SLOVENSKI STANDARD
SIST EN 16907-7:2021

01-september-2021

Zemeljska dela - 7. del: Hidravlično odlaganje mineralnih odpadkov

Earthworks - Part 7: Hydraulic placement of extractive waste

Erdarbeiten - Teil 7: Hydraulische Einbringung von mineralischen Abfällen

Terrassements - Partie 7 : Placement hydraulique d'excédents miniers

Ta slovenski standard je istoveten z: **EN 16907-7:2021**

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Earthworks - Part 7: Hydraulic placement of extractive waste

Terrassements - Partie 7 : Placement hydraulique d'excédents miniers

Erdarbeiten - Teil 7: Hydraulische Einbringung von mineralischen Abfällen

This European Standard was approved by CEN on 7 June 2021.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 16907-7:2021) has been prepared by Technical Committee CEN/TC 396 "Earthworks", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2022, and conflicting national standards shall be withdrawn at the latest by January 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document is one of the European Standards within the framework series of EN 16907 on *Earthworks.* The set of standards prepared by CEN/TC 396 is divided into several parts, which correspond to different steps of the planning, execution and control of earthworks and should be considered collectively as a group of standards for executing earthworks. The full set of Parts is as follows:

— EN 16907-1, Earthworks — Part 1: Principles and general rules;

— EN 16907-2, Earthworks — Part 2: Classification of materials;

— EN 16907-3, Earthworks — Part 3: Construction procedures;

— EN 16907-4, Earthworks — Part 4: Soil treatment with lime and/or hydraulic binders;

— EN 16907-5, Earthworks — Part 5: Quality control;

— EN 16907-6, Earthworks — Part 6: Land reclamation earthworks using dredged hydraulic fill;

— EN 16907-7, Earthworks — Part 7: Hydraulic placement of extractive waste (this document).

Within this document, references to specific parts of the standard are written by reference to the full reference (e.g. "EN 16907-2").

These "Earthworks standards" do not apply to the environmental planning and geotechnical design that determines the required form and properties of the earth-structure that is to be constructed. They apply to the design of the earthworks materials, execution, monitoring and checking of earthworks construction processes to ensure that the completed earth-structure satisfies the geotechnical design.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

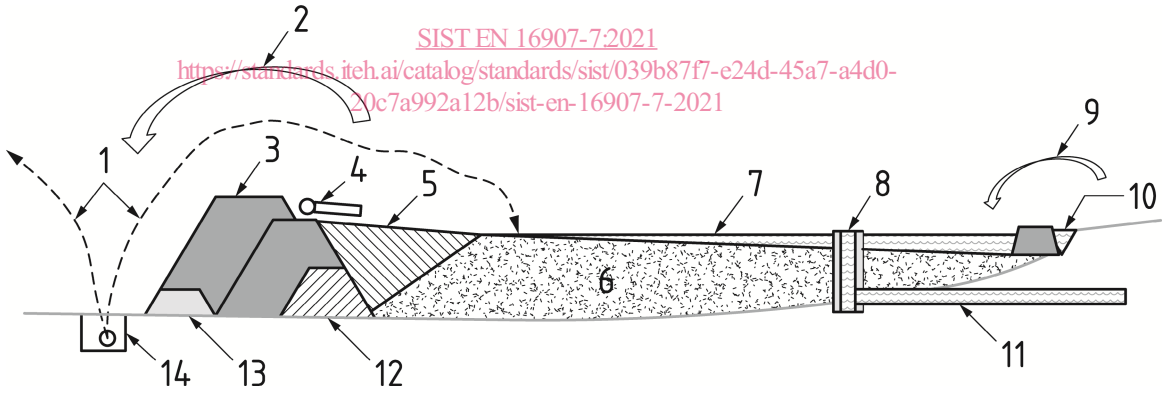
According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

European Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from the extractive industries states that the preparation of a waste management plan is required for certain mine waste facilities (MWFs). One of the objectives of the waste management plan is to ensure both short- and long-term safe disposal of the extractive waste by choosing a design which achieves geotechnical and geochemical stability of any hydraulic fill placed above a pre-existing ground surface. By inference this requires that suitable features are incorporated into the design, construction, operation and maintenance, closure and after-closure of a MWF to prevent major accidents and to limit any adverse consequences for human health and/or the environment. This document addresses all technical stages of the development of a hydraulic fill project in the context of the Extractive Waste Directive (EWD), with an emphasis on waste and facility characterization and on earthworks procedures.

