A RESEARCH PROJECT SUPPORTED BY THE EUROPEAN COMMISSION UNDER THE FIFTH FRAMEWORK PROGRAMMME
AND CONTRIBUTING TO THE IMPLEMENTATION OF THE KEY ACTION "SUSTAINABLE MANAGEMENT AND QUALITY OF WATER"
WITHIN THE ENERGY, ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

EVK1-CT-2000-00053

REPORT

No. 1.2 – March 2002

CARE-W WP1
D2 – Validation of the rehabilitation performance indicators 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. 2

Validation of the rehabilitation performance indicators system

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Lisbon, March 2002

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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, which is formally in three Tasks, each one with its specific objective, schedule, deliverables and methodology, according the original proposal:

- Task 1.1 – Choice of performance indicators: Major research is currently being done in international programmes to define appropriate performance indicators for water systems. The objective of this Task was to select indicators to be used for the analyses of short term as well as long-term rehabilitation needs.
- Task 1.2 – Test of performance indicators on cities: 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.
- Task 1.3 – Predictable performance indicators: The objectives of this Task are (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).

Two deliverables have been proposed:

- D1 – Control panel of performance indicators.
- D2 – Predictable performance indicators – reference values and data base.

According to the adjustments agreed in the project meetings, the WP1 planning can now be detailed in six tasks:

Task 1.1

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

b) Discussions with partners of pre-selected rehab PI, based on the IWA-PI system.

c) Identification of the specific PI-related requirements of the rehab models to be used within CARE-W framework.

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

Deliverable: Report No. 1 (December 2001).

Task 1.2

e) Preparation and launching of a questionnaire to the partners with questions regarding performance indicators, utility information and external information.

f) Preparation and launching of a questionnaire to the co-operating cities to assess data availability, reliability and accuracy regarding performance indicators, utility information and external information.

g) Detailed revision and validation of the PI system by the CARE-W partners.

h) Definition of the predictable performance indicators for medium/long term rehabilitation planning.

Deliverable: Report No. 2 (March 2002) and report No. 3 (May 2002)

Task 1.3

i) Definition of the structure of the rehab PI software module and definition of a first prototype draft.

j) Development of the full rehab PI software module (standalone version).

k) Preparation of a summarised users guide for internal project use.

Deliverable: Report No. 4 (July 2002).

Task 1.4

l) Test of the software and collection of the rehab PI values from selected areas of the CARE-W end-users and other selected cities.

m) Definition of PI thresholds.

Deliverable: Report No. 5 (January 2003).

Task 1.5

n) Preparation of the final WP1 report based on the previous reports and including all changes agreed during the course of the project.

Deliverable: Report No. 6 (Deadline to be agreed).

Task 1.6

o) Preparation of the WP1 contributions for the CARE-W Best Management Practice Manual (BMP).

Deliverable: CARE-W Best Management Practice Manual (BMP) (Deadline to be agreed).

Report No.1 [1], produced in December 2001, refers to the Task 1.1 of this working package. A preliminary CARE-W rehab listing was proposed, with a set of performance indicators, part of them obtained directly from the IWA system and a few new ones specific for the rehabilitation analysis. They were completed with the corresponding utility information and external information parameters.

This Report No. 2 refers to the Task 1.2 of this working package. It can be seen as an extended version of the former and presents a consolidated listing of the CARE-W PI system. It is based on the first report and on the results of questionnaire to the partners and end-users. For ease of use, this report is self-contained and repeats part of the contents of the first report.

The current version of the CARE-W PI system aims to be the PI reference for the other working packages, and needs to be used and refined during the course of the project, according to the effective needs of CARE-W prototype. A definitive version will be included in the final report of WP1 and in the CARE-W manual.

2 QUESTIONNAIRE TO THE PARTNERS

2.1 Objectives

The main objectives of this questionnaire were:

- to simplify and consolidate the preliminary listing of PI, utility information and external information;
- to prepare the questionnaire to the end-users inquiring about availability, reliability and accuracy of the utility data identified as necessary in the overall external of CARE-W prototype.

Complementary objectives were to identify:

- for what each parameter is relevant within the CARE-W external;
- at what level (network, sector, cluster or individual pipes) each parameter is relevant;
- what parameters can be predicted by modelling.

2.2 Questionnaire contents

The questionnaire replied by the partners contained the following questions regarding performance indicators, utility information and external 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?

2.3 Methodology of analysis of the questionnaire

One of the main objectives being to simplify the preliminary listing of PI, UI and CI, the analysis aimed to identify what could be eliminated. The following criterion was adopted:

- PI, UI and CI required by the existing models are kept.
- PI, UI and CI recognised to be important for the diagnosis or for the decision making processes are kept as well.
- PI, UI and CI not included in the previous groups are eliminated.

The results achieved are presented in Appendix 1, including not only the viewpoints above referred but also the remaining questions. The analysis conclusions are summarised in the following section.

2.4 Questionnaire conclusions

2.4.1 Replies received

The following partners replied to the questionnaire:

- AGAC, RE
- Bologna University
- Brno University
- CEMAGREF
- Dresden University
- Ferrara University
- SINTEF
- Water Research Centre

2.4.2 Performance indicators

The following PI listing results directly from the replies provided by the partners, according to the methodology above described. The PI included in the preliminary listing (Report No. 1) and eliminated in this listing are typed in italics at this stage for an easier tracking of the changes.

WATER RESOURCES INDICATORS

WR1 - Inefficiency of use of water resources (%)

WR2 - Resources availability ratio (%)

PHYSICAL INDICATORS

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)

Ph13 - Network hydraulic reliability (-)
Ph14 - Node hydraulic reliability (-)
Ph15 - Mains residual service life (years)

OPERATIONAL INDICATORS

Inspection and maintenance

Op3 - Network inspection (%/year)
Op4 - Leakage control (%/year)
Op5 - Active leakage control repairs (No/100km/year)
Op6 - Hydrant inspection (%/year)

Mains 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)
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

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 tests compliance (%)
  - QS16a - water taste tests compliance (%)
  - QS16b - water colour tests compliance (%)
- QS17 - microbiological tests compliance (%)
- QS18 - physical-chemical tests compliance (%)

Customer complaints

QS22 - Service complaints (No. complaints/connection/year)
- QS23 - pressure complaints (%)

QS24 - continuity complaints (%)
QS25 - water quality complaints (%)
QS25a - water taste complains (%)
QS25b - water colour complains (%)
QS26 - interruptions complaints (%)
QS26a - critical interruptions complains (%)

FINANCIAL INDICATORS[1]

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

Fi38 - Balance of costs and benefits (%)
Fi39 - Internal rate of return (%)

2.4.3 Utility information

The following UI listing resulted directly from the replies provided by the partners, according to the methodology above described. The UI included in the preliminary listing (Report No. 1) and eliminated in this listing are typed in italics at this stage, for an easier tracking of the changes.

PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK

Water storage

- *Transmission & distribution storage tanks capacity (m^3)*

Pumping stations

- Pumping stations (No.)
- Pumping stations capacity (kW)

Transmission and distribution network

- Mains length (km; m only to single pipes)
- Network extension (km/year)
- Mains diameters (mm)
- Mains materials (-)
- Mains protection (-)
- Mains age (years)

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

- Mains protection age (years)
- Mains location (-)
- Mains installation depth (m)
- Trench mains installation width (m)
- Bedding soil type (-)
- Backfilling soil type (-)
- Average closeness to trees (m)
- Type of joints (-)
- Main valves (No.)
- Isolating valves (No.)
- Hydrants (No.)
- Node elevation (m)

PHYSICAL ASSETS DATA - SERVICE CONNECTIONS

- Number of service connections (No.)
- Number of sensitive service connections (No.)
- Average service connection length (m)
- Service connection materials (-)
- Service connections density (No./km)

WATER VOLUME DATA

- Annual abstraction capacity (m^3/year)
- Imported water allowance (m^3/year)
- Water abstracted (m^3/year)
- *Imported raw water (m^3/year)*
- *Exported raw water (m^3/year)*
- Water produced (m^3/year)
- *Imported treated water (m^3/year)*
- *Exported treated water (m^3/year)*
- Billed metered consumption (m^3/year)
- Billed unmetered consumption (m^3/year)
- Billed authorised consumption (m^3/year)
- *Unbilled metered consumption (m^3/year)*
- *Unbilled unmetered consumption (m^3/year)*
- *Unbilled authorised consumption (m^3/year)*
- *Authorised consumption (m^3/year)*
- Water losses (m^3/year)
- *Unauthorised consumption (m^3/year)*
- *Metering inaccuracies water losses (m^3/year)*
- *Apparent losses (m^3/year)*
- Real losses (m^3/year)
- *Revenue water (m^3/year)*
- *Non-revenue water (m^3/year)*

CONSUMPTION AND PEAK FACTORS

- *Daily average input (m^3/day)*
- Consumption per type of customer (-)
- Total per capita consumption (l per inhabitant/day)
- Consumption per service connection (m^3/connection/year)

- Peak factors of supplied and exported water (-)
- *Network delivery rate (m^3/km/year)*

OPERATIONAL DATA

Service pressure

- Average operating pressure (kPa)
- *Minimum static pressure (kPa)*
- *Maximum static pressure (kPa)*
- 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)
- Delivery points with adequate pressure (No.)
- Water interruptions (No.)
- Service interruptions (No.)
  - critical interruptions (No.)
- *Water use restrictions (No.)*
- *Days with restrictions to water service (days)*

Network velocities

- *Pipe flow velocity (m/s)*

Water quality monitoring

- *Water quality tests performed* (No.)
- *Aesthetic tests performed (N*o.)
- Microbiological tests performed (No.)
- Physical-chemical tests performed (No.)
- Compliance of aesthetic tests (No.)
- Compliance of microbiological tests (No.)
- Compliance of physical-chemical tests (No.)

Physical and chemical water characteristics in the network

- Hydrogenionic concentration range in water (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)
- Standardization factor (m^3)

Inspection and maintenance

- Network inspection (km)
- Leakage control (km)
- Leaks repaired due to active leakage control (No.)
- Hydrant inspection (No.)

Preventive maintenance

- Mains rehabilitation (km)
- Mains relining (km)
- Replaced or renewed mains (km)
- Replaced valves (No.)

- Service connection rehabilitation (No.)
- Pumps refurbishment (kW)
- Pumps replacement (kW)

Failures

- Mains failures (No.)
- Critical mains failures (No.)
- Service connection failures (No.)
- Hydrant failures (No.)
- Power failures (h)

Rehabilitation dates

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

Interference with other infrastructures

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

TECHNOLOGICAL RESOURCES

- *Computerized information systems (-)*
- *Mapping (-)*
- *Failure data availability (-)*

QUALITY OF SERVICE DATA

- Population supplied (No.)
- Population supplied with service pipes (No.)
- *Population served by public taps or standpipes (No.)*
- Customer complaints (No.)

FINANCIAL DATA

- Annual running costs (€/year)
- Annual capital costs (€/year)
- *Operational costs (€/year)*
- *Internal manpower costs (€/year)*
- *External services costs (€/year)*
- *Imported (raw and treated) water costs (€/year)*
- *Energy costs (€/year)*
- *Purchased merchandises (€/year)*
- *Leasing and rentals (€/year)*
- *Taxes, levies and fees (€/year)*
- *Exceptional earnings and losses (€/year)*
- *Other operating expenditures (€/year)*
- *Other operating costs (€/year)*
- Planning, design, construction, operations & maintenance running costs (€/year)
- Annual depreciation costs (€/year)
- *Interest expenses costs (€/year)*
- *Interest income (€/year)*
- *Net interest (€/year)*
- *Annual investment in tangible assets (€/year)*
- Annual investments for new assets (€/year)

- Annual investments for assets replacement (€/year)
- *Water sales revenue for direct consumption (€/year)*
- *Water sales revenue for exported water (€/year)*
- *Average water charges for direct consumption (€/m^3)*
- Attributed unit cost for real losses (€/m^3)
- Water tariffs (€/m^3)

2.4.4 External information

The following CI listing resulted directly from the replies provided by the partners, according to the methodology above described. The CI included in the preliminary listing (Report No.1) and eliminated in this listing are typed in italics at this stage, for an easier change tracking.

