ENV2.2

Potable water demand and waste water volume

Objective

Our objective is to maintain the natural water cycle and reduce potable water demand by recycling waste water and using local resources.

Benefits

Reduction of potable water and waste water demand reduces running costs. In addition, a high level of waste water recycling and the use of local resources (wells, rainwater) helps achieve independence from price fluctuations and availability.

Contribution to overriding sustainability goals

	CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS (SDGS) OF UNITED NATIONS (UN)		CONTRIBUTION TO THE GERMAN SUSTAINABILITY STRATEGY	
Moderate	6.3	Improvement of water quality		
	6.4	Efficient use and sustainable extraction of water		
Low	6.5	Implementation of integrated water resource management	6.2	Potable water and sanitation

Outlook

The issue of potable water will continue to increase in importance, particularly in an international context. The DGNB will monitor developments and update the criterion accordingly. In addition, a quality assessment can be added in the long term, as contamination of potable water with nitrates will increase in relevance.

Share of total score

	SHARE	WEIGHTING FACTOR[1]
Office, Education, Residential, Hotel, Consumer market, Department stores, Logistics, Production	2.4%	2
Shopping centre	2.3%	2
Assembly buildings	2.5%	2

[1] Share of the total score and weighting factor may vary depending on the country specific Water Stress Indicator (WSI), detailed description in Appendix 1

EVALUATION

The quantitatively determined water use value that represents the balance of potable water and waste water can be used for evaluation. In addition, maintenance of the natural water cycle and reduction of potable water demand by recycling waste water and using local resources is taken into account using the indicators "Watering and retention" and "Integration into the district infrastructure". In this criterion, the maximum possible number of 100 points can be achieved.

NO.	INDICATOR	POINTS
1	**Potable water demand and waste water volume**	
1.1	**Water use value**	**Max. 90**
	■ Dynamic limit value ≤ water use value	10
	■ Dynamic reference value ≥ water use value	45
	■ Dynamic target value ≥ water use value	90
Re 1	**CIRCULAR ECONOMY** Explanation: The use of rainwater or grey water is incorporated into the assessment of the water use value. The potable water saved and the reduced waste water are recorded in the assessment of the water parameter and are incorporated into the life cycle assessment evaluation. The contribution to the circular economy is thereby fully implemented in the criterion.	
2	**External works**	
2.1	**Watering and retention**	**Max. 5**
	■ Watering the outdoor facilities with potable water is not foreseen.	+2.5
	■ The outdoor facilities include rainwater retention devices.	+2.5
3	**Integration into the district infrastructure**	
3.1	**Level of integration** The rainwater and waste water disposal method is geared towards the existing infrastructure in the surrounding district and uses all available opportunities for separation, reduction, etc.	**5**

SUSTAINABILITY REPORTING AND SYNERGIES

Sustainability reporting

Appropriate key performance indicators (KPIs) include using the water use value determined in indicator 1 for communication. In addition, the water demand of the users can be used for communication in accordance with the "Level(s) – Common EU framework of core environmental indicators" (more detailed description is under the [T&D_02]).

NO.	KEY PERFORMANCE INDICATORS (KPIS)	UNIT
KPI 1	Water use value and WSI in accordance with the DGNB; corresponds to Level(s) indicator 3.1 "Use stage water consumption" incl. water exploitation index (WEI+) Note 1: This indicator should be communicated differentiated by "Sanitary water consumption", "Water consumption by devices that need water" and "Total water consumption", and should also relate to the number of people	[m³/a]
KPI 2	GRI Disclosure 303-1 (an international sustainability reporting organization) "Total water withdrawal by source" Note 1: The total water demand, indicating the source (groundwater, rainwater, waste water of another organisation, communal water supply)	[m³/a]

Synergies with DGNB system applications

- **DGNB BUILDINGS IN USE:** High synergies with criterion ENV9.1 from the scheme for buildings in use : The demand values for water from the water parameter calculation can be used for the operation. This enables consumption values to be checked and helps users to optimise operation.

- **DGNB RENOVATED BUILDINGS:** High synergies with criterion ENV2.2 (calculation of indicator 1) from the scheme for renovated buildings.

- **DGNB DISTRICT:** The results determined for use of rainwater or grey water in the buildings, details of watering of the external works and information regarding integration into the district have high synergies with criterion ENV2.2 from the schemes for urban districts and business districts.

APPENDIX A – DETAILED DESCRIPTION

I. Relevance

Reduction of potable water demand reduces running costs. In addition, a high level of waste water recycling and the use of local resources (wells, rainwater) helps achieve independence from price fluctuations and availability. All these and many other aspects may vary in severity depending on the geographical location. During the country specific adaptation process of the system, the share and weight of this criterion may be adjusted according to the WSI listed in the Appendix 1 of this document.

II. Additional explanation

In order to ensure supply of high-quality potable water, water is withdrawn from the natural cycles on a daily basis, subjected to cost-intensive preparation and then used. The resulting waste water must then be purified of harmful substances and contamination before it is returned to the natural water cycle. The objective of sustainable construction is therefore to reduce potable water demand and waste water volume in order to disturb the natural water cycle as little as possible.

These requirements are tested and evaluated on the basis of established assumptions regarding user behaviour and planned use of grey water and rainwater. Equally important is the issue of how the water is drained and treated within the building. A holistic approach that also takes design aspects into account enables conditions to be established that are crucial for achieving the objectives specified in the DGNB criterion.

