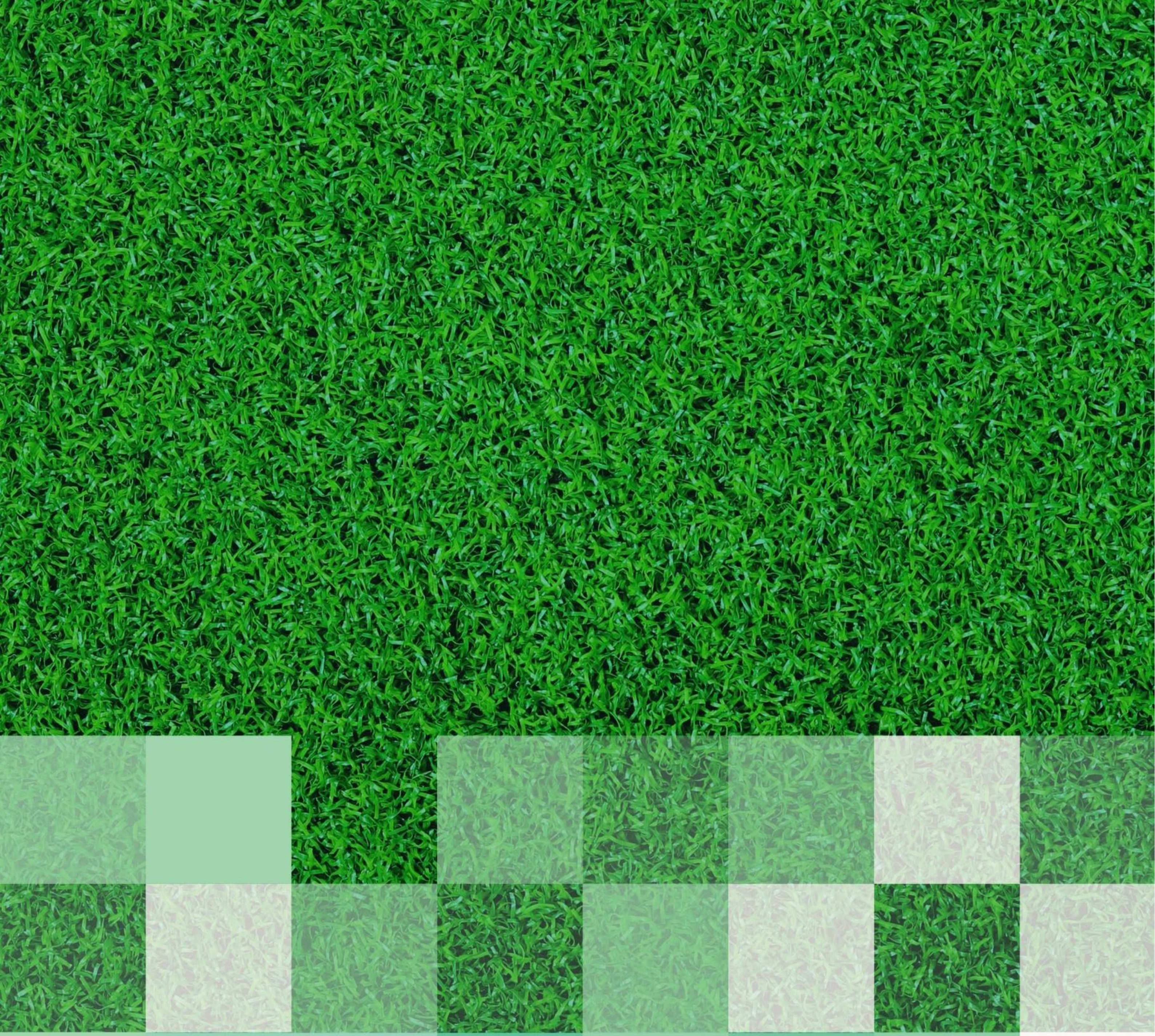


SALGRSN - GUIDE 1

SYNTHETIC SPORTS SURFACES

PERFORMANCE, CONSTRUCTION, ENVIRONMENT,
SAFETY & SUSTAINABILITY

ACKNOWLEDGEMENTS

Acknowledgement of Country

The South Australian Local Government Association Recreation and Sport Network (SALGRSN) and partnering local governments acknowledge First Nations peoples as the Traditional Owners of South Australian land and waters and we extend our respect to Elders past, present and emerging.

We value and recognise the ongoing cultural and heritage beliefs and relationship First Nations peoples have with these lands and waters and the continuing importance of this today.

The South Australian Local Government Association Recreation and Sports Network (SALGRSN) has, in partnership with the South Australia Office of Recreation, Sport and Racing, collaborated with industry expert Smart Connection Consultancy to develop a suite of Guidelines and Tools.

We acknowledge and thank the South Australian Government Office for Recreation, Sport and Racing for providing the funding that has made this synthetic turf project possible. We also recognise Craig Hobart - City of Onkaparinga for leading the project on behalf of the South Australian Local Government Recreation and Sport Network, and extend our appreciation to our project steering committee Colin Donnely - City of Port Adelaide Enfield, Bryce Norton - Town of Gawler, Travis Beard - City of Mitcham, Emily Moskwa - City of Campbelltown and David Nash and Sarah Horgan from the Office for Recreation, Sport and Racing for their contribution and support.

These required resources aim to increase knowledge, provide a suite of tools to use, and provide a transparent and rigorous approach to the planning, design, procurement and management of these surfaces.

The SALGRSN Decision Making Framework builds upon the NSW Department of Planning, Housing and Infrastructure Draft Guidelines for Decision Makers (2024) regarding Synthetic Turf in Public Open Space.

Guidelines Structure

The SALGRSN Guidelines refers to a library of documents including:

Synthetic Sports Surfaces Guidelines for Decision Makers

Technical Guides

1. Synthetic Sports Surface Standards
2. Maintenance
3. Environmental Sustainability Opportunities

Toolbox

Self-Assessment Questionnaire for each stage:
- Planning
- Design
- Procurement
- Management

Quality Policy Template

UN's SDG Guidelines – For Synthetic Turf

Natural v Hybrid v Synthetic Surface infographic

CONTENTS

1. Changing Narrative for Sports Surfaces

1.1 Changing Demographic Impacting on Surface Options

Over the past 21 years, Australia's population has grown by over six million people—a 33% increase—from approximately 18 million to over 25 million. This growth, coupled with ongoing urbanisation and evolving participation trends, has created substantial demand for resilient and adaptable sports field infrastructure nationwide.

In South Australia, the 2021 population was 1.82 million. According to the South Australian Department of Infrastructure and Transport's population projections, this figure is expected to grow to between 2.33 million (medium scenario) and 2.53 million (high scenario) by 2051. This increase of approximately 532,000 to 731,000 people—representing around 30% growth—will place added pressure on urban centres like Adelaide, Mount Gambier, Whyalla, and the Barossa region, as well as fast-growing peri-urban and regional communities. Many of these communities already face significant constraints in the availability and capacity of natural turf fields to meet increased demand for training and competition.

The growth is further compounded by changes in how sport is played. Across Australia and particularly in urban South Australian regions, there has been a rapid increase in the popularity of modified and small-sided sports formats—such as AFL 9's, Touch Rugby, 5-a-side Football, Viva Rugby, and Hockey 5's—particularly among younger players and culturally diverse communities. These formats often involve more frequent turnover and higher player density on fields. For instance, a traditional football (soccer) field, typically used by 22 players in a standard match, may now be used by 80 or more players per hour in these small-format or training contexts. This shift significantly increases field wear and raises the question of how to sustainably meet this new demand profile.

Australia's 2022 Population Statement, developed by the Australian Government, reflects the long-term impacts of COVID-19 on population trends. It predicts growth from 25.7 million (2021) to 29.9 million by June 2033, with a projected national population of 39.2 million by 2060. For both South Australia and the nation at large, this will necessitate forward- thinking planning in community infrastructure—particularly open spaces and sports precincts.

Health data underscores the urgency of planning for active living environments:

- 1 in 4 children aged 5–17 and 1 in 2 young adults (18–24) in Australia are now considered overweight or obese.
- Sedentary behaviours are rising due to increased screen time and declining informal outdoor play, a trend visible across urban Adelaide and regional centres.
- There is growing concern that today's sedentary children may become tomorrow's sedentary adults, compounding intergenerational health risks.

Cultural and demographic shifts are also shaping demand for inclusive, accessible, and adaptable sports facilities:

- 29.1% of Australia's population was born overseas, placing Australia 9th globally in the United Nations' multicultural population rankings.
- South Australia, particularly Greater Adelaide, is home to emerging communities from India, China, the Philippines, Nepal, and African nations, which bring new sporting preferences, expectations, and engagement styles.
- By 2060, 74% of Australia's population growth is expected to come from overseas migration, further diversifying sport and recreation needs.

These trends point to the growing importance of sport as a platform for social cohesion and community integration— especially in South Australia where community sporting clubs are often the first point of connection for new arrivals. Sport plays a key role in promoting belonging, health, and social mixing.

With limited land and competing demands for green space—particularly in expanding Adelaide suburbs like Playford, Salisbury, and Onkaparinga—sporting infrastructure must be both efficient and future-proofed. Synthetic sports surface technology can be a key part of this solution. Unlike natural turf, synthetic fields can support 2–3 times the intensity of use, accommodate multiple sports codes, and maintain playable conditions year-round, regardless of rainfall or irrigation restrictions—a critical advantage in South Australia's dry climate.

Strategically locating multi-sport synthetic surfaces in growth corridors, supported by master planning frameworks from the South Australian Office for Recreation, Sport and Racing, could reduce the need to convert passive open space to active space. This allows for a better balance between community recreation, environmental conservation, and population growth pressures.

Physical Activity Levels of South Australian Children and Young Adults

Despite broad awareness campaigns and investments in physical activity programs, many South Australian children and young people are not meeting recommended activity levels. According to the 2022 AusPlay survey, only 18% of South Australian children aged 0–14 met the Australian Physical Activity Guidelines, which recommend at least 60 minutes of moderate to vigorous physical activity per day. This is slightly below the national average of 20%.

For young people aged 15–24, participation rates in sport and active recreation decline significantly. The Office for Recreation, Sport and Racing's (ORSR) Strategic Plan notes that:

- Only 44% of South Australians aged 15–17 participate in organised sport at least once per week.
- Among 18–24-year-olds, participation drops further to around 35%, as pressures from work, study, and transport access increase.
- Girls and young women in both age groups are less likely to participate in club-based sport than boys and young men, although informal and social formats (e.g., dance, gym workouts, social sport) are more popular.

Concerningly, the South Australian Department for Health and Wellbeing's 2021 Childhood Health Indicators Report found:

- Just one in five primary school-aged children in the state achieved the daily physical activity recommendation.
- Physical activity levels decline with age, particularly during the transition from primary to secondary school.
- Screen time continues to displace physical activity for many children and teens, with over 75% of adolescents exceeding recommended screen time limits.

These trends highlight the need for accessible, appealing, and high-capacity sporting facilities that can engage young people in both structured and unstructured physical activity. With changing social preferences, there is growing demand for facilities that support flexible, casual, and small-sided formats rather than traditional full-sized, single-use fields.

The implementation of synthetic sports surfaces—particularly in school-community shared sites and community hubs— can play a critical role in enabling higher frequency, informal, and multi-sport activity among young people, helping reverse the inactivity trend and promote lifelong participation.

1.2 The Importance of Standards for Sports Surfaces to be Fit for Purpose

To ensure that the surface is 'Fit for Purpose' means that a number of aspects should be considered to have a holistic, sustainable approach to the planning, design, procurement, construction and management of the facility surfaces. Understanding the need for standards across the range of community sports fields would be beneficial for sports, local governments as the owners of the assets and the users of the surfaces.

Natural/synthetic surfaces don't normally become aligned with many of the standards, yet the non-natural surfaces have all identified performance standards by the International Federations that use them.

Standards are critical to allowing all parties to define quality, scope, and expectations and then deliver that standard. This will ensure they are 'Fit for Purpose'.

There are many levels that 'standards' can be viewed against some key aspects, including:

- Entry-level standards (e.g. FIFA Quality mark).
- Smart standards – to increase usage and life expectancy, specifically in the Australian climate.
- Smart Sustainability Development standards – to embrace environmental, community, economical and performance best practices.

Within each of these levels (standards), these will be specific standards against specific Multi-bottom line aspects, including:

- Performance standards (e.g. International Federation standards, equipment etc).
- People/community (e.g. The hours used, intensity of use, safety and accessibility).
- Planet/environment (e.g. climate, environmental, circular economy, civil construction etc).
- Prosperity / economic (e.g. Whole of life costs – capital, operational and replacement).

This matrix approach should be explored to identify what is appropriate for each project

	Performance Standards	People /Community standards	Planet / Environmental standards	Prosperity / Economic Standards
Sustainable Standards	Holistic best practice that helps with sustainability of club & parkland	Increased patrons & with multi–use & inclusive programming	Environmental best practice across the parkland that encourages any holistic whole of site impact to Circle positive environmental impact	Capital $1.6m
Smart Standards	More durable, larger premium fields to meet next level of play	Expected 60 hours with significant durability requirements for 60 people per hr. Health standards	Environmental concerns are addressed within the Field of Play	Capital $1.5m
Entry Level Standards	International Federation for Community or stadium usage.	Standard hours of 42p.w. & durability pf 50 ppl per hr.	Construction & drainage standards for expected 10-12 years.	Capital $1.2m

Table 1: Table of Standards

1.3 Evolution of Sports Surfaces

The popularity of synthetic surface technology in sport and recreation has been embraced by both community and elite levels over the past six decades, with different reasons for their use and introduction.

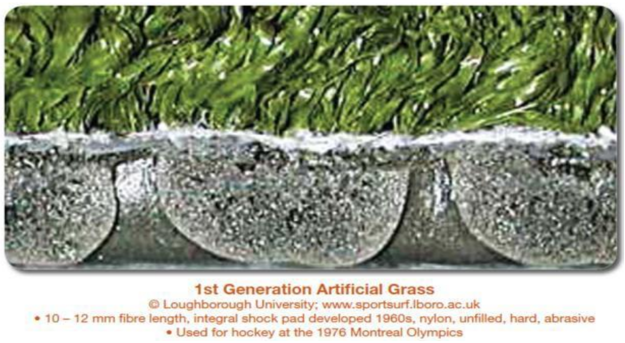


Photo 1: First Generation Artificial Grass

The technology has evolved significantly from the first generation carpet that was developed by Monsanto for the Ford Foundation at Moses Brown School, Providence, Rhode Island in 1964. The first major commercial mainstream surface was used in 1966 at the Houston Astrodome in Texas. Key milestones for their usage and development over the past 60 years include:

1960's

First Generation Turf (1964). A knitted nylon carpet with a foam backing was used for indoor Gridiron but lacked the sophistication of the present systems.

The first synthetic athletics track was used at the Mexico Olympic Games (1968) and has been the surface of choice since for track and field athletics.

1970's

The use of the 1st generation nylon carpets continued in American stadiums where the light was too poor for natural grass growth. Although the "turf look" was a positive use of technology for the TV and spectators, it wasn't so good for the athletes; it didn't provide an accurate reflection of natural playing surfaces. The coarseness of the nylon resulted in inconsistent playing conditions and injuries caused the majority of football and baseball surfaces to be replaced with natural grass again.

One sport that prospered with the use of synthetic turf during this time was hockey. When the synthetic grass was wet, the ball played far faster, and the game was far more enjoyable. The sport embraced the technology, and the first international hockey game using artificial turf was played at McGill University, Canada, in 1975.
The following year, it was showcased at the Montreal Olympics and has been used ever since.

At the turn of the decade, there were two schools of thought relating to the use of synthetic technology:

- Performance needs to mirror natural grass – with the use of the 1st generation surfaces needing to perform more closely to natural grass; and
- Performance enhanced surfaces – with World Athletics (athletics) choosing the rubber tracks and FIH (hockey) choosing technology to improve the speed of the game and the performance compared to natural surfaces.

These opposing viewpoints can still be seen 40 years on when we compare how sports have embraced the use of technology.

1980's

The 2nd generation synthetic turf was developed to look and feel like grass, with the soil replaced with sand and the blades of grass replaced with 20-35mm tightly packed polypropylene yarn. This was softer than the nylon on players' skin, but when combined with sand, created some challenges:

- Playability – the sand infill and yarn combination didn't let the large ball used for football

(soccer) have the same playing characteristics as on natural turf. It bounced unpredictably, and the roll was far faster; and
- Safety– the friction on skin was significant and caused 'skin burns' which then developed into wounds if not treated.

The durability of community football pitches (5-a-side facilities) was excellent, allowing many more people to play the game. This was a positive outcome as 5-a-side in the United Kingdom has larger participation rates than 11-a-side.

Four United Kingdom professional football clubs, including Queens Park Rangers (Loftus Road), Luton Town (Kenilworth Road), and Oldham Athletic (Boundary Park), invested in synthetic turf in the 1980s.

Hockey continued to embrace the technology, with most major competitions being played on synthetic watered turf.

Photo 2: 2nd Generation Synthetic Turf (Source: Cranfield University www.cranfield.ac.uk)

At the end of the decade, the European governing body for soccer, UEFA, ruled that professional level games should not be played on synthetic turf.

1990's

The major manufacturers of synthetic turf understood the benefits to community and elite sport that the technology could offer but could not convince the world sports' governing bodies by themselves.

The world governing body for football (soccer) that generated the most interest in the 1990s was FIFA, which made it clear that playability and performance needed to reflect the standards of natural turf.

The 3rd generation (3G) synthetic turf was born using a different and more holistic approach in Europe and America. After much research, the end of the 1990's saw a new generation of turf, using a softer yarn, polyethylene, with rubber granules and sand now used more as ballast rather than the key component of the infill. This allowed the surface to take a normal stud/cleat, which convinced the rugby codes, AFL and cricket to try this 3rd generation, joining football and gridiron.

2000's

The decade saw the defining period for the use and adoption of synthetic technology, with many sports embracing the benefits. Many of the sport's world governing bodies:

- Developed standards for elite and/or community pitch performance, including football (FIFA), rugby union (World Rugby), hockey (FIH), bowls (WB).
  athletics (World Athletics), Australian rules football (AFL) and tennis (ITF).
- Introduced an accreditation scheme for suppliers and/or products.
- Changed the rules of the game so that players could compete on the surfaces including Football (FIFA), Rugby Union (World Rugby), Bowls and Australian Rules (AFL).
- Ensured that pitches were tested regularly to meet the standards; and
- Promoted the use of the technology to grow participation in the game.

2010's

The last decade saw systems become more sophisticated, and the research has been embraced around the science of the issues affecting play, including:

- Multi-sport – so that more than a single code, including the football codes of soccer, union, league, and Aussie rules, could all be played on a single surface.
- Durability – the technology has developed to allow more hours and intensity of usage; and
- Environmental considerations – removal of heavy metals; increased usage of virgin rubber and organic material and attempting to address the heat issue

2020's

This decade will see the industry continue addressing environmental challenges such as microplastics, heat, water usage and recycling. The key evolutions of the sector may include:

- ***Design*** – to allow for the growing trend of multi-sport and multi-use on full-size fields as well as mini-fields.
- ***Environmental considerations*** – addressing community concerns about the safety, health and environmental challenges that the industry faces.
- ***Management opportunities*** – the design and planning will reflect how the fields will be managed, including embracing technology to monitor usage increase programming, shared by multiple clubs and organisations.
- ***Cost reduction strategy*** – the Whole of Life costs will be embraced in the cost to use the facility.
- ***Possible 4th generation*** – with limited infill to

- reduce the environmental impact of the infill.
- ***Recycling end of life*** – the whole system needs to be able to be recycled 100% before they are installed now. This should include the carpet backing (primary and secondary) and infill.
- ***Whole of precinct strategy*** – the field of play is situated within the whole parks landscape and the landscape design should be integrated with that footprint to create more environmental benefits.

The Future

As manufacturers of different sports surfaces continue to innovate systems to embrace challenges such as heat absorption, environmental concerns and performance improvements. Over the next few years it is expected to see:

- Hockey fields that need significantly less water.
- 4th Generation fields with low or no infill for the football long-pile; and
- Acrylic hard surfaces with heat repellent and lower temperatures that can be installed during the majority of the year.

2. Performance Standards of Sports

2.1 Commitment by Sport

Many global sports have embraced the use of synthetic sports surface technology for their sports and have developed standards for the sport for fields/surfaces that could be used for community sport and stadium/elite sport. A summary is shown in Table 1: Performance standards on synthetic playing surfaces for a range of sports.

The performance standards for each sport identify the safety, performance, playability, technical and durability standards that a synthetic sports system needs to achieve. This demonstrates and provides confidence to users that the field will play with similar 'playing characteristics' to a quality natural turf field. Some sports with an engineered base surface, such as hockey and hard surfaces for tennis, netball and athletics, do not attempt to replicate grass but are designed to enhance the surface playing characterises that grass gives. The emphasis of these standards is focused on the interaction between the surface, players and the ball, reflecting the playing characteristics of each sport.

It is critical for all sports that when a purchaser is considering procuring a synthetic sports system the installation is to the appropriate International Federation sports required standards, also detailed below.

Sport	Elite/Stadium Level	Community Level
ATHLETICS	IAAF 1	IAAF 2
HOCKEY	Global and Global Elite	National and Multi-sport
FOOTBALL (SOCCER)	Quality Pro	Quality
RUGBY UNION	Regulation 22	Regulation 22
RUGBY LEAGUE	Stadia	Community
GRIDIRON	None	None
TENNIS	ITF 2	ITF 1
AFL/CRICKET AUS	N/A	Community

Table 2: Performance Standards of Synthetic Playing Surfaces for a Range of Sports

This Smart Guide explains the standards for each sport and the surfaces that they use.

It should be noted that these standards are actually the lowest commonly agreed approach globally that the respective International Federation could gain agreement for. It is worth appreciating that a global standard needs to be able to be achieved in every corner of the world, even when resources are scarce. This is why local standards should also be considered. With the high usage and high U.V. standards in Australia, there is a significant need for standards to counter these impacts.

2.2 Athletics

Athletics was an early adopter of synthetic technology and in 1968 athletics installed its first synthetic athletics track for the Mexico City Olympics. The times and performances were so impressive that the sport's governing body has never returned to natural surfaces, supporting the technology in order to continue to improve performances.