ENVIRONMENT FACTORS

- *Annual rainfall*
- *Air temperature (ºC)*
- *Topography (m)*

MAINS AGRESSIVE FACTORS

- Physical and chemical soil and groundwater characteristics (-)
- Geotechnical conditions (-)
- Seismic conditions (-)
- Traffic class (-)
- Interference with other infrastructures (-)

ECONOMICS

- Inflation rate (%/year)

3 QUESTIONNAIRE TO THE END-USERS

3.1 Objectives

Taking as reference the PI, UI and CI validated by the partners, the project end-users were requested to inform about the availability, reliability and accuracy of the utilities information variables listing for their specific case. The listing used was the one presented in the previous section, complemented with a small number of missing UI required to assess the selected PI. The objective was to check the effective feasibility of assessment of the proposed PI.

3.2 Questionnaire contents

The questionnaire contained four questions for each data item:

- Is this data available in your organisation? (yes/no)
- How many years of records do you have? (<1; 1-2; 3-5; 6-10; 11-20; >20)
- What is the reliability of these data? (A; B; C; D)
- What is the estimated accuracy of these data? (1; 2; 3; 4; 5; 6)

The last three questions were applied only when the reply to the first question was “yes”.

CARE-W partners were requested to assist the end-users in full-filling the questionnaire. In that stage the end-users were not required to provide any numerical data. A new contact will be established in a latter stage, requesting data to assess the PI ranges.

The interpretation to be adopted for the questions on data confidence, split into reliability and accuracy, was the same adopted by IWA [2] and states as follows:

DATA RELIABILITY	Definition
A - Highly reliable	Data based on sound records, procedures, investigations or analyses that are properly documented and recognised as the best available assessment methods.
B - Reliable	Generally as in band A, but with minor shortcomings, e.g.: some of the documentation is missing, the assessment is old, or some reliance on unconfirmed reports or some extrapolations are made.
C - Unreliable	Data based on extrapolation from a limited sample for which band A or B is available.
D - Highly unreliable	Data based on unconfirmed verbal reports and/or cursory inspections or analysis.
DATA ACCURACY	**Definition**
1 - Error (%): [0;1]	Better than or equal to +/- 1%
2 - Error (%):] 1;5]	Not band 1, but better than or equal to +/- 5%
3 - Error (%):] 5;10]	Not bands 1 or 2, but better than or equal to +/- 10%
4 - Error (%):] 10;25]	Not bands 1, 2 or 3, but better than or equal to +/- 25%
5 - Error (%):] 25;50]	Not bands 1, 2, 3 or 4 but better than or equal to +/- 50%
6 - Error (%):] 50;100]	Not bands 1, 2, 3, 4 or 5 but better than or equal to +/- 100%
Error (%): > 100	Values which fall outside the valid range, such as > 100%.

3.3 Methodology of analysis of the questionnaire

The methodology adopted aimed to identify:

- the variables not available for the majority of the end-users;
- for the remaining variables, the average size of the recording period and the average levels of reliability and accuracy;
- the PI assessed on the basis of the data with foreseeable data availability, reliability or accuracy difficulties.

3.4 Questionnaire conclusions

The following end-users replied to the questionnaire:

- ACOSEA (Italy) [partner Bologna-Ferrara]
- Brno Water and Sewerage Company, BVK,a.s. (Czeck Republic) [partner BUT]
- Conzorzio Acque Delta Ferrarese (Italy) [partner Bologna-Ferrara]
- Dresden (Germany) [partner Dresden University]
- Lausanne (Switzerland) [partner Cemagref]
- Lyon (France) [partner INSA]

- Oeiras & Amadora (Portugal) [partner LNEC]
- Roubaix-Tourcoing (France) [partner Cemagref]
- Stuttgart (Germany) [partner Dresden University]
- Trondheim kommune (Norway) [partner SINTEF]

The main conclusions from the analysis of the replies to this questionnaire are, for the different groups of the utilities information variables:

PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK

- Availability difficulties are anticipated for the following variables:

  Transmission and distribution network: mains protection age, mains installation depth, trench mains installation width, bedding soil type, backfilling soil type, average closeness to trees and type of joints.
- These difficulties have no implications on the assessment of any rehab PI.
- Records are generally available for medium length periods and with reliable and accurate data for the variables:

  Transmission and distribution network: mains length, mains diameters, mains materials, mains protection, mains age, mains location, mains valves, isolating valves, hydrants and node elevation.
- Records are generally available for long periods and with highly reliable and very accurate data for the remaining variables:

  Pumping stations: pumping stations and pumping stations capacity.

PHYSICAL ASSETS DATA – SERVICE CONNECTIONS

- Availability difficulties are anticipated for the following variables: service connection materials and service connections density.
- These difficulties have no implications on the assessment on the rehab PI.
- Records are generally available for a wide range of periods and with reliable and accurate data for the variables: number of sensitive service connections and average service connection length.
- Records are generally available for medium or long periods, but with lower reliability and accuracy for the number of service connections.
- These confidence difficulties may affect the indicators: service connection rehabilitation (Op19), water losses (Op22), real losses (Op24), infrastructure leakage index (Op25), service connection failures (Op27), pressure of supply adequacy (QS9), interruptions per connection (QS12) and service complains (QS22).

WATER VOLUME DATA

- Availability difficulties are anticipated for the real losses.
- These difficulties have implications on the assessment of the following PI: inefficiency of use of water resources (WR1), real losses (Op24), infrastructure leakage index (Op25).
- Records are generally available for a long period, with reliable or very reliable and accurate or very accurate data for the variables: annual abstraction capacity, imported water allowance, water abstracted, exported raw water, water produced, exported treated water, billed metered consumption, billed unmetered consumption and billed authorised consumption.

- Records are generally available for a long period, with reliable or very reliable, but less accurate data for the remaining variables: authorised consumption and water losses.
- These difficulties have implications on the assessment of the following PI: inefficiency of use of water resources (WR1), resources availability ratio (WR2), water losses (Op22), real losses (Op24), infrastructure leakage index (Op25), unit total costs (Fi1), unit running costs (Fi2), unit investment (Fi18) and average water charges for direct consumption (Fi21).

CONSUMPTION AND PEAK FACTORS

- Availability difficulties are anticipated for the consumption per service connection.
- These difficulties have no implications on the assessment of any rehab PI.
- Records are generally available for a long period and with reliable or very reliable and accurate or very accurate data for the remaining variables: consumption per type of customer, total per capita consumption and peak factors of supplied and exported water.

OPERATIONAL DATA

- Availability difficulties are anticipated for the following variables:

  Service pressure: static pressure variation;

  Service continuity: time system is pressurised, delivery points with adequate pressure, service interruptions, critical interruptions, water use restrictions and days with restrictions to water service;

  Inspection and maintenance: network inspection, leaks repaired due to active leakage control and hydrant inspection;

  Failures: hydrant failures;

  Interference with other infrastructures: repairs risk to affect other infrastructures.
- These difficulties have implications on the assessment of the following PI: active leakage control (Op5), real losses (Op24), infrastructure leakage index (Op25) and hydrant failures (Op28), pressure of supply adequacy (QS9), interruptions per connection (QS12), population experiencing restrictions to water service (QS13) and days with restrictions to water service (QS14).
- Records are generally available for a wide range of periods and with very reliable or reliable and very accurate or accurate data for the variables:

  Service pressure: average operating pressure;

  Service continuity: water interruptions;

  Inspection and maintenance: leakage control.
- In the case of water interruptions, the reliability and accuracy is clearly below the other variables.
- These confidence difficulties may affect the PI water interruptions (QS11).
- Records are generally available for medium length periods and with very reliable or reliable and very accurate or accurate data for the following variables:

  Water quality monitoring: water quality tests performed;
  Preventive maintenance: mains rehabilitation, mains relining, replaced or renewed mains, replaced valves, service connection rehabilitation, pumps refurbishment and pumps replacement;

  Failures: mains failures, critical mains failures, service connection failures and power failures;

  Rehabilitation dates: failure repair date, replacement date, renovation date and average duration of failure repair.

QUALITY OF SERVICE DATA

- No major difficulties are anticipated. Records are generally available for long periods and with reliable and accurate data for the following variables: population supplied, population supplied with service pipes and customer complaints.

FINANCIAL DATA

- Availability difficulties are anticipated for the attributed unit cost for real losses.
- These difficulties have no implications on the assessment of any rehab PI.
- No major difficulties are anticipated for the remaining variables. Records are generally available for medium or long periods and with very reliable or reliable and very accurate data for the following variables: annual running costs, annual capital costs, planning, design, construction, operations & maintenance running costs, annual depreciation costs, annual investments for new assets, annual investments for assets replacement, water sales revenue for direct consumption, water sales revenue for exported water, attributed unit cost for real losses and water tariffs.

4 CONSOLIDATED CARE-W PI SYSTEM

4.1 Introductory note

This chapter presents the listing of the CARE-W PI system that resulted from the work developed in the scope of WP1, from the inquiries to partners and end-user presented above and from a further detailed analysis held by the authors and a final revision by all the partners.

These listings aim to be used as a common reference for the PI software module and in the subsequent stages of the project, by the other working packages. However, minor refinements are likely to occur during the course of the project, i.e. resulting from the second edition of the IWA PI Manual under preparation. The definitive listing will be presented in the final WP1 report.

In Appendix 3, definitions are presented for a number of key expressions which are generally used in rehabilitation and whose precise meaning must be made clear for the interpretation of this report.

4.2 Basic concepts

The core of the CARE-W PI system is the set of performance indicators required to support network rehabilitation, as well as the corresponding data to assess them.

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

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 be ratios between values of identical or different nature;

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

g) 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;

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

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

j) to refer to well-defined geographical areas;

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

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

Additionally to this set of PI it was decided to add some “Additional performance measures”, which can be useful for the CARE-W project but cannot be included in the previous list to the fact that:

a) are difficult to be defined in a concise way in order to provide a unique interpretation;

b) are difficult to assess and require more sophisticated tools, like hydraulic modelling and statistic tools;

c) do not guaranty to be unbiased and thresholds are difficult to established.

The assessment and interpretation of rehab PI also require other relevant information, considered as part of the CARE-W PI system as well. The input data for the CARE-W PI system can be generated internally (UI - Utility Information) or externally (EI - External Information) to the undertaking. This terminology slightly differs from the previously adopted, but seems be more coherent. The main difference is the use of the term ‘external information’ instead of ‘context information’. In fact, a part of the utility information is also context information (corresponding to the IWA CI/system profile), and the therefore the former terminology might cause confusion.

The CARE-W rehab listing of performance indicators, including additional performance measures, as well as the corresponding utility information and external information has been established according to the following concepts:

- As referred in Report No.1, *performance indicators* (PI) are ratios 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 *additional performance measures* (APM) are also ratios between values of identical or different nature, expressing the performance of the undertaking regarding a given point of view relevant in the rehabilitation framework, but more difficult to define and assess.
- 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, as defined in the IWA-PI system) or for the CARE-W decision making process.
- The *external information* (EI) 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.). This basically corresponds to the ‘External information / Region profile’ group of the IWA-PI system.

Compared with the Report No. 1 [1], the CARE-W rehab listing includes now only 49 performance indicators, part of them obtained directly from the IWA system and some new ones specific for the rehabilitation analysis. They were completed with the corresponding 154 utility information and 29 external information parameters.