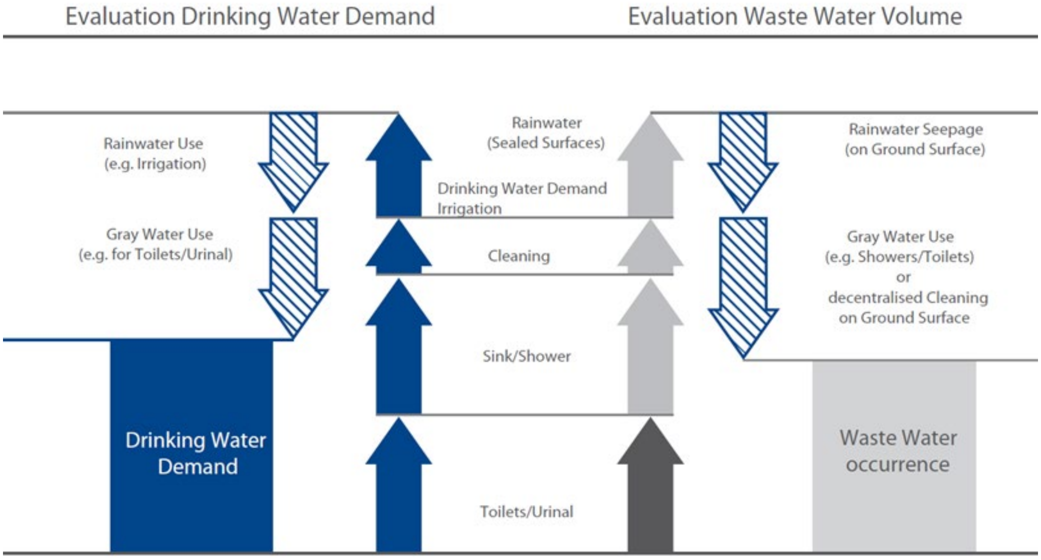
III. Method

Adding together the determined potable water demand and waste water volume results in the "water use value". This represents a simple value for evaluating the use of water in the building. The water expended during construction is ignored. Established assumptions regarding user behaviour and actually determined parameters are incorporated into the evaluation.

System limits

Measures that can be affected by the designer are primarily considered for evaluation of the potable water demand and waste water volume. This does not include demand for potable water for drinking or, where applicable, food preparation, for example. A selective analysis of individual criteria is not permitted, as this conflicts with a holistic evaluation. This means that elements such as decentralised waste water treatment plants and planned use of rainwater, river water or waste water may only be incorporated into the assessment if they are also taken into consideration in the other relevant criteria (particularly the building-related life cycle costs).
In general, consumption by users is the deciding factor for the water demand, meaning that water-saving technology is particularly worthwhile for reducing water consumption. In contrast, cleaning has only a minor impact, while the impact of the total area used for plants and rainwater management must be evaluated differently depending on the local circumstances.

Figure 1: System limits of the water use value calculation



Benchmarks

Depending on the number of users, roof surface area and amount of plants, a building's annual demand for potable water and the amount of waste water produced can vary greatly. For this reason, a dynamic limit value is determined using the individual conditions of the building. Usage-specific limit values are determined according to the formulas in indicator 1, whereby neither grey nor rain or river water use or decentralized wastewater treatment is taken into account.

Indicator 1.1: Water use value

The water use value (WUV) is calculated as follows:

$$W_{UV} = (WD_U + WW_U) + (WW_{RW}) + (WD_{SPA} + WW_{SPA}) \quad (1)$$

where

- W_{UV} Water use value in [m³/a]
- WD_U Employee water demand in [m³/a]
- WW_U Waste water by users in [m³/a]
- WW_{RW} Portion of rainwater diverted to the drain system in [m³/a]
- WD_{SPA} Drinking water requirement for spa area in [m³/a]
- WW_{SPA} Waste water for spa area in [m³/a]

IV. Usage-specific description

Office
Education
Residential (up to "Specifications for user behaviour" and "Presence days")
Logistics
Production (up to "Specifications for user behaviour")

Indicator 1: Potable water demand and waste water volume – by users
The water demand of employees (WD_U) is determined from the total of the potable water demand of installations under the established assumptions regarding user behaviour. Use of rainwater, river water or grey water that can replace the use of potable water is subtracted from the water demand:

$$\mathbf{W_{DU} = \sum_{i=1}^{n} wd_I - N_{RW} - N_{GW}} \qquad \textbf{(2)}$$

where

- WD_U Water demand by users/residents/employees in [m³/a]
- wd_I Specific water demand of installations in the building in [m³/a]
- N_{RW} Amount of rainwater or river water used, e.g. to flush toilets, in [m³/a]
- N_{GW} Amount of grey water used, e.g. to flush toilets, in [m³/a]

The amount of rainwater, river water and grey water used can be taken from the profitability calculation for use of rainwater, river water and grey water.
The specific water demand of installations (wd_I) is determined on the basis of the daily water demand under established assumptions regarding user behaviour and presence days:

$$\mathbf{wd_I = (n_U * f_I * cv_I * d/a) / 1000} \qquad \textbf{(3)}$$

where

- wd_I Specific potable water demand of installations in the building in [m³/a]
- n_U Number of users
- f_I Installation-specific factor for water use in accordance with Table 1, in [seconds/day] or [flushes/day]
- cv_I Installation-specific consumption value in [litres/seconds] or [litres/flush]
- d Presence days (= 210 days)
- a Year

The waste water produced by users (WW_U) is calculated as the total of the specific water demand of the installations, subtracting reused grey water and/or waste water purified via decentralised treatment on-site:

$$\mathbf{.WW_U = \sum_{i=1}^{n} wd_I - N_{GW} - R_{BW}} \qquad \textbf{(4)}$$

where

- WW_U Waste water by users in [m³/a]
- wd_I Specific potable water demand of installations in the building in [m³/a]

- N_{GW} Amount of grey water reused, e.g. to flush toilets, in [m³/a]
- R_{BW} Amount of waste water purified on-site in [m³/a]

The amount of purified waste water can be taken from the design of the decentralised (small) sewage treatment plant.

Table 1: Specifications for user behaviour

INSTALLATION	INSTALLATION-SPECIFIC FACTOR F_I FOR WATER USE [SECONDS OR FLUSHES PER PERSON AND DAY]
Hand washbasin	45
Water-saving WC flush	1
WC	1
Urinal	1
Shower	30
Kitchen sink	20

The installation-specific factors are derived from the assumptions that:

- Each user washes their hands three times a day, for 15 seconds each time
- The ratio of water-saving WC flush/urinal usage to normal WC flush usage is 2:1; this assumes an equal gender ratio (50% each)
- 10% of employees shower daily, for 5 minutes each time (if shower facilities are available)
- The kitchen sink is used to wash up e.g. one cup per employee

Table 2: Specifications for the limit value of the installation-specific consumption value (cvl) in [litres/second] or [litres/flush]

INSTALLATION	CONSUMPTION VALUE (IN LITRES/SECOND OR LITRES/FLUSH)
Hand washbasin (litres/second)	0.15
Water-saving WC flush (litres/flush)	3
WC (litres/flush)	6
Urinal (litres/flush)	1.5
Shower (litres/second)	0.25
Kitchen sink (litres/second)	0.25