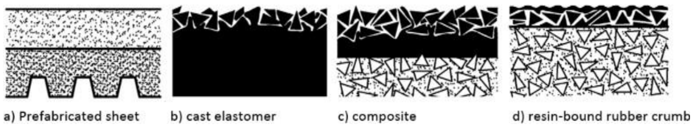


Figure 2: Synthetic Surface Types for Athletics Tracks

1. Types of system

A range of synthetic surface systems for athletics facilities is currently approved for use by World Athletics.

In Australia, the most commonly used systems are:

- In-situ resin bound rubber crumb system ('structural spray') system
- In-situ composite ('sandwich') system
- In-situ cast elastomer ('full PUR') surface
- Prefabricated sheet synthetic surface

2. Athletics track standards

The world governing body for athletics is World Athletics and they have a certification system for the tracks which, similar to other sports have a product testing certification and a facility test, in-situ at the venue.

The competition has two standards of track: elite and community.

The facility manual can be sourced from https://www.worldathletics.org/about-iaaf/documents/technical-information

Athletics Australia has a number of guides available, including:

- **General Facility Brief** - This outline brief may be used as a starting point for the group designated to advise consultants on designing new athletics facilities. The facility envisaged here is a major facility with an extensive grandstand. However, it can be adapted for lesser facilities.
- **Recommended Procedures for Operating and Maintaining Athletics Facilities** - A synthetic surfaced athletic facility is a major investment. This paper covers recommended procedures for operating and maintaining athletic facilities.

(Editor's note: these are both 2005 documentation and need to be updated).

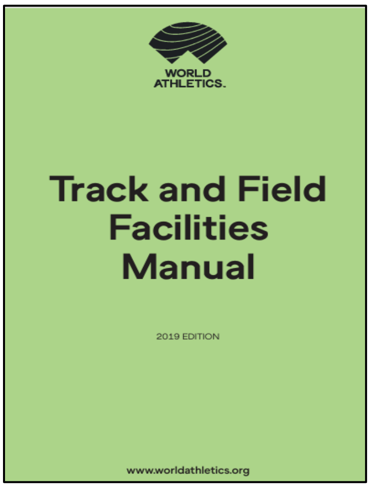


Figure 3: World Athletics Track and Field Facilities Manual

3. Expected life cycle

The lifecycle of an athletics track surface is heavily dependent on the following:

- Level of use
- Level of maintenance
- Standard of initial construction
- Environmental factors (e.g. UV exposure)

The following table provides an overview of the expected life cycle for an acrylic surface:

Year	Activity
0	Pavement constructed Athletics track surface system installed
3-5	Repair high-wear areas
7	End of the warranty period
10 – 15	Grind down to the pavement profile and apply 'wearing surface'
20+	Full resurface

Table 3: Expected Life Cycle of Acrylic Track

4. Costs

The following table outlines typical costs for the above systems depending on exchange rates.

Athletics Track System	Rate (/m^2)
In-situ Resin Bound Rubber Crumb System	\$40 – \$45
In-situ Composite System	\$65 – \$70
In-situ Cast Elastomer System	\$90 – \$95
Prefabricated Sheet Synthetic Surface	\$110 – \$120

Table 4: Typical Costs of Athletics Track

[10] Ballarat University (now Federation University)


Photo 9: Paralympic Athlete

2.3 Australian Rules Football

As custodian of the game, the AFL has recognised the need to develop ways to increase the carrying capacity of their surfaces and protect them against weather extremes as more people wish to play their sport. This approach should help increase participation rates, reduce injuries, and allow more people to play more often.

1. Type of system

In 2007, the AFL, together with Cricket Australia, Sport and Recreation Victoria and Australia's largest public-sector insurance company, JLT Trustees, collaborated with researchers[10] to develop a set of guidelines for community use of synthetic surfaces on which to play Australian Rules Football and Cricket. As the majority of Australian Rules Football grounds are also cricket grounds, it was important for any standards to ensure that they were suitable for both sports.

The research explored the playing characteristics of quality natural turf and developed the performance criteria against which the surface needs to be judged, including its mechanical properties and ball and player interactions with it. It used internationally recognised testing equipment and procedures.


Photo 10: AFL/Cricket and Football at ELS Hall Field, Ryde City Council NSW (source: Turf One)

2. Australian rules standards

The results of the study enabled the development of standards for Artificial Turf for AFL and Cricket[11]. Since this time numerous pitches have been tested, a number of others have been installed where cricket is played on football (soccer pitches), and the same standards are used. In 2018, the standards were updated with a user-friendly handbook[12]. The handbook 'fine-tuned' the standards in light of what has been learnt on synthetic turf since 2013; the main changes are to the benefit of the game. The new standard[13] also allows for the product and not just the manufacturer to be accredited, which is a very positive step forward in Australia as it provides greater competition in the marketplace, similar to today's global approach.

Figure 4: AFL/Cricket Australia Program Overview

3. Expected life cycle

The lifecycle of an Aussie Rules field surface is heavily dependent on the following:

- Level of use
- Level of maintenance
- Standard of initial construction
- Environmental factors (e.g. UV exposure)

The following table provides an overview of the expected life cycle for an synthetic surface:

Year	Activity
0	Pavement constructed AFL/Cricket surface system installed
3-5 years	Repair high-wear areas
8-10 & 16-20 & 24-30 years	Replace carpet and infill, renovation to civil pavement may be needed Shockpad will probably need to be replaced between 24 and 30 years

Table 5: Life Cycle of Synthetic Surface

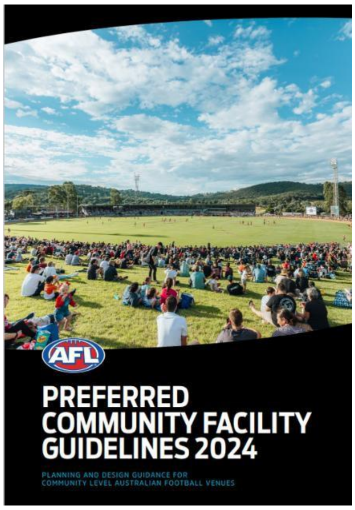


Figure 5: AFL Preferred Community Facility Guidelines 2024

4. Costs

The estimated cost for a typical Aussie Rules field (17,500m^2) would be in the region of $2.6-$3.0 million. The annual maintenance costs associated would be approximately in excess of $35,000 per field. Replacement expectation based on 50 hours per week on medium intensity would be approximately 10 years.

2.4 Cricket

Regarding cricket, many councils have used synthetic wickets for years, and this has historically been covered by soil during the winter months. This often causes safety concerns and reduces the consistency of play where the soil is located.

According to Cricket Australia's guidance[14], the wicket should be 25m-28m long and 2.4m to 2.8m wide, and the turf should be between 9mm and 11mm long. This information can be found in their AFL Preferred Facilities Guidelines (2019)[15].

1. Cricket standards

Unfortunately, there are no standards for the cricket wicket in Australia to this date, and the England and Wales Cricket Board have the only global standards which have not been embraced yet in Australia. So, depending upon the standard that the synthetic turf wicket is being used for this should be considered.

Cricket Australia have provided guidance on synthetic sports surfaces in their Community Cricket Facility Guidelines[16].

[11] Development Standards for the use or Artificial Turf for Australian Football and Cricket (2008 DIW May; L. Otago; N. Saunders; E. Schwarz: University of Ballarat School of Human Movement and Sport Science

[12] Australian Football League and Cricket Australia Handbook of Testing for Synthetic Turf (Sep 2013 www.aflcommunity.com.au)

[13] http://www.aflcommunityclub.com.au/fileadmin/user_upload/Manage_Your_Club/Facilities/2E_AFL_CA_Synthetic_Turf_Product_Certification_2018_Overview_f_AFL_CA_Synthetic_Turf_Certification_.pdf

[14] Reference: Letter to LGA's in Victoria – dated 2010

[15] http://www.aflcommunityclub.com.au/fileadmin/user_upload/Manage_Your_Club/Facilities/AFL_Venue_Guidelines_2019_-_FINAL.pdf

[16] https://www.community.cricket.com.au/clubs/facilities/facilities-

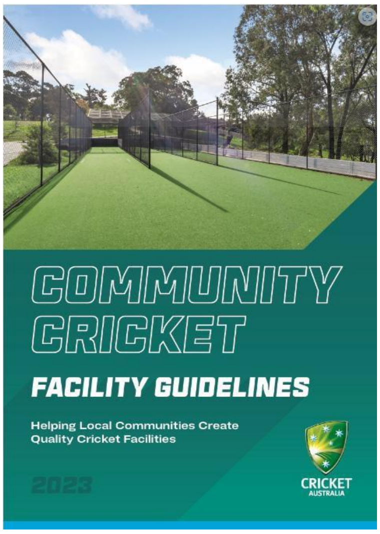


Figure 6: Cricket Australia Community Facility Guidelines

2. Expected life cycle

The expected life of a synthetic cricket wicket can be between 10 and 15 years depending upon usage and the type of winter protection applied (e.g. sand, natural turf, rubber or synthetic turf). The normal maintenance is at the start of summer which includes clearing the surface with a brush and/or high pressure hose followed by cutting the grass around the concrete wicket. It is important to secure the soil around the concrete wicket so that there are no trip hazards.

3. Costs

The estimated cost for a typical wicket with a concrete base is approximately $30,000.

2.5 Bowls

There are two main surface options (natural and synthetic) utilised for bowling greens. This guidance paper will provide an overview of the following surfaces:

- Natural turf
- Sand-filled synthetic turf
- Woven carpet
- Needle punch carpet

Typically, state and international competitions are played on high-quality natural turf greens.

1. Standards and requirements

The governing body for lawn bowls, World Bowls Ltd, provides standards for the minimum performance requirements of a lawn bowls surface, specifically in regard to the following:

- Green speed (the number of seconds taken by a bowl from the time of its delivery to the moment it comes to rest)
- Surface draw (the distance between the trajectory of a rolling biased bowl and a straight line between start and end points)
- Surface evenness (measurement under a 3m straight edge)
- Design level (a comparison of theoretical and actual levels)
- Infiltration rate (the rate at which water enters the green surface)

World Bowls has developed an approval system for manufacturers/ suppliers of synthetic surfaces, utilising the above standards to ensure surfaces are being sourced from reputable suppliers.

Natural Turf

Natural turf is the traditional surface type for a bowling green. The profile would typically comprise of a growing medium (e.g. sand or soil) and a warm or cool season turf. The turf species selected on a bowling green will typically depend on the local climate and availability at time of construction

The advantages of this system are:

- Lower surface temperature on hot days compared with synthetic surfaces
- Easier to rectify damages/ uneven patches in localised areas

The disadvantages of this system are:

- Higher maintenance practices required
- Weather-dependent play
- Reduced hours of use
- Requires watering throughout the year to maintain turf coverage
- Longer construction phase due to the period required for turf establishment

Sand Filled / Dressed Synthetic Turf

A sand-filled synthetic turf is a tufted synthetic carpet laid over a free draining engineered base and filled with sand to hold the synthetic fibres upright. A sand-filled carpet pile height is typically 13-15mm with approximately 8mm of sand infill (i.e., 5-7mm pile height exposed), and historically, it has had an average of 20 tons of sand.

Figure 7: Sand Filled Carpet (source: ABS Sport Surfaces)

Currently, many synthetic carpet suppliers are leaning toward sand-dressed carpets in preference to sand-filled carpets. By embracing a denser fibre mix, the sand-dressed carpet only uses 12-14 tons of sand.

The advantages of the sand-dressed system are:

- All weather surface
- Higher allowable hours of use compared with a natural turf green
- If systems consist of a shockpad, it will provide comfort underfoot for users

Can be bowled on in all four directions (i.e. ability to rotate wear patterns)

The disadvantages of this system are:

- Can scratch the woods
- Hotter surface temperature compared to a natural turf green
- Higher capital costs than natural turf

This is the most 'forgiving' system, but many traditional and competitive bowlers are not fans of this surface.

Woven Carpets

Woven carpet is a tensioned bowling green unfilled synthetic surface. Typically, a woven carpark has a height of around 4mm. The surface is tensioned to provide a consistent playing surface performance.

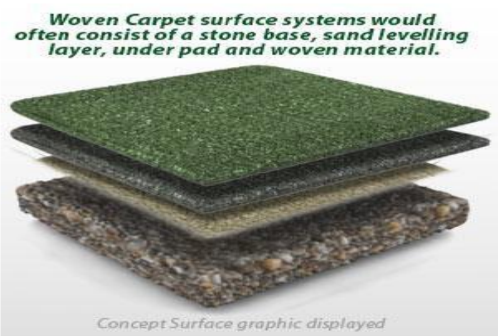


Figure 8: Woven Carpet Bowls Green (source: ABS Sport Surfaces)

The advantages of this system are:

- Consistent performance
- Higher allowable hours of use compared with a natural turf green

The disadvantages of this system are:

- Hotter surface temperature compared to a natural turf green
- Higher capital costs than natural turf
- Can generally only be used in two directions (perpendicular to seams)

Needle Punch Carpet

Needle punch carpets are manufactured by converting loose fibres into a non-woven fabric. The product is generally 6-9mm high, overlying a 3-9mm underlay.

Needle Punch and Woven Carpets can be played in both directions, and clubs are encouraged to do so, thus creating even wear across the surface. Most clubs prefer to play pennants across the seams, but local inhouse bowls and barefoot bowls can be played with the seams. It is recommended that clubs use the seams as the centre, therefore negating any controversy about bowls bouncing or running in the seam. Again, the seam should not affect the bowl trajectory if the green is laid correctly.

The advantages of this system are:

- Higher allowable hours of use compared with a natural turf green
- All weather surfaces

The disadvantages of this system are:

- Hotter surface temperature compared to a natural turf green
- Higher capital costs than natural turf

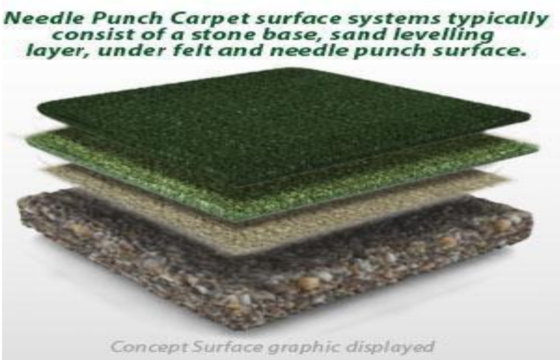


Figure 9: Needle Punch Carpet (source: ABS Sport Surfaces)

This system, although the more expensive, is the most commonly adopted surface type by bowlers and is recognised as performing closest to natural grass.

2. Expected life cycle

The lifecycle of a synthetic surface is heavily dependent on the following:

- Level of use
- Level of maintenance
- Standard of initial construction
- Environmental factors (e.g. UV exposure)

The following table provides an overview of the expected life cycle for a Needle Punched carpet bowling green surface.

Year	Activity
0	Pavement constructed, and synthetic system installed
7	End of synthetic product warranty period (standard for all quality manufacturers)
10-12	Resurface of synthetic surface depending on maintenance and usage
10-12	Minor base rectifications
20+	Possible pavement reconstruction/ remedial works

Table 6: Expected Life Cycle for Needle Punched Carpet

Typically, a sand dressed green, subject to usage and maintenance would last approximately 12-14 years, compared to a Needle Punched Carpet which would be expected to last up to 12 years.

3. Cost of installation

The cost of conversion for the two greens would be expected to be approximately $535,425, with no investment allowed for lights, fences, etc. The report has allowed for a contingency and for project management (10%) costs.

Bowls Australia has developed a Bowling Greens Construction Guidelines[17]

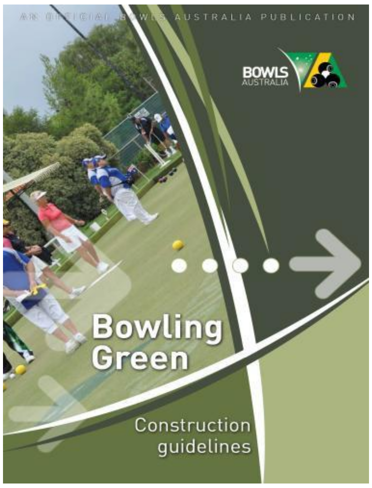


Figure 10: Bowls Australia Construction Guidelines

The difference in surface costs compared to a Needle Punch Carpet would be as follows:

- Woven $3,000 less per green
- Sand Dressed $15,000 less per green

1. Type of Green	Bowls	Life Expect	8 - 12 years
2. Size of area of field (40m wide x 40m long)			3,200
3. Green establishment direct costs	per m2 / lin. Metre		Total cost of field
Design			$4,000
Site establishment, documentation & project management			$20,000
Excavation works	$9		$28,800
Drainage	$10		$32,000
Pavement and associated concrete works	$42		$134,400
Plinth Construction	$5		$16,000
Surface Type - Needle punch carpet system	$77		$246,400
Surface Type - Sand Dressed carpet system			$216,400
Surface Type - Woven carpet system			$240,400
Needle Punched Carpet Green Sub total	$143		$481,600
Ancillary Costs			
Fencing			$0
Lighting			
Mainatenace Equipment / Training and Manuals			$5,150
Other			
Ancillary costs Sub-Total	$0		$5,150
Contingency & PM Costs	10%		$48,675.00
Total investment (as at Feb 2025)			$535,425

Table 7: costs as of November 2025

4. Maintenance costs

The maintenance costs will vary from club to club, depending on the usage, local landscape conditions (e.g. trees, shade, weather etc.) and the level of maintenance embraced by the club compared to external contractors.

To provide an indicative cost for external contractors the following should be considered.

- Sand dressed
  - Deep clean – annually $1,250
  - Light brush $1,050
- Needle Punch / Woven
  - Annual Algae/Moss spray $950

5. Replacement costs

The replacement costs for two Needle Punch Carpeted greens would be approximately:

[17] https://www.bowls.com.au/wp-content/uploads/2018/09/Bowling_Green_Construction_Guidelines.pdf

Replacement Costs (unit rates based on todays prices)		
Component	**Cost per m2 / linear m**	**Cost of this project**
Green Costs		
Site mobilisation and Documentation		16,500
Removal & disposal of existing synthetic grass surface	7.5	$ 24,000
Base rectification	4.4	$ 14,080
Needle punch carpet system installation		$ 246,400
Green Sub total		**$300,980**
Ancillary Costs		
Fencing (replace chainmesh)		
Lighting		
Equipment		$ 1,000
Ancillary costs Sub-Total		**$1,000**
TOTAL COST FOR FIELDS		**$301,980**

Table 8: Replacement costs based on Nov 2025

2.6 Football (Soccer)

Football has been played on synthetic grass for several decades, with the Federation Internationale de Football Association (FIFA) embracing the benefits of synthetic turf, allowing more people to play 'The World Game'. The use of synthetic grass surfaces (designated 'Football Turf' by FIFA) over the past 15 years has resulted in developing performance standards based on quality natural turf performance standards.

1. Football standards

To ensure that the quality of football turf was consistent across the globe, FIFA developed the FIFA Quality Programme in 2001 and is continually improved with the latest guidelines[18]. These guidelines were updated and re-issued in 2024 and are constantly updated with various versions[19].

The FIFA Quality Programme for Artificial Turf is a rigorous test program for football turf that assesses the product's durability and interaction with the ball and player surfaces.

FIFA has four categories of performance standards, namely:

FIFA Quality mark field – aimed at high surface use for municipal or sports club level field (recommended for approximately 40 hours use per week). This was referred to as the FIFA 1 Star previously.

FIFA Quality PRO mark field – for professional and stadium usage (recommended for less than 20 hours of use per week). This was referred to as the FIFA 2 Star previously.

A standard that reflects the multi-sport surfaces that are used, primarily indoors, to play Futsal.

FIFA Basic – a new standard to allow temporary fields to be certified for a short period (e.g. 3 months) or for certain parts of the world where certification may not be important. This standard is not appropriate for Australia, due to the quality standards we need to play the intensity on each field.

The performance standards measured are the same for both categories, although the acceptable criteria range differs slightly. This allows the FIFA Quality mark field categories have greater latitude (less than 5 percent difference in most categories) to meet the needs of the intensity that a 40 to 60-hour usage pattern would expect.

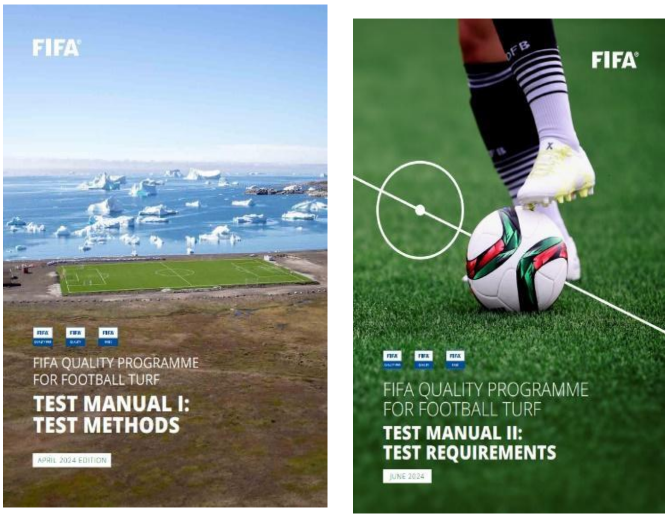


Figure 11: FIFA Quality Test Manual 1 and 2

The schedule for re-testing of fields is FIFA Quality mark pitch every three years and FIFA Quality PRO recommended pitch every 12 months.