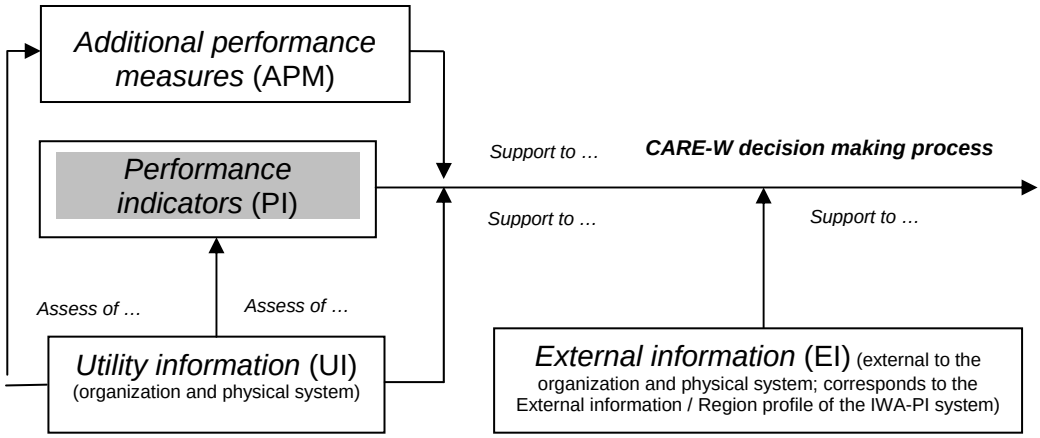

Figure 1– CARE-W PI system

4.3 Performance indicators

The following PI's have been identified as relevant for the CARE-W system. They include the PI required for the various modules of CARE-W prototype, as well as other PI relevant to support the diagnosis and decision-making phases of the rehabilitation process.

The PI's are grouped in five sections (the same adopted by IWA). The most important group is the Operational Indicators, including not only the indicators that better allow to express the alternative options for rehabilitation to be adopted (control factors) but also those related with failures and repairs and water losses. Also very important are the Quality of Service Indicators, including service and customer complaints, and the Financial Indicators, including annual cost, annual investments and tariffs. Additional useful references are the Water Resources and Physical Indicators.

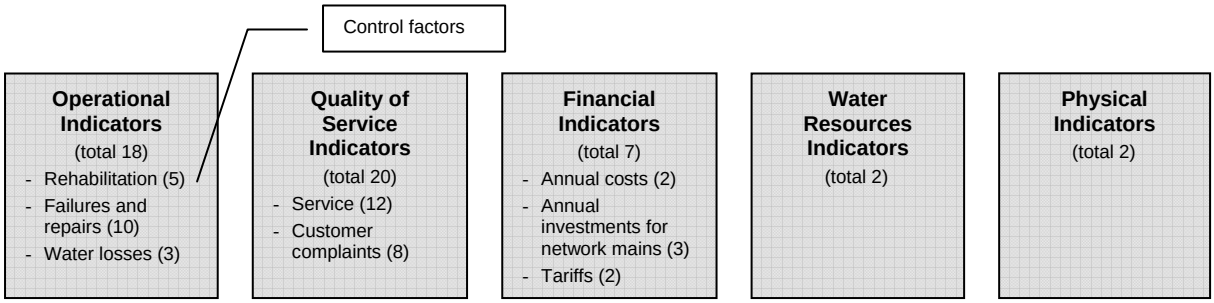

Figure 2 - Groups of performance indicators (PI) for network rehabilitation

For each indicator, the designation, the unit, the code, the level of applicability, the predictability and the data shortcomings (according to item 3.4) are presented.

The level of applicability and the predictability indicated reflect the critical analysis held by the authors, based also on the partners' questionnaire replies. Three possibilities have been considered: entire network (N), network sector (S), network cluster (C). The applicability to the individual element, either pipe or node, was not considered. However, in same cases the adopted concept can be applied at the individual level, but comparison with the other levels is not possible.

With regard to the data shortcomings, the information available refers to the parameters included in the questionnaire (sub-parameters resulting from splitting of main level parameters were not included in the questionnaire). If there is data shortcoming for the upper

level parameter, in general the more detailed information is likely to be problematic as well. However, the reverse is not valid and in this case data shortcoming is indicated as unknown.

Appendix 4 presents tables with a detailed description of each PI, based on the code, title, unit, concept and processing rule.

DESIGNATION	Unit	Code	Level of applicability	Predictable	Data shortcomings
OPERATIONAL INDICATORS					
Rehabilitation					
Mains rehabilitation	%/year	Op15	N,S,C	yes	no
mains relining	%/year	Op16	N,S,C	possibly	unknown
replaced or renewed mains	%/year	Op17	N,S,C	possibly	unknown
replaced or renewed valves	%/year	Op18	N,S,C	possibly	unknown
Service connection rehabilitation	%/year	Op19	N,S,C	yes	yes
Failures and repairs					
Mains failures	No./100 km/year	Op26	N,S,C	yes	no
pipe failures	No./100 km/year	Op26a	N,S,C	yes	unknown
joint failures	No./100 km/year	Op26b	N,S,C	yes	unknown
valves failures	No./100 km/year	Op26c	N,S,C	yes	unknown
service connection insertion point failures	No./ 100 km /year	Op26d	N,S,C	yes	unknown
Critical mains failures	No./100 km/year	Op26e	N,S,C	possibly	unknown
Service connection failures	No./1000 connections/year	Op27	N,S,C	yes	yes
Hydrant failures	No./1000 hydrants/year	Op28	N,S,C	no	yes
Power failures	hours/ pumping station/year	Op29	N,S,C	no	no
Active leakage control repairs	No./100 km /year	Op5	N,S,C	no	yes
Water losses					
Water losses	m^3/connection/ year	Op22	N,S,C	yes	yes
real losses	l/connection/ day when the system is pressurized	Op24	N,S,C	yes	yes

DESIGNATION	Unit	Code	Level of applicability	Predictable	Data shortcomings
Infrastructure leakage index	-	Op25	N,S	possibly	yes
QUALITY OF SERVICE INDICATORS					
Service					
Pressure of supply adequacy	%	QS9	N,S,C	yes	yes
Water interruptions	%	QS11	N,S,C	possibly	yes
Interruptions per connection	No./1000 connections	QS12	N,S,C	possibly	yes
critical interruptions per connection	No./1000 connections	QS12a	N,S,C	possibly	unknown
Population experiencing restrictions to water service	%	QS13	N,S,C	possibly	yes
Days with restrictions to water service	%	QS14	N,S,C	possibly	yes
Quality of supplied water	%	QS15	N,S,C	yes	no
Aesthetic test compliance	%	QS16	N,S,C	yes	no
water taste test compliance	%	QS16a	N,S,C	yes	unknown
water colour test compliance	%	QS16b	N,S,C	yes	unknown
microbiological test compliance	%	QS17	N,S,C	yes	no
physical-chemical test compliance	%	QS18	N,S,C	yes	no
Customer complaints					
Service complaints per connection	No. complaints/ 1000 connection/ year	QS22	N,S,C	no	yes
pressure complaints	%	QS23	N,S,C	no	unknown
continuity complaints	%	QS24	N,S,C	no	unknown
water quality complaints	%	QS25	N,S,C	no	unknown
water taste complaints	%	QS25a	N,S,C	no	unknown
water colour complaints	%	QS25b	N,S,C	no	unknown
interruptions complaints	%	QS26	N,S,C	no	unknown
critical interruptions complaints	%	QS26a	N,S,C	no	unknown
FINANCIAL INDICATORS[2]					
Annual costs					
Unit total costs	€/m^3	Fi1	N,S	possibly	yes
unit running costs	€/m^3	Fi2	N,S	possibly	yes
Annual investment for network mains					
Unit investment for network mains	€/m^3	Fi18a	N,S	possibly	yes

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

DESIGNATION	Unit	Code	Level of applicability	Predictable	Data shortcomings
annual investments for new and upgrading mains	%	Fi19a	N,S	possibly	yes
annual investments for mains replacement	%	Fi20a	N,S	possibly	yes
Tariffs					
Average water charges for direct consumption	€/m^3	Fi21	N	yes	yes
Average water charges for exported water	€/m^3	Fi22	N	yes	no
WATER RESOURCES INDICATORS					
Inefficiency of use of water resources	%	WR1	N	yes	yes
Annual water resources availability ratio	%	WR2	N	yes	yes
PHYSICAL INDICATORS					
Transmission and distribution storage capacity	days	Ph3	N,S	-	no
Valve density	No./km	Ph7	N,S,C	-	no

4.4 Additional performance measures

As referred before, additionally to this set of PI it was decided to create a group of "Additional performance measures", which can be useful for the CARE-W project but are more difficult to be defined, are difficult to assess, do not guaranty to be unbiased and thresholds are difficult to established.

Those measures can be developed by each CARE-W partner according their own needs and based on their specific tools, like hydraulic modelling and statistic tools.

Some potential examples of "Additional performance measures" can be:

- Network hydraulic reliability
- Mains residual service life
- Service connections residual service life
- Balance of costs and benefits
- The internal rate of return

4.5 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.

They are grouped in six sections (the same adopted by IWA).

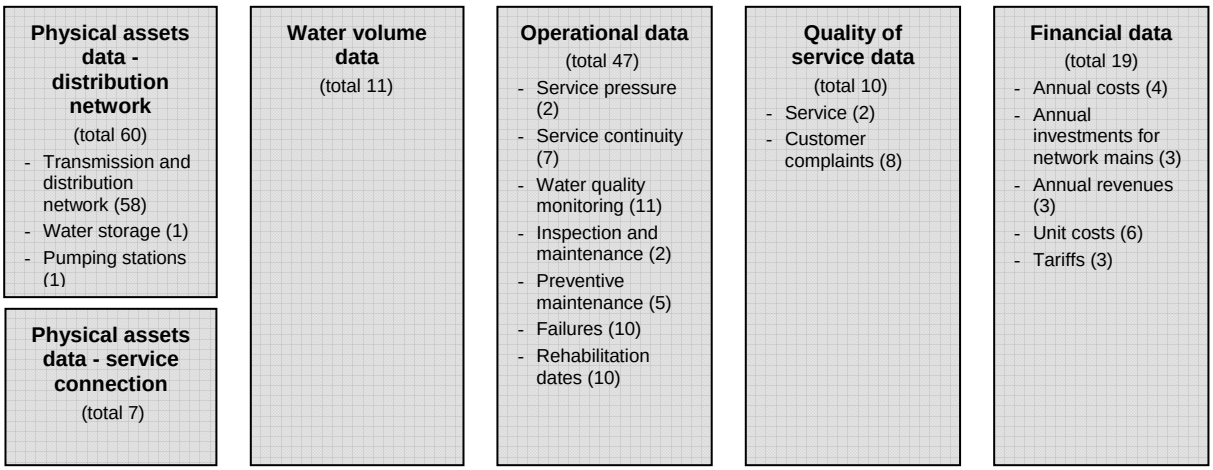

Figure 3 - Groups of utility information (UI) for network rehabilitation

Units, code, PI use, level of applicability and data shortcomings are referred. Variables that are used exclusively for PI assessment and variables used both for PI assessment and for diagnosis or decision making are tagged in the column 'Used for PI assessment'. The remaining ones (right hand side column) are used exclusively for diagnosis or decision-making. The level of applicability is indicated for the variables used only for diagnosis and decision making, as for the others this information is provided in the PI listing.

Appendix 5 presents tables with UI detailed information, based on the title, code, unit of expression, reference date, variable type, definition and additional comment.

