



BSI Standards Publication

Sustainability in buildings and civil engineering works — Sustainability indicators

Part 2: Framework for the development of indicators for civil engineering works

National foreword

This British Standard is the UK implementation of ISO 21928-2:2023.

The UK participation in its preparation was entrusted to Technical Committee B/558, Sustainability of construction works.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Sustainability in buildings and civil engineering works — Sustainability indicators —

Part 2: Framework for the development of indicators for civil engineering works



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 17, *Sustainability in buildings and civil engineering works*.

This first edition cancels and replaces ISO/TS 21929-2:2015, which has been technically revised.

The main changes are as follows:

- new indicators are provided;
- core and additional indicators and some specific indicators for different typologies of CEW are listed in [Annex A](#);
- the relationship between the indicators and United Nations SDGs (Sustainable Development Goals) is addressed.

A list of all parts in the ISO 21928 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document describes and provides guidelines for the development of sustainability indicators related to civil engineering works and defines the aspects and impacts of civil engineering works to consider when developing systems of sustainability indicators.

These guidelines form a basis for the suite of ISO/TC 59/SC 17 standards intended to address specific issues and aspects of sustainability relevant to civil engineering works. The issue of sustainable development is broad and of global concern and, as such, involves all communities and stakeholders. Both current and future needs define the extent to which economic, environmental and social aspects are considered in a sustainable development process.

The built environment (buildings and civil engineering works) is a key element in determining quality of life and contributes to cultural identity and heritage. As such, it is an important factor in the appreciation of the quality of the environment in which people live and work.

The built environment is highly important for sustainable development because:

- it is a key sector in national economies;
- it has a significant impact on poverty reduction through the provision of improved basic economic and social services within the built environment;
- it is one of the single largest industrial sectors and, while providing value and employment, it uses considerable resources and contributes to the transformation of areas, with consequential impacts on economic and social conditions and the environment;
- it represents a significant share of the economic assets of individuals, organizations and nations, providing societies with their physical and functional environment;
- it has considerable opportunity to show improvement relative to its economic, environmental and social impacts.

While the challenge of sustainable development is global, the strategies for addressing sustainability in civil engineering works are essentially local and differ in context and content from region to region. These strategies reflect the context, the preconditions and the priorities and needs, not only in the built environment, but also in the social environment. This social environment includes social equity, cultural issues, traditions, heritage issues, human health and comfort, social infrastructure and safe and healthy environments.

In addition, these strategies can include poverty reduction, job creation, access to safe, affordable and healthy shelter, and loss of livelihoods. These aspects are closely related to the United Nations Sustainable Development Goals (SDG). For this reason, in [Annex D](#), the relation of the provided indicators to these SDG is shown.

This document defines a framework for the development of sustainability indicators for civil engineering works based on the premise that civil engineering works contribute to improving the economic, social and environmental aspects at local, regional and global levels with minimum adverse impact. This document follows the general principles presented in ISO 15392.

Indicators are figures or other qualitative or descriptive measures that enable information on a complex phenomenon, such as, environmental impact, to be simplified into a form that is relatively easy to use and understand.

The four main functions of indicators are quantification, simplification, communication and decision making. Changes in a civil engineering works over time and the development of changes in relation to stated objectives and targets should be monitored with the help of indicators.

When developing and selecting indicators, the starting point is the identification of the main users and user needs. Sustainability indicators for civil engineering works are needed in decision-making by several stakeholders, such as:

- public bodies and policy makers;
- investors, owners and promoters;
- planners, developers and designers;
- governmental and non-governmental organizations (considering interest groups both at national and at local level);
- manufacturers of products;
- contractors;
- operators and maintainers;
- users and other stakeholders who are given service by the infrastructure; and
- local residents.

An example of utilization of indicators for decision support in the selection of alternatives is provided in [Annex E](#).

Sustainability indicators, as well as sets and systems of indicators, for the specification, assessment and representation of the contribution of a civil engineering works to sustainable development can be used in many ways. For example, among others, their application can support the following:

- design and decision-making process(es) during the planning and design stage of a civil engineering works (e.g. incorporation in the design of sustainable material, technologies, processes and other components);
- development and application of assessment methods and certification systems;
- specification and verification of environmental and social requirements in the context of procurement;
- indicating the civil engineering performance (e.g. marketing);
- measuring, monitoring or evaluating the performance and achievement of sustainability objectives over the different life cycle stages of the civil engineering works;
- identifying critical trends, both positive and negative, in the development and operation of civil engineering works;
- accepting responsibility for impacts on the environment and the society;
- representation of activities and results in the context of responsibility towards the economy, environment and society (e.g. sustainable development reporting).

NOTE The monitoring and evaluation of objectives can contribute to the continual improvement related to a specific or group of civil engineering works.

Aspects and impacts are the basis of the framework for the development of sustainability indicators for assessing the sustainability performance of new or existing civil engineering works, related to their design, construction, operation, maintenance, refurbishment and end-of-life. The indicators developed from these sets of aspects and impacts provide measures to express how the performance of a civil engineering works contributes to sustainability and sustainable development. The indicators developed based on these sets represent aspects of civil engineering works that potentially impact on issues of concern related to sustainability and sustainable development.