[18] FIFA Quality Concept for Football Turf – Handbook of Requirements

[19] Inside FIFA

Photo 11: Kareela Oval, Two Football Fields (Sutherland Shire Council, NSW)

There are a range of Facility Guides that many State Football Associations have developed to be embraced by government and sport that wish to develop such facilities. Football NSW have led the industry with their Facilities Department developing a range of Facility Guides, including:

- Building Development
- Drainage and Irrigation
- Field Markings and Equipment
- Grass Field Maintenance
- Football Lighting
- Project Management
- Provider Procurement and Management
- Synthetic Fields
- Football Scoreboards

2. Costs

The whole of life costs for a typical football field (8,500m^2) when considering the capital (including contingency of 12.5%), maintenance and replacement costs, would be in the region of:

Whole of Life Costings	10 years	20 Years	30 years
Capital costs	$1,904,625	$1,904,625	$1,904,625
Maintenance costs	$262,000	$524,000	$786,000
Replacement costs		$466,400	$1,085,800
Totals over period	**$2,166,625**	**$2,895,025**	**$3,776,425**
Annual amortized rate	**$216,663**	**$144,751**	**$125,881**

Table 9: Expected Whole of Life Costs

This can be broken down as follows: Initial Capital Costs

Table 11: Initial Capital Cost of Synthetic Surface Installation			
1. Type of synthetic field of play (sports name)			**Football (Soccer)**
2. Size of area of field			**8,500**
3. Field Planning and Procurement Costs	**Variable costs (per m^2 / lin. Metre)**	**Fixed costs**	**Total cost of field**
Detailed site survey		**$12,000.00**	**$12,000.00**
Geotechnical investigation		**$14,000.00**	**$14,000.00**
Technical Specification and Design Package		**$55,000.00**	**$55,000.00**
Procurement		**$20,000.00**	**$20,000.00**
Project Management		**$60,000.00**	**$60,000.00**
Approvals i.e. Development Approval		**$10,000.00**	**$10,000.00**
Field Planning and Procurement Costs Sub-total			**$171,000.00**
4. Synthetic Field Direct Costs			
Site establishment, documentation & project management		**$100,000.00**	**$100,000.00**
Disposal of spoil	**$75.00**		**$75,000.00**
Sub grade works	**$30.00**		**$255,000.00**
Drainage, gutters and concrete works		**$200,000.00**	**$200,000.00**
Base pavement (e.g. road base)	**$20.00**		**$170,000.00**
Additional costs to offset site challenges (see Part 2 Section 6)	**$0.00**	**$0.00**	**$0.00**
Synthetic sports surface and infill	**$55.00**		**$467,500.00**
Shock pad installation	**$30.00**		**$255,000.00**
Other (if required)	**$0.00**	**$0.00**	**$0.00**
Pitch Sub-total			**$1,522,500.00**
5. Synthetic Field Indirect Costs			
Field fencing / gates	**$150.00**		**$54,000.00**
Field lighting		**$175,000.00**	**$175,000.00**
Player benches / shelter		**$24,000.00**	**$24,000.00**

Equipment (i.e. shoe cleaning)		**$4,000.00**	**$4,000.00**
Retractable Netting	**$0.00**	**$0.00**	**$0.00**
Spectator Seating	**$0.00**	**$0.00**	**$0.00**
Pathways	**$85.00**		**$75,480.00**
Goals		**$4,000.00**	**$8,000.00**
Maintenance machinery		**$18,000.00**	**$18,000.00**
Marketing and Communications		**$0.00**	**$0.00**
Other (e.g. drinking water etc.)	**$0.00**	**$0.00**	**$0.00**
Ancillary costs Sub-total			**$358,480.00**
Investment without Contingency (Pitch + Ancillary costs)			**$1,880,980.00**
Contingency Allowance	10.0%		**$188,098**
PM Costs	0.0%		**$0.00**
Total investment			**$2,239,460.00**
6. Less Grants Expected / Income Available			
1. State Government Grant Aid			$0.00
2. Other Grant Aid			$0.00
3. Self-funded money available			$0.00
Total revenue expected to offset initial capital costs			**$0.00**
Net Capital Cost			**$2,051,980.00**

Table 10: Capital Cost for a 3G Field to Achieve FIFA Quality Mark, with Shockpad and SBR Infill as at Feb 2025

3. Maintenance costs

Table 12: Annual Maintenance Costs			
Maintenance costs compared to usage expectations			
Component	**Aus. $ cost**		
Field of Play Maintenance Costs	**under 40 hours**	**40 - 60 hours**	**Over 60 hours**
Routine grooming	**$13,000**	**$15,000**	**$17,000**
Professional service grooming	**$9,000**	**$9,000**	**$9,000**
Algaecide / Herbicide application	**$3,000**	**$3,000**	**$3,000**
Visual inspection	**$2,000**	**$2,000**	**$2,000**
Field performance testing	**$0**	**$0**	**$0**
Other (please list)	**$0**	**$0**	**$3,000**

Pitch Sub-total	**$27,000**	**$29,000**	**$34,000**
Ancillary Costs			
Fencing	**$4,000**	**$4,000**	**$4,000**
Field lighting	**$3,000**	**$3,000**	**$3,000**
Irrigation (if required)	**$1,500**	**$1,500**	**$1,500**
Goals	**$0**	**$0**	**$0**
Equipment (i.e. shoe cleaning)	**$0**	**$0**	**$0**
Retractable Netting	**$0**	**$0**	**$0**
Machinery maintenance	**$1,500**	**$1,500**	**$1,500**
Staff costs including staff training (if required)	**$0**	**$0**	**$0**
Other (please list)	**$0**	**$0**	**$0**
Ancillary costs Sub-total	**$10,000**	**$10,000**	**$10,000**
Total Annual Maintenance Cost For Field	**$37,000**	**$39,000**	**$44,000**

Table 11: Expected Maintenance Costs

4. Replacement costs

Table 13: Whole of Life Replacement Costs			
Replacement costs for each expected replacement (every 10 yrs.)			
Component	**Aus. $ (with CPI)**		
Pitch Costs	**After 10 years**	**After 20 years**	**After 30 years**
Field planning and procurement	**$76,200.00**	**$163,068.00**	**$228,600.00**
Site establishment, documentation & project management	**$100,000.00**	**$214,000.00**	**$300,000.00**
Removal & disposal of existing synthetic turf surface	**$75,000.00**	**$160,500.00**	**$225,000.00**
Base rectification	**$25,000.00**	**$53,500.00**	**$75,000.00**
Synthetic surface installation	**$467,500.00**	**$1,000,450.00**	**$1,402,500.00**
Shock pad replacement should be every 20-25 years or allow 10% for upgrade in between	**$25,500.00**	**$54,570.00**	**$255,000.00**

Drainage system, pavement base and other civil works (assuming life expectancy of 30 years & 50% needs replacing)			**$312,500.00**
Pitch Sub-total	**$769,200**	**$1,646,088**	**$2,798,600**
Ancillary Costs			
Fencing (replace chainmesh - allowed 33% replacement)	**$17,820.00**	**$38,134.80**	**$54,000.00**
Lighting (allowed 40%)	**$70,000.00**	**$149,800.00**	**$219,800.00**
Other (e.g. drinking water etc.)	**$0.00**	**$0.00**	**$0.00**
Mobile Equipment (allowed 100%)	**$18,000.00**	**$38,520.00**	**$54,000.00**
Fixed Equipment (allowed 20%)	**$0.00**	**$0.00**	**$0.00**
Ancillary costs Sub-total	**$105,820.00**	**$226,454.80**	**$327,800.00**
Contingency costs (15%)	**$131,253.00**	**$280,881.42**	**$468,960.00**
Total Replacement Costs for Field of Play	**$1,006,273.00**	**$1,872,542.80**	**$3,126,400.00**

Table 12: Expected Replacement Costs

2.7 Hockey

Hockey, under the guidance of the International Hockey Federation (FIH), has been promoting the use of synthetic surfaces since the first surface was used in Canada in 1976 for an international game.

Photo 12: London Blue Hockey Field, as it is now known (source: Polytan)

In their latest handbook for synthetic surfaces FIH states that their objectives to code the relevant performance requirements are to ensure that hockey pitches and matches are conducted for:

- Consistency – to reflect relative team merit,
- Quality – to provide an opportunity for players to display and develop their skills,
- Safety – to ensure playing conditions offer comfortable playing considerations and reduce risk to players/officials and
- Playability – to extend playability, especially in adverse weather conditions.

FIH are keen to promote the game across the world and believe that the use of synthetic sports and synthetic hockey surfaces will provide greater access to facilities to participate in various forms of hockey. By providing quality, safety and consistency of play, participants will feel more confident in developing their skills and enjoying the game more, and FIH hopes to continue playing the game throughout their lives.

1. Standards for the sport

Hockey, under the guidance of the International Hockey Federation (FIH), has been promoting the use of synthetic surfaces since the first surface was used in Canada in 1976 for an international game.

In 2024, they updated their global standards to include the following categories:

- **Global Elite** – fields designed to satisfy the competition requirements of FIH Tier One hockey events. These fields are surfaced with Global Approved Products and require watering prior to play.
- **Global** – fields designed for international and top- level national competitions; they also are surfaces with globally approved products and require watering prior to play.
- **National** – this category of field may be used for competitive play when dry or wet. Normally with a National Approved Product (Class 1 or 2) the fields are used for lower level national, regional and club play.
- **Multi-Sport Surface** – recognising that facilities on which hockey is played also often have to be used by other sports, the FIH Quality Programme for Hockey Turf includes three categories of Multi-Sport Surface. Multi-Sport 1 and Multi-Sport 2 Approved Products are based on sand-dressed or sand-filled synthetic turf surfaces or textile surfaces that are laid on shockpads that provide slightly wider ranges of performance than those used specifically for hockey.
- **Hockey 5's Courts** – there are four standards

for Hockey 5's courts, including Global elite, Global, National and Multi-Sport.

A new GEN 2 standard offering certification for football (futsal), hockey 5's, netball, and tennis was introduced and Hockey Australia are embracing it as a surface to encourage our young people to be more active.

These are the key aspects that FIH have identified to underpin their performance requirements[22].

i.) The performance standards aim at allowing players to use the fields in a safe and comfortable manner,

ii.) Approved products from licensed manufacturers are published on the FIH website (www.fih.ch), and have been tested by an FIH-accredited laboratory, demonstrating compliance with the appropriate FIH standards. These products are only valid for the specified duration, and

iii.) Pitches are granted a certificate of compliance after field testing by an accredited laboratory only when they meet the specified performance standards. A current list of certified pitches is published on the FIH website (www.fih.ch), which are valid for two (2) years from the date of testing.

2. Product licensing

Manufacturers of synthetic turf for hockey pitches or multi-sport used for hockey may apply to the FIH to have their products registered as FIH approved products. Once tested by an independent and accredited laboratory they are listed on the FIH website. Only licensed manufacturers, their subsidiaries and licensees may seek FIH approval for their products.

3. Costs

The whole of life costs for a typical hockey national standard field (6,500m^2) when considering the capital including contingency of 12.5%) $1.2m, maintenance $12,000 and replacement costs allow $40,000 annually.

4. Hockey Australia's guides

Hockey Australia has published a number of Guides that support local government and Hockey clubs/Associations while they are currently updating their facilities. These are all available at the Hockey Australia Facilities Hub.

2.8 Rugby League

Rugby League in Australia and New Zealand is controlled under their national governing body, namely the National Rugby League (NRL) in Australia and the NZRL in New Zealand.

The International Federation for the sport, the Rugby League International Federation (RLIF) currently seems to have limited scope in relation to synthetic surface governance.

Photo 13: Australia's first Rugby League only field in Blacktown (NSW)

The UK's governing body for Rugby League, the Rugby Football League (RFL) have embraced the technology and set standards which have been used at both community and stadium/professional level. In Australia, the National Rugby league (NRL) has worked with the English RFL and has adopted their standards and enhanced them for Australia.

1. Standards for the sport

The original Rugby Football League (RFL) standard based on the European Standard EN 15330-1: Surfaces for Sport Areas has been modified for the specific requirements of Rugby League in 2020. The standard considers the results of a comprehensive study into the performance of natural grass pitches.

Recognising that many artificial turf Rugby League pitches will also be used for Football or Rugby Union, the NRL is updating its current standard, which should be issued in the middle of 2020. It will align with the requirements for FIFA and World Rugby Regulation 22 wherever possible.

Similar to the FIFA Quality Concept, the NRL performance standard recognises requirements for community and stadium use. Products suitable for Rugby League play must pass initial laboratory approval before being allowed to be installed and tested in the actual field application.

The NRL standard specifies two categories of performance: The category called 'stadium' is intended to replicate the characteristics of high-level natural grass as found in well maintained stadium settings.

Surfaces meeting the 'stadium' category are intended for use in professional matches and training. The second category, called 'community', which has a wider acceptance range than the stadium category, is supposed to replicate the characteristics of good quality community natural grass fields.

Whilst community pitches shall be retested every two years, stadium pitches require a field retest on an annual basis.

In general, community grounds have to sustain a much higher level of use compared to stadium pitches that are predominantly used for competition matches and professional training. In this respect, the NRL categories 'stadium' and 'community' are comparable to the FIFA Quality PRO and Quality marks.

2. Product licensing

There is no product licensing presently in Australia or by the world governing body.

3. Costs

The costs of a Rugby League standard field are similar to that of Football and Rugby Union and for a typical 9,120m^2 field of play. The capital costs would be approximately:

Initial Capital Cost of Synthetic Surface Installation		
1. Type of synthetic field of play (sports name)		**Rugby League**
2. Size of area of field		**9,120m^2**
3. Field Planning and Procurement Costs	**per m^2 / lin. metre**	**Total cost of field**
Detailed site survey	**$5,000.00**	$5,000.00
Geotechnical investigation	**$9,000.00**	$9,000.00
Technical Specification and Design Package	**$40,000.00**	$40,000.00
Procurement	**$15,000.00**	$15,000.00
Project Management	**$25,000.00**	$25,000.00
Approvals i.e. Development Approval	**$10,000.00**	**$10,000.00**
Field Planning and Procurement Costs Sub-total		**$104,000.00**
4. Synthetic Field Direct Costs		
Site establishment, documentation and project management	**$100,000.00**	$100,000.00
Disposal of spoil	**$50.00**	
Sub grade works	**$40.00**	$364,800.00
Drainage, gutters and concrete works	**$200,000.00**	$200,000.00
Base pavement (e.g. road base)	**$20.00**	$182,400.00
Additional costs to offset site challenges (see Part 2 Section 6)	**$0.00**	$0.00
Synthetic sports surface and infill	**$43.00**	$392,160.00
Shockpad installation	**$24.00**	$218,880.00
Other (if required)	**$0.00**	$0.00
Pitch Sub- total		**$1,458,240.00**
5. Synthetic Field Indirect Costs		
Field fencing / gates	**$150.00**	**$54,000.00**
Field lighting	**$175,000.00**	**$175,000.00**
Player benches / shelter	**$12,000.00**	**$12,000.00**
Equipment (i.e. shoe cleaning)	**$2,000.00**	**$2,000.00**
Retractable Netting	**$50,000.00**	**$50,000.00**
Spectator Seating	**$45,000.00**	**$45,000.00**
Pathways	**$85.00**	**$98,328.00**
Goals	**$4,000.00**	**$8,000.00**
Maintenance machinery	**$18,000.00**	**$18,000.00**
Marketing and Communications	**$10,000.00**	**$10,000.00**
Other (e.g. drinking water etc.)	**$2,500.00**	**$2,500.00**
Ancillary costs Sub-total		**$474,828.00**
Contingency Allowance	*12.0%*	**$244,448.16**
PM Costs	3.0%	**$61,112.04**
Total investment		**$2,342,628.20**

Table 13: Initial Capital Costs of Synthetic Surface Installation

The expected Whole of Life costs of the fields would be:

Whole of Life Costing Amortisation			
Whole of Life Costings	**1-10 years**	**11-20 years**	**21-30 years**
Capital Costs	**$2,342,628**		
Maintenance Costs	**$440,000**	**$880,000**	**$1,320,000**
Replacement costs (at yrs. 10,20 & 30)		**$892,248**	**$1,551,736**
Total WOL (over 10, 20 & 30 years)	**$2,782,628**	**$4,114,876**	**$5,214,364**
Total M&R (over 10, 20 & 30 years)	**$440,000**	**$1,772,248**	**$2,871,736**
Annual Whole of Life Cost Average	**$278,263**	**$205,744**	**$173,812**
Annual Maintenance and Replacement Average	**$44,000.00**	**$88,612.41**	**$95,724.53**

Table 14: Whole of Life Costs

2.9 Rugby Union

Rugby Union has historically been played on grass, despite several proposals over the years for alternative solutions, including clay, shale, sand and the Second- Generation artificial grass. All presented a similar problem of critical head fall and skin abrasion.

Photo 14: Rugby Union playing on Blackman Park, Lane Cove, NSW (installed by Team Sports, 2013)

In the past half-decade, synthetic turf technology has provided proven solutions for rugby, and the rugby world has embraced this because of its benefits for increasing participation, quality of play, and consistency.

[23] IRB Artificial Rugby Turf Performance Specification One Turf Technical Manual

24 Regulation 22: Standard relating to the use of artificial rugby turf

1. Rugby Union standards

To ensure the quality and consistency of the surface, World Rugby developed the Artificial Rugby Turf Performance Specification[23], in consultation with FIFA. This standard was integrated into the Game Regulation 22[24] and provides guidance on how it can be used for the game.

World Rugby has only one standard for synthetic turf that applies to both community and stadium use. Similar to the FIFA performance standards, World Rugby has identified three basic categories that are broadly defined as:

- Ball/surface Interaction: The reaction of a ball to the surface
- Player/surface Interaction: The reaction of a player to the surface
- Durability: The resistance of the surface to wear and tear and the environment
- The performance criteria can be sourced at www. http://playerwelfare.worldrugby.org/

World Rugby in 2024issued their Thought Leader Report "Rugby and Climate Change – Projected impacts on Rugby in a +2°c world"[25]
Australian Senator and former Wallabies Captain, David Pocock states in it, "Climate change is no longer a future threat to our communities. It is already here." Climate change impact on sport means that the way we design and standards we require need to be specific to our Australian climate and we can not rely purely on the International Federation performance standards to do this. We need to understand the impact of the science and then how to proven landscape approaches can impact our thinking and design to reduce impact on players, spectators, field and stadium.

World Rugby Preferred Turf Producer

The following companies are Preferred Turf Producers (PTP's), and a full updated list can be found on the World Rugby website (www.irbplayerwelfare.com):

- Edel Grass B.V. (N/A),
- FieldTurf Tarkett SAS (Turf One),
- Greenfields B.V. (HG Sports Turf),
- Limonta Sports C.P.A. (Greenplay Australia), and
- Polytan.

[25] Rugby for Nature | World Rugby
[27]https://www.itftennis.com/en/about-us/tennis-tech/recognised-courts/

Field Installations

Over the past few years, global adoption of synthetic turf for Rugby Union has progressed significantly, with countries such as Canada (3 fields), China (1), Hong Kong (3), France (23), the United Kingdom (15), and New Zealand (8) installing the surface. Within Australia, there are a number of competition fields, including Blackman Park, Lane Cove, Randwick (x 2), Moore Park, and Woollahra.

2. Cost

The costs of a Rugby Union field are very similar to that of a Rugby League field (see previous costs, Section 2.9.2).

2.10 Tennis

The International Tennis Federation (ITF) has developed a series of 'Court Surface Association Programs' that categorise the courts' speed and quantify the installation's quality. Irrespective of the surface type, the two programs explore the pace of the surface through the ITF Court Pace Classification Program. The ITF Recognition Program allows for both products to be tested against the Court Pace Classification Program and individual courts can be rated.

3. Types of surface

The types of surfaces that the ITF recognises have been classified in their publication ITF Approved Tennis Balls, Classified Surfaces and Recognised Courts. A Guide to Products and Test Methods[26] and are summarised in 15 below.

Surface code	Type	Description
A	Acrylic[1]	Textured pigmented, resin-bound coating
B	Artificial Clay[2]	Synthetic surface with the appearance of clay
C	Artificial grass[2]	Synthetic surface with the appearance of natural grass
D	Asphalt[3]	Bitumen-bound aggregate
E	Carpet	Textile or polymeric material supplied in rolls or sheets of finished product
F	Clay[4]	Unbound mineral aggregate
G	Concrete[3]	Cement-bound aggregate
H	Grass	Natural grass grown from Seed
I	Other	e.g. Modular systems (tiles), wood, canvas

Table 15: ITF Approved Tennis Balls, Classified Surfaces and Recognised Courts

Notes: All surfaces may be porous or non-porous, with the exception of 'clay' and 'grass', which are always porous.

[1] Normally forms only the uppermost few millimetres of a court.

[2] "Appearance" relates only to the form of the uppermost surface material and no other characteristics (e.g. colour). These surfaces typically comprise a carpet matrix dressed with clay, sand and/or rubber aggregate.

[3] Used only when the material itself forms the playing surface. When used as a base for other surfaces (e.g. acrylic), reference will be made only to the playing surface.

[4] This term denotes a type of surface that is constructed from naturally-derived materials and includes unbound sand or clay.

ITF Court Pace Classification Program.

To assist clubs and tennis organisations in selecting the surface most suited to their requirements the ITF Court Pace Classification Program identifies the surface into one of five (5) categories:

Slow	≤ 29,
Medium-slow	30 – 34,
Medium	35 – 39,
Medium-fast	40 – 44, and
Fast	≥ 45.

Photo 15: Andy Murray Returns a Shot at The Australian Open on the Cushioned Floor (Source: Martin Sheppard)

The court pace is established by using a simple test[28] which records the velocity before and after the bounce. The increased smoothness of the court surface increases the speed of the ball, and similarly, the rougher the surface, the more it slows the ball down.

[28] ITF Approved Tennis Balls, Classified Surfaces and Recognised Courts – A Guide to Products and Test Methods

Additionally, the higher a bounce a surface produces the slower the court will be because players have more time to reach the ball. Both of these factors are reviewed.

A product that has been tested in an ITF Accredited Laboratory (on-site or in a laboratory) is included purely on the Court Park Rating and is classified for three (3) years. This list can be seen as part of ITF's website (www.itftennis.com).

ITF Recognition Program

The ITF Recognition Program is targeted at those venues where the standard of play demands the specification of precise playing characteristics. Although the ITF states that this may include regional tennis centres or where national/international tournaments may be held, it is just as relevant as the quality control process to ensure that the court standards and pace required have been delivered.

There are two levels of recognition, which, according to the ITF[29] guidelines state:

i.) One-Star ITF Recognition, and
ii.) Two-Star ITF Recognition.

The ITF Recognition Programme is targeted at those venues where the standard of play demands the specification of precise playing characteristics, e.g. at international tournaments and national or regional tennis centres.