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK						
Transmission and distribution network						
Mains length:						
• Mains length	km	C6	✓		-	no
• Mains length in sensitive areas	km	C6a	✓		-	unknown
• Network extension	km/year	C6b		✓	N,S	unknown
Mains diameters:						
• mains with < 100/110 mm diameter	km	C15		✓	N,S,C	no
• mains with 100/110 < diameter ≤ 300/315 mm	km	C16		✓	N,S,C	no
• mains with diameter > 300/315 mm	km	C17		✓	N,S,C	no
Mains materials:						
• cast, spun & grey iron mains	km	C7		✓	N,S,C	no
• ductile iron mains	km	C8		✓	N,S,C	no

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
• steel mains	km	C9		✓	N,S,C	no
• asbestos cement mains	km	C10		✓	N,S,C	no
• polyethylene mains	km	C11		✓	N,S,C	no
• polyvinyl chlorine mains	km	C12		✓	N,S,C	no
• concrete mains	km	C13		✓	N,S,C	no
• other material mains	km	C14		✓	N,S,C	no
Mains protection:						
• mains with internal protection	km	C34		✓	N,S,C	no
• mains with external protection	km	C35		✓	N,S,C	no
• mains with cathodic protection	km	C36		✓	N,S,C	no
Mains age:						
• average mains age	years	C37		✓	N,S,C	no
• mains laid between 2006 and 2010	km	C18a		✓	N,S,C	no
• mains laid between 2001 and 2005	km	C18b		✓	N,S,C	no
• mains laid between 1996 and 2000	km	C18c		✓	N,S,C	no
• mains laid between 1991 and 1995	km	C18d		✓	N,S,C	no
• mains laid between 1986 and 1990	km	C18e		✓	N,S,C	no
• mains laid between 1981 and 1985	km	C18f		✓	N,S,C	no
• mains laid between 1976 and 1980	km	C18g		✓	N,S,C	no
• mains laid between 1971 and 1975	km	C19a		✓	N,S,C	no
• mains laid between 1966 and 1970	km	C19b		✓	N,S,C	no
• mains laid between 1961 and 1965	km	C19c		✓	N,S,C	no
• mains laid between 1956 and 1960	km	C19d		✓	N,S,C	no
• mains laid between 1951 and 1955	km	C19e		✓	N,S,C	no
• mains laid between 1946 and 1950	km	C20a		✓	N,S,C	no
• mains laid between 1941 and 1945	km	C20b		✓	N,S,C	no
• mains laid between 1936 and 1940	km	C20c		✓	N,S,C	no
• mains laid between 1931 and 1935	km	C20d		✓	N,S,C	no
• mains laid between 1926 and 1930	km	C20e		✓	N,S,C	no
• mains laid between 1921 and 1925	km	C21a		✓	N,S,C	no
• mains laid between 1916 and 1920	km	C21b		✓	N,S,C	no

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
• mains laid between 1911 and 1915	km	C21c		✓	N,S,C	no
• mains laid between 1906 and 1910	km	C21d		✓	N,S,C	no
• mains laid between 1901 and 1905	km	C21e		✓	N,S,C	no
• mains laid before 1900	km	C21f		✓	N,S,C	no
Mains location:						
• under flexible roadway	km	C38		✓	N,S,C	no
• under rigid roadway	km	C39		✓	N,S,C	no
• under sidewalk	km	C40		✓	N,S,C	no
• under green areas	km	C41		✓	N,S,C	no
Mains installation depth	m	C42		✓	N,S,C	yes
Bedding type:						
• mains with appropriate bedding	km	C43		✓	N,S,C	yes
• mains with inadequate bedding	km	C43a		✓	N,S,C	yes
Backfilling soil type:						
• mains with very aggressive backfilling soil	km	C44		✓	N,S,C	yes
• mains with medium aggressive backfilling soil	km	C44a		✓	N,S,C	yes
• mains with low aggressive backfilling soil	km	C44b		✓	N,S,C	yes
• mains with not aggressive backfilling soil	km	C44c		✓	N,S,C	yes
Average closeness to trees	m	C45		✓	N,S,C	yes
Type of joints:						
• pipe rigid joints	km	C46		✓	N,S,C	yes
• pipe flexible joints	km	C47		✓	N,S,C	yes
• Main valves	No.	C29		✓	N,S,C	no
• Isolating valves	No.	C30	✓		-	no
• Hydrants	No.	C31	✓		-	no
Water storage						
• Transmission & distribution storage tanks capacity	m^3	C2	✓		-	no
Pumping stations						
• Pumping stations	No.	C4	✓		-	no
PHYSICAL ASSETS DATA - SERVICE CONNECTIONS						
• Number of service connections	No.	C32	✓		-	yes

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
• Number of sensitive service connections	No.	C32a	✓		-	no
• Average service connection length to measurement point	m	C33	✓		-	no
Service connection materials:						
• plastic service connections	%	C48a (IWA CI)		✓	N,S,C	yes
• steel service connections	%	C48b (IWA CI)		✓	N,S,C	yes
• lead service connections	%	C48c (IWA CI)		✓	N,S,C	yes
• others service connections	%	C48d (IWA CI)		✓	N,S,C	yes
WATER VOLUME DATA						
• Annual abstraction capacity	m^3/year	A1	✓		-	no
• Imported water allowance	m^3/year	A2	✓		-	no
• Water abstracted	m^3/year	A4	✓		-	no
• Imported raw water	m^3/year	A5	✓		-	no
• Exported raw water	m^3/year	A6	✓		-	no
• Water produced	m^3/year	A7	✓		-	no
• Imported treated water	m^3/year	A8	✓		-	no
• Exported treated water	m^3/year	A9	✓		-	no
• Authorised consumption	m^3/year	A19	✓		-	yes
• Water losses	m^3/year	A20	✓		-	yes
• Real losses	m^3/year	A24	✓		-	yes
OPERATIONAL DATA						
Service pressure						
• Average operating pressure	kPa	D31	✓		-	no
• Pressure variation	kPa	D31a (IWA CI)		✓	N,S,C	yes
Service continuity						
• Time system is pressurised	h/year	D29	✓		-	yes
• Delivery points with adequate pressure	No./year	D30	✓		-	yes

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
• Water interruptions	No. /year	D32	✓		-	yes
• Service interruptions	No. /year	D33	✓		-	yes
• critical interruptions	No. /year	D33a	✓		-	yes
• Water use restrictions	No. /year	D34	✓		-	yes
• Days with restrictions to water service	days/year	D35	✓		-	yes
Water quality monitoring						
• Water quality tests performed	No. /year	D41	✓		-	no
• Aesthetic tests performed	No. /year	D42	✓		-	no
• taste tests performed	No. /year	D42a	✓		-	no
• colour tests performed	No. /year	D42b	✓		-	no
• Microbiological tests performed	No. /year	D43	✓		-	no
• Physical-chemical tests performed	No. /year	D44	✓		-	no
• Compliance of aesthetic tests	No. /year	D51	✓		-	no
• compliance of taste tests	No. /year	D51a	✓		-	no
• compliance of colour tests	No. /year	D51b	✓		-	no
• Compliance of microbiological tests	No. /year	D52	✓		-	no
• Compliance of physical-chemical tests	No. /year	D53	✓		-	no
Inspection and maintenance						
• Network inspection	km/year	D7		✓		yes
• Leaks repaired due to active leakage control	No. /year	D9	✓		-	yes
Preventive maintenance						
• Mains rehabilitation	km/year	D18	✓		-	no
• mains relining	km/year	D19	✓		-	no
• replaced or renewed mains	km/year	D20	✓		-	no
• replaced or renewed valves	No. /year	D21	✓		-	no
• Service connection rehabilitation	No. /year	D22	✓		-	no
Failures						
• Mains failures	No. /year	D25	✓		-	no
• pipe failures	No./year	D25a	✓		-	unknown
• joint failures	No./year	D25b	✓		-	unknown
• valve failures	No. /year	D25c	✓		-	unknown

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
• service connection insertion point failures	No. /year	D25d	✓		-	unknown
• Mains failures caused by third parties	No. /year	D25e	✓		-	yes
• Critical mains failures	No. /year	D25f	✓		-	yes
• Service connection failures	No. /year	D26	✓		-	no
• Hydrant failures	No. /year	D27	✓		-	yes
• Power failures	h/year	D28	✓		-	no
Rehabilitation dates						
• Mains rehabilitated	km			✓	N,S,C	no
• Mains rehabilitation average date	year			✓	N,S,C	no
• mains relined	km			✓	N,S,C	no
• mains relining average date	year			✓	N,S,C	no
• replaced or renewed mains	km			✓	N,S,C	no
• replaced or renewed mains average date	year			✓	N,S,C	no
• replaced or renewed valves	km			✓	N,S,C	no
• replaced or renewed valves average date	year			✓	N,S,C	no
• Service connection rehabilitated	km			✓	N,S,C	no
• Service connection rehabilitation average date	year			✓	N,S,C	no
QUALITY OF SERVICE DATA						
Service:						
• Population supplied	No. persons	F1	✓		-	no
• Population supplied with service pipes	No. persons	F2	✓		-	no
Customer complaints:						
• Service complaints	No./year	F11	✓		-	no
• pressure complaints	No./year	F12	✓		-	unknown
• continuity complaints	No./year	F13	✓		-	unknown
• water quality complaints	No./year	F14	✓		-	unknown
• water taste complaints	No./year	F14a	✓		-	unknown
• water colour complaints	No./year	F14b	✓		-	unknown
• complaints on interruptions	No./year	F15	✓		-	unknown
• complaints on critical interruptions	No./year	F15a	✓		-	unknown
FINANCIAL DATA						

DESIGNATION	Unit	Code	Used for PI assessment	Used only for diagnosis or decision making	Level of applicability	Data shortcomings
Annual costs:						
• Annual costs	€/year	G1	✓		-	no
• Annual running costs	€/year	G2	✓		-	no
• Annual capital costs	€/year	G3	✓		-	no
• Annual depreciation costs	€/year	G19		✓	N	no
Annual investments:						
• Annual investment in tangible assets	€/year	G26	✓		-	no
• Annual investments for new assets	€/year	G27	✓		-	no
• Annual investments for assets replacement	€/year	G28	✓		-	no
Annual revenues:						
• Annual revenue	€/year	G21	✓		-	no
• Water sales revenue for direct consumption	€/year	G30	✓		-	no
• Water sales revenue for exported water	€/year	G31	✓		-	no
Unit costs:						
• Pipe rehabilitation cost	€/m	G51		✓	N,S,C	unknown
• Pipe repair cost	€/m	G52		✓	N,S,C	unknown
• Pipe maintenance cost	€/m	G53		✓	N,S,C	unknown
• Pipe inspection cost	€/m	G54		✓	N,S,C	unknown
• Reduced cost from pipe repair	€/year	G55		✓	N,S,C	unknown
• Reduced cost from leakage repair	€/year	G56		✓	N,S,C	unknown
Tariffs:						
• domestic water consumption tariff	€/m^3	G57 (IWA CI)		✓	N	no
• industrial water consumption tariff	€/m^3	G58		✓	N	no
• public water consumption tariff	€/m^3	G59		✓	N	no

4.6 External information

The following EI variables are needed for the CARE-W decision-making process. Units, code and the level of applicability are referred. They are grouped in three sections (environmental, mains aggressive and economic factors). The users must select the adequate EI for the interpretation of each PI.

Appendix 6 presents tables with the title, unit and concept for each external information variable.