Residential

Indicator 1: Potable water demand and waste water volume – by users
Presence days for the specific water requirements of existing installations wbi:

- d presence days (=345 d)

Table 3: Specifications for user behaviour

INSTALLATION	INSTALLATION-SPECIFIC FACTOR F_i FOR WATER USE IN [SECONDS OR FLUSHES PER PERSON AND DAY]
Hand washbasin	195
Water-saving WC flush	4
WC	1
Shower	120
Dishwasher	0.5
Washing machine	0.25

Dwellings with bathtubs:
In terms of saving water, showering is clearly preferable to bathing. Bathtub types must be selected that can also be used for showering without compromising comfort or convenience.
For bathtubs, the water savings are directly proportional to the volume of the bathtub. The smaller the bathtub, the greater the possible water savings.
The type of distribution fitting does not affect the water demand when filling the bathtub. Savings as a result of the fittings are only possible in the case of showers.
For dwellings with bathtubs, it is assumed that they are used to take a bath with a full bathtub once every 14 days, and are used for showering on the remaining days.

Table 4: Specifications for the limit value of the installation-specific consumption value (cvl) in [litres/second] or [litres/flush]

INSTALLATION	CONSUMPTION VALUE (IN LITRES/SECOND OR LITRES/FLUSH)
Hand washbasin (litres/second)	0.15
Water-saving WC flush (litres/flush)	3
WC (litres/flush)	6
Shower (litres/second)	0.25
Bathtub (litres/full bathtub)	70 (volume)
Dishwasher (litres/wash cycle)	20
Washing machine (litres/wash cycle)	60

Production

Indicator 1: Potable water demand and waste water volume – by users

Presence days for the specific water requirements of existing installations wbi:

- d presence days (=260 d)

Table 5: Specifications for user behaviour

INSTALLATION	INSTALLATION-SPECIFIC FACTOR F_i FOR WATER USE [SECONDS OR FLUSHES PER PERSON AND DAY]
Hand washbasin	90
Water-saving WC flush	1
WC	1
Urinal	1
Shower	150
Kitchen sink	20

The installation-specific factors are derived from the assumptions that:

- Each employee washes their hands three times a day, for 30 seconds each time
- The ratio of water-saving WC flush/urinal usage to normal WC flush usage is 2:1; this assumes an equal gender ratio (50% each)
- 50% of employees shower daily, for 5 minutes each time (if shower facilities are available)
- The kitchen sink is used to wash up e.g. one cup per employee

Table 6: Specifications for the limit value of the installation-specific consumption value (cvl) in [litres/second] or [litres/flush]

INSTALLATION	CONSUMPTION VALUE (IN LITRES/SECOND OR LITRES/FLUSH)
Hand washbasin (litres/second)	0.15
Water-saving WC flush (litres/flush)	3
WC (litres/flush)	6
Urinal (litres/flush)	1.5
Shower (litres/second)	0.25
Kitchen sink (litres/second)	0.25

Supermarket **Shopping centre** **Department store** **Assembly buildings**

Indicator 1: Potable water demand and waste water volume – by users

$$WD_U = WD_E + WD_{CU} \quad (2)$$

where

- WD_U Water demand by users in [m³/a]
- WD_E Water demand by employees in [m³/a]
- WD_{CU} Water demand by customers in [m³/a]

$$WW_U = WW_E + WW_{CU} \quad (3)$$

where

- WW_U Waste water by users in [m³/a]
- WW_E Waste water by employees in [m³/a]
- WW_{CU} Waste water by customers in [m³/a]

Employees

The water demand of employees (WD_E) is determined from the total of the potable water demand of installations under the established assumptions regarding user behaviour. Use of rainwater, river water or grey water that replaces the use of potable water is subtracted from the water demand:

$$WD_E = \sum_{i=1}^{n} wd_I - N_{RW} - N_{GW} \quad (4)$$

where

- WD_E Water demand by employees in [m³/a]
- wd_I Specific water demand of installations in the building in [m³/a]
- N_{RW} Amount of rainwater or river water used, e.g. to flush toilets, in [m³/a]
- N_{GW} Amount of grey water used, e.g. to flush toilets, in [m³/a]

The amount of rainwater, river water and grey water used can be taken from the profitability calculation for use of rainwater, river water and grey water.

The specific water demand of installations (wd_I) is determined on the basis of the daily water demand under established assumptions regarding user behaviour and presence days:

$$wd_I = (n_E * f_I * cv_I * d/a) / 1000 \quad (5)$$

where

- wd_I Specific potable water demand of installations in the building in [m³/a]
- n_E Number of employees
- f_I Installation-specific factor for water use in accordance with Table 1, in [seconds/day] or [flushes/day]
- cv_I Installation-specific consumption value in [litres/seconds] or [litres/flush]
- d Presence days according to the table 7
- a Year

The waste water produced by employees (WW_E) is calculated as the total of the specific water demand of the installations, subtracting reused grey water and/or waste water purified via decentralised treatment on-site:

$$\mathbf{WW_E = \sum_{i=1}^{n} wd_I - N_{GW} - R_{BW}} \quad \textbf{(6)}$$

where

- WW_E Waste water by employees in [m³/a]
- wd_I Specific potable water demand of installations in the building in [m³/a]
- N_{GW} Amount of grey water reused, e.g. to flush toilets, in [m³/a]
- R_{BW} Amount of waste water purified on-site in [m³/a]

The amount of purified waste water can be taken from the design of the decentralised (small) sewage treatment plant.

Table 7: Specifications for days of attendance

BUILDING USE	PRESENCE DAYS IN YEAR
Consumer market, Department stores Shopping centre	312
Congress, - Trade fair, - and Municipal halls,	150
Museums, Exhibition halls	250
Theatre and Concert halls	250
Libraries	300

Specification (days of attendance per use profile) of table 7 is based on DIN V 18599-10: 2016-10 (Table 5 - Guide values for the boundary conditions for non-residential buildings).