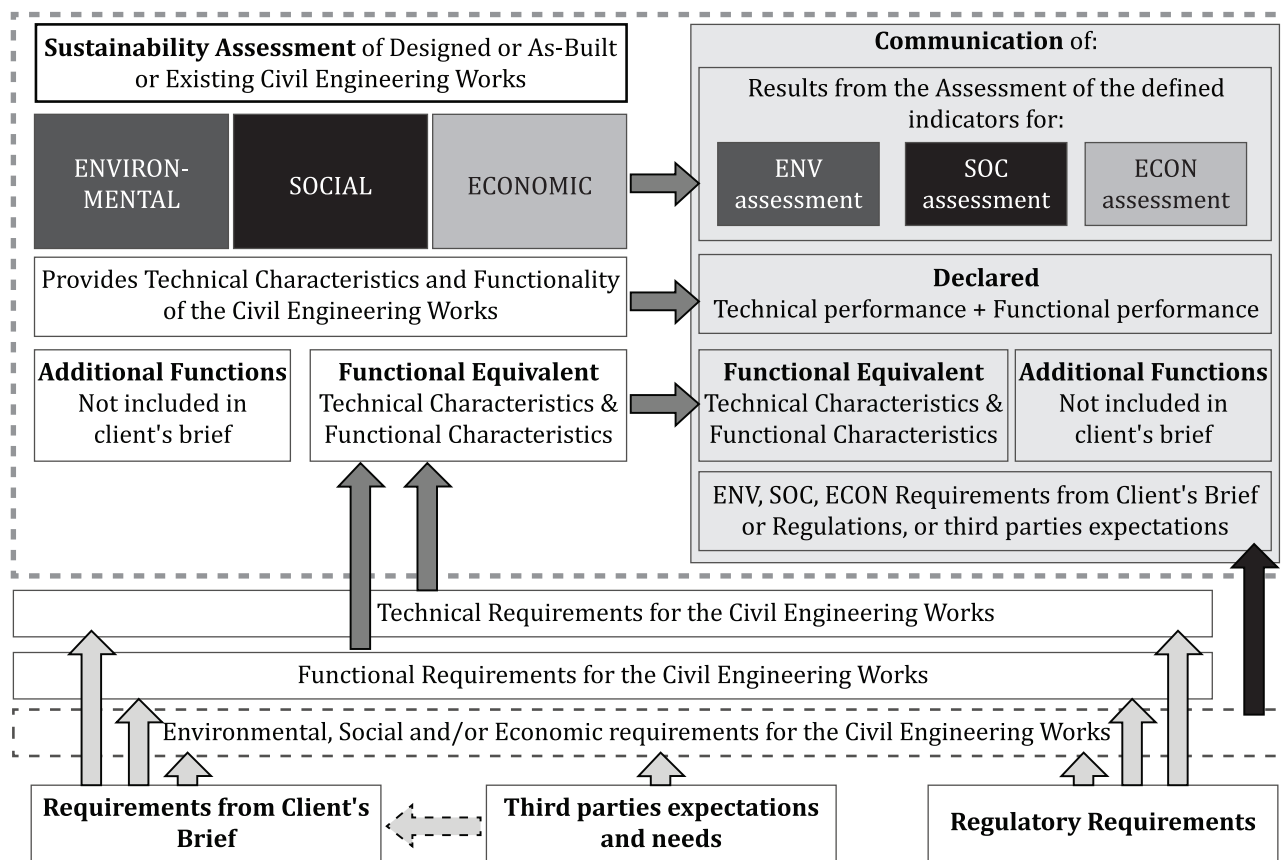
The object of consideration in this document is a civil engineering works, a part of the civil engineering works or a combination of several civil engineering works.

This document is one in a suite of International standards dealing with sustainability in buildings and civil engineering works, which includes ISO 15392, ISO 21929-1, ISO 21930, ISO 21931-1, ISO 21931-2, along with the terminology of sustainability in buildings and civil engineering works defined by ISO/TR 21932. The relationship among these International standards is shown in [Figure 1](#).

ISO/TC 59/SC 17	Environmental aspects	Social aspects	Economic aspects	Technical aspects	Functional aspects
Principles	ISO 15392 General principles				
	ISO/TS 12720 Guidelines on the application of ISO 15392				
	ISO/TR 21932 A review of terminology				
Buildings (Parts 1) + Civil engineering works, CEW (Parts 2)	ISO 21929-1 Framework for the development of indicators – Part 1: Buildings				
	ISO 21928-2 Framework for the development of indicators – Part 2: CEW				
	ISO 21931-1 Framework for methods of assessment of the environmental, social and economic performance of construction works as a basis for sustainability assessment – Part 1: Buildings				
	ISO 21931-2 Framework for methods of assessment of the environmental, social and economic performance of construction works as a basis for sustainability assessment – Part 2: Civil engineering works				
	ISO 20887 Design for disassembly and adaptability – Principles, requirements and guidance				
	ISO 16745-1+ 2 Carbon metric of an existing building during use stage – Part 1: Calculation, reporting, communication – Part 2: Verification				
	ISO 21678 Indicators and benchmarks – Principles, requirements and guidelines				
Products	ISO 22057 Data templates for the use of environmental product declarations (EPDs) for construction products in building information modelling (BIM)				
	ISO 21930 Core rules for environmental product declarations of construction products and services				

Figure 1 — Suite of related international standards for sustainability in buildings and civil engineering works

[Figure 2](#) illustrates how the assessment of the environmental, economic and social performances fits within the concept of the sustainability assessment of a civil engineering works.



NOTE The outer box with the thick dotted line represents the area within the scope of this document.

Figure 2 — Concept of sustainability assessment of civil engineering works

Indicators related to technical and functional performance are beyond the scope of this document. Technical and functional characteristics are taken into account here by reference to the functional equivalent, which also forms a basis for comparison of the results.

This document supports the development of indicators as a basis for quantification of the contribution of the assessed civil engineering works to sustainable construction and sustainable development.

Third parties' expectations and needs include those from societal, NGOs and local communities.

Environmental, social and/or economic requirements for the civil engineering works (based on the client's brief, as part of third parties' expectations and needs or imposed by regulation) are taken into account. Thus, they are part of the communication and included in the report. However, they are not assessed.

This document adapts general sustainability principles for civil engineering works and follows the principles set out in ISO 15392 and, where appropriate, is intended to be used in conjunction with, and following the principles set out in, ISO 26000, ISO 14040 and the family of International Standards that includes ISO 14020, ISO 14021, ISO 14024 and ISO 14025. Where deviation occurs, this document goes beyond the requirements of these standards.

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Sustainability in buildings and civil engineering works — Sustainability indicators —

Part 2: Framework for the development of indicators for civil engineering works

1 Scope

This document establishes a set of common aspects and impacts for all typologies of civil engineering works, and identifies core sets of environmental, social and economic aspects and impacts for each typology of civil engineering works defined.

The common core set of aspects and impacts described in this document are applicable to all types of civil engineering works. In addition, this document describes specific core sets of aspects and impacts for different typologies of civil engineering works (industrial process infrastructures; linear infrastructures; dams and other fluvial works; maritime works; public spaces; and other civil engineering works not contained in the previous typologies).

Further, the document gives rules for establishing a system of indicators and describes how to use sustainability indicators regarding civil engineering works.

This document does not provide guidelines for the weighting of indicators or the aggregation of assessment results.

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.

