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# Directive on the Safety of Water Retaining Facilities

## Part A: Introduction

*Note: This document is a preprint of Part A of the Directive on the Safety of Water Retaining Facilities (revised version, 2014-2015).*

This version replaces all earlier versions.

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## 1. Legal bases and principles

On 1 January 2013, the new legislation governing dams and reservoirs entered into force, namely the Federal Act of 1 October 2010 on Water Retaining Facilities (hereinafter, “WRFA”) and the Federal Ordinance of 17 October 2012 on Water Retaining Facilities (hereinafter “WRFO”). These replaced the previous Federal Act of 22 June 1877 on Hydraulic Engineering Inspectorate and the Federal Ordinance of 7 December 1998 on Dams and Reservoirs.

Operators of dams and reservoirs are responsible for the safety of their facilities. During their construction and operation, their operators are required to implement all safety measures and controls that are stipulated in the applicable legal provisions, specifically requested by the relevant supervisory authority or necessary in accordance with the state of the art in science and technology.

The term “state of the art in science and technology” refers to the findings that are regarded by specialists in the field in question as established and for which implementation options do exist. These findings must be implemented in the form of safety and controls measures for ensuring the safety of a water retaining facility if this is necessary in order to achieve the specified safety objectives.

Within the scope of their supervisory activities, the relevant federal (Swiss Federal Office of Energy, SFOE) and cantonal supervisory authorities ensure that the legal provisions are complied with and the operators of the facilities implement the required safety measures. The sole objective of state supervision in accordance with the applicable legislation is to protect the population against the consequences of large quantities of water escaping from a retaining facility in an uncontrolled manner.

Other safety aspects than those relating to the dam or reservoir, in particular workplace and operating safety, are not subject to the provisions of the legislation governing water retaining facilities, and are therefore not addressed in this Directive.

In Articles 13 to 21 of the WRFA, the legislator introduced new strict liability provisions. These take the form of special regulations that deviate from the general provisions of the Swiss Code of Obligations; they are not addressed in this Directive.

The SFOE is responsible for the publication of this Directive, which was prepared in collaboration with the cantons, as well as universities, professional organisations and the economy (WRFO, Article 29, paragraph 2).



## 2. Scope of this Directive

This Directive is intended to function as an aid to the enforcement of the legislation governing water retaining facilities. It is not a legislative instrument *per se*, nor is it directly contestable. However, rulings by supervisory authorities that are based on its content are contestable.

On the one hand, the Directive clarifies the terminology contained in the legislation governing water retaining facilities, and on the other hand it describes measures (particularly those of a constructive or organisational nature) and methods (notably those relating to verification and surveillance) that are normally accepted by the relevant supervisory authorities. Other measures and methods are also acceptable, however, as long as the specified safety objectives are attained.

This Directive is applicable to all water retaining facilities for which the provisions of the above-mentioned Act and Ordinance apply (see Figure A1), regardless of the type and/or size of the retaining structure, the purpose of the facility or the relevant supervisory authority.

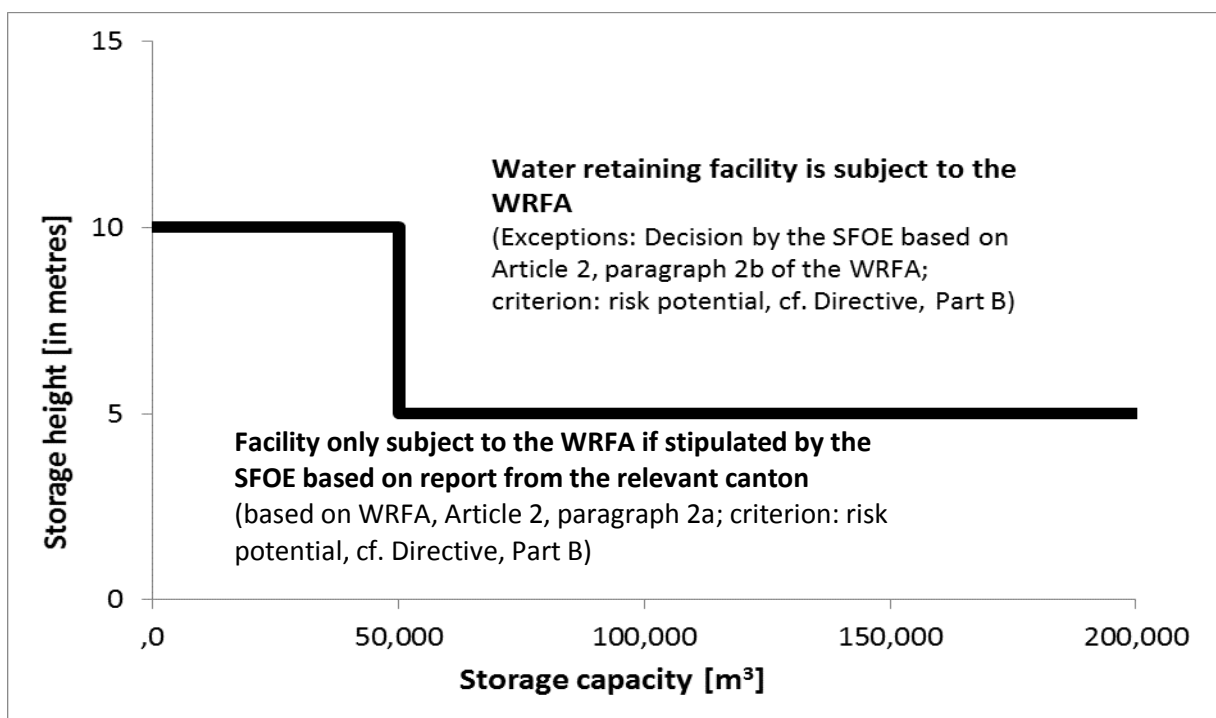


Figure A1: Scope of application of the legislation on water retaining facilities (size criterion, cf. WRFA, Article 2, paragraph 1)

Within the scope of the compelling legal provisions, and in consideration of the defined safety objectives, the relevant supervisory authority is empowered to exercise discretion in its application of this Directive on a case-by-case basis.



Operators of water retaining facilities and their personnel and contractors should be able to base their behaviour on this Directive, though they may not derive any legal claims from its content.

