential from the rehab point of view. The opinions are mainly split into useful and irrelevant for other 5 PI, related to total personnel (1 PI), personnel per main function (3 PI) and technical service personnel per activity (1 PI). All the others (17 PI) are considered irrelevant.

Physical indicators: Only one PI is considered important (valve density Ph7) from the rehab point of view. The opinions are mainly split into useful and irrelevant for other 5 PI, related to storage (1 PI), pumping (3 PI) and transmission and distribution network (1 PI). All the others (6 PI) are mostly considered irrelevant.

Operational indicators: 7 indicators are considered essential: 4 related to mains, valves and service connection rehabilitation (mains rehabilitation Op15, mains relining Op16, replaced or renewed mains Op17 and replaced valves Op18), 1 related to water losses (real losses Op25) and 2 related to failures (mains failures Op27 and service connection failures Op28). 7 indicators are considered important: 3 related to inspection and maintenance mains (network inspection Op3, leakage control Op4 and active leakage control repairs Op5), 1 related to service connection rehabilitation (service connection rehabilitation Op19) and 3 related to water losses (water losses Op22, apparent losses Op23 and infrastructure leakage index Op25). The opinions are mainly split into useful and irrelevant for other 12 PI, related to inspection and maintenance (1 PI), pump rehabilitation (2 PI), failures (2 PI) and water quality monitoring (4 PI). All the others (13 PI) are mostly considered irrelevant.

Quality of service indicators: 1 indicator related to service (pressure of supply adequacy QS9) is considered essential. 11 indicators are considered important: 6 related to service (water interruptions QS11, interruptions per connection QS12, quality of supplied water QS15, aesthetic quality of supplied water QS16, microbiological quality of supplied water QS17 and physical-chemical quality of supplied water QS18) and 5 related to customer complaints (service complaints QS22, pressure complaints QS23, continuity complaints QS24, water quality complaints QS25 and interruptions complaints QS26). The opinions are mainly split into useful and irrelevant for other 6 PI related to service. All the others (11 PI) are mostly considered irrelevant.

Financial indicators: None of the IWA PI is considered essential from the rehab point of view. 8 indicators are considered important: 3 related to annual costs (unit total costs Fi1, unit running costs Fi2 and energy cost ratio Fi7), 3 related to annual investment (unit investment Fi18, annual investments for new and upgrading assets Fi19 and annual investments for assets replacement Fi20) and 2 indicators related to water losses (non-revenue water by volume Fi36 and non-revenue water by cost Fi37). The opinions are mainly split into useful and irrelevant for 1 PI related to annual costs and 2 PI related to average water charges. All the others (26 PI) are mostly considered irrelevant. All these indicators will be included in the final list of PI (item 9.2).

This means that 8 PI have been considered essential and 29 important for mains rehabilitation, representing 26% of the global IWA PI system (133), according to this first approach.

8.2 Analysis of the input /output data of existing rehab models

Appendix 2 synthesise the results of the questionnaire “CARE-W PI questionnaire.xls”, regarding the input and output data of the existing rehab models. The last column of the table relates this information with the global IWA PI system[3].

The models analysed in the context of performance evaluation for rehabilitation were Utilnets, NHPP and AQUAREL from NTNU/SINTEF, Failnet Reliab and Failnet Stat from CEMAGREF, Poisson Regression and Stochastic models - ageing functions from INSA, KANEW from Dresden University, and RelNet model from BRNO University.

In the model Utilnets, 21 new CI (maximum flow capacity, trench width, internal protection date, external protection date, bedding description, backfill description, joint type, internal

[3] In this context, the model inputs or outputs that correspond to IWA PI are designated as “performance indicator”, even though they are not used as such for that specific model.

lining, external lining, surge pressure, surge pressure occur rate, water source type, cathodic protection, other utilities, truck load, pavement condition, soil class zone, depth, soil type parameters, water type parameters and road class specifications) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model NHPP, 2 new CI (type of soil and water velocity) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model AQUAREL, 1 new CI (link importance) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model Failnet Reliab, 2 new CI (elevation and flow) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model Failnet Stat, 11 new CI (replacement date, rehabilitation date, observation starting date, observation stopping date, failure date, soil type, soil characteristics, traffic, pipes location, failure type and installation depth) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model INSA1 – Poisson Regression, 6 new CI (duration of failure records, road class, location, soil class, type of joint and depth class) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model INSA2 - Stochastic models - ageing functions, there is no need to add additional parameters to the existing IWA system. All the input and output variables are related with the existing IWA system.

In the model KANEW, 2 new PI (balance of costs and benefits and internal rate of return) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

In the model RelNet, 3 new CI or PI (node elevation, node reliability and total pressure of the pressure zone) must be added to the existing IWA system. All the other input and output variables fit or are related with the existing IWA system or are not indicators neither indicators variables nor context information.

From this analyses new PI, PI variables and CI have been added to the PI list resulting from item 8.1.

8.3 Analysis of partners´ suggestions for relevant rehab PI

Appendix 3 syntheses the results of the questionnaire regarding additional rehabilitation performance indicators and context information considered relevant for CARE-W prototype by the partners.

Regarding *performance indicators*, CEMAGREF suggested 2 PI identified or related with existing IWA PI. INSA suggested 1 PI identified or related with existing IWA PI and 5 new PI (critical mains failures, critical interruptions, water taste complaints, discoloured water complaints, critical interruptions complaints). Dresden University suggested 3 PI identified or related with existing IWA PI and 1 new PI (burst rate). Bologna University suggested 9 PI identified or related with existing IWA PI. Ferrara University suggested 4 PI related with existing IWA PI. Related to IWA PI Op16-18.

Regarding *context information*, CEMAGREF suggested 4 CI identified or related with existing IWA CI or PI variables and 5 new CI (soil type, soil characteristics, traffic, pipes location, installation depth). Dresden University suggested 10 CI identified or related with existing IWA CI or PI variables and 2 new CI or PI variables (network extension, percentage of variable costs in water production and inflation rate). Bologna University suggested 2 CI identified or related with existing IWA CI or PI variables and 1 new CI (pipe depth). Ferrara University suggested 1 CI identified with existing IWA CI and 3 new CI (temperature, soil moisture, soil composition, closeness of trees).

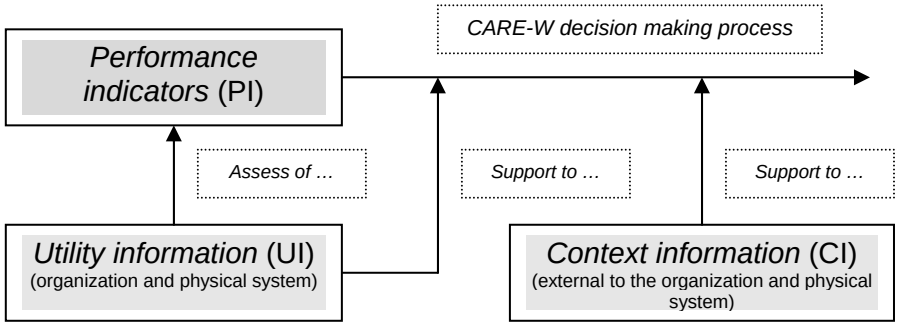
From this analyses new PI, PI variables and CI have been added to the PI list resulting from items 8.1 and 8.2.

9 DEFINITION A PRELIMINARY CARE-W REHAB PI LISTING

9.1 General

At this stage it is possible to define in the next sections a preliminary CARE-W rehab listing of performance indicators, as well as the corresponding utility information and the context information needed to a better understanding of the PI: according the following concepts:

- As referred above, *performance indicators* (PI) are ratio between values of identical or different nature, expressing the performance of the undertaking regarding a given point of view relevant in the rehabilitation framework.
- The *utility information* (UI) is the set of data that is directly related to the activity of the utility (organization and its physical system) and is under its direct control. It is used either for the assessment of the selected PI (as PI input variables) or for the CARE-W decision making process.
- The *context information* (CI) is the set of data that cannot be directly influenced by the utility (external to the organization and to its physical system) but that is critical for establishing the rehab diagnosis or for support to the CARE-W decision-making process (e.g. rain fall, temperature, ground slope, type of soil, etc.).



Appendix 4 presents a set of definitions that are relevant for the next sections and for Appendices 5, 6 and 7.

9.2 Performance indicators

The following PI are proposed for rehabilitation planning in the framework of CARE-W project (codes and units are referred and the new ones related to the IWA PI are in blue):

WATER RESOURCES INDICATORS (This section refers to the whole network)

WR1 - Inefficiency of use of water resources (%)
WR2 - Resources availability ratio (%)

PHYSICAL INDICATORS (This section may refer to the whole network, sector, cluster or individual pipe)

Storage

Ph3 - Transmission and distribution storage capacity (days)

Pumping

Ph4 - Standardized energy consumption (Wh/m^3 at 100 m)

Transmission and distribution network

Ph7 - Valve density (No./km)
Ph8 - Hydrant density (No./km)
Ph8a - Network hydraulic reliability (-)
Ph8b - Node hydraulic reliability (-) (applicable to single nodes only)
Ph8c - Mains residual service life (years)

OPERATIONAL INDICATORS (This section may refer to the whole network, sector, cluster or individual pipe)

Inspection and maintenance

Op3 - Network inspection (%/year)
Op4 - Leakage control (%/year)
Op5 - Active leakage control repairs (%/year)
Op6 - Hydrant inspection (%/year)

Mains, valves and service connection rehabilitation

Op15 - Mains rehabilitation (%/year)
    Op16 - mains relining (%/year)
    Op17 - replaced or renewed mains (%/year)
    Op18 - replaced valves (%/year)
Op19 - Service connection rehabilitation (%/year)

Pumps rehabilitation

    Op20 - pump refurbishment (%/year)
    Op21 - pump replacement (%/year)

Water losses

Op22 - Water losses (m^3/connection/year)
    Op23 - apparent losses (m^3/connection/year)
    Op24 - real losses (l/connection/day when system is pressurised)
Op25 - Infrastructure leakage index (-)

Failures

Op26 - Mains failures (No./100 km/year)
    Op26a - pipe failures (No./100 km/year)
    Op26b - joint failures (No./100 km/year)
    Op26c - valves failures (No./100 km/year)
Op26d - Critical mains failures (No./100 km/year)
Op26e - Mains failures in sensitive areas (No./100 km/year)
Op27 - Service connection failures (No./1000 connections/year)
    Op27a - service connection insertion point failures (No./100 km/year)
Op28 - Hydrant failures (No./1000 hydrants/year)
Op29 - Power failures (hours/pumping station/year)

QUALITY OF SERVICE INDICATORS (This section may refer to the whole network, sector or cluster)

QS9 - Pressure of supply adequacy (%)

QS11 - Water interruptions (%)
QS12 - Interruptions per connection (No./1000 connections)
QS12a - critical interruptions per connection (No./1000 connections)
QS13 - Population experiencing restrictions to water service (%)
QS14 - Days with restrictions to water service (%)
QS15 - Quality of supplied water (%)
QS16 - aesthetic (%)
QS16a - water taste (%)
QS16b - water colour (%)
QS17 - microbiological (%)
QS18 - physical-chemical (%)
Customer complaints
QS22 - Service complaints (No. complaints/connection/year)
QS23 - pressure complaints (%)
QS24 - continuity complaints (%)
QS25 - water quality complaints (%)
QS25a - water taste (%)
QS25b - water colour (%)
QS26 - interruptions (%)
QS26a - critical interruptions (%)

FINANCIAL INDICATORS[4] (This section refers to the whole network)
Annual costs
Fi1 - Unit total costs (€/m^3)
Fi2 - unit running costs (€/m^3)
Fi7 - energy costs ratio (%)
Fi12 - Technical services costs ratio (%)
Annual investment
Fi18 - Unit investment (€/m^3)
Fi19 - annual investments for new and upgrading assets (%)
Fi20 - annual investments for assets replacement (%)
Tariffs
Fi21 - Average water charges for direct consumption (€/m^3)
Fi22 - Average water charges for exported water (€/m^3)
Water losses
Fi36 - Non-revenue water by volume (%)
Fi37 - Non-revenue water by cost (%)
Economical rehab assessment
Fi37a - Balance of costs and benefits (%)
Fi37b - Internal rate of return (%)

Appendix 5 presents tables with a detailed presentation of each PI, based on the code, title, unit, concept and processing rule.

[4] In the IWA PI manual the monetary unit adopted is US$.

9.3 Utility information

The following UI variables are needed to assess the selected PI (as PI input variables) or for the CARE-W decision making process (units and correspondence to the IWA PI variables or CI are referred and the new ones related to the IWA PI variables are in blue):

PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK (This section may refer to the whole network, sector, cluster or individual pipe)

Water storage

- Transmission & distribution storage tanks capacity (m^3) (corresponds to the IWA PI variable C2)

Pumping stations

- Pumping stations (No.) (corresponds to the IWA PI variable C4)
- Pumping stations capacity (kW) (corresponds to the IWA PI variable C5)

Transmission and distribution network

- Mains length (km; m only to single pipes) (corresponds to the IWA PI variable C6)
- Network extension (km/year)
- Mains diameters:
  - mains diameter (mm) (applicable only to single pipes)
  - mains with < 100/110 mm diameter (km) (corresponds to the IWA PI variable C15)
  - mains with 100/110 < diameter ≤ 300/315 mm (km) (corresponds to the IWA PI variable C16)
  - mains with diameter > 300/315 mm (km) (corresponds to the IWA PI variable C17)
- Mains materials:
  - cast, spun & grey iron mains (CI) (km) (corresponds to the IWA PI variable C7)
  - ductile iron mains (DI) (km) (corresponds to the IWA PI variable C8)
  - steel mains (ST) (km) (corresponds to the IWA PI variable C9)
  - asbestos cement mains (AC) (km) (corresponds to the IWA PI variable C10)
  - polyethylene mains (PE) (km) (corresponds to the IWA PI variable C11)
  - polyvinyl chlorine mains (PVC) (km) (corresponds to the IWA PI variable C12)
  - concrete mains (CO) (km) (corresponds to the IWA PI variable C13)
  - other material mains (OT) (km) (corresponds to the IWA PI variable C14)
- Mains protection:
  - mains with internal protection (IP) (km)
  - mains with external protection (EP) (km)
  - mains with cathodic protection (CP) (km)
- Mains age: (corresponds to the IWA CI and IWA PI variables C18-C21)
  - average mains age (years)
  - mains laid before 1899 (km)
  - mains laid between 1900 and 1904 (km)
  - mains laid between 1905 and 1909 (km)
  - mains laid between 1910 and 1914 (km)
  - mains laid between 1915 and 1919 (km)
  - mains laid between 1920 and 1924 (km)
  - mains laid between 1925 and 1929 (km)
  - mains laid between 1930 and 1934 (km)
  - mains laid between 1935 and 1939 (km)
  - mains laid between 1940 and 1944 (km)
  - mains laid between 1945 and 1949 (km)
  - mains laid between 1950 and 1954 (km)
  - mains laid between 1955 and 1959 (km)
  - mains laid between 1960 and 1964 (km)

- mains laid between 1965 and 1969 (km)
- mains laid between 1970 and 1974 (km)
- mains laid between 1975 and 1979 (km)
- mains laid between 1980 and 1984 (km)
- mains laid between 1985 and 1989 (km)
- mains laid between 1990 and 1994 (km)
- mains laid between 1995 and 1999 (km)
- mains laid between 2000 and 2004 (km)
- mains laid between 2005 and 2009 (km)

- Mains protection age:
  - internal protection date (year)
  - external protection date (year)
  - cathodic protection date (year)
- Mains location:
  - under flexible roadway (UFR)
  - under rigid roadway (URR)
  - under sidewalk (USW)
  - under green areas (UGA)
- Mains installation depth (m)
- Trench mains installation width (m)
- Bedding soil type:
  - (categories to be defined)
- Backfilling soil type:
  - (categories to be defined)
- Average closeness to trees (m)
- Type of joints:
  - rigid joints (RJ)
  - flexible joints (FJ)
- Main valves (No.) (corresponds to the IWA PI variable C29)
- Isolating valves (No.) (corresponds to the IWA PI variable C30)
- Hydrants (No.) (corresponds to the IWA PI variable C31)
- Node elevation (m)

PHYSICAL ASSETS DATA - SERVICE CONNECTIONS (This section may refer to the whole network, sector or cluster)

- Number of service connections (No.) (corresponds to the IWA PI variable C32)
- Number of sensitive service connections (No.)
- Average service connection length:
  - to delivery point (m) (corresponds to the IWA CI)
  - to measurement point (m) (corresponds to the IWA CI and IWA PI variable C33)
- Service connection materials:
  - plastic (PL) (corresponds to the IWA CI)
  - steel (ST) (corresponds to the IWA CI)
  - lead (LD) (corresponds to the IWA CI)
  - others (OT) (corresponds to the IWA CI)
- Service connections density (No./km) (corresponds to the IWA CI)

WATER VOLUME DATA (This section refers to the whole network)

- Yearly abstraction capacity (m^3/year) (corresponds to the IWA PI variable A1)

