Highlights of the IWA system of performance indicators for water supply services

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INTRODUCTION

The objective of this paper is to provide an overview of the IWA system of performance indicators for water supply services, including a short description of the organisation of the corresponding Manual of Best Practice (Alegre *et al.,* 2000) and a listing of the performance indicators and context information considered.

ORGANIZATION OF THE IWA PI MANUAL

The structure of the IWA PI Manual is shown in Figure 1.

Figure 1 – Structure of the PI Manual

Sections 1 to 3 of the document cover general matters such as concepts and uses of PI, presentation of the structure of the Manual and, separately, a detailed list and full explanation of the definitions used in the subsequent text. Special attention is paid to the definitions related to the water balance, to the main functions of the undertaking and to the financial terminology and conventions. Section 4 is titled 'Data reporting' and considers the means of assessing the reliability of the contextual and PI information, by use of the confidence-grading scheme above presented. Section 5 describes the operating context under three headings, profiling the undertaking itself, its operating systems and the operating region. Section 6 of the IWA Manual is devoted entirely to the tabulation of all 133 suggested indicators together with their respective priority level, base concept and processing rule in the form of a simple equation. The background data definitions and processing rules are very fully elaborated in an appendix, which accounts for over half of the entire Manual. Figure 2 and Figure 3 show the organization of this chapter, containing the identification, classification, definition and processing rules of the performance indicators.

6.4 Operational indicators

INDICATOR *Level of importance* (*)	*(unit)*	CONCEPT Processing rule
INSPECTION AND MAINTENANCE		
Op1 - Pump inspections *L2*	*(%/year)*	Σ (nominal power of pumps and related ancillaries subjected to *inspection* during the year) / Σ (nominal power of pumps) x 100 *Op1 = D5/C5 x 100*
Op2 - Storage tank cleaning *L2*	*(%/year)*	Volume of storage tank cells cleaned during the last five years /total volume of storage tank cells x 100 / 5 *Op2= D6/C2 x 100*
Op3 - Network inspection *L2*	*(%/year)*	Length of transmission and distribution mains where at least valves and other fittings were *inspected* during the year / total mains length x 100 *Op3 = D7/C6 x 100*
Op4 - Leakage control *L2*	*(%/year)*	Length of mains subject to *active leakage control* / total mains length x 100 *Op4 = D8/C6 x 100*
Op5 - Active leakage control repairs *L2*	*(%/year)*	Number of leaks detected and repaired due to *active leakage control* / total mains length x 100 *Op5 = D9/C6 x 100*
Op6 - Hydrant inspection *L3*	*(%/year)*	Number of hydrants *inspected* during the year / total number of hydrants x 100 *Op6 = D10/C31 x 100*
		…

Figure 2 – General outline of the PI definitions within the Manual

(*) ***L1*** – Level 1 indicator; *L2* – Level 2 indicator; *L3* – Level 3 indicator, a guidance of the PI relative importance defined further on in this text.