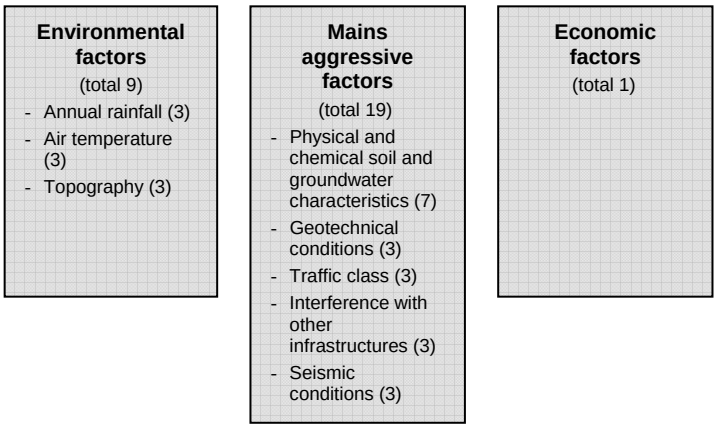

Figure 4 - Groups of external information (EI) for network rehabilitation

DESIGNATION	Unit	Code	Level of applicability
ENVIRONMENTAL FACTORS			
Annual rainfall:			
• average	(mm/year)	EI01	N
• maximum	(mm/year)	EI02	N
• minimum	(mm/year)	EI03	N
Air temperature:			
• daily average	(ºC)	EI04	N
• daily maximum	(ºC)	EI05	N
• daily minimum	(ºC)	EI06	N
Topography:			
• source average elevation	(m)	EI07	all
• maximum delivery elevation	(m)	EI08	all
• minimum delivery elevation	(m)	EI09	all
MAINS AGRESSIVE FACTORS			
Physical and chemical soil and groundwater characteristics:			
• hydrogenionic concentration range (pH)	(pH-pH)	EI10	all
• aggressive carbon dioxide concentration range (CO_2)	(mg/l-mg/l)	EI11	all
• sulphate concentration range (SO_4^{2-})	(mg/l-mg/l)	EI12	all
• chloride concentration range (Cl^-)	(mg/l-mg/l)	EI13	all
• resistivity concentration range	(Ωm -Ωm)	EI14	all
• organic compounds	(yes/no)	EI15	all
• stray currents	(yes/no)	EI16	all

Geotechnical conditions:			
• hight seat stability	(yes/no)	EI21	all
• medium seat stability	(yes/no)	EI22	all
• low seat stability	(yes/no)	EI17	all
Traffic class:			
• heavy traffic	(yes/no)	EI21	all
• normal traffic	(yes/no)	EI22	all
• light traffic	(yes/no)	EI23	all
Interference with other infrastructures:			
• high risk to be affected by other infrastructures works	(yes/no)	EI24	C,E
• medium risk to be affected by other infrastructures works	(yes/no)	EI25	C,E
• low risk to be affected by other infrastructures works	(yes/no)	EI26	C,E
Seismic conditions:			
• range of forecasted maximum soil movement due to liquefaction	(mm-mm)	EI18	all
• range of forecasted maximum angular deflection in joints	(º-º)	EI19	all
• range of forecasted maximum axial displacement in joints	(mm-mm)	EI20	all
ECONOMIC FACTORS			
• Inflation rate	(%/year)	EI27	N

5 NEXT ACTIVITIES

Next WP1 activities will be:

Task 1.3

- Definition of the structure of the rehab PI software module and definition of a first prototype draft (Deadline: Lisbon project meeting, in April 2002).
- Development of the full rehab PI software module (standalone version) (Deadline: end of July 2002).
- Preparation of a summarised users guide for internal project use (Deadline: end of July 2002).

Deliverable: Report No. 4 (July 2002).

Task 1.4

- Test of the software and collection of the rehab PI values from selected areas of the CARE-W end-users and other selected cities (Deadline: Dresden project meeting, October/November 2002).
- Definition of PI thresholds (December 2002).

Deliverable: Report No. 5 (January 2003).

Task 1.5

- Preparation of the final WP1 report based on the previous reports and including all changes agreed during the course of the project.

Deliverable: Report No. 6 (Deadline to be agreed).

Task 1.6

- Preparation of the WP1 contributions for the CARE-W Best Management Practice Manual (BMP).

Deliverable: CARE-W Best Management Practice Manual (BMP) (Deadline to be agreed).

6 REFERENCES

[1] BAPTISTA, J.M.; ALEGRE, H.; – Report No. 1 – *Preliminary proposal of a performance indicator system for rehabilitation,* 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. Lisbon, June 2001.

[2] 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.).

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Appendix 1
Results of the questionnaire to CARE-W partners

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

WP1.1 - Choice of performance indicators for rehabilitation

Questionnaire to CARE-W partners

Partner: _____

Person: _____

Model/process: _____

Regarding performance indicators, utility information and external information, please select the adequate answers (x) for the following questions only in the non-coloured rows:

1. 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? Select one column (or none if you do not intend to use this parameter in your model or process). Please duplicate the sheets if you have several models/processes.
2. For what purpose do you think you can primarily 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; monitoring? Select one or more columns (or none if you think you do not need to use this parameter in the CARE-W framework).
3. Do you think this parameter is important for rehabilitation purposes at: the entire network level, network sector level, network cluster level, individual pipes level or not important? Select one or more columns.
4. Can you predict this parameter based on modelling: yes or no? Select one column.

The partners who run a model must answer all the four questions. The other partners must answer only questions 2, 3 and 4.

Please use the WP1 report for definitions of the parameters.

Please fill this questionnaire and return it before 20.06.2001 to: jmbaptista@lnec.pt and halegre@lnec.pt. Thanks for your participation.

Legend:

Question 1	4	3	2	1
Question 2	8-7	6-5	4-3	2-1
Question 3	8-7	6-5	4-3	2-1
Question 4	yes	no		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
		4	3	2	1	8-7	6-5	4-3	2-1				8-7	6-5	4-3	2-1			
	PERFORMANCE INDICATORS																		
	WATER RESOURCES INDICATORS																		
	Inefficiency of use of water resources																		
	Resources availability ratio																		
	PHYSICAL INDICATORS																		
	Storage																		
	Transmission and distribution storage capacity																		
	Pumping																		
	Standardized energy consumption																		
	Transmission and distribution network																		
	Valve density																		
	Hydrant density																		
	Network hydraulic reliability																		
	Node hydraulic reliability																		
	Mains residual service life																		
	OPERATIONAL INDICATORS																		
	Inspection and maintenance																		
	Network inspection																		
	Leakage control																		
	Active leakage control repairs																		
	Hydrant inspection																		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
	Mains, valves and service connection rehabilitation																		
	Mains rehabilitation																		
	Service connection rehabilitation																		
	Pumps rehabilitation																		
	Pump refurbishment																		
	Pump replacement																		
	Water losses																		
	Water losses																		
	Infrastructure leakage index																		
	Failures																		
	Mains failures																		
	Critical mains failures																		
	Sensitive areas mains failures																		
	Service connection failures																		
	Hydrant failures																		
	Power failures																		
	QUALITY OF SERVICE INDICATORS																		
	Pressure of supply adequacy																		
	Water interruptions																		
	Interruptions per connection																		
	Population experiencing restrictions to water service																		
	Days with restrictions to water service																		
	Quality of supplied water																		
	Customer complaints																		
	Service complaints																		
	FINANCIAL INDICATORS																		
	Annual costs																		
	Unit total costs																		
	Technical services costs ratio																		
	Annual investment																		
	Unit investment																		
	Tariffs																		

Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
	As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
Average water charges for direct consumption																		
Average water charges for exported water																		
Water losses																		
Non-revenue water by volume																		
Non-revenue water by cost																		
Economical rehab assessment																		
Balance of costs and benefits																		
Internal rate of return																		
Utility information																		
PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK																		
Water storage																		
Transmission & distribution storage tanks capacity																		
Pumping stations																		
Pumping stations																		
Pumping stations capacity																		
Transmission and distribution network																		
Mains length																		
Mains diameters																		
Mains materials																		
Mains protection																		
Mains age																		
Mains protection age																		
Mains location																		
Mains installation depth																		
Trench mains installation width																		
Bedding soil type																		
Backfilling soil type																		
Average closeness to trees																		
Type of joints																		
Mains valves																		
Isolating valves																		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
	Hydrants																		
	Node elevation																		
	PHYSICAL ASSETS DATA - SERVICE CONNECTIONS																		
	Number of service connections																		
	Number of sensitive service connections																		
	Average service connection length																		
	Service connection materials																		
	Service connections density																		
	WATER VOLUME DATA																		
	Annual abstraction capacity																		
	Imported water allowance																		
	Water abstracted																		
	Imported raw water																		
	Exported raw water																		
	Water produced																		
	Imported treated water																		
	Exported treated water																		
	Billed metered consumption																		
	Billed unmetered consumption																		
	Billed authorised consumption																		
	Unbilled metered consumption																		
	Unbilled unmetered consumption																		
	Unbilled authorised consumption																		
	Authorised consumption																		
	Water losses																		
	Unauthorised consumption																		
	Metering inaccuracies water losses																		
	Apparent losses																		
	Real losses																		
	Revenue water																		
	Non-revenue water																		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
	CONSUMPTION AND PEAK FACTORS																		
	Daily average input																		
	Consumption per type of customer																		
	Total per capita consumption																		
	Consumption per service connection																		
	Peak factors of supplied and exported water																		
	Network delivery rate																		
	OPERATIONAL DATA																		
	Service pressure																		
	Average operating pressure																		
	Minimum static pressure																		
	Maximum static pressure																		
	Static pressure variation																		
	Maximum expected surge pressure																		
	Minimum expected surge pressure																		
	Surge pressure occurrence rate																		
	Service continuity																		
	Time system is pressurised																		
	Delivery points with adequate pressure																		
	Water interruptions																		
	Service interruptions																		
	Critical interruptions																		
	Water use restrictions																		
	Days with restrictions to water service																		
	Network velocities																		
	Pipe flow velocity																		
	Water quality monitoring																		
	Water quality tests performed																		
	Aesthetic tests performed																		
	Microbiological tests performed																		
	Physical-chemical tests performed																		
	Compliance of aesthetic tests																		
	Compliance of microbiological tests																		
	Compliance of physical-chemical tests																		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
	Physical and chemical water characteristics in the network																		
	Hydrogenionic concentration range in water																		
	Aggressive carbon dioxide concentration range in water																		
	Sulphate concentration range in water																		
	Chlorine concentration range in water																		
	Water temperature range in water																		
	Energy consumption																		
	Pumping energy consumption																		
	Standardization factor																		
	Inspection and maintenance																		
	Network inspection																		
	Leakage control																		
	Leaks repaired due to active leakage control																		
	Hydrant inspection																		
	Preventive maintenance																		
	Mains rehabilitation																		
	Mains relining																		
	Replaced or renewed mains																		
	Replaced valves																		
	Service connection rehabilitation																		
	Pumps refurbishment																		
	Pumps replacement																		
	Failures																		
	Mains failures																		
	Critical mains failures																		
	Service connection failures																		
	Hydrant failures																		
	Power failures																		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
	Rehabilitation dates																		
	Failure date																		
	Replacement date																		
	Renovation date																		
	Average duration of failure repair																		
	Interference with other infrastructures																		
	Repairs risk to affect other infrastructures																		
	TECHNOLOGICAL RESOURCES																		
	Computerized information systems																		
	Mapping																		
	Failure data availability																		
	QUALITY OF SERVICE DATA																		
	Population supplied																		
	Population supplied with service pipes																		
	Population served by public taps or standpipes																		
	Customer complaints																		
	FINANCIAL DATA																		
	Annual running costs																		
	Annual capital costs																		
	Operational costs																		
	Internal manpower costs																		
	External services costs																		
	Imported (raw and treated) water costs																		
	Energy costs																		
	Purchased merchandises																		
	Leasing and rentals																		
	Taxes, levies and fees																		
	Exceptional earnings and losses																		
	Other operating expenditures																		
	Other operating costs																		
	Planning, design, construction, operations & maintenance running costs																		
	Annual depreciation costs																		
	Interest expenses costs																		

	Parameter	For what do you intend to use this parameter in your model or process?				For what purpose do you think you can primarily use this parameter in the CARE-W framework?							Do you think this parameter is important for rehabilitation purposes at …					Can you predict this parameter ?	
		As an essential input of the model	As a non essential input of the model	As a model intermediate processing step	As an output of the model	System characterisation and understanding	Problem(s) identification	Diagnosis	Decision making (short/medium term rehab planning)	Decision making (long term rehab planning)	Solution implementation	Monitoring	the entire network level?	network sector level?	network cluster level?	individual pipes level?	not important	Yes	No
	Interest income																		
	Net interest																		
	Annual investment in tangible assets																		
	Annual investments for new assets																		
	Annual investments for assets replacement																		
	Water sales revenue for direct consumption																		
	Water sales revenue for exported water																		
	Average water charges for direct consumption																		
	Attributed unit cost for real losses																		
	Water tariffs																		
	External information																		
	ENVIRONMENT FACTORS																		
	Annual rainfall																		
	Air temperature																		
	Topography																		
	MAINS AGRESSIVE FACTORS																		
	Physical/ chemical soil and groundwater character.																		
	Geotechnical conditions																		
	Seismic conditions																		
	Traffic class																		
	Interference with other infrastructures																		
	ECONOMICS																		
	Inflation rate (%/year)																		

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Appendix 2
Results of the questionnaire to CARE-W end-users

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

Questionnaire to CARE-W end-users

End-user: _____ Partner: _____

Please fill-in the following questionnaire regarding the utility information needed for the CARE-W project, with the support of the partner you have a direct contact to. In this stage you are not required to provide any numerical data.