- One-Star ITF Recognition

Key installation properties of a court must meet ITF recommendations, which include a visual inspection to identify any cracks or gaps in the surface and to confirm that the appearance is uniform. Any bumps or dips in the surface are measured and the slope and planarity of the court are established. Finally, the positions of the court markings and net are checked to ensure they are within acceptable limits.

- Two-Star ITF Recognition

In addition to the One-Star ITF Recognition process, the Court Pace Rating is compared with the ITF Classified value for the surface product. Therefore, only surfaces that have obtained ITF classification can be tested for Two-Star ITF Recognition. If the surface product is not classified, the supplier can apply for ITF classification using the results of the on-site Two-Star Pace Rating test.

- Applications and Validity

An application for ITF Recognition can be submitted by any party with interest in the tennis facility, such as the owner, the organiser of a tournament held at that facility, or the supplier or installer of the court.

ITF Recognition expires when the court is resurfaced or after 10 years, depending on which is sooner. However, the results are only valid on the day of testing, as properties of the court may change due to factors such as ambient conditions, use and maintenance[30].

Therefore, if the venue is used for high-level competitions annually, it should be re-tested accordingly.

The application for ITF Recognition can be submitted by the installer, court owner (e.g., Local Government), tennis club or peak body (e.g., Tennis NSW, etc.), or tournament organiser.

If successful, the results for the venue and courts will be published on the ITF technical website for a One-Star Recognition. If a Two-Star is established, the product brand name will also be displayed.

ITF Recognised Supplier or Installer

Suppliers who have obtained a certain number of ITF Recognition awards for their courts will be awarded Elite ITF Recognition Supplier/Installer status in recognition of their continued quality of products and workmanship.

The two levels are:

- Elite Silver Level – for 10 or more installations as either an installer or supplier and
- Elite Gold Level – for 50 or more installations as either an installer or supplier.

Within Australia, the governing body of tennis is Tennis Australia (www.tennis.com.au).

4. Costs

The following table provides an estimate for the typical costs for the above systems.

Acrylic System	Rate (/m^2)
Multi-layered acrylic system	$12.50 – $14
Liquid applied cushioned acrylic system	$50
Prefabricated acrylic system	$50 – 70
Gel system	$55

Table 16: Expected Costs of Acrylic Surface

2.11 Multi-Sport and Multi-Games Areas

With the changing trends from traditional community sport participation to active recreation, coupled with the growing sedentary lifestyles of adults and especially children, new facilities can and should be developed to encourage increased play for children and young people.

Photo 16: Multi-games area, used for schools and local parklands

The development of Multi-use Activity Zones has taken traction in Europe and is now starting to gain interest in Australia. Many local governments have embraced the multi-games areas where the designs have evolved around youth play areas and multi-sport play areas.

These Multi-Use Activity Zones are colourful and encourage greater usage but are not designed to meet any performance standards, just safety standards.

1. Multi-Sport standards

There are a number of multi-sports and multi-games area guides or standards including:

One-Turf Standard

Aimed at the long turf (3G) sports of Football (Soccer), Rugby Union and Hockey (Multi-sports standard).

In Australia, the common approach is to utilise the individual 3G Football codes of Soccer, Aussie Rules, Rugby League and Rugby Union. By identifying specific additional requirements around durability, porosity, environmental mitigation strategies and design parameters.

The One-Turf standard can be sourced from Word Rugby Player Welfare site[31]

Gen 2: Multi-sports Areas – Sports Pitch Design Guideline

Focussed on combining the sports of Hockey 5's, Netball, Tennis with others such as Futsal, mini-soccer, Lacrosse, Softball, Korfball and fitness/athletics training. This new standard (2020) allows for the integration of these key short pile surfaces to meet the needs of the sports.

This can be sourced from: FIH Facility Guidance

Multi-use Games Areas

Many of these developments do not use any design, guidelines or surface standards, and aim at meeting the recreational needs of many 'sporting activities' which may include 3 on 3 basketball, netball, 5-a-side football, hockey 5's, fitness training. It is important that if there is a chance that older children or adults will use these multi-use areas, then the safety of the surface should be considered by exploring embracing the Gen 2 – Sports Pitch Design Guidelines approach.

Photo 17: Football and Hockey field (source: Team Sports)

In Australia there is only one published standard to date that formally combines two sports and that is the AFL/Cricket Australia community surface standard. The reality of this standard is that it is predominantly for Aussie Rules, as the cricket wicket has no standard, just the outfield.

Photo 18: Multi-sports field Moore Park, NSW (source: Centennial Parklands Trust)

The benefits for the client or purchaser will be that they can program many sports at different times of the year, which could be very beneficial. Although there is a common standard, known as the 'One Turf' standard, it has not been embraced in Australia.

2.12 Conclusion

The challenges facing both sport and government relate to satisfying the growing demand, as the population continues to grow. Embracing the synthetic sports surface technology around single sport, multi-sport, recreational and elite surfaces allows for increased usage.

There are a range of technological solutions that meet the majority of play, recreational and sporting needs. This is reflected in the number of schools who are embracing the technology to replace asphalt and seeing the results of a growing number of children enjoying playing on the new surface.

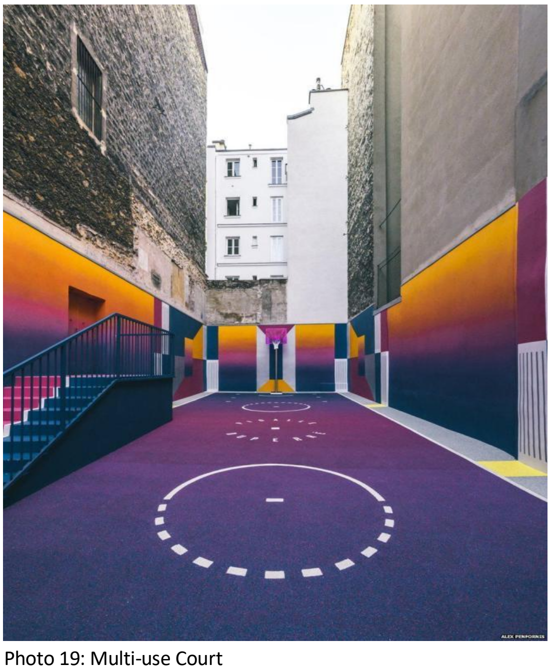


Photo 19: Multi-use Court

Multi-use sports or Active Sports Zones are becoming increasingly popular for encouraging casual sports recreation by combining facilities where many sports can be played locally, such as 5-a-side football, basketball, netball, cricket, etc.

The International Federations have all embraced the technology and established the base standards that need to be achieved for community fields. Smart Connection Consultancy believes that for Australia, their base standards need to be enhanced in some areas to meet the Australian conditions, especially around durability, UV radiation and porosity.

3. Performance Standards for Surface Type

3.1 Synthetic Sports Turf (Football Turf)

System Components

The quality of the playing surface's performance is influenced by the components that make up the overall synthetic sports turf system. All of these components are as important as each other, with the civil-engineered solution for the pavement and drainage probably more important than any other aspect in the long term.

The 'system', as it is commonly referred to, consists of the pavement, base and drainage solution which the performance surface sits upon. The performance grass system which has the synthetic carpet (yarn, backing and infill) as well as the shockpad.

3.2 Synthetic Turf Yarn

1. Yarn manufacturing

The synthetic turf aspect of the system uses yarn developed through an extrusion process from a combination of polymers to provide either a softer polyethylene-based fibre or a slightly harder polypropylene fibre. The first generation was made from nylon (polyamide) yarn, which was prone to friction burns due to its coarse nature.

Photo 20: Extrusion Process Producing Mono-Filament Yarn

The current manufacturing process produces one of two forms of yarn, a monofilament single thread of yarn or a slit-film tape, commonly known as fibrillated yarn. The process for both types of yarn includes taking the raw materials, namely the polyethylene polymer (which is almost exclusively used for long grass fields) with the colour and melting them in an extruder.

The melted and coloured material is then either pushed through a spinneret (similar to a thick spaghetti maker) to the shape of the monofilament and then cooled, or formed into a film, cooled and then perforated in a fibrillated tape.

The mix of polymers follows the above process. The formulas of the polymers are proprietary intellectual property of the yarn manufacturers as they strive for the right balance between fibre rigidity (to keep the fibre upright) and softness for feel and skin/player interaction.

2. Yarn manufacturing parameters

The key variables that need to be considered with the yarn include:

- **UV Resistance**

As Australia has one of the most aggressive climates with one of the highest UV levels in the world, it has a direct impact on the longevity of the synthetic turf system. The yarn should be provided with a warranty against UV. Some cheaper yarns that are being imported into Australia may not have been tested to the appropriate levels needed, and this should be considered. The UV stabilisation is a big part of the yarn cost and is tested using a QUV machine that exposes the yarn to high levels of artificial UV light and, combined with artificial weathering (heat, light, rain, etc.), simulates eight years of exposure. This now involves 5,000 hours of testing.

The Australian standard that the surface needs to adhere to is AS2001-4: B02-2001 for minimal UV degradation.

- **Colour Fastness**

Extensive weathering, such as heat, rain and wind, can impact the colour fastness of the pigments in the yarn. When combined with intensive play, the pigments, if not stabilised with the yarns' polymers, can cause accelerated breakdown. In some earlier yarns (pre-2002) the use of heavy lead pigments (e.g. lead chromate) was used. The key manufacturers in the late 1990's embraced the EU Packaging Directive removing heavy metals from recycled plastic packaging products (1994). Some cheaper imported products may not have embraced these standards. It is important that any purchaser of synthetic surfaces ensures that this is adhered to by the supplier.

The Australian standard for colour fastness in artificial light, which can be used to test colour fastness, is AS2001-4 BO2-2001, which also addresses minimum UV degradation.

The safety of the colour pigment is not addressed by any Australian standard, and the European DIN standard 18035 states that the levels should be:

Heavy Metal	Acceptable Level	Units
Lead	<0.04	mg/L
Cadmium	<0.0005	mg/L
Chrome Total	<0.05	mg/L
Mercury	<0.001	mg/L
Zinc	<3.0	mg/L

Table 17: Acceptable Heavy Metal Levels (Source: DIN 18035)

- **Length of Yarn**

The length of the yarn is determined by the purpose of use, whether that is 11mm for Hockey, 60mm for Rugby Union, or 220mm for synthetic horse racing tracks. Some sports determine the length of the yarn (e.g., Rugby Union at a minimum of 60 mm), while others focus on the performance outcomes only.

Sport	Normal Range
Bowls	10mm - 15mm
Football (11-a-side)	50mm - 60mm
Football (5-a-side)	20mm - 60mm
Rugby League	60mm minimum
Rugby Union	60mm minimum
Tennis	10mm - 25mm
Australian Rules	50mm - 60mm
Hockey	10mm - 45mm
Cricket Wicket	9mm - 12mm

Table 18: Example Of Yarn Height Ranges For Each Sport

From experience, we have found that with a football field with a 40mm-50mm yarn, the disbursement of the infill being 'kicked out' has meant that the infill 'disappears' down to the sand quickly. So, we would suggest a minimum of 50mm length for large ball sports.

There is a balance between the thickness of the yarn, which may assist with its ability to remain standing and the softeners of a slightly thinner yarn. Over the years, manufacturers have tried many sorts of yarn types to optimise the balance of thickness and softness to polymers.

- **Yarn Extrusion Options**

When the yarn is extruded, there are normally five (5) broad options:

- ***Monofilament fibre*** – a single length or blade which tries to replicate that of a single blade of natural grass. A grass with this yarn would normally have a greater amount per square metre. It is also renowned for staying upright longer and being more durable.
- ***Fibrillated yarn*** – the yarn is produced in a sheet (slit-film sheet) then cut to the width desired, so the texture has more uniformity than the single blade of the mono-filament yarn with the superior turf bind and economies of a fibrillated yarn.
- ***Hybrid system*** – some manufacturers are offering a combined yarn system that offers the aesthetics and durability of a monofilament yarn with the superior tuft bind and economies of a fibrillated yarn.
- Knit-de-knit – straight yarn that is given the tight curly appearance for hockey pitches, producing a non-directional surface.
- ***Texturised*** – straight yarn that is heat-set to produce a tight curly appearance, which is non-directional to meet the needs of hockey. This approach is also used for the "thatch" part of the 'grass-system' mainly for landscape grass, reducing the need for infill.

- **Cooler Grass Technology**

Most of the manufacturers have a proprietary approach to the reduction of the heat retention in the yarn; some claim by 20-30%. This is worth considering when purchasing. It is always worth considering the question 20-30 percent of what? This reduction normally occurs because the polymers in the yarn are able to reflect infrared and dissipate heat into the atmosphere, as opposed to absorbing them into the yarn.

- **Pile Weight/Density**

Identifying the quality of yarn within a square meter, using the number of stitches and the gauge manufacture. As a rule, the tighter the pile, the higher the price. The linear density is a measure of the weight of the yarn and is referred to as the 'Denier'.
This should be linked to the type and use of a shockpad.

3. The carpet backing

The backing material is critical as it holds the tufted or woven yarn in place but also needs to be durable enough to hold the field in place, so there is no shrinkage or expansion. It is also critical for connecting each roll of grass on the field, allowing water to pass through the surface.

The tufted yarn option is predominantly tufted through the backing, and the yarn needs to have a coating or glue-type bonding agent so that the tufts cannot be easily moved or pulled out.

The most commonly used coating is a polyurethane (PU) bonding agent due to its superior water resistance. Latex, thermo-plastic coatings, natural rubber and other bonding agents can also be used. The porosity of the backing is normally achieved in one of two ways; either using a heat soldering hole and puncturing across the roll of grass, or having the polyurethane backing only attributed to the yarn tufted areas and the space in between the tufts is therefore more porous.

The majority of carpet backing is double-backed, with the 'second backing' sprayed on to seal the carpet tufts. Some manufacturers only 'seal' the turf and gauge, leaving the space between not double-sealed, allowing for greater water porosity. The pictures below provide an understanding of the two key options.

The water porosity through the carpet backing must be achieved for the key sports. For instance, in Football (Soccer), the FIFA guidelines are 180ml per hour. In Rugby Union, the World Rugby guideline is 500ml per hour, whilst Australian Rules (AFL) is 200ml. Smart Connection Consultancy recommends all pitches should have a porosity rate of 500ml per hour. It is important to design drainage rates to cope with this. The important aspect is that the drainage system needs to be able to cope with the level of rain that the porosity requires.

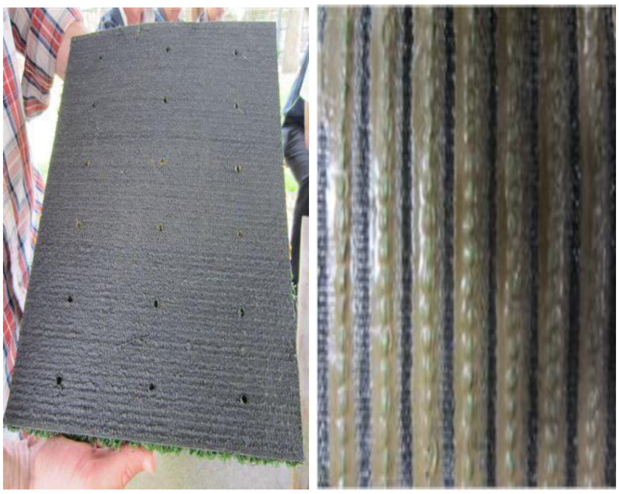


Photo 21: Examples of Backing Surfaces

4. Carpet seams and joining

The carpet is normally created on rolls of 3.2m-4.5m in width and these are laid width wise across the field. The 'straight lines' are normally integrated when woven, and the circular lines are laid at installation.

Any other straight seams are usually secured by sewing or using an adhesive, depending upon the manufacturer's system. The important point is that the carpet should be seamless and have a maximum possible joint strength.

The adhesives used should be proven in Australia and are not considered volatile in adverse weather conditions (e.g. heat, rain, wind, humidity etc.). The FIFA assessment standards (Quality Manual – 2015) state that as part of the certification process that a visual inspection will be conducted to ensure that there are no significant defects, these include:

- Failed or excessively open joints (greater than 3mm)
- No looped pile

Photo 22: Example of Seam Failure

3.3 Infill

The infill within the 3G long grass synthetic turf aims to provide a consistency between the ball, player and surface interaction that allows the synthetic system to perform to the required standards set by each sport (e.g. FIFA, World Rugby etc.).

There are a number of aspects that need to be considered when choosing the most appropriate infill for a sports field, including:

- The type of infill for the surface;
- The depth and height of the infill compared to the yarn and
- The amount of infill per m^2.

1. Purpose of infill

The infill, or lack of it, is needed to assist the performance of the whole synthetic grass system, which ensures that the infill plays a similar role as the soil in natural grass fields. The different types of grass surfaces that are commonly categorised are as follows:

Unfilled

Although the first nylon pitches in the 1960's were unfilled, the pitch systems are far more sophisticated now-a-days. Water is used predominantly for hockey's premium standard – global. Water is applied through an irrigation system immediately prior to play, increasing the speed of the ball interaction with the surface. Technology is now looking for infilled fields that have similar playing conditions as traditional water-based pitches. Many are sand-dressed instead.

The next generation of football surfaces with no performance infill is being used in Europe. In some Central European countries (Austria and Switzerland), these have been used for the past two decades, with growth in Germany, Scandinavia, and France. The performance infill is replaced with a heavy 'Thatch' of yarn; the amount of yarn is linked to whether the surface is sand-dressed or has no ballast at all.

The important consideration is that FIFA and World Rugby have not recognised these field Systems as acceptable for certification. We would not recommend these field systems for competitive yarns or Rugby at all. These surface types may be considered for recreational use.

It is our strong view that these should be a sand dressing and only used for recreational usage until the next integration is developed to meet the safety and performance needs of specific sports.

Sand-Dressed

Dressed synthetic surfaces aim to add weight to the carpet to keep the denier pile upright while also maintaining hockey playing standards. Some football (soccer) 5-a-side/futsal courts use this type of system, which seems to provide a more durable solution for people using flat training shoes.

Photo 23: Example of a Mixed Profile of Sand And Rubber Infill

Filled Fields

The aim of the filling is to replicate the sand or soil profile in a natural pitch where the grass/synthetic yarn is held upright. The filling can be compiled from rubber, sand or organic infill's. The amount of fill is normally determined by the manufacturer when they consider the length of grass yarn, the performance outcomes, the shockpad and the purpose of the field. For instance, rugby union has to be at least 50mm, whilst hockey can be around 11mm.

2. Type of infill

In the past 2-3 years, there has been a significant change in direction regarding the type of infill used in 3G fields. Recent European legislation has provided the industry with a lifeline to change from rubber/plastic infill to organic. Although this legislation is not global, there is encouragement for ANZ to adopt organics moving forward.

There was good environmental benefits of rubber infill, with approximately 20,000 recycled tyres being used for a standard football field (9,000m²). On reflection, this benefit is outweighed by the microplastic migration impacts on environmental health if the field isn't designed well.

Organic Infill

There seems to be some experimentation using organic or natural infills by a small number of companies. The mix of the organic infill may have a bearing on other considerations. The basic approaches seem to be:

i.) **Cork infill** – allowing the cork to be stripped from trees (every nine years) and then used as a top-up type infill with similar rebound qualities as the larger rubber patches. As it takes on a small amount of water, it will not break down as quickly as other organic infills. It is cooler when wet than rubber, stable and retains its shape. The marketing rationale from a key supplier states that it has 12 million air cells per cubic cm.

ii.) **Cork/organic infill** – allowing less cork with other plant/organic compounds such as coconut husk etc. There seems to be more concerns about this combination due to:

- The plant/organic compound breaking down quickly with the typical level of use that Australian LGA's programme their pitches (e.g. 40-60 hours).
- Additional maintenance cost due to compaction and possible organic growth with plant substance.
- Additional cost of continual replacement and top-up.
- This option, in Australia's climate, also needs to be watered regularly, as it will turn to dust as the natural fibres break down.

Photo 24: Organic Infill (Source: Limonta)

Having the organic infill could be a significant operational cost, which could be an additional $10,000-$20,000 p.a. Many people see the benefit of this.

- **iii.)** **Woodfibre Infill** – most companies now have a propriety product from the USA, which has been treated and smoothed to ensure that is playable. The benefit of this type of wood fibre is that it absorbs the water, which means that it is slightly heavier than water and, once wet, holds the water longer, keeping the playing field cool.
- **iv.)** **Other organics** – other organic infills are available to Australia, including walnut husk, olive pips, and corn husk, among the initial options.

Crumbed Rubber (SBR)

This is the most popular infill in the Asia Pacific region, probably due to the cost-effective price point. It is derived from recycled truck tyres that are ground up and recycled. Two types of crumbled rubber are used – ambient and organic. They are both predominantly metal free, and according to the United States Synthetic Turf Council's (STC) Guidelines for crumb rubber infill should not contain liberated fibre in the amount that exceeds 0.01 percent of total weight of crumbed rubber.

Recycled and shredded rubber is normally 0.5-2mm in size, is the least expensive and still provides the necessary sliding and shock absorbing qualities. The shredding of the rubber is normally completed mechanically. Sifting technology is used to ensure that the dimensions are correct. The benefits are that it is recycled, economical, UV stable and has a long-life span.

The black rubber has, according to the UK's Sport and Play Construction Association's (SAPCA) independent Consultant polymer chemist, Dr Bryon Willoughby, been "selected to offer optimum performance in a demanding application which requires strength, fatigue and abrasion resistance". SBR is a general-purpose rubber.

Both the ambient and cryogenically shredded rubber can be coated with obscurants, sealers or anti-microbial substance if required. This approach provides a great aesthetic appeal, but the additional cost may not justify it for may LGA's. From examples in Australia, these coated infills have not been successful.

Sands

Silica sand is the preference for sports fields due to the rounding of each particle, as opposed to the sharpness of natural sand, as you would find on the beach. This sand is chemically stable, fracture resistant, non-toxic and is rounded.

Photo 25: Silica Sand (Source: www.flexsand.com)

It can be used by itself, as seen in some sites in Victoria and ACT, or in combination with rubber or organic infills. The STC recommends that the Silica sand be of a high purity of grains, more than 90 percent. This sand can also be coated with either a firm or flexible coating, normally elastomeric or acrylic, forming a coating that allows for different sizes depending on the system's needs.