ISO 1996-2:2017, *Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of sound pressure levels*

ISO 2631 (all parts), *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration*

ISO 14020, *Environmental statements and programmes for products — Principles and general requirements*

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 15392:2019, *Sustainability in buildings and civil engineering works — General principles*

ISO 15686-1:2011, *Buildings and constructed assets — Service life planning — Part 1: General principles and framework*

ISO 15686-2, *Buildings and constructed assets — Service life planning — Part 2: Service life prediction procedures*

ISO 15686-5:2017, *Buildings and constructed assets — Service life planning — Part 5: Life-cycle costing*

ISO 15686-7, *Buildings and constructed assets — Service life planning — Part 7: Performance evaluation for feedback of service life data from practice*

ISO 15686-8, *Buildings and constructed assets — Service-life planning — Part 8: Reference service life and service-life estimation*

3 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 airport

area containing an airfield and facilities for handling passengers and cargo

[SOURCE: ISO 6707-1:2020, 3.1.3.12]

3.2 area of influence

area or combination of areas surrounding a *civil engineering works* (3.6) that can be affected with changes to their economic, environmental or social conditions by the civil engineering works' operations throughout its *life cycle* (3.23)

Note 1 to entry: The area of influence is variable and dependent on the civil engineering works project, its location and its life cycle stage. As an overall approach, the area of influence is usually limited to the civil engineering works itself and its immediate surroundings and neighbourhoods.

3.3 avoided emissions

emissions that are not produced (are avoided) as a result of the implementation of voluntary initiatives or good practices

3.4 built environment

collection of man-made or induced physical objects located in an area or region

Note 1 to entry: When treated as a whole, the built environment typically is taken to include buildings, external works (landscaped areas), *infrastructure* (3.20) and other construction works within the area under consideration.

[SOURCE: ISO 21929-1:2011, 3.7, modified — Note 2 to entry has been removed.]

3.5 civil engineering work

work of constructing *civil engineering works* (3.6)

[SOURCE: ISO 6707-1:2020, 3.5.1.3]

3.6 civil engineering works

construction works comprising a *structure* (3.40), such as a *dam* (3.9), bridge, *road* (3.35), *rail-transit* (3.30), runway, utilities, *pipeline* (3.28), or *sewerage system* (3.38), or the result of operations such as dredging, *earthwork* (3.11), geotechnical processes, but excluding a building and its associated site works

[SOURCE: ISO 6707-1:2020, 3.1.1.2]

3.7

system boundary

set of criteria specifying which unit processes are part of the specific analysis of a *civil engineering works* (3.6)

[SOURCE: ISO 14044:2006, 3.32 modified — Reference to “a product system” has been replaced by “the specific analysis of a civil engineering works”; note 1 to entry has been removed.]

3.8

construction work

activity of forming a *civil engineering works* (3.6)

[SOURCE: ISO 6707-1:2020, 3.5.1.1, modified — The alternative term “construction, US” and note 1 to entry have been removed; “activities” has been changed to “activity”; “construction works” has been changed to “a civil engineering works”.]

3.9

dam

barrier constructed to retain water to raise its level, form a reservoir, or reduce or prevent flooding

[SOURCE: ISO 6707-1:2020, 3.1.2.22]

3.10

dock

partially enclosed or sheltered area of water where vessels may be moored or docked, used for shipping

3.11

earthwork

work of excavating, or the raising or sloping of ground

[SOURCE: ISO 6707-1:2020, 3.5.1.6, modified — The alternative terms “excavation” and “work, US” have been removed.]

3.12

economic aspect

characteristic of *civil engineering works* (3.6), part of works, processes or services related to their *life cycle* (3.23), that can cause change to economic conditions

[SOURCE: ISO 15392:2019, 3.12, modified — “construction works” has been replaced by “civil engineering works”.]

3.13

energy efficiency

measure of energy use against a baseline

EXAMPLE An energy efficient lamp which produces the same amount of light as a conventional lamp but uses up to 75 % less energy to do so.

3.14

environmental aspect

characteristic of *civil engineering works* (3.6), part of works, processes or services related to their *life cycle* (3.23), that can cause change to environment

[SOURCE: ISO 15392:2019, 3.13, modified — “construction works” has been replaced by “civil engineering works”.]

3.15

external costs

costs associated with an asset that are not necessarily reflected in the transaction costs between provider and consumer and that, collectively, are referred to as externalities

Note 1 to entry: These costs may include business staffing, productivity and user costs; these can be taken into account in a *life-cycle cost* ([3.24](#)) analysis but are to be explicitly identified.

[SOURCE: ISO 15686-5:2017, 3.1.6]

3.16

impact

the result of a change or existing condition that may be adverse or beneficial

[SOURCE: ISO 15392:2019, 3.17]

3.17

impact category

class representing an economic, environmental or social issue(s) of concern (areas of protection) to which analysis (assessment) results may be assigned

Note 1 to entry: Issues of concern can involve either *impacts* ([3.16](#)) or aspects related to the economy, the environment or the society.

[SOURCE: ISO 21929-1:2011, 3.15, modified — Note 2 to entry has been removed.]

3.18

indicator

quantitative, qualitative or descriptive measure representative of one or more *impact categories* ([3.17](#))

Note 1 to entry: Periodic evaluation and monitoring using indicators can show direction of any *impact* ([3.16](#)).

[SOURCE: ISO 21929-1:2011, 3.16, modified — Note 2 to entry has been removed.]

3.19

indirect indicator

indicator ([3.18](#)) that does not express the subject of interest directly or only expresses it in a proxy way

3.20

infrastructure

civil engineering works ([3.6](#)), part of the civil engineering works or combination of several civil engineering works

Note 1 to entry: In this document, the term "infrastructure" is sometimes used as a synonym for civil engineering works.

Note 2 to entry: Use of the preferred term, infrastructure, is derived from the definition of civil engineering works in ISO 15392.

3.21

stakeholder

interested party

person or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity

EXAMPLE Customers, communities, suppliers, regulators, non-governmental organizations, investors and employees.

[SOURCE: ISO 21931-1:2022, 3.5.6]

3.22

issue of concern

aspect(s) of the economy, the environment or the society that can be impacted by *civil engineering works* (3.6), goods or services

EXAMPLE Asset value, cultural heritage, resources, human health and comfort, social infrastructure.

[SOURCE: ISO 15392:2019, 3.3 — The preferred term to designate this concept has been changed from ‘areas of concern’ to ‘issue of concern’ and the admitted terms removed. “Construction works” has been replaced by “civil engineering works”.]

3.23

life cycle

all consecutive and interlinked stages in the life of the object under consideration

Note 1 to entry: For consideration of environmental impacts and *environmental aspects* (3.14), the life cycle comprises all stages, from raw material acquisition or generation of natural resources to end-of-life.