All sectors of the extractive industry are likely to produce a residue which, during mineral processing, will have been physically, and sometimes chemically, altered due to both the comminution and concentration processes employed. These residues (extractive waste/tailings) comprise fine particulate materials which are generally discharged from the process plant in slurry form as a hydraulic fill, noting that coarse particles are generally neither transported nor deposited by hydraulic means. Such extractive wastes, regardless of their consistency and general characteristics, need to be placed in a secure containment facility unless they are to be immediately recycled. The metal mining industry tends to refer to these facilities as “tailings management facilities” (Figure 1), the aggregates and industrial minerals sectors as “silt lagoons” (Figure 2), and the energy sector as “ash lagoons”. Within this standard, all three are referred to as mine waste facilities (MWFs).

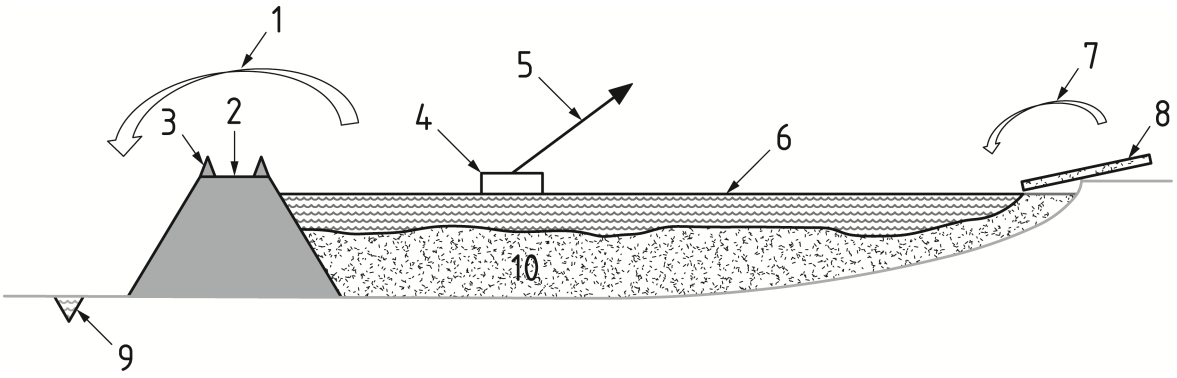
NOTE Definitions of some of the less familiar terms used in this document can be found in Clause 3.



Key

1	seepage recycle to MWF or return water dam	8	process water/excess runoff via decant
2	emergency spillway	9	plant site runoff
3	stage-raised confining embankment	10	perimeter runoff diversion system
4	tailings discharge pipeline	11	return pipeline to process plant or return water dam
5	tailings beach	12	pre-deposition embankment
6	fine tailings/slimes	13	seepage control drain
7	supernatant pond/reservoir	14	seepage return pump

Figure 1 — Typical section — tailings management facility



Key

1	emergency overflow/spillway	6	lagoon
2	earthfill confining embankment	7	site runoff
3	edge protection	8	silt discharge pipeline
4	floating lagoon level pump control system	9	drainage control channel
5	return to clean water lagoon	10	unconsolidated silt deposit

Figure 2 — Typical section — silt lagoon

When deposited using hydraulic filling techniques, the MWF for such fine particulate wastes comprises an engineered facility impounding or containing both the extractive waste and a proportion of free water derived from processing operations, from other site waters and from rainfall. This process requires the design and construction of a dam, confining embankment or other structure serving to contain, retain, confine or otherwise support such wastes on surface in a terrestrial environment, together with the appurtenant infrastructure.