TPE (Thermo Plastic Elastomer) or TPV

This is a new material that is heated and compressed into grains or various shapes for performance. Once cooled, it retains its new shape, is elastic in nature, and can also be recycled. According to various manufacturers, it has a long life and shows durability. However, there does seem to be some question about its suitability in hot climates over 40 degrees and its ability to retain its structural integrity.

This 'virgin plastic' infill is non-toxic, chemically stable, resists fading and is long-lasting. It can also provide the benefit of being recycled at the end of the "grass life". Providing a wide range of colours, TPE is often used in playgrounds, athletic tracks as well as for field infills. It has elastic properties; uniform shape and its virgin rubber and filling provide a high-performance infill option.

EPDM Infill (Ethylene-Propylene-Diene-Rubber)

This type of infill is produced from a polymer recovered from three monomers: ethylene, propylene and diene. It is manufactured new with options for various colours made to order.

Photo 26: EPDM Infill (Source: Smart Connection Consultancy)

It is odourless and offers consistent quality. It is often used beside playgrounds and on tracks as well as for performance infill. It is commonly coloured in light colours and provides a significant contrast from the traditional black SBR.

With recent global examples of EPDH agglomeration in warmer and high UV clients there is a view to move away from this option.

3. Future considerations for infill

As stated, the infill strategy will be moving towards organic from now, for Australia to embrace Europe's banning of SBE rubber and other intentionally added microplastics from synthetic sports turf, Australia is now only considering organic infill for its short and long pile grass surfaces.

Other considerations include:

- **Amount of Infill**

The amount of infill is determined by a number of technical and specific performance criteria and in a laypersons language, what we have been observing here in Australia is that with a good quality shockpad, it reduces the amount of infill needed in the carpet. This difference can be a reduction of 80% from 26km/m² to 4-5km/m², because of the shockpads quality.

- **Safety of Infill**

There has been community discussion around the environmental, health, and safety impact of some infills, which is covered later. To provide community comfort, we recommend that the rubbers used are virgin rubbers and have been assessed to EN71.3 (Table 2 Category III), which is Europe's Safety Standard for Toy Ingestion.

There is a move to adopt virgin rubber so as to move away from the recycled infills, which are the most economical option. The virgin rubbers predominantly add an additional 8-10% to the field project costs.

Europe has new standards (2020) that are aligned with the acceptable level of the eight most dangerous PAHs. All infill in Australia should have certification that it can achieve this level. Rugby League in the UK (and soon in Australia) is the first body to adopt this new standard.

The synthetic turf carpet must comply with the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations XVII Entry 50. The infill placed within the synthetic turf carpet should comply with the draft REACH restriction requirements of the European Chemical Agency (≤ 20mg/kg of the REACH 8-PAH's).

[32] Environmental Impact Study on Artificial Football Turf (Environmental Research and Consulting for FIFA: March 2017)

3.4 Shockpad

1. Shockpad considerations

The shockpad is a layer between the pavement base and the synthetic grass carpet. It is used by many suppliers to provide a degree of comfort, meet the sports' requirements for critical fall height and extend the life of the pitch.

The types and thickness of shockpads need to be considered as part of the overall synthetic surface system to ensure that the important requirements of international sports standards regarding shock absorption, energy restitution and vertical deformation are met. These requirements may not be met with the compaction of rubber infill.

There has been much consideration and numerous opinions and sales propositions put forward as to whether a shockpad for a synthetic grass field for football (soccer, rugby and AFL) is needed. Many experts believe that if the pitch is played on intensively, it is unlikely the playing characteristics will meet the sports performance standards over time if there is not a shockpad in place. The belief of the majority of Australian suppliers is that a shockpad is critical in the long term to achieve performance standards. Over the next couple of years, it will be interesting to explore how many FIFA Quality pitches have a shockpad that are re-tested and achieve the performance criteria, after three and six years.

In September 2014, the European Synthetic Turf Organisation (ESTO), which represents the majority of turf manufacturers, produced an information sheet with the following conclusion:

- "When a Football Turf (World name for synthetic football field) system is regularly and adequately maintained, all systems (with and without shockpad) did retain an acceptable level of performance; and
- Within the range of tested samples, we see that the systems containing a high-quality shockpad were likely to show less deterioration than those without a shockpad in cases where the maintenance was not done correctly."[33]

The question, therefore, is what needs to be considered when deciding on the type of shockpad, especially if the client feels less confident that they will be able to meet the exact routine maintenance obligations.

There are systems that have longer yarn and a denser rubber infill that provide an excellent case for why a shockpad is not needed. The considerations for when a shockpad is believed to be more important is when:

- The field is being used for high contact sports (e.g. Rugby and AFL)
- There may not be adequate maintenance (recommendation is 1 hour per 10 hours of usage)
- There is going to be intense use with flat soled shoes
- The sport stipulates that it is needed (e.g. Rugby Union)

2. Types of shockpad

The type and thickness of shockpads need to be considered as part of the overall synthetic surface system. This is to ensure that the important requirements of international sports standards regarding shock absorption, energy restitution and vertical deformation are met.

There are a range of shockpads offered as part of sports turf systems to the market of varying quality, which need to be carefully considered. The most important aspect of the shockpad is its ability to help the overall system meet its performance standards over time, not just the first carpet.

It is recommended that the shockpad be reused and, therefore, needs to be able to cope with the level of usage that the field will endure. This will be addressed in the warranty offered. The two considerations of the warranty should be the life expectancy and the usage parameters. The parameters must be fit for purpose, as it is no use having a 20-plus year warranty if that only covers 2,000 hours annual usage (38.5 hours a week) if the field will average 60 hours a week.

There are two kinds of shockpads:

i.) Pre-fabricated construction

There are many systems on the market, including roll-out pads, normally up to 10m in width, and prefabricated sheets, which, once laid out, can reduce the time of installation. The latest approach to the preformed shockpads is to allow for breathing in the pad for when they expand and contract.

Some shockpads are currently being developed with breathable channels which allow water through easier and trap air, making them cooler (according to the marketing literature). Tests are being held to ascertain the reality of this process. The challenge with these options is that it may reduce the integrity of the shockpad over time and secondly the channels may not be broad enough to cater for a specific rain event (e.g. 1 = 20 years etc.).

[33] Press Release – European Synthetic Turf Organisations Recommend Shockpads

Photo 27: Prefabricated Shockpad Being Laid (Source: Team Sports)

ii.) In-situ construction

This surface infill mix comes in a variation of thickness between 35mm and 10mm and consists of a polyurethane binder mixer combined with rubber crumb (SBR) or shredded rubber (e.g. soles of training shoes). The mix needs to be perfected with the infill for the system to be optimised.

World Rugby have stated in their performance standards that "shockpads are preferred'' and at a conference in New Zealand[34] said they would recommend a shockpad is used for their fields every time.

Loughborough University http://sportsurf.lboro.ac.uk identified that the binder (glue) percentage strength should ideally be between 12 percent and 16 percent when laying shockpads.

Photo 28: Insitu Shockpad Being Laid (Source: Polytan)

It is likely to conclude what industry experts have been saying for some time; that if a synthetic system does not have a shockpad, the level of maintenance needs to be higher and more consistent. The shockpad is providing more certainty of achieving the performance targets over time, particularly with the higher level of use.

3. Reuse of shockpads

If a shockpad is to be reused, which should be expected for at least two further changes of the carpet, as the majority of shockpads now offer a 20 plus year warranty, the pad needs to be able to demonstrate key performance characteristics. According to the FIFA Quality Manual (2015) it needs to be able to show:

- The shock absorption of the existing shockpad is between 90% and 110% of the shock absorption value declared by the manufacturer when the Football Turf system was initially type approved;
- The deformation of the existing shockpad is +2mm of the deformation declared by the manufacturer when the Football Turf system was initially type approved; and
- The water permeability of the shockpad is greater than 180mm/h when tested in accordance with EN 12616.

The shockpad must also be able to meet the following additional requirements (source: RFL Guide to the Use of Synthetic Turf Pitches for Competition and Training – 2020 Edition page 31).

Shockpads and Elastic Layers					
Tensile Strength	Shockpads and elastic layers less than 25mm thick	En12230	Unaged	≥ 0.15MPa	
				% loss in strength compared to unaged result	≤ 25 %
	Shockpads and elastic layers 25mm or thicker	FIH Hockey Turf and field standards Part 3 clause 8.A.1.2	Unaged	≥ 0.10 MPa	
			After air ageing	% loss in strength compared to unaged result	≤ 25 %
	Shockpads with channels and slots	FIH Hockey Turf and Field standards Part 3 clause 8.17.13	Unaged	≥ 0.10 MPa	
			After air ageing	% loss in strength compared to unaged results	≤ 25 %

Table 19: Shockpad Requirements

This is a new standard for Australia and should be included in all specifications for all football codes.

[34] NZRA Turf Conference (June 2013)

3.5 Playing Capacity Standards

The playing capacity of a typical community based durable synthetic sports field is between 50 and 80+ hours per week. The number of hours of play is linked to the level of maintenance. It is recommended that one hour of maintenance be considered for every 10 hours of play, depending on the intensity of use for each hour.

If the field will be used intensively and more than 50 hours per week, it is worth ensuring that the durability of the Lisport Test is more than the 20,200 requested by FIFA Quality Recommended Pitches. We recommend at least 80,200 cycles. Some quality yarn systems can cope with 200,000+ cycles on this test.

The usage strategy can vary from 20 hours for a traditional stadium up to more than 70 hours per week for a comprehensively programmed facility. The options may include:

- **Stadium usage**

Low use, around 20 hours per week for training a couple of hours per day and matches at the weekend. In this case a FIFA Quality PRO, FIH Global, RFL Stadium standard pitch could be used.

- **Club (medium) usage**

Medium use, around 30 hours per week and used for training (four hours per day) and weekend matches (five hours each day). The usage would indicate a higher durability need than the one identified in the FIFA Quality PRO Standard of 5,200 to 20,200 reps (FIFA Quality Manual: 2012 Lisport Test).

- **Club/mixed (high) usage**

Integrating weekday, evening, and weekend usage for matches allows organisations such as schools and community groups to use approximately 40 hours' usage.

- **Mixed (intense) usage**

Starting around 50 hours per week, requires greater durability with usage being opened to coaching sessions, club use and matches. Normally this diversity of use is programmed by the owner to ensure transparency and a rigour in the allocation of times.

- **Intense program**

Programming daily (9 hours plus) including weekend games. Many organisations may have usage that includes schools (at a nominal fee), lunch time recreational competitions, coaching sessions, club training and social competitions on weekdays, and matches on a weekend. Typically, a 60-hour week

- **Comprehensive program**

Developing the previous category to around 70 hours or above. There needs to be enough time built into the program for maintenance at this level.

3.6 Opportunities and Recommendations

The following opportunities and recommendations are made:

i.) The decision-making process on the priorities of which sport and fields should be used for synthetic sports surface technology should be holistic to achieve the needs of the whole Local Government Area or sport across a wide geographical zone.
  - The discussion points should be monitored annually to identify if circumstances have changed.
  - A three-year review should assess priorities against playing capacity/condition of each field, standards of play needed; economic conditions, growth of participation and strategic alignment.
  - The type of synthetic surface technology should be aligned with the needs of the sport, the durability /sustainability and the technology available at the time.

ii.) Where possible, multi-sports fields should be adopted to allow maximum community usage.
  - Where possible, Football (all codes) should be considered for any future design unless there is so much usage in one venue that it would only warrant a single sport.
  - Design fields for Football (Soccer) where the field can encourage match, training and recreational needs by including lines for half, quarter and 5-a-side Football pitches.
  - The standards for football codes to be used are listed below, and this should provide 40-45 hours a week of usage. To create more durable football turf, the Smart standards need to be adopted, which include a significantly high Lisport Test (≥200,000 cycles).
    - Football – FIFA Quality
    - Rugby Union – World Rugby Regulation 22
    - Australian Rules – AFL/Cricket Australia Community Facility standard
    - Rugby League – NRL Community Surface standard
    - Hockey – FIH National standard

iii.) Utilize the natural turf/hybrid turf technology for higher wear areas of key fields to allow all fields to be used for up to 30 hrs per week.
  - Explore the various Hybrid/Root reinforced systems for the identified fields.

- Develop a three-year strategy for adoption of hybrid/root reinforced technology to assist with the development of the fields to cope with continued demand.
- Conduct an EoI process with current and new companies looking to enter the market to maximise interest and minimise cost to Council or sport.

iv.) Develop fields that are environmentally friendly.

- Where possible, when procuring synthetic turf, request premium infill that will negate the negative perceptions around recycled SBR tyres.
- Ensure that the infill has been tested against the 'toy ingestion standard' EN71-03 Table 2 Category III.
- Encourage heat reduction technology to be part of the scoping strategy for the procurement of a synthetic system.
- If the infill is recycled car tyres, ensure that the batch of rubber used have been tested to REACH standards.

3.7 Hard Court – Tennis and Netball

Currently within the Australian market there is a wide selection of manufacturers and installers of acrylic products. Generally, the final outcome of an acrylic system will be highly dependent of the skills of the installer, rather than the product itself.

The intention of this Guide is to provide guidance on the various acrylic systems on the market for tennis and netball facilities, including maintenance and expected life cycles for the surface.

Acrylic surfaces are popular playing surface options for both tennis and netball facilities across Australia.

1. Standards and requirements

The governing bodies for both sports provide guidance on surface selection.

Photo 29: Testing Apparatus for Slip Resistance

Netball Australia assesses the performance of courts based on slip-resistant properties of the surface. There are two tests used to determine the slip resistance of an acrylic surface for a netball court:

- Initial Construction Test – AS/NZS 4586: 2004 Slip Resistance Classification of New Pedestrian Surface materials – British Pendulum Number for wet slip resistance testing of not less than 75
- Re-testing – AS/ NZS 4633: 2004 Slip Resistance Classification of Existing Pedestrian Surface Materials - British Pendulum Number for wet slip resistance testing of not less than 75

The International Tennis Federation (ITF) have developed a Court Pace Classification system to assist in determining speed and type of surface that is most suited for a facility. ITF classified surfaces do not imply any form of approval for the products.

For multi-use facilities (e.g. Netball and Tennis) it is important to consider the dominant sports when selecting the acrylic system to be installed. Netball surfaces typically contain a high content of sand to create surface with more grip to enable wet weather play.

2. Systems

An acrylic surfaced court requires the application of multiple layers of acrylic materials on an asphalt or concrete pavement. There are 4 main types of acrylic surfacing systems available in Australia:

- Multi-layered acrylic system
- Liquid Applied cushioned acrylic system
- Prefabricated system
- Gel system

The type of acrylic system selected should consider the following:

- Project budget
- Level and type of use for the facility (e.g. will the facility host tournaments)
- Local environmental and weather conditions
- Site conditions (e.g. reactive soil conditions)
- On-going maintenance requirements and associated costs
- Replacement costs
- User preferences

Multi-Layered Acrylic System

A multi-layered acrylic system comprises of 3-4 layers of filler and topcoat applied directly to the underlying pavement.

The advantages of this system are:

- Affordable option with comparable playing characteristics to other acrylic surfaces
- Lower resurfacing costs

The disadvantages of this system are:

- Does not provide any shock absorption to users
- Acrylic surface will crack with any cracking or movement of the underlying pavement Application timeframe is restricted to warmer months

Liquid Applied Cushioned Acrylic System

- A liquid applied cushioned acrylic system comprises of 8-12 layers of base, rubber filled resin and topcoat. This system provides a level of shock absorption through the rubber layers applied within the system.

Photo 30: Application of Acrylic System

The advantages of this system are:

- System provides a level of cushioning for

users The disadvantages of this system are:

- Application timeframe is restricted to warmer months
- Rubber cushioning may require topping up when resurfacing occurs

Prefabricated Acrylic System

Prefabricated (mat laid) acrylic systems consist of manufactured rolls of a rubber surface bonded to an asphalt or concrete pavement. A liquid applied acrylic product is then applied over the prefabricated mat.

The advantages of this system are:

- Can provide a bridge over moving/ cracked pavements
- More consistent performance due to manufacturing in a controlled environment

The disadvantages of this system are:

- Initial construction/ repair of worn areas/ resurfacing can be expensive

Photo 31: Installation of Prefabricated Mat System

Gel System

Gel systems are relatively new technology providing a cushioned court surface with a self-levelling applied gel layer.

The advantages of this system are:

- Gel layer is self-levelling to provide uniform thickness and ease of application
- Greater force reduction compared with other acrylic systems

The disadvantages of this system are:

- Lifespan in Australian climate is unknown due to limited installations

Photo 32: Application of Gel System

3. Maintenance

Generally, an acrylic surface has lower maintenance requirements than other outdoor surface options for both sports. To ensure the performance and longevity of an acrylic surface, it is recommended that a regular maintenance regime is undertaken and includes:

- Regular removal of debris and foreign matter
- Remove standing water to reduce risk of staining
- Annual high-pressure clean
- Repair of surface cracks to prevent moisture migration under acrylic surface
- Resurfacing of acrylic typically every 7-10 years

4. Expected life cycle

The lifecycle of an acrylic surface is heavily dependent on:

- Level of use
- Level of maintenance
- Standard of initial construction

The following table provides an overview of the expected life cycle for an acrylic surface:

Year	Activity
0	Pavement constructed
	Acrylic surface system installed
3 - 5	End of product warranty period
5 - 7	Resurface of acrylic surface
20+	Possible pavement reconstruction/ remedial works

Table 20: Expected Life Cycle of an Acrylic Surface

5. Costs

The following table provides an estimate for the typical costs for the above systems:

Acrylic System	Rate (/m²)
Multi-layered acrylic system	$12.50 – $14
Liquid applied cushioned acrylic system	$50
Prefabricated acrylic system	$50 – $70
Gel system	$55

Table 21: Typical Cost of an Acrylic Surface

3.8 Hybrid Technology for Football Fields

Hybrid Grass Systems are simply the combining of the positive properties of natural grass with the strength and durability of synthetic turf fibres into a single sports turf system. This will create a higher quality and more durable all year-round natural playing surface, combining the playability of natural grass with the durability of synthetic turf.
Forms of ‘hybrid grass systems’ have been around for over 20 years, particularly in Europe. Hybrid grass systems enhance the performance of a natural turf profile by increasing:

- Playing capacity of 30-40 hours per week
- Stability of surface and root zone
- Load bearing capacity
- Durability of the natural grass
- Consistent Playing performance characteristics
- Agronomic performance, (stability and uniformity)
- Bio-mechanical performance
- Professional playing surface longevity >15 yr.

The additional benefit of a hybrid system is that it aesthetically provides a partially green surface if the natural grass becomes worn through increased usage.
Some considerations in choosing a hybrid solution are:

- Modified maintenance regime compared to natural turf field to manage thatch levels and keep the fibres interacting with the surface;

- On excessively used fields, or where not maintained well, the synthetic yarn fibres can lose interaction at the surface. Where built up thatch or organic matter bury the fibres, resulting in a “false top” reducing infiltration, traction etc;

- Annual renovation is required to maintain the hybrid system's benefits and increase its playing life to more than 15 years.

Photo 3: Eclipse Stabilised Hybrid “Ready to Play Turf” (picture courtesy of HG Sports Turf)

There are predominantly two types of hybrid systems used to enhance natural fields of play, including:

- ***Mat System*** – where a mat, carpet, or grid backing (knitted, woven or tufted), similar to synthetic turf backing, supports the fibres, which are infilled with various growing mediums in which the natural turf is grown. Knitted and woven hybrid grass systems have very strong fibre anchorage to the backing whilst turfed systems are less so.
- ***Permanent Systems*** – where synthetic fibres are injected or stitched into the surface, not attached to any backing, with some of the synthetic fibre (20mm) standing proud of the pitch and stitched 200mm below the surface, with the natural grass growing between the fibres and the root system intertwining, or anchoring, around the buried fibres.

The hybrid system manufacturer should be consulted to determine the most appropriate system for use in each application and the natural grass species to complement the selected system.

1. Profile Reinforcement

In addition to the above hybrid systems, there is also a range of profile reinforcement systems. A profile reinforcement system incorporates synthetic elements within the growing medium to improve the structural performance of the profile, (i.e. reduce divoting). Example of these systems include:

- ***Fibre System*** – where various types of synthetic fibre and elastic material are mixed into the soil or growing medium homogenously and into which the natural grass is grown, providing root stability within the growing medium (e.g. sand or soil). Ideally replaced or replenished every 4 years.
- ***Mesh-based System*** – where either a mesh or shredded mesh is mixed into or placed in-situ into the root zone area, where the grass will grow.

2. Types of Systems

Mat, carpet, grid / ready to play systems

The mat, carpet or grid system can be 'built' into the field of play in-situ or pre-grown at a turf farm/ nursery and then brought to the field as a Hybrid Grass "ready to play" Turf System.
These systems can be incorporated into existing grounds or placed on sand-carpeted/constructed fields; however, some of the drainage performance may be restricted and would have to be evaluated on a case-by-case basis.
The mat system is filled with a growing medium, which could include sand, soil, organic components, to best allow the natural grass to grow in the local environment.

Photo 4: Xtragrass Hybrid Grass

Some hybrid mat, carpet or grid system backings are designed to partially biodegrade over time allowing the roots an open zone to grow down into the lower profile layer thus creating a very stable system that performs as one.

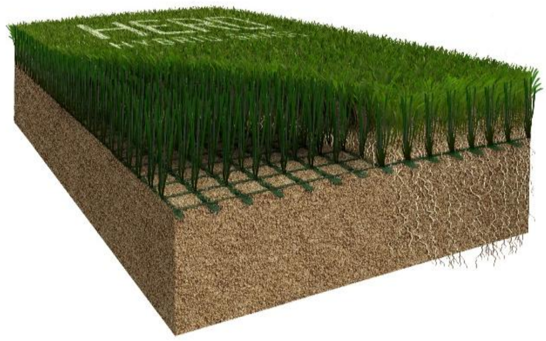


Photo 5: HERO Hybrid Grass

The finished surface presents itself as a mixture of synthetic grass fibres and natural turf.

Advantages

- Quick to install (if grown offsite as a ready-to-play system);
- Good for community and higher-use sports fields than natural turf due to its durable and robust construction;
- Good for stadiums where schedules do not allow annual renovation of the field.