Note 2 to entry: For consideration of economic impacts and *economic aspects* (3.12), in terms of costs, the life cycle comprises all stages from construction to decommissioning. A *period of analysis* (3.27) can be chosen to be different from the life cycle, see ISO 15686-5.

[SOURCE: ISO 15392:2019, 3.19]

3.24

life-cycle cost

cost of an asset or its parts throughout its *life cycle* (3.23), while fulfilling its *performance* (3.26) requirements

[SOURCE: ISO 15686-1:2011, 3.11, modified — The abbreviated term “LCC” has been removed.]

3.25

linear infrastructure

civil engineering works (3.6) characterized by its length, that transfers persons, materials or energy from one specific point to an end point

Note 1 to entry: It includes civil engineering works such as *roads* (3.35), *rail-transits* (3.30), bridges, *pipelines* (3.28) or channels.

3.26

performance

observed (or predicted) behaviour of a *civil engineering works* (3.6), construction product or construction service in fulfilling (to fulfil) required functions or intended use conditions

Note 1 to entry: Performance in this context pertains to functional and technical requirements in use.

[SOURCE: ISO 15392:2019, 3.20, modified — “construction works” has been replaced by “civil engineering works”.]

3.27

period of analysis

period of time over which *life-cycle costs* (3.24) or *whole-life costs* (3.44) are analysed

Note 1 to entry: The period of analysis is determined by the client.

[SOURCE: ISO 15686-5:2017, 3.3.6]

3.28

pipeline

long continuous line of pipes, including ancillary equipment, used for transporting liquids or gases

[SOURCE: ISO 6707-1:2020, 3.1.2.30]

3.29

primary energy resource

energy resource that has not been subjected to any conversion or transformation process

[SOURCE: ISO 6707-3:2022, 3.6.22, modified — The word “energy” has replaced by “energy resource”.]

3.30

rail-transit

national or regional transport system for guided passage of wheeled vehicles on rails

[SOURCE: ISO 6707-1:2020, 3.1.3.3, modified — The term has been changed from “railway” or “railroad, US” to “rail-transit”.]

3.31

recovery

waste (3.43) treatment operation that serves a purpose in replacing other resources or prepares waste for such a use

3.32

recycling

recovery (3.31) operation by which *waste* (3.43) materials are reprocessed into products, materials or substances

Note 1 to entry: This can be done by “upcycling or high-level-recycling or recycling in closed cycles” or “low-level-recycling or downcycling in open cycles”.

3.33

resilience

ability to resist, adapt to, or quickly recover from a potentially disruptive event, whether natural or manmade in order to maintain or restore the intended service

3.34

re-use

operation by which products or components previously used are used again, without reprocessing, as products, materials or substances

3.35

road

way mainly for vehicles

[SOURCE: ISO 6707-1:2020, 3.1.3.1]

3.36

secondary energy source

energy source recovered from a previous use or from *waste* (3.43) which substitutes primary energy sources

3.37

set of indicators

non-structured list of *indicators* (3.18)

[SOURCE: ISO 21929-1:2011, 3.30]

3.38

sewerage system

system of sewers and ancillary works that conveys the contents to a sewage treatment works or another place of disposal

[SOURCE: ISO 6707-1:2020, 3.3.4.40, modified — The alternative term “sewage system, US” has been removed.]

3.39

social aspect

characteristic of *civil engineering works* (3.6), part of works, processes or services related to their *life cycle* (3.23) that can cause change to society or quality of life

[SOURCE: ISO 15392:2019, 3.14, modified — “construction works” has been replaced by “civil engineering works”.]

3.40

structure

civil engineering works (3.6) having an organized combination of connected parts designed to provide some measure of rigidity

3.41

sustainability indicator

indicator (3.18) related to economic, environmental, or social impacts

[SOURCE: ISO 21929-1:2011, 3.33]

3.42

system of indicators

structured list of *indicators* (3.18)

[SOURCE: ISO 21929-1:2011, 3.34]

3.43

waste

substances or objects that the original holder has disposed of or intends to or is required to dispose of

Note 1 to entry: In this document, this concept is not confined to hazardous waste.

Note 2 to entry: Adapted from the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (22 March 1989), Article 2 Definitions, Item 1. The wording has been simplified and the reference to national law as the basis for any requirements has been removed.

[SOURCE: ISO 21929-1:2011, 3.37]

3.44

whole-life cost

all significant and relevant initial and future costs and benefits of an asset, throughout its *life cycle* (3.23), while fulfilling the *performance* (3.26) requirements

[SOURCE: ISO 15686-5:2017, 3.1.14, modified — The abbreviated term “WLC” has been removed.]

3.45

whole-life costing

methodology for systematic economic consideration of all *whole-life costs* (3.44) and benefits over a *period of analysis* (3.27), as defined in the agreed scope

Note 1 to entry: The projected costs or benefits may include *external costs* (3.15) (including, for example, finance, business costs, income from land sale, user costs).

Note 2 to entry: Whole-life costing can address a period of analysis that covers the entire *life cycle* (3.23) or (a) selected stage(s) or periods of interest thereof.

[SOURCE: ISO 15686-5:2017, 3.1.15, modified — Note 3 to entry has been removed.]

4 General rules for sustainability indicators development and its framework

4.1 General

There are several issues that shall be considered when expressing or describing an assessment of the contribution which a civil engineering works has on achieving sustainability and sustainable development with the help of indicators.

Indicators are quantitative, qualitative or descriptive measures representative of one or more impact categories or classes of economic, environmental or social issues of concern, to which analysis (assessment) results may be assigned. An indicator is intended to be relevant and representative of a wider, more complex issue, which it helps to illustrate. The use of indicators reduces the complexity of an issue that is to be assessed and allows the assessment of issues that in themselves are not measurable.

When assessing or setting targets for the contribution of a civil engineering works to sustainability, the use of other sustainability indicators may be relevant depending on the specific circumstances of the civil engineering typology and location. Indicators can address economic, environmental and social impacts directly as well as issues that have indirect consequences on such impacts. In some cases, the indicators address more than just a single aspect of sustainability.

NOTE For instance, the hypothetical indicator “reused excavation material”, that can be developed under the aspect “use of material resources” can be used to measure the surplus of excavated material that is reused or recycled on site, instead of taken to landfill. This indicator can address economic, social and environmental impacts, as detailed below.