Use a "x" to reply to the questions.

If you have any doubt on the exact meaning of the listed variables, please see appendix 3 of the 2nd WP1 report, available in project website.

The interpretation to be adopted for the questions on data reliability and data accuracy are as follows:

DATA RELIABILITY	Definition
A - Highly reliable	Data based on sound records, procedures, investigations or analyses that are properly documented and recognised as the best available assessment methods.
B - Reliable	Generally as in band A, but with minor shortcomings, e.g.: some of the documentation is missing, the assessment is old, or some reliance on unconfirmed reports or some extrapolations are made.
C - Unreliable	Data based on extrapolation from a limited sample for which band A or B is available.
D - Highly unreliable	Data based on unconfirmed verbal reports and/or cursory inspections or analysis.
DATA ACCURACY	**Definition**
1 - Error (%): [0;1]	Better than or equal to +/- 1%
2 - Error (%):] 1;5]	Not band 1, but better than or equal to +/- 5%
3 - Error (%):] 5;10]	Not bands 1 or 2, but better than or equal to +/- 10%
4 - Error (%):] 10;25]	Not bands 1, 2 or 3, but better than or equal to +/- 25%
5 - Error (%):] 25;50]	Not bands 1, 2, 3 or 4 but better than or equal to +/- 50%
6 - Error (%):] 50;100]	Not bands 1, 2, 3, 4 or 5 but better than or equal to +/- 100%
Error (%): > 100	Values which fall outside the valid range, such as > 100%.

Please fill this questionnaire and return it before 15.09.2001 to: jmbaptista@lnec.pt and halegre@lnec.pt. We thank you in advance for your kind collaboration.

Utility information	Is this data available in your organisation?		If you replied "yes" to the previous question, please proceed to the following columns	How many years of records do you have?						What is the reliability of these data?				What is the estimated accuracy of these data?					
	yes	no		≤ 1	1-2	3-5	6-10	11-20	> 20	A	B	C	D	1	2	3	4	5	6
PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK																			
Pumping stations																			
Pumping stations	10	0		0	1	0	2	1	4	9	1	0	0	7	2	0	0	0	0
Pumping stations capacity	10	0		0	2	0	2	1	3	8	2	0	0	5	5	0	0	0	0
Transmission and distribution network																			
Mains length	10	0		0	0	3	2	1	3	5	5	0	0	2	6	1	1	0	0
Mains diameters	10	0		0	0	3	3	1	2	4	6	1	0	3	1	5	0	0	0
Mains materials	10	0		0	0	3	3	1	2	0	8	2	0	0	2	5	0	0	0
Mains protection	7	3		0	0	1	2	1	2	2	5	0	0	0	2	1	1	0	0
Mains age	8,5	0,5		0	1	1	4	1	2	0	8	2	0	0	3	3	1	1	0
Mains protection age	5	5		0	0	1	2	1	1	2	2	1	0	0	3	0	1	1	0
Mains location	9	1		0	0	1	4	1	2	1	7	0	0	0	2	3	1	0	0
Mains installation depth	4	6		0	0	1	2	0	1	0	3	1	0	0	0	3	1	0	0
Trench mains installation width	1	9		0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Bedding soil type	2	8		0	0	0	2	0	0	0	1	0	1	0	0	1	1	0	0
Backfilling soil type	3	7		0	0	0	2	0	0	0	1	0	1	0	0	1	1	0	0
Average closeness to trees	2	8		0	0	0	2	0	0	0	2	0	0	0	0	1	0	1	0
Type of joints	5	5		0	0	1	2	0	1	2	3	0	0	2	2	0	0	0	0
Mains valves	9	1		1	0	2	2	1	2	3	4	2	0	3	3	2	0	0	0
Isolating valves	8	2		1	0	2	2	1	2	4	3	1	0	4	2	2	0	0	0
Hydrants	9	1		1	1	1	3	1	1	3	6	0	0	3	3	2	0	0	0
Node elevation	7	3		1	0	1	2	1	1	1	5	0	0	0	3	1	2	0	0

	Is this data available in your organisation?		If you replied "yes" to the previous question, please proceed to the following columns	How many years of records do you have?						What is the reliability of these data?				What is the estimated accuracy of these data?					
Utility information	yes	no		≤ 1	1-2	3-5	6-10	11-20	> 20	A	B	C	D	1	2	3	4	5	6
PHYSICAL ASSETS DATA - SERVICE CONNECTIONS																			
Number of service connections	9	1		1	0	0	3	1	3	1	4	4	0	1	4	2	1	1	0
Number of sensitive service connections	7	3		0	2	1	2	0	1	1	4	1	0	1	3	3	0	0	0
Average service connection length	9	1		2	0	0	2	1	3	0	6	3	0	0	1	4	2	1	0
Service connection materials	4,5	5,5		1	0	0	1	0	2	1	2	2	0	1	1	2	0	0	0
Service connections density	3	7		0	0	1	2	0	0	0	1	2	0	0	1	1	0	1	0
WATER VOLUME DATA																			
Annual abstraction capacity	7	1		0	0	0	1	1	4	3	3	0	0	2	3	1	0	0	0
Imported water allowance	8	2		0	0	1	4	2	1	6	2	0	0	4	3	0	0	0	0
Water abstracted	10	0		0	1	0	3	2	3	6	4	0	0	5	4	1	0	0	0
Exported raw water	5	2		0	0	0	1	1	2	4	1	0	0	4	1	0	0	0	0
Water produced	10	0		0	1	0	2	2	4	7	3	0	0	4	6	0	0	0	0
Exported treated water	9	1		0	0	1	3	1	2	6	2	0	0	5	3	0	0	0	0
Billed metered consumption	10	0		0	1	0	2	0	5	5	5	0	0	3	6	0	0	0	0
Billed unmetered consumption	5	3		0	0	0	2	0	2	2	2	1	0	2	3	1	0	0	0
Billed authorised consumption	6	4		0	0	0	2	0	3	3	2	1	0	3	2	1	0	0	0
Authorised consumption	6	4		0	0	0	2	1	2	2	2	1	0	1	2	2	1	0	0
Water losses	7	3		0	0	2	2	0	2	2	4	1	0	0	2	5	0	0	0
Real losses	5	5		0	0	1	2	0	2	1	2	2	0	0	1	2	1	1	0

Utility information	Is this data available in your organisation?		If you replied "yes" to the previous question, please proceed to the following columns	How many years of records do you have?						What is the reliability of these data?				What is the estimated accuracy of these data?					
	yes	no		≤ 1	1-2	3-5	6-10	11-20	> 20	A	B	C	D	1	2	3	4	5	6
CONSUMPTION AND PEAK FACTORS																			
Consumption per type of customer	8	3		0	0	0	2	0	4	2	5	0	0	3	1	3	0	0	0
Total per capita consumption	8	3		0	0	0	3	0	3	2	5	0	0	2	3	2	0	0	0
Consumption per service connection	4	5		0	0	0	2	1	2	2	2	1	0	1	3	0	0	1	0
Peak factors of supplied and exported water	6	3		0	0	0	3	2	1	4	2	0	0	2	4	0	0	0	0
OPERATIONAL DATA																			
Service pressure																			
Average operating pressure	7	3		2	0	2	0	1	1	2	4	1	0	2	2	3	0	0	0
Static pressure variation	3	7		0	0	2	0	1	0	1	1	1	0	1	0	2	0	0	0
Service continuity																			
Time system is pressurised	5	5		0	0	0	1	1	2	4	1	0	0	4	0	1	0	0	0
Delivery points with adequate pressure	3	7		0	0	1	2	0	0	1	1	1	0	0	2	1	0	0	0
Water interruptions	6	4		0	1	1	1	1	1	1	1	3	0	1	1	1	3	0	0
Service interruptions	5	5		0	0	2	1	0	1	2	2	0	0	2	2	1	0	0	0
Critical interruptions	3	7		0	0	1	1	0	1	2	1	0	0	2	1	0	0	0	0
Water use restrictions	3	5		0	0	1	1	0	0	1	1	0	0	1	0	1	0	0	0
Days with restrictions to water service	3	5		0	0	1	1	0	0	2	1	0	0	2	1	0	0	0	0
Water quality monitoring																			
Water quality tests performed	10	0		0	0	1	6	0	1	9	1	0	0	8	1	0	0	0	0
Inspection and maintenance																			
Network inspection	5	5		0	1	1	2	0	1	2	3	0	0	2	1	2	0	0	0
Leakage control	6.5	3.5		2	1	0	1	1	1	3	2	0	0	3	2	1	0	0	0
Leaks repaired due to active leakage control	4	6		0	1	1	1	1	0	1	3	0	0	0	3	1	0	0	0
Hydrant inspection	5	5		2	0	1	2	0	0	3	3	0	0	3	1	0	0	0	0

Utility information	Is this data available in your organisation?		If you replied "yes" to the previous question, please proceed to the following columns	How many years of records do you have?						What is the reliability of these data?				What is the estimated accuracy of these data?					
	yes	no		≤ 1	1-2	3-5	6-10	11-20	> 20	A	B	C	D	1	2	3	4	5	6
Preventive maintenance																			
Mains rehabilitation	10	0		0	1	4	2	1	1	2	7	1	0	1	5	2	1	0	0
Mains relining	10	0		0	1	3	2	2	2	6	4	0	0	4	4	1	0	0	0
Replaced or renewed mains	10	0		0	0	4	2	2	2	4	6	0	0	3	6	1	0	0	0
Replaced valves	7	3		1	0	1	3	1	0	2	5	0	0	1	5	1	0	0	0
Service connection rehabilitation	9	1		1	0	3	3	0	1	4	5	0	0	2	5	1	0	0	0
Pumps refurbishment	9	0		0	1	0	6	0	2	1	8	0	0	0	8	0	0	0	0
Pumps replacement	9	0		0	0	1	6	0	2	2	7	0	0	1	7	0	0	0	0
Failures																			
Mains failures	10	0		1	0	1	4	1	4	2	8	0	0	2	6	1	0	0	0
Critical mains failures	5	5		1	0	1	2	0	1	3	2	0	0	3	2	0	0	0	0
Service connection failures	7	3		0	0	1	2	1	3	1	5	0	0	1	4	1	0	0	0
Hydrant failures	5	5		0	0	1	2	1	2	2	4	0	0	2	2	0	0	0	0
Power failures	6	4		0	0	1	3	0	1	1	4	0	0	1	3	1	0	0	0
Rehabilitation dates																			
Failure date	9	1		1	0	2	3	1	3	4	4	1	0	2	4	2	0	0	0
Replacement date	9	1		1	0	2	3	0	2	5	4	0	0	2	5	1	0	0	0
Renovation date	9	1		1	0	2	3	0	2	5	4	0	0	2	4	2	0	0	0
Average duration of failure repair	6	4		1	0	2	2	0	1	1	5	0	0	1	4	1	0	0	0
Interference with other infrastructures																			
Repairs risk to affect other infrastructures	2	8		0	0	0	1	0	1	0	2	0	0	0	1	1	0	0	0
QUALITY OF SERVICE DATA																			
Population supplied	9	1		0	1	0	2	0	5	3	6	0	0	2	5	2	0	0	0
Population supplied with service pipes	7	3		0	1	0	2	0	4	2	6	0	0	1	5	2	0	0	0
Customer complaints	7	3		1	1	1	2	0	1	1	4	2	0	0	3	3	1	0	0