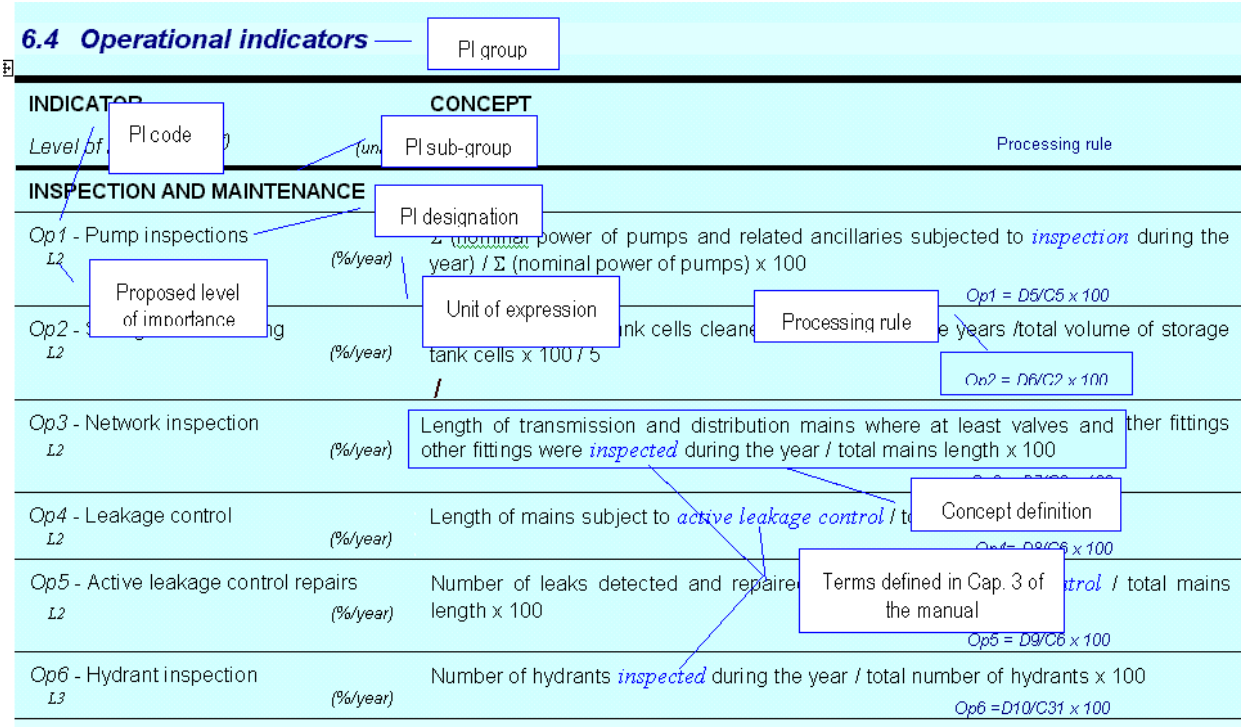

Figure 3 – PI identification and classification, description, terms and processing rules

Figure 4 and Figure 5 show the organization of the appendix of the IWA Manual, containing the definition of every variable required.

A5 - **IMPORTED RAW WATER**		
UNIT OF EXPRESSION: m^3/day	PERIOD: *[dd.mm].yy-1 – [dd.mm].yy*	VALID VALUES: ≥ 0
DEFINITION: Total annual volume of raw water transferred from other water supply systems.		
PROCESSING RULE:	Input data (Reliability: *[targeted reliability]* ; Accuracy: *[targeted accuracy]*)	
COMMENT:		
RESPONSIBILITY:	*[service responsible for this data (e.g. Operational indicators team)]*	
USED FOR VARIABLES:	*[A2], A20, A24 (A20), A26*	
USED FOR INDICATORS:	*[WR1 (A2)], WR2, Ph2 (A20), Ph3 (A20), Op22 (A20), Op24 (A24), Fi36 (A26), F137 (A24)*	