Numerous techniques are available for the execution, operation and rehabilitation of a MWF, some of which are standardized and have a long history of application to the extractive industry. It is therefore recognized that no standard can prescribe or recommend specific engineering or environmental elements of the design of a complex hydraulic fill structure such as a MWF, which is site-specific and determined by the climate, geology, topography, hydrology, seismology and environmental setting. However, of importance is that hydraulic placement of extractive waste can only be managed properly if sufficient knowledge of its geochemical, physical and geotechnical properties and behaviour is available. Such knowledge may be obtained through detailed characterization of the waste and of the waste facility and its subsequent consequence classification. The different regional situations in geology and climate result in national differences in the earthwork procedures, and therefore this standard identifies the general principles and systems for the execution, operation and rehabilitation of a MWF as they relate to earthworks.

This document is part of a European Standard on Earthworks, it having been decided by CEN/TC 396 to establish a stand-alone document on the hydraulic placement of extractive wastes relating to earthworks. This document provides the geotechnical and geochemical standards necessary to meet the requirements of Directive 2006/21/EC and presents a unified approach for all stakeholders involved in the development of hydraulic fill projects and in the extension of existing mine waste facilities, together with a framework for project initiation and implementation.

This document is generic in content, and much of the text is synoptic as it is recognized that the range of extractive operations is broad and that the precise characteristics of each waste and its depositional properties will be dependent on the geology, the extraction and mineral processing techniques adopted, and on the type and location of the MWF. For more detail, reference is made to textbooks and other documents included in the Bibliography, particularly "*The hydraulic transport and storage of extractive waste, Guidelines to European Practice*".

1 Scope

This document gives recommendations for the hydraulic placement of extractive wastes and may be applicable to the following:

— all stakeholders engaged in the deposition of extractive wastes using hydraulic placement techniques with respect to geotechnical and geochemical aspects of the investigation, engineering design, construction and operation of a mine waste facility and all associated monitoring activities;

— those extractive industries involving the production of fine particulate wastes which, in the course of industrial processing, require to be stored in a safe, stable and environmentally acceptable location;

— practitioners in non-extractive industries in fields where similar techniques may be applicable and for which no other European guidance exists.

The scope of this document includes all aspects of a dam, confining embankment or other structure serving to contain, retain, confine or otherwise support such wastes on surface in a terrestrial environment. The overall framework for the standard and for each stage of a hydraulic fill project is shown in Figure 3.

This document addresses the characterization of the extractive waste for the purposes of hydraulic placement in the MWF, both as part of the confining embankment and for safe storage. In addition the standard recommends:

— minimum requirements for the data to be acquired before the design and execution stage of a hydraulic fill project;

— guidelines for the selection of the type of confining embankment appropriate for the selected site;

— guidelines for the selection and characterization of the construction materials;

— general principles on the design and execution of the hydraulic fill project from pre-deposition through operation to closure and rehabilitation;

— guidelines for monitoring and quality control of all stages of the hydraulic fill project to ensure long-term safety and stability.

This document considers how to store safely a given material resulting from a preceding process. It does not define, establish or specify detailed elements of the design of a hydraulic fill project but provides overall recommendations in order to comply with good regulatory and engineering practice. The document recognizes that similar techniques may be applicable to the hydraulic placement of materials in the non-extractive industries where no other European guidance exists.

This document does not consider the design of earth-structures in terms of safety and serviceability. These are ruled by EN 1997 (series) (Eurocode) and other relevant standards. This document assumes that the earth-structures have been properly designed.

This document is not applicable to landfill, dredging or the hydraulic filling aspects related to grouting.

