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Jutta Katthage & Martin Thieme-Hack

Sustainable Outdoor Sports Facilities

Approaches to implementing sustainable development
in outdoor sports facilities

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List of abbreviations

BBSR	Federal Institute for Building, Urban Affairs and Spatial Research
BISp	Federal Institute of Sport Science
BNB	Assessment System for Sustainable Building
BMZ	Federal Ministry for Economic Cooperation and Development
BREEAM	Building Research Establishment Environmental Assessment Method
DBU	German Federal Foundation for the Environment
DFB	German Football Association
DGNB	German Sustainable Building Council
DIN	German Institute for Standardization
DOSB	German Olympic Sports Federation
DTB	German Tennis Federation
EPDM	Ethylene-propylene-diene rubber; M group
FLL	The Landscape Development and Landscaping Research Society
GIS	Geo Information System
GRIS	Green space information system
LCC	Life cycle costs
LEED	Leadership in Energy and Environmental Design
MIV	Motorised private transport
ÖPNV	Public transport
PAH	Polycyclic aromatic hydrocarbons
PE	Polyethylene (thermoplastic resin)
SBR	Styrene-butadiene rubbers (granules)
VDE	Association for Electrical Engineering, Electronics and Information Technology

1 Introduction

1.1 Why do we need sustainable outdoor sports facilities?

Outdoor sports facilities use a lot of space, are cost-intensive and require special building materials, especially for the playing surfaces. In addition, operators of outdoor sports facilities play a singular role: Municipalities often build and maintain sports facilities for clubs, schools and sports practitioners, but are not the end users themselves. Furthermore, changes in user behaviour and requirements can be observed (see Wetterich et al., 2009), with the popularity of trend sports such as parcours or calisthenics greatly increasing, while tennis (see DTB, 2016) and athletics, for example, have declined in popularity. What is urgently needed is a system for the sustainable development of outdoor sports facilities that promotes a lasting consensus between the stakeholders, the costs and the environment.

Such an assessment system would offer outdoor sports facility operators, users, planners and executing companies a guideline to help them coordinate the ecological, economic, social and cultural, technical as well as process- and siterelated requirements. This creates the opportunity to push ahead with life cycle optimisations in the planning phase, so that in addition to cost savings, natural resources can be conserved, and high land consumption is reduced.

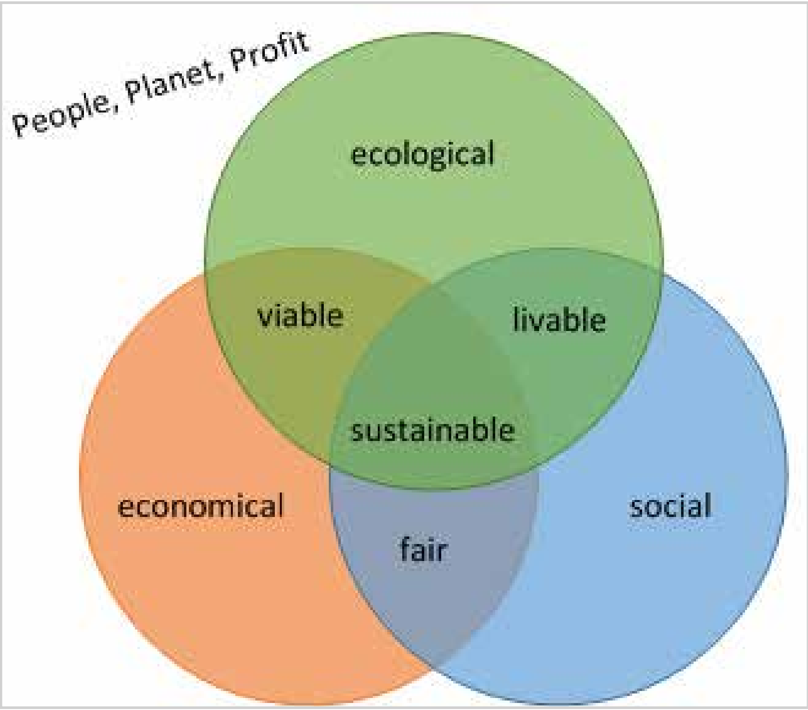

Figure 1.1: Principles of sustainable building (according to: PECO Institute)

Outdoor sports facilities incur costs throughout their entire life cycle, especially in the implementation and utilisation phase. The ability to influence costs decreases along the life cycle, while at the same time the total costs increase. The point of intersection between the cost curve and the cost influenceability curve is in the creation or implementation phase (see Figure 1.2). The ability to influence costs is highest in the design and planning phase (see Thieme-Hack in: Niesel, 2011).

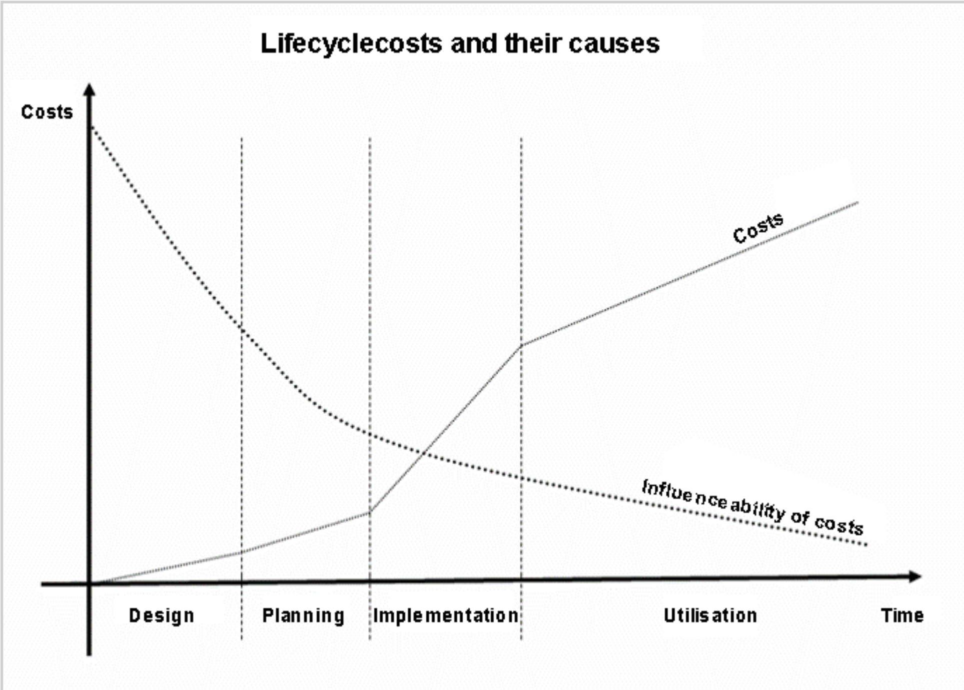

Figure 1.2: Influence of planning on life cycle costs (Thieme-Hack in: Niesel, 2011)

A model which maps life cycle costs and their influenceability not only describes construction and maintenance costs, but also other areas of upkeep. For example, the development of an irrigation and drainage concept allows not only costs but also drinking water resources to be saved. The situation is comparable for the criteria ‘soil’ or ‘energy’. But also taking into account the possibilities for conversion and adaptation – and thus their adaptation to user needs – in the planning phase of the outdoor sports facility can save money and natural resources and at the same time meet user demands.

1.2 What are the goals of a sustainable outdoor sports facility?

When designing a sustainable outdoor sports facility, the goal is to develop a concept for long-term operation, taking into account the interests of users, operators, residents and the environment. The planning phase of an outdoor sports facility should consider the development over a period of 50 years, while weighing up different criteria.

The following subgoals should be taken into consideration:

- the principles of sustainable building should be incorporated into the planning process at an early stage;
- sustainability points should be incorporated into the cost-benefit calculation;
- planning recommendations are to be formulated that promote user-friendliness and thus facilitate structural implementation;
- ommon goods such as the environment, resources, health, culture and capital are to be protected;
- the assessment system should be resultoriented, i.e. the entire property must be assessed, thus creating a view that is as holistic as possible; and
- the outdoor sports facility must be optimised in the long term in an integrated maner.

1.3 Structure of the 'sustainable outdoor sports facility' system

In addition to the criteria, the 'sustainable outdoor sports facility' system consists of a matrix for surface selection and a standard plan. The criteria profiles enable the definition of a sustainable outdoor sports facility by systematic integration into the Assessment System for Sustainable Building ("Bewertungssystem Nachhaltiges Bauen" – BNB).

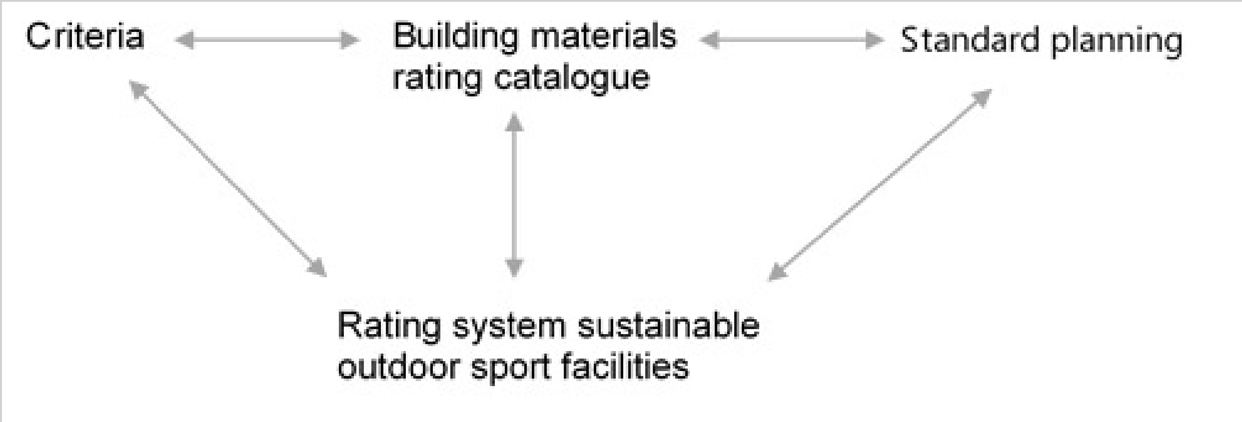

Figure 1.3: Assessment System for Sustainable Outdoor Sports Facilities (Thieme-Hack et al., 2017)

The criteria combine the special features of outdoor sports facilities with the requirements of sustain-ability. The criteria profiles were developed on the basis of an examination into the possible applications and modification of existing assessment systems such as BNB, DGNB, BREEAM, LEED, SITES and others. In addition, new content was developed on the basis of literature research and interviews with experts. By combining adapted, modified and innovative criteria, a system has been created that takes into account the special features and individuality of outdoor sports facilities.

Planners, operators and users were interviewed to develop a planning tool to be used as a matrix for surface selection. The result was a utility matrix.

To increase user-friendliness, a standard plan was defined, which provides guidance in particular for the peripheral areas of the playing field.

The synthesis of the three elements results in the assessment system for sustainable outdoor sports facilities (see Figure 1.3).

2 General principles for application of the assessment system

The project group has defined general principles on the application area and target group.

2.1 Application area

The assessment system for sustainable outdoor sports facilities is primarily intended for the planning of new construction and conversion projects for popular sports. Other areas of application must be examined on a case-by-case basis. An outdoor sports facility is defined according to DIN 18035-1: 2003-02 as:

"Outdoor facility which serves both organised competitive sports according to the nationally and internationally agreed rules of the sports associations and non-competitive, open-rule sports, exercise and leisure activities. A sports field generally consists of the usable playing and sports area with its full-size, rule-compliant playing fields, small playing fields and athletics facilities, as well as areas and facilities for regular and open-rule forms of exercise, combinations of these regular and open-rule areas and facilities and the necessary supplementary areas."

(DIN 18035-1: 2003-02, p. 4)

The present assessment system has applied this definition. An outdoor sports facility comprises play and sports areas, supplementary spaces, paths and other areas of the property. It does not include the paths to the sports facility, vegetation areas outside the sports grounds and buildings. Since outdoor sports facilities have an influence on the surroundings and are conversely influenced by the surroundings, areas that do not belong to the outdoor sports facility can still have impact individual criteria, such as the criterion ‚integration into the surroundings'. These areas are therefore taken into account in the quality of the location. Golf and water sports facilities and riding paths are not considered, in accordance with DIN 18035, Part 1.

The project group does not consider it expedient to differentiate between different types of facilities (e.g. competition facilities or large playing fields) or according to the type of outdoor sports facility (e.g. for football, hockey or tennis). Rather, a differentiation is made according to the types of surfacing, as these permit a clear distinction from other outdoor installations. An outdoor sports facility is therefore a property whose main function is sport activities. Nevertheless, other functions such as sojourn, sociability and environmental protection must be taken into account, both on the sports areas and on the supplementary areas.

2.2 Target group of the assessment system

The target group of the assessment system includes specialist planners for outdoor sports facilities working in new construction and conversion projects. With the help of the criteria profiles, the selection matrix for surface selection and standard planning, they should be given an instrument that promotes long-term use. An early consideration of alternatives should help to make secure decisions and to reduce or avoid short-term and/or cost-intensive solutions that arise, for example, from lack of care or ignorance.

3 Structure of the 'sustainable outdoor sports facility' system

The criteria of the sustainable outdoor sports facility system are based on the Assessment System for Sustainable Building (BNB). This means that the criteria themselves are divided into groups, which in turn are divided into primary criteria, the socalled 'qualities'.

3.1 Qualities of sustainable building

The weighting of the qualities is important for the overall result and accordingly for the certificate to be achieved. The German Council for Sustainable Development (Rat für nachhaltige Entwicklung – RNE) states that "environmental considerations must be given equal weighting to social and economic considerations". As a result, the three pillars of sustainability – ecology, economy and social aspects – are equally weighted (each with 20%) in the assessment system for sustainable outdoor sports facilities.

The technical and process quality are decisive for long-term use and durability of the facility, as the processes before, during and after the construction of the outdoor sports facility have to be considered and must correlate with the technical solutions. The two cross-sectional functions 'processes' and 'technology' each account for 17.5% of the total system (see Figure 2.1).