Disadvantages

- Cannot be installed after turf is grown;
- Potential to impede on the performance of the playing surface profile growing medium due to mat backing;
- Should not top dress the system as this can bury the synthetic yarn.

Many global stadiums have installed these types of hybrid surfaces, including MCG, AAMI Park, ANZ Stadium, and Optus Stadium in Australia. Several stadia in New Zealand, including Eden Park, Westpac Stadium, and McLean Park Stadium, have also installed them. In Asia, these include Singapore National Stadium and Nissan Stadium, Yokohama.

At a local community level mat, carpet or grid backing Hybrid Grass installations completed in Australia are in high wear areas, goal squares, centre bounces, soccer boxes, linesman runs and cricket run-ups.

A number of councils have installed these systems, including:

- Casey Council – Casey Fields
- Monash Council – Brandon Park
- Hume City Council – John Ilhan Reserve
- Bayside Council – Dendy Park
- City of Port Phillip – Wattie Watson Reserve
- Whitehorse Council – Mont Albert Reserve
- City of Wyndham – Galvin Park
- Alexandra Football Club
- Carlton FC – Ikon Park

Photo 6: High Wear Area with Hybrid Surface in Goal Mouth (Source: HG Sports Turf)

Example of the mat, carpet or grid systems are:

- XtraGrass Hybrid
- HERO Hybrid Grass
- Mixto
- Desso Play Master
- Extreme Grass

Photo 7: Hybrid Carpet – Mixto by Limonta – www.mixtosystem.com

Permanent systems

The permanent systems involve the injection of fibres into the surface, which are approximately 20mm proud of the growing medium (sand, soil, etc.), with the synthetic yarn installed to a depth of 180mm below the surface.
The stitching process is ideally stitched straight after construction, before seeding allowing to ensure 100% is perfect. Although, it can be completed after seeding and after turf sods have been laid, e.g. San Siro, Milan Italy where they annually stitch into new turfMany stadiums globally have this type of system. Now the original patent has run out on the Desso Grassmaster, other companies are offering similar technology. The only current stitched field in Australia is Melbourne City Football Club's training venue at La Trobe University, Victoria.
These systems are normally only used in stadiums or high-quality Centres of Excellence and don't have the intensity of usage that community fields would normally have. A stadium field has time to renovate at the end of each season and can accommodate the capital costs over the expected life of 10 years plus.

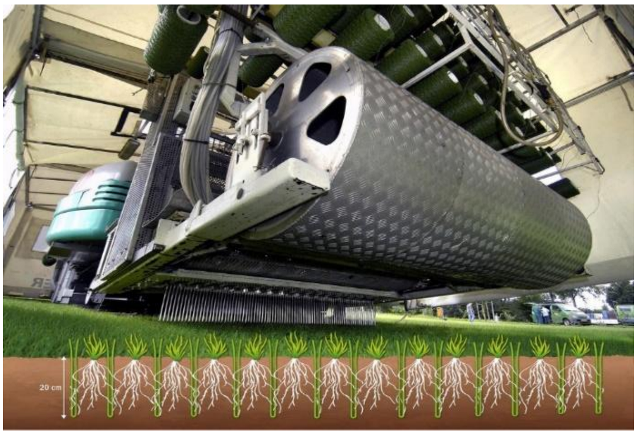


Photo 8: Desso GrassMaster System

Advantages

- Increased stability of surface and root zone;
- Uniformity and stability;
- Consistent playing characteristics from site to site, sport to sport, country to country;
- Increase playing capacity up to 30-35 hours per week;
- Can be installed with existing fields as long as the growing medium and drainage design meets the high standards needed. The US Golf Association Specification is the standard used to ensure that it's not stitched into native soils or fields with too organic rootzones;
- Does not impede on the performance playing surface profile growing medium;
- Desso GrassMaster machine stitching the yarn into the field and Melbourne City FC GrassMaster Pitch (pictures opposite courtesy HG Sports Turf and SPORTENG).

Disadvantages

- Cost for community fields but for stadiums the cost is offset against the standard of play and life expectancy;
- The event calendar of many Australian Stadiums would be a challenge as a window for renovation annually is needed. Alternatively, a quality Lay and Play system can be used to alleviate this intense usage challenge.

Typical examples in Australia:

- Melbourne City FC Elite Training Pitch – La Trobe University

Examples of the permanent system are:

- Desso Grassmaster
- SIS GRASS

3. Use of hybrid systems for community fields

Australia and New Zealand have started considering the adoption of hybrid technology for high-use natural turf sports fields for either the whole field or the high-use areas.

The high-use areas may include goal boxes, the halfway line, the 'kicking area' straight up and down between the goals or the line referees' areas on the touchline. High-use areas and training fields are also being considered to alleviate wear on primary fields.

Maintenance Commitment

Depending on the hybrid system, the maintenance regime is similar to that for a natural turf playing surface with some restrictions (i.e. slit aeration methods due to the integrity of the backing for mat systems) Annually it would be recommended that the following maintenance is considered:

- Fraise mowing – cleaning thatch and organic debris
- Vert cutting 15mm deep – opening surface and release buried fibres
- Limited top dressing
- Deep aeration with vertidrain
- Fertilization
- Over seeding/Grass re-establishment
- Irrigation and maintenance

3.9 Conclusion

The type of performance surface should be determined by the type of use, the intensity of programming or the performance level or requirements. If the surface is to be multi-sports, it is important that they relate to these standards.

4. Construction Standards

4.1 Introduction

When developing the construction standards, these will be driven by the design strategy and specifically need to address the following considerations:

- Location and site design standards
- Pavement design strategy
- Drainage strategy
- Construction standards

4.2 Location and Site Design Standards

Location Guidelines and Considerations

The location of the project is critical for the success and sustainability of the build, the funding, community embracement and stakeholder support. Understand the geographical areas that will provide your organisations users and members for the future, so that investment will be resourcing the right location. Does the site lend itself to meeting the needs of that part of the city, suburb or region, and if so, how? Is the project easily accessible with public transport? Is there adequate car parking so that there is limited impact on the local community? Can the facility be shared with local schools, other sports and accessible for more than just the current membership base? These are some of the questions that will ensure a more positive response from funding agencies.

Site Environmental Investigation

Many sports fields that Councils have inherited have challenges. Some are located on tips, on contaminated land, in close proximity to residential buildings, or have a flood overlay plan. If historical challenges are known, all challenges need to start with mandatory investigation before plans are developed.

Photo 33: Bicentennial Park (NSW), which was Built Over a Closed Tip Site with Gas Capture Built into the Field

Site specific considerations create both challenges and opportunities for any project, and the only way to understand them and their impact on the project design is to collect all of the information first before a clear direction is agreed. This is normally part of a feasibility study or business case prior to a grant submission.

Traditionally closed landfill sites have been perceived as likely to be unsuitable for synthetic fields due to the following:

- Geotechnical instability and landfill gas risks and the cost of remediation to ensure site suitability
- Presence of existing landfill management infrastructure
- The restriction imposed by the synthetic surface on required future remediation and maintenance works for the closed landfill, such as waste reprofiling, installation of leachate collection and landfill gas
- Cost of pre-construction remediation works

With a greater understanding of the engineered solutions available, some sites may be able to overcome these challenging characteristics, albeit with increased investment needed.

This additional investment may include:

- Addressing gas risks
- Installing leachate systems that would most likely preclude synthetic systems being embraced
- Stabilisation of a pavement base to address future movement from the decomposing the waste

When considering the design of the site, there are a number of aspects to consider and some aspects that, although they may not be avoided, could result in a significant increase in the level of investment needed. Some of the considerations, challenges and solutions are addressed in the table below:

Challenge and Impact	Mitigation Strategy
1. Reactive clay soils	
Base and sub-base movement and field integrity is compromised	• Design pavement to ensure water table (wet or dry) does not compromise the base pavement
2. Large trees within 20m of field of play	
Roots can impact on base movement	• Use of root barriers can assist
3. Sufficient space for run-off zones and paths outside of fence line	
• Lack of space on field of play for run-offs will impact on compliance and standards Lack of pathway will impact on spectator's ability to move around site	• Ensure adequate space to plan field of play, compliance obligations and the movement around the site

Challenge and Impact	Mitigation Strategy
4. Underground services	
• Underground services may impact safety of build and management • Services, etc. may need access to be upgraded to ensure that there is adequate electricity for the new lights etc.	• Preference is to design around the services, not over them, so explore them being moved • Access to pipes under the field could be reduced by "rebuilding" access outside field of play
5. Increased traffic flows	
• Complaints from residents on quality of lifestyle	• Address traffic flow • Address car parking
6. Uncontrolled fill and closed landfill sites	
• Moveable sub-base impacts on ability to build firm base	• Compact uncontrolled fill and place layer of clay over and re-compact • Build slab over moveable fill and if necessary, use pylons to secure base
7. Poor drainage creates backlog of water and flood	
• Pooling of water on field • Increased maintenance • Backlog of water in drainage and possibly onto field	• Increase storm water exit • Use detention strategy in base (e.g. voids in the aggregate base) or build detention tank
8. Flood plain which is designed to be on a retention basin for short periods	
• Impact on synthetic system that could cause complete failure	• Allow the level of water to be retained under the surface in the void space of an aggregate base, or in a retention tank
9. Flood plain for overflow path	
• Leaves significant damage to surface top which could cause failure of system at worse and significant maintenance damage at best	• Direct the flow of the water under or around the field of play
10. Contaminated infill	
• Leaching (chemicals and gases) into environment • Compliance OHS issues	• Capping of contaminated infill • OHS mitigation strategies

Table 22: Considerations, Challenges and Solutions

Importance of Site Investigation

The site investigation is a crucial stage of any sports field development. The design solution and project budget will be dictated by the limitations and constraints of the site. It is important to undertake a detailed site investigation during the planning process of any project to understand possible limitations for development on the site. The following minimum investigation is recommended to be undertaken during the planning stage:

- Identify existing in-ground services
- Flood overlay
- Detailed feature survey
- Geotechnical Investigation
- Contamination Assessment
- Dial Before You Dig

Existing In-Ground Services

Confirm that there are no existing in-ground services that will impact the proposed development (e.g., local water authority assets, etc.). This also includes overhead services (e.g., high-voltage power lines), which often require clearance offsets that may impact the proposed development.

Dial Before You Dig (DBYD) is a free national referral service designed to identify authority assets and prevent damage and disruption to in-ground services for sites within Australia. It is a single point of contact for all of Australia's underground asset owners.

A Dial Before You Dig enquiry can be submitted online to provide information regarding the underground and above-ground assets and easements in and around the site. Local utility providers' assets may limit the site's development.

On more serious contaminated sites, the best solution is to work with the Council. Although the field may to the layperson look normal, there may be contamination from previous uses, and the treatment approaches would preclude such an investment with synthetic surfaces.

It is important also to remember that not all services will be picked up on a Dial Before You Dig enquiry.

Flood Overlay and Drainage Considerations

Understanding the rain and flooding possibilities for a field of play, including the annual rain intensity and the field's ability to absorb rain events, is essential. This is linked to the storm water channels, which should be the basis of the drainage strategy employed.

The two main drainage strategies are vertical draining over and aggregate base, which hold up to 40% of water in the voids, which details the water before it leaves the field through the storm water. Ag drains are no longer used for this option.

The alternative option is to ensure no leakage into the compacted base. This is an excellent method for quickly removing water, but if the storm water cannot cope with it, then this option is not good.

Detailed Feature Survey

A qualified surveyor should be engaged to undertake a detailed feature survey of the site. This information allows designers to plan the location of the sports field and associated infrastructure within a site.

3D elements of the detailed feature survey will enable designers to accurately tie into the surrounds of the site and determine the amount of imported fill/material to be taken off-site.

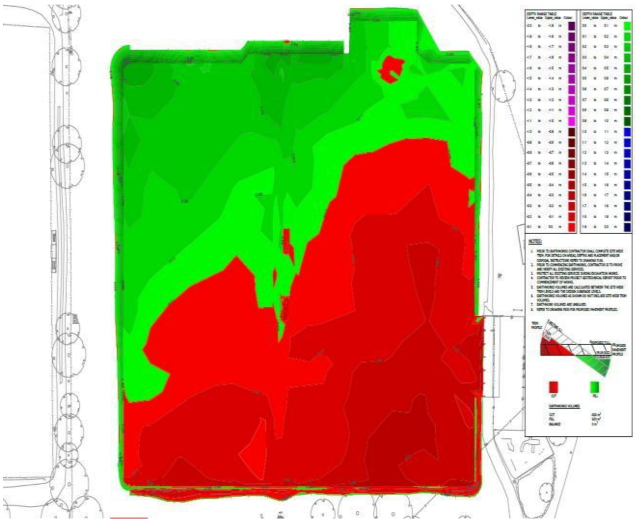


Figure 12: Typical Example of Cut and Fill Modelling from a 3D Site Survey (Source: SPORTENG)

Geotechnical Investigation

A qualified geotechnical engineer should be engaged to undertake soil testing and provide recommendations for the construction of the proposed sports field. The geotechnical investigation will provide information on the composition of the underlying subgrade material.

If the site consists of poor ground conditions (e.g. reactive clays), the geotechnical report will provide recommendation for the remediation of the subgrade and measures to avoid potential movement and cracking of the proposed field of play pavement.

Geotechnical investigations are crucial to assist in reducing risk of failing pavements by providing an appropriate design solution (e.g. capping layers, subgrade stabilisation).

Contamination Assessment

A contamination assessment will provide important information regarding the presence of contaminates on a site that may pose health and development risks for a project. If contaminants are present on the site, an action plan with appropriate methods of disposal/ management will be provided.

There are typically two options that will be provided if contaminated material is found on-site:

- Capping over the contaminated material
- Disposal off-site to an approved Environmental Protection Authority (EPA) disposal site

Disposal of contaminated material can add significant cost to a project, possibly resulting in the project becoming unfeasible.

4.3 Pavement Design Strategy

It is critical to ensure that the sub-base and pavement is designed by a civil engineering specialist so that it can support the synthetic surface system. The design should be based against data from the locations/field inspections including topographical survey, geotechnical report, environmental analysis, drainage study, etc., which needs to be completed by a qualified specialists.

The focus of the sub-base and pavement base design must be able to achieve the following:

- Support the vehicle load during the construction, maintenance and replacement phases;
- Integrate with the synthetic surface to ensure that the sports' performance criteria are achieved;
- Support the load on the pitch once in use, including players and maintenance machinery, to ensure no negative deformation of the surface; and
- Protect the surface from other sub-grade movement or water.

There should be an appropriately deep bore for each of the light towers in addition to the field analysis which typically would be between 8 and 12 bore holes.

The pavement should be designed for a specific life expectancy to ensure sustainability; at minimum, this should be 30 years or 3 surface lives.

The construction standards must meet all legislative obligations which are accessible from the planning department of Council. The construction design should also be built around Universal Design principles and sport specific approaches can be seen.

Field of Play Compliance

It is important that the sports field is designed and constructed to meet the standards that are appropriate for how the field is to be used, so if it is to be used as a community playing field then there is no benefit of requesting a stadium standard field. Indeed, in many instances, this would work against the performance requirements and would not be fit for purpose.

The various sports in each state have their performance design and surface standards linked on their websites. These standards should be included in the Assessment Process to ensure that the right standards are being complied with. This will ensure that the field dimensions, lighting levels, surface standards, and ancillary designs are fit for purpose.

The best site for sports field sizes and measurements is the WA Department of Sport and Recreation, who have a summary of all sports dimensions[36].

Field of Play Orientation

If site constraints allow, the orientation of the field should take into account the sun, wind and other natural aspects that may impact on a fair game of sport. The aim should be to ensure that during the game that both teams benefit or are disadvantaged equally. The time of day (early morning or late afternoon), as well as the time of year (winter or summer), has a bearing on optimum orientation. The WA Department of Sport and Recreation[37] state in their guide on field orientation that:

- The aim however is to share between opposing participants the advantages and/or disadvantages of the sun's direction and other natural factors such as breezes. It is generally recommended that playing areas are orientated approximately in a north-south direction to minimise the effect of a setting sun on players. The best common orientation is 15° east of north.
- However, with more sports being played under lights, this may be less of a concern. Limits of good orientation where a uniform direction for all facilities can be arranged:
    - *athletics, basketball, bowls, croquet, handball, lacrosse, netball, tennis – between 20° west of north and 35° east of north*
    - *football: soccer, five-a-side, Australian rules, Gaelic, rugby league, rugby union – between 20° west of north and 45° east of north*
    - *hockey, polo, polocrosse – between 45° west of north and 45° east of north*
    - *baseball, cricket, softball – between 45° west of north and 35° east of north*
- Prevailing winds also have to be taken into account. In athletics, the potential problems caused by strong winds are worse than the inconvenience caused by the setting sun. Athletes approaching the finish line should not have to contend with strong winds. Pole vaulters should not be exposed to crosswinds or strong opposing headwinds. The discus is best thrown into a headwind.
- In outdoor diving pools, springboards and platforms should face south. In shooting sports and archery, outdoor ranges should be constructed so that the sun is behind the shooter as much as possible.
- Lawn bowling greens must be located away from tall buildings and trees that may cast shadows over the bowling surface, thereby affecting turf performance. This is not relevant for synthetic surfaces.
- Cricket pitches must run approximately north/south to minimise the risk of batsmen or bowlers facing a low sun. The pitch axis must point in a direction between 55° and 325° on the compass.
- Tennis courts must be oriented with play along an approximate north/south axis.

The WA Departments (Figure 13) Guide on Field Orientation illustrates the optimum orientation for Australia for various sporting activities. Local conditions may override these recommendations.

[35] http://sport.vic.gov.au/publications-and-resources/design-everyone-guide
[36] https://www.dsr.wa.gov.au/support-and-advice/facility-management/developing-facilities/dimensions-guide
[37] https://www.dsr.wa.gov.au/support-and-advice/facility-management/developing-facilities/dimensions-guide/orientation-of-outdoor-playing-areas

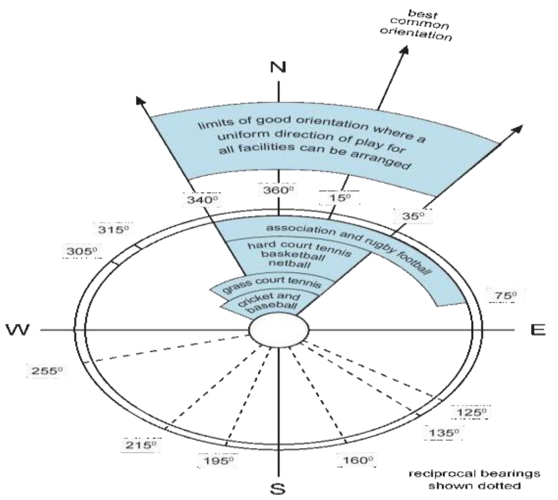


Figure 13: WA Department of Sport and Recreation, Guidance on Field Orientation

4.4 Drainage Strategy

Drainage is critical for the success of any engineered project, especially with synthetic turf sports fields. For quality fields, there should be little or no surface drainage, but for rubber and hard surfaces, there needs to be surface drainage.

For Football Turf and Hockey Turf there is a basic thought process.

- What level of rain event does the site need to cope with. This is measured by siting the Annual Rain Event (ARI) (e.g. 1 in 10 years to 1 in 100 year ARI with an intensity for 20 mins etc). This will allow the hydrology engineers to calculate the flow of water that needs to be taken 'off-site' by the stormwater system.
- Calculate the stormwater discharge rate against the ARI to ascertain of a retention or detension strategy.
- Consider whether vertical or horizontal drainage will be best to adopt.
- Decide Retention Strategy should be adopted (e.g. water harvesting to allow the captured water to be used to irrigate the surrounding landscape, grasses, fences and trees.

The two normal approaches to drainage include:

- **Vertical Drainage Option**

Traditionally, vertical draining utilised the 'AG-drain' strategy, which needed to cut through the pavement or sub-base (and which, over time), showed a loss of integrity to the pavement base for 3G fields.

A more sophisticated approach utilising different sized aggregate stones was introduced by Turf One into Australia and now has been embraced by the market. The void space between the stones (≤ 40%) allows the water under gravity to seep through the stones vertically to collector drains before being taken away.

This is an excellent option to detain the water on site before being connected to the stormwater outlet.

- **Horizontal Drainage Option**

A horizontal drainage option is becoming more popular for synthetic sports turf where the pavement is compacted, and the storm water pipe can handle the quantity of water leaving the field of play, as opposed to a slower release in an aggregate vertical draining base.

Photo 34: Example of Horizontal Drainage Cell Under Shockpad (Source: Wayne Stuart - City of Swan, WA)

The water permeates through the turf/shockpad system either through a drainage cell or by using the drainage channels in a shockpad. Alternatively, the road base can be designed on an angle, so the water can dissipate to drainage around the outside of the field before being taken away.

4.5 Construction Standards

The construction industry in Australia have specific standards that need to be specified. This is critical if the client wishes to aspire to a design that will last 20-30 years and beyond. The challenge with the Design and Construct (D&C) project is that more of these standards will be specified, and therefore, a lower quality project will be designed, which may sound satisfactory due to the lower cost, but these projects have constantly been shown to degrade quicker and cost more money over time. A wide range of performance standards by Standards Australia should be specified to provide the Quality Assurance these projects need.

4.6 Quality Assurance and Procurement Standards

Procurement and construction of the fields and surfaces are best value for the community.

It is unlikely that a Council would not endorse specific contractors or service providers but depending on the value of the investment would make the following recommendations:

- ***Define the scope for the works*** – what standards for the sports performance surface and the civil engineering solution are needed to be fit for purpose, ensuring that this standard is signed off by the State Sport Organisation
- ***Develop a budget*** - that is realistic and ensure that the project can be procured for this price
- ***Obtain technical advice*** – both from the State Sports Organisation and most likely from a synthetic sports surface and sport's engineering consultant. Specialise advice from Geotech engineers to ensure that the surface can accommodate the design is critical.
- ***Prepare a technical specification and design package*** – it is recommended that the organisation engages a technical expert to assist them in the process as many times it may seem logical that a specific product or solution is procured, but the specialist can ensure that the best standards are chosen with the organisation and where needed additional quality and performance standards are specified. A good design and specification package will ensure that the tenderers area all bidding on the same rules and conditions, that the detailed drawings ensure that the tenderers consider the site constraints and that the Bill of Quantities ensures that the correct price is submitted.
- ***Scope the procurement approach*** – depending on the size it may be as simple as obtaining a quote or defining a full procurement process. It is important for a Council that the procurement of the field and associated equipment follows good practice to ensure best value for its rate payers.