Customers

The water demand of customers (WD_{CU}) is determined from the total of the potable water demand of installations under the established assumptions regarding user behaviour. Use of rainwater, river water or grey water that replaces the use of potable water is subtracted from the water demand:

$$\mathbf{WD_{CU} = \sum_{i=1}^{n} wd_I - N_{RW} - N_{GW}} \quad \textbf{(7)}$$

where

- WD_{CU} Water demand by customers in [m³/a]

- wd_I Specific water demand of installations in the building in [m³/a]
- N_{RW} Amount of rainwater or river water used, e.g. to flush toilets, in [m³/a]
- N_{GW} Amount of grey water used, e.g. to flush toilets, in [m³/a]

The amount of rainwater, river water and grey water used can be taken from the profitability calculation for use of rainwater, river water and grey water.

The specific water demand of installations (wd_I) is determined on the basis of the daily water demand under established assumptions regarding user behaviour and presence days:

$$wd_I = (n_{CU} * f_I * as_I * d/a) / 1000 \qquad (8)$$

where

- wd_I Specific potable water demand of installations in the building in [m³/a]
- n_{CU} Number of customers
- f_I Installation-specific factor for water use in accordance with Table 1, in [seconds/day] or [flushes/day]
- cv_I Installation-specific consumption value in [litres/seconds] or [litres/flush]
- d Presence days according to the table 7
- a Year

Consumer market **Department stores** **Shopping centre**

- It is assumed that 5% of customers use the sanitary facilities.

Assembly buildings

The maximum number of customers according to the seating plan of the largest event hall located in the building or assigned to the building. Alternatively, the maximum number of authorized visitors (customers) can be used. The number of customers determined in this way must be multiplied by the following factor in order to determine the average number of customers on annual usage:

- **0.5** for Assembly buildings that are designed for predominantly seated events (e.g. congress, theatre, cinema)
- **0.3** for Assembly buildings that are designed for both seated and standing events (such as exhibition halls, town halls) Alternatively, another basis can be used to determine the number of visitors, if this is reasonably justified and corresponds to the building and the operating concept.

The waste water produced by customers (WW_{CU}) is calculated as the total of the specific water demand of the installations, subtracting reused grey water and/or waste water purified via decentralised treatment on-site:

$$\mathbf{WW_{CU}} = \sum_{i=1}^{n} \mathbf{wd_I} - \mathbf{N_{GW}} - \mathbf{R_{BW}} \qquad (9)$$

where

- WW_{CU} Waste water by customers in [m³/a]
- wd_I Specific potable water demand of installations in the building in [m³/a]
- N_{GW} Amount of grey water reused, e.g. to flush toilets, in [m³/a]
- R_{BW} Amount of waste water purified on-site in [m³/a]

The amount of purified waste water can be taken from the design of the decentralised (small) sewage treatment plant.

Table 8: Specifications for user behaviour

INSTALLATION	INSTALLATION-SPECIFIC FACTOR F_I FOR WATER USE [SECONDS OR FLUSHES PER PERSON AND DAY]	
	EMPLOYEES	CUSTOMERS
Hand washbasin	45	15
Water-saving WC flush	1	0.3
WC	1	0.5
Urinal	1	0.2
Shower	30	-
Kitchen sink	20	-

The installation-specific factors are derived from the assumptions that:

Employees

- Each employee washes their hands three times a day, for 15 seconds each time
- The ratio of water-saving WC flush/urinal usage to normal WC flush usage is 2:1; this assumes an equal gender ratio (50% each)
- 10% of employees shower daily, for 5 minutes each time (if shower facilities are available)
- The kitchen sink is used to wash up e.g. one cup per employee.

Customers

- 5% of customers use the sanitary facilities
- The customers using the sanitary facilities are 60% female customers and 40% male customers
- Each user washes their hands for an average of 15 seconds
- Female customers use the water-saving WC flush and the normal WC flush in a 1:1 ratio, while male customers use the urinal/water-saving WC flush and the normal WC flush in a 1:1 ratio

Hotel

Indicator 1: Potable water demand and waste water volume – by users

The water demand of guests (WD_U) is determined from the total of the potable water demand of installations under the established assumptions regarding user behaviour. Use of rainwater, river water or grey water that replaces the use of potable water is subtracted from the water demand:

$$\mathbf{WD_U = \sum_{i=1}^{n} wd_I - N_{RW} - N_{GW}} \qquad \textbf{(2)}$$

where

- WD_U Water demand by guests in [m³/a]
- wd_I Specific water demand of installations in the building in [m³/a]
- N_{RW} Amount of rainwater or river water used, e.g. to flush toilets, in [m³/a]
- N_{GW} Amount of grey water used, e.g. to flush toilets, in [m³/a]

The amount of rainwater, river water and grey water used can be taken from the profitability calculation for use of rainwater, river water and grey water.

The specific water demand of installations (wd_I) is determined on the basis of the daily water demand under established assumptions regarding user behaviour and presence days:

$$wd_I = (n_U * f_I * cv_I * d/a) / 1000 \qquad (3)$$

where

- wd_I Specific potable water demand of installations in the building in [m³/a]
- n_U Number of guests
- f_I Installation-specific factor for water use in accordance with Table 1, in [seconds/day] or [flushes/day]
- cv_I Installation-specific consumption value in [litres/seconds] or [litres/flush]
- d Presence days (= 360 days)
- a Year

The specific water demand of installations (wd_I) is determined on the basis of the daily water demand under the assumption of 360 days of occupancy, usage of 65% of the total capacity and an average occupancy for double rooms of 1.2 people:

$$n_U = (n_{SR} + (n_{DR} * 1.2)) * 0.65 \qquad (4)$$

where

- n_U Number of guests
- n_{SR} Number of single rooms
- n_{DR} Number of double rooms

The waste water produced by guests (WW_U) is calculated as the total of the specific water demand of the installations, subtracting reused grey water and/or waste water purified via decentralised treatment on-site:

$$\mathbf{WW_U} = \sum_{i=1}^{n} \mathbf{wd_I} - \mathbf{N_{GW}} - \mathbf{R_{BW}} \qquad (5)$$

where

- WW_U Waste water by guests in [m³/a]
- wd_I Specific potable water demand of installations in the building in [m³/a]
- N_{GW} Amount of grey water reused, e.g. to flush toilets, in [m³/a]
- R_{BW} Amount of waste water purified on-site in [m³/a]

The amount of purified waste water can be taken from the design of the decentralised (small) sewage treatment plant.