- Imported water allowance (m^3/year) (corresponds to the IWA PI variable A2)
- Water abstracted (m^3/year) (corresponds to the IWA PI variable A4)
- Imported raw water (m^3/year) (corresponds to the IWA PI variable A5)
- Exported raw water (m^3/year) (corresponds to the IWA PI variable A6)
- Water produced (m^3/year) (corresponds to the IWA PI variable A7)
- Imported treated water (m^3/year) (corresponds to the IWA PI variable A8)
- Exported treated water (m^3/year) (corresponds to the IWA PI variable A9)
- Billed metered consumption (m^3/year) (corresponds to the IWA PI variable A13)
- Billed unmetered consumption (m^3/year) (corresponds to the IWA PI variable A14)
- Billed authorised consumption (m^3/year) (corresponds to the IWA PI variable A15)
- Unbilled metered consumption (m^3/year) (corresponds to the IWA PI variable A16)
- Unbilled unmetered consumption (m^3/year) (corresponds to the IWA PI variable A17)
- Unbilled authorised consumption (m^3/year) (corresponds to the IWA PI variable A18)
- Authorised consumption (m^3/year) (corresponds to the IWA PI variable A19)
- Water losses (m^3/year) (corresponds to the IWA PI variable A20)
- Unauthorised consumption (m^3/year) (corresponds to the IWA PI variable A21)
- Metering inaccuracies water losses (m^3/year) (corresponds to the IWA PI variable A22)
- Apparent losses (m^3/year) (corresponds to the IWA PI variable A23)
- Real losses (m^3/year) (corresponds to the IWA PI variable A24)
- Revenue water (m^3/year) (corresponds to the IWA PI variable A25)
- Non-revenue water (m^3/year) (corresponds to the IWA PI variable A26)

CONSUMPTION AND PEAK FACTORS (This section refers to the whole network)

- Daily average input (m^3/day)
- Consumption per type of customer:
  - residential consumption (%)
  - commercial consumption (%)
  - public or institutional consumption (%)
  - industrial consumption (%)
  - bulk water consumption (%)
- Total per capita consumption (l per inhabitant/day)
  - residential per capita consumption (l per inhabitant/day)
- Consumption per service connection (m^3/connection/year)
- Peak factors of supplied and exported water:
  - monthly peak factor (-)
  - daily peak factor (-)
  - hourly peak factor (-)
- Network delivery rate (m^3/km/year)

OPERATIONAL DATA (This section may refer to the whole network, sector, cluster or individual pipe)

Service pressure

- Average operating pressure (kPa) (corresponds to the IWA PI variable D31 and IWA CI)
- Minimum static pressure (kPa) (corresponds to the IWA CI)
- Maximum static pressure (kPa) (corresponds to the IWA CI)
- Static pressure variation (kPa)
- Maximum expected surge pressure (kPa)
- Minimum expected surge pressure (kPa)
- Surge pressure occurrence rate (No./year)

Service continuity

- Time system is pressurised (h) (corresponds to the IWA PI variable D29)
- Delivery points with adequate pressure (No.) (corresponds to the IWA PI variable D30)
- Water interruptions (No.) (corresponds to the IWA PI variable D32)
- Service interruptions (No.) (corresponds to the IWA PI variable D33)
  - critical interruptions (No.)
- Water use restrictions (No.) (corresponds to the IWA PI variable D34)
- Days with restrictions to water service (days) (corresponds to the IWA PI variable D35)

Network velocities

- Pipe flow velocity:
  - maximum velocity (m/s)
  - average velocity (m/s)

Water quality monitoring

- Water quality tests performed (No.) (corresponds to the IWA PI variable D41)
- Aesthetic tests performed (No.) (corresponds to the IWA PI variable D42)
  - taste tests performed (No.)
  - colour tests performed (No.)
- Microbiological tests performed (No.) (corresponds to the IWA PI variable D43)
- Physical-chemical tests performed (No.) (corresponds to the IWA PI variable D44)
- Compliance of aesthetic tests (No.) (corresponds to the IWA PI variable D51)
  - compliance of taste tests (No.)
  - compliance of colour tests (No.)
- Compliance of microbiological tests (No.) (corresponds to the IWA PI variable D52)
- Compliance of physical-chemical tests (No.) (corresponds to the IWA PI variable D53)

Physical and chemical water characteristics in the network

- Hydrogenionic concentration range in water (pH-pH)
- Aggressive carbon dioxide concentration range in water (CO_2) (mg/l-mg/l)
- Sulphate concentration range in water (SO_4^{2-}) (mg/l-mg/l)
- Chloride concentration range in water (Cl^-) (mg/l-mg/l)
- Water temperature range in water (ºC-ºC)

Energy consumption

- Pumping energy consumption (Wh) (corresponds to the IWA PI variable D1)
- Standardization factor (m^4) (corresponds to the IWA PI variable D2)

Inspection and maintenance

- Network inspection (km) (corresponds to the IWA PI variable D7)
- Leakage control (km) (corresponds to the IWA PI variable D8)
- Leaks repaired due to active leakage control (No.) (corresponds to the IWA PI variable D9)
- Hydrant inspection (No.) (corresponds to the IWA PI variable D10)

Preventive maintenance

- Mains rehabilitation (km) (corresponds to the IWA PI variable D18)
- Mains relining (km) (corresponds to the IWA PI variable D19)
- Replaced or renewed mains (km) (corresponds to the IWA PI variable D20)
- Replaced valves (No.) (corresponds to the IWA PI variable D21)
- Service connection rehabilitation (No.) (corresponds to the IWA PI variable D22)
- Pumps refurbishment (kW) (corresponds to the IWA PI variable D23)
- Pumps replacement (kW) (corresponds to the IWA PI variable D24)

Failures

- Mains failures (No.) (corresponds to the IWA PI variable D25)
  - pipe failures (No.)
  - joint failures (No.)

    - valve failures (No.)
  - Critical mains failures (No.)
  - Mains failures in sensitive areas (No.)
  - Service connection failures (No.) (corresponds to the IWA PI variable D26)
    - service connection insertion point failures (No.)
  - Hydrant failures (No.) (corresponds to the IWA PI variable D27)
  - Power failures (h) (corresponds to the IWA PI variable D28)

Repairs (This section refers to single pipes)

  - Failure repair date (yy.mm.dd)
  - Replacement date (yy.mm.dd)
  - Rehabilitation date (yy.mm.dd)
  - Average duration of failure repair (h)

Interference with other infrastructures

  - Repairs risk to affect other infrastructures (yes/no)

TECHNOLOGICAL RESOURCES (This section refers to the whole network)

  - Computerized Information systems:
    - maintenance (yes/no) (corresponds to the IWA CI)
    - customer complaints (yes/no) (corresponds to the IWA CI)
  - Mapping:
    - updated mapping (%) (corresponds to the IWA CI)
    - digital mapping (%) (corresponds to the IWA CI)
  - Failure data availability:
    - duration of failure records (year-year)
    - nature of failure records (paper/digital)

QUALITY OF SERVICE DATA (This section may refer to the whole network, sector or cluster)

  - Population supplied (No.) (corresponds to the IWA PI variable F1)
  - Population supplied with service pipes (No.) (corresponds to the IWA PI variable F2)
  - Population served by public taps or standpipes (No.) (corresponds to the IWA PI variable F3)
  - Customer complaints:
    - service complaints (No.) (corresponds to the IWA PI variable F11)
    - pressure complaints (No.) (corresponds to the IWA PI variable F12)
    - continuity complaints (No.) (corresponds to the IWA PI variable F13)
    - water quality complaints (No.) (corresponds to the IWA PI variable F14)
    - water taste complaints (No.)
    - water colour complaints (No.)
    - complaints on interruptions (No.) (corresponds to the IWA PI variable F15)
    - complaints on critical interruptions (No.)

FINANCIAL DATA (This section refers to the whole network)

  - Annual running costs (€/year) (corresponds to the IWA PI variable G2)
  - Annual capital costs (€/year) (corresponds to the IWA PI variable G3)
  - Operational costs (€/year) (corresponds to the IWA PI variable G4)
  - Internal manpower costs (€/year) (corresponds to the IWA PI variable G5)
  - External services costs (€/year) (corresponds to the IWA PI variable G6)
  - Imported (raw and treated) water costs (€/year) (corresponds to the IWA PI variable G7)
  - Energy costs (€/year) (corresponds to the IWA PI variable G8)
  - Purchased merchandises (€/year) (corresponds to the IWA PI variable G9)

- Leasing and rentals (€/year) (corresponds to the IWA PI variable G10)
- Taxes, levies and fees (€/year) (corresponds to the IWA PI variable G11)
- Exceptional earnings and losses (€/year) (corresponds to the IWA PI variable G12)
- Other operating expenditures (€/year) (corresponds to the IWA PI variable G13)
- Other operating costs (€/year) (corresponds to the IWA PI variable G14)
- Planning, design, construction, operations & maintenance running costs (€/year) (corresponds to the IWA PI variable G18)
- Annual depreciation costs (€/year) (corresponds to the IWA PI variable G19)
- Interest expenses costs (€/year) (corresponds to the IWA PI variable G20)
- Interest income (€/year) (corresponds to the IWA PI variable G24)
- Net interest (€/year) (corresponds to the IWA PI variable G25)
- Annual investment in tangible assets (€/year) (corresponds to the IWA PI variable G26)
- Annual investments for new assets (€/year) (corresponds to the IWA PI variable G27)
- Annual investments for assets replacement (€/year) (corresponds to the IWA PI variable G28)
- Water sales revenue for direct consumption (€/year) (corresponds to the IWA PI variable G30)
- Water sales revenue for exported water (€/year) (corresponds to the IWA PI variable G31)
- Average water charges for direct consumption (€/m^3) (corresponds to the IWA PI variable G49)
- Attributed unit cost for real losses (€/m^3) (corresponds to the IWA PI variable G50)
- Water tariffs:
  - domestic consumption tariff (€/m^3) (corresponds to the IWA CI)
  - industrial consumption tariff (€/m^3)
  - public consumption tariff (€/m^3)

Appendix 6 presents tables with PI variables detailed information, based on the code, title, unit of expression, time period, variable type, definition, processing rule and additional comments.

9.4 Context information

The following CI are proposed for establishing the rehab diagnosis or for support to the CARE-W decision-making process rehabilitation planning (units are referred and the new CI related to the IWA CI are in blue):

ENVIRONMENT FACTORS

- Yearly rainfall:
  - average (mm/year)
  - maximum (mm/year)
  - minimum (mm/year)
- Air temperature:
  - daily average (ºC)
  - daily maximum (ºC)
  - daily minimum (ºC)
- Topography:
  - source average elevation (m)
  - maximum delivery elevation (m)
  - minimum delivery elevation (m)

MAINS AGRESSIVE FACTORS

- Physical and chemical soil and groundwater characteristics:
  - hydrogenionic concentration range (pH-pH)
  - aggressive carbon dioxide concentration range (CO_2) (mg/l-mg/l)
  - sulphate concentration range (SO_4^{2-}) (mg/l-mg/l)
  - chloride concentration range (Cl^-) (mg/l-mg/l)
  - resistivity concentration range (Ωm -Ωm)
  - organic compounds (yes/no)
  - stray currents (yes/no)
- Geotechnical conditions:
  - pipe seat stability (yes/no)
- Seismic conditions:
  - forecasted maximum soil movement due to soil liquefaction (mm)
  - forecasted maximum angular deflection in joints (º)
  - forecasted maximum axial displacement in joints (mm)
- Traffic class:
  - heavy traffic (HT)
  - normal traffic (NT)
  - light traffic (LT)
- Interference with other infrastructures:
  - risk to be affected by other infrastructures works (yes/no)

ECONOMICS

- Inflation rate (%/year)

Appendix 7 presents tables with the title, unit and concept for each context information variable.

10 Next activities

In this report a preliminary CARE-W rehab listing is proposed, with a set of performance indicators, part of them obtained directly from the IWA system and some new ones specific for the rehabilitation analysis.

They are completed with the corresponding utility information and context information parameters.

According to the project planning and the adjustments agreed in the project meetings, the next activities will be (Task 1.2):

- preparation and launching of a questionnaire to the partners with the following questions regarding performance indicators, utility information and context information:
  - for what do you intend to use this parameter in your model or process: as an essential input of the model, as a non essential input of the model, as a model intermediate processing step or as an output of the model?
  - for what purpose do you think you can use this parameter in the care-w framework: system characterisation and understanding, problem(s) identification, diagnosis, decision making (short/medium term rehab planning), decision making (long term rehab planning), solution implementation or monitoring?

- do you think this parameter is important for rehabilitation purposes at the entire network level, at the network sector level, at the network cluster level or at the individual pipes level or is not important?
- can you predict this parameter based on modelling?

- preparation and launching of a questionnaire to the co-operating cities to assess data availability, reliability and accuracy regarding performance indicators, utility information and context information.

11 References

[1] ALEGRE, H.; HIRNER, W. BAPTISTA, J.M.; PARENA, R. (2000) – *Performance indicators for water supply services*, Manual of Best Practice Series, IWA Publishing, London, ISBN 1 900222 18 3 (150 pp.).

Lisbon, 9 June 2001

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Appendix 1

Results of the questionnaire regarding the selection of relevant IWA PI in the framework of CARE-W

Note: All the performance indicators of the IWA PI system [1] that have been graded as "irrelevant" by most CARE-W partners from the rehab point of view were removed from the listing presented in this appendix. The original codes have been kept for an easier cross-reference.

The following tables keep the IWA's organisation of the indicators. The four right hand side columns indicate the number of replies in each category.

WATER RESOURCES INDICATORS

Code	Indicator	Unit	Essential	Important	Useful	Irrelevant
WR1	Inefficiency of use of water resources	%	0	**5**	**5**	1
WR2	Resources availability ratio	%	0	3	**6**	2

PERSONNEL INDICATORS

Code	Indicator	Unit	Essential	Important	Useful	Irrelevant
	TOTAL PERSONNEL					
Pe1	Employees per connection	No./1000 connections	0	0	**5**	**6**
	PERSONNEL PER MAIN FUNCTION					
Pe5	Technical services personnel	No./1000 connections	0	1	**5**	**5**
Pe6	*planning & construction personnel*	No./1000 connections	0	0	**6**	5
Pe7	*operations & maintenance personnel*	No./1000 connections	0	0	**6**	5
	TECHNICAL SERVICE PERSONNEL PER ACTIVITY					
Pe9	Transmission, storage and distribution personnel	No./10^2 km	0	1	**5**	**5**

PHYSICAL INDICATORS

Code	Indicator	Unit	Essential	Important	Useful	Irrelevant
	STORAGE					
Ph3	Transmission and distribution storage capacity	days	0	3	**4**	**4**
	PUMPING					
Ph4	Standardised energy consumption	Wh/m^3 at 100 m	0	0	**7**	4
Ph5	Reactive energy consumption	%	0	0	4	**6**
Ph6	Energy recovery	%	0	0	4	**6**
	TRANSMISSION AND DISTRIBUTION NETWORK					
Ph7	Valve density	No./km	1	**6**	1	3
Ph8	Hydrant density	No./km	0	3	**4**	**4**

OPERATIONAL INDICATORS

Code	Indicator	Unit	Essential	Important	Useful	Irrelevant
	INSPECTION AND MAINTENANCE					
Op3	Network inspection	%/year	1	**8**	1	1
Op4	Leakage control	%/year	2	**8**	0	1
Op5	Active leakage control repairs	%/year	1	**8**	0	2
Op6	Hydrant inspection	%/year	0	1	**6**	4
	MAINS, VALVES AND SERVICE CONNECTION REHABILITATION					

Op15	Mains rehabilitation	%/year	**7**	3	0	1
Op16	*mains relining*	%/year	**5**	4	0	2
Op17	*replaced or renewed mains*	%/year	**7**	1	0	3
Op18	*replaced valves*	%/year	**4**	**4**	0	3
Op19	Service connection rehabilitation	%/year	3	**7**	0	1
	PUMPS REHABILITATION					
Op20	*pump refurbishment*	%/year	0	0	5	**6**
Op21	*pump replacement*	%/year	0	1	4	**6**
	WATER LOSSES					
Op22	Water losses	m^3/connection/year	3	**6**	0	2
Op23	*apparent losses*	m^3/connection/year	0	**8**	0	3
Op24	*real losses*	l/connection/day when system is pressurised	**6**	3	0	2
Op25	Infrastructure leakage index	-	4	**5**	0	2
	FAILURES					
Op26	Mains failures	No./100 km/year	**9**	0	0	2
Op27	Service connection failures	No./1000 connections/year	**8**	1	0	2
Op28	Hydrant failures	No./1000 hydrants/year	0	2	**5**	4
Op29	Power failures	hours/pumping station/year	0	0	5	**6**
	WATER QUALITY MONITORING					
Op32	Tests performed	%	0	2	3	**4**
Op33	*aesthetic*	%	0	3	**4**	**4**
Op34	*microbiological*	%	0	**4**	3	**4**
Op35	*physical-chemical*	%	0	3	**4**	**4**

QUALITY OF SERVICE INDICATORS

Code	Indicator	Unit	Essential	Important	Useful	Irrelevant
	SERVICE					
QS1	Households and businesses supply coverage	%	0	0	4	**7**
QS2	Buildings supply coverage	%	0	0	4	**7**
QS3	Population coverage	%	0	1	4	**6**
QS9	Pressure of supply adequacy	%	**8**	0	0	3
QS10	Continuity of supply	%	0	3	2	**6**
QS11	Water interruptions	%	1	**4**	**4**	2
QS12	Interruptions per connection	No./1000 connections	0	**5**	**5**	1
QS13	Population experiencing restrictions to water service	%	0	0	**6**	5
QS14	Days with restrictions to water service	%	0	0	**6**	5
QS15	Quality of supplied water	%	1	**8**	0	2
QS16	*aesthetic*	%	3	**5**	0	3
QS17	*microbiological*	%	**4**	**4**	0	3
QS18	*physical-chemical*	%	1	**7**	0	3
	CUSTOMER COMPLAINTS					
QS22	Service complaints	No. complaints/ connection/ year	2	**7**	0	2
QS23	*pressure complaints*	%	2	**6**	0	3
QS24	*continuity complaints*	%	1	**5**	1	4
QS25	*water quality complaints*	%	3	**5**	1	2
QS26	*Interruptions complaints*	%	1	**5**	1	**5**

FINANCIAL INDICATORS

Code	Indicator	Unit	Essential	Important	Useful	Irrelevant
	ANNUAL COSTS					
Fi1	Unit total costs	€/m^3	0	**5**	3	3
Fi2	*unit running costs*	€/m^3	1	**4**	3	3
Fi3	*unit capital costs*	€/m^3	1	3	**4**	3
	Composition of annual running costs per type of costs					
Fi7	*energy costs ratio*	%	0	**5**	2	4
	ANNUAL INVESTMENT					
Fi18	Unit investment	€/m^3	2	**6**	1	2
Fi19	*annual investments for new and upgrading assets*	%	2	**5**	1	3
Fi20	*annual investments for assets replacement*	%	3	**5**	1	2
	AVERAGE WATER CHARGES					
Fi21	Average water charges for direct consumption	€/m^3	0	3	**5**	3
Fi22	Average water charges for exported water	€/m^3	0	0	**7**	4
	WATER LOSSES					
Fi36	Non-revenue water by volume	%	1	**7**	1	2
Fi37	Non-revenue water by cost	%	0	**8**	1	2

Appendix 2

Results of the questionnaire regarding the input and output data of the existing rehab models

Note: The data of the three first columns was obtained from the information send by the partners in the answers to the questionnaire regarding the input and output data of the existing rehab models. The last column contains the comment from LNEC regarding the following several possibilities:

a) is not a Performance Indicator nor a Performance Indicator Variable nor a Context Indicator;
b) corresponds to the existing IWA Performance Indicator #
c) is related to the existing IWA Performance Indicator #
d) is a new Performance Indicator;
e) corresponds to the existing IWA Performance Indicator Variable # (or Utility Information);
f) is related to the existing IWA Performance Indicator Variable # (or Utility Information);
g) is a new Performance Indicator Variable (or Utility Information);
h) corresponds to the existing IWA Context Information #
i) is related to existing IWA Context Information #
j) is a new Context Information.