- Economic impacts: The higher the excavated surplus material is reused on site, instead of being taken to landfill, the less will be the filling material that the project needs to purchase for its construction. The reuse of material on site also decreases the transport of raw material to the site and the transport of surplus construction materials to landfill, and it consequently reduces the fuel consumption. All these effects have an important economic impact for the project.
- Environmental impacts: On the one hand, the reduction of borrow pits by reusing the surplus materials on site, minimises the consumption of soil resources and the dust generation. On the other hand, the reduction of waste taken to landfill reduces the need of space for this activity and consequently minimises the environmental impact on natural habitats. As well, the reduction of transport reduces the emissions to air and, in the long term, the depletion of non-renewable sources like fuel. These examples show the environmental impacts that can be addressed through the potential indicator.
- Social impacts: The reuse of excavated materials on site reduces the space needed for landfills. This avoids landscape modification and territory segregation. The excavated materials can be reused for land levelling; which increases the useful surface area that can be for instance beneficial for agriculture uses. These are examples of social impacts, which can be addressed through the potential indicator.

There are some technical design specifications that can affect the civil engineering works and its sustainability. For example, selecting one- or two-layer porous pavements instead of dense asphalt in the design stage of a road can be used to reduce tyre road noise. This may avoid or reduce the need to take corrective measures for noise abatement, such as noise barriers or sound insulation in the use stage, and may affect the values of several indicators of economic, environmental or social impact when comparing it to other alternatives.

Guidelines on the selection of materials, products and systems can be given as practical recommendations, aiming to favour a certain type of technical measure. Practical recommendations depend in any case on geographical and technological circumstances. The degree of implementation of these measures, which are either defined as a design alternative or adopted as a preventive measure or good practice, can be used as an indicator to assess the sustainability of the civil engineering works.

4.2 Life cycle approach

The character, quality and availability of relevant information are all dependent on the life cycle stage of the civil engineering works. This document applies the life cycle stages as defined in the ISO 21931 series. In the life cycle of a civil engineering works, the following stages should be considered.

- Product stage: covers the period from “cradle” (extraction of natural resources) to the factory “gate” (before the products are transported to the site). It includes:
 - natural resources extraction and/or harvesting;
 - transport;
 - manufacturing and all upstream processes from cradle to gate.

Design and procurement are included in the construction process stage. When considering activities such as site investigation or archaeological studies, which are undertaken during planning, procurement or design stages, their impact shall be considered in the construction process stage.

- Construction process stage: covers the transportation of products to the site and the period between the point of time when construction work starts and the point when the civil engineering works is “ready” to be used or to give its service to the related community. It includes:
 - on site extraction;
 - transportation to and on the site;
 - construction of the civil engineering works.

NOTE 1 The pre-construction stage can be considered within the construction process stage: non-physical processes before construction, preliminary studies, tests, acquisition of land/site and design.

- Use stage: covers the period in which the civil engineering works is used or gives its service to the related community. It includes:
 - use;
 - operation and management;
 - maintenance and repair;
 - replacement;
 - refurbishment.
- End of life stage: covers the stages that occur during the end-of-life process. It includes:
 - decommissioning, deconstruction and demolition;
 - transport;
 - processing for reuse, recovery and/or recycling of construction materials;
 - disposal of construction material;
 - relandscaping.

NOTE 2 Impacts and benefits during and beyond end of life stage (reuse, recovery and recycling, as well as exported utilities) can be expressed as additional information.

Beyond the system boundary of the assessment two parts should be considered: the potential resources for future use including reused products, recycled materials and energy recovery, and the benefits and loads of exported energy or other utilities.

In the different life stages of a civil engineering works, the indicators may need to be considered differently. Indicators addressing the same issues may, therefore, initially relate to values predicted at the planning and design stage, while during the construction or use stage, indicators addressing that same issue of concern may be based on measurements or inquiries.

NOTE 3 For example, the sources of the data needed for the quantification of material supply change over time depending on the life stage of the civil engineering works, since during the design stage and at the beginning of the works, most of these data are predictions obtained from the construction project, literature, estimates or experts' views, whereas during the construction and use stage the quantity of materials used can be calculated with solid data, gathered from self-records, measurements, invoices, accounting systems or delivery notes.

Figure 3 illustrates the organization of the different stages in the life cycle of a civil engineering works, which should be considered in the assessment.

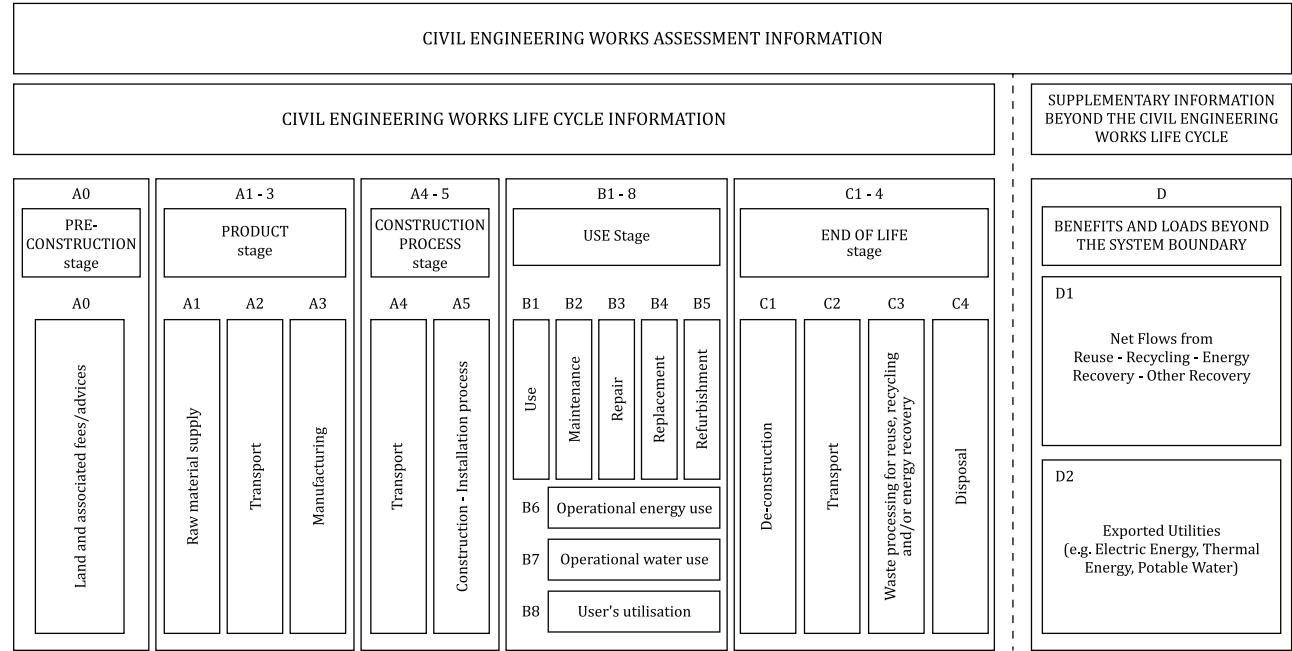


Figure 3 — Display of modular information for the different stages of civil engineering works' assessment