	Is this data available in your organisation?		If you replied "yes" to the previous question, please proceed to the following columns	How many years of records do you have?						What is the reliability of these data?				What is the estimated accuracy of these data?					
Utility information	yes	no		≤ 1	1-2	3-5	6-10	11-20	> 20	A	B	C	D	1	2	3	4	5	6
FINANCIAL DATA																			
Annual running costs	10	0		0	1	1	5	1	2	6	3	0	0	6	3	0	0	0	0
Annual capital costs	10	0		0	1	1	5	0	2	7	2	0	0	6	3	0	0	0	0
Planning, design, construction, operations & maintenance running costs	7	3		0	0	1	4	0	1	3	3	0	0	5	1	0	0	0	0
Annual depreciation costs	8	2		0	1	1	4	0	2	7	1	0	0	6	2	0	0	0	0
Annual investments for new assets	9	1		0	1	1	4	0	2	6	2	0	0	5	3	0	0	0	0
Annual investments for assets replacement	9	1		1	0	0	5	0	2	6	2	0	0	5	3	0	0	0	0
Water sales revenue for direct consumption	10	0		0	1	1	5	0	2	7	2	0	0	6	3	0	0	0	0
Water sales revenue for exported water	9	1		0	0	1	3	0	2	6	1	0	0	6	1	0	0	0	0
Attributed unit cost for real losses	4	6		1	0	0	3	0	0	2	2	0	0	2	1	0	0	0	0
Water tariffs	10	0		1	0	1	3	1	3	8	2	0	0	8	1	0	0	0	0

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Appendix 3
Definitions related to rehabilitation

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Definitions

In this section, definitions are presented for a number of key expressions which are generally used in rehabilitation and whose precise meaning must be made clear:

- 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.
- Complaints: Any customer complaint expressed to the services either personally (verbal or written), by telephone, fax, post, e-mail or any other written format.
- Inspection: Formal, probably written, procedure that is subsequently recorded in a form that enables the undertaking to assess the serviceability of the assets and to take corrective action as appropriate.
- 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.
- 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.
- Relining: The removal of all deposits from inside an existing pipeline, 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 pipelines), power (for pumping systems), etc. In the case of pipelines, replacement includes the provision of a structural liner (sliplining). The new pipeline may or may not have the same carrying capacity as the existing pipeline.
- 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 connection.
- Water losses: The difference between system input volume and authorised consumption. 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 losses and apparent losses.
- Real losses: Physical water losses from the pressurised system, up to the point of measurement of customer use. The annual volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average duration of individual leaks. Note: Although physical losses after the point of customer flow measurement are excluded from the assessment of real losses, they are often significant (particularly where customers are unmetered) and worthy of attention for demand management purposes.

Appendix 4
Proposal of rehab performance indicators

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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 [2] for variables identification when necessary.

Operational indicators

INDICATOR (unit)	CONCEPT Processing rule
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 or renewed valves* *(%/year)*	Number of mains valves replaced or renewed 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*
FAILURES AND REPAIRS	
Op26 - Mains failures[3] *(No./100 km/year)*	Number of mains failures during the year, including failures of pipes, valves, fittings and 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 / 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 *Op26b = D25b/C6 x 100*
Op26c - valve failures *(No./100 km/year)*	Number of valve failures during the year / total mains length x 100 *Op26c = D25c/C6 x 100*
Op26d - service connection insertion point failures *(No./100 km/year)*	Number of failures that occur in the insertion point of the service connection during the year / total mains length x 100 *Op26d = D25d/C6 x 1000*
Op26e - Critical mains failures *(No./100 km/year)*	Number of mains failures in sensitive areas during the year / total mains length in sensitive areas x 100 *Op26e = D25e/C6a x 100* *Sensitive areas can be defined as urban zones where serious human consequences (for example hospitals, dialysis patients, etc), severe damages (landslide, flooding) or severe disturbances (traffic interruptions) may occur due to water main bursts.*
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.*
Op28 - Hydrant failures	Number of hydrant failures during the year / total number of hydrants

[3] 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.

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INDICATOR *(unit)*	**CONCEPT** Processing rule
(No./1000 hydrants/year)	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*
Op5 - Active leakage control repairs *(No./100 km/year)*	Number of main leaks detected and repaired due to active leakage control / total mains length x 100 *Op5 = D9/C6 x 100*
WATER LOSSES	(Water balance definitions to be adopted according to [2])
Op22 - Water losses per connection *(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*
• *Op24 - real losses* per connection *(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/(C32x365xD29/365/24)* *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 (*Op24*)/ 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 P 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.*

Quality of service indicators

INDICATOR *(unit)*	CONCEPT Processing rule
SERVICE	
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[4] *(%)*	Σ (Population subject to a water interruption x duration of the interruption in hours) / (population served x 24 x 365) x 100 *QS11 = D32/(F1x24x365) 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)*	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)*	Number of supply interruptions to sensitive service connections during the year / number of sensitive service connections x 1000 *QS12a = D33a/C32a x 1000* *Sensitive service connections can be defined as connections where serious human consequences may occur due to supply interruptions (for example hospitals, dialysis patients, etc).*
QS13 - Population experiencing restrictions to water service[5] *(%)*	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 applicable standards or legislation during the year / total number of tests of treated water performed during the year x 100 *QS15 = (D51+D52+D53)/D41 x 100*
• *QS16 - aesthetic* tests compliance *(%)*	Number of aesthetic tests of treated water complying with the applicable standards or 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* tests compliance *(%)*	Number of water taste tests of treated water complying with the applicable standards or 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* tests compliance *(%)*	Number of water colour tests of treated water complying with the applicable standards or 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* tests compliance *(%)*	Number of microbiological tests of treated water complying with the applicable standards or 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* tests compliance *(%)*	Number of physical-chemical tests of treated water complying with the applicable standards or legislation during the year / total number of physical-chemical tests of treated water performed during the year x 100 *QS18 = D53/D44 x 100*

[4] Indicators *QS11* and *QS12* shall be used in alternative.
[5] Indicators *QS13* and *QS14* shall be used in alternative.

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INDICATOR (unit)	CONCEPT / Processing rule
CUSTOMER COMPLAINTS	
QS22 - Service complaints per connection *(No. complaints/1000 connections/year)*	Number of service complaints during the year / number of service connections x 1000 *QS22 = F11/C32 x 1000*
• *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 complains* *(%)*	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 complains* *(%)*	Number of water colour complaints during the year / number of service complaints during the year x 100 *QS25b = F14b/F11 x 100*
• *QS26 - interruptions complains* *(%)*	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 complains* *(%)*	Number of complaints due to supply interruptions to sensitive service connections during the year / number of service complaints during the year x 100 *QS26a= F15a/F11 x 100* *Sensitive service connections can be defined as connections where serious human consequences may occur due to supply interruptions (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 [2] 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*
ANNUAL INVESTMENT FOR NETWORK MAINS	
Fi18a - Unit investment for network mains *(€/m³)*	Annual cost of investments (expenditures for network mains) / authorised consumption (including exported water) *Fi18= G26/A19*

INDICATOR *(unit)*	CONCEPT Processing rule
	The annual values of this ratio can be misleading. A multi-annual analysis must be adopted.
• *Fi19a - annual investments for new and upgrading mains* *(%)*	Cost of investments for new mains (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.*
• *Fi20a - annual investments for mains replacement* *(%)*	Cost of investments for the replacement of existing mains/ 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 *(€/m^3)*	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 *(€/m^3)*	Annual water sales revenue from exported water (excluding public water taxes) / exported water *Fi22 = G31/(A6+A9)*

Water resources indicators

INDICATOR *(unit)*	CONCEPT Processing rule
WR1 - Inefficiency of use of water resources *(%)*	Real losses / system input volume x 100 *WR1 = A24/(A4+A5+A8) x 100* *This indicator must not be used as a measure of efficiency of management of the transmission and/or the distribution system.*
WR2 - Annual water resources availability ratio *(%)*	System input volume / total annual abstraction capacity and imported water allowance x 100 *WR2 = (A19+A20)/(A1+A2) 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 annual abstraction capacity and imported water allowance taking into account water quality requirements and according to its own guaranteed schemes, drought management and operation procedures. This indicator is not suitable for comparisons, unless the same underlying assumptions are adopted to assess A1.*

Physical indicators

INDICATOR *(unit)*	CONCEPT Processing rule
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 operator by the water undertaking. The interpretation of the values of this indicator shall take into account the seasonal, monthly, daily and hourly peak factors.*
Ph7 - Valve density *(No./km)*	Number of isolating valves / total distribution mains length *Ph7 = C30/C6*

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Appendix 5
Proposal of rehab utility information

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Proposal of rehab utility information

Note: The IWA codes for PI variables [2] are kept in this Appendix to allow for an easier cross-reference.

PHYSICAL ASSETS DATA - DISTRIBUTION NETWORK

TRANSMISSION AND DISTRIBUTION NETWORK

C6 - MAINS LENGTH (IWA PI variable)		
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).		
COMMENT: Mains that are not yet in use or have been put out of service on a permanent basis shall not be accounted for.		

C6a - MAINS LENGTH IN SENSITIVE AREAS (subset of 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).		
COMMENT: Mains that are not yet in use or have been put out of service on a permanent basis shall not be accounted for.		

C6b - NETWORK EXTENSION (subset of 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)		
COMMENT:		

C15 - MAINS WITH < 100/110 mm DIAMETER (IWA PI variable)		
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).		
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.		

C16 - MAINS WITH 100/110 < DIAMETER ≤ 300/315 mm (IWA PI variable)		
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).		
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.		

C17 - MAINS WITH DIAMETER > 300/315 mm (IWA PI variable)		
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).		
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.		

C7 - CAST SPUN AND GREY IRON MAINS (IWA PI variable)		
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).		
COMMENT:		

C8 - DUCTILE IRON MAINS (IWA PI variable)		
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).		
COMMENT:		

C9 - STEEL MAINS (IWA PI variable)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of steel transmission and distribution mains (Service connections not included).		
COMMENT:		

C10 - ASBESTOS CEMENT MAINS (IWA PI variable)		
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).		
COMMENT:		

C11 - POLYETHYLENE MAINS (IWA PI variable)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of polyethylene transmission and distribution mains (Service connections not included).		
COMMENT:		

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C12 - POLYVINYL CHLORINE MAINS (IWA PI variable)		
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).		
COMMENT:		

C13 - CONCRETE MAINS (IWA PI variable)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of concrete transmission and distribution mains (Service connections not included).		
COMMENT:		

C14 - OTHER MATERIAL MAINS (IWA PI variable)		
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).		
COMMENT: If appropriate, this variable can be split into sub-variables.		

C34 - MAINS WITH INTERNAL PROTECTION		
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).		
COMMENT: If appropriate, this variable can be split into sub-variables.		

C35 - MAINS WITH EXTERNAL PROTECTION)		
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).		
COMMENT: If appropriate, this variable can be split into sub-variables.		

C36 - MAINS WITH CATHODIC PROTECTION		
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).		
COMMENT: If appropriate, this variable can be split into sub-variables.		

C37 - 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		
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.		

C18a - MAINS LAID BETWEEN 2006 AND 2010		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 2006 and 2010 (Service connections not included).		
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.		

C18b - MAINS LAID BETWEEN 2001 AND 2005		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 2001 and 2005 (Service connections not included).		
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.		

C18c - MAINS LAID BETWEEN 1996 AND 2000		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1996 and 2000 (Service connections not included).		
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.		

C18d - MAINS LAID BETWEEN 1991 AND 1995		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1991 and 1995 (Service connections not included).		
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.		

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C18e - MAINS LAID BETWEEN 1986 AND 1990		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid between 1986 and 1990 (Service connections not included).		
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.		

C18f - MAINS LAID BETWEEN 1981 AND 1985		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid between 1981 and 1985 (Service connections not included).		
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.		