Figure 4 – General outline of variable definition

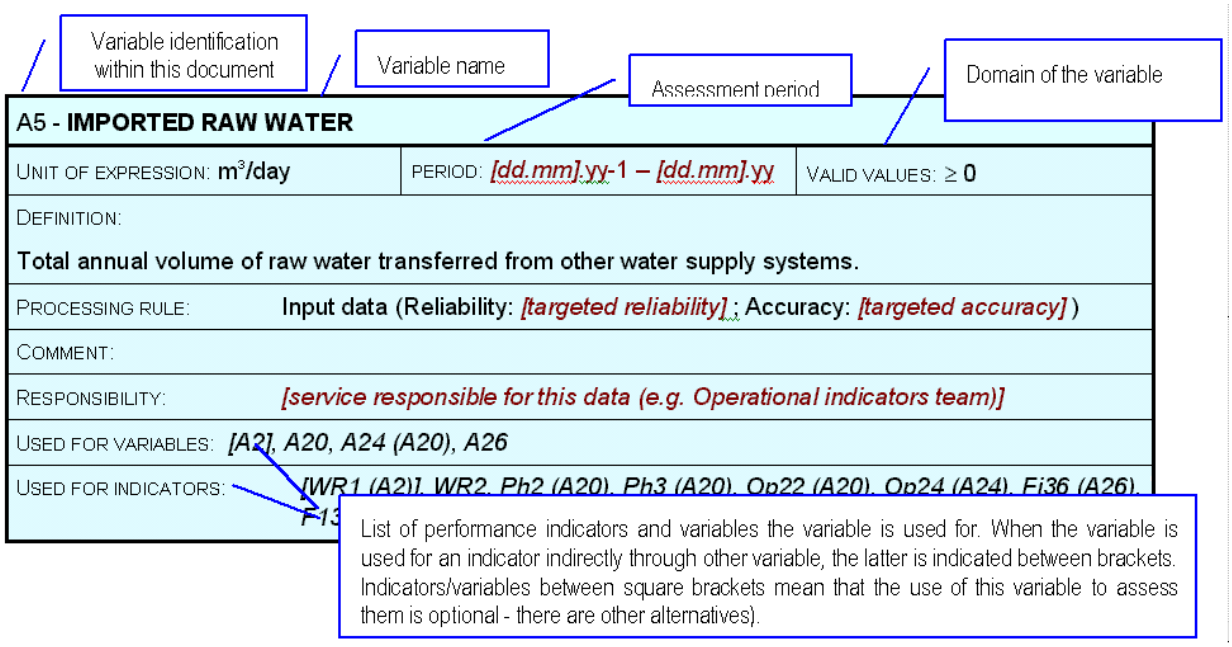

Figure 5 – Variable definition, classification and description

The main text concludes with a section on the relative importance of the PI to water undertakings, regulators and users. All 133 indicators are re-tabulated into the appropriate priority levels for each of the separate user groups.

In order to meet the criterion that the PI system be independent of the state of development or internal organizational structure of any particular undertaking, the indicators have been framed in terms of the principal management objectives common to all undertakings. These are structured in six separate categories of performance: 2 water resources indicators, 22 personnel indicators, 12 physical indicators, 36 operational indicators, 25 quality of service indicators and 36 financial indicators.

In recognition of the differing states of development and management needs that may apply in different undertakings, the Manual includes a tentative grading of level of priority of implementation, to be improved during the on-going field-test. However, this is just a general guidance and it is up to each undertaking to define the importance and applicability of every indicator for the organization. Any subsets can easily be selected, according to the utility's needs and objectives. Conversely, if the degree of detail is considered insufficient, users are naturally free to split the existing indicators in subcategories or add their own indicators, provided that they keep in mind that these new PI are not standard and therefore are not suitable for future comparisons among undertakings.

However, as referred in Alegre *et al.*(2002), the interpretation of an undertaking's performance cannot be assessed without taking its own context into account, as well as the most relevant characteristics of the system and of the region. This is why the IWA PI system includes the definition of context information, structure within the profiles of the undertaking, of the system and of the region. These profiles contain the figures that many good managers know by heart and frequently use to present their companies. The undertaking profile outlines the framework of the organization. The system profile focuses mainly on the water volumes managed, on the physical assets, on the technological means used and on the customers. The region profile will be relevant for comparisons

between undertakings, allowing for a better understanding of the demographic, economic, geographical and environmental context.

LISTING OF THE IWA PERFORMANCE INDICATORS AND GUIDANCE ON THEIR RELATIVE IMPORTANCE

The IWA PI system as a whole aims to fit the needs and of the undertakings interested in a comprehensive global assessment of their performance. The PI considered aim to incorporate all the relevant aspects required to express management objectives and results of all the key functions of a water supply undertaking.

The tentative grading of level of priority of implementation referred in the previous section include three categories, plus one of 'complementary indicators', more detailed, that are generally much more organization dependent and therefore are not included in the IWA PI system.

- LEVEL 1 (tagged "***L1***"): a first layer of indicators that provide a synthetic global overview of the efficiency and effectiveness of the water undertaking.
- LEVEL 2 (tagged "***L2***"): additional indicators, which provide a better insight than the Level 1 indicators for users who need to go further in depth.
- LEVEL 3 (tagged "***L3***"): indicators that provide the referred comprehensive global assessment of the undertaking assessment; all these indicators are still relevant at the top management level.
- COMPLEMENTARY (not included in the IWA Manual): further indicators, which may be relevant for a global assessment but be organization or country specific, or that are relevant for specific uses at departmental level (which tend to be undertaking-dependent).