4.3 Area of influence

Civil engineering works affect a specific area throughout its life cycle; this spatial area over which the civil engineering works has significant economic, environmental or social influence is called “area of influence”. Since the area of influence is variable and dependent on several factors, such as the civil engineering work typology, its location, the affected sustainability indicators and the life cycle specific stage, determining the area of influence is an important step when performing a sustainability assessment of civil engineering works.

For determining the area of influence of a civil engineering works, it is necessary to define the beginning and end of this area. Given that the area of influence is not always limited to the civil engineering works itself or some set distance from this area, the area of influence shall be defined for every typology

of civil engineering works and for each of the dimensions of sustainability: environmental, social and economic.

NOTE 1 For example, the area of influence related to land use, in general, is localized and restricted to the civil engineering works itself and immediate surroundings, whereas the area of influence related to releases of pollutants to a water body can be limited to a single river or stream, but can extend many miles downstream. Additionally, the spatial boundaries of the construction process stage normally include the civil engineering works area and immediate surroundings, and the socioeconomic regions supplying workers, whereas the spatial boundaries of the use stage include the civil engineering works itself and surroundings, the areas affected by emissions and effluents of the civil engineering works' use and the socioeconomic regions supplying workers.

NOTE 2 The definition of the spatial boundaries is a part of the system boundary definition.

Indicators have a relationship to both the concerns of the stakeholders and the overall assessment goal. The selection of the relevant set of indicators shall reflect the concerns of stakeholders and the proper representation of the assessment goal.

4.4 Civil engineering works typologies

The development and use of indicators require the classification of civil engineering works in different typologies, such as:

- industrial process infrastructures;

EXAMPLE 1 Waste disposal, sewerage, nuclear plants, cars factories, quarries, water treatment systems.

- linear infrastructures (including above and below ground);

EXAMPLE 2 Roads, pipelines, rail-transits, electrical transmission lines under the sea, runways, bridges.

- dams and other fluvial works;

EXAMPLE 3 Dams, locks, cofferdams, dredging, aquifer recharge.

- maritime works;

EXAMPLE 4 Electrical transmission lines under the sea, harbours, dredging, breakwater, wharves.

- public spaces.

EXAMPLE 5 Parks, airports, stadiums, railway stations, earthworks, landfill, public realm works.

Civil engineering works can be considered within one or more typologies. Consideration shall be given to all appropriate indicators for the identified typologies.

EXAMPLE 6 Canals can be considered as a linear infrastructure as well as a fluvial works.

In the case of a civil engineering works that does not fit very well into any of the five typologies defined, either because it is different or because it is a combination of several, the typologies that best fit the one under consideration shall be selected, and the indicators of all those selected shall be considered.

NOTE This includes some multifunctional and cross-typology infrastructures.

4.5 General principles and relationship to other relevant standards

4.5.1 General principles and procedures

In addition to the requirements of this document, the principles and procedures set out in ISO 15392, ISO 14040 and the ISO 14020 family of standards shall apply. The principles set out in ISO 26000 should also be taken into consideration, where appropriate. Where this document provides more specific requirements than these standards, such specific requirements shall be followed.

ISO 15392 presents six objectives for applying the concept of sustainability to buildings and civil engineering works and at the same time promoting sustainable development. These are:

- improvement of the construction sector and the built environment;
- reduction of adverse impacts while improving value, where impacts as well as value may be judged against any combination of the three primary aspects of sustainability;
- stimulation of a proactive approach;
- stimulation of innovation;
- decoupling of economic growth from increasing adverse impacts on the environment and/or society;
- reconciliation of contradictory interests or requirements arising from short-term and long-term planning or decision.

4.5.2 ISO 15392 — General principles of sustainability in building construction

ISO 15392 lists nine general principles applied to reach the objectives for applying the concept of sustainability to civil engineering works. These general principles are:

- continual improvement;
- equity;
- global thinking and local action;
- holistic approach;
- involvement of stakeholders;
- long term consideration and resilience;
- responsibility;
- risk management;
- transparency.

Sustainability indicators provide a means for taking into consideration the different principles related to sustainability and aid in the implementation of these principles.

4.5.3 ISO 14000 — Management systems standards

The ISO 14000 family of standards are intended to address the implementation of environmental management systems within organizations to help them manage the environmental impacts of their operations. Regarding the ISO 14020 family of standards, the overall goal related to environmental declarations and claims is to encourage the demand for, and supply of, those products (goods and services) that cause less stress on the environment, through communication of verifiable and accurate information that is not misleading, thereby stimulating the potential for market-driven continuous environmental improvement. ISO 14040 on life cycle assessment (LCA) provides one of several environmental management techniques (e.g. risk assessment, environmental performance evaluation, environmental auditing, and environmental impact assessment) and might not be the most appropriate technique to use in all situations. LCA typically does not address the economic or social aspects of a product, but the life cycle approach and methodologies described in ISO 14040 can be applied to these other aspects.

4.5.4 ISO 26000 — Social responsibility standard

ISO 26000 presents guidance on social responsibility relative to organizations and is intended to assist organizations in contributing to sustainable development. It describes seven high-level underlying

general principles related to social responsibility that an organization should respect and address, which includes:

- accountability;
- transparency;
- ethical behaviour;
- respect for stakeholder interests;
- respect for the rule of law;
- respect for international norms of behaviour;
- respect for human rights.

It also identifies lower-level principles specific to several core subjects (issues), such as, the environment, consumer issues and community development.

In assessing the contribution of civil engineering works projects to sustainable development, how and when these different standards and their principles apply vary and depend on the issue of concern under consideration. It also depends on the goods and services (products) used, and the different activities and decisions that the various stakeholders use or undertake, during the life cycle of the building.

NOTE 1 ISO/TS 12720 provides guidelines on the application of the general principles described in ISO 15392.