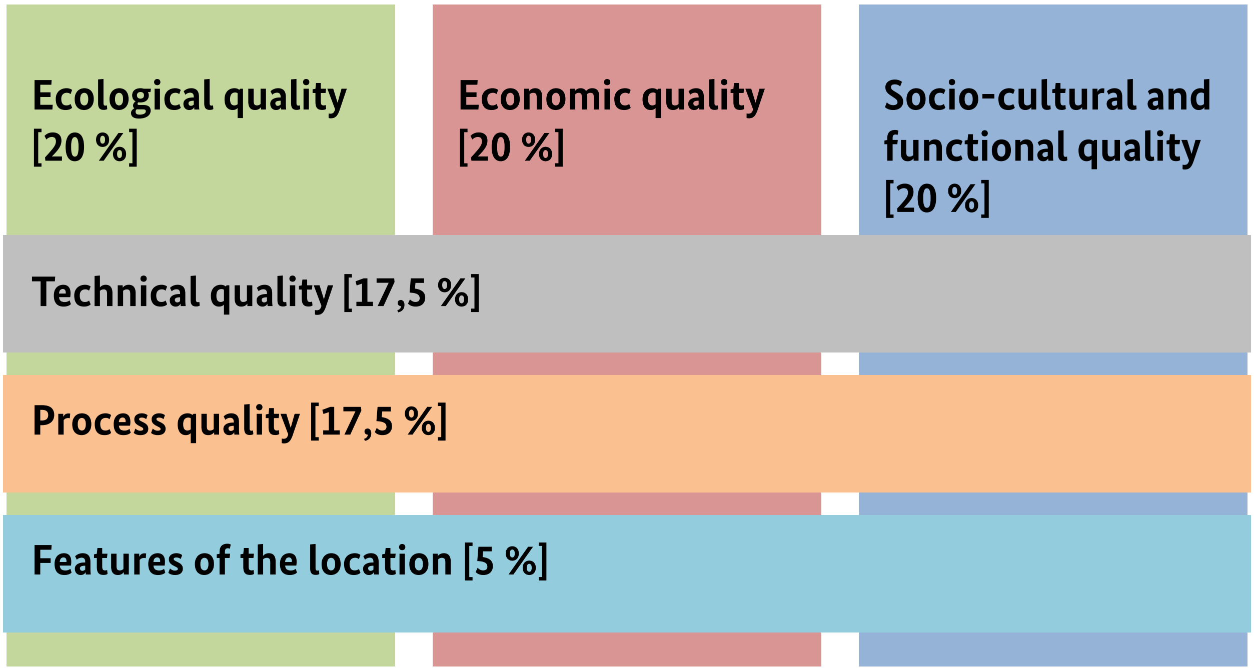

Figure 2.1: Qualities for sustainable outdoor sports facilities (Thieme-Hack et al., 2017)

As in the case of the BNB, the quality of the location is included in the calculation of the outdoor facilities of federal properties, since the location has a special influence on accessibility and thus also on use. The reverse influence is also taken into account, e.g. on residents, other sports facilities and green spaces. Location quality accounts for five percent of the total result. This may seem insignificant at first glance, but there are only four criteria in quality, ensuring that the individual criterion is taken into account in the overall system.

The quality 'sports function', as described in the guidelines for sustainable sports facility construction (Leitfaden Nachhaltiger Sportstättenbau, Essig et al. 2015), was deliberately omitted, since all 'sustainable outdoor sports facility' system criteria should take into account the special features of these facilities and thus also the functional sport requirements.

3.2 Development of criteria

The criteria were derived from the definition of new criteria, expert interviews and literature research, as well as by modifying the criteria used by other assessment systems.

As a first step, criteria from the other assessment systems were examined for a possible use in the assessment system 'sustainable outdoor sports facility'. The criteria were evaluated according to three parameters:

- fundamental suitability for outdoor sports facilities in terms of relevance and objectives;
- practicability of the evaluation method for outdoor sports facilities and
- criteria title is promising, but the evaluation method is not.

The assessment itself is based on four standards. These include:

- must criterion,
- should criterion,
- indicator for further processing and
- exclusion.

In the selection process, the aim is to define the important criteria that best reflect the sustainable development and holistic planning of outdoor sports facilities. The assessment system for sustainable outdoor sports facilities contains 35 criteria that are divided into the six qualities in the following proportions

- 7 criteria of ecological quality,
- 4 criteria of economic quality,
- 7 criteria of social-functional quality,
- 6 criteria of technical quality,
- 7 process quality criteria and

Table 3.1: Overview of the criteria of the rating system sustainable outdoor sports facility (Thieme-Hack et al. 2017)

	Groups of criteria/criterion	Weighting	Weighting of assessment criteria
Ecology	1.1 Effect on the environment		
	Ecological effect	2	2.22 %
	Risks for the local environment	3	3.33 %
	Vegetation	3	3.33 %
	Biological diversity and crosslinking	1	1.11 %
	1.2 Utilisation of resources		
	Water – needs and drainage	3	3.33 %
	Soil	3	3.33 %
	Lighting	3	3.33 %
Economy	2.1 Life cycle costs		
	Life cycle costs of outdoor sports facilities	3	8.57 %
	Area efficiency – costs per hour of play	2	5.71 %
	2.2 Value maintenance and development		
	Financing options in the production and utilisation phase	1	2.86 %
	Further development planning	1	2.86 %
Social functionality	3.1 Health, comfort and user-friendliness		
	Reference points for further processing.	2	4.00 %
	Vandalism prevention	1	2.00 %
	Safety	1	2.00 %
	3.2 Functionality		
	Convertibility and reutilisation capacity	2	4.00 %
	Public accessibility	2	4.00 %
	Accessibility and orientation	1	2.00 %
	Convenience for cyclists	1	2.00 %
Technology	4.1 Building materials and methods		
	Sustainable building materials and methods	3	3.28 %
	Waste – end of life: dismantling. separation and utilisation	2	2.19 %
	Waste – utilisation and disposal in the utilisation phase	2	2.19 %
	4.2 Technical design		
	Care and maintenance	3	3.28 %
	Energy consumption for maintenance	3	3.28 %
	Sport functionality and utilisation	3	3.28 %
Process	5.1 Quality of planning		
	Inventory and project preparation	2	2.33 %
	Integrative planning	2	2.33 %
	Variant comparisons in object planning	2	2.33 %
	Tender and commissioning	2	2.33 %
	5.2 Quality of construction		
	Construction site	2	2.33 %
	Quality control during the construction process	2	2.33 %
	5.3 Management quality		
	Management quality of outdoor sports facilities	3	3.50 %
Location	6.1 Accessibility		
	Pedestrians and cyclists	2	1.67%
	Public transport and motorised individual transport	2	1.67 %
	6.2 Influence on the surrounding area		
	Emissions from the outdoor sports facility	1	0.83%
	Integration into the surrounding area	1	0.83%

- 4 criteria of location quality.

Since the criteria of a sustainability assessment can also conflict with each other, the interactions must be indicated. These can be positive, neutral or negative. The relationships can be best depicted in tabular form. Two criteria that positively reinforce each other receive a "+" (symmetrical complementarity). Criteria that are in mutual competition are a "-" and criteria that have no influence on each other are a "0". Here it is possible that one criterion has a positive influence on a second criterion, but the second criterion has only a neutral influence on the first (asymmetric complementarity).

Table 3.2: Interactions of the criteria with each other (Thieme-Hack et al., 2017)

Kriterium	1.1.1	1.1.2	1.1.3	1.1.4	1.2.1	1.2.2	1.2.3	2.1.1	2.2.1	2.2.2	3.1.1	3.1.2	3.1.3	3.2.1	3.2.2	3.2.3	3.2.4	4.1.1	4.1.2	4.2.1	4.2.2	4.2.3	4.2.4	5.1.1	5.1.2	5.1.3	5.1.4	5.2.1	5.2.2	5.3.1	6.1.1	6.1.2	6.2.1	6.2.2
1.1.1		0	+	+	+	+	0	0	+	0	+	0	0	+	0	0	0	0	0	+	+	+	0	0	0	0	0	0	+	0	0	0	0	0
1.1.2	+		+	+	+	+	0	0	+	0	0	0	0	0	0	0	0	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.3	+	+		+	+	+	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	+	0
1.1.4	+	+	+		+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
1.2.1	+	+	+	+		+	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0
1.2.2	+	+	+	+	+		1	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
1.2.3	+	+	0	+	0	0		0	0	0	+	+	+	0	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1.1	0	0	0	0	+	0	+		+	+	0	0	0	+	+	0	0	+	+	+	+	+	+	+	+	+	+	0	0	+	0	0	0	0
2.2.1	0	0	0	0	+	0	+	+		+	+	+	+	+	+	0	0	+	+	+	+	0	0	+	+	+	+	0	0	+	0	0	0	0
2.2.2	0	0	0	0	+	1	+	+	+		+	+	+	+	+	0	0	0	0	+	+	0	0	+	+	+	+	0	0	+	0	0	0	0
3.1.1	+	+	+	+	0	0	+	+	+	+		+	+	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	+
3.1.2	0	0	0	0	0	0	+	+	+	0	+		+	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	+
3.1.3	0	0	0	0	0	0	+	+	+	1	+	+		1	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	+
3.2.1	0	0	0	0	0	0	0	+	+	+	+	+	+		+	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	+	+	0	0
3.2.2	0	0	0	0	0	0	0	0	0	0	+	+	+	+		0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0
3.2.3	0	0	0	0	0	0	0	0	0	0	+	+	+	+	+		0	0	0	0	0	0	0	+	0	0	0	0	0	+	0	0	0	0
3.2.4	0	0	0	0	0	0	0	+	0	0	+	0	0	+	+	0		0	0	0	0	0	0	+	0	0	0	0	0	0	+	0	0	0
4.1.1	+	+	+	+	+	+	+	+	0	0	0	0	0	+	0	0	0		+	+	+	0	0	0	+	+	+	+	+	+	0	0	0	0
4.1.2	+	+	+	+	+	+	+	+	0	0	0	0	0	+	0	0	0	+		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.2.1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0	0	0	+	+		+	0	0	0	0	0	0	0	0	+	0	0	0	0
4.2.2	0	0	0	0	0	0	+	+	+	+	0	0	0	0	0	0	0	+	0	+		0	+	0	0	0	0	0	0	0	0	0	0	0
4.2.3	0	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0	0	+	0	+	+		+	0	0	0	0	0	0	0	0	0	0	0
4.2.4	0	0	0	0	0	0	0	+	+	+	+	+	+	+	+	0	0	+	0	+	+	+		+	+	0	0	0	0	0	0	0	0	0
5.1.1	0	0	0	0	0	0	0	+	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0		+	+	+	0	0	0	0	0	0	0
5.1.2	0	0	0	0	0	0	0	+	+	+	0	0	0	+	0	0	0	0	0	0	0	0	0	0		+	+	0	0	0	0	0	0	0
5.1.3	+	+	+	+	+	+	+	+	+	+	0	0	0	0	0	0	0	+	+	+	+	0	0	0	0		0	0	0	0	0	0	0	0
5.1.4	0	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0	0	+	+	+	+	+	+	0	0	+		0	0	0	0	0	0	0
5.2.1	+	+	+	+	+	+	0	+	0	0	0	0	0	0	0	0	0	+	+	+	+	0	0	0	0	0	0		+	0	0	0	0	+
5.2.2	+	+	+	+	+	+	0	+	0	0	0	0	0	0	0	0	0	+	+	+	+	0	0	0	0	0	0	+		0	0	0	0	0
5.3.1	+	+	+	+	+	+	0	+	+	+	+	+	+	0	0	0	0	+	+	+	+	0	0	0	0	0	0	0	0		0	0	0	0
6.1.1	0	0	0	0	0	0	0	0	0	0	+	0	0	0	+	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0		+	-	0
6.1.2	0	0	0	0	0	0	0	0	0	0	+	0	0	0	+	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	+		0	0
6.2.1	+	+	+	+	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0		0
6.2.2	0	0	0	0	0	0	0	0	0	0	+	+	+	+	+	+	+	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0	0	

4 Content of the criteria

4.1 Ecological quality

IMPACT ON THE LOCAL ENVIRONMENT

The **ecological impact** takes into account the share of green space in an outdoor sports facility, i.e. the sports areas and supplementary areas (see Figure 4.1). It also examines how high the facility's share of vegetation is, to positively influence the carbon footprint and air quality. Table 4.1 shows a model for calculating the ecological impact.

Table 4.1: List of examples for calculating the ecological impact and proportion of green space (Thieme-Hack et al., 2017)

	Unit	Area share	Total area
Sports areas			
Sports turf areas m^2	m^2		
Synthetic turf m^2	m^2		
Synthetic surfaces m^2	m^2		
Sand surfaces m^2	m^2		
Other surfaces m^2	m^2		
Vegetation areas in the supplementary areas			
Seed areas	m^2		
Utility turf areas m^2	m^2		
Landscape lawns and meadows m^2	m^2		
Wooded areas			
Trees, large crown, 200 m^2/pc. (crown diameter of approx. 15 m)*	m^2		
Trees, medium crown, 100 m^2/pc (crown diameter of approx. 10 m)*	m^2		
Trees, small crown, 25 m^2/pc (crown diameter of approx. 5 m)* *When calculating the area of the trees, it is always necessary to start from the planned state. The assignment to the three tree types is done by rounding (example: 7 m crown diameter corresponds rounded off to class 5 meter -> small trees)	m^2		
Free growing hedges and shrubbery groups	m^2		
Topiary hedges in projection	m^2		
Bedding areas			
Perennial areas	m^2		
Perennial areas with solitary shrubs	m^2		
Ground-covering woody plants	m^2		
Ground-covering woody plants with solitary shrubs	m^2		
Roof areas and facades			
Without roof greening	m^2		
Intensive roof greening	m^2		
Extensive roof greening	m^2		
Facade greening** ** Total area column' corresponds here to the possible total area	m^2		

Figure 4.1: High proportion of green space on the sports field and in the supplementary areas (Katthage)

The criterion **risk to the local environment** deals with the potential hazards that may be posed by the various surfaces of outdoor sports facilities during the construction or use phase. The issue of polycyclic aromatic hydrocarbons (PAH) is currently being discussed in technical literature (e.g. Kalbe, 2015). Maximum levels of PAHs to be complied with can be derived, for example, from the PAH Guidance Document on Risk Assessment and Categorisation for Toys. Further requirements for plastic fillers are:

- the resistance to weathering,
- the abrasion resistance,
- the elasticity,
- the environmental compatibility and
- the material compatibility of fibres and fillers.