LISTING OF THE IWA PERFORMANCE INDICATORS

The full listing of performance indicators and of the respective preliminary guidance of level of implementation priority is as follows:

Table 1 – Water resources indicators

INDICATOR	*(unit)*	**Suggested level**
Inefficiency of use of water resources	*(%)*	***L1***
Resources availability ratio	*(%)*	*L2*

Table 2 – Personnel indicators

INDICATOR	*(unit)*	Suggested level
TOTAL PERSONNEL		
Employees per connection	*(No./1000 connections)*	***L1***
PERSONNEL PER MAIN FUNCTION		
Management and support personnel	*(No./1000 connections)*	*L2*
Financial, commercial personnel	*(No./1000 connections)*	*L2*
Customer service personnel	*(No./1000 connections)*	*L2*
Technical activities personnel	*(No./1000 connections)*	*L2*
• *Planning & construction personnel*	*(No./1000 connections)*	*L3*
• *Operations & maintenance personnel*	*(No./1000 connections)*	*L3*
Water resources, catchment and treatment personnel	*(No./10^6 m^3/year)*	*L3*
Transmission, storage and distribution personnel	*(No /10^2 km)*	*L3*
Laboratory personnel	*(No./1000 tests)*	*L3*
Meter maintenance personnel	*(No./1000 meters)*	*L3*
Other personnel	*(No./10^6 m^3/year)*	*L3*
PERSONNEL QUALIFICATION		
University degree personnel	*(%)*	*L3*
Personnel with basic education	*(%)*	*L3*
Other personnel	*(%)*	*L3*
PERSONNEL TRAINING		
Total training	*(hous/employee/ year)*	*L3*
• *internal training*	*(hours/employee/ year)*	*L3*
• *external training*	*(hours/employee/ year)*	*L3*
PERSONNEL HEALTH AND SAFETY		
Working accidents	*(No./employee/ year)*	*L3*
Absenteeism	*(days/employee/ year)*	*L3*
• *absenteeism due to working accidents or disease*	*(days/employee/ year)*	*L3*
• *absenteeism due to other reasons*	*(days/employee/ year)*	*L3*

Table 3 – Physical indicators

INDICATOR	*(unit)*	Suggested level
TREATMENT		
Treatment availability	(%)	***L1***
STORAGE		
Impounding reservoir capacity	*(days)*	*L2*
Transmission and distribution storage capacity	*(days)*	*L2*
PUMPING		
Standardized energy consumption	*(Wh/m^3 at 100 m)*	*L2*
Reactive energy consumption	*(%)*	*L3*
Energy recovery	*(%)*	*L3*

TRANSMISSION AND DISTRIBUTION NETWORK		
Valve density	*(No./km)*	*L3*
Hydrant density	*(No./km)*	*L3*
Meters		
• *district meter density*	*(No./1000 service connections)*	*L3*
• *customer meter density*	*(No./service connection)*	*L2*
• *metered customers*	*(No./ customer)*	*L3*
• *metered residential customers*	*(No./ customer)*	*L3*

Table 4 – Operational indicators

INDICATOR	*(unit)*	**Suggested level**
INSPECTION AND MAINTENANCE		
Pumping inspection	*(%/year)*	*L2*
Storage tank cleaning	*(%/year)*	*L2*
Network inspection	*(%/year)*	*L2*
Leakage control	*(%/year)*	*L2*
Active leakage control repairs	*(%/year)*	*L2*
Hydrant inspection	*(%/year)*	*L3*
Instrumentation calibration		
• *system flow meters*	*(%/year)*	*L3*
• *meter replacement*	*(%/year)*	*L2*
• *pressure meters*	*(%/year)*	*L3*
• *water level meters*	*(%/year)*	*L3*
• *on-line water quality monitoring equipment*	*(%/year)*	*L3*
Electrical equipment inspection		
• *electrical equipment inspection by number*	*(%/year)*	*L3*
• *electrical equipment inspection by power*	*(%/year)*	*L3*
Vehicle availability	*(vehicles/km)*	*L3*
MAINS, SERVICE CONNECTION AND PUMPS REHABILITATION		
Mains rehabilitation	*(%/year)*	***L1***
• *mains relining*	*(%/year)*	*L2*
• *replaced or renewed mains*	*(%/year)*	*L2*
• *replaced valves*	*(%/year)*	*L2*
Service connection rehabilitation	*(%/year)*	***L1***
Pumps rehabilitation		
• *pump refurbishment*	*(%/year)*	*L2*
• *pump replacement*	*(%/year)*	*L2*
WATER LOSSES		
Water losses	*(m^3/connection/year)*	***L1***
• *apparent losses*	*(m^3/connection/year)*	*L3*
• *real losses*	*(l/connection/day when system is pressurized)*	***L1***
• *infrastructure leakage index*	*(-)*	*L3*
FAILURES		
Mains failures	*(No./100 km/year)*	***L1***
Service connection failures	*(No./1000 connections/ year)*	***L1***
Hydrant failures	*(No. / 1000 hydrants/ year)*	*L2*
Power failures	*(hours/pumping station/year)*	*L2*