It is also the responsibility of operators and applicants to carry out further-reaching measures or use more comprehensive methods if those cited in this Directive do not suffice to achieve the specified safety objectives.

In the event of any contradictions between the sections of this Directive, the SFOE shall decide on the applicable interpretation.

### 3. Safety concept for water retaining facilities in Switzerland

The safety of water retaining facilities is based on three elements (cf. Figure A2):

- (1) Structural safety
- (2) Surveillance and maintenance
- (3) Emergency concept

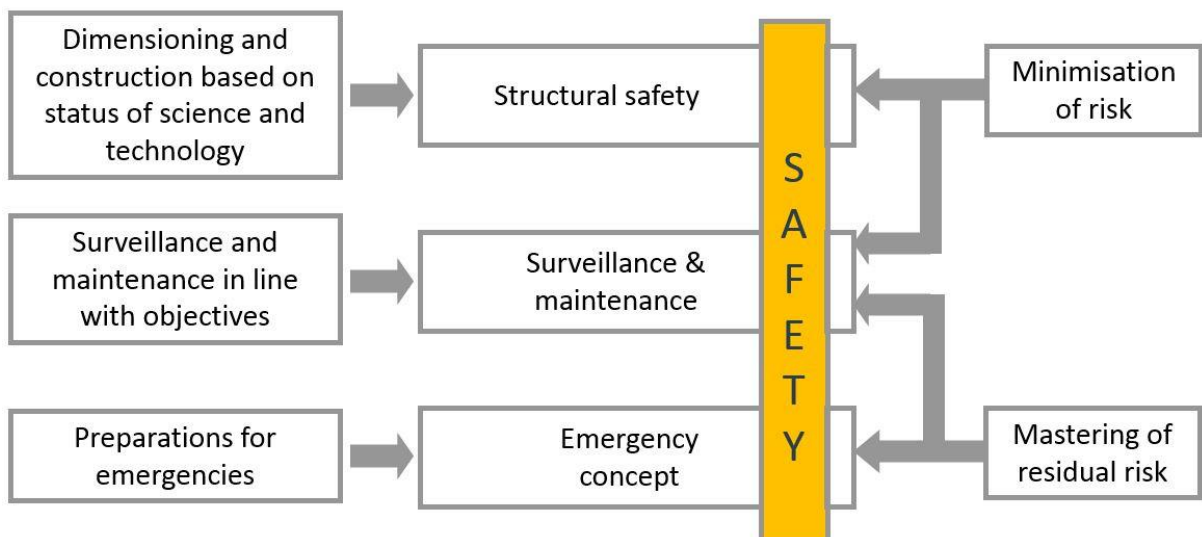


Figure A2: Elements of the safety concept for water retaining facilities

The objective of structural safety is to ensure that a water retaining facility is able to withstand all foreseeable operating conditions and loads. It encompasses the planning and construction of water retaining facilities and system components, and includes calculating potential loadings, as well as the corresponding safety assessments and structural requirements.



The objective of surveillance is the early identification of the development of condition and behaviour characteristics that could have a negative effect on the safety of a facility. Maintenance activities are intended to help prevent the development of the above characteristics and ensure that the measuring instruments remain fully functional.

The emergency concept comes into play if it is no longer possible to guarantee the safe operation of a water retaining facility. This encompasses preparatory measures for taking the necessary action without delay, including the procedure for notifying the authorities and for warning and evacuating the population at risk.

#### **4. Supervisory authority and responsibility for direct supervision**

The SFOE is the federal authority responsible for supervising the safety of water retaining facilities. In addition, each canton has its own supervisory authority. The responsibilities and tasks of the federal and cantonal supervisory authorities are specified in the applicable legislation (WRFA and WRFO).

The provisions relating to responsibility are laid down in Articles 22 and 23 of the WRFA. Large water retaining facilities as defined in Article 3, paragraph 2 of the WRFA are subject to direct federal supervision (cf. Figure A3), while smaller facilities for which the legislation applies are subject to the direct supervision of the relevant cantonal authority. In certain circumstances, the federal supervisory authority may conclude a supervision agreement with the canton concerned, the provisions of which deviate from those cited in Articles 22 and 23 above (WRFA, Article 24).

Which authority supervises which facilities is not based on the scope of application of the legislation as depicted in Figure A1 – here, other criteria apply. The corresponding arrangements are strictly organisational in nature. In particular, the obligations on the part of operators do not depend on whether the federal government or the canton is responsible for direct supervision.

No supervisory authorities are specified for facilities for which the legislation does not apply.