MODEL UTILNETS FROM SINTEF (PHYSICAL MODEL)

Input variables	Unit	Short description	Comment
Link_ID	-	Code of single pipe	Not PI nor PI variable nor CI
A_End	-	Code of node A connected to a Link ID	Not PI nor PI variable nor CI
B_End	-	Code of node B connected to a Link ID	Not PI nor PI variable nor CI
Length	m	Length of Link ID	IWA PI var. C6
Max_Flow_Capacity	l/s		**New CI**
People	-	number of people supplied by the Link	Related to IWA PI var. F1
DMA	-	Code of district meter area the link belongs to	Not PI nor PI variable nor CI
Supply_Zone	-	Code of supply zone the link belongs to	Not PI nor PI variable nor CI
Compliance_Zone	-	Code of compliance zone the link belongs to	Not PI nor PI variable nor CI
Is_Made_Of	-	Code of pipe material	Related to PI var. C7-14 and IWA CI
Supply	-	Category of importance for link regarding supply	Not PI nor PI variable nor CI
Danger	-	Category of potential danger in case of pipe burst	Related to PI var. C32a
Damage	-	Category of potential damage in case of pipe burst	Related to PI var. C32a
Nominal_Diameter	mm	-	Related to PI var. C15-17 and IWA CI
Orig_Int_Diameter	mm	Original internal diameter	Related to PI var. C15-17 and IWA CI
Orig_Ext_Diameter	mm	Original external diameter	Related to PI var. C15-17 and IWA CI

Input variables	Unit	Short description	Comment
Orig_Wall_Thickness	mm	Original pipe wall thickness	Related to PI var. C15-17 and IWA CI
Year_Laid	-		Related to PI var. C18-21 and IWA CI
Trench_Width	m	Width of the trench	**New CI**
Burst_Rate	times/year	Estimated failure rate of the single link	IWA PI Op26
Internal_Protection_Date	-	Year when link was protected internal	**New CI**
External_Protection_Date	-	Year when link was protected external	**New CI**
Bedding_Description	-	Type of soil the pipe is bedded on	**New CI**
Backfill_Description	-	Type of soil the trench is filled with	**New CI**
Joint_Type	-	Type of connection between two links (rigid, flexible,…)	**New CI**
Internal_Lining	-	Type of internal lining	**New CI**
External_Lining	-	Type of external lining	**New CI**
Has_Subsistance	-	Is the pipe likely fully supported? [yes/no]	Related to new CI
Working_Pressure	N/m x m	Average working pressure	IWA CI
Surge_Pressure	N/m x m	Expected pressure in surge conditions	**New CI**
Surge_Pressure_Occur_Rate	times/year	Expected number of surge conditions per year	**New CI**
Water_Source_type	-	Name of water type defined in an extra table	**New CI**
Hydraulic_Failure	-	Has the pipe likely a leakage? [yes/no]	Related to PI var. D25-26 and IWA PI Op26
Cathodic_Protection	-	Has the pipe a cathodic protection? [yes/no]	**New CI**
Other_Utilities	-	Are other utilities affected when working on this pipe? {yes/no]	**New CI**

Segment_ID	-	Code of a segment (part of a link, identically with Link ID when a link consists only of one segment)	Not PI nor PI variable nor CI
Depth_At_Crown	m	Depth of the segment (Depth of the link)	New CI
Length	m	Length of the segment (part of a link)	IWA PI var. C6
Truck_Load	-	Refers to the Road Class (expected traffic load)	**New CI**
Temperature_Zone	-	Code of temperature zone defined in an extra table	Related to IWA CI
Pavement_Condition	-	Type of pavement (for traffic load distribution)	**New CI**
Soil_Class_Zone	-	Type of surrounding soil, defined in an extra table	**New CI**

Node_ID	-	Code of Node between to links	Not PI nor PI variable nor CI
Depth	m	Depth of node	**New CI**

Further tables, containing specific parameters and values for the calculation of loads and resistance, partly filled with default values:			
Soil type parameters	-	-	**New CI**
Water type parameters	-	-	**New CI**
Pipe material specifications	-	-	Related to IWA CI
Rehabilitation methods and costs	-	-	Not PI nor PI variable nor CI
Air temperature and frost parameters	-	-	IWA CI
Customer specifications	-	Sensitive customers	Not PI nor PI variable nor CI
Road class specifications	-	-	**New CI**

Output variables	Unit	Short description	Comment
Expected life-time	year of failure	Prediction of the pipe lifetime for each single pipe (threshold of failure probability can be chosen), plus survival curve	Not PI nor PI variable nor CI
Expected failures	-	Prediction of specific Link and Segment failures in a chosen time horizon	Related with IWA PI Op26
Order of rehabilitation	-	Recommended order of rehabilitation considering year of failure, costs, budget, methods, customer specifications and more	Not PI nor PI variable nor CI
Costs of rehabilitation	€/year	Expected cost for each rehabilitation	Related to IWA PI Fi19-20 and Fi37a
Reliability factor	-	A factor representing to what extension the input variables are filled by the user (weighted regarding sensitivity)	Not PI nor PI variable nor CI

MODEL WINRIC USING NHPP METHOD FROM NTNU (FAILURE FORECASTING MODEL)

Input variables	Unit	Short description	Comment
Pipe identification		Code of single pipe	Not PI nor PI variable nor CI
Pipe material	-	Code of the pipe material according to a convention	Related to PI var. C7-14 and IWA CI
Pipe diameter	mm	-	Related to PI var. C15-17 and IWA CI
Pipe length	m	Length of a pipe	IWA PI var. C6
Pipe age	years	Time from installation of pipe	Related to PI var. C18-21 and IWA CI
Type of soil	-	Soil classification system	**New CI**
Water pressure	m	Static water pressure in each pipe	Related to PI var. D31 and IWA CI
Water velocity	m/s	Water velocity in each pipe	**New CI**
No of previous breaks	-	Number of previous failures for each pipe	IWA PI var. D25-26

Note: The examples of the explanatory variable explained above are just examples. Other variables might be applied from case to case.

Output variables	Unit	Short description	Comment
Regression coefficients	-	Relative importance of the significant variables	Not PI nor PI variable nor CI
Failure intensity	-	Time derivate of the expected cumulative number of failures	Not PI nor PI variable nor CI
Expected number of failures	-	Expected number of failures for each pipe within a given time interval	PI var. D25-26 and related to IWA PI Op26

MODEL AQUAREL FROM SINTEF (HYDRAULIC RELIABILITY MODEL)

Input variables	Unit	Short description	Comment
Pipe identification	-	Code of single pipe	Not PI nor PI variable nor CI
Failure rate	failures/year	Failure rate for each pipe	PI var. D25-26 and related to IWA PI Op26
MTTR	hours	Mean time to repair	Not PI nor PI

			variable nor CI
TTR 95	hours	95 % percentile of the time to repair	Not PI nor PI variable nor CI
Required pressure	m	Minimum required pressure for satisfying supply at a given node	IWA CI

Note: An EPANET compatible hydraulic model is required

Output variables	**Unit**	**Short description**	**Comment**
Water supply availability	%	Portion of time in a given state	Related to IWA PI QS11-14
Frequency of degraded pressure	times/year	Number of times per year with degraded pressure	IWA PI QS9
Link importance B	-	Birnbaum's importance measure of each link	**New CI**
Link importance U	-	Importance measure of each link wrt unavailability	Not PI nor PI variable nor CI
Link importance F	-	Importance measure of each link wrt frequency	Not PI nor PI variable nor CI

MODEL FAILNET RELIAB FROM CEMAGREF (HYDRAULIC RELIABILITY MODEL)

Input variables	**Unit**	**Short description**	**Comment**
Link identification	Alpha-numeric	Identification variable of the links	Not PI nor PI variable nor CI
Node identification	Alpha-numeric	Identification variable of the nodes	Not PI nor PI variable nor CI
Length	m	Link length	PI var. C6
Material	Alpha-numeric	Codes the pipe material	Related to PI var. C7-14 and IWA CI
Diameter	mm	Internal diameter of the pipe	Related to PI var. C15-17 and IWA CI
Roughness	mm or Hazen-Williams unit	This value is used to compute head-losses with Hazen-William's Formula	Not PI nor PI variable nor CI
Elevation	m	Node elevation above sea level	**New CI**
Type of node	Alpha-numeric	Demand node, tank, water source	Not PI nor PI variable nor CI
Desired pressure	m	Pressure desired by the consumer	IWA CI
Maximum demand d_i	l/s	Maximum demand of the consumers at node i	Not PI nor PI variable nor CI
Minimum pressure	m	Pressure below which the actual consumption vanishes (c=0)	IWA CI
Maximum pressure	m	Pressure above which the actual demand is satisfied (c=d)	IWA CI
Water level	m	Level of water in a tank or a water source	Not PI nor PI variable nor CI
w_i	Dimension-less	Weight of node i representing the qualitative and quantitative importance of the demand at this node	Not PI nor PI variable nor CI
Unavailability probability pe_j	Dimension-less	Probability of link j to be under repair, all other links being operational; takes into account the probability of failure and the mean repair duration of a break on link j	Not PI nor PI variable nor CI
pe_0	Dimension-less	Probability of all links to be simultaneously operational	Not PI nor PI variable nor CI

Output variables	**Unit**	**Short description**	**Comment**
Pressure at a node	m	Value of the pressure computed at a given node	PI var. D31 and IWA CI
Actual consumption	l/s	Actual water quantity consumed at a given node with	Not PI nor PI

		respect to the available pressure	variable nor CI
Flow	l/s	Flow of the link	**New CI**
Satisfaction rate	Dimension-less	Actual supply (l/s) divided by the demand	Related to IWA PI QS11-14
Satisfaction rate SR_{ij}	Dimension-less	Satisfaction rate at node i when link j is under repair (event of probability pe_j)	Related to IWA PI QS11-14
Satisfaction rate SR_{i0}	Dimension-less	Satisfaction rate at node i when none of the links is under repair	Related to IWA PI QS11-14
Satisfaction rate SRN_i	Dimension-less	Weighted (with weights pe_j) mean satisfaction rate at node i when one or none of the links of the network is under repair	Related to IWA PI QS11-14
Satisfaction rate SRP_j	Dimension-less	Weighted (with weights $w_i x d_i$) mean satisfaction rate over all nodes when link j is under repair	Related to IWA PI QS11-14
Satisfaction rate SRP_0	Dimension-less	Weighted (with weights $w_i x d_i$) mean satisfaction rate over all nodes when none of the links is under repair	Related to IWA PI QS11-14
Global satisfaction rate of the system GSR	Dimension-less	Overall reliability of the network defined as the weighted mean of SRP_j (with weights pe_j), or equivalently of SRN_i (with weights $w_i x d_i$)	Related to IWA PI QS11-14

MODEL FAILNET STAT USING WEIBULL RENEWAL PROCESS FROM CEMAGREF (FAILURE FORECASTING MODEL)

Input variables	**Unit**	**Short description**	**Comment**
Section Identification	Alpha-numeric coding	Identifies a section of network homogeneous in material, diameter, installation date and location (road); serves to merge failure dates and covariates valued at the road level	Not PI nor PI variable nor CI
Geographic location	Alpha-numeric coding	Identifies the geographic zone in which the section is located; serves to merge covariates valued at a level larger than that of the road	Not PI nor PI variable nor CI
Length	m	Length (m) of the section, used as covariate	IWA PI var. C6
Material	Alpha-numeric coding	Categorical covariate used to split the population of sections into strata to be separately analysed	Related to PI var. C7-14 and IWA CI
Diameter	mm	Pipes diameter (mm), used as covariate, either continuous or coded in categories	Related to PI var. C15-17 and IWA CI
Installation date	Integer (days)	Installation date of the section (number of days elapsed since 1/1/1960)	Related to PI var. C18-21 and IWA CI
Replacement date	Integer (days)	Replacement date of the section (number of days elapsed since 1/1/1960); serves as stopping time for the failure dates series of the ancient section, and as installation date for the new section	**New CI**
Rehabilitation date	Integer (days)	Rehabilitation date of the section (number of days elapsed since 1/1/1960); serves as stopping time for the failure dates series related to the section before its rehabilitation, and as installation date for the rehabilitated section	**New CI**
Observation starting date	Integer (days)	Date (number of days elapsed since 1/1/1960) since which complete computerized maintenance records are available	**New CI**
Observation stopping date	Integer (days)	Date (number of days elapsed since 1/1/1960) until which complete computerized maintenance records are available	**New CI**
Failure date	Integer (days)	Date of observed failure on the section (number of days elapsed since 1/1/1960); the time delay between successive failures on the same section constitutes the central analysis variable in the parameterisation phase of the model usage	**New CI**
Soil type	Alpha-numeric	Code of soil type, used as categorical covariate	**New CI**

Input variables	Unit	Short description	Comment
	coding		
Soil characteristics	Alpha-numeric coding	Codes of soil characteristics (humidity, resistivity, geotechnical risk, etc.), used as categorical covariates	**New CI**
Traffic	No. vehicles / day or alpha-numeric coding	Traffic intensity possibly distinguishing categories of vehicles	**New CI**
Pipes location	0/1	Under sidewalk or roadway indicator variable	**New CI**
MaxSP	bar	Daily maximum static pressure, used as continuous covariate	Related to IWA CI
MinDP	bar	Daily minimum dynamical pressure, used as continuous covariate	Related to IWA CI
Pressure variation	bar	Daily maximum difference between static pressure and dynamical pressure, used as continuous covariate	Related to IWA CI
NOPF	Integer	Number of observed previous failures, used both as stratification variable (often 2 strata: NOPF=0 and NOPF>0) and covariate in the stratum of failure dates consecutive to at least one already observed failure	IWA PI Op26
Failure type	Alpha-numeric coding	Possible categorical stratification variable used to perform separate analysis for *e.g.* failures occurring on pipe body or pipe junction	**New PI** (split from Op26)
Forecasting horizon	Integer (years)	Time horizon after the observation stopping date, in which a forecast of the number of future failures is wanted	Not PI nor PI variable nor CI
Pipe length	m	Unit length of pipes, used as continuous or categorical covariate	IWA PI var. C6
Installation depth	m	Depth of pipes installation, possibly used as continuous covariate	**New CI**
Density of connections	km^{-1}	Number of supply connections served by the section divided by the length of the section	IWA CI
APF	Integer (years)	Age at previous failure = time (years) elapsed between installation of the section and previous failure; the transformed variable Log(APF+1) is used as covariate	Related to new CI