Furthermore, the resilience, UV stability and splice resistance of synthetic turf must be proven. Additional test parameters include zinc values, weathering stability, dusting behaviour and abrasion resistance. Furthermore, the test method for substance release and the minimum age of the test documents should be set at one year.

Requirements for other building materials for outdoor sports facilities are also derived from RAL Quality Mark 515/1 – Granular surface materials for outdoor sports facilities, 515/2 – Factory-pro-duced grass base layer mixtures and building material mixtures for drainage layers for sports fields, 943 – Synthetic surfaces in outdoor sports facilities and 944 – Synthetic turf systems in outdoor sports facilities as well as the German Federal Soil Protection Ordinance (Bundesbodenschutzverordnung) and the study on the environmental compatibility of synthetic surfaces and synthetic turf for outdoor sports facilities (Kalbe et al., 2012).

Similarly, the use of fertilisers and pesticides in sports turfs is analysed. Fertiliser plans should be developed individually with the help of a fertiliser register, as created by the Forschungsgesellschaft Landschaftsentwicklung, Landschaftsbau e. V. (Research Society for Landscape Development, Landscape Construction). The fertilisation plan should take account of adjustments to growth conditions, drought or disease damage or damage caused by zonal overuse. The aim should be to monitor the results annually.

Plant protection may only be carried out in accordance with good professional practice (Section 3 of the German Plant Protection Act (Pflanzenschutzgesetz). The general principles of integrated pest management must be observed.

In the criterion **vegetation**, **in particular woody plants** are compared with existing woody plants. On the other hand, a list of trees suitable for outdoor sports facilities is provided in the appendix for new planting in order to promote functional and site-appropriate replanting.

The socalled "tree-free zone" must be observed. The distance from trees to the sports area depends on the tree species. As a matter of principle, woody plants for outdoor sports facilities should be selected according to the tree list. The DFB (2011, p. 17) recommends that trees and shrubs are placed at least 20 m from the edge of the pitch.

The criterion **biological diversity and connectivity** deals with the protection and development of biodiversity. Schüler and Stahl (2008) note that biodiversity is generally not a major factor in sports turf due to intensive use, frequent cutting and regular fertilisation. In their opinion, exceptions to this rule are extensively used village sports fields and wide-ranging areas on golf courses. In comparison to other outdoor sports surfaces, sports turf has a higher value in terms of biodiversity and biological interconnectedness. The Sportplatzdschungel (Playing Field Jungle) project has confirmed that sports grounds are often poor in vegetation types due to their specific use and offer only few habitats for plants and animals. Nevertheless, a high species diversity can be created in the supplementary areas by creating structures that connect different ecological spaces.

RESOURCE CONSUMPTION

The criteria group 'Resource consumption' deals with the consumption of **water, soil** and **energy**. Breitenstein (2016) has investigated not only the use of rainwater and well water for irrigation, but also the possibilities of using grey water. This means that slightly contaminated grey water, e.g. from the hand basin and shower, can be collected, treated on site, stored and used for irrigation. With regard to water consumption, the selected materials and components, the control of the plant technology and the quality of the irrigation water are also evaluated.

With regard to **soil**, measures for protection during construction and maintenance work must be taken into account and a concept for soil protection on the construction site must be prepared. In addition to land use, impacts on or in the soil, soil loss or harmful soil changes must be avoided. The soil expertise provides information about current soil conditions and the suitability of the existing soil for planned construction or vegetation measures. The integration of soil protection during construction is to be carried out.

Figure 4.2: Compacted soil (Thieme-Hack)

Figure 4.3: Soil protection during construction (Thieme-Hack)

Lighting causes high energy consumption. For a sustainable outdoor sports facility, a light and radiation calculation must be carried out. In this context, space lighting and glare must be reduced as a matter of principle. Assessment standards can be taken from the “Notes on the measurement, assessment and reduction of light immissions” of the Immission Control Committee of Germany‘s federal states (LAI 2012). On path surfaces, a lighting concept with motion and presence detectors can promote demand-based control. Steffen (2017) confirms that users are very willing to use this type of lighting. Energy consumption must also be reduced. The system efficiency of the light distribution shall be determined in lumens per watt. In addition, bird and insect protection measures must be taken into account.

4.2 Economic quality

LIFE CYCLE COSTS

The **life cycle costs** and the space efficiency are calculated as costs per playing hour. The objective of the first criterion is to optimise the total costs in the course of the implementation and utilisation phase. As far as possible, the costs of dismantling must also be taken into account. The life cycle costs are calculated using the net present value method. The annual cost is calculated as a constant payment of an annuity per period, using constant payments and a constant interest rate to simplify matters.

The **cost of an hour of play** results from the annual costs, whereby the calculated annuity should be used here, divided by the actual hours of use per year. Both parameters also give an indication of the choice of surface, e.g. for a full-size football pitch. Table 4.2 shows a recommendation for the number of match hours per week for full-size football pitch (see FLL, 2014).

Table 4.2: Recommendation playing hour per week for full-size football pitches (according to: FLL, 2014)

Type of floor surface	Useful life		
	Hours/year	Hours/week	
		Summer half year	Winter half year
Sports turf[1)2)]	up to 800	20 - 30	0 - 10
Granular surface[1)2)]	up to 1.500	30 - 40	0 - 20
Synthetic turf	over 1.500	30 - 50	0 - 30

[1)] After heavy rainfalls, restrictions of the use including closure are possible.

[2)] In case of frost/thaw change as well as with complete snow cover, restrictions of use including closure are possible.

Taking into account an interest rate of 5 % and a calculation period of 50 years, the following Table 4.3 shows an example calculation for the various outdoor sports surfaces. Life cycle costs were calculated on the basis of the unit prices determined by Homölle (2004). The playing hours per week follow the recommendation of FLL (2014). In line with the DFB (2011), the following expected service lives per pitch surface have been taken into account:

- Sports turf: 40 years
- Granular surface: 20 years
- Synthetic turf: 12 to 15 years (for the surface).

Table 4.3: Sample calculation for the costs of the match hour – based on life cycle costs (Thieme-Hack et al., 2017)

Interest rate	5 %		
Calculation period	50 Jahre		
	Variant 1.1 Natural turf - Drainage layer construction	**Variant 1.2 Natural turf - Near-ground construction**	**Variant 2 Granular surface covering**
Payments, discounted to year 0	339.344,53 €/facility	313.402,53 €/facility	414.251,38 €/facility
Annual cost (annuity)	18.588,19 €/year	17.167,17 €/year	22.691,34 €/year
Cost per hour of play	17,87 €/hour	16,51 €/hour	14,55 €/hour
Assumption	20 Std./week	20 Std./week	30 Std./week

	Variante 3.1 artificial turf without infill	Variante 3.2 artificial turf sand infill	Variante 3.3 artificial turf rubber and sand infill
Payments, discounted to year 0	802.790,37 €/facility	755.7653,77 €/facility	945.358,63 €/facility
Annual cost (annuity)	52.222,67 €/year	49.163,65 €/year	61.496,94 €/year
Cost per hour of play	25,11 €/hour	23,64 €/hour	29,57 €/hour
Assumption	40 Std./week	40 Std./week	40 Std./week

This calculation makes it clear that, for example, a synthetic turf pitch for a full-size football pitch is only economically viable if it is heavily used. Sports turf and granular surfaces are more cost-effective in the case of low-intensity use. However, this does not take into account the fact that the sports turf cannot be used in some cases during the winter months (see Table 4.3). Furthermore, the optimal choice of surface should not be examined solely from an economic point of view. User requirements, the environmental impact and needs of the local environment must also be taken into account.

VALUE MAINTENANCE AND DEVELOPMENT

In order to be able to estimate the **costs of production and maintenance** in advance, a cost and financing plan must be drawn up and financing options considered. This ensures that not only investment costs for the construction of a new facility are available, but maintenance costs are also adequately reflected.

In addition, **value development planning** can help to maintain the value of the outdoor sports facility by examining whether measures can have a positive impact on optimal, long-term use of the outdoor sports facility. This means that temporary uses by other actors can be integrated without neglecting or damaging the original use. Possibilities here include renting space for trend sports programmes, e. g. from the health and fitness sector, or the integration of social facilities, such as youth clubs.

4.3 Socio-cultural and functional quality

HEALTH, COMFORT AND USER SATISFACTION

First, the criterion **“quality of stay in the supplementary areas”** deals with the further user requirements for outdoor sports facilities. Wetterich et al. (2009) have shown that users want sports facilities for non-club organised sports. The DFB confirms that “rest areas with seating niches and benches as well as areas for lying down and spaces for socialising (e.g. barbecue areas) should be planned" (DFB, 2011, p. 31). In addition, storage areas for sports and care equipment must be included in the supplementary areas, so that they are not located on the playing field or in the security rooms, for example.

Figure 4.4: Barbecue area in the shape of a kota hut (Müller)

Figure 4.5: Possible storage area (Katthage)

As part of **vandalism prevention**, structural measures to protect against vandalism must be examined. Wherever possible, approaches to social control and the like can also be taken into account. This criterion is complemented by that of **security**, which deals with user security as well as the subjective perception of security and protection against attacks. A concept for possible hazardous situations, e.g. during thunderstorms (see VDE, 2013), must be developed, and paths must be clearly arranged and illuminated (see Ecology, Lighting), so that discomfort for the user is reduced.

Figure 4.6 and 4.7: Vandalism at the goal net by fire, burnt net (Katthage)

FUNCTIONALITY

User needs have changed. Ott (2010, p. 95 ff) explains: "Today, sports facilities increasingly fail to satisfy the ideas, desires and needs of the users and the associated changes in quantitative and qualitative requirements." Moreover, "economic, ecological and social conditions have changed" (ibid.). From the sum of the changed conditions, the necessity for "a highly adaptable building structure" and "an expansion of structural diversity" is derived (ibid.). In order to be able to respond to fluctuations in demand and demand structures and thus forecast high and long-term facility utilisation, a concept for **adaptability** and **conversion capability** must be developed.

The need for **public accessibility** is a seemingly controversial factor. A balance must be found between intensity of use, openness to society, safety and prevention of vandalism. The individuality of the location must be taken into account. Nevertheless, public accessibility, even if only in some areas, is generally welcomed by individual sport participants. In individual cases, a consensus between the criteria can be found.

The criterion of **accessibility and guidance** requires that the outdoor sports facility is designed to be accessible and has sports programmes that are suitable for the disabled. In particular, the requirements defined in DIN 18040 Part 3: 2014-12, 'Construction of accessible buildings – Design principles – Part 3: Public circulation areas and open spaces' must be observed.

Figure 4.8: Orientation aid for users of the sports outdoor facility (Müller)

The criterion **cyclist comfort** does not consider the access routes to the outdoor sports facility (see section 4.6 Location quality), but the conditions for cyclists at the outdoor sports facility. The design of the bicycle parking spaces, including their location on the site and the number offered, can create significant incentives to travel by bicycle.

4.4 Technical quality

BUILDING MATERIALS AND CONSTRUCTION METHODS

The choice of building materials and construction methods has a decisive influence on the lifespan of the outdoor sports facility and should be made accordingly. If a long service life is desired, the building materials and construction methods should also be selected accordingly. The opposite is true for short-term or even temporarily used facilities.

There are three parameters within the criterion of **sustainable materials and construction methods**: resource consumption, reuse rate and recycled construction materials. In order to optimise the consumption of resources, the use of raw materials should be reduced as far as possible or renewable raw materials should be selected. For this purpose, construction methods with low resource consumption must be selected.

Reuse describes the use of materials and components for the same purpose (see Section 3 (21) oft the German closed Substance Cycle and Waste Management Act (Kreislaufwirtschaftsgesetz)). Recycling is a recovery process in which building materials and components that have previously been used for other purposes are transferred to a new purpose (see Section 3 (25) of the German closed Substance Cycle and Waste Management Act).

Nevertheless, **dismantling, separation and recycling** after the use phase must also be considered in the planning phase. Here it is desirable that existing components are easy to dismantle. In addition, a socalled waste concept must be drawn up, which contains information on waste mapping, waste avoidance, separation and organisation of disposal (see Ecological Movement Network (Netzwerk ökologische Bewegung)).

Waste is not only generated in the disposal phase, but also in the utilisation phase. A distinction must be made here between inorganic and organic waste. Where technically feasible, organic waste should remain on the property. As a minimum, inorganic waste should be separated, preferably in containers that offer both protection from animals and vandalism.

Figure 4.9: Litter (Katthage)

TECHNICAL EXECUTION

The criterion **care and maintenance** examines the accessibility of the components and technical systems to be maintained, as well as the replaceability of components and technical systems. In addition, it must be checked whether and to what extent a care and maintenance concept is available. A care and maintenance concept must be developed for the entire outdoor sports facility and should take the following points into account:

- the requirements of users, operators and owners,
- consideration of the consumption of resources and
- estimation of the expected cost
  (see FLL, 2014).

The type, scope and timing of the services must be determined individually for each sports area (see FLL, 2014).

Furthermore, the **energy consumption during construction and maintenance** of the outdoor sports facility must be taken into account. An energy concept must be drawn up which includes the use of energy-efficient machines and equipment for care and maintenance as a prerequisite and declaration of intent. In her study, Dick (2016) shows alternative and fuel-saving drive solutions.