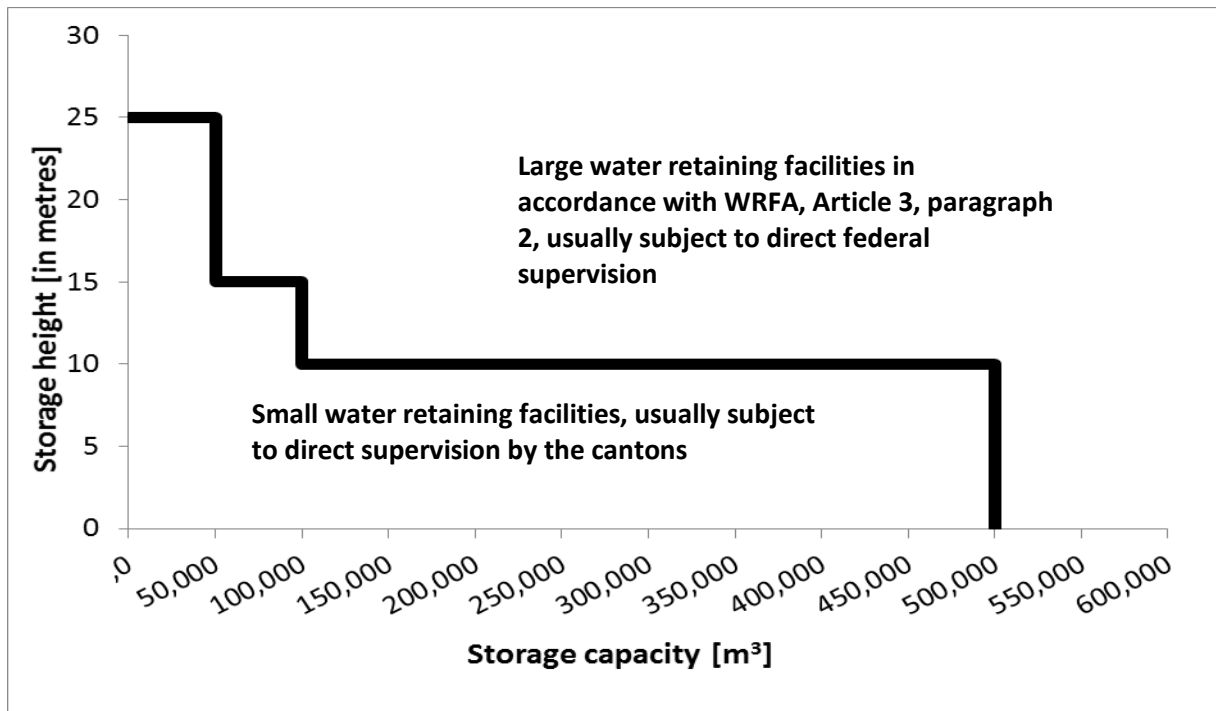


Figure A3: Definition of large and small water retaining facilities as the basis for the organisation of responsibility between the federal government and the cantons (WRFA, Article 3, paragraph 2).

## 5. Structure of this Directive

The structure of this Directive is based on that of the applicable legislation (WRFA and WRFO); it is divided into five sections as follows:

- Part A: Introduction
- Part B: Particular risk potential as subordination criterion
- Part C: Planning and construction
- Part D: Commissioning and operation
- Part E: Emergency concept

### Part A: Introduction

- Explains the legal bases and the purpose and relevance of the Directive
- Describes the applicable concept for the safety of water retaining facilities
- Contains uniform definitions of terms for all sections of the Directive
- Presents an overview of the various procedural stages in the development of a water retaining facility
- Contains a list of references for the complete Directive <sup>1</sup>

<sup>1</sup> Not implemented yet





#### Part B: Particular risk potential as subordination criterion

- Defines the term “particular risk potential”
- Contains uniform criteria:
  - o For the cantons to register small facilities that may have a particular risk potential
  - o For the SFOE to declare small facilities subject to the applicable legislation in view of their particular risk potential
  - o For the SFOE to exempt a facility from the scope of application of the legislation due to the fact that it does not indicate a particular risk potential

#### Part C: Structural safety

Part C1: Design and construction

Part C2: Flood safety and lowering reservoir water level

Part C3: Earthquake safety

- Contains information relating to the planning approval procedure and to construction
- Contains information on the preparation of the utilisation agreement and the project basis of a water retaining facility
- Describes protection objectives and minimum requirements concerning the loads, load combinations and safety factors to be taken into account for normal, extraordinary and extreme loadings
- Contains criteria for dimensioning relief and outlet works
- Describes the content of the gates regulations

#### Part D: Commissioning and operation (Commissioning, Maintenance, Surveillance)

- Contains information relating to the commissioning procedure and operation of the facility
- Defines the surveillance regulations
- Specifies the precise scope of continual, annual and five-yearly inspections
- Specifies the precise content of the operator’s archives
- Specifies the precise procedure for planned overhauls

#### Part E: Emergency plan

- Specifies the requirements pertaining to the operator’s emergency plan
- Specifies the requirements concerning the harmonisation of the operator’s emergency plan with the emergency response planning of the organisations responsible for civil protection
- Presents an overview of the responsibilities regarding the compilation of the emergency plan and the handling of emergencies
- Describes the alarming systems and danger levels
- Defines the content of the emergency regulations



## 6. Definitions

The following definitions are based on (ICOLD Bulletin 31a – “A glossary of words and phrases related to dams”, 1982).

### 6.1. Terminology used in the legislation governing water retaining facilities

#### Scope of application of the legislation governing water retaining facilities

The provisions of the Federal Act on Water Retaining Facilities and the accompanying Federal Ordinance are *a priori* applicable if a water retaining facility fulfils the criteria with respect to storage capacity and storage height as stipulated in Article 2, paragraph 1 of the WRFA. The scope of application is depicted in Figure A1.

In certain cases, in accordance with Article 2, paragraph 2 of the WRFA, the federal supervisory authority may grant (at the request of the operator – cf. WRFO, Article 3) or confirm (following a notification by the canton – cf. WRFO, Article 2) exemptions based on the existing risk potential (risk criterion).

The scope of application is valid regardless of the definition of a large water retaining facility (cf. Figure A3) and the relevant direct supervisory authority.

#### Operator

The holder or *de facto* holder of the licence to commission a water retaining facility is classified as its operator (WRFO, Article 1, paragraph 5). If an operator as defined above cannot be identified, then the land owner is responsible for fulfilling the obligations of the operator (WRFA, Article 8, paragraph 6).

If the operator calls on the services of external personnel for the operation, maintenance or revision of the facility, he or she remains responsible for the fulfilment of his/her obligations as stipulated in the applicable legislation.

#### Owner

Depending on the specific circumstances in each case, the term “owner” refers to the owner of the land or the facility:

- Land owner: The term “land owner” refers to the owner of the plot of land or geographically defined area on which the water retaining facility has been constructed (WRFA, Article 8, paragraph 6).
- Facility owner: The term facility owner refers to the owner of the retaining structure and the accompanying auxiliary installations.

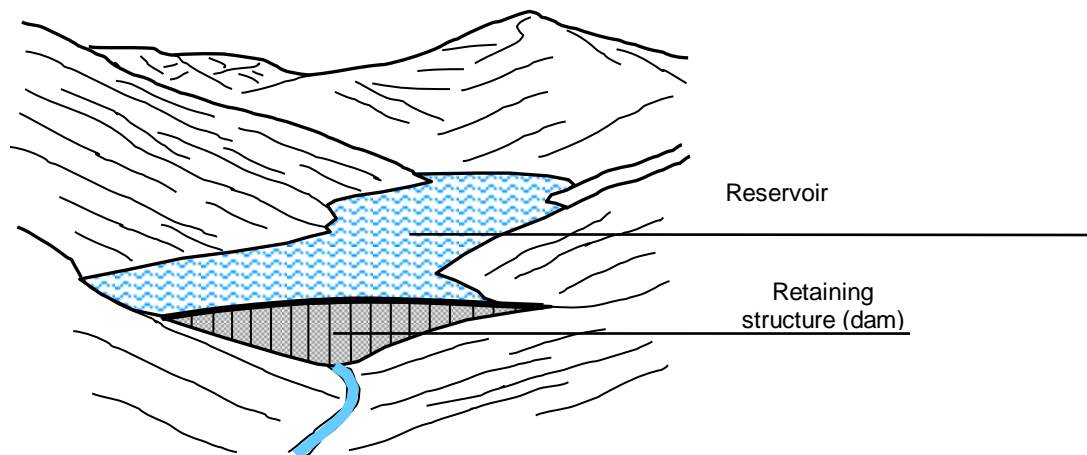


### Water retaining facility

Water retaining facilities are structures designed to dam up or store water and mud, and to hold back sediment, ice and snow. The term also refers to facilities intended to temporarily retain water (WRFA, Article 3, paragraph 1). A water retaining facility comprises a retaining structure, a reservoir and various auxiliary installations (cf. Figure A4).