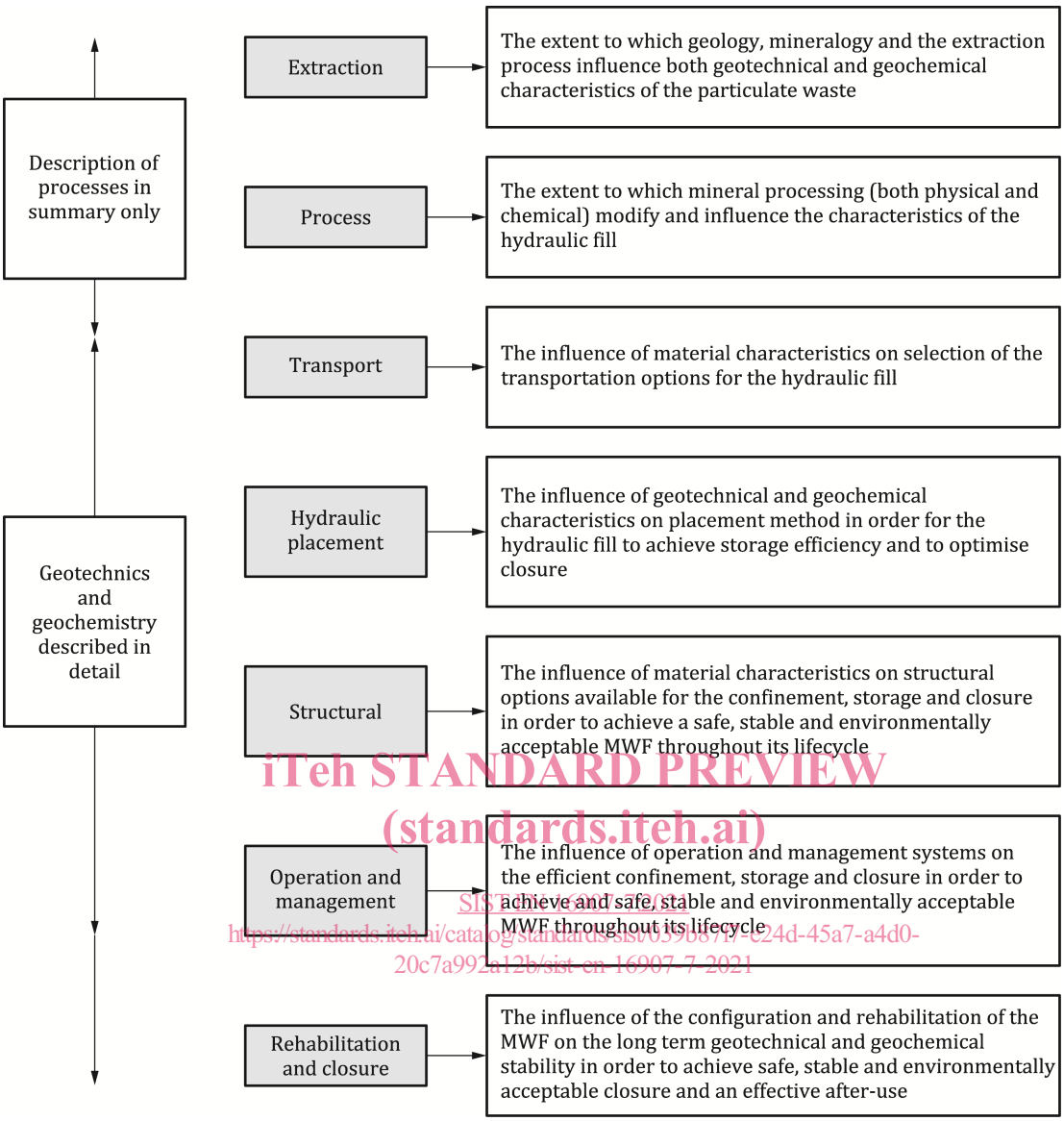


Figure 3 — Stages of hydraulic placement covered by this document

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1990, *Eurocode - Basis of structural design*