An important criterion is the **sports function and use** with the implementation of a matrix for the selection (see section 5) of an individual, sustainable outdoor sport surface. For this purpose, the service life, the intensity of use and the main type of sport must be highlighted. This selection matrix can be supplemented by further indicators of economic, ecological, socio-cultural and functional as well as technical quality (see section 5). In addition, the suitability of surface combinations and of adjacent surfaces must be examined (see FLL, 2014).

4.5 Process quality

QUALITY IN PLANNING

To ensure high quality of planning, **appraisal and project preparation** must first be carried out. As part of the appraisal process, existing data, e.g. from the administration, must be considered together with local sports behaviour, use and condition of the facility. This allows the current sports needs to be derived and transferred into measures for implementation. Various methods can be used to determine the needs: The reference value approach uses fixed guideline values per type of sports facility, number of inhabitants and size of municipality (see Golden Plan, 1961) to measure the demand. The sports behaviour-based needs analysis, in contrast, records the specific demand (see BISp guideline, 2000). In the collaborative identification of needs, all stakeholders and interest groups are involved in the process (see Wetterich et al., 2009 and Rütten et al., 2010).

Figure 4.10: Appraisal (Katthage)

Figure 4.11: Appraisal (Katthage)

The coordination between all stakeholders has a significant influence on the quality of the planning. In terms of sustainable development, it is essential to establish an integrative planning approach with an integrated planning team and process.

The criterion **comparison of variants in building planning** deals with the implementation and coordination of planning variants, which must be checked in advance with regard to their sustainability impact. In the evaluation table for the comparison of variants (see Table 4.4), various indicators of the qualities of sustainable sports outdoor facilities are listed and weighted in a utility value matrix. By evaluating at least two variants with the grades 1 (not applicable) to 4 (fully applicable), the most sustainable variant can be selected.

Table 4.4: Evaluation table for the criterion comparison of variants in object planning (Thieme-Hack et al., 2017)

Parameters	Weighting	Variant 1	Variant 2
ECOLOGY			
Areas of vegetation will be retained or new ones planned.	2		
No drinking water is needed for the irrigation of the green and sports areas.	2		
Any precipitation remains on the property (storage, collection or sprinkling).	2		
Little soil is resealed.	2		
Parameters	Weighting	Variant 1	Variant 2
The energy requirement for training and path lighting has been minimised.	2		
ECONOMY			
A life cycle cost approach has been followed.	3		
Financing concepts take into account not only new construction, but also maintenance and renovation.	1		
SOCIOCULTURAL/FUNCTIONAL			
Design and construction methods have been selected according to expected use.	2		
Vandalism and safety points have been developed.	1		
The conversion capacity of the outdoor sports facility has been considered.	2		
Public accessibility is a given.	1		
TECHNOLOGY			
Materials and components are selected with a high level of deconstruction, recyclability and reuse.	2		
The selection of building materials and construction methods takes maintenance into account.	2		
The selection of the sports surface was made with a building material utility matrix.	3		
LOCATION			
The location is easy to reach on foot or by bike.	1		
Light and noise emissions have been minimised.	1		
TOTAL			

Evaluation: 4 = fully applicable, 3 = largely applicable, 2 = partially applicable, 1 = not applicable

Building on this, the criterion **tendering and awarding** deals with the integration of sustainability aspects in tendering and awarding. The Sustainable Procurement Toolbox (see BMZ, 2014) offers approaches in this regard.

QUALITY OF THE CONSTRUCTION WORK

Construction sites have an impact on their environment, which should be minimised. **Soil protection during construction** must be implemented by reducing harmful effects during the construction phase and by taking into account soil moisture and soil type. In addition, **waste on the construction site** must be largely avoided or unavoidable waste must be recycled or, in the case of waste that cannot be recycled at all, disposed of. In terms of **noise protection**, construction sites must be planned and carried out in such a way that the requirements of the Federal Immission Control Act are complied with and noise is largely prevented or avoided. Finally, **tree protection** in accordance with the requirements of DIN 18920 “Vegetation technology in landscaping – Protection of trees, plant stocks and vegetation areas during construction measures” must be observed.

Figure 4.12: Damage to the trunk and root area that can be avoided by tree protection (Thieme-Hack)

The quality controls in the construction process can be divided into general and special requirements. The former promote construction by defining specifications for the construction processes (see Niesel, 2017). Special requirements can in turn be separated into the proficiency test and the control test. Different requirements are specified depending on the outdoor sports surface.

QUALITY OF MANAGEMENT

Management plays a major role in process quality, even if it can only be defined as a declaration of intent at the time of planning and implementation. A maintenance handbook is regarded as essential to achieve high management quality (see FLL, 2009). The scope of a maintenance handbook can depend on the client, the type of use, the design intention, the complexity and the budget.

Possible contents may result from:

- description of the outdoor sports facility,
- design intention and objective,
- the substances and construction methods used, with details of the sources of supply,
- technical documentation with operating and maintenance instructions,
- regular and special facilitative services,
- execution instructions and
- graphic representations
  (see FLL, 2009).

The maintenance handbook is usefully supplemented by a geographic information system (GIS) or green space information system (GRIS). Here visual data is combined with factual data. Possible information results from:

- existence of the outdoor sports facility (infrastructures and equipment),
- value of the outdoor sports facility,
- frequency of care and maintenance measures and
- costs
  (see FLL, 2009).

In order to compare the actual situation with the planning data, a traffic safety concept is helpful. The latter must take stock of the current situation, including any safety deficiencies. This provides an up-to-date picture of the situation on the ground, in addition to meeting requirements for safety on the road.

4.6 Location quality

PUBLIC ACCESSIBILITY

Wetterich et al. (2009) point out that “the need for decentralised sports facilities close to residential areas in the neighbourhood/urban district” is increasing. Long distances are particularly difficult for children and young people. The need for a good connection of **footpaths and cycle paths** to the outdoor sports facility must be taken into account, as well as locations close to residential areas.

In addition, a concept for **local public transport** and a **transport and parking concept** for motorised individual transport can be helpful if the outdoor sports facility has a remote location.

INFLUENCES ON THE ENVIRONMENT

The choice of a location should not be determined solely by accessibility. Although the amendment of the sports facilities noise regulation (Sportanlagenlärmschutzverordnung) of the 18th Federal Immission Control Act (BImSchV) a higher level of **sports noise** has been permissible since 2017, but Meinen et al. (2016) have nevertheless confirmed that real estate in the vicinity of outdoor sports facilities suffer from a loss of value. This is mainly due to noise. Accordingly, from a noise control point of view, it may seem favourable to build outdoor sports facilities further away from residential buildings; however, this stands in contradiction to public accessibility. Thus, it must be examined in each individual case which criterion is given priority and whether construction measures can be used to reduce the noise.

An outdoor sports facility can also have a positive **influence on its surroundings** and/or enjoy the benefits of its surroundings. If an outdoor sports facility is not isolated but combined with other sports and leisure facilities, they can offer an alternative to bad weather, especially if they are covered. However, when integrated into existing green and outdoor areas, such as the Green Ring in Hamburg, it is beneficial to the environment and encourages the use of the facility and its surroundings.

Figure 4.13: Further sports programmes outside the outdoor sports area (Müller)

5 Matrix for surface selection

EXPERT OPINION: SELECTION MATRIX FOR THE SURFACE TYPES OF LARGE PLAYING FIELDS

To assist in finding a practical solution, the sustainability assessment system must include a selection matrix for the surface types of large playing fields. For this purpose, indicators for the various types of outdoor sports surfaces are compiled from the literature and criteria and evaluated by an expert group of planners, operators and state sports federations. This or a comparable selection matrix can be used in addition to determining the required service life, intensity of use and main sport. Table 5.1 below shows the indicators and their explanations.

Table 5.1: Indicators and their explanation of the selection matrix for surface types for large football fields (Thieme-Hack et al., 2017)

Indicator	Explanation	Source (extract)
ECOLOGICAL QUALITY		
Water demand/consumption for maintenance	Water required to maintain the surface funtion, bind dust or reduce the surface temprature	DFB 2011 DIN 18035 FLL 2014
Pollutant potential through leaching and/or abrasion	Possible leaching of harmful substances from the materials of the surface during installation or use	Kalbe et al. 2012
Environmental Compatibility	Do substances accumulate in the course of production, operation or disposal that can have a detrimental effect on the environment?	DFB 2011 DIN 18035 FLL 2014 Niesel 2013
RESOURCE CONSUMPTION		
in construction/building materials	Expenditure and consumption of building materials for construction	DFB 2011 FLL 2014 Niesel 2013

Indicator	Explanation	Source (extract)
in maintenance	among other things, fillers and soil additives which are necessary to maintain a functional surface	DFB 2011 FLL 2014 Niesel 2013
ECONOMIC QUALITY		
Service life of the surface	Time until the necessary surface renewal	FLL 2014 Niesel 2013
Life cycle costs	All costs from planning, construction, operation to dismantling and disposal	FLL 2014 Niesel 2013
Possible hours of use	Intensity of use without significant damage to the surface due to overuse	FLL 2014 DFB 2011
Vulnerability to vandalism	Risk of damage, e.g. mechanical or by fire	Criteria profiles
SOCIOCULTURAL AND FUNCTIONAL QUALITY		
User acceptance	Acceptance of the floor surface by the user	Criteria profiles
Prestige/visibility	Effect on third parties, image for operators and/or users	Criteria profiles
Fatigue of the players	In the course of training or matches	DFB 2011
Commitment of the players	Activity of the players. Reduced commitment, e. g. to avoid injuries.	DFB 2011 FLL 2014
TECHNICAL QUALITY		
Sports function		
Suitability for football	Suitability of the surface for the sport of football	DFB, 2011 FLL, 2014
Ball roll behaviour	Characteristics of the ball when rolling, e. g. speed, accuracy	DFB, 2011 FLL, 2014
Ball reflection/Ball bounce	Calculability of the ball behaviour	DFB, 2011 FLL, 2014
Shear strength/torsional strength	Resistance of a material to the stress of opposing forces	DFB, 2011 DIN 18035 FLL, 2014
Protection		
Flatness	of the playing surface at the time of use	DFB, 2011 DIN 18035 FLL, 2014
Risk of injury	Risk of injury due to the properties of the playing surface	DFB, 2011 FLL, 2014
Force reduction	Energy absorption of the pad, e. g. as a result of falls	DFB, 2011 DIN 18035 FLL, 2014
Susceptibility to dust formation in dry weather	Dust formation on the surface if not sufficiently moistened/watered	DFB, 2011 FLL, 2014
Surface temperature in summer	Temperature of the surface in summer with intensive sunlight	Nonn, 2015
Technical function		
Water permeability/infiltration rate	Water absorption of the covering	DFB, 2011 DIN 18035 i. T. FLL, 2014
Restrictions in case of unfavourable weather conditions	To avoid damage to the surface and/or the system structure	DFB, 2011 FLL, 2014

Susceptibility to inadequate or incorrect care	Duration until surface damage occurs	DFB, 2011 FLL, 2014
Wear resistance during use	Resistance of the surface and/or fillers	DFB, 2011 FLL, 2014
Remediation frequency and costs	Time intervals between remediation measures and the amount of remediation costs	DFB, 2011 FLL, 2014
Reusability of building materials	Possibility of material reuse of the individual building materials	Niesel, 2013
Cost of separation and disposal of building materials	Costs for the separation of the individual building materials of a surface system from each other. Possibility of disposal of the individual building materials	Niesel, 2013

A total of 29 indicators were defined and weighted by experts[1] The significance of an indicator can be weighted with a value between 1 (= low significance) and 3 (= high significance).

In summary, seven indicators have a weighting average value greater than or equal to 2.6. On average, the respondents considered life cycle (2.9), life cycle costs (2.8) and suitability (2.7) to be particularly important. There is a divergence in life cycle costs between the different groups of experts. Without exception, operators of outdoor sports facilities weight the life cycle costs as very important. The group of planners/architects, as persons involved in the construction of an outdoor sports facility, weighted the life cycle costs on average at 2.4 (see Table 5.2).

Table 5.2: Comparison of the importance weighting according to professional background on the basis of the mean value (according to: Kleine-Bösing, Katthage, Thieme-Hack, 2016)

Technical background	Indicators: Life time	Life cycle costs	Suitability	Fatigue	Prestige/ exterior impact	Vandalism
Total	2,9	2,8	2,7	1,7	1,7	1,4
Operators	2,9	3,0	2,6	1,6	1,8	1,6
Planners	2,9	2,4	2,7	1,7	1,6	1,3
State sports federations	2,8	2,8	2,7	2,0	1,7	1,3

The lowest weighting was given to susceptibility to vandalism (1.4), prestige/exterior impact (1.7) and player fatigue (1.7), with the latter being weighted higher by the state sports federations (2.0).

Furthermore, the evaluation of the indicators for the outdoor sports surface is carried out. The scoring is done for the surfaces: Sports turf, granular surface, synthetic turf (infill: granularsand mixture, sand, without, cork and others) and hybrid turf according to the school grading system from 1 (= very good/ positive) to 5 (= very bad/negative).

1 The evaluation matrix was sent as a blank sheet including explanations and letters from the project management to 150 municipalities, specialist planners of sports facility construction and other experts such as associations and universities. A total of 24 usable feedback messages were received. 8 feedback messaged were from planners, 10 from operators and 6 from other experts (state sports federations).

Figure 5.1: Plastic surface (Katthage)

Figure 5.2: Granular surface (Katthage)

Figure 5.3: Sandy surface (Katthage)

Table 5.3 shows that sports turf was rated best overall by the respondents, both as an indicator-weighted and an equally weighted variant. In the first variant, the weighting is calculated from the mean value of the indicator weighting (see column b) in relation to all mean values (column c). In the case of the second option, each quality receives a share of 25 % (column d).