The following objects are not classified as water retaining facilities or retaining structures as defined in the applicable legislation:

- Nets and other lightweight structures intended to protect against rock falls, mud flows and avalanches
- Lateral embankments constructed to protect against flooding, as long as they are not within the area of influence of a water retaining facility (cf. distinction from run-of-river dams, Figure A13)
- Hydraulic engineering installations for residential development (e.g. reservoirs for drinking water and for storing water for fire-fighting)
- Swimming pools
- Natural lakes and their regulating structures, if their capacity is not artificially increased through the use of retaining structures



*Figure A4: Schematic view of a water retaining facility*

### Storage capacity and storage height

Whether a water retaining facility is subject to the corresponding legislation due to its dimensions (WRFA, Article 2, paragraph 1), its classification as a large facility (WRFA, Article 3, paragraph 2) and the decision to install a water alarm system for facilities with a storage capacity of more than 2 million cubic metres (WRFA, Article 11, paragraph 1), is based on the storage capacity and storage height.

- Storage capacity ( $V_R$ ): This refers to the volume of water stored in a water retaining facility that could be released in the event of a breach in the retaining structure when the

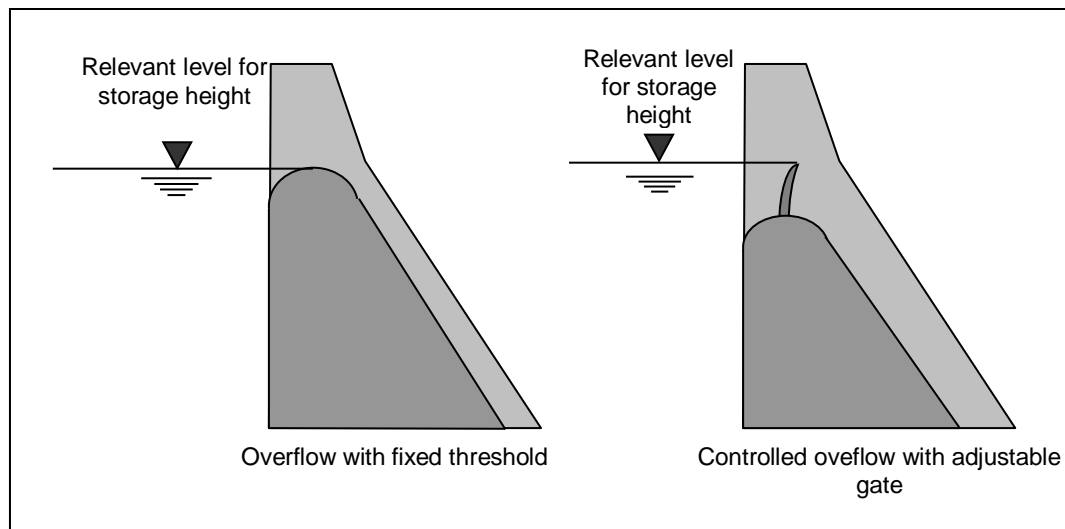


reservoir is full. For the purposes of this Directive, this means that the term “storage capacity” does not refer to the usable or total volume of the water retaining facility.

- Storage height ( $H_R$ ): This refers to the height of water in the reservoir behind the retaining structure which corresponds to the storage capacity. For the purposes of this Directive, this means that the term “storage height” does not refer to the height of the retaining structure itself.

Calculating the storage capacity and the corresponding storage height is based on the following principles:

- In the case of water retaining facilities with free overflow, the relevant water level is the overflow threshold (cf. Figure A5, left).
- In the case of water retaining facilities in which the quantity of discharged water is fully or partly controlled with the aid of adjustable gates, the relevant level corresponds to the highest point of the gate (cf. Figure A5, right).



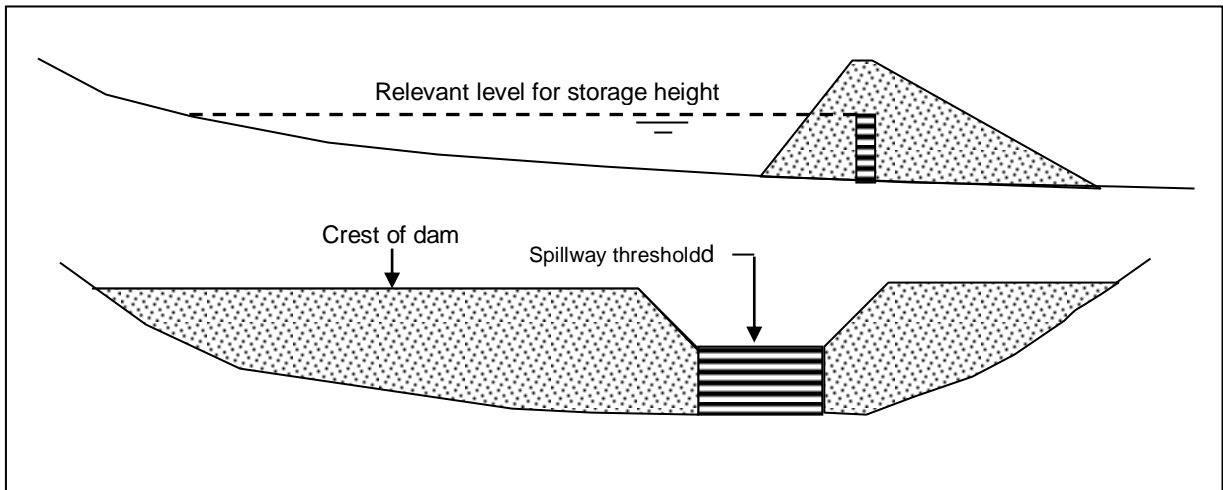
*Figure A5: Relevant level for storage height*

- If a water retaining facility is equipped with a spillway that is susceptible to clogging, this is assumed to be the case when calculating the storage capacity and storage height (e.g. fine screen in avalanche retention basins; cf. e) below).
- For flood control reservoirs, the relevant level is the elevation of the overflow threshold. It is the horizontal plane of this level that is of relevance for calculating the storage capacity.
- For debris barriers, sediment traps and avalanche retention basins, it is the level of the overflow threshold that is of relevance. The presence of any openings (drains) is not taken into account. If the spillway is equipped with any elements that are subject



to clogging, it is the uppermost edge of these elements that is of relevance (cf. Figure A6).