Output variables	Unit	Short description	Comment
Beta's	Inverse of covariate unit	Influence parameters of covariates, estimated by log-likelihood function maximization; the position parameter of the Weibull distribution is calculated as a linear combination of the beta's with the values of the corresponding covariates	Not PI nor PI variable nor CI
Sigma	Dimension-less	Scale parameter of the Weibull distribution estimated by log-likelihood function maximization	Not PI nor PI variable nor CI
Significant Covariates	-	Subset of available covariates selected according to the Wald test of significance of their beta's	Not PI nor PI variable nor CI
Probability of next failure	Dimension-less	This is the probability of next failure of the section at the time horizon (computed from Weibull function)	Not PI nor PI variable nor CI
Number of forecasted failures/section	Real	Mean number of future failures on a given section inside the time horizon, computed from Monte Carlo simulation (using a random variable X: number of future failures of a section)	Related to IWA PI Op26
$X_{0.025}$,$X_{0.975}$	Real interval	95% confidence interval of the random variable X	Not PI nor PI variable nor CI
Global forecasted number	Real	This is the number of forecasted failures at the time horizon for the whole network, a sector or a group of predetermined pipe	Related to IWA PI Op26
Mean failure rate	km^{-1}	Mean number of future failures E(X) on a given section or sector inside the time horizon divided by the length (in km)	IWA PI Op26

MODEL INSA1 – POISSON REGRESSION FROM INSA (FAILURE FORECASTING MODEL)

Input variables	Unit	Short description	Comments
Requested data:			
Length (total)	km	Total length of pipes	IWA PI var. C6
Duration of failure records	years	No. of years during which failures have been recorded	**New CI**
No. of failures	-	Total number of failures per category	IWA PI var. D25-26
Material	-	Code of the pipe material	Related to PI var. C7-14 and IWA CI
Recommended data:			
Age class	-	e.g.]0,10],]10,20], etc.	Related to PI var. C18-21 and IWA CI
Diameter class	-	e.g. [60-80], [100,135], etc.	Related to PI var. C15-17 and IWA CI
Road class	-	Code referring to the available road classification	**New CI**
Location	-	Location of the pipes (under roadway / under pavement)	**New CI**
Class of water pressure	-	-	Related with IWA CI
Soil class	-	Code referring to the available soil classification	**New CI**
Type of joint	-	-	**New CI**
Depth class	-	-	**New CI**

Output variables	Unit	Short description	Comment
Predicted failure rate	failure / km / year	Predicted failure rate, for each category that have been defined after Poisson analysis	IWA PI Op26
Risk Index	-	Predicted failure rate / average failure rate	Not PI nor PI variable nor CI
%TL 50	-	Percentage of the total length of the asset corresponding to 50% of the total number of failures	Not PI nor PI variable nor CI
%TL 80	-	Percentage of the total length of the asset corresponding to 80% of the total number of failures	Not PI nor PI variable nor CI
Rate ratios & confidence interval	-	Rate ratios (or risk ratios) for modalities of the significant variables, e.g. RR (under roadway/ under pavement)=4.1	Not PI nor PI variable nor CI

Note: failure = burst or failure = leak

MODEL INSA2 AGING STOCHASTIC MODELS - AGEING FUNCTIONS FROM INSA (FAILURE FORECASTING MODEL)

Input variables	Unit	Short description	Comment
NoF (Ci, Y_L, Y_O)	-	For each category C_i (defined a priori or after Poisson analysis), NoF is the number of failures observed in year Y_O for pipes laid in year Y_L	Related to IWA PI var. D25-26
L (Ci, Y_L, Y_O)	-	Total length of pipes belonging to category C_i, laid in year Y_L and observed in Year Y_O	Related to PI var. C6
Rehab_rate (Ci, Yj) [5]	-	Rehabilitation rate applied to category C_i for year Y_j	Related to IWA PI Op15

Output variables	Unit	Short description	Comment
PFR (Ci, Age)	-	Predicted failure rate as a function of the age, for category C_i according to the selected model	Related to IWA PI Op26 and PI var. D25-26

[5] In this context, rehabilitation rate is a decision variable for INSA 2 and not a PI, used as a hypothesis to be tested in simulating impact on future failure rates.

Output variables	Unit	Short description	Comment
ExNoF (Ci, Yk)	-	Expected number of failures in year Y_k for pipes belonging to category C_i	Related to IWA PI Op26 and PI var. D25-26

MODEL KANEW FROM DRESDEN UNIVERSITY

Input variables	Unit	Short description	Comment
(1) Pipe type	-	Code of pipe type according to definition (e.g. type of material, joints, protection, exposure to traffic and seismic loads, etc.)	IWA CI
(2) Construction year or period	-	Year or period of installation, replacement or renovation	Related to PI var. C18-21 and IWA CI
(3) Length	m	Length of pipe type by year or period of construction	IWA PI var. C6
(4) Median service life	years	Life-time expected to be reached by 50 percent of pipes of particular pipe type (band of years)	Not PI nor PI variable nor CI
(5) Standard deviation of service life	years	Degree of variation around mean value (band of years)	Not PI nor PI variable nor CI
(6) Extreme service life	years	Life-time expected to be reached by the most resistant pipes (e.g. 10%) of particular pipe type (band of years)	Not PI nor PI variable nor CI
(7) Ageing parameters		Describes the ageing/deterioration process of pipe types leading to rehabilitation	-
(7.1) Resistance time	years	Number of years expected to be reached by all pipes of particular pipe type without rehabilitation, just spot repair in case of burst or leakage	Not PI nor PI variable nor CI
(7.2) Rehab factor	1/year	Asymptotic annual rehab rate of pipe type at high age	Related to IWA PI Op15
(7.3) Ageing factor	-	Factor (>1) describes the degree to which pipe deterioration increases with age. (factor = 1 means no increase of bursts and leakage with age)	Not PI nor PI variable nor CI

Output variables	Unit	Short description	Comment
(1) Age distribution of pipe types	%	Percent of pipes in specific age, now and in the future	Related to PI var. C18-21 and IWA CI
(2) Cumulative of age distribution of pipe types	%	Percent of pipes younger or older than specific age, now and in the future	Related to PI var. C18-21 and IWA CI
(3) Average age of pipes	years	Percentage of pipes that reach a specific age (band of years) under more or less optimistic assumptions, now and in the future	Related to PI var. C18-21 and IWA CI
(4,5) Aggregate of pipe types (total network)	%	See (1) and (2)	Not PI nor PI variable nor CI
(6) Average age of network	%	See (3)	Related to PI var. C18-21 and IWA CI
(7) Survival function	%	Percentage of pipes that reach a specific age (band of years) under more or less optimistic assumptions	Not PI nor PI variable nor CI
(8) Residual life expectancy of pipe types	years	Number of years (band of years) a pipe of specific type and age is expected to remain in service	Not PI nor PI variable nor CI
(9) Cumulative residual service life of pipe types	%	Cumulative residual life distribution of pipe types (band of percentages), now and in the future	Not PI nor PI variable nor CI
(10) Cumulative residual service life of all pipes	%	Cumulative residual service life distribution of all pipes in the network (band of percentages), now and in the future	Not PI nor PI variable nor CI

Output variables	Unit	Short description	Comment
(11) Annual pipe type rehab needs	km of pipe type/year	Length of pipes (band of km) by pipe type to be rehabilitated in future years	Related to IWA PI Op15-17
(12) Annual network rehab needs	km/year	Aggregate of (11)	Related to IWA PI Op15-17
(13,14) Annual rehab rates	%	Annual rehab needs related to total length of pipes in future years (band of percentage), see (11), (12)	Related to IWA PI Op15-17
Output for specified medium term rehab programmes[6]*:*			
(15) Annual rehab needs of pipe types	km	Long term performance after medium term rehab programme (band of km)	IWA PI Op15-17
(16) Average age of pipes in the network	years	Long term performance after medium term rehab programme (band of years)	Related to PI var. C18-21 and IWA CI
(17) Average residual service life of pipes in the network	years	Long term performance after medium term rehab program (band of years)	Not PI nor PI variable nor CI
(18) Annual failure rate	failures/(km x year)	Long term performance after medium term rehabilitation program	IWA PI Op26
(19) Annual leakage rate	m³/(km x year)	Long term performance after medium term rehabilitation program	IWA PI Op22-25
(20) Annual costs for maintenance, inspection and repair	Euro/year	Long term performance after medium term rehabilitation program	IWA PI Fi12
(21) Annual rehab investments by type of pipe and rehab technology	Euro/year	Long term performance after medium term rehabilitation program	IWA PI Fi18-20
(22) Annual total rehab investments	Euro/year	Long term performance after medium term rehabilitation program (aggregate of 21)	IWA PI Fi18-20
(23) Annual amount of failures and water losses avoided by rehab program	-/year m³/year	Long term performance after medium term rehabilitation program	Related to IWA PI Op26 & Op22-25
(24) Savings from avoided failures and water losses	Euro/year	Long term performance after medium term rehabilitation program	Related to IWA PI Fi12 & Fi36, 37
(25) Balance of costs and benefits	Euro/year	Long term performance after medium term rehabilitation program	**New PI**
(26) Internal rate of return	% Euro/year	Long term performance after medium term rehabilitation program	**New PI**

MODEL RELNET FROM BRNO UNIVERSITY (PIPE MODEL)

Input variables	Unit	Short description	Comment
Link_ID	-	Code of single pipe section	Not PI nor PI variable nor CI
NB	-	Code of node 1 connected to the Link_ID	Not PI nor PI variable nor CI
NE	-	Code of node 2 connected to the Link_ID	Not PI nor PI variable nor CI

[6] Variables (15) to (26) are predictable.

Input variables	Unit	Short description	Comment
Length	m	Length of Link_ID	PI var. C6
DN	mm	Nominal diameter of the Link_ID	Related to PI var. C15-17 and IWA CI
k	mm	Roughness coefficient of the material used in the Link_ID	Related to PI var. C15-17 and IWA CI
c1	-	Number of units supplied (e.g. flats, persons, etc.)	Related to PI var. C15-17 and IWA CI
c2	-	Specific consumption per unit per day	Not PI nor PI variable nor CI
PZ	-	Pressure zone	Related to IWA CI
TC	l/s	Total max. consumption in the evaluated pressure zone	Not PI nor PI variable nor CI
NT	-	Code of tank node	Not PI nor PI variable nor CI
TNL	m	Tank node water level	Not PI nor PI variable nor CI
NL	m	Node elevation	**New CI**
PN	m	Requested min. hydrodynamic pressure in the node	IWA CI
APS	-	The Link_ID availability (probability that the pipe section is in service function)	Not PI nor PI variable nor CI
TPC1	-	Type of probability curve for total water consumption	Not PI nor PI variable nor CI
TPC2	-	Type of probability curve for roughness	Not PI nor PI variable nor CI
TPC3	-	Type of probability curve for tank water level	Not PI nor PI variable nor CI
TPC4	-	Type of probability curve for node consumption	Not PI nor PI variable nor CI
n	-	Number of hydraulic analysis	Not PI nor PI variable nor CI

Output variables	Unit	Short description	Comment
RN	-	Node reliability	**New PI**
RPZ	-	Total reliability of the pressure zone	**New PI**
Ri	-	Impact of i-pipe section on total reliability of the pressure zone	Not PI nor PI variable nor CI

Appendix 3

Additional rehabilitation performance indicators and context information considered relevant for CARE-W prototype by the partners

Note: The data of the three first columns was obtained from the information send by the partners in the answers to the questionnaire regarding the additional rehabilitation performance indicators and context information considered relevant for CARE-W prototype. The last column contains the comment from LNEC regarding the following several possibilities:

a) is not a Performance Indicator nor a Performance Indicator Variable nor a Context Indicator;
b) corresponds to the existing IWA Performance Indicator #
c) is related to the existing IWA Performance Indicator #
d) is a new Performance Indicator;
e) corresponds to the existing IWA Performance Indicator Variable # (or Utility Information);
f) is related to the existing IWA Performance Indicator Variable # (or Utility Information);
g) is a new Performance Indicator Variable (or Utility Information);
h) corresponds to the existing IWA Context Information #
i) is related to existing IWA Context Information #
j) is a new Context Information.

NEW PROPOSED PERFORMANCE INDICATORS

Partner	Performance indicator	Unit	Short description	Comment
Cemagref	Global forecasted numbers of failures	Integer	Summation of the forecasted numbers of failures per section over sectors of the network, the whole network, or categories of sections relevant for asset management	Related to IWA PI var. D25-26, not a PI
	Failure rates	Number per length unit (km^{-1})	Divided by the corresponding lengths, the global forecasted numbers of failures provide interesting more or less aggregated failure rates	IWA PI Op26
	First failure rate	Dimensionless	Total length of sections with NOPF>0 divided by the total length of the network	Related to IWA PI Op26
INSA	Op26b – Critical mains failures	No./100 km/year	Number of failures during the year situated in highly sensitive areas / total mains considered x 100 (Op26b = D25b / C6 x 100. This PI could be divided in two PI, one relative to potential damages and the second one relative to local disruptions (traffic, etc.)	**New PI** related to Op26
	QS12b – Non-programmed interruptions exceeding 6 (or 12, 24, etc.) hours	No./1000 connections	Total number of non-programmed water interruptions exceeding 6 hours / number of service connections x 1000 (QS12b = D33b / C32 x 1000)	IWA QS12 (exactly, referred to 12 hours)
	QS12c – Critical interruptions	No./1000 connections	Total number of critical interruptions / number of sensitive service connections x 1000 (QS12c = D33c / C32b x 1000)	**New PI** (split from QS12)
	QS25b – Water taste complaints	%	Number of water taste complaints during the year / number of service complaints during the year x 100 (QS26b = F14b / F11 x 100)	**New PI** (split from QS25)

Partner	Performance indicator	Unit	Short description	Comment
	QS25c – Discoloured water complaints	%	Number of discoloured water complaints during the year / number of service complaints during the year x 100 (QS26c = F14c / F11 x 100)	**New PI** (split from QS25)
	QS26b – Critical interruptions complaints	%	Number of interruptions complaints during the year / number of service complaints during the year x 100 (QS26b = F15b / F11 x 100)	**New PI** (split from QS26)
Bologna University	Service connection failures	No./1000 connections/ year	Number of connections failures during the year/ 1000 connections	IWA PI Op27
	Mains rehabilitation	%/year	-	IWA PI Op15
	Infrastructure leakage index	%	% of water losses	IWA PI Op25
	Pressure of supply adequacy	%	-	IWA PI QS9
	Leakage control	%/year	-	Op4
	Quality of supplied water	%	-	IWA PI QS15-18
	Unit total cost	€/m^3	-	IWA PI Fi1
	Average unit investment	€/m^3	-	IWA PI Fi18
	Non revenue water by cost	%	-	IWA PI Fi37
Ferrara University	Failure rate per material	No./km	Number of failures in mains of a given material during the year x km / total length for the material at issue	Related to Op26
	Mains failures per quarter	No./km	Number of mains failures during a quarter x km / mains length	Related to Op26
	Failure rate per area	No./km	Number of failures in mains of a given area during the year x km / mains length in the area at issue	Related to Op26
	Failure rate annual trend	No./km	Number of mains failures during the single years at study x km / mains length	Related to Op26

NEW PROPOSED CONTEXT INFORMATION

Partner	Performance indicator	Unit	Short description	Comment
Dresden University	(1) Service population	-	-	IWA PI var. F1
	(2) Per capita consumption	l/inhab./d	-	IWA CI
	(3) Percentage of domestic/industrial consumption	%	-	IWA CI
	(4) Water production/ abstraction	m^3/year	No matter whether produced or bought	Sum of IWA PI var. (A7+A8)
	(5) Water production/ abstraction capacity	m^3/d	Peak demand	Related to IWA PI
	(6) Non-revenue water	m^3/year	-	IWA PI var. A26 and related to Fi37
	(7) Leakage rate	m^3/km x year	-	Related to IWA PI Op24
	(8) Burst rate	no./km x year	-	**New PI** (split from Op26)
	(9) Failure rate	no./km x year	-	IWA PI Op26

Partner	Performance indicator	Unit	Short description	Comment
	(10) Network rehabilitation	km/year	Average of last 5 years	IWA PI var. D18
	(11) Network extension	km/year	Average of last 5 years	**New PI var.**
	(12.1) Domestic tariff	Euro/m³	-	IWA CI
	(12.2) Industrial tariff	Euro/m³	-	IWA CI
	(13) Percentage of variable costs in water production	%	Proxy for marginal cost of leakage reduction	Related to IWA PI var. G2
	(14) Inflation rate	%/year	-	**New CI**
	(15) Pipe materials	%	E.g. metallic vs. plastic	Related to PI var. C7-14 and IWA CI
	(16) Rehab technologies	%	E.g. no dig, renovation	Related to IWA PI Op16-18
	(17) Service connection age	-	-	Related to IWA PI var. C18-21
Cemagref	Soil type	Alpha-numeric coding	Code of soil type, used as categorical covariate.	**New CI**
	Soil characteristics	Alpha-numeric coding	Codes of soil characteristics (humidity, resistivity, geotechnical risk, etc.), used as categorical covariates	**New CI**
	Traffic	No. vehicles / day or alpha-numeric coding	Traffic intensity possibly distinguishing categories of vehicles	**New CI**
	Pipes location	0/1	Under sidewalk or roadway indicator variable	**New CI**
	MaxSP	bar	Daily maximum static pressure, used as continuous covariate	Related to IWA CI
	MinDP	bar	Daily minimum dynamical pressure, used as continuous covariate	Related to IWA CI
	Pressure variation	bar	Daily maximum difference between static pressure and dynamical pressure, used as continuous covariate	Related to IWA CI
	Installation depth	m	Depth of pipes installation, possibly used as continuous covariate	**New CI**
	Density of connections	km^{-1}	Number of supply connections served by the section divided by the length of the section	IWA CI
Bologna University	Temperature	°C	Average temperature, by month/season if applicable	IWA CI
	Pipe depth	m	Value of average pipe depth, by material/diameter if applicable	**New CI**
	Rainfall	mm	Rainfall intensity, by month/season if applicable	IWA CI
Ferrara University	Temperature	°C	Necessary to take into account the different climate conditions of the areas to which our model will be applied	IWA CI
	Soil moisture	-	Code corresponding to an average value, according to a convention	**New CI**
	Soil composition	-	To evaluate soil-aggressiveness towards the pipes	**New CI**
	Closeness of trees	-	The action of their roots can provoke mains failures	**New CI**

Appendix 4
Definitions

Abnormal demand: demand records having given average and standard deviation values for each period of the year and day of the week, can be considered abnormal if they exceed, for the relevant period, values higher than (average + 2 x standard deviation).