Table 5.3: Result of the survey with weighted and equally weighted evaluation sum (Thieme-Hack et al., 2017)

Line	Column a	b	c	d	e	f	g	h	i	j	k
1		Weighting	Indicator weighting share	Equal weighting share	Sports turf	Hybrid turf	Synthetic turf sand infill	Synthetic turf granular sand infill	Synthetic turf without infill	Synthetic turf different filling	Granular surface
2	Ecological quality	2,30	0,26	0,25	2,30	3,00	2,50	2,90	2,60	2,80	2,60
	Ecological quality	2,40	0,27	0,25	2,30	2,60	2,50	2,70	2,60	2,80	2,20
	Sociocultural-functional quality	2,00	0,22	0,25	1,50	1,60	2,30	1,70	2,20	1,90	3,90
	Technical quality	2,30	0,26	0,25	1,97	2,07	2,13	2,07	2,07	2,10	2,97
3	Indicator-weighted valuation sum				2,04	2,34	2,36	2,37	2,37	2,42	2,88
	Rank				**1**	**2**	**3**	**4**	**5**	**6**	**7**
4	Equally weighted valuation sum				2,02	2,32	2,36	2,34	2,37	2,40	2,92
	Rank				**1**	**2**	**4**	**3**	**5**	**6**	**7**
5	Differences (indicator-weighted - equally weighted variant)				0,02	0,02	0,00	0,03	0,00	0,02	-0,04

Only the scores of the sand-filled and granular sand-filled synthetic turf rank differently in the in-di-cator-weighted variant than in the equally-weighted variant. It should be noted that the differences in weighting between the indicator-weighted and equally-weighted variants are small. The biggest difference is in socio-cultural and functional quality. This was considered less important by the re-spondents compared to the other qualities and accounted for 22 % of the indicator-weighted varian (see column c).

Due to the small difference in weighting, the evaluation score for sports surfaces is similar (see lines 3 and 4). Only the granular surface receives a worse result with the equally weighted variant than with the indicator-weighted variant (see differences in line 5). This is due in particular to the poor assessment of the socio-cultural and functional quality of this surface (see line 2).

In a comparison of the various fillers of synthetic turf, it is striking that “other fillers” were rated worse (column j). It remains uncertain whether the respondents were thinking here of new granulates made of PE or cork. A distinction of the granulates according to the raw materials, e.g. SBR or EPDM, has not been made, as the focus of the survey is on the comparison of sports surfaces and not on the comparison of granulates.

Similarly, no distinction was made between hybrid turf and hybrid turf base layer, as this differentiation is not necessary for this study. Hybrid turf had a good result; however, its ecological quality is poor. This is presumably due to the introduction of synthetic fibres into a sports turf surface. However, the number of replies was low, so that the result should not be attributed too much importance.

6 Standard planning

Standard planning is intended to support different planning situations. It consists of three levels of detail: function overview plan, standard plan for large playing fields and standard sections.

A function overview plan is shown first, which takes up various requirements of the criteria profiles. The following topics are combined in the function overview planning:

- Ecological impact’ criterion: Use of sports turf and greening, e.g. roof and facade greening of buildings and grandstands.
- ‘Vegetation, especially woody plants’ criterion: preservation and protection of existing trees and shrubs and selection of new planting in accordance with Appendix 1 at intervals of at least 20 m depending on the tree species.
- ‘Lighting’ criterion: training lighting that takes account of space illumination, glare reduction and measures to protect birds and insects; path lighting with motion and presence detectors.
- ‘Adaptability and conversion capacity’ criterion: areas that are easy to adapt or reuse.
- In addition to multifunctional areas, these lawns can be without predefined use (i.e. without lines or permanently installed sports equipment).
- ‘Public accessibility’ criterion in conjunction with the ‘Vandalism prevention and security’ criterion. Here, a concept must be developed to harmonise the three criteria. Alternatively, priority should be given to one criterion.
- ‘Accessibility and orientation’ criterion: Compliance with the requirements for accessibility and orientation (see standard sections A1 and A2).
- ‘Cyclist comfort’ criterion: To increase bicycle use, a concept for the location and number of bicycle parking spaces must be developed.
- ‘Public transport and motorised private transport’ criterion: Notwithstanding the aforementioned criterion, it can be assumed that many users will arrive by motorised private transport, leading to the need for parking spaces. In addition, accessibility by local public transport, in particular buses, is important, especially for outdoor sports facilities located in suburban areas.

- 'Noise emissions from the outdoor sports facility' criterion: Many residents in the immediate vicinity of an outdoor sports facility may suffer from the disturbances. Meinen et al. (2016) have pointed out that properties in the vicinity of outdoor sports facilities have a lower value due to noise disturbance. For this reason, noise immissions must be reduced.
- 'Integration into the environment' criterion: The connection to other sports and leisure facilities and/or the connection to green and open spaces is to be welcomed, so that the outdoor sports facility is in context with its surroundings.

In addition to the function plan overview (see Figure 6.1), detailed solutions for the perimeter areas of full-size football pitches are presented.

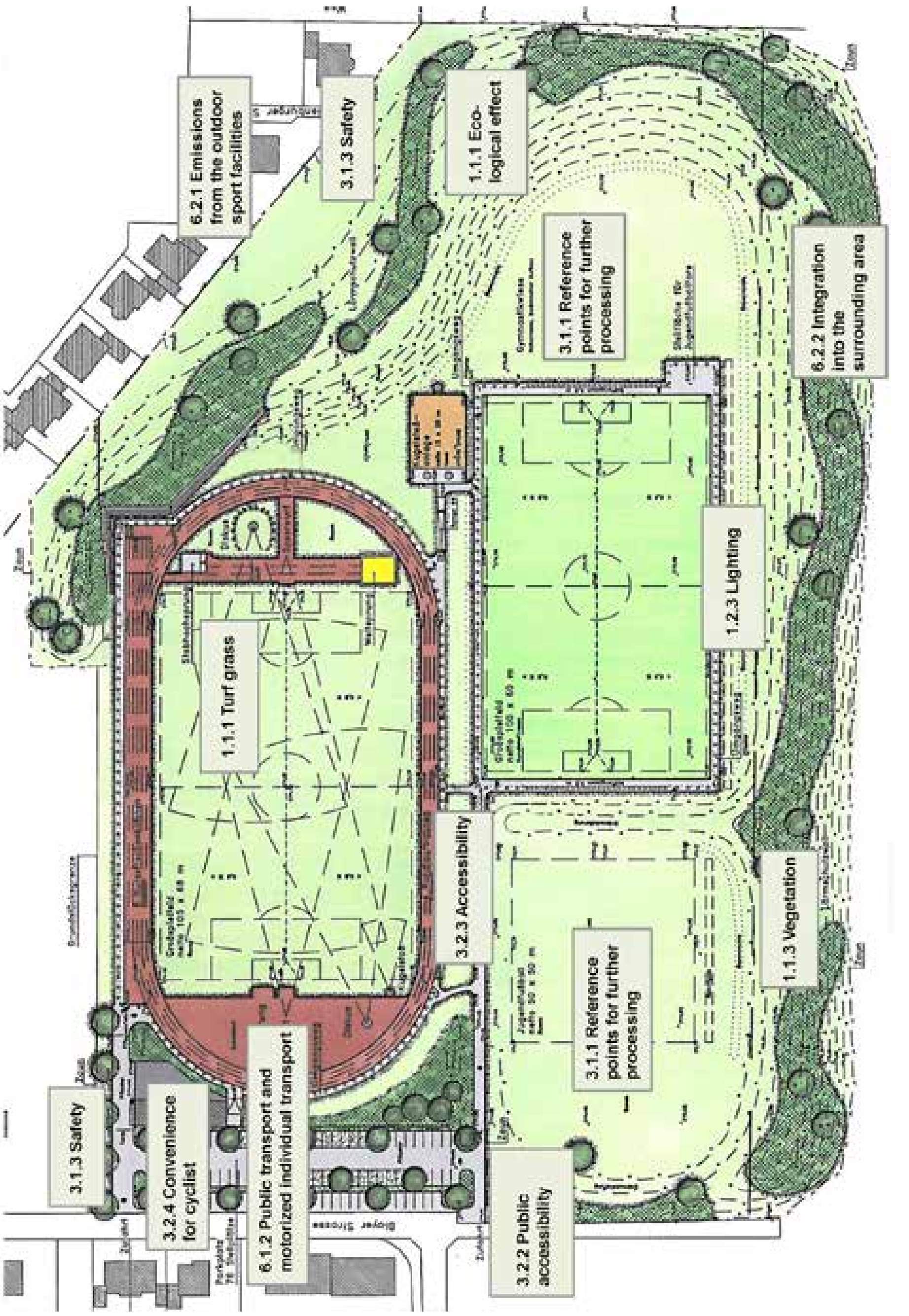

Figure 6.1: Overview function chart with location of selected criteria profiles (Illgas in: Thieme-Hack et al.,2017)

Finally, the level of detail is defined with standard sections (see Figures 6.2 to 6.8). These describe, among other things, the path width, ball catching fence and barriers as the connecting areas of a large playing field to the supplementary areas.

Irrespective of the pitch surface, the safety distance and the obstacle-free space must be observed. On the long side, the safety distance is 1.00 m and the obstacle-free space must be at least 1.00 m (preferably 2.00 m). At the front side the safety distance is 2.00 m and the obstaclefree space must be at least 2.00 m (preferably 3.00 m). The safety clearance must have same surface as the pitch surface. The obstacle-free space can be made of a different surface. It is important that it is free of superstructures, e.g. floodlight masts, barriers, unneeded care equipment or similar (see DIN 18035 Part 1).

If mobile goals are to be set up on the long side as small pitch goals, an area of at least 1.50 m with pitch surface is required for a goal projection of 1.50 m, so that no surface change takes place within the goal area. The remaining obstacle-free area (at least 0.50 m) can be paved. If mobile gates are installed, outlet gates or bulges in the barrier must be provided as storage areas.

The adjoining spectator path requires a minimum width of 1.50 m for barrier-free construction. To separate the spectator path from the obstacle-free area, a barrier can be placed in the areas where there is no ball fence. An additional mesh mat with a narrow mesh size at the barrier can prevent rabbits or other small animals from entering the playing field. For optimum maintenance, care should be taken to ensure that the barrier posts and floodlight poles are surrounded by paving stones to avoid time-consuming mowing work around the posts (see Figure 6.2 and 6.3).

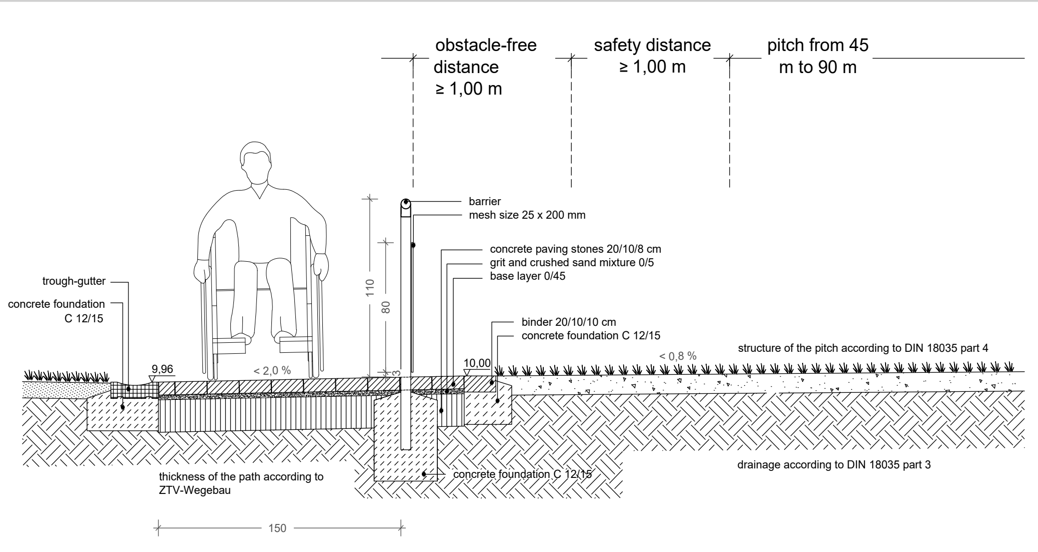

Figure 6.2: Standard section A1, long side of sports turf (Illgas in: Thieme-Hack et al., 2017)

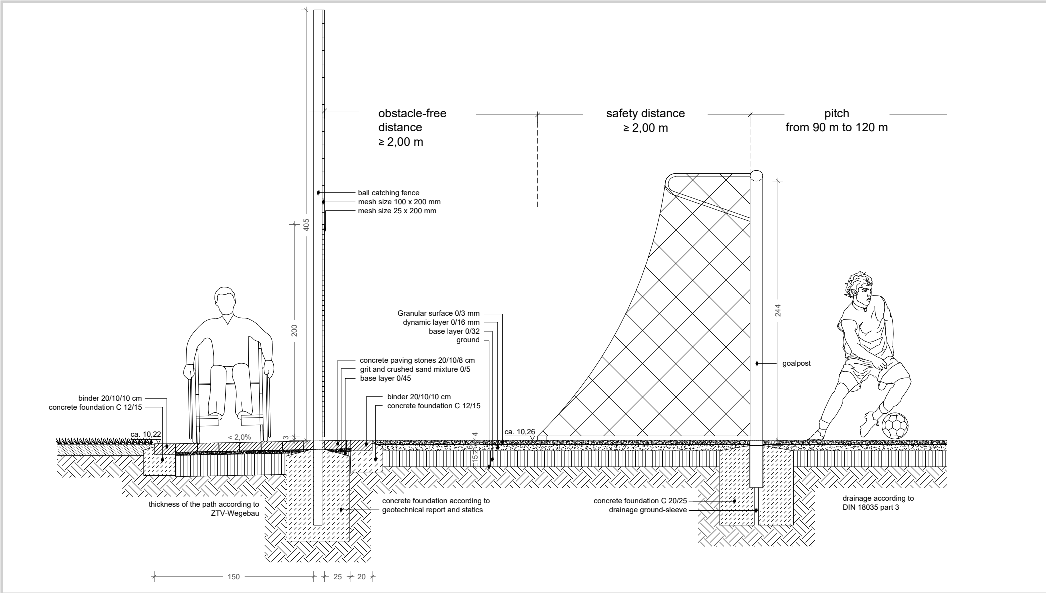

Figure 6.3: Standard section A2, front side of granular surface (Illgas in: Thieme-Hack et al., 2017)

Variant B (Figure 6.4 and 6.5) does not provide a barrier-free spectator path, so that production costs for the path can be saved. It is conceivable to place the path only along one long side, for example, and not completely around the playing field. This must be checked individually for variants A and B. Optionally, the main longitudinal and front side can be designed barrier-free while the other two sides are designed as a non-barrier-free detour.