METERING		
Customer reading efficiency[1]	*(%)*	***L1***
Residential customer reading efficiency[3]	*(%)*	***L1***
WATER QUALITY MONITORING		
Tests performed (quantity compliance)	*(%)*	***L1***
• *aesthetic*	*(%)*	*L2*
• *microbiological*	*(%)*	*L2*
• *physical-chemical*	*(%)*	*L2*
• *radioactivity*	*(%)*	*L3*

Table 5 – Quality of service indicators

INDICATOR	*(unit)*	**Suggested level**
SERVICE		
Households and businesses supply coverage [2]	*(%)*	***L1***
Buildings supply coverage[4]	*(%)*	***L1***
Population coverage[4]	*(%)*	***L1***
• *with service connections*	*(%)*	*L2*
• *public taps and standpipes*	*(%)*	*L2*
Public taps and standpipes		
• *distance to households*	*(m)*	***L1***
• *quantity of water consumed*	*(l/person/day)*	***L1***
• *population per public tap or standpipe*	*(persons/tap)*	*L2*
Pressure of supply adequacy	*(%)*	*L2*
Continuity of supply	*(%)*	***L1***
Water interruptions[3]	*(%)*	*L2*
Interruptions per connection[5]	*(No./1000 connections)*	*L2*
Population experiencing restrictions to water service [4]	*(%)*	*L2*
Days with restrictions to water service[6]	*(%)*	*L2*
Quality of supplied water (quality compliance)	*(%)*	***L1***
• *aesthetic*	*(%)*	*L2*
• *microbiological*	*(%)*	*L2*
• *physical-chemical*	*(%)*	*L2*
• *radioactivity*	*(%)*	*L3*
New connection efficiency	*(%)*	*L2*
Connection repair efficiency	*(%)*	*L2*

[1] These indicators shall be used in alternative.

[2] These indicators shall be used in alternative.

[3] These indicators shall be used in alternative.

[4] These indicators shall be used in alternative.

CUSTOMER COMPLAINTS		
Service complaints	*(No. complaints/ connection/ year)*	***L1***
• *pressure complaints*	*(%)*	*L2*
• *continuity complaints*	*(%)*	*L2*
• *water quality complaints*	*(%)*	*L2*
• *restrictions or interruptions*	*(%)*	*L2*
Billing complaints	*(No. complaints/ customer/ year)*	***L1***
Other complaints and queries	*(No. complaints & queries/ customer/ year)*	*L2*
Response to written complaints	*(%)*	*L2*

Table 6 – Financial Indicators

INDICATOR	*(unit)*	Suggested level
ANNUAL COSTS		
Unit total costs	*(US$/m^3)*	*L2*
• *unit running costs*	*(US$/m^3)*	***L1***
• *unit capital costs*	*(US$/m^3)*	*L3*
Composition of annual running costs per type of costs		
• *internal manpower costs ratio*	*(%)*	*L3*
• *external services costs ratio*	*(%)*	*L3*
• *imported (raw and treated) water costs ratio*	*(%)*	*L3*
• *energy costs ratio*	*(%)*	*L3*
• *other costs ratio*	*(%)*	*L3*
Composition of annual running costs per main function of the water undertaking		
• *management and support costs ratio*	*(%)*	*L3*
• *financial and commercial costs ratio*	*(%)*	*L3*
• *customer service costs ratio*	*(%)*	*L3*
• *technical services costs ratio*	*(%)*	*L3*
Composition of annual capital costs		
• *depreciation costs ratio*	*(%)*	*L3*
• *interest expenses costs ratio*	*(%)*	*L3*
ANNUAL REVENUE		
Unit annual revenue	*(US$/m^3)*	*L2*
• *sales revenues*	*(%)*	*L2*
• *other revenues*	*(%)*	*L2*
ANNUAL INVESTMENT		
Average unit investment	*(US$/m^3)*	*L2*
• *average annual investments for new assets*	*(%)*	*L3*
• *average annual investments for assets replacement*	*(%)*	*L3*
AVERAGE WATER CHARGES (without public taxes)		
Average water charges for direct consumption	*(US$/m^3)*	***L1***
Average water charges for exported water	*(US$/m^3)*	***L1***