The horizontal plane of this level is of relevance for calculating the reservoir capacity.



*Figure A6: Relevant level for calculating the storage height in the case of a spillway equipped with elements subject to clogging*

- f) At the request of the operator, a layer of sediment in the basin may be taken into account for determining the storage height or storage capacity if the operator is able to demonstrate that the sediment is consolidated. Sediment is regarded as consolidated if, in the event of a sudden and total breach of the retaining structure, it does not escape from the reservoir and does not discharge any water. In this case, for the purpose of calculating the storage capacity it is only the volume above the consolidated sediment layer that is taken into account (cf. Figure A7, b)); the storage height is calculated accordingly. If the operator is unable to demonstrate that the sediment is consolidated, the corresponding volume is assumed to be part of the calculated storage capacity (cf. Figure A7, a)).

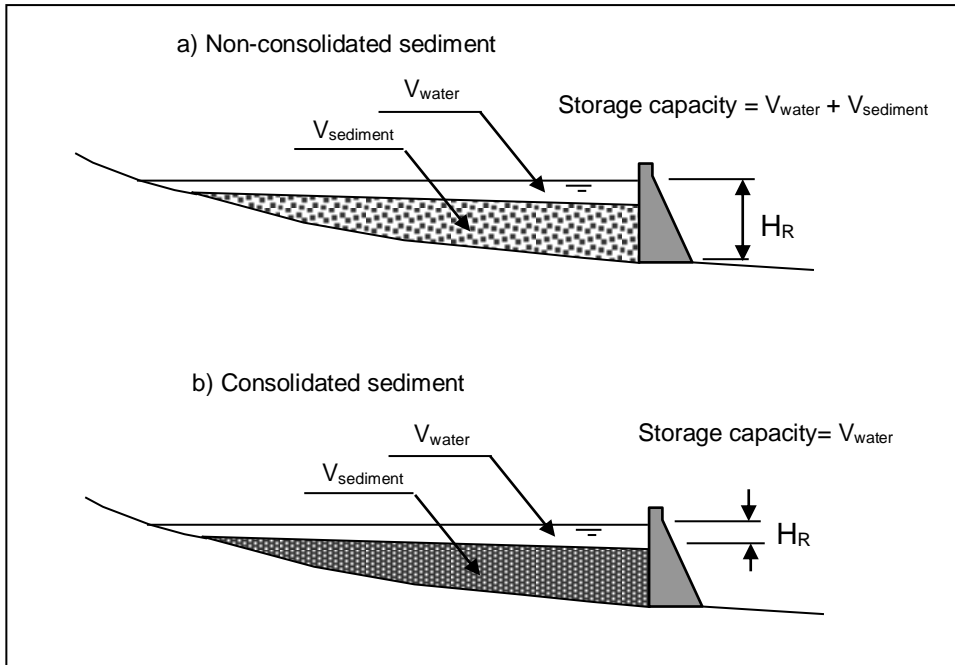


Figure A7: Inclusion of sediment in the calculation of storage capacity and storage height

- g) In the calculation of the storage height and storage capacity of elements of a weir, the lower reference level may be assumed to be the same as the upstream level of the low-water level (i.e.  $Q_{347}$ ) of the natural status (cf. Figure A8). The relevant level corresponds to the maximum operating level as specified in the licence provisions.

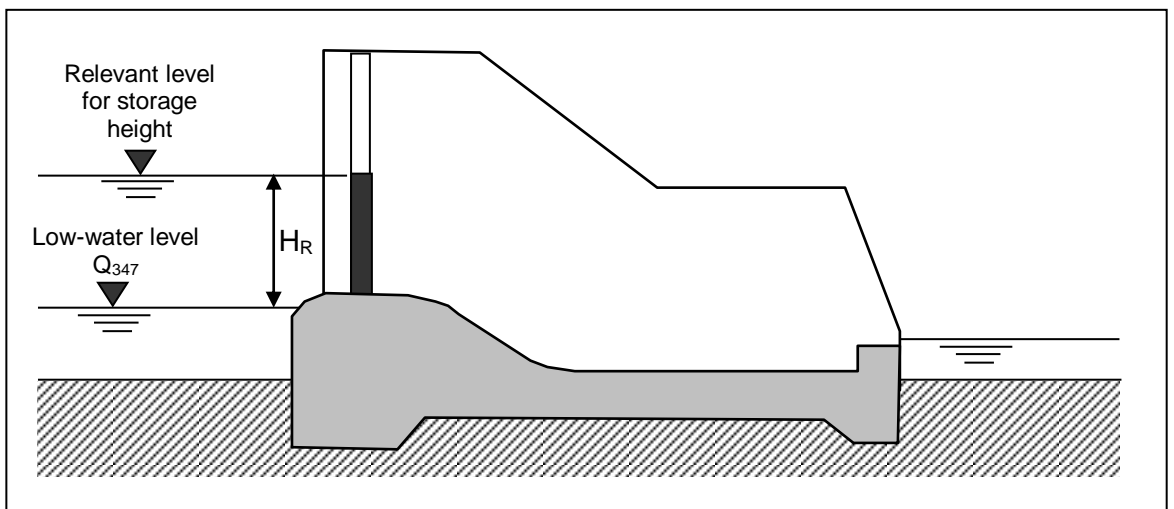
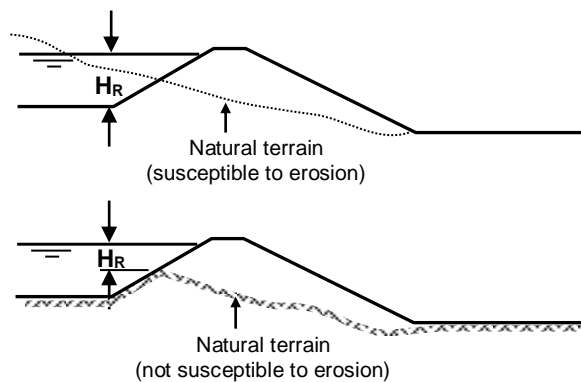