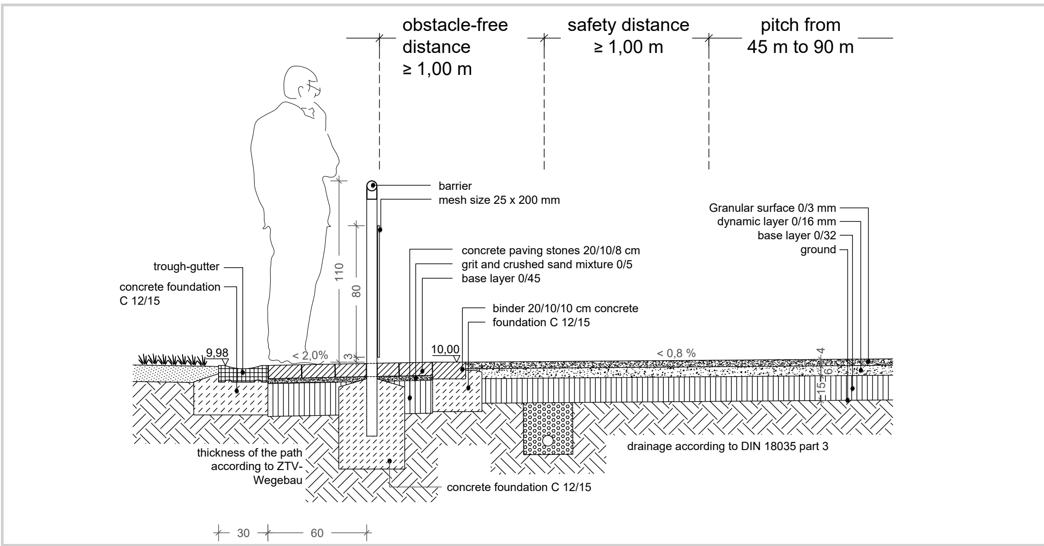

Figure 6.4: Standard section B1, long side of granular surface covering (Illgas in: Thieme-Hack et al., 2017)

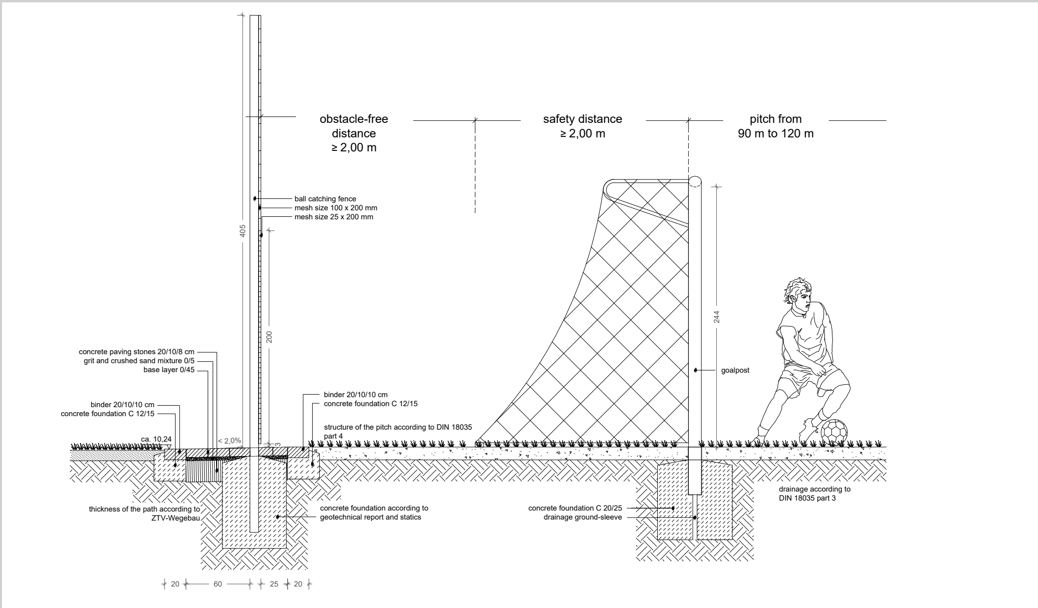

Figure 6.5: Standard section B2, front side of sports turf (Illgas in: Thieme-Hack et al., 2017)

Variant C (Figures 6.6, 6.7 and 6.8) is designed without a barrier (Figure 6.6). There is no spectator path in the standard section C2. Regardless of the sports surface, it is unwise to install a barrier without a pavement boundary. This would lead to a significantly increased maintenance effort, especially for grass. In standard section C3, the obstacle-free area is shown with paving, since in this example a synthetic turf was chosen as the sports surface. The paved area is less costly than the design of the obstacle-free area with synthetic turf. It must not be wrongly assumed that the paved area in front of the ball fence is a circumferential path.

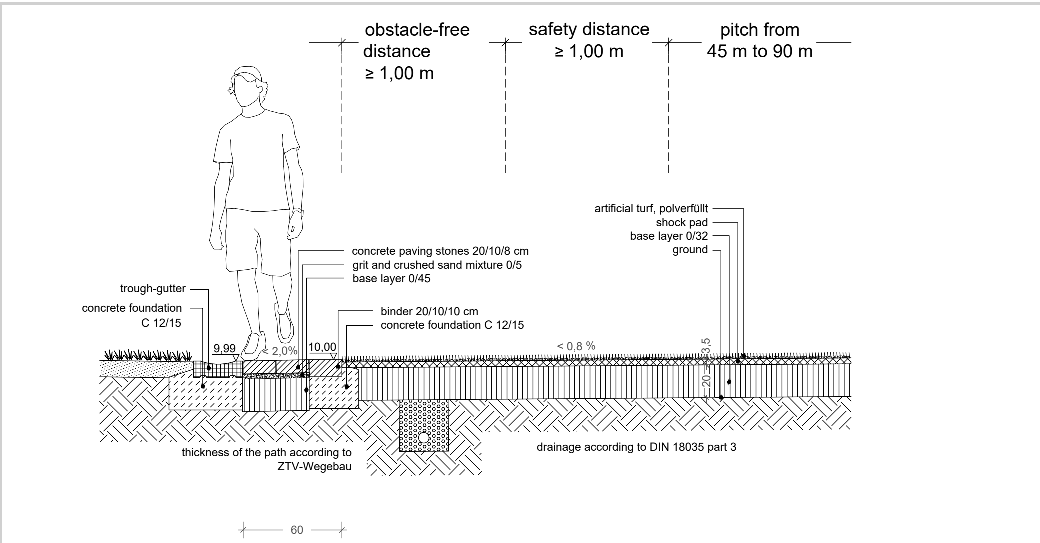

Figure 6.6: Standard section C1, long side of synthetic turf (Illgas in: Thieme-Hack et al., 2017)

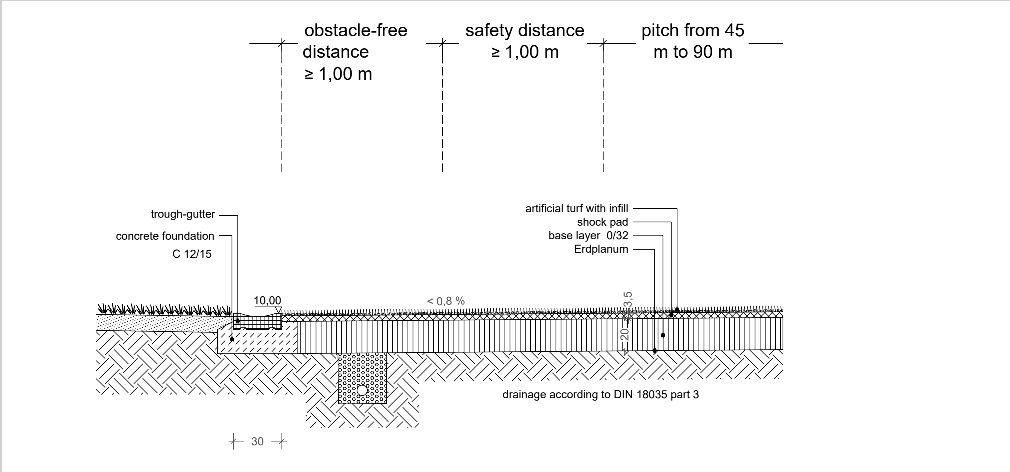

Figure 6.7: Standard section C2, long side of synthetic turf (Illgas in: Thieme-Hack et al., 2017)

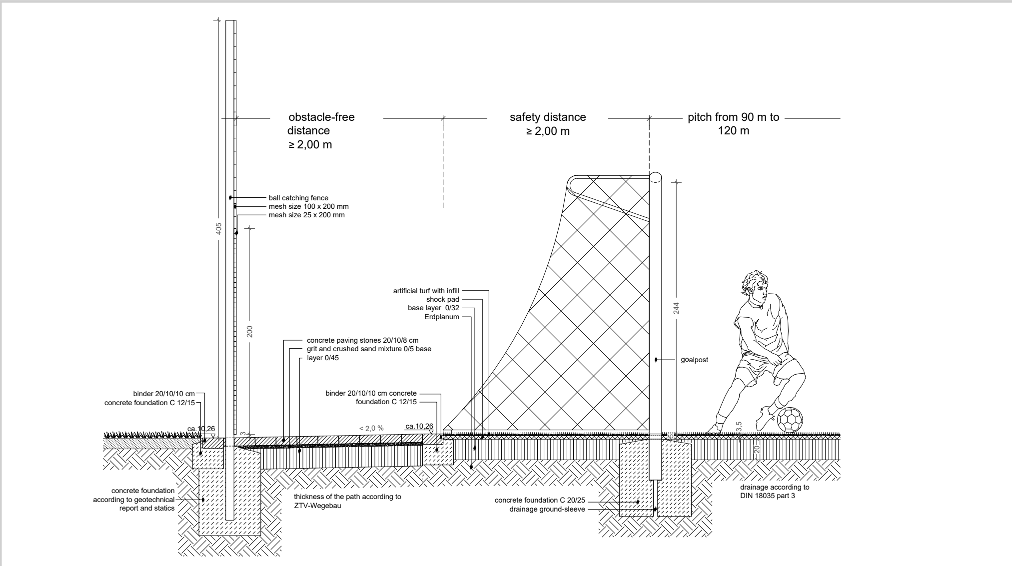

Figure 6.8: Standard section C3, front side of synthetic turf (Illgas in: Thieme-Hack et al., 2017)

7 Discussion and results

The assessment system offers the possibility to optimise sports facilities in terms of users, surround¬ings, environment and financial situation. The obligation for stakeholders to weigh up conflicting options and explain the decision-making process promotes the sustainability of outdoor sports facili¬ties. The criteria take into consideration the interests of different groups of participants. For example, the criterion 'noise protection' promotes the reduction of noise emissions in the immediate vicinity, thereby counteracting noise pollution in the surroundings. At the same time, the criteria 'pedestrians and bicycles' and 'public transport and motorised private transport' encourage the construction of sports facilities close to residential areas.

The same applies to vegetation at the outdoor sports facility. Trees as well as façade and roof greening are generally to be welcomed, but care must be taken to ensure that the vegetation does not damage the sports grounds, ball-catching fences or other equipment during growth. It is therefore often nec¬essary to balance the criteria. Public accessibility must also be coordinated with the criteria 'vandalism prevention and security'.

The ‘sustainable outdoor sports facility’ system cannot be understood as a template. An individually optimised solution is created through coordination and balancing of interests. It is important that all stakeholders are involved in the process of coordination and consideration, so that a uniform understanding of decisions is achieved.

By supplementing the criteria profiles with tools such as the selection matrix for the types of surfacing and standard planning, a fully-fledged evaluation instrument is created, which ensures the balanced and long-term operation of a sports facility.

Figure 7.1: Sustainable outdoor sports facilities are to be used on a long-term basis (Thieme-Hack)

8 Summary

The assessment system ‘sustainable outdoor sports facilities’ takes up the various topics that relate to sports outdoor facilities and associates them with the differentiated needs of users, operators and residents. For this purpose, innovative approaches are taken into account alongside traditional topics such as sports functionality, costs and new construction. These include:

- Determination of the risks to the local environment from PAHs in synthetic turf and synthetic surfaces.
- Implementation of a so-called “tree-free zone” to protect sport functionality and use, without forgoing the positive environmental impact of trees.
- Requirement of a lighting concept with motion and presence detectors on the paths and consideration of space illumination and glare in the training lighting.
- Calculation of life cycle costs and costs per hour of play.

- Definition of the required service life, intensity of use and main sport for the selection of the optimum sports surface.
- Planning of areas for changing user requirements and trend sports and fitness sports.
- Development of a concept for public accessibility for individual sports practitioners, taking into account use by clubs and schools as well as security and the prevention of vandalism.
- Description of a maintenance handbook according to a care and development concept.
- Representation of marginal playing field situations for the design of barrier-free detours.

The assessment system is to be used for the long-term planning and design of outdoor sports facilities in order to be able to adjust the life cycle costs with the associated ecological, socio-cultural and functional effects of a facility as early as the planning phase. Equal attention must be paid to the use of natural resources, including processes, technologies and location.

In order to obtain a uniform standard in sustainability assessment, special sports facility sustainability consultants must be trained. Important areas of responsibility lie in the determination of existing and required data, the evaluation and assessment of this data and the determination of adjustment screws for the optimisation of the sustainable outdoor sports facility.

9 References

Bartels, A. (2008): Technische Vertragsgestaltungen bei PPP-Projekten für Sportanlagen im Freien [Technical contract drafting for PPP projects for outdoor sports facilities]. Diploma thesis at the Osnabrück University of Applied Sciences.