Table 9: Specifications for user behaviour

INSTALLATION	INSTALLATION-SPECIFIC FACTOR F_i FOR WATER USE [SECONDS OR FLUSHES PER PERSON AND DAY]
Hand washbasin	75
Water-saving WC flush	1
WC	1
Urinal	1
Hand washbasin in SPA	15
Water-saving WC flush in SPA	1
Shower in SPA	600

The installation-specific factors are derived from the assumptions that:

- Each guest uses the hand washbasin once a day, for 75 seconds each time
- The water-saving WC flush or urinal is used twice per overnight stay, and the normal WC flush is used once per overnight stay
- The shower is used for 300 seconds per overnight stay
- In the spa area, the hand washbasin is used for 15 seconds per spa visitor, the shower is used for 600 seconds per spa visitor and the water-saving WC flush is used once per spa visitor
- Swimming pools are not taken into consideration

Table 10: Specifications for the limit value of the installation-specific consumption value (cvl) in [litres/second] or [litres/flush]

INSTALLATION	CONSUMPTION VALUE (IN LITRES/SECOND OR LITRES/FLUSH)
Hand washbasin (litres/second)	0.15
Water-saving WC flush (litres/flush)	3
WC (litres/flush)	6
Shower (litres/second)	0.25

Indicator 1: Potable water demand and waste water volume – waste water due to rainwater diverted to the drain system

The portion of rainwater diverted to the drain system (WW_{RW}) is determined as follows:

$$WW_{RW} = N_P - P_{RW} - N_{RW} \quad (6)$$

where

- WW_{RW} Waste water due to rainwater diverted to the drain system
- N_P Amount of precipitation in [m³/a]
- P_{RW} Amount of rainwater infiltrating into soil or diverted into rivers or canals in [m³/a]

- N_{RW} Amount of rainwater used, e.g. to flush toilets, in [m³/a]

Suitable documentation of the amount of rainwater infiltrating into the soil must be provided. The amount of precipitation to be taken into consideration N_P is determined as follows:

$$N_P = (A_R * e_R + A_S * e_S) * S_{RW} / 1000 \qquad (7)$$

where

- A_R Roof surface area
- A_S Sealed surface area [m²]
- e_R Yield coefficient of roof surface
- e_S Yield coefficient of sealed ground surface
- S_{RW} Site-specific annual precipitation

Table 11: Specifications for the limit value for the drainage of rainwater

Yield coefficient of roof surface	0.8
Yield coefficient of ground	0.8

Outdoor green spaces with natural infiltration have a yield coefficient of 0.0.
The plot area that must be taken into account is the plot area, not including the building floor area.

Table 72: Yield coefficients[2]

CONDITION	YIELD COEFFICIENT % E
Sloped hard roof (deviations depending on the absorbency and roughness)	0.8
Flat roof, not gravelled	0.8
Flat roof, gravelled	0.6
Green roof, intensive	0.3
Green roof, extensive	0.5
Paved area/interlocking paved area	0.5
Asphalt surface	0.8

Indicator 1: Potable water demand and waste water volume – by the spa area
The water demand of the spa area (WD_{SPA}) is determined from the total of the potable water demand of installations under the established assumptions regarding user behaviour:

[2] In accordance with DIN 1989

$$\mathbf{WD_{SPA}} = \sum_{i=1}^{n} \mathbf{wd_I} - \mathbf{N_{RW}} - \mathbf{N_{GW}} \qquad \textbf{(8)}$$

where

- WD_{SPA} Water demand by spa visitors in [m³/a]
- wd_I Specific water demand of installations in the building in [m³/a]
- N_{RW} Amount of rainwater used, e.g. to flush toilets, in [m³/a]
- N_{GW} Amount of grey water used, e.g. to flush toilets, in [m³/a]

The specific water demand of installations (wd_I) is determined on the basis of the daily water demand under the assumption of the spa area being open for 360 days and usage by 25% of the average total guests staying overnight:

$$\mathbf{n_{SPA} = n_U * 0.25} \qquad \textbf{(9)}$$

where

- n_{SPA} Number of spa visitors
- n_U Number of guests

$$\mathbf{wd_I = (n_{SPA} * f_I * cv_I * 360\ d/a) / 1000} \qquad \textbf{(10)}$$

where

- wd_I Specific water demand of installations in the building in [m³/a]
- n_{SPA} Number of spa visitors
- f_I Installation-specific factor for water use in accordance with Table 1, in [seconds/day] or [flushes/day]
- cv_I Installation-specific consumption value in accordance with Table 9 in [litres/second] or [litres/flush]

The waste water produced by spa guests (WW_{SPA}) is calculated as the total of the specific water demand of the installations, subtracting reused waste water or waste water purified via decentralised treatment on-site plus the amount of rainwater used for flushing toilets:

$$\mathbf{WW_{SPA}} = \sum_{i=1}^{n} \mathbf{wd_I} - \mathbf{N_{GW}} - \mathbf{R_{BW}} - \mathbf{N_{RW}} \qquad \textbf{(11)}$$

where

- WW_{SPA} Waste water for spa visitors in [m³/a]
- wd_I Specific water demand of installations in the building in [m³/a]
- N_{GW} Amount of grey water reused, e.g. to flush toilets, in [m³/a]
- R_{BW} Amount of waste water purified on-site in [m³/a]
- N_{RW} Amount of rainwater used, e.g. to flush toilets, in [m³/a]

The amount of waste water used can be taken from the profitability calculation for use of waste water, while the amount of purified waste water can be taken from the design of the decentralised (small) sewage treatment plant.