C18g - MAINS LAID BETWEEN 1976 AND 1980		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid between 1976 and 1980 (Service connections not included).		
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.		

C19a - MAINS LAID BETWEEN 1971 AND 1975		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid between 1971 and 1975 (Service connections not included).		
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.		

C19b - MAINS LAID BETWEEN 1966 AND 1970		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1976 and 1970 (Service connections not included).		
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.		

C19c - MAINS LAID BETWEEN 1961 AND 1965		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1961 and 1965 (Service connections not included).		
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.		

C19d - MAINS LAID BETWEEN 1956 AND 1960		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1956 and 1960 (Service connections not included).		
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.		

C19d - MAINS LAID BETWEEN 1951 AND 1955		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1951 and 1955 (Service connections not included).		
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.		

C20a - MAINS LAID BETWEEN 1946 AND 1950		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1946 and 1950 (Service connections not included).		
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.		

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C20b - MAINS LAID BETWEEN 1941 AND 1945		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1941 and 1945 (Service connections not included).		
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.		

C20c - MAINS LAID BETWEEN 1936 AND 1940		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1936 and 1940 (Service connections not included).		
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.		

C20d - MAINS LAID BETWEEN 1931 AND 1935		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1931 and 1935 (Service connections not included).		
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.		

C20e - MAINS LAID BETWEEN 1926 AND 1930		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1926 and 1930 (Service connections not included).		
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.		

C21a - MAINS LAID BETWEEN 1921 AND 1925		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1921 and 1925 (Service connections not included).		
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.		

C21b - MAINS LAID BETWEEN 1916 AND 1920		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1916 and 1920 (Service connections not included).		
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.		

C21c - MAINS LAID BETWEEN 1911 AND 1915		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1921 and 1925 (Service connections not included).		
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.		

C21d - MAINS LAID BETWEEN 1906 AND 1910		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1906 and 1910 (Service connections not included).		
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.		

C21e - MAINS LAID BETWEEN 1901 AND 1905		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total length of transmission and distribution mains laid between 1901 and 1905 (Service connections not included).		
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.		

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C21f - MAINS LAID BEFORE 1900		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total length of transmission and distribution mains laid before 1900 (Service connections not included).		
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.		

C38 - MAINS LOCATION UNDER FLEXIBLE ROADWAY)		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under flexible roadway		
COMMENT:		

C39 - MAINS LOCATION UNDER RIGID ROADWAY		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under rigid roadway		
COMMENT:		

C40 - MAINS LOCATION UNDER SIDEWALK		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under sidewalk		
COMMENT:		

C41 - MAINS LOCATION UNDER GREEN AREAS		
UNIT OF EXPRESSION: km	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Mains location under green areas		
COMMENT:		

C42 - 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		
COMMENT:		

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C43 - BEDDING SOIL TYPE		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Alpha-numeric
DEFINITION: Soil type where is bedded the pipe, according to categories to be defined		
COMMENT:		

BACKFILLING SOIL TYPE (C44)		
UNIT OF EXPRESSION: -	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Alpha-numeric
DEFINITION: Soil type where is bedded the pipe, according to categories to be defined		
COMMENT:		

AVERAGE CLOSENESS TO TREES (C45)		
UNIT OF EXPRESSION: m	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Average closeness between the pipe and the trees		
COMMENT:		

PIPE RIGID JOINTS (C46)		
UNIT OF EXPRESSION: number???	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Pipe with rigid joints		
COMMENT:		

PIPE FLEXIBLE JOINTS (C47)		
UNIT OF EXPRESSION: number???	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION: Pipe with flexible joints		
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.		
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.		
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.		
COMMENT:		

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WATER STORAGE

C2 - TRANSMISSION & DISTRIBUTION STORAGE TANKS CAPACITY (IWA PI variable)		
UNIT OF EXPRESSION: m^3	REFERENCE DATE: *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total volume of transmission and distribution storage tanks.		
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

C4 - PUMPING STATIONS (IWA PI variable)		
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).		
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.		
COMMENT:		

SENSITIVE SERVICE CONNECTIONS (C32a - corresponds to a subset of the IWA PI variable C32)		
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.)		
COMMENT:		

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.		
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 (C48a - 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		
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 (C48b - 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		
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 (C48c - 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		
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 (C48d - 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		
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

ANNUAL 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 annual allowance of water abstraction for water supply, based on the availability of water resources.		
COMMENT:		
If the maximum annual 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.		
COMMENT:		
If the maximum annual allowance is not contracted with the supplier, it shall be estimated as accurately as possible.		

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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.		
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.		
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.		
COMMENT:		

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.		
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 from the supply area.		
COMMENT:		

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.		
COMMENT:		
These transfers can occur anywhere downstream of the treatment plants.		

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.		
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.		
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.		

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.		
COMMENT:		
The annual volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average duration of individual leaks.		

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.		
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.		

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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		
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.		
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).		
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).		
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.		
COMMENT:		
Interruptions inherent to a systematic intermittent supply must not be accounted in this variable.		

CRITICAL INTERRUPTIONS (D33a - corresponds to a subset of the IWA PI variable D33)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Total number of supply interruptions to sensitive service connections during the year.		
COMMENT:		
Sensitive areas can be defined as urban zones where serious human consequences (for example hospitals, dialysis patients, etc), severe damages (landslide, flooding) or severe disturbances (traffic interruptions) may occur due to water main bursts. 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).		
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.		
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.		
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.		
COMMENT:		

TASTE TESTS PERFORMED (D42a - corresponds to the IWA PI variable D42)		
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.		
COMMENT:		

COLOUR TESTS PERFORMED (D42b - corresponds to the IWA PI variable D42)		
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.		
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.		
COMMENT:		

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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.		
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.		
COMMENT:		

COMPLIANCE OF WATER TASTE TESTS (D51a - corresponds to a subset of the IWA PI variable D51)		
UNIT OF EXPRESSION: - (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of water taste tests of treated water performed during the year and complying with the applicable standards or legislation.		
COMMENT:		

COMPLIANCE OF WATER COLOUR TESTS (D51b - corresponds to a subset of the IWA PI variable D51)		
UNIT OF EXPRESSION: - (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of water colour tests of treated water performed during the year and complying with the applicable standards or legislation.		
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 water performed during a year and complying with the applicable standards or legislation.		
COMMENT:		

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.		
COMMENT:		

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.		
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.		
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.		
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.		
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.		
COMMENT:		

REPLACED OR RENEWED 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 or renewed during the year.		
COMMENT: Valves installed in service connections shall not be included.		

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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.		
COMMENT:		

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.		
COMMENT:		

PIPE FAILURES (D25a - corresponds to a subset of the IWA PI variable D25)		
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.		
COMMENT:		

JOINT FAILURES (D25b - corresponds to a subset of the IWA PI variable D25)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of joint failures during the year.		
COMMENT:		

VALVE FAILURES (D25c - corresponds to a subset of the IWA PI variable D25)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION: Number of valve failures during the year.		
COMMENT:		

SERVICE CONNECTION INSERTION POINT FAILURES (D25d - corresponds to a subset of the IWA PI variable D25)		
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.		
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.		

CRITICAL MAINS FAILURES (D25e - corresponds to a subset of the IWA PI variable D25)		
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.		
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.		
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.		
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).		
COMMENT:		

REHABILITATION

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		
COMMENT:		

RENOVATION DATE		
UNIT OF EXPRESSION: yy.mm.dd	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Renovation date of the pipe (Note: end of the failure dates series of the previously existing pipe and beginning of the new series)		
COMMENT:		

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INTERFERENCE WITH OTHER INFRASTRUCTURES

REPAIRS RISK TO AFFECT OTHER INFRASTRUCTURES		
UNIT OF EXPRESSION: yes/no	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Alphanumeric
DEFINITION:		
Relevant risk to affect other infrastructures due to repair works in the water supply system		
COMMENT:		

QUALITY OF SERVICE DATA

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.		
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.		
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.		
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.		
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.		
COMMENT:		

WATER TASTE CUSTOMER COMPLAINTS (F14a - corresponds to a subset of the IWA PI variable F14)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of water taste customer complaints during the year.		
COMMENT:		

WATER COLOUR CUSTOMER COMPLAINTS (F14b - corresponds to a subset of the IWA PI variable F14)		
UNIT OF EXPRESSION: (number)	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Integer
DEFINITION:		
Number of water colour customer complaints during the year.		
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 customer complaints due to supply interruptions during the year.		
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.		

CUSTOMER COMPLAINTS ON CRITICAL INTERRUPTIONS (F15a - corresponds to a subset of 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 in critical areas during the year.		
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 COSTS (corresponds to the IWA PI variable G1)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total annual costs, including capital and running costs.		
PROCESSING RULE: G2+G3		
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

ANNUAL RUNNING COSTS (corresponds to the IWA PI variable G2)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION:		
Total annual operations and maintenance costs + internal manpower costs - capitalised costs of self-constructed assets.		
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.		

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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).		
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.		

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

ANNUAL REVENUE (corresponds to the IWA PI variable G21)		
UNIT OF EXPRESSION: €/year	PERIOD: *[dd.mm]*.yy-1 – *[dd.mm]*.yy	TYPE: Real
DEFINITION: Total operating revenues – capitalised costs of self constructed assets		
PROCESSING RULE: Input data		
COMMENT: Capitalised costs of self-constructed assets have more correctly to be intended not as revenue but as an economic correction of each type of cost to negative apportion. These capitalisations have consequently to be negative allocated even for the calculation of annual revenues. 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).		
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).		
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).		
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.		
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.		
COMMENT:		
Exchange rate of local currencies shall be referred to the end of the year.		

G51-56 – To be defined according to the decision to be made regarding Fi38 (Raimund).

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

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

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Appendix 6
Proposal of rehab external information

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Proposal of rehab external information

DATA	(unit)	CONCEPT
ENVIRONMENT		(These statistics relate to the area of service)
Annual rainfall		(average for the past 30 years)
• *average*	*(mm/year)*	Annual average rainfall (average for the past 30 years)
• *maximum*	*(mm/year)*	Annual maximum rainfall assessed as the annual maxima of the last 30 years
• *minimum*	*(mm/year)*	Annual 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		
Hight seat stability	*(yes/no)*	Existence of high seat stability conditions of the soil below the pipes
Medium seat stability	*(yes/no)*	Existence of medium seat stability conditions of the soil below the pipes
Low seat stability	*(yes/no)*	Existence of low seat stability conditions of the soil below the pipes
Seismic conditions		
Range of maximum soil movement		Forecasted maximum soil movement due to soil liquefaction in

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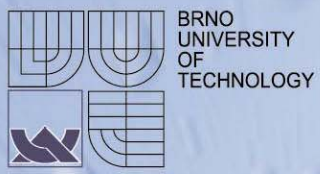
DATA	(unit)	CONCEPT
due to liquefaction	*(mm)*	seismic conditions
Range of maximum angular deflection in joints	*(º)*	Forecasted maximum angular deflection in pipe joints in seismic conditions
Range of maximum axial displacement in joints	*(mm)*	Forecasted maximum axial displacement in pipe joints in 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		
High risk to be affected by other infrastructures works	*(yes/no)*	High risk of the pipes to be affected by other infrastructure works
Medium risk to be affected by other infrastructures works	*(yes/no)*	Medium risk of the pipes to be affected by other infrastructure works
Low risk to be affected by other infrastructures works	*(yes/no)*	Low risk of the pipes to be affected by other infrastructure works
ECONOMICS		
Inflation rate	*(%/year)*	Official annual inflation rate at the end of the year in the country





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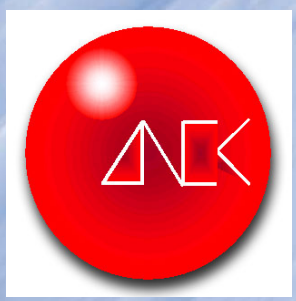
University of Ferrara, Ferrara, Italy
AGAC, Reggio Emilia, Italy



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