INDICATOR	*(unit)*	Suggested level
EFFICIENCY INDICATORS		
Total cost coverage ratio	*(-)*	***L1***
Operating cost coverage ratio	*(-)*	***L1***
Delay in accounts receivable	*(months equivalent)*	*L2*
Investment ratio	*(%/year)*	*L2*
Contribution of internal sources to investment = CTI	*(%)*	***L1***
Average age of tangible assets	*(%)*	*L2*
Average depreciation ratio	*(%)*	*L3*
Late payments ratio	*(%)*	*L2*
LEVERAGE INDICATORS		
Debt service coverage ratio = DSC	*(%)*	*L2*
Debt equity ratio	*(-)*	*L2*
LIQUIDITY INDICATOR		
Current ratio	*(-)*	***L1***
PROFITABILITY INDICATORS		
Return on net fixed assets	*(%)*	*L2*
Return on equity	*(%)*	*L2*
WATER LOSSES INDICATORS		
Non-revenue water by volume	*(%)*	***L1***
Non-revenue water by cost	*(%)*	*L3*

DATA RELIABILITY AND ACCURACY

Control of data quality is a fundamental issue inherent to the IWA PI system. Aiming to support management decision-making, values of any performance indicator cannot be dissociated of their corresponding confidence grade. This requirement is considered so important that the software SIGMA (Cabrera *et al.*, 2002) does not accept the values of the input values if the fields corresponding the data confidence are not full-filled as well.

The methodology of assessing and reporting data confidence was borrowed from the solution adopted in England and Wales by the OFWAT, where economic regulation of the water supply companies is highly structured and detailed. As the authors of the Manual note, within this structure is a carefully developed scheme for grading the confidence that can be placed on the reliability and accuracy of inputs. The testing results currently available seem to demonstrate that this confidence-grading scheme is adequate for any other country.

The confidence-grading scheme includes a four-grade measure of the reliability of the data (sound records, analysis result, forecast, etc.) and a seven-grade classification for their respective accuracy.

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

Table 7 – Definition of the confidence-grading scheme

DATA RELIABILITY	Definition
A - Highly reliable	Data based on sound records, procedures, investigations or analyses that are properly documented and recognized 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%.

The confidence grades will be an alphanumeric code, which couples the reliability band and the accuracy band – for instance:

A2 - Data based on sound records etc. (Highly Reliable, Band A) which is estimated to be within +/- 5% (Accuracy band 2).
C4 - Data based on extrapolation form a limited sample (Unreliable, Band C), which is estimated to be within +/- 25% (Accuracy band 4).

The reliability and accuracy bands would form the matrix of confidence grades shown below:

Table 8 – Matrix of confidence grades

Accuracy Bands (%)	Reliability bands			
	A	B	C	D
[0; 1]	A1	++	++	++
]1; 5]	A2	B2	C2	++
]5; 10]	A3	B3	C3	D3
]10; 25]	A4	B4	C4	D4
]25; 50]	++	++	C5	D5
]50; 100]	++	++	++	D6

Note: '++' indicates confidence grades that are considered to be incompatible

FINAL REMARKS

The IWA-PI system is characterised by its structure, adaptable to any existing water undertaking, the detail of the definitions and its flexibility, allowing for an easy customisation without losing its standard character.

The indicators have been selected in order to cover the most relevant and common needs of the water undertakings. Special attention has been paid in order to assure that the

system is applicable to undertakings and regions of the world with different characteristics, particularly in terms of development. Most indicators are applicable in any undertaking. Some have been included to fit the requirements of complex and well-equipped undertakings. Some others may be irrelevant for the industrialised countries but are of major importance for developing regions. Each undertaking is encouraged to select the subset of indicators that better corresponds to its case.

REFERENCE

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