EN 1997 (series), *Eurocode 7: Geotechnical design*

EN 1998 (series), *Eurocode 8: Design of structures for earthquake resistance*

EN 14899, *Characterization of waste - Sampling of waste materials - Framework for the preparation and application of a Sampling Plan*

EN 15875, *Characterization of waste - Static test for determination of acid potential and neutralisation potential of sulfidic waste*

EN 16907 (series), *Earthworks*

EN ISO 14688 (series), *Geotechnical investigation and testing – Identification and classification of soil (ISO 14688 (series))*

EN ISO 14689, *Geotechnical investigation and testing - Identification, description and classification of rock (ISO 14689)*

EN ISO 17892 (series), *Geotechnical investigation and testing – Laboratory testing of soil (ISO 17892 (series))*

EN ISO 18674 (series), *Geotechnical investigation and testing – Geotechnical monitoring by field instrumentation (ISO 18674 (series))*

EN ISO 22282 (series), *Geotechnical investigation and testing – Geohydraulic testing (ISO 22282 (series))*

EN ISO 22475-1, *Geotechnical investigation and testing - Sampling methods and groundwater measurements - Part 1: Technical principles for execution (ISO 22475-1)*

EN ISO 22476 (series), *Geotechnical investigation and testing – Field testing (ISO 22476 (series))*

CEN/TR 15310 (series), *Characterization of waste – Sampling of waste materials*

CEN/TS 16229, *Characterization of waste - Sampling and analysis of weak acid dissociable cyanide discharged into tailings ponds*

CEN/TR 16363, *Characterization of waste - Kinetic testing for assessing acid generation potential of sulfidic waste from extractive industries*

CEN/TR 16365, *Characterization of waste - Sampling of waste from extractive industries*

CEN/TR 16376, *Characterization of waste - Overall guidance document for characterization of waste from the extractive industries*

3 Terms and definitions

For the purposes of this document the following terms and definitions apply

Note 1 to entry: For additional information, see Directive 2006/21/EC.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
comminution
act of crushing, milling and grinding geomaterials in order to reduce their grain size in advance of mineral processing

3.2
confining embankment
engineered dam constructed from both natural and processed geotechnical materials to retain in safety the fine-grained hydraulic fills (extractive waste) and process water derived from a mineral-processing plant, together with any residual natural runoff

3.3
construction material
geomaterials comprising soil, rock or suitably-sized extractive waste placed and compacted by conventional earthmoving equipment to form the confining embankment

3.4
crest of confining embankment
top level of the dam structure or the lowest part of the top of the embankment if, or in cases where, the upper surface undulates

3.5
critical value
value of a particular parameter, such as pore pressure or surface movement, defined in the design or by the operating rules and which should not be exceeded

3.6
decant
engineered structure designed to facilitate recycling of process water and, as appropriate, to discharge natural runoff

Note 1 to entry: This structure may comprise a tower, a floating/static pump or a gravity overflow system.

3.7
design criteria
parameters for the mine waste facility which define the structure and its subsequent operation

3.8
design flood
flood inflow to the reservoir which produces the maximum stillwater level the dam is required to accept under normal conditions with no damage and with a safety margin provided by the freeboard

3.9
emergency spillway
engineered structure designed to operate only during extreme events and to pass in safety flood surcharge water without endangering the stability of the confining embankment

3.10
extractive waste
see tailings

3.11
flood surcharge
maximum rise of stillwater level above reservoir top water level (or retention water level) during a flood event

3.12
freeboard
vertical height from the top of the dam to top water level (or retention water level)

3.13
hydraulic fill
material placed in a liquid form in a deliberate manner as a mixture of soil particles and water so that the particles accumulate as a deposit, and densify as further fill is placed above to create a body of fill

3.14
hydraulic fill system
reticulation and deposition pipework and infrastructure necessary to transport and to deposit the hydraulic fill

3.15
independent
free from any personal interest and, in particular, from family and financial interests in the outcome of a related inspection

Note 1 to entry: Payment for inspection services is not to be considered an impairment to independence.