Indicator 1: Calculation of the limit value (Benchmarks)

The limit value (L) is determined according to the formulas in Table 13, here neither grey nor rain or River water use or decentralized wastewater treatment taken into account:

Table 13: Dynamic limit value formulas

Office / Education / Logistics	
Building without shower	L (m³/a) = (n_U *9.35 m³/a_U) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m³/a) = (n_U*12.5 m³/a_U) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Residential	
Buildings without bathtubs	L (m³/a) = (n_U *70.6 m³/a) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Buildings with bathtubs	L (m³/a) = (n_U*72.6 m³/a) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Consumer market / Department stores / Shopping centre	
Building without shower	L (m³/a) = (n_E*13.9 m³/a_E) + (0.05*n_{CU}*5.5 m³/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m³/a) = (n_E*18.6 m³/a_E) + (0.05*n_{CU}*5.5 m³/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Production	
Building without shower	L (m³/a) = (n_U *15.1 m³/a) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m³/a) = (n_U*34.6 m³/a) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Hotel	
Building without spa	L (m³/a) = (n_U *69.7 m³/a) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with spa	L (m³/a) = (n_U*69.7 m³/a) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000 + (n_{SPA} *113.0 m³/a)
Assembly buildings / Congress, - Trade fair, - and Municipal halls	
Building without shower	L (m³/a) = (n_E*6.5 m³/a_E) + (0.3*n_{CU}*2.57 m³/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m³/a) = (n_E*8.75 m³/a_E) + (0.3*n_{CU}*2.59 m³/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000

Assembly buildings
Museums, Exhibition halls

Building without shower	L (m^3/a) = (n_E*10.83 m^3/a_E) + (0.3*n_{CU}*4.28 m^3/a_{CU}) + (A_R*0,8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m^3/a) = (n_E*14.58 m^3/a_E) + (0.3*n_{CU}*4,31 m^3/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000

Assembly buildings
Theatre und Concert halls

Building without shower	L (m^3/a) = (n_E*10.64 m^3/a_E) + (0.5*n_{CU}*4.21 m^3/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m^3/a) = (n_E*14.37 m^3/a_E) + (0.5*n_{CU}*4.25 m^3/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000

Assembly buildings
Libraries

Building without shower	L (m^3/a) = (n_E*12.77 m^3/a_E) + (0.5*n_{CU}*5.05 m^3/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000
Building with shower	L (m^3/a) = (n_E*17.25 m^3/a_E) + (0.5*n_{CU}*5.1 m^3/a_{CU}) + (A_R*0.8 + A_S*0.8)* S_{RW}/1000

Office **Education** **Hotel** **Consumer market** **Department stores** **Logistics** **Production** **Shopping centre** **Assembly buildings**

The reference (R) and target value (T) result from discount factors:
R = X * G
T = Y * G

The associated values of X and Y are set as follows:
X = 0.66
Y = 0.33

Residential

The associated values of X and Y are set as follows:
X = 0.68
Y = 0.46

Indicator 2: Outdoor facilities

The evaluation is carried out based on two qualitative questions. The first question is whether watering the outdoor facilities with potable water is intended or not. The second question is whether the outdoor facilities include rainwater retention devices.

Indicator 3: Integration into the district infrastructure

The degree of integration into the district infrastructure is evaluated on the basis of a qualitative question. If the building's rainwater and waste water disposal method is fully geared towards the existing infrastructure in the surrounding district and uses all available opportunities for separation, reduction, etc., this can be incorporated positively into the evaluation.

Appendix 1: country specific water stress indicator (WSI)

The table below refers to the working paper WRI (World Recourses Institute) a weighted aggregation methodology that brings Aqueduct's granular sub-basin level information up to the country and river basin scale, generating global rankings of water-quantity-related risks for all users, as well as sector-specific rankings for agricultural, municipal, and industrial water users.

Baseline Water Stress (definition)
Baseline water stress measures the ratio of total water withdrawals to available renewable water supplies. Water withdrawals include domestic, industrial, irrigation and livestock consumptive and non-consumptive uses. Available renewable water supplies include surface and groundwater supplies and consider the impact of upstream consumptive water users and large dams on downstream water availability. Higher values (total score) indicate more competition among users.

Table 14: Aqueduct Country Rankings: https://www.wri.org/applications/aqueduct/country-rankings/

Name	Abbr.	Total score	Rank	Category	Label
Qatar	QAT	4,97	1	4	Extremely High (>80%)
Israel	ISR	4,82	2	4	Extremely High (>80%)
Lebanon	LBN	4,82	3	4	Extremely High (>80%)
Iran	IRN	4,57	4	4	Extremely High (>80%)
Jordan	JOR	4,56	5	4	Extremely High (>80%)
Libya	LBY	4,55	6	4	Extremely High (>80%)
Kuwait	KWT	4,43	7	4	Extremely High (>80%)
Saudi Arabia	SAU	4,35	8	4	Extremely High (>80%)
Eritrea	ERI	4,33	9	4	Extremely High (>80%)
United Arab Emirates	ARE	4,26	10	4	Extremely High (>80%)
San Marino	SMR	4,14	11	4	Extremely High (>80%)
Bahrain	BHR	4,13	12	4	Extremely High (>80%)
India	IND	4,12	13	4	Extremely High (>80%)
Pakistan	PAK	4,05	14	4	Extremely High (>80%)
Turkmenistan	TKM	4,04	15	4	Extremely High (>80%)
Oman	OMN	4,04	16	4	Extremely High (>80%)
Botswana	BWA	4,02	17	4	Extremely High (>80%)
Chile	CHL	3,98	18	3	High (40-80%)
Cyprus	CYP	3,97	19	3	High (40-80%)
Yemen	YEM	3,97	20	3	High (40-80%)
Andorra	AND	3,92	21	3	High (40-80%)
Morocco	MAR	3,89	22	3	High (40-80%)
Belgium	BEL	3,89	23	3	High (40-80%)
Mexico	MEX	3,86	24	3	High (40-80%)
Uzbekistan	UZB	3,82	25	3	High (40-80%)
Greece	GRC	3,80	26	3	High (40-80%)
Afghanistan	AFG	3,80	27	3	High (40-80%)