Bewertungssystem Nachhaltiges Bauen (BNB) (2011): Bewertungssystem Nachhaltiges Bauen – Büro und Verwaltung [Sustainable building assessment system - office and administration]. Berlin.

Bewertungssystem Nachhaltiges Bauen (BNB) (2012): Nachhaltig geplante Außenanlagen auf Bundesliegenschaften – Empfehlung zu Planung, Bau und Bewirtschaftung [Sustainably planned outdoor facilities on federal properties – Recommendations for planning, construction and management]. Berlin.

BMZ (2014): Toolbox nachhaltige Auftragsvergabe – Ein Leitfaden zur Berücksichtigung von Nachhaltigkeitsaspekten bei Ausschreibungen in Vorhanden der Finanziellen Zusammenarbeit Version [Toolbox for sustainable procurement – A guide to the consideration of sustainability aspects in tenders in the existing Financial Cooperation version]. KfW (ed.) Produced with funds from the Study and Advisory Fund of the German Federal Ministry for Economic Cooperation and Development (BMZ).

Breitenstein, J. (2016): Nachhaltige Be- und Entwässerungskonzepte für Sportfreianlagen – Möglichkeiten und Grenzen [Sustainable irrigation and drainage concepts for outdoor sports facilities – Possibilities and limitations]. Master thesis at the University of Applied Sciences Osnabrück, Management in Landscape Architecture.

Bundesinstitut für Sportwissenschaft (BISp) (2000). Leitfaden für die Sportstättenentwicklungsplanung [Guidelines for sports facility development planning]. Schorndorf: Hofmann.

Bundesinstitut für Sportwissenschaft (2009): Zehn Thesen zur Weiterentwicklung von Sportanlagen [Ten theses for the further development of sports facilities]. Organisation: P. Ott, Bonn.

Bundesministerium für Verkehr, Bau und Stadtentwicklung (2011): Leitfaden Nachhaltiges Bauen [Sustainable building guidelines]. Berlin.

Dethlefs, T. (2007): Fußball auf Rindenziegelbelag – Möglichkeiten und Grenzen Diplomarbeit, Hochschule Osnabrück [Football on a bark tile surface – Possibilities and limits, Diploma thesis, University of Osnabrück].

Deutsche Olympische Gesellschaft (DOG) (1961). Der Goldene Plan in den Gemeinden. Ein Handbuch. [The Golden Plan in the municipalities. A manual.] Frankfurt/Main.

DFB (2011): Sportplatzbau und -erhaltung [Sports ground construction and maintenance]. Druck- und Verlagshaus Zarbock, Frankfurt.

Dick, I. (2016): Alternative und spritsparende Antriebslösungen [Alternative and fuel-saving drive solutions]. In bi-Galabau. Edition: 03/16.

DTB (2016): Membership development since 1948. http://www.dtb-tennis.de/Verband/Wir-ueber-uns/Daten-Fakten. Retrieved on: 2017-09-11.

Essig, N. (2010): Nachhaltigkeit von Sportanlagen – Analyse der Umsetzbarkeit und Messbarkeit von Nachhaltigkeitsaspekten bei Wettkampfstätten von Olympischen Spielen [Sustainability of sports facilities – Analysis of the feasibility and measurability of sustainability aspects for Olympic Games competition venues]. Dissertation at TU Darmstadt, Fraunhofer Verlag, Stuttgart.

Essig N., S. Lindner, S. Magdolen, L. Siegmund(2015): Leitfaden Nachhaltiger Sportstättenbau – Kriterien für den Neubau nachhaltiger Sporthallten [Guide to sustainable sports facility construction – Criteria for the construction of sustainable sports halls]. Bundesinstitut für Sportwissenschaft (ed.). Cologne: Sportverlag Strauß.

Homölle, A. (2005): Kosten von Sportbelägen; Bau, Unterhaltung, Nutzung [Cost of sports surfaces; construction, maintenance, use]. Hochschule Osnabrück (ed.), Osnabrücker Beiträge zum Landschaftsbau (OBL 2/2005).

Kähler, R. S. (2015): Städtische Freiräume für Sport, Spiel und Bewegung [Urban open spaces for sport, play and exercise]. Schriften der Deutschen Vereinigung für Sportwissenschaft, Volume 50. Deutsche Vereinigung für Sportwissenschaft (ed.). Feldhaus, Hamburg.

Kalbe, U. (2015): Modellierung der Stofffreisetzung und des Stofftransportes aus Materialien in Sportböden auf Kunststoffbasis (Kunststoff- und Kunststoffrasenbeläge) auf Sportfreianlagen, als Bewertungsgrundlage für die Boden- und Grundwasserverträglichkeit. [Modelling of substance release and substance transport in synthetic-based sports surfaces (synthetic and synthetic turf surfaces) at outdoor sports facilities, as an assessment basis for soil and groundwater compatibility.] BISp research project. Institutions involved: Bundesanstalt für Materialforschung und -prüfung. 01/2014 – 12/2015. Registration number: PR020140100012.

Kalbe, U.; O. Kröger; V. Wachtendorf; W. Berger (2012): Umweltverträglichkeit von Kunststoff- und Kunststoffrasenbelägen auf Sportfreianlagen: Erfassung von potentiellen Schadstoffen bei Sportböden auf Kunststoffbasis (Kunststoff- und Kunststoffrasenbeläge) auf Sportfreianlagen, unter Berücksichtigung von Alterungs- und Verschleißprozessen [Environmental compatibility of synthetic and synthetic turf surfaces on outdoor sports facilities: Detection of potential pollutants in synthetic sports surfaces (synthetic and synthetic turf) at outdoor sports facilities, taking into account ageing and wear processes]. Bundesinstitut für Sportwissenschaft (ed.). Cologne: Sportverlag Strauß.

Kempkes, H. (2015): Standortgebundene funktionellen Trainingsanlagen im Freien – Möglichkeiten und Grenzen [Location-specific functional outdoor training facilities – Possibilities and limits]. Bachelor thesis at the University of Applied Sciences Osnabrück, Bachelor of Engineering in Landscape Architecture.

Kleine-Bösing, U. (2016): Entscheidungsmatrix für Großspielfelder – Unter Aspekten des Nachhaltigen Bauens [Decision matrix for large playing fields – Under aspects of sustainable construction]. Bachelor thesis at the University of Applied Sciences Osnabrück, Engineering in Landscape Architecture.

LAI (2012): Hinweise zur Messung, Beurteilung und Minderung von Lichtimmissionen der Bund/Länder-Arbeitsgemeinschaft für Lichtimmissionsschutz (LAI) [Information on the measurement, assessment and reduction of light immissions provided by the Federal and State Working Group on Light Immission Control (LAI)]. Decision of the LAI of 13.09.2012.

Landessportbund Hessen e. V. Geschäftsbereich Sportinfrastruktur (2009): Kostenminderung und Ressourcenschutz im Sport – Aufbau eines Netzwerkes nachhaltiger Sportstättenbau durch Beratung sowie Aus- und Fortbildung. Programm Sport und Umwelt [Cost reduction and protection of resources in sport – Development of a network of sustainable sports facility construction through consulting, education and training. Programme Sport and Environment]; DSB – DBU, File no. 20406.

Lay, B.-H.; A. Niesel, M. Thieme-Hack(2010): Bauen mit Grün – Die Bau- und Vegetationstechnik des Garten- und Landschaftsbaus [Building with green – The construction and vegetation technology of gardening and landscaping]. New 4th edition, revised and extended. Stuttgart: Ulmer .

Loidl-Reisch, C. (2012): Außenanlagen nachhaltig planen und bauen – Zertifizierung als Investition in die Zukunft [Sustainable planning and construction of outdoor facilities – Certification as an investment in the future]. In: Neue Landschaft, 01/2012, p. 50-52.

Meinen, H; M. Morgenstern; K. Kock (2016): Grundstücks- und Immobilenbewertung spezial – Nachhaltigkeit in der Immobilienbewertung [Land and property valuation special – Sustainability in property valuation]. MEINEN, H. and W. PAUEN (eds.), Bundesanzeiger Verlag, Cologne.

Netzwerk ökologischer Bewegung (2012): Sportplatzdschungel [Sports field jungle]. Sponsored by the Federal Institute for Nature Conservation with funds from the: Federal Ministry for Environment, Nature Conservation and Nuclear Safety. https://www.grueneliga-berlin.de/wp-content/uploads/2017/07/Broschuere_Sportplatzdschungel.pdf. Retrieved on: 2017-09-11.

Niesel, A. (2017): Nachhaltigkeitsmanagement im Landschaftsbau [Sustainability management in landscape construction]. Stuttgart: utb Ulmer.

Ott, P. (2010): Bauliche Modernisierung von Sportanlagen, orientiert – an veränderte Sportnachfrage, – an neuen Rahmenbedingungen, – an neuen Bautechnologien [Structural modernisation of sports facilities, oriented – to changed sports demand, – to new framework conditions, – to new construction technologies]. In: Kähler, R. S. and Ziemainz, J. (eds.) Sporträume neu denken und entwickeln [Rethinking and developing sports spaces]. 4th and 5th annual conference of the dsv commission "Sport und Raum" 2010 and 2011 in Erlangen, Nuremberg and Kiel respectively.

PECO-Institut E.V. Institut für nachhaltige Regionalentwicklung. http://www.peco-ev.de/index.php. Retrieved on: 2015-10-28.

Rat für nachhaltige Entwicklung: Was ist Nachhaltigkeit? [Council for Sustainable Development: What is sustainability?] http://www.nachhaltigkeitsrat.de/nachhaltigkeit/ Aufgerufen am: 2015-10-28.

Richter, E., C. Loidl-Reisch, K. Brix, J. Zelt, A. Zimmermann (2011): Leitfaden Nachhaltiges Bauen – Außenlagen – Endbericht [Guide to sustainable construction – External locations – Final report].

Rütten, A., Hübner, H., Wetterich, J., Wopp, C., Klages, A., Stucke, N. (2010): Memorandum zur kommunalen Sportentwicklungsplanung. Erarbeitet vom ad-hoc-Ausschuss Sportentwicklungsplanung [Memorandum on municipal sports development planning. Prepared by the ad hoc committee "Sportentwicklungsplanung"].

Schlesiger, G. (2011): Sportplätze – Planung – Bau – Ausstattung – Pflege [Sports fields – Planning Construction – Equipment – Maintenance]. Bundesinstitut für Sportwissenschaft (ed.). Cologne: Sportverlag Strauß.

Schüler, D., H. Stahl (2008): Ökobilanz für den Vergleich der Umweltauswirkungen von Natur- und Kunstrasenspielfeldern. Endbericht [Life cycle assessment for comparing the environmental impact of natural and artificial turf pitches. Final report]. Ökoinstitut.

Conference of Sports Ministers in cooperation with the German Olympic Sports Federation and Deutscher Städtetag (Association of German Cities) (2002): Sportstättenstatistik der Länder [Sports facility statistics of the federal states], in-house publication, Berlin

Steffen, M. (2017): Trends in der nachhaltigen Entwicklung von Sportfreianlagen - Anforderungen zur Akzeptanz und Möglichkeiten der Umsetzung [Trends in the sustainable development of outdoor sports facilities – Requirements for acceptance and possibilities for implementation]. Master's thesis at the University of Applied Sciences Osnabrück, Management in Landscape Architecture.

Thieme-Hack, M. (2011): Grünflächen-Pflegemanagement – Dynamische Pflege von Grün [Green space maintenance management – Dynamic maintenance of greenery]. In: NIESEL, A. (Eds.). Stuttgart: Ulmer.

Thieme-Hack, M.; Büchner, U.; Katthage, J.; Kleine-Bösing, U.; Müller, B. (2017): Nachhaltigkeit von Sportanlagen im Freien – Erarbeitung eines Bewertungssystems zur nachhalitgen Entwicklung und ganzheitlichen Planung von Sportanlagen im Freien [Sustainability of outdoor sports facilities – Development of an evaluation system for sustainable development and holistic planning of outdoor sports facilities]. Fraunhofer IRB, Stuttgart.

Ulenberg, A. (2010a): Vergleich verschiedener Sportbeläge: Tenne, Sportrasen, Kunststoffrasen [Comparison of different sports surfaces: granular surfaces, sports turf, synthetic turf]. In: Neue Landschaft. Berlin: Patzer Verlag.

Ulenberg, A. (2010b): Vergleich verschiedener Sportbeläge: Tenne, Sportrasen, Kunststoffrasen, Teil 2. [Comparison of different sports surfaces: granular surfaces, sports turf, synthetic turf, Part 2.] In: Neue Landschaft. Berlin: Patzer Verlag.

VDE (2013): Fußball bei Gewitter? Richtiges Verhalten im Freien [Football in a thunderstorm? Correct behaviour outdoors]. Ed: DFB and VDE www.vde.com/de/blitzschutz/publikationen/freizeit-und-sport/fussball. Retrieved on: 2017-09-11.

Wetterich, J., Eckl, S., Schabert, W. (2009): Grundlagen zur Weiterentwicklung von Sportanlagen [Fundamentals for the further development of sports facilities]. Ed: Bundesinstitut für Sportwissenschaft. Cologne: Sportverlag Strauß.

Zehrer, H., E. Sasse (2005): Handbuch Facility Management [Facility Management Manual] (p. 243). Landsberg am Lech: Verlag Ecomed Sicherheit.

STANDARDS AND GUIDELINES

DIN 18035-1 (2003): Sports fields – Part 1: Outdoor play and athletics areas, planning and dimensions. German Institute for Standardization, Building Standards Committee. Edition: 02/2003.

DIN 18040 (2014): Construction of accessible buildings – Design principles – Part 3: Public circulation areas and open spaces. German Institute for Standardization, Building Standards Committee. Edition 12/2014.

DIN 18920 (2014): Vegetation technology in landscaping – Protection of trees, plantations and vegetation areas during construction work. German Institute for Standardization, Building Standards Committee. Edition 07/2014.