Key considerations that should be addressed in the procurement process include:

- Probity
- Value for money evidence
- Audit trail for public funds

Council oversight of the selection process for contractors:

- Guidance for quality delivery
- Council involvement in the procurement process
- Evaluation team member
- Approval to proceed with the recommended contractor
- Approval to proceed with works on the quotation provided
- Ability to inspect site

Typical procurement expectations for a synthetic surface on Council Land:
- At least three written quotes
- Evaluation plan with criteria and including a Council officer as part of evaluation team (must use schedule following this table to be included as a schedule to the funding agreement)
- Evaluation documenting selection and recommendation required
- Provide the quotes and evaluation note to Council prior to work being awarded
- Obtain written authorisation from Council to proceed with work
- Expectations of successful contractor
- Specification of works recommended

Schedule provided to complete for evaluation of the quotes and recommendation of contractor:

- Provision of works program
- Obligation re workmanship, quality and delivery
- Defects liability
- Appropriate insurances
- WH&S and quality documentation
- Access for Council staff to inspect
- Documentary evidence supplied to Council
- Copy of all quotes

Evaluation plan, selection criteria and recommendation supporting the suitability of the Contractor:

- Executed contract
- Contractor's insurances
- Construction program

Project Management Achieves Outcomes on Time and Within Budget

It is critical that an experienced project manager is identified to manage the contract to ensure that the outcomes are achieved. At key points of the project delivery there should be some Critical Hold Points that ensure that the civil engineering work components have been delivered and are appropriate.

A typical Project Manager would ensure that key critical stages of the project are reviewed with the contractor and would normally ensure that these hold and a qualified person in that area of the construction process assesses witness points. These points may include:

Witness Points

- Earthworks – Subgrade affected by moisture
- Earthworks – Placing fill
- Earthworks – Compaction
- Earthworks – Proof roll
- Earthworks – Excavating service trenches
- Earthworks – Backfilling services trenches
- Stormwater – Testing and inspections
- Stormwater – Testing and inspections
- Flexible Pavements – Compaction tests
- Flexible Pavements – Placing base and subbase
- Flexible Pavements – Proof roll

Hold Points

- Design Documentation
- Earthworks – Bad ground
- Earthworks – Compaction Tests
- Earthworks – CBR Tests
- Earthworks – Sediment and Erosion Control Plan
- Stormwater – Backfill density testing
- Stormwater – Pipe bedding material
- In-Situ Concrete – Concrete tests
- In-Situ Concrete – Contractors Submissions
- In-Situ Concrete – Materials
- Flexible Pavements – Execution
- Flexible Pavements – Compaction tests
- Flexible Pavement – Crushed rock material
- Flexible Pavement – Subbase and base compaction
- Synthetic Surface Field of Play – Acceptance of Base
- Synthetic Surface Field of Play – Survey Verification

It is important that the key standards are tested at handover to ensure quality control and quality assurance. All defects should be listed, and an agreed-upon timeline for correction should be in place.

At handover, it is critical that there are a number of aspects that are needed prior to acceptance of the field/surface from the supplier/builder. It is important that a handover the supplier provides the following:

- All warranties and guarantees;
- All finished drawings;
- Equipment handbooks;
- Field of play/surface manual;
- Certification by the International Federation;
- Synthetic System details/ delivery forms; and
- Any 3rd party assessments.

5. Environmental Standards

5.1 Introduction

Many Councils are becoming more aware of the importance of good environmental practices in their open spaces and sports fields, regardless of the surface type.

The days of installing asphalt tennis and netball courts that are only used seasonally, all for limited hours, are now being changed to multi-use so that there is usage each day and throughout the year.

With the increase in investment into natural turf fields, the challenge of balancing demand, usage, and the impact on the environmental footprint is becoming more important with sports fields. This should be the starting point of the majority of sports fields improvements, starting with natural turf upgrades, embracing limited synthetic technology (e.g. high wear areas with hybrid) and then full synthetic technology (e.g. rubber running tracks, hockey fields and football turf).

With the technological advances in design, manufacturing, construction and management, there should be greater emphasis on reducing the impact on the environmental footprint to how we design the positive impact on the environmental footprint. This section (6.2) explores these options, firstly through the eyes of a concerned reader then addresses solutions and good practice, that will have a positive impact.

5.2 Environmental Considerations

1. Key concerns

The key concerns that community groups raise with sport and government around:

- Leaching of heavy metals into water
- Urban heat island impact
- Microplastics and their impact on land and waterways
- Circular economy
- Loss of carbon sequation compound to natural grass
- Loss of habitat for worms, bird life and flora/fauna
- Water use for fields

2. Heavy metal leaching

The concern is that heavy metals are used in the pigments of the grass colour. This may still be the case with some cheaper imported landscape grasses but the quality products stopped using heavy metals over 2 decades ago, with lead chromate being removed.

The European standards including the Swiss and German Regulation DIN 18035 parts 6 and 7 and ESM105, state the requirements of metals need to be less than:

- Mercury ≤ 0.01 mg/l,
- Lead ≤ 0.04 mg/l,
- Cadmium ≤ 0.005 mg/l,
- Chromium ≤ 0.008 mg/l,
- Zinc ≤ 3.0 mg/l, and
- Tin ≤ 0.05 mg/l.

We also recommend that all grasses and infills are tested against EN71-3 (2013) Table 2 Category III, which is the standard for Safety of Toys – Part 3 Migration of certain elements, and Category III (Scraped-off materials).

Both the European and US alternative standards measure the possible heavy metal migration of material that may be hazardous if ingested. Smart Connection Consultancy recommends that all turf procured in Australia adopts this standard.

Concern regarding leaching from recycled rubber (SBR) may be a problem to the environment.

The conclusions are best summarised by the Swiss Study[38] by the Ministry of Environment, Traffic, Energy and Communications. The study was on the Environmental Compatibility of Synthetic Sports Surfaces, which explored the secretion of synthetic surfaces from disintegration by UV radiation, mechanical destruction by abrasion, and diffusion of ingredients and washing off by rainwater.

The testing was in a controlled environment with rain washing through the synthetic and natural turf systems over a two-year period then collected and measured for the secreted substances. The report summarises there is no risk for the environment from Poly Aromatic Hydrocarbons (PAH's) or heavy metals including Mercury, Lead, Cadmium, Chromium, Zinc, and Tin, which were all lower than the required European safety levels.

[38] Muller, E. (2007). Results of a Field Study on Environmental Environment, Traffic, Energy and Communication Authority of Environment Section Water

Photo 35: Swiss Study Collecting Rainwater Through Various Synthetic Sports Surface Systems

3. Water use for synthetic and natural turf fields

Natural turf fields need a substantial amount of water to nurture the grass to keep growing, depending upon whether warm or cool grass is used. Football NSW[39] state "Approximately 3 applications (50,000 litres) are required per week (150,000 litres per week) to keep a pitch healthy and in safe condition". Assume that natural rainfall may provide 50% of that requirement (spread over the year), which means that 3.9 million litres are still needed.

Natural grass requires water to grow and remain in good condition. The amount of water required for irrigation of a natural grass pitch depends on climate conditions, the conditions of the pitch and the way in which irrigation is carried out. Two US studies provide estimates of 2-11 million litre of water each year per 7600m2 pitch per year (Simon Rachel, 2010; Cheng et al., 2014) 117. The Government of Western Australia website provides an estimate of 4.8 million litres of water for an 8000m^2 soccer pitch.

Comparing natural grass with artificial turf, it can be said that artificial turf essentially requires no irrigation, so it is fair to assume that only a fraction of the water used in the case of natural grass pitch will be used on a synthetic sports field. Especially in areas with limited fresh water available, synthetic turf will be preferred when it comes to water use.

Although the cost of water is not normally passed on to sports clubs, with continued climate challenges, the impact of climate on available water will become increasingly significant.
The opportunity for synthetic sports services to be used to harvest rain water is becoming more important with potential drought season projected across Australia over the next decade. The harvested water can be stored and used to improve the natural landscape around the field of play, including trees, grass landscapes and local fauna/flora. This could significantly improve the ambience of the park and increase the quality of experience for the local community.

4. Urban Heat Island effect

The urbanisation of Australia has radically transformed environments from native vegetation through farmland to present day's urban footprints of towns and cities with an urban sprawl. Away from the coastal areas, where the natural land receives a moderating influence of cooling sea breeze, population heartlands in urban areas are now showing 'Urban Heat Island' effects.

Urban surfaces such as roads and roofs absorb, hold, and re-radiate heat; raising the temperature in our urban areas. This effect is often worsened by development activity when green spaces are replaced with more hard surfaces that absorb heat.

This Urban Heat Island (UHI) shows that the area is significantly warmer than its surrounding rural areas due to the number of direct and indirect causes including:

- Absorption of short-wave radiation in concrete, asphalt and buildings and then slow release during the night;
- Change in surface materials which do not have evapotranspiration properties (e.g. concrete v grass vegetation);
- Increase of carbon dioxide, through increases in traffic pollutants and people, with reduced trees capturing carbon dioxide in cities; and
- Use of building materials – pavements and roofs has significantly different thermal bulk properties and surface radiative properties (e.g. shade and evaporation). Also, high buildings normally reduce wind penetration, which also acts as a coolant and assists in the disbursement of pollutants.

The NSW Chief Scientist & Engineer[40] found that "The contribution of synthetic turf fields to the UHI effect at scale is likely, small". That said, by using organic infills, reduced concrete for paths and natural turf, and increased tree canopy, the synthetic field could have a zero or even positive impact on UHI.

5. Loss of carbon sequation of grass

There is a shortage of quality research on Australian natural grass types and their ability to carbon capture over a 30 year period. Once the grass is cut (weekly) the sugars that eventually form the carbon are released and so have reduced impact. Further quality research is needed in this area.
That said, the design of future fields should aspire to maintain the same carbon equation as natural grass or replace it with an extended tree canopy.

6. Loss of habitat

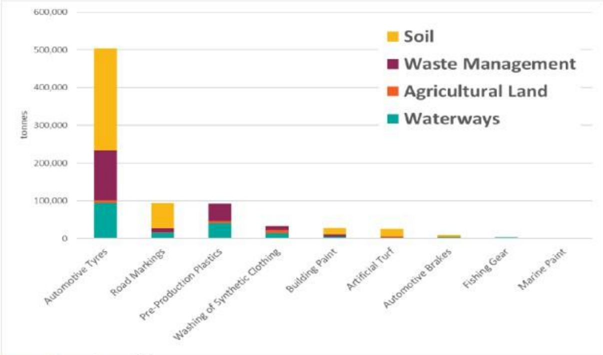
Concern has been raised regarding the loss of habitat for worms and, therefore, birdlife in the area. This is difficult as the value of children being more active and the health benefits that this brings by many may be seen as a higher value than worms and insects. That said, the placement of a synthetic field should take into account the impacts on fauna/flora and, as a percentage of the area, what impact it has on the whole landscape.

7. Microplastics

Microplastics is a term commonly used to describe extremely small pieces (less than 5mm in all directions) of synthetic or plastic material in the environment resulting from the disposal and breakdown of products and waste materials. The concerns around microplastics centres on their potential to cause harm to living organisms in the aquatic and other land-based environments.

The European Commission received a report (DG Environment) in February 2018[41] which explores this in detail and provides the most extensive study to date. It specifically explores synthetic sports surfaces as part of a broader sector of microplastics.

Synthetic fields are "…a relatively small source…"[42] as shown in the table below.



Source: Eunomia modelling

Figure 14: Sources of Microplastics Found in Europe

Soil is the largest single sink for microplastics, which may, over time, be washed into waterways. The key aspects of a synthetic sports field that could be classified in this category would be the tips of the grass over time as they breakdown due to UV Radiation, which could be between 0.5 and 0.8%, and also the infill.

The report suggests that the level of infill that needs topping up over a year would equate to 1-4% of the total infill installed initially. Although some of that is caused from compression, other is lost to the environment. Assuming that on a typical mid-ranged football field (7,500m2) with a typical infill of 10kg per metre2, this would equate to 75 tonnes, with a range of 0.8 tonnes to 3 tonnes per annum. It is envisaged that the 'loss' of infill can be seen to migrate as follows:

- Migration to the surrounding soil area;
- Migration to surrounding paved areas and then subsequently released into the sewerage system via grates etc.;
- Into indoor environments (including washing machines) on kit, shoes and bags of participants, which again will be released into the sewerage system; and
- Release into drains and waterways.

Aspects That Can Impact on Microplastics Entering the Environment

There are a number of aspects of the design, construction and management of the fields that could impact on the level of microplastic migration into the environment.

[40] NSW Chief Scientist & Engineer: Independent Review into the design, use and impacts of synthetic turf – public open space. Final Report (page 41 section 4.3 Findings) 2023

[41] Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products

[42] Section E1.1. Estimating Microplastics

This could include:

- **Infill splash** – with the infill migrating off the field of play
- **Infill being washed away** – in wet weather or through snow
- **Drainage transportation** – with many early designs having spoon drains at field level
- **Excessive infill levels** – increasing probability of migration off the field
- **Player transmission** – on boots etc.
- **Breakdown of yarn** – due to UV degradation with age
- **Fields not fit for purpose**

It is critical that purchasers for synthetic sports fields can appreciate how the design, management and construction can have such a significant impact on reducing the propensity of microplastics entering the environment.

Smart Connection Consultancy is committed to working with all levels of government, sport, synthetic field manufacturers and construction companies to reduce the amount of microplastics that could enter the environment. It has developed a 21 point plan, which it has shared in this Smart Guide.

Global and Australian Approach to Containment of Microplastics

Globally, sport peak bodies and industry associations have embraced this challenge with enthusiasm to reduce the impact on the environment and, therefore, on society. The majority of global sports International Federations for sports, including Football (FIFA), Rugby (World Rugby) and Hockey (FIH), have all researched this and have issued guidance on how fields should be constructed and managed.

The peak body associations have also provided similar information, including the Synthetic Turf Council (https://www.estc.info/wp-content/uploads/2021/03/2021-RMM-flyer-final-with-ESTC-logo-v2.pdf).

This standard will then allow councils to quote this standard in their tender documents so the dispersion of infills can be reduced. This is positive information we can give to councils and show that the industry is doing something to mitigate the issue.

Smart Connection Consultancy believes that in Australia, we can go further as we appreciate the impact on the community, and this has been addressed below.

We are encouraging all purchasers of synthetic surfaces to now use organic infill, which reduces the microplastics almost completely.

8. Circular economy

The circular economy can now be considered with confidence in Australia and is addressed in these Smart Guide Sustainability standards. The commitment to design, procurement, management, and recycling at the end of life is paramount. This reduces waste to the natural environment.

a. Conclusion

The importance of enhancing our environment for future generations shall be part of all our focus, and the new technology, environmentally friendly civil construction and whole of life circular economy certainly allows this to happen.

Councils can embrace these options and shall be requiring their consultants to specify it in the design and procurement documentation. This means that the cheaper and quicker Design and Construct (D&C) tenders are not the appropriate method for contract procurement.

A separate guide, SALGRSN Guide 3 – Environmental Sustainability Opportunities is also provided with more detailed advice.

6. Safety and Health Focused Standards

6.1 Introduction

The health and safety of all sports facilities is a concern to the asset owner and the sports program providers. As a result, there tends to be a sophisticated decision-making process considered in regard to any potential risk to players, when investing in 'new' technology.

Photo 36: Field After Being Converted (Hornsby Council NSW)

At times, there is a perception that if the surface is not natural grass, it is unsafe. In Australia, local community groups have expressed concern at the prospect of the natural grass being replaced by synthetic surfaces.

What may not be appreciated by these community groups is that if many community level natural grass surfaces were tested to the same rigour as synthetic sports surfaces, they would not pass the performance criteria that synthetic turf needs to. Therefore, the synthetic sports turf is safer than most badly-worn community playing fields.

The key concerns for health and safety are predominantly:

- Player safety and injuries;
- Surface playability;
- Environmental impacts;
- Health risks to community; and
- Heat management.

6.2 Player Safety and Injuries

There is a perception that there are more sports injuries on synthetic grass surfaces than on natural turf. Several studies show that this is not the case. For example, the New York State Department of Health[43] provides specific guidance from its research:

"There is a common perception that there are more sports injuries on synthetic than on natural turf athletic fields. Many factors influence the rate of sports injuries, including the type of playing surface. The many kinds of synthetic turf surfaces and changes in the turf products over the years complicate the assessment of how the playing surface affects injury rates".

Photo 37: Field With Markings for Several Sports (Source: Tigerturf)

1. Injury studies conducted by FIFA and UEFA

The world governing body of football, FIFA, and the Union of European Football Associations (UEFA) conducted one of the early studies on injuries comparing artificial turf and natural grass. The three-year study covered 18 professional teams with a total exposure of 160,000 hours[44]. The study yielded a slightly lower risk of muscle injuries but showed a slightly higher risk on ligament injuries, with the rate of knee injuries being the same between both surface types (Table 6). However, the study did not analyse the influence of footwear when playing on both surfaces.

	Artificial Turf	Natural Grass
Muscle Injury		
Strain	4	7
Hamstring	2	3.5
Ligament		
Sprain	7	5
Ankle	4	2.5
Knee	2	2

Table 23: Number of Injuries per 1,000 hours Exposure

[43] Fact Sheet: Crumb-Rubber Infilled Synthetic Turf Athletic Fields (2008) (NYS DOH Factsheet)

[44] Ekstrand, J., Timpka, T., Haegelund, M.; British Journal of Sports Medicine; 40; 975-980; 2006

Following the initial study, FIFA conducted a two-month study with thirty semi-professional players on three artificial turf and six natural grass fields located across

With regards to player-kicking dynamics, the backward inclination of the leg (see Photo 10), (#1) the kicking foot angle (#2), the knee position (#3), the pronation of the standing foot (#4) as well as the upper body positioning (#5) were analysed. As performance measures, heart rate, blood lactate levels and movement analysis of the players were used.

The results showed no statistical differences in kicking dynamics, no evidence of increased physiological stress or difference in velocity when performing on artificial turf and natural grass. In fact, the climatic differences between the various locations had a bigger influence than the difference between the two surface types.

Photo 38: Single Cut Move

2. Injury studies conducted on behalf of Rugby Union

The risk of injury associated with play of rugby union on artificial turf was the subject of a medical study in 2010[45]. In particular the study looked at lower limb and joint-ligament injuries. The results when comparing artificial versus natural surfaces showed no significant statistical differences in the rate of injuries when comparing the two surface types. In addition, the study yielded no significant difference in the severity of injury sustained. Overall, the study concluded that the risk of injury was not different when comparing playing activity on artificial turf with natural grass surfaces.

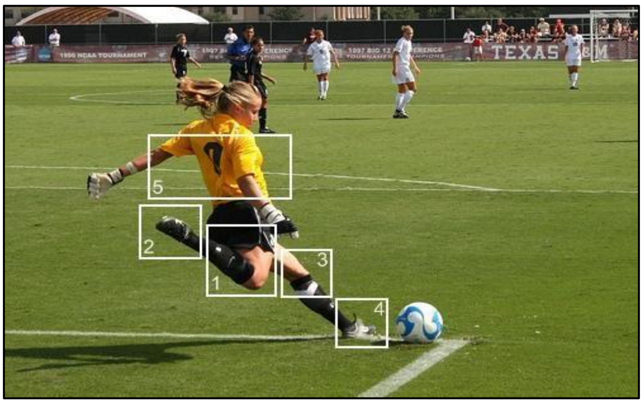


Photo 39: Kicking Dynamics

3. NCAA injury surveillance program

The National Collegiate Athletic Association (NCAA) in the United States maintains a comprehensive injury surveillance program which regularly summarises the injuries sustained in various sports. According to the surveillance data collected between the seasons 2004/05 to 2008/09 the majority (more than half) of injuries occur in the lower limb area. However, the study did not distinguish between playing surfaces.

Injury	Percentage (in %)
Concussion	7.4
Head, face, neck	4.3
Upper limb	16.9
Torso, pelvis	11.9
Lower limb	50.4
Other	9.1

Table 24: American Football Injuries (Surveillance Program 2004-2009)

A five-year study of American high schools[46] also concluded that more than half of the injuries sustained in American football at a high-school level are recorded in the lower extremity area. This study differentiated between playing activity on artificial turf and natural grass and showed slightly higher injury rates on artificial grass than natural grass. Similar findings were concluded by Hershman et al[47] When looking at specific lower extremity injury rates on grass and artificial turf playing surfaces in National Football League (NFL) games, it is important to remember that the NFL does not have the comprehensive play and performance standards that Soccer, Rugby, or AFL do.

[45] Fuller, C., Clarke, L., Molloy, M.; Journal of Sports Sciences; Vol 28; Issue 5; 2010

[46] Meyer, M., Barnhill, B.; The American Journal of Sports Medicine; Vol 32; No. 7

[47] Hershman, E., Anderson, R., Berfeld, J., Bradley, J., Coughlin, M., Johnson, R., Spindler, K., Wojtys, E., Powell, J.; American Journal of Sports Medicine, Online Sep 2012

Body Area	Artificial Turf	Natural Grass
Cranial/cervical	10.1 %	19.2 %
Upper extremity	28.1 %	23.2 %
Thoracic	7.9 %	6.4 %
Lower extremity	53.9 %	51.2 %

Table 25: American High-School Football Injuries

4. Independent evaluation and research

The Synthetic Turf Council has identified the following research Studies and Technical Papers for consideration:

i.) Epidemiology of Patellar Tendinopathy in Elite Male Soccer Players, Hagglund, Zwerver and Ekstrand (2011).

Patellar tendinopathy is a relatively mild but fairly common condition among elite soccer players, and the recurrence rate is high. This study investigated the epidemiology of patellar tendinopathy in 2,229 elite male soccer players from 51 European elite soccer clubs playing on natural grass and synthetic turf between 2001 and 2009. Objective: To compare the risk for acute injuries between natural grass (NG) and third generation artificial turf (3G) in male professional football.