Spain	ESP	3,74	28	3	High (40-80%)
Algeria	DZA	3,69	29	3	High (40-80%)
Tunisia	TUN	3,67	30	3	High (40-80%)
Syria	SYR	3,64	31	3	High (40-80%)
Turkey	TUR	3,56	32	3	High (40-80%)
Albania	ALB	3,53	33	3	High (40-80%)
Armenia	ARM	3,43	34	3	High (40-80%)
Burkina Faso	BFA	3,42	35	3	High (40-80%)
Djibouti	DJI	3,37	36	3	High (40-80%)
Namibia	NAM	3,31	37	3	High (40-80%)
Kyrgyzstan	KGZ	3,31	38	3	High (40-80%)
Niger	NER	3,28	39	3	High (40-80%)
Nepal	NPL	3,17	40	3	High (40-80%)
Portugal	PRT	3,14	41	3	High (40-80%)
Iraq	IRQ	3,13	42	3	High (40-80%)
Egypt	EGY	3,07	43	3	High (40-80%)
Italy	ITA	3,01	44	3	High (40-80%)
Thailand	THA	2,98	45	2	Medium - High (20-40%)
Azerbaijan	AZE	2,94	46	2	Medium - High (20-40%)
Sudan	SDN	2,92	47	2	Medium - High (20-40%)
South Africa	ZAF	2,89	48	2	Medium - High (20-40%)
Luxembourg	LUX	2,86	49	2	Medium - High (20-40%)
Australia	AUS	2,67	50	2	Medium - High (20-40%)
Tajikistan	TJK	2,65	51	2	Medium - High (20-40%)
Macedonia	MKD	2,59	52	2	Medium - High (20-40%)
South Korea	KOR	2,55	53	2	Medium - High (20-40%)
Bulgaria	BGR	2,53	54	2	Medium - High (20-40%)
Mongolia	MNG	2,51	55	2	Medium - High (20-40%)
China	CHN	2,40	56	2	Medium - High (20-40%)
Guatemala	GTM	2,36	57	2	Medium - High (20-40%)
Estonia	EST	2,26	58	2	Medium - High (20-40%)
France	FRA	2,19	59	2	Medium - High (20-40%)
Kazakhstan	KAZ	2,16	60	2	Medium - High (20-40%)
Mauritania	MRT	2,14	61	2	Medium - High (20-40%)
Germany	DEU	2,14	62	2	Medium - High (20-40%)
Lesotho	LSO	2,13	63	2	Medium - High (20-40%)
Denmark	DNK	2,08	64	2	Medium - High (20-40%)
Indonesia	IDN	2,07	65	2	Medium - High (20-40%)
Peru	PER	2,05	66	2	Medium - High (20-40%)
Venezuela	VEN	2,03	67	2	Medium - High (20-40%)
Cuba	CUB	2,02	68	2	Medium - High (20-40%)
North Korea	PRK	1,95	69	1	Low - Medium (10-20%)

Romania	ROU	1,85	70	1	Low - Medium (10-20%)
United States	USA	1,85	71	1	Low - Medium (10-20%)
Zimbabwe	ZWE	1,79	72	1	Low - Medium (10-20%)
Dominican Republic	DOM	1,75	73	1	Low - Medium (10-20%)
Haiti	HTI	1,74	74	1	Low - Medium (10-20%)
Japan	JPN	1,66	75	1	Low - Medium (10-20%)
Angola	AGO	1,66	76	1	Low - Medium (10-20%)
Sri Lanka	LKA	1,66	77	1	Low - Medium (10-20%)
El Salvador	SLV	1,66	78	1	Low - Medium (10-20%)
Tanzania	TZA	1,63	79	1	Low - Medium (10-20%)
Netherlands	NLD	1,61	80	1	Low - Medium (10-20%)
Ecuador	ECU	1,59	81	1	Low - Medium (10-20%)
Lithuania	LTU	1,59	82	1	Low - Medium (10-20%)
Philippines	PHL	1,55	83	1	Low - Medium (10-20%)
South Sudan	SSD	1,52	84	1	Low - Medium (10-20%)
Ukraine	UKR	1,49	85	1	Low - Medium (10-20%)
Poland	POL	1,48	86	1	Low - Medium (10-20%)
Chad	TCD	1,44	87	1	Low - Medium (10-20%)
Senegal	SEN	1,44	88	1	Low - Medium (10-20%)
United Kingdom	GBR	1,40	89	1	Low - Medium (10-20%)
Georgia	GEO	1,39	90	1	Low - Medium (10-20%)
Nigeria	NGA	1,39	91	1	Low - Medium (10-20%)
Argentina	ARG	1,31	92	1	Low - Medium (10-20%)
Czech Republic	CZE	1,29	93	1	Low - Medium (10-20%)
Russia	RUS	1,22	94	1	Low - Medium (10-20%)
Bolivia	BOL	1,15	95	1	Low - Medium (10-20%)
Ethiopia	ETH	1,11	96	1	Low - Medium (10-20%)
Bosnia and Herzegovina	BIH	1,10	97	1	Low - Medium (10-20%)
Swaziland	SWZ	1,08	98	1	Low - Medium (10-20%)
Moldova	MDA	1,06	99	1	Low - Medium (10-20%)
Somalia	SOM	1,01	100	1	Low - Medium (10-20%)
Rwanda	RWA	0,99	101	0	Low (<10%)
Liechtenstein	LIE	0,99	102	0	Low (<10%)
Guinea-Bissau	GNB	0,98	103	0	Low (<10%)
Mozambique	MOZ	0,98	104	0	Low (<10%)
Vietnam	VNM	0,94	105	0	Low (<10%)
Kenya	KEN	0,93	106	0	Low (<10%)
Costa Rica	CRI	0,92	107	0	Low (<10%)
Canada	CAN	0,88	108	0	Low (<10%)
Serbia	SRB	0,83	109	0	Low (<10%)
Zambia	ZMB	0,81	110	0	Low (<10%)
Switzerland	CHE	0,80	111	0	Low (<10%)