Figure A8: Definition of storage height ( $H_R$ ) of a weir (cross-section diagram showing the pillars, sluice and slot)

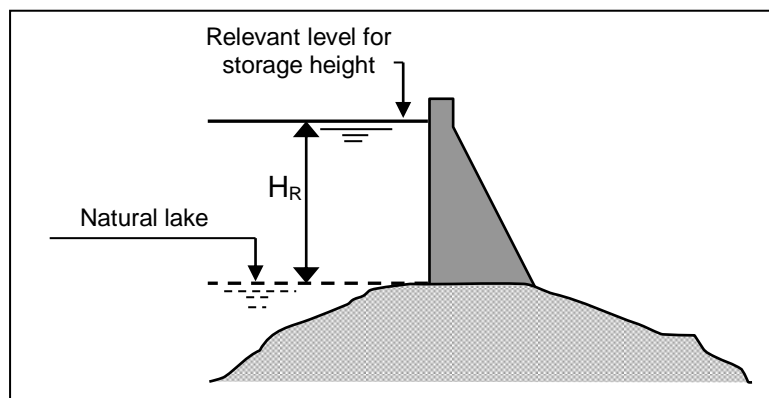


- h) For the calculation of the storage height and storage capacity, the upstream level of the natural terrain may be taken as the lower reference level (cf. Figure A, bottom), as long as the terrain is not susceptible to erosion (Figure A9, top). This generally applies in the case of bedrock.



*Figure A9: Level of natural terrain for calculating the storage capacity and storage height*

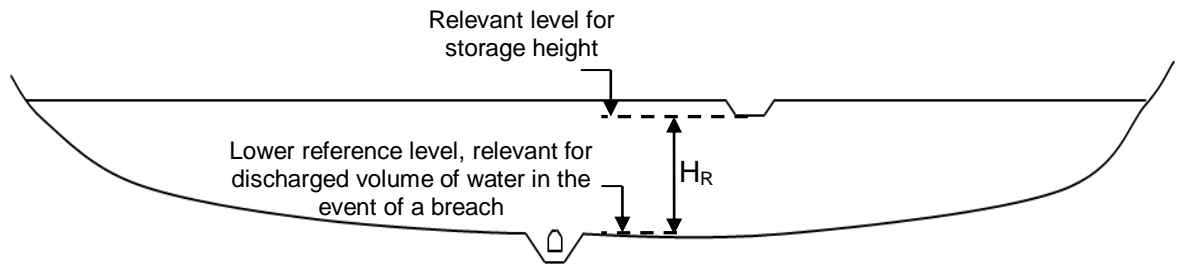
- i) In water retaining facilities with several retaining structures, the storage capacity corresponds to the volume retained by all the structures. The storage height corresponds to the highest storage level of the individual retaining structures.
- j) In the case of the damming of a natural lake, the storage height corresponds to the difference between the applicable level for the storage height and the level of the overflow of the natural lake prior to damming (cf. Figure A10).



*Figure A10: Specification of storage capacity and storage height for a dammed natural lake*



- k) Narrow cuts or indentations in the vicinity of the foundations that have a negligible influence on the volume and rate of discharged water in the event of a breach of the retaining structure are not taken into account for determining the storage height (cf. Figure A11).



*Figure A11: Specification of storage height if local indentations exist that have a negligible influence on the consequences of a breach*

#### Operational unit (cf. WRFA, Article 24, paragraph 2)

An operational unit between two or more water retaining facilities exists if the operation of a given facility is dependent on another facility. This is typically the case between a main reservoir, an afterbay reservoir and an intake basin.

In cases of uncertainty the SFOE decides whether an operational unit exists, particularly with regard to water retaining facilities that are arranged in cascade and influence one another.

## **6.2. Terminology relating to water retaining facilities and reservoirs**

### Purposes of a water retaining facility

The purposes of water retaining facilities are differentiated as follows (abbreviations as used by ICOLD):

- Hydroelectricity / use of hydropower (H)
- Flood control, sediment retention (C)
- Irrigation (I)
- Navigation / navigability (N)
- Recreation / biotope (R)
- Water supply (S)
- Other purposes (X)

### Relevant level of storage height

The upper level used for specifying the storage height and storage capacity.

### Danger level

Water level at which the safety of the water retaining facility is threatened.





#### Low water level inflow ( $Q_{347}$ ), low water level

$Q_{347}$  corresponds to the quantity of water that flows on the average at least 347 days per year. The low water level refers to the corresponding water level.

#### Commissioning year

The year in which the water retaining facility was put into operation.

### **6.3. Terminology relating to the retaining structure**

#### Type of retaining structure

The types of retaining structures are differentiated according to construction material and static system as follows (abbreviations as used by ICOLD):

- Gravity dam (PG)
- Arch dam (VA)
- Arch gravity dam (PV)
- Multiple arch dam (MV)
- Rockfill dam (ER)
- Earthfill dam (TE)
- Weir (BM)
- Buttress dam (CB)

#### Year of construction (year of completion)

Year in which the construction of the retaining structure was completed and the water retaining facility was ready for operation.

#### Elevation of dam crest

Elevation of the crest of a retaining structure. If there is also a parapet, this is not taken into account and the elevation of the dam crest is therefore below that of any existing parapet (cf. Figure A12).

#### Parapet

Parapet wall on the crest of a retaining structure (cf. Figure A12).

#### Dam height

Height of a dam structure. Corresponds to the difference between the dam crest elevation and lowest elevation of the structure's foundations, excluding any grout curtain or foundation toe wall (cf. Figure A12).

#### Crest length

The length of the crest axis of a retaining structure, measured from one abutment to the other.