3.16
inspection
act of checking and monitoring performance and compliance with criteria to indicate that identified objectives have been met and that critical values have not been exceeded

3.17
intrinsic parameters
parameters that do not change in the course of earthworks, such as particle size distribution or plasticity

3.18
Long-term
design or operating time scale generally measured in years

3.19
maximum reservoir level
maximum safe level of the supernatant pond defined in the design and operating rules for the MWF

3.20
Mine Waste Facility
MWF
engineered structure which, together with all necessary appurtenant works, is designed to retain or confine extractive waste in safety and to temporarily store and recycle, where necessary, process and flood waters

Note 1 to entry: These facilities are often known by the quarries/industrial minerals sector as “silt lagoons”, by the energy sector as “ash lagoons” and by the metal mining industry as “tailings management facilities”

3.21
mineral processing
mechanical, physical, biological, thermal or chemical processes carried out on a mineral resource for the purpose of extracting the economic mineral, together with the re-processing of previously discarded waste but excluding smelting, thermal manufacturing processes (other than the burning of limestone) and metallurgical processes

3.22
monitoring
systematic surveillance of the mine waste facility, including all associated operations such as geochemical and geotechnical characterisation, physical measurements and instrumentation readings, together with their processing, analysis and interpretation

3.23
paste
highly-thickened hydraulic fill with solids content which exhibits high viscosity and minimal solids/water separation during placement

3.24
polymetallic
mineral source/ore which is the source of more than one metal suitable for recovery

3.25
Probable Maximum Flood
PMF
flood hydrograph resulting from the PMP and, where applicable, snow-melt, coupled with the worst flood-producing catchment conditions which can be realistically expected in the prevailing meteorological conditions

3.26
Probable Maximum Precipitation
PMP
theoretical greatest depth of precipitation meteorologically possible for a given duration

3.27
regulatory inspection
act of checking and promoting compliance with relevant legislation (e.g. local, national or international regulations or permit conditions) and/or monitoring impacts to determine whether further action is required to secure such compliance (e.g. with safety, stability or environmental provisions)

Note 1 to entry: Regulatory inspections may be carried out by any public authority which is designated responsible, or may be delegated under its authority and supervision to independent experts acting on its behalf.

3.28
reservoir flood routing
passage of a flood volume through a reservoir

3.29
return period
average expected probability of occurrence of floods equal to or greater than a stated magnitude

3.30
return water dam
optional additional water storage facility designed to facilitate recirculation or discharge of excess process and meteoric waters from the MWF

3.31
reservoir
see supernatant pond

3.32
risk assessment
overall process of risk identification, risk analysis and risk evaluation, including the identification of all potential hazards and the risk of their occurrence

3.33
risk management
engineering design, operation and closure to achieve the agreed level of risk mitigation

3.34
risk mitigation
process of reducing risk and consequence through risk management procedures in order to reduce the probability of occurrence and/or negative outcomes to an acceptable rate of death, injury or damage

3.35
safety check flood
flood inflow to the reservoir which produces the maximum stillwater level which the dam is required to accept and beyond which the safety of the dam cannot be assured

Note 1 to entry: Key components may exhibit only marginally safe performance for this flood condition.

3.36
short-term
design or operating time scale generally measured in months

3.37
silt lagoon
see Mine Waste Facility

3.38
solids concentration/content
weight of solid material per unit weight of extractive waste in slurry form

3.39
spillway
see emergency spillway

3.40
state parameter
parameters that change during earthworks, such as density, water content or strength

3.41
stillwater level
supernatant pond level in the absence of any wave effects

3.42
sub-aerial deposition
deposition of hydraulic fill which takes place above water level to form a ‘beach’

3.43
sub-aqueous deposition
deposition of hydraulic fill which takes place below water level