Cases of abnormal demand are often combined with abrupt pressure drops in the system, as well as with increases in large leaks or pipe bursts.

Active leakage control: a formal regime of regular (periodic) or continuous monitoring of the network that detects and repairs *unreported* bursts; includes regular surveying (sounding, waste metering) and/or leakage monitoring. Does not include repair of *reported* bursts.

Reported bursts are those that are notified to the relevant department of the water undertaking, either by own personnel or third parties, arising from visual evidence of leakage or found as a result of investigating customer complaint of loss of supply or low pressure.

Cleaning: a range of techniques including flushing, swabbing, air scouring and pressure jetting intended to remove loose or soft deposits from inside water mains and storage tanks.

Complaints: any customer complaint expressed to the services either personally (verbal or written), by telephone, fax, post, e-mail or any other written format.

Context information (CI): set of complementary absolute value or ratio between values of identical or different natures, that cannot be directly influenced by the utility (external to the organization and to its physical system), but that is critical for establishing the rehab diagnosis or for support to the CARE-W decision-making process (e.g. rain fall, temperature, ground slope, type of soil, etc.).

Delivery point: the point on the service connection where ownership of the pipe changes from the water undertaking to the customer (this is usually, but not always, at the boundary between the public highway and private land.)

Interruption: unplanned (even if notified) or un-notified water supply interruption to customers with a duration (measured to full restoration of supply) of more than 12 hours, caused by bursts or failures in the water supply system and the subsequent repair/renewal measures. Includes those planned interruptions that exceed the notified period.

Mains failure: detected water leaks of transmission and/or distribution mains necessitating repair / renewal measures. Included are failures of mains, defective pipe connections, valves and fittings, caused by:

- ❑ defective materials, design, construction or operational-related defects, in pipes, joints, valves and other fittings;
- ❑ corrosion of materials, externally or internally, primarily but not exclusively ferrous materials;
- ❑ external mechanical damage e.g. due to excavation, including third party damage;
- ❑ earth movements related to effects of frost, dry periods, heavy traffic, earthquakes, floods, and others.

Measurement point: the point on the service connection where customer meters are or would be located. In this definition, the customer meter may be either:

- ❑ a master meter serving two or more individual premises, which may or may not be individually metered; or
- ❑ an individual customer meter.

Performance indicators (PI): ratio between values of identical or different nature, expressing the performance of the undertaking regarding a given point of view relevant in the rehabilitation framework.

Utility information (UI): set of data that is directly related to the activity of the utility (organization and its physical system) and is under its direct control, used either for the assessment of the selected PI (as PI input variables) or for the CARE-W decision making process.

Rehabilitation: any physical intervention that extends the life of the system and involves changing their condition or specification.

Refurbishment: all methods for restoring the existing assets in order to achieve the requisite performance.

Reinforcement: construction of an additional facility that supplements the capacity of an existing one or provides an alternative to it.

Relining: the removal of all deposits from inside an existing pipe, followed by the *in situ* application of a non-structural lining to provide corrosion protection, such as cement or epoxy mortar (relining is sometimes referred to as scraping and lining, renovation or reconditioning).

Replacement: substitution of a new facility for an existing one where the latter is no longer used for its former objective. Renewal is a particular form of replacement in which the function of the new facility is the same as that of the existing. In practice this usually means that is of the same nominal diameter (for pipes), power (for pumping systems), etc. In the case of pipes, replacement includes the provision of a structural liner (slip lining). The new pipe may or may not have the same carrying capacity as the existing pipe.

Restrictions to water service: limitations to the use of water, as imposed by the water undertaking, such as hosepipe or sprinkler bans.

Service connection: the authorised pipe connecting the main to the measurement point or to the customer stop-valve, as applicable. Where several registered customers or individually occupied premises share a physical connection or tapping off the main, e.g. apartment buildings, this will still be regarded as the one connection for the purposes of the applicable PI, irrespective of the configuration and number of customers or premises.

Service connection failure: same definition as mains failure applied to service connections.

Station: pumping stations, treatment plants and other control or monitoring points of the water supply system.

Treated water: the water considered by the undertaking as fit for consumption, regardless of the treatment process it may or may not have been subject to. Treated water tests include all the tests performed on treated water samples collected anywhere in the system, including the consumption points.

Appendix 5

Proposal of rehab performance indicators

Note: The IWA codes for PI and PI variables are kept in this Appendix to allow for an easier cross-reference. See [1] for variables identification when necessary.

Water resources indicators

INDICATOR (unit)	CONCEPT Processing rule
WR1 - Inefficiency of use of water resources *(%)*	Real losses / water abstracted and imported water x 100 *WR1 = A24/(A4+A2) x 100* *This indicator must not be used as a measure of efficiency of management of the transmission and/or the distribution system.*
WR2 - Resources availability ratio *(%)*	[Authorised consumption (including exported water) + water losses] / total yearly abstraction capacity and imported water allowance x 100 *WR2 = (A19+A20)/(A1+A5+A8) x 100 or WR2 = (A7+ A8)/(A1+A2) x 100* *A value of 100% for this indicator means that all available resources are being used. Although this indicator is sometimes difficult to assess, and is not easily auditable, its used is encouraged as a management tool, particularly in rapid growing areas or areas subject to scarcity problems. Each water undertaking should estimate the yearly abstraction capacity and imported water allowance according to its own guaranteed schemes, drought management and operation procedures.*

Physical indicators

INDICATOR (unit)	CONCEPT Processing rule
STORAGE	
Ph3 - Transmission and distribution storage capacity *(days)*	Total capacity of transmission and distribution storage tanks (private storage tanks excluded) / [authorised consumption (including exported water) + water losses] x 365 *Ph3 =C2/(A19+A20) x 365* *In case of bulk supply systems, if the delivery point is a storage tank, its capacity can be accounted for, even though it is neither owned nor operated by the water undertaking. The interpretation of the values of this indicator shall take into account the seasonal, monthly, daily and hourly peak factors.*
PUMPING	
Ph4 - Standardised energy consumption *(Wh/m^3 at 100 m)*	Annual energy consumption for pumping / Σ (volume elevated x pump head in hundreds of meters) *Ph4 = D1/D2* *This indicator is the average amount of energy consumed per m^3 at a pump head of 100 m. For reference, this indicator is normally of the order of 0,5 kWh/m^3 at 100 m. It is the inverse of the average pumping group efficiency. 0,5 kWh/m^3 at 100 m corresponds to an average pumping efficiency of 9810 N x 100 m / (3600 J/Wh) /500 Wh x 100 = 54%.*
TRANSMISSION AND DISTRIBUTION NETWORK	
Ph7 - Valve density *(No./km)*	Number of isolating valves / total mains length *Ph7 = C30/C6*

Ph8 - Hydrant density *(No./km)*	Number of hydrants / total mains length *Ph8 = C31/C6*
Ph8a – Network hydraulic reliability *(-)*	(to be defined) *(?)*
Ph8b – Node hydraulic reliability *(-)*	(to be defined) *(?)*
Ph8c – Mains residual service life *(years)*	(to be defined) *(?)*

Operational indicators

INDICATOR *(unit)*	CONCEPT Processing rule
INSPECTION AND MAINTENANCE	
Op3 - Network inspection *(%/year)*	Length of transmission and distribution mains where at least valves and other fittings were inspected during the year / total mains length x 100 *Op3 = D7/C6 x 100*
Op4 - Leakage control *(%/year)*	Length of mains subject to active leakage control / total mains length x 100 *Op4 = D8/C6 x 100*
Op5 - Active leakage control repairs *(%/year)*	Number of leaks detected and repaired due to active leakage control / total mains length x 100 *Op4 = D9/C6 x 100*
Op6 - Hydrant inspection *(%/year)*	Number of hydrants inspected during the year / total number of hydrants x 100 *Op6 = D10/C31 x 100*
MAINS, VALVES AND SERVICE CONNECTION REHABILITATION	
Op15 - Mains rehabilitation *(%/year)*	Length of transmission and distribution mains rehabilitated during the year / total mains length x 100 *Op15 = D18/C6 x 100 or Op15 = Op16 + Op17*
• *Op16 - mains relining* *(%/year)*	Length of mains relined during the year / total mains length x 100 *Op16 = D19/C6 x 100*
• *Op17 - replaced or renewed mains* *(%/year)*	Length of mains replaced or renewed during the year / total mains length x 100 *Op17 = D20/C6 x 100*
• *Op18 - replaced valves* *(%/year)*	Number of mains valves replaced during the year / total number of mains valves x 100 *Op18 = D21/C29 x 100*
Op19 - Service connection rehabilitation *(%/year)*	Number of service connections replaced or renewed during the year / total number of service connections x 100 *Op19 = D22/C32 x 100*
PUMPS REHABILITATION	
• *Op20 - pump refurbishment* *(%/year)*	Total nominal power of pumps subject to overhaul during the year / total nominal power of pumps x 100 *Op20 = D23/C5 x 100*
• *Op21 - pump replacement* *(%/year)*	Total nominal power of pumps replaced during the year / total nominal power of pumps x 100 *Op21 = D24/C5 x 100*

WATER LOSSES	(Water balance definitions to be adopted according to [1])
Op22 - Water losses *(m^3/connection/year)*	Water losses / number of service connections *Op22 = A20/C32* *If service connections density < 20/km of mains (e.g. transmission networks), then this indicator should be expressed in m^3/ km of water mains / year*
• *Op23 - apparent losses* *(m^3/connection/year)*	Apparent losses / number of service connections *Op23 = A23/C32* *If service connections density < 20/km of mains (e.g. transmission networks), then this indicator should be expressed in m^3/ km of water mains / year*
• *Op24 - real losses* *(l/connection/day when system is pressurised)*	Real losses x 1000 / (number of service connections x 365 x T/100) (T = % of year system is pressurised) *Op24 = A24 x 1000/(C32x365xD29/365)* *If service connections density < 20/km of mains (e.g. transmission networks), then this indicator should be expressed in l / km of water mains / day*
Op25 - Infrastructure leakage index *(-)*	Real losses (*Op*)/ technical achievable low-level annual real losses (when system is pressurised) *Op25 = Op24/(18xC6/C32+0.7+0.025xC33)xD31* *The technical achievable low-level annual real losses are equal to the "best estimate" of so called Unavoidable Annual Real Losses, UARL, which can be calculated with the equation derived by the Water Losses Task Force (see AQUA Dec. 1999 and IWA Blue Pages "Losses from water supply systems"):* *UARL (litres/service connection/day)= (18 x Lm/Nc + 0,7 + 0,025 Lp) x P* *This equation, based on empirical results of international investigations, recognises separate influences on real losses from:* - *Length of mains Lm in km (C6)* - *Number of service connections Nc (C32)* - *Average length of service connections Lp in m (C33)* - *Average operating pressure in m (D31)* *Well-managed systems are expected to have low values of this Infrastructure leakage index – close to 1.0 – while systems with infrastructure management deficiencies will present higher values.*
FAILURES	
Op26 - Mains failures[7] *(No./100 km/year)*	Number of mains failures during the year, including failures of valves and fittings and excluding service connection insertion point failures / total mains length x 100 *Op26 = D25/C6 x 100* *If mains failures are to be used for regulating objectives, the use of a complementary indicator, similar to Op26 but excluding failures by third parties is advisable, as they are not a direct fault of the water undertaking. Number should exclude repairs under active leakage control.*
Op26a - pipe failures *(No./100 km/year)*	Number of pipe failures during the year, excluding failures of valves joints and links to service connections / total mains length x 100 *Op26a = D25a/C6 x 100*
Op26b - joint failures *(No./100 km/year)*	Number of joint failures during the year / total mains length x 100 *Op26a = D25b/C6 x 100*
Op26c - valves failures *(No./100 km/year)*	Number of valve failures during the year / total mains length x 100 *Op26a = D25c/C6 x 100*
Op26d – Critical mains failures *(No./100 km/year)*	Number of critical mains failures during the year, including failures of valves and fittings and excluding service connection insertion point failures / total mains length x 100 *Op26d = D25d/C6 x 100*
Op26e – Mains failures in sensitive areas *(No./100 km/year)*	Number of mains failures in sensitive areas during the year, including failures of valves and fittings and excluding service connection insertion point failures / total mains length x 100 *Op26d = D25e/C6 x 100*

[7] This definition differs from the present IWA's one. In the latter it is not clear whether the service connection insertion point failures shall be accounted for.

Op27 - Service connection failures *(No./1000 connections/year)*	Number of service connection failures during the year / number of service connections x 1000 *Op27 = D26/C32 x 1000* *If service connection failures are to be used for regulating objectives, the use of a complementary indicator, similar to Op27 but excluding failures by third parties is advisable, as they are not a direct fault of the water undertaking. Number should exclude repairs under active leakage control.*
Op27a – Service connection insertion point failure *(No./100 km/year)*	Number of failures that occur in the insertion point of the service connection / number of service connections x 1000 *Op27a = D26a/C32 x 1000*
Op28 - Hydrant failures *(No./1000 hydrants/year)*	Number of hydrant failures during the year / total number of hydrants x 1000 *Op28 = D27/C31 x 1000* *If hydrant failures are to be used for regulating objectives, the use of a complementary indicator, similar to Op28 but excluding failures by third parties is advisable, as they are not a direct fault of the water undertaking. Number should exclude repairs under active leakage control.*
Op29 - Power failures *(hours/pumping station/year)*	$\Sigma_{\text{(for all pumping stations)}}$ (number of hours during the year each pumping station is out of service or is reliant on standby power generation due to power supply interruptions)/ total number of pumping stations *Op29 = D28/C4*

Quality of service indicators

INDICATOR *(unit)*	CONCEPT Processing rule
QS9 - Pressure of supply adequacy *(%)*	Number of delivery points that receive and are likely to receive pressure equal to or above the guaranteed or declared target level at the peak demand hour (but not when demand is abnormal) / number service connections x 100 *QS9 = D30/C32 x 100*
QS11 - Water interruptions[8] *(%)*	Σ (Population subject to a water interruption x duration of the interruption in hours) / (population served x 24 x 365) x 100 *QS11 = D32/(F1 x24 x 365) x 100* *Since, for many water undertakings, the information required for this indicator is neither available nor feasible to be collected in a near future, QS12 is alternatively proposed.*
QS12 - Interruptions per connection *(No./1000 connections)*	Total number of interruptions / number of service connections x 1000 *QS12 = D33/C32 x 1000* *This indicator should only be used if QS cannot be calculated.*
QS12a – Critical interruptions per connection *(No./1000 connections)*	Total number of critical interruptions / number of sensitive service connections x 1000 *QS12 = D33a/C32a x 1000* *This indicator should only be used if QS cannot be calculated.*
QS13 - Population experiencing restrictions to water service[9] *(%)*	Σ (Population affected by restrictions to water service x duration of the restrictions to water service in hours) / (total population served x 24 x x 365) x 100 *QS13 = D34/(F1x24x365) x 100*
QS14 - Days with restrictions to water service *(%)*	Total number of days with restrictions to water service during the year / 365 x 100 *QS14 = D35/365 x 100* *This indicator should only be used if QS13 cannot be calculated.*
QS15 - Quality of supplied water *(%)*	Total number of treated water tests complying with the legislation during the year / total number of tests of treated water performed during the year x 100

[8] Indicators *QS11* and *QS12* shall be used in alternative.
[9] Indicators *QS13* and *QS14* shall be used in alternative.