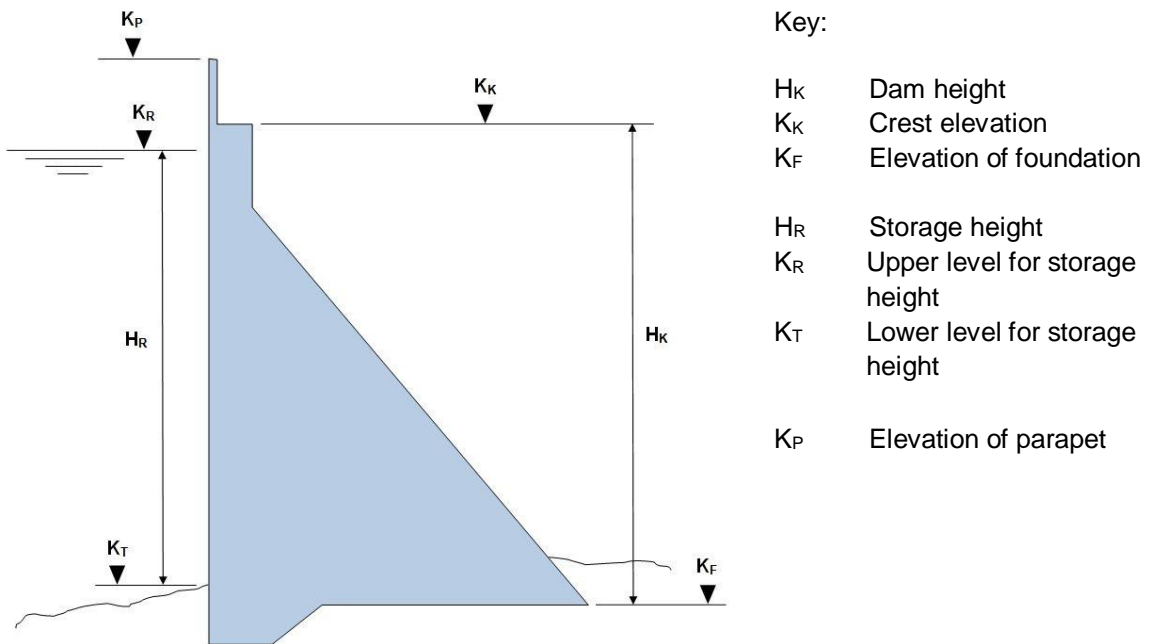


Figure A12: Diagram depicting the various terms defined above

Lateral embankments and extent of run-of-river dams

On rivers, lateral embankments (run-of-river dams) separate the adjacent, lower-lying terrain from the reservoir and thus form an integral part of the water retaining facility. The tail boundary is obtained from the geometric intersection of a horizontal line at the relevant level for the storage height, increased by one metre, with the low water level inflow  $Q_{347}$  (cf. Figure A13).

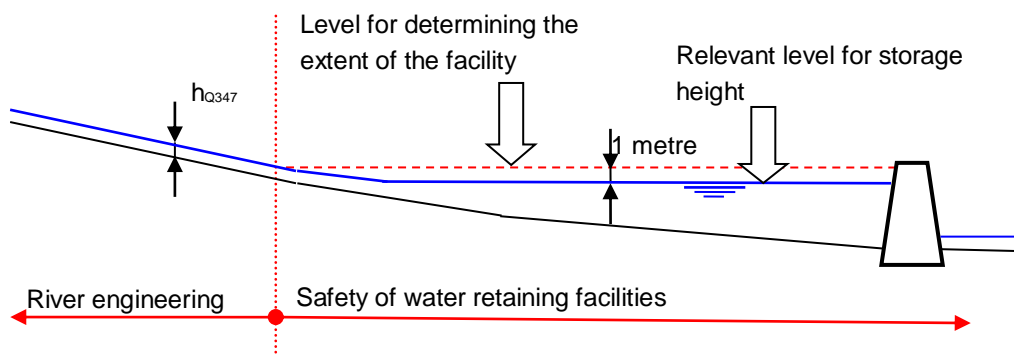


Figure A13: Extent of a run-of-river dam as water retaining facility

Location coordinates of a retaining structure

Location coordinates of a retaining structure are defined as the intersection of the crest axis with the axis of the channel or, for facilities on lateral valleys, the centre of the crest axis. For closed retaining structures the location is the position of the crest axis at the greatest dam height.



#### **6.4. Auxiliary facilities**

In accordance with Article 1, paragraph 4 of the WRFO, auxiliary facilities are those structures and installations that are required for the safe operation of the water retaining facility,

- the malfunction of which could result in an uncontrolled discharge of large quantities of water from the reservoir,
- thanks to which it is possible to prevent such a discharge,
- or with the aid of which the risk of such a discharge can be identified at an early stage.

These include relief and outlet works (spillway, bottom outlet, middle outlet) and instruments for monitoring the water retaining facility.

They do not include structures and installations primarily intended for operational purposes, such as water in-takes, penstocks and shafts with shut-off devices (e.g. regulators) and surge tanks.



## 7. Stages of development

From the initial project concept through to the operation of a water retaining facility, a variety of development stages have to be completed that are reflected in the corresponding legislation, including (see also chronology and references in Figure A14):

**Project stage** (construction, modification or decommissioning of a water retaining facility):

- Concept and planning by the owner
- Application by the owner to the relevant authority for planning approval
- Issue of planning approval by the relevant authority, including conditions relating to technical safety as stipulated by the relevant supervisory authority

**Construction stage:**

- Prior to construction, verification by the relevant supervisory authority of compliance with its safety regulations
- Construction of facility accompanied by progress reports by the owner
- During construction, verification by the relevant supervisory authority of compliance with its safety regulations
- Completion of construction work and compilation of corresponding report by the owner
- Acceptance by the relevant supervisory authority, with accompanying acceptance report

**Commissioning and operation:**

- Application by the operator to the relevant supervisory authority for permission to commission the facility (and for approval of the gate regulations and emergency regulations)
- Issue of commissioning licence by the relevant supervisory authority, including conditions relating to commissioning and operation. The licence also serves as operating licence
- Commissioning by the operator
- Verification by the relevant supervisory authority of compliance with its commissioning conditions
- Compilation of a commissioning report by the operator
- Preparation by the operator of surveillance regulations for approval by the relevant supervisory authority
- Commencement of normal operation by the operator
- During operation, verification by the relevant supervisory authority of compliance with its safety regulations