Brazil	BRA	0,78	112	0	Low (<10%)
Hungary	HUN	0,77	113	0	Low (<10%)
Ghana	GHA	0,75	114	0	Low (<10%)
Belarus	BLR	0,75	115	0	Low (<10%)
Madagascar	MDG	0,69	116	0	Low (<10%)
Slovenia	SVN	0,66	117	0	Low (<10%)
Colombia	COL	0,65	118	0	Low (<10%)
Myanmar	MMR	0,65	119	0	Low (<10%)
Belize	BLZ	0,62	120	0	Low (<10%)
Montenegro	MNE	0,58	121	0	Low (<10%)
Malawi	MWI	0,56	122	0	Low (<10%)
Mali	MLI	0,55	123	0	Low (<10%)
Finland	FIN	0,54	124	0	Low (<10%)
Slovakia	SVK	0,50	125	0	Low (<10%)
Ireland	IRL	0,46	126	0	Low (<10%)
Sweden	SWE	0,44	127	0	Low (<10%)
Bangladesh	BGD	0,43	128	0	Low (<10%)
Cambodia	KHM	0,42	129	0	Low (<10%)
Burundi	BDI	0,42	130	0	Low (<10%)
Latvia	LVA	0,38	131	0	Low (<10%)
Malaysia	MYS	0,28	132	0	Low (<10%)
Honduras	HND	0,27	133	0	Low (<10%)
Austria	AUT	0,27	134	0	Low (<10%)
Uganda	UGA	0,26	135	0	Low (<10%)
Panama	PAN	0,23	136	0	Low (<10%)
Nicaragua	NIC	0,21	137	0	Low (<10%)
Guinea	GIN	0,19	138	0	Low (<10%)
Benin	BEN	0,18	139	0	Low (<10%)
Croatia	HRV	0,18	140	0	Low (<10%)
Papua New Guinea	PNG	0,06	141	0	Low (<10%)
New Zealand	NZL	0,05	142	0	Low (<10%)
Democratic Republic of the Congo	COD	0,04	143	0	Low (<10%)
Côte d'Ivoire	CIV	0,04	144	0	Low (<10%)
Cameroon	CMR	0,04	145	0	Low (<10%)
Gambia	GMB	0,04	146	0	Low (<10%)
Laos	LAO	0,03	147	0	Low (<10%)
Central African Republic	CAF	0,03	148	0	Low (<10%)
Sierra Leone	SLE	0,01	149	0	Low (<10%)
Paraguay	PRY	0,01	150	0	Low (<10%)
Uruguay	URY	0,00	151	0	Low (<10%)
Togo	TGO	0,00	152	0	Low (<10%)

Norway	NOR	0,00	153	0	Low (<10%)
Republic of Congo	COG	0,00	154	0	Low (<10%)
Bhutan	BTN	0,00	155	0	Low (<10%)
Timor-Leste	TLS	0,00	156	0	Low (<10%)
Brunei	BRN	0,00	157	0	Low (<10%)
Gabon	GAB	0,00	157	0	Low (<10%)
Equatorial Guinea	GNQ	0,00	157	0	Low (<10%)
Guyana	GUY	0,00	157	0	Low (<10%)
Iceland	ISL	0,00	157	0	Low (<10%)
Jamaica	JAM	0,00	157	0	Low (<10%)
Liberia	LBR	0,00	157	0	Low (<10%)
Suriname	SUR	0,00	157	0	Low (<10%)

APPENDIX B – DOCUMENTATION

I. Required documentation

A range of different forms of documentation is listed below. The documentation submitted must comprehensively and clearly demonstrate compliance with the requirements for the target evaluation of the individual indicators.

Indicator 1: Potable water and waste water volume
Indicator 1.1: Water use value

- Calculation of the water use value (WUV)
Clear calculation of the water use value for the constructed building and the limit value, reference value and target value throughout the calculation process for the criterion. All results and interim results of the calculation must be clearly presented here, e.g. in the form of a table.

- If river water is used, the following points must be noted:
(1) Extraction of river water:
River water can be used within the building as an alternative to grey water or rainwater for flushing toilets, etc., if the building is in the immediate vicinity of such a body of water. If rainwater is discharged into the body of water at the same time, this would form a cycle of discharge and extraction.
(2) Discharge of non-hazardous rainwater into surface waters (rivers/canals/streams)
Requirement: Permission for discharge into a surface body of water in accordance with local regulations and an exemption from compulsory connection and usage.

- Potable water demand and waste water volume by users
  - Number of employees
  - Flow rate values for fittings from data sheets
  - Amount of rainwater or river water used
  - Amount of grey water used
  - Amount of waste water purified via decentralised treatment, e.g. as a result of the design of the sewage treatment plant

- Waste water due to rainwater diverted to the drain system
  - Plausible determination of the annual rainfall at the site
  - Plausible determination of river water discharge
  - Plausible calculation of sealed areas and green spaces
  - Plausible determination of the yield coefficients of the sealed areas according to the table 12

- Calculation of the rainwater used for watering or flushing toilets

Indicator 2: External works
Indicator 2.1: Watering and rainwater retention

- Documents in the form of plans, photos, etc., including details of rainwater retention

Indicator 3: Integration into the district infrastructure
Indicator 3.1: Level of integration

- Documents regarding rainwater and waste water disposal systems in the building and the surrounding district, including photos of the implemented measures (and localisation in an overall plan) if necessary

Country specific adaptation (optional):

- WSI to be communicated with the DGNB during the adaptation process, the country specific (incl. province specific) WSI can be downloaded as an Excel file from the following link: https://www.wri.org/applications/aqueduct/country-rankings/

APPENDIX C – LITERATURE

I. Version

Change log based on version 2018

PAGE	EXPLANATION	DATE
all	General and Method: scheme „Assembly buildings" has been added	16.09.2021
185	Method indicator 1: presence days Production scheme has been added	16.09.2021
188	Benchmarks: Table 7, presence days have been added for variety of "Assembly buildings" sub-uses, congress halls, libraries, theatres etc.	16.09.2021
195	Benchmarks indicator 1: Table 11, unit corrections	16.09.2021
197	Benchmarks Indicator 1: Calculation of the usage-specific limit and target values	16.09.2021

II. Literature

- DIN EN 246. Sanitary tapware – General specifications for flow rate regulators. Berlin: Beuth publisher. November 2003
- DIN 1989-1. Rainwater harvesting systems – Part 1: Planning, installation, operation and maintenance. Berlin: Beuth publisher. April 2002
- DIN 1988/3. Drinking water supply systems; pipe sizing (DVGW code of practice). Berlin: Beuth publisher. December 1988
- DIN EN 12056-1. Gravity drainage systems inside buildings – Part 1: General and performance requirements. Berlin: Beuth publisher. January 2001
- VDI 3818. Public sanitary facilities. Düsseldorf: Verein Deutscher Ingenieure. February 2008
- VDI 6024 sheet 1, Table 10: Saving of water in drinking-water installations – Requirements for planning, installation, operation, and maintenance. Düsseldorf: Verein Deutscher Ingenieure. September 2008
- Feurich. Sanitärtechnik [Sanitary engineering], 9th edition, Düsseldorf 2005; pages 12-29 (specifies the water consumption for administrative and office buildings as 20 to 25 litres per working day and employee)
- Sustainable Development Goals icons, United Nations/globalgoals.org
- "Aqueduct country and river basin rankings: a weighted aggregation of spatially distinct hydrological indicators." Working paper. Washington, DC: World Resources Institute