DIN EN 15643-1 (2010): Sustainability of construction works – Sustainability assessment of buildings – Part 1: General framework. German Institute for Standardization, Building Standards Committee. Edition 12/2010.

FLL (ed.) (2009): Empfehlung für die Planung, Vergabe und Durchführung von Leistungen für das Management von Freianlagen. RWA "Freiflächenmanagement" [Recommendation for the planning, awarding and implementation of services for the management of outdoor facilities. RWA "Open Space Management"]. Thieme-Hack, M. (RWA Head), Bonn.

FLL (ed.) (2014): Sportplatzpflegerichtlinien – Richtlinien für die Pflege und Nutzung von Sportanlagen im Freien; Planungsgrundsätze. RWA "Sportplatzpflege" [Sports field maintenance guidelines – Guidelines for the maintenance and use of outdoor sports facilities; planning principles.

RWA "Sports Field Care" guidelines], Ulenberg, A. (RWA-Leitung), Bonn.

FLL (ed.) (2017): Fertiliser database. http://duengemittel.fll.de/

RAL-GZ 515/1 (2013): Tennenbaustoffe für Sportanlagen [Granular surface materials for outdoor sports facilities]. Deutsches Institut für Gütesicherung und Kennzeichnung e. V.

RAL-GZ 515/2 (2013): Werkseitig hergestellte Rasentragschichtgemische und Baustoffgemische für Drainschichten für Sportplätze. [Factory-made grass base layer mixtures and building material mixtures for drainage layers for sports fields]. Deutsches Institut für Gütesicherung und Kennzeichnung e. V.

RAL-GZ 943 (2014): Kunststoffbelage in Sportfreianlagen. [Synthetic surfaces in outdoor sports facilities]. Deutsches Institut für Gütesicherung und Kennzeichnung e. V.

RAL-GZ 944 (2014): Kunststoffrasensysteme in Sportfreianlagen [Synthetic turf systems in outdoor sports facilities]. Deutsches Institut für Gütesicherung und Kennzeichnung e. V.

LAWS

Eighteenth Ordinance for the Implementation of the Federal Immission Control Act [Sports Facilities Noise Protection Ordinance (Sportanlagenlärmschutzverordnung – 18. BImSchV)] Date of issue: 18.07.1991, last amended by Article 1 of the Ordinance of 01 June 2017 (BGBl. I p. 1468).

Act on the Protection of Cultivated Plants (Pflanzenschutzgesetz – PflSchG). Date of issue: 06.02.2012.

Act to Promote recycling and Ensure the Environmentally Compatible Management of Waste (Kreislaufwirtschaftsgesetz – KrWG). Date of issue: 24.02.2012.

10 Appendix

Botanical name	English name	Class	Suitability as bee pasture	KLAM	GALK	Comment	Origin
Acer buergerianum	Trident maple	1	-	2.1	-	-	East Asia
Acer campestre	Field maple	2	Good	1.1	Suitable with restrictions	Tolerates a high degree of sealing, good soil stabiliser for slopes	Domestic
Acer monspes-sulanum	Montpellier maple	1	Good	1.2	-	Thermophilic, frost damage in some areas	East Asia
Acer platanoides 'Allershausen'	Norway maple	2	Good	2.1	Suitable	Honeydew	Breeding
Acer platanoides 'Cleveland'	Norway maple	2	Good	2.1	Suitable	Honeydew	Breeding
Acer platanoides 'Columnare'	Norway maple	2	Good	2.1	Suitable	Wind-resistant, shade tolerant, honeydew	Breeding
Acer platanoides 'Globosum'	Norway maple	1	Good	2.1	Suitable	Wind-resistant, shade tolerant, honeydew	Breeding
Acer platanoides 'Olmsted'	Norway maple	2	Good	2.1	Suitable	for narrow spaces, honeydew	Breeding
Acer plataonides	Norway maple	3	Good	2.1	Suitable with restrictions	Sensitive to soil compaction, honeydew	Domestic
Acer x zoeschense	Zoeschen maple	1	-	1.1	-	-	Breeding
Aesculus x carnea	Red horse chestnut	2	Good	2.1	Suitable with restrictions	Sensitive to soil compaction, hon-eydew	Breeding
Alnus cordata	Italian alder	2	Medium	2.2	Suitable with restrictions	Very wind compati-ble, danger of snow breakage	Southern Europe
Alnus x spaethii	Spaeth's alder	2	Medium	2.1	Very suitable	Wind resistant, danger of snow breakage	Breeding
Amelanchier arborea 'Robin Hill'	Serviceberry 'Robin Hill'	1	Medium	2.1	Suitable	-	Breeding
Amelanchier arborea	Downy ser-viceberry	1	Medium	2.1	-	-	North America
Carpinus betulus 'Fastigiata'	Pyramid hornbeam	2	Medium	2.1	Suitable	-	Breeding
Carpinus betulus	Common hornbeam	2	Medium	2.1	Suitable with restrictions	Not suitable for paved areas	Domestic

Botanical name	English name	Class	Suitability as bee pasture	KLAM	GALK	Comment	Origin
Castanea sativa	Sweet chest-nut	3	Good	2.2	-	-	South West Europe
Catalpa speciosa	Northern catalpa	2	Medium	1.2	Suitable with restrictions	-	North America
Cedrus brevifolia	Cyprus cedar	2	-	1.2	-	-	Southern Europe
Cedrus libani	Lebanon cedar	2	-	1.2	-	-	West Asia
Celtis caucasica	Caucasian hackberry	2	-	1.2	-	-	West Asia
Celtis glabrata	Celtis plan-choniana	1	-	1.2	-	-	West Asia
Celtis occidentalis	Common hackberry	2	-	1.2	Not suitable	Low floor requirements, light space prism difficult to achieve	North America
Cladrastis sinensis	Chinese yel-lowwood	1	Medium	1.1	-	-	China
Cornus mas	Cornelian cherry	1	Good	1.1	Very suitable	Low mainte-nance, fruit fall	Domestic
Corylus colurna	Turkish hazel	2	Medium	2.2	Suitable	Fruit fall	South-East Europe
Crataegus crusgalli	Cockspur hawthorn	1	-	2.1	Suitable with restrictions	Thorns	North America
Crataegus laciniata	Oriental haw-thorn	1	Medium	2.1	-	Thorns	Eastern Europe
Crataegus lavallei 'Carrierei'	Hybrid cock-spur thorn	1	-	1.1	Suitable	Thorns	Breeding
Crataegus monogyna	Common hawthorn	1	Medium	2.1	Suitable with restrictions	Thorns	Domestic
Cupressus arizonica	Arizona cy-press	2	-	1.2	-	-	Central America
Diospyros lotus	Date plum	2	-	1.2	-	Fruit fall	West Asia
Diospyros virginiana	Common persimmon	2	-	2.2	-	Fruit fall	North America
Elaeagnus angustifolia	Russian olive	1	Medium	1.2	-	-	Southern Europe
Fraxinus angustifolia 'Raywood'	Raywood ash	2	-	1.2	Suitable with restrictions	-	Breeding
Fraxinus excelsior	European ash	3	-	2.2	Suitable with restrictions	Sensitive to soil compaction	Domestic
Fraxinus excelsior 'Atlas'	Atlas ash	2	-	2.2	Suitable	-	Breeding
Fraxinus excelsior 'Diversifolia'	One-leaf ash	2	-	2.2	Suitable	-	Breeding
Fraxinus excelsior 'Geessink'	Ash	2	-	2.2	Suitable	-	Breeding

Botanical name	English name	Class	Suitability as bee pasture	Class	GALK	Comment	Origin
Fraxinus excelsior 'Globosa'	Globe ash	1	-	2.2	Suitable	-	Breeding
Fraxinus excelsior 'Westhof's Glorie'	Gewone es	3	-	2.2	Suitable	-	Breeding
Fraxinus ornus	Manna ash	1	Medium	1.4	Suitable	Not suitable for paved areas	Southern Europe
Fraxinus ornus 'Rotterdam'	Flowering ash	2	Medium	1.4	Suitable	Not suitable for paved areas	Breeding
Fraxinus pallisiae	Pallis' ash	2	-	1.1	-	-	South-East Europe
Ginkgo biloba	Ginkgo	3	-	1.2	Very suitable	Pest-free	China
Juniperus communis	Common juniper	1	-	1.1	-	Slightly toxic, skin irritant	Domestic
Juniperus rigida	Temple juniper	1	-	1.2	-	-	East Asia
Juniperus scopulorum	Rocky Moun-tain juniper	1	-	1.1	-	-	North Amer-ica
Maackia amurensis	Amur maackia	2	-	1.2	-	-	East Asia
Maclura pomifera	Osage orange tree	2	-	1.2	-	-	North Amer-ica
Malus tschonoskii	Pillar crab apple	2	Good	2.1	Very suitable	Fruit fall	Japan
Mespilus germanica	Common medlar	1	Good	2.2	-	Fruit fall	South-East Europe
Morus alba	White mul-berry	2	-	1.3	-	-	China
Nyssa sylvatica	Tupelo	2	Medium	2.2	-	-	North Amer-ica
Ostrya carpinifolia	European hop-horn-beam	2	-	1.1	Suitable	-	Southern Europe
Ostrya virginiana	American hophornbeam	2	-	1.2	-	-	North Amer-ica
Phellodendron amurense	Amur cork tree	2	Medium	2.2	-	-	East Asia
Phellodendron sachalinense	Sakhalin cork tree	2	Medium	1.1	-	-	East Asia
Pinus bungeana	Bunges pine	3	-	1.2	-	-	China
Pinus heldreichii	Lacebark pine	2	-	1.1	-	-	Southern Europe
Pinus mugo	Mountain pine	1	-	2.1	-	-	Domestic
Pinus peuce	Macedonian pine	2	-	2.2	-	-	South-East Europe
Pinus ponderosa	Ponderosa pine	3	-	1.2	-	-	North Amer-ica

Botanical name	English name	Class	Suitability as bee pasture	KLAM	GALK	Comment	Origin
Pinus rigida	Pitch pine	2	-	1.2	-	-	North America
Pinus sylvestris	Scots pine	3	low	1.1	-	-	Domestic
Platycladus orientalis	Chinese thuja	1	-	1.2	-	-	China
Prunus armeniaca	Armenian plum	1	Good	1.2	-	Fruit fall	East Asia
Prunus avium	Sweet cherry	2	Very good	1.1	Not suitable	Fruit drop, sensitive to soil compaction and paving	Domestic
Prunus cerasifera	Cherry plum	1	Good	1.2	-	Fruit fall	South-East Europe
Pyrus calleryana	Callery pear	2	Good	1.2	Suitable with restrictions	Leaf fall only after heavy frost	China
Pyrus communis	European pear	2	Good	2.2	Suitable with restrictions	Fruit fall	South-East Europe
Pyrus salicifolia	Willow-leaved pear	1	Good	1.2	-	Fruit fall, occasionally thorny	South-East Europe
Quercus bicolor	Swamp white oak	2	-	1.1	-	Fruit fall	North America
Quercus cerris	Turkey oak	3	-	1.2	Suitable	Fruit fall	Southern Europe
Quercus coccinea	Scarlet oak	3	-	1.2	-	Fruit fall	North America
Quercus frainetto	Hungarian oak	2	-	1.2	-	Fruit fall	Southern Europe
Quercus libani	Lebanon oak	2	-	1.2	-	Fruit fall	West Asia
Quercus macranthera	Caucasian oak	2	-	1.2	-	Fruit fall	West Asia
Quercus macrocarpa	Bur oak	3	-	1.1	-	Fruit fall	North America
Quercus muehlenbergii	Chinkapin oak	2	-	1.2	-	Fruit fall	North America
Quercus petraea	Sessile oak	3	Medium	2.2	Suitable	Fruit fall	Domestic
Sorbus aria	Whitebeam	1	Medium	1.1	Suitable with restrictions	-	Domestic
Sorbus badensis	Düll	1	Medium	1.1	-	-	Domestic
Sorbus domestica	Service tree	2	Very good	1.2	-	-	Southern Europe
Sorbus intermedia 'Brouwers'	Swedish whitebeam	2	Medium	2.1	Suitable	-	Breeding
Sorbus intermedia	Swedish whitebeam	2	Medium	2.1	Suitable with restrictions	-	Northern Europe
Sorbus latifolia	Broad-leaved whitebeam	2	Medium	1.2	-	-	Domestic

Botanical name	English name	Class	Suitability as bee pasture	KLAM	GALK	Comment	Origin
Sorbus torminalis	Wild service tree	2	Medium	1.2	-	-	Domestic
Sorbus x thuringiaca 'Fastigiata'	Thuringian pillar creeper	1	Medium	1.1	Suitable	-	Breeding
Sorbus x thuringiaca	Hybrid white-beam, service tree	1	Medium	1.1	-	-	Domestic
Tilia cordata 'Erecta'	Small-leafed lime tree	2	Medium	2.1	Suitable	Slightly honeydew-se-creting	Breeding
Tilia cordata 'Rancho'	Little-leaved linden	2	Medium	2.1	Suitable	Slightly honeydew-se-creting	Breeding
Tilia cordata 'Roelvo'	Little leaf lin-den 'Roelvo'	2	Medium	2.1	Suitable	Slightly honeydew-se-creting	Breeding
Tilia mandshurica	Manchurian lime tree	2	Medium	1.1	-	-	Asia
Tilia tomentosa 'Brabant'	Brabant silver lime	3	Medium	1.2	Very suitable	No honeydew	Breeding
Tilia tomentosa	Silver lime	3	Medium	1.2	Suitable with restrictions	No honeydew	South-East Europe
Tilia x euchlora	Caucasian lime tree	2	Good	2.1	Suitable	Honeydew	Breeding

These guidelines build on the findings of the research project:

Sustainability of Outdoor Sports Facilities [Nachhaltigkeit von Sportanlagen im Freien]

Development of an assessment system for sustainable development and holistic planning of outdoor sports facilities [Erarbeitung eines Bewertungssystems zur nachhaltigen Entwicklung und ganzheitlichen Planung von Sportanlagen im Freien]

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