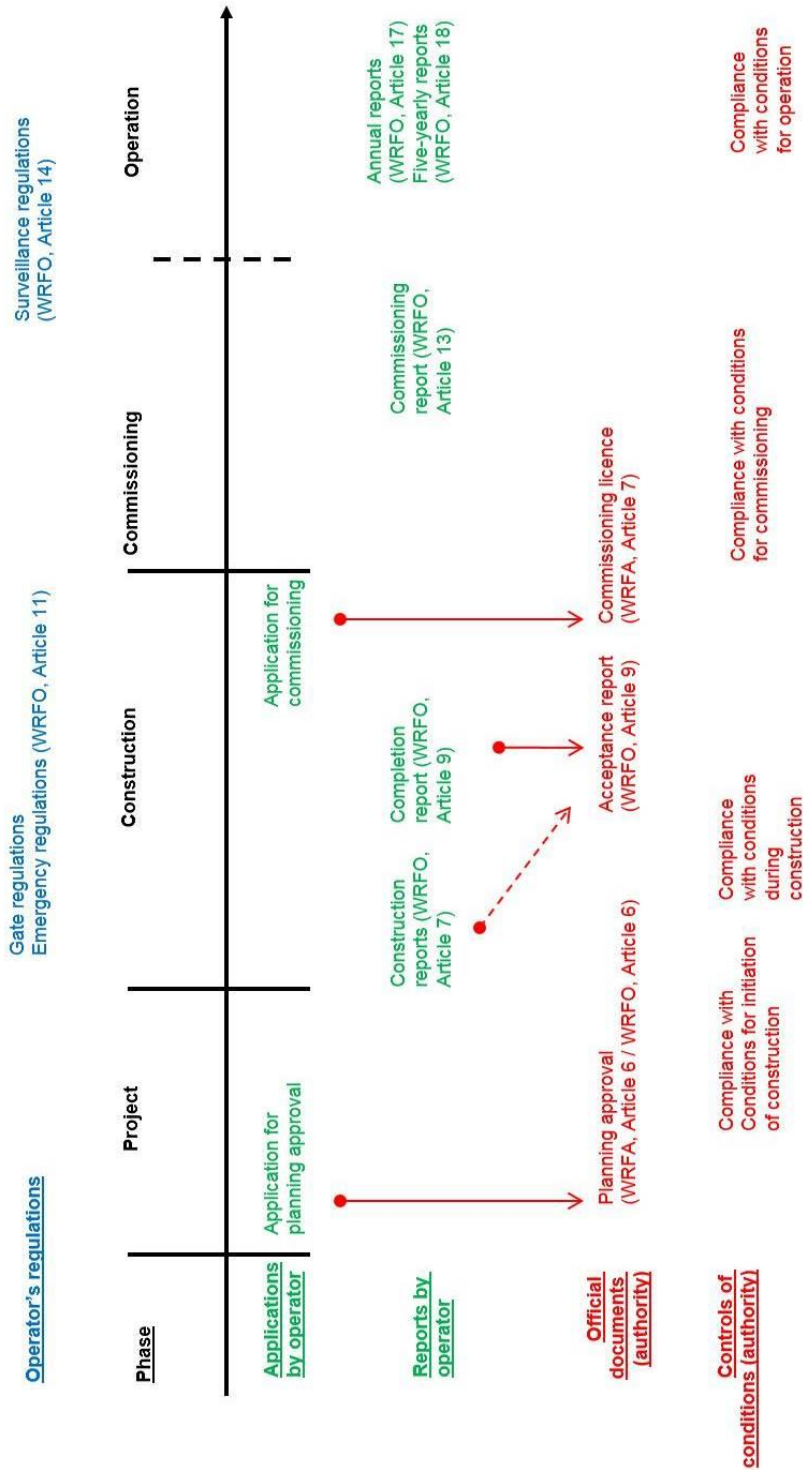


Figure A14: Stages in the development of a water retaining facility



## 8. Other federal legislation of relevance to water retaining facilities

Document	Content	Classified Compilation (SR) no., specific Article
DETEC Organisation Ordinance	Supervision of the safety of water retaining facilities is the responsibility of the Swiss Federal Office of Energy (SFOE).	[SR 172.217.1] (Article 9)
Geoinformation Ordinance	Water retaining facilities subject to federal supervision and those subject to cantonal supervision – integral part of the catalogue of official geodata (sections 193 and 194).	[SR 510.620] (Annex 1)
Ordinance on the Territorial Duties of the Armed Forces	Possibility for the army to influence the precautionary reduction of water levels in water retaining facilities within the scope of its territorial duties.	[SR 513.311.1] (Article 7)
Federal Defence and Civil Protection Act	Obligation for operators to install, maintain and where necessary replace structural components of a water-alarm system. Responsibility of the Federal Council to specify the technical requirements governing flood warning systems and the necessary structural components.	[SR 520.1] (Article 43b)
Federal Civil Protection Ordinance	Regulations governing premature release from civil protection duty for members of civil protection partner organisations that are required for deployment in the event of disasters and emergencies.	[SR 520.11] (Article 2)
Federal Ordinance on Warnings and Alarms	Regulations governing the responsibilities and procedures relating to warnings and alarms, and to the issue of instructions concerning the behaviour of the population in emergencies.	[SR 520.12]
National Alarm Centre Ordinance	Regulates the duties, responsibilities, organisation and funding of the National Alarm Centre.	[SR 520.18]
Ordinance on Charges and Supervisory Fees in the Energy Sector	Definition of the SFOE's applicable charges and supervisory fees relating to the safety of water retaining facilities.	[SR 730.05] (Articles 9 and 9a)
Federal Act on the Protection of Bodies of Water	Provisions governing the flushing and emptying of reservoirs and the handling of debris.	[SR 814.20] (Articles 40 and 41)
Forestry Act	Trees and bushes on water retaining facilities and immediately bordering terrain are not classified as forest.	[SR 921.0] (Article 2, paragraph 3)
Forestry Ordinance	The immediately bordering terrain of a water retaining facility is the terrain that borders on	[SR 921.01] (Article 3,



	the facility downstream. As a rule, this encompasses a strip with a width of around 10 metres.	paragraph 2)
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## **9. References**

This document is a preprint of Part A of the Directive on the Safety of Water Retaining Facilities (revised version, 2014-2015). The definitive version will contain a full list of references.