INDICATOR (unit)	CONCEPT Processing rule
	QS15 = (D51+D52+D53)/D41 x 100
• *QS16 - aesthetic* (%)	Number of aesthetic tests of treated water complying with the legislation during the year / total number of aesthetic tests treated water performed during the year x 100 *QS16 = D51/D42 x 100*
• *QS16a - water taste* (%)	Number of water taste tests of treated water complying with the legislation during the year / total number of water taste tests of treated water performed during the year x 100 *QS16a = D51a/D42a x 100*
• *QS16b - water colour* (%)	Number of water colour tests of treated water complying with the legislation during the year / total number of water colour tests of treated water performed during the year x 100 *QS16 b= D51b/D42b x 100*
• *QS17 - microbiological* (%)	Number of microbiological tests of treated water complying with the legislation during the year / total number of microbiological tests of treated water performed during the year x 100 *QS17 = D52/D43 x 100*
• *QS18 - physical-chemical* (%)	Number of physical-chemical tests of treated water complying with the legislation during the year / total number of physical-chemical tests of treated water performed during the year x 100 *QS18 = D53/D44 x 100*
CUSTOMER COMPLAINTS	
QS22 - Service complaints *(No. complaints/connection/year)*	Number of complaints of quality of service during the year / number of service connections *QS22 = F11/C32*
• *QS23 - pressure complaints* (%)	Number of pressure complaints during the year / number of service complaints during the year x 100 *QS23 = F12/F11 x 100*
• *QS24 - continuity complaints* (%)	Number of continuity complaints during the year / number of service complaints during the year x 100 *QS24 = F13/F11 x 100* *This indicator refers to medium- or long-term supply constraints, due to insufficient water quantity or quality at source, insufficient system capacity or on-going works.*
• *QS25 - water quality complaints* (%)	Number of water quality complaints during the year / number of service complaints during the year x 100 *QS25 = F14/F11 x 100*
• *QS25a - water taste* (%)	Number of water taste complaints during the year / number of service complaints during the year x 100 *QS25a = F14a/F11 x 100*
• *QS25b - water colour* (%)	Number of water colour complaints during the year / number of service complaints during the year x 100 *QS25b = F14b/F11 x 100*
• *QS26 - interruptions* (%)	Number of complaints due to supply interruptions during the year / number of service complaints during the year x 100 *QS26 = F15/F11 x 100* *This indicator refers to short-term supply interruptions, due to accidental system failures or repair works.*
• *QS26a - critical interruptions* (%)	Number of complaints due to supply interruptions in critical areas during the year / number of service complaints during the year x 100 *QS26a= F15a/F11 x 100* *Critical areas can be defined as urban zones where severe damages (landslide, flooding) or severe disturbances (traffic interruptions) may occur due to water main bursts; sensitive connections (for example hospitals, dialysis patients, etc).* *This indicator refers to short-term supply interruptions, due to accidental system failures or repair works.*

Financial Indicators

INDICATOR (unit)	CONCEPT / Processing rule
ANNUAL COSTS	(Refer to [1] for definitions)
Fi1 - Unit total costs (€/m³)	(Annual running costs + annual capital costs) / authorised consumption (including exported water) *Fi1 = (G2+G3)/A19*
• *Fi2 - unit running costs* (€/m³)	Annual running costs / authorised consumption (including exported water) *Fi2 = G2/A19*
Composition of annual running costs per type of costs	
• *Fi7 - energy costs ratio* (%)	Annual energy costs / annual running costs x 100 *Fi7 = G8/G2 x 100*
Composition of annual running costs per main function of the water undertaking	
• *Fi12 - technical services costs ratio* (%)	Annual running costs of the technical services: planning, design, construction, operations and maintenance / annual running costs x 100 *Fi12 = G18/G2 x 100*
ANNUAL INVESTMENT	
Fi18 - Unit investment (€/m³)	Annual cost of investments (expenditures for plant and equipment) / authorised consumption (including exported water) *Fi18= G26/A19* *The annual values of this ratio can be misleading. A multi-annual analysis must be adopted.*
• *Fi19 - annual investments for new and upgrading assets* (%)	Cost of investments for new assets (or upgrading of existing ones) / total cost of the investments x 100 *Fi19 = G27/G26 x 100* *The annual values of this ratio can be misleading. A multi-annual analysis must be adopted.*
• *Fi20 - annual investments for assets replacement* (%)	Cost of investments for the replacement of existing assets / cost of the investments x 100 *Fi20 = G28/G26 x 100* *The annual values of this ratio can be misleading. A multi-annual analysis must be adopted.*
TARIFFS	
Fi21 - Average water charges for direct consumption (€/m³)	Annual water sales revenue from residential, commercial, industrial, public, institutional and other customers (exported water excluded; public water taxes excluded) / (total annual authorised - exported water) *Fi21 = G30/(A19-A9)*
Fi22 - Average water charges for exported water (€/m³)	Annual water sales revenue from exported water (excluding public water taxes) / exported water *Fi22 = G31/(A6+A9)*
WATER LOSSES	
Fi36 - Non-revenue water by volume (%)	Non-revenue water / system input volume x 100 *Fi36 = A26/(A7+A8) x 100*
Fi37 - Non-revenue water by cost (%)	Valuation of non-revenue water components / annual running costs x 100 *Fi37 = ((A18+A23) xG49+A24 xG50)/ G2 x 100* *This is the sum of separate valuations for unbilled authorised consumption, apparent losses and real losses. In respect of real losses, the attributed unit cost (G50) will be the highest of the variable component of bulk supply charge o long run marginal cost for own sources. It is usually worthwhile to calculate and review the three components of Fi separately.*

INDICATOR *(unit)*	CONCEPT Processing rule
ECONOMICAL REHAB ASSESSMENT	
Fi37a – Balance of costs and benefits *(€/year)*	Annual costs for rehabilitation, repair, maintenance and inspection minus benefits from reduced repair and leakage $Fi37a(t)= G51(t)+G52(t)+G53(t)+G54(t)-{}^{t}\sum_{1}(G55+G56)$
Fi37b – Internal rate of return *(%)*	Annual discount rate, for which the present values of costs and benefits are equal, witch can be calculated by solving the following formula for z: $^{n}\sum_{t=0}(R_t-E_t)x(1+z)^{-(t-1)}=0$ R_t annual revenues (benefits) E_t annual expenditures (costs) z internal rate of return (discount rate) $Fi37b = z$

Appendix 6

Proposal of rehab utility information

Note: The IWA codes for PI variables [1] are kept in this Appendix to allow for an easier cross-reference.

PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK

WATER STORAGE

TRANSMISSION & DISTRIBUTION STORAGE TANKS CAPACITY (corresponds to the IWA PI variable C2)		
UNIT OF EXPRESSION: m^3	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total volume of transmission and distribution storage tanks.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: The customer storage tanks must not be included. If appropriate, this variable can be split into capacity for fire flow protection and remaining capacity.		

PUMPING STATIONS

PUMPING STATIONS (corresponds to the IWA PI variable C4)		
UNIT OF EXPRESSION: (number)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Total number of pumping stations of the system (treatment plants and customer pumping systems excluded).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PUMPING STATIONS CAPACITY (corresponds to the IWA PI variable C5)		
UNIT OF EXPRESSION: kW	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total nominal power of the system pumps (treatment plants and customer pumping systems excluded).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

TRANSMISSION AND DISTRIBUTION NETWORK

MAINS LENGTH (corresponds to the IWA PI variable C6)		
UNIT OF EXPRESSION: km (or m in single pipes)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total transmission and distribution mains length (service connections not included).		
PROCESSING RULE:	C7+C8+C9+C10+C11+C12+C13+C14 or C15+C16+C17 or C18+C19+C20+C21 or, if these partial data are not available: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

NETWORK EXTENSION (corresponds to the IWA PI variable C6)		
UNIT OF EXPRESSION: km/year	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average annual extension of transmission and distribution mains length over the last 5 years (service connections excluded).		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT:		

MAINS DIAMETER (applicable only to single pipes)		
UNIT OF EXPRESSION: mm	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Internal (or external for plastic pipes) diameter of the pipes.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT:		

MAINS WITH < 100 mm DIAMETER (corresponds to the IWA PI variable C15)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains with internal/external diameter ≤ 100/110 mm (Service connections not included).		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information.		

MAINS WITH 100 < DIAMETER ≤ 300 mm (corresponds to the IWA PI variable C16)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains with internal/external diameter > 100/110 mm and ≤ 300/315 mm (Service connections not included).		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information.		

MAINS WITH DIAMETER > 300 mm (corresponds to the IWA PI variable C17)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains with internal/external diameter > 300/315 mm (Service connections not included).		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information.		

CAST SPUN AND GREY IRON MAINS (CI) (corresponds to the IWA PI variable C7)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of cast iron transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

C8 - **DUCTILE IRON MAINS** (code DI) (corresponds to the IWA PI variable C8)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of ductile iron transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

STEEL MAINS (code ST) (corresponds to the IWA PI variable C9)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of steel transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

ASBESTOS CEMENT MAINS (code AC) (corresponds to the IWA PI variable C10)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of asbestos cement transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

POLYETHYLENE MAINS (code PE) (corresponds to the IWA PI variable C11)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of polyethylene transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

POLYVINYL CHLORINE MAINS (code PVC) (corresponds to the IWA PI variable C12)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of polyvinyl chlorine transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

CONCRETE MAINS (code CO) (corresponds to the IWA PI variable C13)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of concrete transmission and distribution mains (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

OTHER MATERIAL MAINS (code OT) (corresponds to the IWA PI variable C14)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains made of other material than cast iron, ductile iron, steel, asbestos cement, polyethylene, polyvinyl chlorine and concrete (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If appropriate, this variable can be split into sub-variables.		

MAINS WITH INTERNAL PROTECTION (code IP)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains with internal protection (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If appropriate, this variable can be split into sub-variables.		

MAINS WITH EXTERNAL PROTECTION (code EP)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains with external protection (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If appropriate, this variable can be split into sub-variables.		

MAINS WITH CATHODIC PROTECTION (code CP)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains with cathodic protection (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If appropriate, this variable can be split into sub-variables.		

AVERAGE MAINS AGE		
UNIT OF EXPRESSION: years	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average mains age for the global supply system based on the age of each mains and its length.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information. It is advisable that the water undertaking defines a clear procedure to establish the pipe age of partially renewed or rehabilitated pipes, to allow for a correct interpretation of the results.		

MAINS LAID BEFORE 1899		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid before 1899 (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information. It is advisable that the water undertaking defines a clear procedure to establish the pipe age of partially renewed or rehabilitated pipes, to allow for a correct interpretation of the results.		

MAINS LAID BETWEEN 1900 AND 1904		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid between 1900-1904 (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information. It is advisable that the water undertaking defines a clear procedure to establish the pipe age of partially renewed or rehabilitated pipes, to allow for a correct interpretation of the results.		

(Similar Utility Information between this dates…)

MAINS LAID BETWEEN 2005 AND 2009		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid between 2005-2009 (Service connections not included).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: It is recommended that, whenever feasible, this variable is split into sub-variables according to the pipe material, to allow for a better interpretation of the pipe failure information. It is advisable that the water undertaking defines a clear procedure to establish the pipe age of partially renewed or rehabilitated pipes, to allow for a correct interpretation of the results.		

MAINS INTERNAL PROTECTION DATE		
UNIT OF EXPRESSION: year	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains internal protection date.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS EXTERNAL PROTECTION DATE		
UNIT OF EXPRESSION: year	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains external protection date.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS CATHODIC PROTECTION DATE		
UNIT OF EXPRESSION: year	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains cathodic protection date.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS LOCATION UNDER FLEXIBLE ROADWAY (UFR)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under flexible roadway.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS LOCATION UNDER RIGID ROADWAY (URR)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under rigid roadway.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS LOCATION UNDER SIDEWALK (USW)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under sidewalk.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS LOCATION UNDER GREEN AREAS (UGA)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under green areas.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS INSTALLATION DEPTH		
UNIT OF EXPRESSION: m	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average mains installation depth from the pavement to the external top of the pipe.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

TRENCH MAINS INSTALLATION WIDTH		
UNIT OF EXPRESSION: m	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Trench mains installation width.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

BEDDING SOIL TYPE		
UNIT OF EXPRESSION: Alpha-numeric	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Soil type where is bedded the pipe, according categories to be defined.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

BACKFILLING SOIL TYPE		
UNIT OF EXPRESSION: Alpha-numeric	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Soil type where is bedded the pipe, according categories to be defined.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

AVERAGE CLOSENESS TO TREES		
UNIT OF EXPRESSION: m	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average closeness between the pipe and the trees.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PIPE RIGID JOINTS (code RJ)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Pipe with rigid joints.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PIPE RIGID JOINTS (code FJ)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Pipe with rigid joints.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAINS VALVES (corresponds to the IWA PI variable C29)		
UNIT OF EXPRESSION: (number)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Total number of all kinds of valves installed in transmission and distribution system mains.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Valves installed in the service connections shall not be accounted for.		

ISOLATING VALVES (corresponds to the IWA PI variable C30)		
UNIT OF EXPRESSION: (number)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Total number of isolating valves of all types installed in transmission and distribution system mains.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Valves installed in the service connections shall not be accounted for.		

HYDRANTS (corresponds to the IWA PI variable C31)		
UNIT OF EXPRESSION: (number)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Total number of hydrants of all types installed in transmission and distribution system.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

NODE ELEVATION		
UNIT OF EXPRESSION: (m)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Node topographic elevation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PHYSICAL ASSETS DATA - SERVICE CONNECTIONS

SERVICE CONNECTIONS (corresponds to the IWA PI variable C32)		
UNIT OF EXPRESSION: (number)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Total number of service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SENSITIVE SERVICE CONNECTIONS		
UNIT OF EXPRESSION: (number)	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Total number of sensitive service connections, related with special consumer strongly dependent from the water supply (hospitals, schools, etc.)		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

AVERAGE SERVICE CONNECTION LENGTH TO DELIVERY POINT (corresponds to IWA CI)		
UNIT OF EXPRESSION: m	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average length of pipe between the mains and the delivery point.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

AVERAGE SERVICE CONNECTION LENGTH TO MEASUREMENT POINT (corresponds to the IWA PI variable C33)		
UNIT OF EXPRESSION: m	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average length of pipe between the mains and the measurement point.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

PLASTIC SERVICE CONNECTIONS (code PL) (corresponds to the IWA CI)		
UNIT OF EXPRESSION: %	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Percentage of the total number of plastic service connections regarding the total number of service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

STEEL SERVICE CONNECTIONS (code ST) (corresponds to the IWA CI)		
UNIT OF EXPRESSION: %	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Percentage of the total number of steel service connections regarding the total number of service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

LEAD SERVICE CONNECTIONS (code LD) (corresponds to the IWA CI)		
UNIT OF EXPRESSION: %	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Percentage of the total number of lead service connections regarding the total number of service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

OTHER MATERIALS SERVICE CONNECTIONS (code OT) (corresponds to the IWA CI)		
UNIT OF EXPRESSION: %	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Percentage of the total number of other material service connections regarding the total number of service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

SERVICE CONNECTIONS DENSITY (corresponds to the IWA CI)		
UNIT OF EXPRESSION: No./km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Percentage of the total number of service connections regarding the total mains length.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Frequently water undertakings do not have detailed accurate information to assess the service connection length. In these cases, a qualitative assessment will be adopted.		

WATER VOLUME DATA

YEARLY ABSTRACTION CAPACITY (corresponds to the IWA PI variable A1)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Maximum yearly allowance of water abstraction for water supply, based on the availability of water resources.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)[10]	
COMMENT: If the maximum yearly abstraction capacity is not clearly established as an allowance, it shall be estimated as accurately as possible.		

IMPORTED WATER ALLOWANCE (corresponds to the IWA PI variable A2)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Maximum allowance of raw and treated water importation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If the maximum yearly allowance is not contracted with the supplier, it shall be estimated as accurately as possible.		

WATER ABSTRACTED (corresponds to the IWA PI variable A4)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: The annual volume of water obtained for input to water treatment plants (or directly to the transmission and distribution systems) that were abstracted from raw water sources.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

IMPORTED RAW WATER (corresponds to the IWA PI variable A5)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total annual volume of raw water transferred from other water supply systems.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

EXPORTED RAW WATER (corresponds to the IWA PI variable A6)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total annual volume of raw water transferred to other water supply systems.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

[10] It is most advisable that target confidence grades, specified in terms of reliability and accuracy, are defined for every input data variable.

WATER PRODUCED (corresponds to the IWA PI variable A7)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total annual volume of water treated for input to water transmission lines or directly to the distribution system.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Imported treated water should not be included.		

IMPORTED TREATED WATER (corresponds to the IWA PI variable A8)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total annual volume of treated water imported from other water undertaking or system.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
These transfers can occur anywhere downstream of the treatment plants.		

EXPORTED TREATED WATER (corresponds to the IWA PI variable A9)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total annual volume of treated water exported to other water undertaking or system from the supply area.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*). Whenever applicable, this variable should be split into: A9(a) – water exported from the transmission and storage system A9(b) – water exported from the distribution system	
COMMENT:		
These transfers can occur anywhere downstream of the treatment plants.		

BILLED METERED CONSUMPTION (corresponds to the IWA PI variable A13)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total annual amount of billed metered authorised consumption (including exported water).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*).	
COMMENT:		
Input data results from the sum of customer meter readings. As in general readings dates do not refer to the exact audit period, interpolations will be required to have the best possible estimate of the true value.		

BILLED UNMETERED CONSUMPTION (corresponds to the IWA PI variable A14)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total annual amount of billed unmetered authorised consumption (including exported water).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*).	
COMMENT:		

BILLED AUTHORISED CONSUMPTION (corresponds to the IWA PI variable A15)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Total annual amount of billed water consumed.		
PROCESSING RULE: A13 + A14		
COMMENT: Note that billed authorised 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., if these are billed.		

UNBILLED METERED CONSUMPTION (corresponds to the IWA PI variable A16)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Total annual amount of unbilled metered authorised consumption (including exported water).		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*).		
COMMENT: Note that unbilled metered 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, if these are unbilled and metered.		

UNBILLED UNMETERED CONSUMPTION (corresponds to the IWA PI variable A17)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Total annual amount of unbilled unmetered authorised consumption (including exported water).		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*).		
COMMENT: The input data is the best available estimate, based on surveys or any other forms of assessment the water undertaking can make use of. Note that unbilled unmetered 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., if these are unbilled and unmetered.		