NOTE 2 The purpose of any sustainability assessment of a building is influenced by the specific scenario and different stakeholders involved. ISO 21931-1:2022, Annex B, provides guidance on the intended use, life cycle consideration and the application and/or purpose of assessments of the environmental performance of buildings.

4.6 Requirements for the development of indicators

The development of indicators for the specification and assessment of the contribution of a given civil engineering works to sustainability and sustainable development requires knowledge about the key issues of concern, the dimensions and complex interdependencies of sustainability in general and how these are applied to civil engineering works.

Indicators shall be:

- relevant: able to accomplish the goal of the intended use of the stakeholders;
- simple: presenting information in an easily understandable way to the different users of indicators;
- valid: objective, verifiable and reproducible and based on available and affordable standardized data and methodologies, whenever possible;
- informative: imparting knowledge and reflecting information which can have an influence or effect;
- sensitive and responsive: detecting changes in the system;
- reliable: giving the same result on successive trials (measurements under the same circumstances).

Information about an indicator shall include the following:

- nomenclature;
- a definition, comprising a general description and the underlying definitions and concepts, including a formula or expression when possible;
- unit of measurement (where applicable).

In addition, the indicator should also contain the following:

- method of measurement, including the status of the methodology against recognized standards;
- potential impact on one or more issues of concern, classifying these issues under environmental, economic and social aspects;
- data required to calculate the indicator, including data availability, reliability, accuracy, data sources and limitations of the data;
- organisations and/or responsible people involved in the development of the indicator;
- justification, describing the necessity of including this indicator in the core set and giving references and recognized standards related to the indicator, plus additional reading and sources of information;
- main aspects of the indicator, pointing out the themes to which it is related and those on which it can have a significant influence, including its relationship and links to other indicators.

The set of indicators shall be developed such that double counting is avoided. However, if an indicator is relevant to more than one dimension of sustainability and accounted for accordingly; this should not be regarded as double counting but represents a multi-effect approach.

4.7 Framework of sustainability indicators

4.7.1 General

A sustainability indicator is a quantitative or qualitative measure related to economic, environmental or social aspects. Generally, indicators have numerical values. However, in cases where relevant indicators cannot be measured with quantitative data then qualitative descriptions shall be used.

EXAMPLE A qualitative description can be that improved transportation would lead to economic development.

A sustainability indicator shall be linked to at least one of the three dimensions of sustainability. When developed, a set of indicators shall include the aspects and impacts described in this document.

When some aspects are not considered or are excluded from consideration, the reasons for such omission or exclusion shall be clearly explained and justified.

The sustainability indicators shall be organized within the three dimensions of sustainability, depending on the topic where they fit best. This does not mean that the indicators should be considered exclusively within only one dimension; on the contrary, they can have effects on economic, environmental and social issues of concern.

NOTE 1 For instance, the hypothetical indicator that can be developed under the name “Land take” (total area of land required for the civil engineering works), categorised in the aspect “Land use changes”, has an obvious influence on the environmental conditions, since it affects the use of natural resources, and the surrounding biodiversity and ecosystem. However, it has also economic and social linkages; because the act of taking land for a civil engineering development has a direct cost for the investors and promoters, it can affect the economic value of the nearby properties, it can lead to relocation of communities that lived in this land or to relocation of economic activities or it can change the cultural heritage either damaging it or rising its value through protection measures.

There are two types of sustainability indicators: direct indicators, which refer directly to the subject of interest they have been developed; indirect indicators, the development of which may be necessary, because the subject of interest cannot be measured directly or for ease of use. When used, indirect indicators shall have an evident connection with the subject of interest.

NOTE 2 Water quality can be expressed through different water quality factors. For example, the extent of eutrophication can be reflected either directly, through measures of the phosphate and nitrate contents of the water, or indirectly, through the amount of fertilizers, measured in terms of N or P, consumed in the nearby areas.

All life cycle stages of a civil engineering works shall be considered in the development of the indicators and their measurement (calculation) methods. When some stages are not considered or are excluded from consideration, the reasons for such omission or exclusion shall be clearly explained and justified.

NOTE 3 For example, when indicating the environmental performance of existing infrastructures, it can be justified to exclude the impacts from the original construction process stage.

The indicators addressing the issues of concern over the entire life cycle shall, as a minimum, maintain the distinction of:

- product stage (including materials extraction, transport and manufacturing);
- construction process stage;
- use stage;
- end-of-life stage.

The assessment of the economic impact of civil engineering works should, whenever possible, be based on a whole-life costing approach, and therefore consider all costs occurring in the life cycle of the civil engineering works. For consideration of economic impacts and economic aspects, in terms of costs, the life cycle comprises all stages from product stage to end-of-life stage.

This document provides a set of aspects and impacts common to all the typologies of civil engineering works, but there are also some specific aspects and impacts defined as core for each one of the typologies.

The core set of aspects and impacts are those for which indicators shall always be developed, at least. Depending on the case, specificities, location, etc., some other indicators based on aspects and impacts not included in the core set of aspects and impacts shall be developed.

Aspects and impacts as defined in [Annex A](#) shall be considered.

4.7.2 Issues for the development of environmental indicators

Environmental indicators relate to the environmental aspects of civil engineering works and to related impacts. When developing a system of environmental indicators of civil engineering works, the following environmental impacts and aspects shall be taken into consideration:

- water management;
- energy management;
- material management;
- waste management;
- emissions to environment (air, water and soil);
- noise, vibrations and light impacts (emission and obstruction);
- landscape changes;
- ecosystem health;
- land use changes.

NOTE The use of methods that support the consideration of environmental aspects, such as:

- service life assessment methods;
- environmental assessment methods;
- energy-efficiency assessment methods; and

- procurement and commissioning methods;

can demonstrate the rigour with which environmental issues have been considered within the design process. This can be used as a qualitative additional indicator.

4.7.3 Issues for the development of social indicators

Social indicators relate to the social aspects of civil engineering works and to related impacts.

The following social aspects shall be considered for developing a system of social indicators of civil engineering works.