UNBILLED AUTHORISED CONSUMPTION (corresponds to the IWA PI variable A18)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Total annual amount of unbilled water consumed.		
PROCESSING RULE: A16+A17		
COMMENT: Note that unbilled authorised 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, according to local practice.		

AUTHORISED CONSUMPTION (corresponds to the IWA PI variable A19)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total annual volume of metered and/or non-metered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorised to do so by the water supplier, for residential, commercial and industrial purposes. It includes water exported.		
PROCESSING RULE: A15+A18		
COMMENT:		
Note that authorised 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, according to local practice.		

WATER LOSSES (corresponds to the IWA PI variable A20)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
The difference between SYSTEM INPUT VOLUME and AUTHORISED CONSUMPTION.		
PROCESSING RULE: A4+A5+A8-A19		
COMMENT:		
Water losses can be considered as a total volume for the whole system, or for partial systems such as raw water mains, transmission or distribution. In each case the components of the calculation would be adjusted accordingly. Water losses consist of real and apparent losses.		

UNAUTHORISED CONSUMPTION (corresponds to the IWA PI variable A21)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total annual amount of unauthorised water consumption, including theft.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*).		
COMMENT:		
The input data is the best available estimate, based on surveys or any other forms of assessment the water undertaking can make use of.		

METERING INACCURACIES WATER LOSSES (corresponds to the IWA PI variable A22)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total annual amount of water consumed but unaccounted for due to metering inaccuracies.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*).		
COMMENT:		
The input data is the best available estimate, based primarily on data from the calibration of existing meters and / or surveys held expressly for this scope.		

APPARENT LOSSES (corresponds to the IWA PI variable A23)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total annual amount of water unaccounted for due to metering inaccuracies and unauthorised consumption.		
PROCESSING RULE: A21+A22		
COMMENT:		

REAL LOSSES (corresponds to the IWA PI variable A24)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Total annual amount of physical water losses from the pressurised system, up to the point of customer metering.		
PROCESSING RULE:		
COMMENT: The annual volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average duration of individual leaks.		

REVENUE WATER (corresponds to the IWA PI variable A25)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Total annual amount of billed authorised consumption (including exported water).		
PROCESSING RULE:		
COMMENT: The same as **Error! Reference source not found.** - Billed authorised consumption.		

NON-REVENUE WATER (corresponds to the IWA PI variable A26)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Difference between the annual volumes of system input and billed authorised consumption (including exported water).		
PROCESSING RULE:		
COMMENT: Non-revenue water includes not only the real and apparent losses but also the unbilled authorised consumption. It is recommended that if the term *unaccounted-for water* is used, it should be defined and calculated in the same way as *non-revenue water*. Accordingly, no separate performance indicators have been recommended for UFW in this report.		

DAILY AVERAGE INPUT (corresponds to a IWA CI)		
UNIT OF EXPRESSION: m^3/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Annual input of the transmission system / 365.		
PROCESSING RULE:		
COMMENT:		

RESIDENTIAL CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Residential consumption during the year / authorised consumption (including exported water) x 100.		
PROCESSING RULE:		
COMMENT:		

COMMERCIAL CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Commercial consumption during the year / authorised consumption (including exported water) x 100.		
PROCESSING RULE:		
COMMENT:		

PUBLIC OR INSTITUTIONAL CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Com Public or institutional consumption during the year / authorised consumption (including exported water) x 100.		
PROCESSING RULE:		
COMMENT:		

INDUSTRIAL CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Industrial consumption during the year / authorised consumption (including exported water) x 100.		
PROCESSING RULE:		
COMMENT:		

BULK WATER CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Exported water during the year / authorised consumption (including exported water) x 100.		
PROCESSING RULE:		
COMMENT:		

TOTAL PER CAPITA CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: l per inhabitant/day	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: (Daily average input - exported water)/ population served / 365.		
PROCESSING RULE:		
COMMENT:		

RESIDENTIAL PER CAPITA CONSUMPTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: l per inhabitant/day	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Residential consumption during the year / population served / 365.		
PROCESSING RULE:		
COMMENT:		

CONSUMPTION PER SERVICE CONNECTION (corresponds to a IWA CI)		
UNIT OF EXPRESSION: m^3/connection/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: (Authorised consumption - exported water) / total number of service connections.		
PROCESSING RULE:		
COMMENT:		

MONTHLY PEAK FACTOR OF SUPPLIED AND EXPORTED WATER (corresponds to a IWA CI)		
UNIT OF EXPRESSION: (-)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Actual monthly peak supplied and exported water X 12 / supplied and exported water during the year *(peak month / yearly average).*		
PROCESSING RULE:		
COMMENT:		

DAILY PEAK FACTOR OF SUPPLIED AND EXPORTED WATER (corresponds to a IWA CI)		
UNIT OF EXPRESSION: (-)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Actual daily peak supplied and exported water X 365 / supplied and exported water *(peak day / yearly average).*		
PROCESSING RULE:		
COMMENT:		

HOURLY PEAK FACTOR OF SUPPLIED AND EXPORTED WATER (corresponds to a IWA CI)		
UNIT OF EXPRESSION: (-)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Actual hourly peak supplied and exported water X 24 X 365 / supplied and exported water *(peak hour / yearly average).*		
PROCESSING RULE:		
COMMENT:		

NETWORK DELIVERY RATE (corresponds to a IWA CI)		
UNIT OF EXPRESSION: (m^3/km/year)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Authorised consumption (including exported water) / total mains length.		
PROCESSING RULE:		
COMMENT:		

OPERATIONAL DATA

SERVICE PRESSURE

AVERAGE OPERATING PRESSURE (corresponds to the IWA PI variable D31 and IWA CI)		
UNIT OF EXPRESSION: - kPa	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Average operating pressure at the delivery point when system is pressurised.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
An exact measure of the average operating pressure would require the continuous monitoring of the pressure at every delivery point. In practice, simplifications are required. In flat regions, an estimate of this variable is easy to get. Also when calibrated extended period hydraulic models are available, nodal pressures weighted with the nodal demand can be adopted. In hilly areas where no better estimates can be obtained, simplified pressure contour maps can be drawn and an estimate for the average operating pressure in each contour band is established. The global value is than assessed as a weighted-average of the pressure at each contour band, using their respective equivalent-population as weighting factor.		

MINIMUM STATIC PRESSURE (corresponds to the IWA CI)		
UNIT OF EXPRESSION: - kPa	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Minimum target service pressure at every delivery point of the network.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
An exact measure of the average operating pressure would require the continuous monitoring of the pressure at every delivery point. In practice, simplifications are required. In flat regions, an estimate of this variable is easy to get. Also when calibrated extended period hydraulic models are available, nodal pressures weighted with the nodal demand can be adopted. In hilly areas where no better estimates can be obtained, simplified pressure contour maps can be drawn and an estimate for the average operating pressure in each contour band is established. The global value is than assessed as a weighted-average of the pressure at each contour band, using their respective equivalent-population as weighting factor.		

MAXIMUM STATIC PRESSURE (corresponds to the IWA CI)		
UNIT OF EXPRESSION: - kPa	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Maximum target service pressure at every delivery point of the network.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
An exact measure of the average operating pressure would require the continuous monitoring of the pressure at every delivery point. In practice, simplifications are required. In flat regions, an estimate of this variable is easy to get. Also when calibrated extended period hydraulic models are available, nodal pressures weighted with the nodal demand can be adopted. In hilly areas where no better estimates can be obtained, simplified pressure contour maps can be drawn and an estimate for the average operating pressure in each contour band is established. The global value is than assessed as a weighted-average of the pressure at each contour band, using their respective equivalent-population as weighting factor.		

STATIC PRESSURE VARIATION (corresponds to the IWA CI)		
UNIT OF EXPRESSION: - kPa	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Daily maximum difference between static pressure and dynamic pressure in every delivery point.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MAXIMUM EXPECTED SURGE PRESSURE		
UNIT OF EXPRESSION: - kPa	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Maximum target surge pressure at every delivery point of the network.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MINIMUM EXPECTED SURGE PRESSURE		
UNIT OF EXPRESSION: - kPa	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Minimum target surge pressure at every delivery point of the network.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SURGE PRESSURE OCCURRENCE RATE		
UNIT OF EXPRESSION: - No./year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Number of surge pressure events expected to occur at every delivery point of the network		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SERVICE CONTINUITY

TIME SYSTEM IS PRESSURISED (corresponds to the IWA PI variable D29)		
UNIT OF EXPRESSION: hour	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Amount of time of the year the system is pressurized.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Interruptions due to unplanned system failures, or to on-going repair or rehabilitation works shall not be accounted for by this variable. In most intermittent supply systems, supply interruptions are not simultaneous all over the network. When there are subsystems supplied in different periods, the indicator has to be assessed individually for each subsystem and the result is a weighted average using the number of service connections of each subsystem as weighting factor.		

DELIVERY POINTS WITH ADEQUATE PRESSURE (corresponds to the IWA PI variable D30)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of delivery points that receive and are likely to receive pressure equal to or above the guaranteed or declared target level at the peak demand hour (but not when demand is abnormal).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

WATER INTERRUPTIONS (corresponds to the IWA PI variable D32)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Σ (Population subject to a water interruption x duration of the interruption in hours).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SERVICE INTERRUPTIONS (corresponds to the IWA PI variable D33)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Total number of service interruptions.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Interruptions inherent to a systematic intermittent supply must not be accounted in this variable.		

CRITICAL INTERRUPTIONS		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Total number of critical service interruptions.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Interruptions inherent to a systematic intermittent supply must not be accounted in this variable.		

WATER USE RESTRICTIONS (corresponds to the IWA PI variable D34)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Σ (Population affected by restrictions to water service x duration of the restrictions to water service in hours).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

DAYS WITH RESTRICTIONS TO WATER SERVICE (corresponds to the IWA PI variable D35)		
UNIT OF EXPRESSION: days	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Total number of days with restrictions to water service during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

NETWORK VELOCITIES

MAXIMUM PIPE FLOW VELOCITY		
UNIT OF EXPRESSION: - m/s	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Maximum flow velocity at every pipe of the network.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

AVERAGE PIPE FLOW VELOCITY		
UNIT OF EXPRESSION: - m/s	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average flow velocity at every pipe of the network.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

WATER QUALITY MONITORING

WATER QUALITY TESTS PERFORMED (corresponds to the IWA PI variable D41)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of treated water tests performed during the year.		
PROCESSING RULE:	D42+D43+D44	
COMMENT:		

AESTHETIC TESTS PERFORMED (corresponds to the IWA PI variable D42)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of aesthetic tests of treated water performed during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

TASTE TESTS PERFORMED		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of taste tests of treated water performed during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

COLOUR TESTS PERFORMED		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of colour tests of treated water performed during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

MICROBIOLOGICAL TESTS PERFORMED (corresponds to the IWA PI variable D43)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of microbiological tests of treated water performed during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PHYSICAL-CHEMICAL TESTS PERFORMED (corresponds to the IWA PI variable D44)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of physical-chemical tests of treated water performed during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

COMPLIANCE OF AESTHETIC TESTS (corresponds to the IWA PI variable D51)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of aesthetic tests of treated water performed during the year and complying with the applicable standards or legislation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

COMPLIANCE OF TASTE TESTS		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of taste tests of treated water performed during the year and complying with the applicable standards or legislation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

COMPLIANCE OF COLOUR TESTS		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of colour tests of treated water performed during the year and complying with the applicable standards or legislation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

COMPLIANCE OF MICROBIOLOGICAL TESTS (corresponds to the IWA PI variable D52)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of microbiological tests of treated performed during a year and complying with the applicable standards or legislation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

D53 - **COMPLIANCE OF PHYSICAL-CHEMICAL TESTS** (corresponds to the IWA PI variable D53)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of physical-chemical tests of treated water performed during a year and complying with the applicable standards or legislation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PHYSICAL AND CHEMICAL WATER CHARACTERISTICS IN THE NETWORK

HYDROGENIONIC (pH) CONCENTRATION RANGE IN WATER		
UNIT OF EXPRESSION: -	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Maximum and minimum values of hydrogenionic concentration in water transported in the network based on a minimum sample of one year records.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

AGGRESSIVE CARBON DIOXIDE CONCENTRATION RANGE IN WATER		
UNIT OF EXPRESSION: mg/l – mg/l	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Maximum and minimum values of aggressive carbon dioxide concentration in water transported in the network based on a minimum sample of one year records.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SULPHATE (SO_4^{2-}) CONCENTRATION RANGE IN WATER		
UNIT OF EXPRESSION: mg/l – mg/l	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Maximum and minimum values of sulphate concentration in water transported in the network based on a minimum sample of one year records.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

CHLORIDE (Cl^-) CONCENTRATION RANGE IN WATER		
UNIT OF EXPRESSION: mg/l – mg/l	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Maximum and minimum values of chloride concentration in water transported in the network based on a minimum sample of one year records.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

WATER TEMPERATURE RANGE IN WATER		
UNIT OF EXPRESSION: ºC-ºC	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Maximum and minimum values of water temperature in water transported in the network based on a minimum sample of one year records.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

ENERGY CONSUMPTION

PUMPING ENERGY CONSUMPTION (corresponds to the IWA PI variable D1)		
UNIT OF EXPRESSION: Wh	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total annual energy consumption for pumping.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: This variable is the sum of the actual energy consumption of every water pumping equipment of the system. It shall be assessed from energy consumption meters. Pumping systems in treatment plants are excluded.		

STANDARDISATION FACTOR (corresponds to the IWA PI variable D2)		
UNIT OF EXPRESSION: m^4	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Sum for all the pumps of the system of D(i), D(i) being: D(i) = V (i)x h(i) / 100, where V is the total volume (m^3) pumped by pump i during the period of assessment and h(i) is the pump head (m).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: For pumps with significant variation of pump head throughout the year, it may be necessary to break down the year into a limited number of time intervals. For instance, if a pump works 1/3 of the year with a flow of 10 m^3/h and a pump head of 50m, and 2/3 of the year with a flow of 12 m^3/h and a pump head of 42m, D(i) will be: D(i) = ((10 x 24 x 365/3) x 50 + (12 x 24 x 365 x 2/3) x 42) / 100 Pumping systems in treatment plants are excluded.		

INSPECTION AND MAINTENANCE

NETWORK INSPECTION (corresponds to the IWA PI variable D7)		
UNIT OF EXPRESSION: km	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Length of transmission and distribution mains where at least valves and other fittings inspected during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

LEAKAGE CONTROL (corresponds to the IWA PI variable D8)		
UNIT OF EXPRESSION: km	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Length of mains subject to active leakage control.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

LEAKS REPAIRED DUE TO ACTIVE LEAKAGE CONTROL (corresponds to the IWA PI variable D9)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Number of leaks detected and repaired due to active leakage control.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

HYDRANT INSPECTION (corresponds to the IWA PI variable D10)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Total number of hydrants inspected during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PREVENTIVE MAINTENANCE

MAINS REHABILITATION (corresponds to the IWA PI variable D18)		
UNIT OF EXPRESSION: km	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Length of transmission and distribution mains rehabilitated during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: This variable includes not only D and D but also the length of mains rehabilitated with other techniques.		

MAINS RELINING (corresponds to the IWA PI variable D19)		
UNIT OF EXPRESSION: km	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Length of mains relined during the year by epoxy resin or cement mortar.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

REPLACED OR RENEWED MAINS (corresponds to the IWA PI variable D20)		
UNIT OF EXPRESSION: km	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Mains length replaced during the year or renewed by trenchless techniques.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

REPLACED VALVES (corresponds to the IWA PI variable D21)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of mains valves replaced during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Valves installed in service connections shall not be included.		

SERVICE CONNECTION REHABILITATION (corresponds to the IWA PI variable D22)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of service connections replaced or renewed during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PUMPS REFURBISMENT (corresponds to the IWA PI variable D23)		
UNIT OF EXPRESSION: kW	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total nominal power of pumps subject to overhaul (i.e. refurbishment or renewal of relevant elements necessary to bring unit back to original performance) during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Treatment plants pumps shall not be included.		

PUMPS REPLACEMENT (corresponds to the IWA PI variable D24)		
UNIT OF EXPRESSION: kW	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total nominal power of pumps replaced during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
The nominal power of the new equipment shall be accounted for.		

FAILURES

MAINS FAILURES (corresponds to the IWA PI variable D25)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of mains failures during the year, including failures of valves and fittings.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

PIPE FAILURES		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of pipe failures during the year, excluding failures of valves joints and links to service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

JOINT FAILURES		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of joint failures during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

VALVE FAILURES		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of valve failures during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

CRITICAL MAINS FAILURES (corresponds to a sub-group the IWA PI variable D25, designated by D25d)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of critical mains failures during the year, including failures of valves and fittings.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

FAILURES IN SENSITIVE AREAS (corresponds to a sub-group the IWA PI variable D25, designated by D25e)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of mains failures in sensitive areas during the year, including failures of valves and fittings.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SERVICE CONNECTION FAILURES (corresponds to the IWA PI variable D26)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of service connections failures during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
If service connections failures are to be used for regulating objectives, the use of a complementary indicator, similar to *Op26* but excluding failures by third parties is advisable, as they are not a direct fault of the water undertaking. Number should exclude repairs under active leakage control. Number should exclude repairs under active leakage control.		

SERVICE CONNECTION INSERTION POINT FAILURES		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of service connections failures that occur in the insertion point of the service connection during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If service connections failures are to be used for regulating objectives, the use of a complementary indicator, similar to *Op26* but excluding failures by third parties is advisable, as they are not a direct fault of the water undertaking. Number should exclude repairs under active leakage control. Number should exclude repairs under active leakage control.		

HYDRANT FAILURES (corresponds to the IWA PI variable D27)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of hydrant failures during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: If hydrant failures are to be used for regulating objectives, the use of a complementary indicator, similar to *Op28* but excluding failures by third parties is advisable, as they are not a direct fault of the water undertaking. Number should exclude repairs under active leakage control.		

POWER FAILURES (corresponds to the IWA PI variable D28)		
UNIT OF EXPRESSION: hour	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: $\Sigma_{\text{(for all pumping stations)}}$ (number of hours during the year each pumping station is out of service or is reliant on standby power generation due to power supply interruptions).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

REPAIRS

FAILURE REPAIR DATE		
UNIT OF EXPRESSION: yy.mm.dd	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Date of the registered failure repair.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

REPLACEMENT DATE		
UNIT OF EXPRESSION: yy.mm.dd	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Replacement date of the pipe (Note: end of the failure dates series of the previously existing pipe and beginning of the new series).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

REHABILITATION DATE		
UNIT OF EXPRESSION: yy.mm.dd	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Rehabilitation date of the pipe (Note: end of the failure dates series of the previously existing pipe and beginning of the new series).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

AVERAGE DURATION OF FAILURE REPAIR		
UNIT OF EXPRESSION: hours	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Average duration of the failure repair, between the failure notification until the restoration of supply.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

INTERFERENCE WITH OTHER INFRASTRUCTURES

REPAIRS RISK TO AFFECT OTHER INFRASTRUCTURES		
UNIT OF EXPRESSION: yes/no	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Relevant risk to affect other infrastructures due to repair works in the water supply system.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

TECHNOLOGICAL RESOURCES

COMPUTERIZED INFORMATION SYSTEMS FOR MAINTENANCE (corresponds to the IWA CI)		
UNIT OF EXPRESSION: yes/no	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Routine use of IT to support maintenance activities.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

COMPUTERIZED INFORMATION SYSTEMS FOR CUSTOMER COMPLAINTS (corresponds to the IWA CI)		
UNIT OF EXPRESSION: yes/no	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Routine use of IT to support customer service quality and network performance appraisal.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

UPDATED MAPPING (corresponds to the IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Length of mapped mains with a capture tolerance compatible to a scale 400 p.p.m. / total mains length x 100 *400 p.p.m. = 1:2500.*		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

UPDATED MAPPING (corresponds to the IWA CI)		
UNIT OF EXPRESSION: %	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Length of digitised mains with a capture tolerance compatible to a scale 400 p.p.m. / total mains length x 100 *400 p.p.m. = 1:2500.*		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

DURATION AVAILABILITY OF FAILURE DATA RECORDS		
UNIT OF EXPRESSION: year-year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Time period availability of failure data records accurate enough to be used for rehabilitation purposes.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

NATURE OF FAILURE DATA RECORDS		
UNIT OF EXPRESSION: paper/digital	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Nature of failure data records, in paper or in digital form, accurate enough to be used for rehabilitation purposes.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

POPULATION SUPPLIED (corresponds to the IWA PI variable F1)		
UNIT OF EXPRESSION: NO. persons	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Resident population served by the water undertaking.		
PROCESSING RULE:	F2+F3	
COMMENT:		

POPULATION SUPPLIED WITH SERVICE PIPES (corresponds to the IWA PI variable F2)		
UNIT OF EXPRESSION: NO. persons	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Resident population served by the water undertaking through service connections.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

POPULATION SERVED BY PUBLIC TAPS OR STANDPIPES (corresponds to the IWA PI variable F3)		
UNIT OF EXPRESSION: NO. persons	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Resident population served by the water undertaking by public taps or standpipes.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		

SERVICE CUSTOMER COMPLAINTS (corresponds to the IWA PI variable F11)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Number of direct, telephone, and written complaints of quality of service during the year.		
PROCESSING RULE: F13+F14+F15+F16		
COMMENT:		

PRESSURE CUSTOMER COMPLAINTS (corresponds to the IWA PI variable F12)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Number of pressure complaints during the year.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT:		

CONTINUITY CUSTOMER COMPLAINTS (corresponds to the IWA PI variable F13)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Number of continuity complaints during the year.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT: This variable refers to medium- or long-term supply constraints. Complaints on supply interruptions or water use restrictions due to insufficient water quantity or quality at source, insufficient system capacity or on-going works shall be accounted for by this variable. Any other complaints on interruptions shall be included in F.		

WATER QUALITY CUSTOMER COMPLAINTS (corresponds to the IWA PI variable F14)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Number of water quality complaints during the year.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT:		

WATER TASTE CUSTOMER COMPLAINTS		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Number of water taste complaints during the year.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT:		

WATER COLOUR CUSTOMER COMPLAINTS		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION: Number of water colour complaints during the year.		
PROCESSING RULE: Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)		
COMMENT:		

CUSTOMER COMPLAINTS ON INTERRUPTIONS (corresponds to the IWA PI variable F15)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION:		
Number of complaints due to supply interruptions during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
This variable refers to short-term supply interruptions, due to accidental system failures or repair works. Supply interruptions due to intermittent supply, insufficient quantity of adequate water at sources, or asset insufficient capacity shall be accounted for in F and not in F.		

F15a - **CUSTOMER COMPLAINTS ON CRITICAL INTERRUPTIONS**		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Integer
DEFINITION:		
Number of complaints due to supply interruptions in critical areas during the year.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
This variable refers to short-term supply interruptions, due to accidental system failures or repair works. Supply interruptions due to intermittent supply, insufficient quantity of adequate water at sources, or asset insufficient capacity shall be accounted for in F and not in F.		

FINANCIAL DATA

ANNUAL RUNNING COSTS (corresponds to the IWA PI variable G2)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real TAG: *[Data base tag]*
DEFINITION:		
Total annual operations and maintenance costs + internal manpower costs - capitalised costs of self-constructed assets.		
PROCESSING RULE:	G5+G6	
COMMENT:		
This definition has, on aggregate level, to be equivalent to the sum of the NET desegregated values allocated at the numerator of the indicators figuring the composition of annual running costs per type of cost: Fi4, Fi5, Fi6, Fi7 and Fi8. Exchange rate of local currencies shall be referred to the end of the year.		

ANNUAL CAPITAL COSTS (corresponds to the IWA PI variable G3)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total annual net interest and depreciation (based on book values).		
PROCESSING RULE:	G25+G19	
COMMENT:		
The net value of interest has to be considered, being the interest income a reduction in capital costs and not a revenue. Exchange rate of local currencies shall be referred to the end of the year.		

OPERATIONAL COSTS (corresponds to the IWA PI variable G4)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Operational costs, including the net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of imported (raw and treated) water, energy, external services, leasing and rentals, purchased merchandises, taxes, levies and fees, exceptional earnings and losses other operating expenditures, excluding manpower.		
PROCESSING RULE:	G6+G7+G8+G9+G10+G14	
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

INTERNAL MANPOWER COSTS (corresponds to the IWA PI variable G5)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Internal manpower costs, referred to the net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of the personnel which salary is paid directly by the water undertaking.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Manpower costs include salaries and other costs that derive directly from them, such as complementary payments or social security complements. Exchange rate of local currencies shall be referred to the end of the year.		

EXTERNAL SERVICES COSTS (corresponds to the IWA PI variable G6)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TAG: *[Data base tag]*
TYPE: Real	LENGTH: *[max length]*	VALID VALUES: ≥ 0
DEFINITION:		
The net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of total costs of external services (i.e. outsourcing), external manpower costs included.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

IMPORTED (RAW AND TREATED) WATER COSTS (corresponds to the IWA PI variable G7)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION:		
Total cost of the water imported (cost of A + cost of A) during the period of assessment.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

ENERGY COSTS (corresponds to the IWA PI variable G8)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total cost of energy within the period of assessment.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: This variable includes not only the component proportional to the energy consumption but also all the other components of energy costs, such as power tariffs and taxes. Energy consumption for other activities different of the water pumping is also included. Exchange rate of local currencies shall be referred to the end of the year.		

PURCHASED MERCHANDISES (corresponds to the IWA PI variable G9)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: The net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of all materials and consumables not included in external services costs.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

LEASING AND RENTALS (corresponds to the IWA PI variable G10)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: The net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of total cost of leasing and rentals.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

TAXES, LEVIES AND FEES (corresponds to the IWA PI variable G11)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: All levies and licences strictly connected with plants' operation to be paid to a governmental or municipal authority (excluding direct taxes on EBT).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

EXCEPTIONAL EARNINGS AND LOSSES (corresponds to the IWA PI variable G12)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Exceptional income or expenditures related to sales / writing-off of fixed assets.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

OTHER OPERATING EXPENDITURES (corresponds to the IWA PI variable G13)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: The net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of other operating expenditures.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

OTHER OPERATING COSTS (corresponds to the IWA PI variable G14)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: The net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of the operational costs not related to external services, water import and energy.		
PROCESSING RULE:	G9+G10+G11+G12+G13	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

PLANNING, DESIGN, CONSTRUCTION, OPERATIONS & MAINTENANCE RUNNING COSTS (corresponds to the IWA PI variable G18)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Part of the annual running cost related to the net value (obtained by negative apportionment of related capitalised costs of self-constructed assets) of the water supply technical planning, design, construction, operations and maintenance (excluding internal construction of plant and rehabilitation).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

ANNUAL DEPRECIATION COSTS (corresponds to the IWA PI variable G19)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Annual depreciation costs (on book values).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

INTEREST EXPENSES COSTS (corresponds to the IWA PI variable G20)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm].*yy	TYPE: Real
DEFINITION: Annual interest expenses costs.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

INTEREST INCOME (corresponds to the IWA PI variable G24)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total interest income.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Interest income has more correctly to be intended not as revenue but as an economic correction of interest expenses, to negative allocate in order to obtain the net interest costs. Exchange rate of local currencies shall be referred to the end of the year.		

NET INTEREST (corresponds to the IWA PI variable G25)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Interest expenses costs – interest income.		
PROCESSING RULE:	G20-G25	
COMMENT: Most times interest expenses are higher than income, what means that the *net interest* is a cost. Exchange rate of local currencies shall be referred to the end of the year.		

ANNUAL INVESTMENT IN TANGIBLE ASSETS (corresponds to the IWA PI variable G26)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 - *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total cost of the investments in tangible (expenditures for plant and equipment), including capitalised cost of self-constructed tangible assets (apportionment of G29 as for related to tangible assets).		
PROCESSING RULE:	G27+G28	
COMMENT: Tangible assets include investment for supporting buildings, vehicles, etc. Exchange rate of local currencies shall be referred to the end of the year.		

ANNUAL INVESTMENTS FOR NEW ASSETS (corresponds to the IWA PI variable G27)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 - *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total cost of the investments in tangible assets that constitute a new development for the service, including capitalised cost of self-constructed new assets (apportionment of G29 as for related to tangible new assets).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

ANNUAL INVESTMENTS FOR ASSETS REPLACEMENT (corresponds to the IWA PI variable G28)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm].*yy-1 - *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total cost of the investments related to the existing assets (i.e. maintaining the existing infrastructure at the same level), including capitalised cost of self-constructed replaced assets (apportionment of G29 as for related to the replacement of tangible assets).		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

WATER SALES REVENUE FOR DIRECT CONSUMPTION (corresponds to the IWA PI variable G30)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Water sales revenue for direct consumption.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

WATER SALES REVENUE FOR EXPORTED WATER (corresponds to the IWA PI variable G31)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Water sales revenue for exported water.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

AVERAGE WATER CHARGES FOR DIRECT CONSUMPTION (corresponds to the IWA PI variable G49)		
UNIT OF EXPRESSION: €/m^3	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Water sales revenue for direct consumption / billed water.		
PROCESSING RULE:	G30/(A13+A14)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

ATTRIBUTED UNIT COST FOR REAL LOSSES (corresponds to the IWA PI variable G50)		
UNIT OF EXPRESSION: €/m^3	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Highest of the variable component of bulk supply charge or long run marginal cost for own sources.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

REHABILITATION COSTS FOR PIPES		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average unit costs for pipe rehabilitation.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

REPAIR COSTS FOR PIPES		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average unit costs for pipe repairs.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	

COMMENT:
Exchange rate of local currencies shall be referred to the end of the year.

MAINTENANCE COSTS FOR PIPES		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Average unit costs for pipe maintenance.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

INSPECTION COSTS FOR PIPES		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Average unit costs for pipe inspection.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

REDUCED COSTS FROM PIPES REPAIR		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Average operation costs reduction due to pipes repair.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT:		
The benefits are cumulative values up to the year t depending on the kind and intensity of rehab measures taken Exchange rate of local currencies shall be referred to the end of the year.		

REDUCED COSTS FROM LEAKAGE REPAIR		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Average operation costs reduction due to leakage control.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT:		
The benefits are cumulative values up to the year t depending on the kind and intensity of rehab measures taken Exchange rate of local currencies shall be referred to the end of the year.		

DOMESTIC WATER CONSUMPTION TARIFF (corresponds to the IWA CI)		
UNIT OF EXPRESSION: €/m^3	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Average domestic water consumption tariff paid by the consumer to the water utility.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

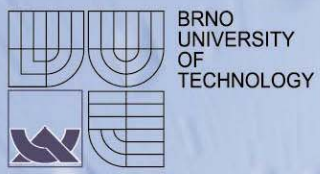
INDUSTRIAL WATER CONSUMPTION TARIFF		
UNIT OF EXPRESSION: €/m^3	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average industrial water consumption tariff paid by the consumer to the water utility.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

PUBLIC WATER CONSUMPTION TARIFF		
UNIT OF EXPRESSION: €/m^3	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average public water consumption tariff.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]*; Accuracy: *[targeted accuracy]*)	
COMMENT: Exchange rate of local currencies shall be referred to the end of the year.		

Appendix 7
Proposal of rehab context information

DATA (unit)	CONCEPT
ENVIRONMENT	(These statistics relate to the area of service)
Yearly rainfall	(average for the past 30 years)
• *average* *(mm/year)*	Yearly average rainfall (average for the past 30 years)
• *maximum* *(mm/year)*	Yearly maximum rainfall assessed as the annual maxima of the last 30 years
• *minimum* *(mm/year)*	Yearly minimum rainfall assessed as the annual minima of the last 30 years
Air temperature	(average for the past 30 years)
• *daily average* *(°C)*	Average daily air temperature of the year (averages for the past 30 years)
• *daily maximum* *(°C)*	Average air temperature for the hottest day of the year (averages for the past 30 years)
• *daily minimum* *(°C)*	Average air temperature for the coldest day of the year (averages for the past 30 years)
Topography	
• *source average elevation* *(m)*	Weighted average elevation above sea level of water sources, including import delivery points, using source production as weighing factors
• *maximum delivery elevation* *(m)*	Maximum elevation above sea level at the water delivery points of water distribution area
• *minimum delivery elevation* *(m)*	Minimum elevation above sea level at the water delivery points of water distribution area
MAINS AGRESSIVE FACTORS	
Physical and chemical soil and groundwater characteristics	
Hydrogenionic concentration range *(pH-pH)*	Maximum and minimum values of the soil and groundwater hydrogenionic concentration in the area around the network
Aggressive carbon dioxide concentration range (CO_2) *(mg/l-mg/l)*	Maximum and minimum values of the soil and groundwater aggressive carbon dioxide concentration in the area around the network
Sulphate concentration range (SO_4^{2-}) *(mg/l-mg/l)*	Maximum and minimum values of the soil and groundwater sulphate concentration in the area around the network
Chloride concentration range (Cl^-) *(mg/l-mg/l)*	Maximum and minimum values of the soil and groundwater chloride concentration in the area around the network
Resistivity concentration range *(Ωm -Ωm)*	Maximum and minimum values of the soil and groundwater resistivity in the area around the network
Organic compounds *(yes/no)*	Existence of organic compounds in the area around the network
Stray currents *(yes/no)*	Existence of stray currents in the area around the network
Geotechnical conditions	
Pipe seat stability *(yes/no)*	Existence of good seat stability conditions of the soil below the pipes

DATA (unit)	CONCEPT
Seismic conditions	
Maximum soil movement due to soil liquefaction *(mm)*	Forecasted maximum soil movement due to soil liquefaction in seismic conditions
Maximum angular deflection in joints *(º)*	Forecasted maximum angular deflection in pipe joints in seismic conditions
Maximum axial displacement in joints *(mm)*	Forecasted maximum axial displacement in pipe joints in seismic conditions
Traffic class	
Heavy traffic *(code HT)*	Heavy traffic conditions in the pavement above the pipes
Normal traffic *(code NT)*	Normal traffic conditions in the pavement above the pipes
Light traffic *(code LT)*	Light traffic conditions in the pavement above the pipes
Interference with other infrastructures	
Risk to be affected by other infrastructures works *(yes/no)*	Significant risk of the pipes to be affected by other infrastructures works
ECONOMICS	
Inflation rate *(%/year)*	Official annual inflation rate at the end of the year in the country





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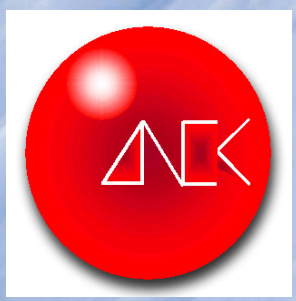

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