- Accessibility: access to nature and access to basic services, i.e. users shall be able to access the service the civil engineering works is providing (water or energy supply, mobility services, etc.). That means that the infrastructure shall be functional and easy to use. However, there are some assets in civil engineering works that need to be inaccessible, to avoid incidents.
- Adaptability.
- Population system: changes in the number and distribution of inhabitants living in the areas of influence of the civil engineering works. The civil engineering works can either attract people to live in an area because of the associated improvements and value increase or make people leave their living areas to settle in other regions. A resettlement happens, for instance, when a location is flooded to build a dam.
- Job creation: working population in the areas of influence of the civil engineering works and their composition, considering different target groups like local, minorities or women employees.
- Cultural heritage elements: aesthetic or cultural concerns, such as preserving historical or archaeological sites, value of nearby properties.
- Stakeholder involvement, including education, training and literacy.
- Human rights.
- Risks and resilience: robustness and resilience of the infrastructure, i.e. durability, resistance to adverse conditions (climate change, natural disasters like fire or earthquakes, terrorism, etc.); retaining function, i.e. in case of disaster or after a terror action carried out against a civil engineering works, it shall have mechanisms to restore its function and value in a short period, so that normality in society is re-established. The redundancy of structural safety is directly related to the resilience of a structure. Infrastructure effects on users' health and safety: the further away from populated areas a gas pipeline is located, the fewer will be the effects on the health of the people who live in the surrounding area, in the case of a gas leak the greater the distance to a railway track, the less the vibrations will be felt by nearby residents; if a road is designed with stricter outline parameters in order to avoid its wandering through a natural protected area, the number of accidents may increase.
- Health and comfort: health and safety of population affected, including construction workers.
- Impacts on the neighbourhood.
- Maintenance and maintainability.
- Sourcing of materials and services.
- Social equity.

Also, process-related issues can be used to indicate the social aspects of new construction or refurbishment.

NOTE Some examples of process-related subject matters that can be used to indicate the social impact of construction process include:

- co-operation with the people who are benefiting from the infrastructure services and the nearby residents;
- consideration of users' needs in the design and construction process;
- ability to support social cohesion in the process, by considering the different social groups of users and their special needs or by making use of local labour.

4.7.4 Issues for the development of economic indicators

Economic indicators relate to the economic aspects of civil engineering works and to related impacts.

The following issues shall be considered when developing a system of economic indicators of civil engineering works:

- life-cycle costs;
- direct costs, such as cost of water and energy supply, cost of material acquisition, cost of preventive measures, cost of waste management;
- direct benefits, such as operating income from a toll road or financial benefits received from the government;
- external costs;
- indirect economic effects: for instance, the monetary value loss or increase of the areas influenced by the civil engineering works, due to noise levels, air pollution, landscape changes, tourism better access, installation of solar panels or integration of local businesses;
- effects on local economy: for instance, the selected infrastructure alternative can boost tourism in one area, since its communications or supplies are more efficient, or it can cause rural areas to depopulate, making these social groups more vulnerable;
- sustainable funding;
- social internal rate of return.

5 Set of aspects and impacts

5.1 General

The development of indicators for the specification and assessment of the contribution of a given civil engineering works to sustainability and sustainable development requires knowledge about the issues of concern, the dimensions and complex interdependencies of sustainability in general, and how these are applied to civil engineering works.

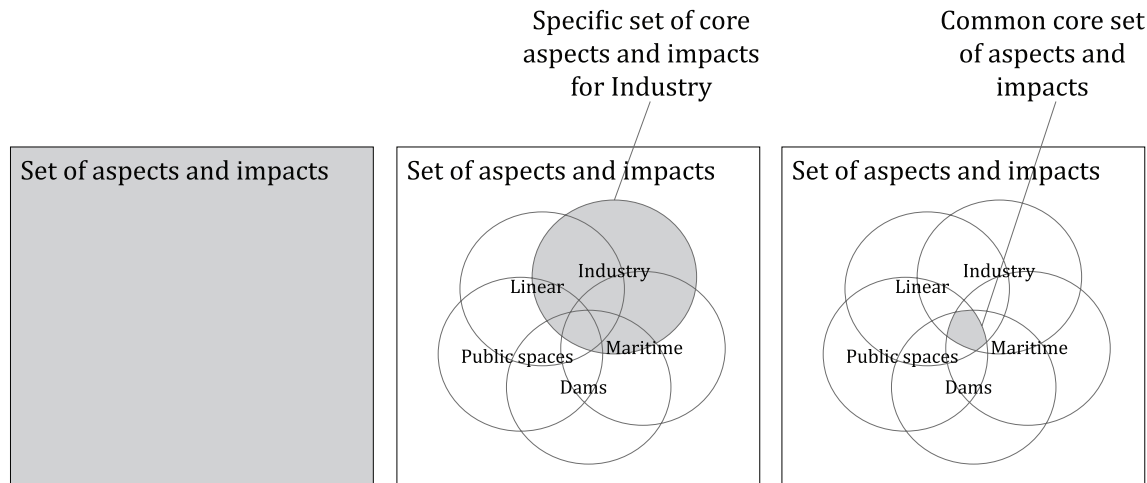


Figure 4 — Core sets of aspects and impacts

This document establishes a set of aspects and impacts as well as its relation to the three dimensions of sustainability (environmental, economic and social). These aspects and impacts should be taken as the basis for the development of indicators for assessing the sustainability performance of civil engineering works. It also provides a core set of aspects and impacts within the whole set that shall be developed when assessing the sustainable performance of a civil engineering works (see [Figure 4](#)). When developed, the sustainability indicators should be:

- essential from the viewpoint of assessing the contribution of a civil engineering works to sustainability and sustainable development;
- relevant for both new and existing civil engineering works.

Indicators shall represent the aspects of a civil engineering works that have a potential impact on issues of concern. The issues of concern relevant to a civil engineering works should be categorised in the following three dimensions of sustainability:

- environmental protection of climate stability, natural resources and ecosystems;
- economic costs and value creation;
- social issues of health and wellness, safety, quality of life, population and community and cultural heritage.

The sustainability indicators shall be developed considering the influence of the issues of concern and the aspects and impacts listed in [4.7.2](#) to [4.7.4](#).

5.2 Description of environmental aspects and impacts

5.2.1 General

[5.2.2](#) to [5.2.10](#) describe the aspects and impacts which shall be considered for developing a system of indicators for assessing the environmental pillar of sustainability performance of new or existing civil engineering works. When some of them are not considered or are excluded from consideration, the reasons for such omission or exclusion shall be clearly explained and justified.

5.2.2 Water management

The water used in civil engineering works can be provided from the following sources: surface water (including water from wetlands, rivers, lakes and oceans), groundwater, rainwater, municipal water supplies or wastewater. Indicators used to assess freshwater consumption should include quantity