Conclusion: Exposure to artificial turf did not increase the prevalence or incidence of injury.

ii.) Risk of injury on third generation artificial turf in Norwegian professional football, Bjorneboe, Bahr and Andersen (2010).

The study aimed to compare the risk for acute injuries between natural grass (NG) and third-generation artificial turf (3G) in male professional football.

All injuries sustained by players with a first-team contract were recorded by the medical staff of each club from 2004 throughout the 2007 season. An injury was registered if the player could not complete the football activity or match play. From a total of 668 match injuries, 526 on grass and 142 on artificial turf the overall acute match injury incidence was 17.1 per 1,000 match hours on grass and 17.6 on artificial turf. Correspondingly, the incidence for training injuries was 1.8 on grass and 1.9 on artificial turf respectively.

Conclusion: No significant differences were detected in injury rate or pattern between 3G and NG in Norwegian male professional football.

iii.) Comparison of injuries sustained on artificial turf and grass by male and female elite football players, Ekstrand, Hagglund and Fuller (2010).

The objective of this study was to compare incidences and patterns of injury for female and male elite teams when playing football on artificial turf and grass. Twenty teams (15 male, five female) playing home matches on third-generation artificial turf were followed prospectively; their injury risk when playing on artificial turf pitches was compared with the risk when playing on grass. The team of medical staff recorded individual exposure, injuries (time loss) and injury severity. In total, 2105 injuries were recorded during 246 hours of exposure to football. Seventy-one percent of the injuries were traumatic and 29 percent overuse injuries.

Conclusion: There were no significant differences in the nature of overuse injuries recorded on artificial turf and grass for either men or women.

iv.) Injury risk on artificial turf and grass in youth tournament football, Soligard, Bahr and Andersen (2010).

The aim of this study was to investigate the risk of acute injuries among young male and female footballers playing on third-generation artificial turf compared with grass. Over 60,000 players 13 – 19 years of age were followed in four consecutive Norway Cup tournaments from 2005 to 2008. Injuries were recorded prospectively by the team coaches throughout each tournament. The overall incidence of injuries was 39.2 per 1000 match hours, 34.2 on artificial turf, and 39.7 on grass. However, there was a lower risk of ankle injuries and a higher risk of back and spine, and shoulder and collarbone injuries, on artificial turf compared with on grass.

Conclusion: There was no difference in the overall risk of acute injury in youth footballers playing on third-generation artificial turf compared with grass.

v.) Medical Research on Artificial Turf, FIFA Medical Assessment and Research Centre (2010).

The aim of this research was to compare injuries sustained at the FIFA U-17 tournament in Peru, which was played entirely on "Football Turf" (synthetic turf) with the injuries sustained at previous U-17 tournaments, which were played mainly on well-manicured grass.

Conclusion: There was very little difference in the incidence, nature and causes of injuries observed during those games played on artificial turf compared with those played on grass.

vi.) Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study, Ekstrand, Timpkin and Hagglund (2006).

The aim of the study was to compare injury risk in elite football [soccer] played on artificial turf compared with natural grass.

Conclusion: No evidence of a greater risk of injury was found when football was played on artificial turf compared with natural grass. The higher incidence of ankle sprain on artificial turf warrants further attention, although this result should be interpreted with caution as the number of ankle sprains was low.

vii.) Risk of injury on artificial turf and natural grass in young female football [soccer] players, Steffen, Andersen and Bahr (2007).

The aim was to investigate the risk of injury on artificial turf compared with natural grass among young female football [soccer] players.

Conclusion: The overall risk of acute injury to among young female football [soccer] players was similar between artificial turf and natural grass.

viii.) Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players, Fuller, Dick Corlette and Schmalz (2007).

The aim was to compare the incidence, nature, severity and cause of match injuries (Part 1) and training injuries (Part 2) sustained on grass and new generation turf by male and female footballers.

The National Collegiate Athletic Association Injury Surveillance System was used for a two-season (August to December) study of American college and university football teams (2005 season: men 52 teams, women 64 teams; 2006 season: men 54 teams, women 72 teams).

Conclusion: There were no major differences in the incidence, severity, nature or cause of match injuries or training injuries sustained on new generation artificial turf and grass by either male or female players.

Photo 40: ELS Hall AFL/Soccer Field with Cork Infill (Ryde City Council and Turf One Installation)

Although each study found some differences in specific injury types, there was no consistent pattern across the studies.

One of the key safety considerations is the potential for head injuries from contact with a synthetic surface, which has been assessed by determining the ability of the surfaces to absorb impact. The force of impact on frozen or well-worn natural turf is typically below the acceptable level but many pitches are not tested against this.

5. Summary of findings

Of the various independent studies[48] [49] [50] [51] reviewed from 2006 to 2011, the common finding is that there is not an increase in the number of injuries associated with synthetic turf when compared to natural turf. Seemingly the only negative consideration is where sports people alternate between surface types which may result in varied and increased injuries.

This may be similar to long distance runners who run on synthetic tracks then on asphalt, which are more susceptible to shin soreness.

Although the studies' ability to detect differences in the injury rates was limited by the small number of injuries reported, they concluded that there were no major differences in overall injury rates between stadium level quality natural and infilled synthetic turf. Although each study found some differences in specific injury types, there was no consistent pattern across the studies.

[48] Ekstrand J, Nigg B. Surface-related injuries in soccer. Sports Medicine 1989; 8:56-62.
[49] Arnason A, Gudmundsson A, Dahl H. Soccer injuries in Iceland. Scandinavian Journal of Medicine & Science in Sport 1996; 6:40-45.
[50] Stanitski CL, McMaster JH, Ferguson RJ. Synthetic turf and grass: A comparative study. Am J Sports Med 1974;2(1):22-26.
[51] Engebretsen L. Fotballskader og kunstgress. Tidsskrift for den Norske lægeforening 1987;107(26):2215

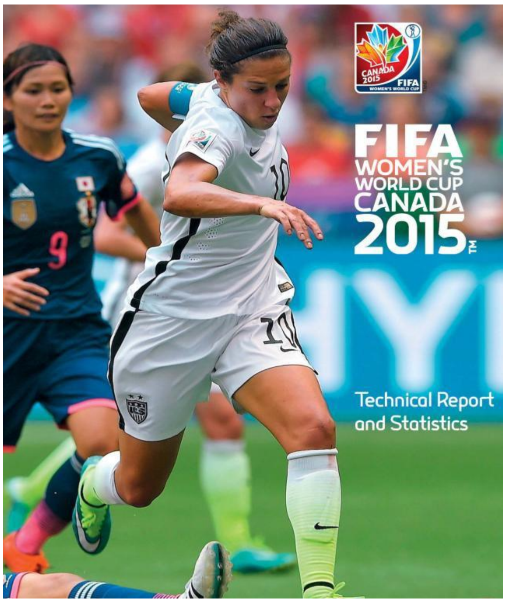


Figure 15: FIFA Womens World Cup Technical Report (2015)

The Canadian hosting of the FIFA Women's World Cup technical report states "Although the FIFA Women's World Cup Canada 2015™ was played on artificial turf, there was no significant difference regarding injuries sustained there and those on grass at previous editions."

One of the key safety concerns expressed by sport organisations is the potential for head injuries from contact with a synthetic surface. This concern is assessed by determining the ability of the surfaces to absorb impact using one of two test methods, which provides the acceptable level of playing surface for specific sports.

By comparison, a recent study of community and stadium natural surface fields in Sydney[52] were typically below the corresponding expected synthetic level. Many natural turf fields are not tested against a standard. (If they were, many fields would fail the standards set for synthetic surfaces).

Rugby union has begun to test natural turf surfaces in some States of Australia to protect their players. The abrasiveness of synthetic turf fibres may contribute to the injury risk among athletes, particularly for abrasions or 'turf burns.' The degree of abrasiveness appears to be dependent on the composition and shape of the turf fibres. A study conducted at Penn State University suggests that synthetic turf with nylon fibres is more abrasive than synthetic turf with other fibre types.

Regarding injury, a study conducted by FIFA's Medical Assessment and Research Centre (F-MARC)[53] compared the injuries sustained at the FIFA U-17 tournament in Peru in 2005, which was played entirely on artificial turf, with the injuries sustained at previous FIFA U-17 tournaments, which were mostly played on natural turf. The research showed that there was very little difference in the incidence, nature and cause of injuries observed during games played on artificial turf compared with those on grass.

In another study reported in the British Journal of Sports Medicine, Reference results showed no evidence of greater injury risk when playing soccer on artificial turf compared with natural turf in the Swedish Premier League. The researchers did report an increased incidence of ankle injuries on artificial turf; however, the study was limited due to its small sample size.

The limited results collated by FIFA suggest that the rate of injury on third generation synthetic turf is similar to that of natural turf, but the type of injury may differ.

The Synthetic Turf Council has provided independent research papers for confirmation of injury occurrence when natural grass and synthetic grass is compared.

6.3 Health Concerns of Users

1. Introduction

The genuine community concern around the health impacts that have been raised by the media and this has caused concerns. The key health concerns around a number of issues surrounding the type of infills and various perceived links to cancer. This section explores those concerns and provides a fuller version of the research than maybe the public would normally find. All the references are publicly available, and references are noted.

2. Health and impacts due to recycled rubber

Synthetic rubber has been made for decades using chemicals that reflect the properties of natural rubber, to provide a robust and flexible surface.

[52] UST study of NSW community natural grass standards (2011) by Acousto Scan

[53] FIFA Medal Assessment and Research Centre (2006)

The synthetic rubber or plastic is made by bringing together various chemicals and curing the 'ingredients' to make polymers into rubber latex and plastics.

This may in some cases include the use of Styrene (liquid) and Butadiene (gas) to form a liquid latex which is prepared into rubber for purposes e.g., shoes, toys and other products handled and used daily, as well as commercial products including rubber matting and vehicle tyres.

Other compounds are also added to vehicle tyres to increase their durability for road use. This provides a significant added benefit to the crumb rubber in synthetic fields, as the infill is extremely durable.

Although Styrene and Butadiene are identified carcinogens in their natural state, when combined they, with other chemicals, form polymers which result in these chemicals being locked within the polymer chain. The latest independent research from the Dutch Government (2016) states "…the effect of these substances on human health is virtually negligible."[54]

Interestingly, both Styrene and Butadiene are also identified by the Gum Base Ingredients Approved for Use by the U.S. Food and Drug Administration (2016), as two substances are also combined in Chewing Gum[55] that is sold to millions of people globally each day.

Photo 41: Australia's Institute of Sport has Embraced the Sports Turf Technology and Invested in EPDM Infill as Opposed to Recycled SBR

Recycled SBR rubber, or crumb rubber as it is commonly known, predominantly sourced from vehicle tyres is used as the performance infill. After the tyres are stripped of the metal rims the rubber is recycled by shredding into crumbs.

Research Around Recycled SBR Infill Health Impacts

The community's concern focuses on the Polymer base chemicals locked in the Polymer chain within the recycled SBR. The concern is that there may be a danger of these components breaking down and the raw components being ingested, reacting against players' skin, or inhaled into their lungs, thus increasing the likelihood of players being exposed to higher health risks.

Photo 42: SBR Recycled Rubber Granular Infill for a Synthetic Surface in Northbridge, NSW by Turf One (Source: Willoughby City Council)

The Synthetic Turf Council (STC), has acknowledged community concern around the use of synthetic rubber and synthetic grasses. In response to this concern they have invested significantly to highlight the independent research by government agencies, chemical engineers, toxicologists, epidemiologists, chemists, biologists and other medical professionals. None of the research that they identify has been funded or developed by STC, they are only offering their site as a knowledge portal of independent advice.

The STC reviewed related research on inhalation toxicity (34 articles); ingestion toxicity (45 articles); dermal toxicity (27 articles); and links to cancer (11 articles).

The findings were STC 'unequivocally failed to find any link between recycled rubber infill and cancer or any other human health risk'.[56]

[54] National Institute for Public Health and the Environment (RIVM) Ministry of Health, Welfare and Sport, Netherlands, report on 'Playing sports on synthetic turf fields with rubber granules' 20-12-2016 OomenAG, de Groot GM (RIVM Summary Report 2016 – 0202) accessed on 22nd December 2016: http://www.rivm.nl/en/Documents_and_publications/Common_and_Present/Newsmessages/2016/Playing_sports_on_synthetic_turf_fields_with_rubber_granulate_is_safe

[55] "CFR - Code of Federal Regulations Title 21". www.accessdata.fda.gov. Retrieved 2016-12-15

[56] Synthetic Turf Council, Executive Summary Catalogue of Available Recycled Rubber Research (March 3, 2016) http://c.ymcdn.com/sites/www.syntheticturfcouncil.org/resource/resmgr/docs/stc_cri_execsummary2016-0303.pdf

In February 2016, the STC produced a video explaining the infills, titled "The Truth About Artificial Turf and Crumb Rubber" (https://www.youtube.com/watch?time_continue=9&v=pVZSVhyMv-A).

In March 2016, the STC issued a statement on the 'Available Recycled Rubber Research'[57]. This was in response to the increased public interest in the potential health effects of recycled rubber in sports fields.

Other independent European research in 2013[58] involved a Tier 2 environmental – sanitary risk analysis, on five synthetic sports turf fields in Italy, Turin. It explored the exposure to adults and children from the projected three opportunities of exposure to any harmful components of the recycled rubber: direct contact, rainwater soaking, and inhalation of dust and gases. The results of the research for all exposure opportunities, was based on the cumulative risk proved to be lower than one in a million.

Photo 43: Coated Sand Being Used in Synthetic Sports Fields

Although dust and gases were found to be the main rate of exposure, the results assessed the impact on the inhalation pathway when compared to a risk assessment conducted on citizens breathing gases and dust from traffic emissions every day in Turin.

For adults and children, the conclusion of the report states: *"the inhalation of atmospheric dusts and gases from vehicular traffic gave risk values of one order of magnitude higher than those due to playing soccer on an artificial field".*[59]

Additional independent research conducted between 2009-2013 have found similar results.[60] [61] [62]

- Over a 12-year period, Simon[63] reviewed impacts of crumb rubber in artificial turf. Results showed: *"ingestion of a significant quality of type shared did not elevate a child's risk of developing cancer, relative to the overall cancer rates of the population".*[64]
- Cardno Chemrisk found: *"regular exposure (e.g. regular play on ground rubber infilled fields) to ground rubber for the length of one's childhood does not increase risk of cancer above levels considered by the state of California to be de minimus (i.e. lifetime excess cancer risk of 1 in a million")*[65]

[57] STC Executive Survey Catalogue of Available Recycled Rubber Research (March 3, 2016) http://c.ymcdn.com/sites/www.syntheticturfcouncil.org/resource/resmgr/docs/stc_cri_execsummary2016-0303.pdf

[58] Ruffino, B., Fiore, S., & Zanetti, M.C., (2013). Environmental-sanitary risk analysis procedure applied to artificial turf sports fields. *Environ Sci Pollut Res Int.* *20*(7):4980-92. doi: 10.1007/s11356-012-1390-2

[59] Ruffino, B., Fiore, S., & Zanetti, M.C., (2013). Environmental-sanitary risk analysis procedure applied to artificial turf sports fields. *Environ Sci Pollut Res Int.* *20*(7):4980-92. doi: 10.1007/s11356-012-1390-2) Abstract Summary - http://link.springer.com/article/10.1007/s11356-012-1390-2

[60] Krüger, O., Kalbe, U., Richter, E., Egeler, P., Römbke J, & Berger, W. (2013). New approach to the ecotoxicological risk assessment of artificial outdoor sporting grounds. Environ Pollut. Apr;175:69-74. doi: 10.1016/j.envpol.2012.12.024.

[61] Sunduk, K., Ji-Yeon, Y., Ho-Hyun, K., In-Young, Y., Dong-Chun, S., & Young-Wook, Lim. (2012). Health Risk Assessment of Lead Ingestion Exposure by Particle Sizes in Crumb Rubber on Artificial Turf Considering Bioavailability. Environ Health Toxicol. 2012; 27: e2012005. doi: 10.5620/eht.2012.27.e2012005

[62] Menichini, E., Abate, V., Attias, L., De Luca, S., di Domenico, A., Fochi, I., Forte, G., Iacovella, N., Iamiceli, AL., Izzo, P., Merli, F., & Bocca, B. (2011). Artificial-turf playing fields: contents of metals, PAHs, PCBs, PCDDs and PCDFs, inhalation exposure to PAHs and related preliminary risk assessment.Sci Total Environ. 409(23):4950-7. doi: 10.1016/j.scitotenv.2011.07.042

[63] Simon, R. (Feb. 2010). Review of the Impacts of Crumb Rubber in Artificial Turf Applications. UNIVERSITY OF CALIFORNIA, BERKELEY LABORATORY FOR MANUFACTURING AND SUSTAINABILITY

[64] Rachel Simon, University of California, Buheberg, Review of Impacts of Crumb Rubber in Artificial Turf Applications (Feb 2010) p31

[65] Review of the human Health and ecological safety of exposure to recycled tire rubber found at playgrounds and synthetic turf fields. Prepared by Cardno ChemRisk, Pittsburgh, PA (Aug 2013) http://c.ymcdn.com/sites/www.syntheticturfcouncil.org/resource/resmgr/files/rma_chemrisk_update-_8-1-13.pdf

Surety of What Chemicals and Components Are in the Recycled Rubber

To ensure quality recycled SBR is used in sports field infill, it is important to appreciate the region of the globe where the infill is sourced and the regions' regulations regarding the component makeup of the tyres.

America and Europe have stricter regulations on the safety of the chemicals and components used to make vehicle tyres.

The US has a voluntary code[66] ASTM D5603 – 01 (2015), which focused on rubber compound materials and Europe has very strict compulsory legislation[67] which has placed restrictions on the use of substances that may be carcinogenic in their raw form in any product being brought into Europe for sale.

This is commonly known as the REACH Regulations, which was introduced in 2010. Unfortunately, tyres before that cannot be verified.

Photo 44: Synthetic Fields Are Being Used for Both Full-Side Games and The Intensity of Training in Small Areas That Natural Turf Could Not Accommodate

The REACH Regulations identify any product against either 'Articles' or 'Mixtures'. Currently, SBR is categorised as a 'Mixture'. The levels of PAH in these mixtures are that six of the PAH's will be under 1,000mg/kg and two at under 10mg/kg.

In summary, as long as the tyres can demonstrate that they have been certified to the American Code and European regulations, there is a strong likelihood that they will not contain any harmful levels of PAH's.

Presently, Australia does not have a similar code.

Global Investigations on Infills

Concerns have been raised in Europe, the Netherlands and the USA about the safety of recycled tyre crumb used in playing fields and playgrounds.

The Dutch Governments' (RIVM – Dec 2016) main recommendation states:

"adjusting the standard for rubber granulate to one that is closer to the standard applicable to consumer products. Rubber granulate is required to satisfy the legal requirements for 'mixtures'. The standard for consumer products is far more stringent: it allows far lower quantities of PAHs (10 to 100 times lower) compared with the standard for mixtures. The quantity of PAH in rubber granulate is slightly higher than the standard for consumer products."[68]

The European Chemicals Agency (ECHA) published their research to determine a suitable standard for rubber granules February 2017[69] which stated:

Photo 45: Synthetic Football Field In NSW Used by a University, Schools and Local Community

"ECHA has evaluated the risk of substances in recycled rubber that is used on artificial sports pitches. Based on the evidence, ECHA has concluded that the concern for

[66] ASTM D5603 - 01(2015): Standard Classification for Rubber Compounding Materials—Recycled Vulcanizate Particulate Rubber. https://www.astm.org/Standards/D5603.htm

[67] EU REACH ANNEX XVII: RESTRICTIONS ON THE MANUFACTURE, PLACING ON THE MARKET AND USE OF CERTAIN DANGEROUS SUBSTANCES, PREPARATIONS AND ARTICLES (Source: http://www.reachonline.eu/REACH/EN/REACH_EN/articleXVII.html)

[68] RVIM Website English Summary (accessed Dec 2016) http://www.rivm.nl/en/Documents_and_publications/Common_and_Present/Newsmessages/2016/Playing_sports_on_synthetic_turf_fields_with_rubber_granulate_is_safe

[69] https://echa.europa.eu/-/recycled-rubber-infill-causes-a-very-low-level-of-concern

players on these pitches, including children, and for workers who install and maintain them is very low."

The US Federal government has requested their Environmental Protection Agency (EPA), the Centres for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (ATSDR), and the U.S. Consumer Product Safety Commission (CPSC), to investigate key community concerns around environmental and human health.[70]

The investigation is transparent and has an informative website (http://www.epa.gov/TireCrumb), and the report is due in late 2020. The government's website refers to further research completed in the USA by their Environmental Protection Agency.[71]

The California Office of Environmental Health Hazard Assessment is currently conducting an in-depth SBR infill study. This study includes a series of scientific studies to determine if chemicals in recycled SBR can potentially be released under various environmental conditions and what, if any, exposures or health risks these potential releases may pose to players who frequently play on artificial fields constructed with SBR.

It will also expand understanding of whether chemicals can be released from the SBR infill when a person encounters it. For example, recycled SBR can come in contact with sweat on the skin or be accidentally ingested by athletes playing on turf fields.

In Europe, comprehensive regulations known as Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) address the chemical industry and anything made from chemicals.

REACH aims to ensure a high level of protection for human health and the environment by applying appropriate risk management measures to chemical substances used in products or mixtures in Europe. This is done by the four-stage process that REACH employs: registration, evaluation, authorisation, and restriction of chemicals.

In the European Synthetic Turf Organisation (ESTO) Crumb Rubber (SBR) infill FAQ Sheet[72], it states that REACH:

"Applies to all individual chemical substances on their own, in preparations or in products. All car and truck tyres sold in the EU since 2012 have had to satisfy the relevant requirements of REACH. In March 2016, the Competent Authorities for REACH also stated that rubber crumb used as infill in synthetic turf pitches should be classified as a mixture and it needs to comply with entry 28 of annex XVII to the REACH regulations. This entry establishes a limit on the presence of substances which are carcinogenic and are placed on the market, or used by themselves, or in mixtures, for supply to the general public".

PAH (mg/kg)	CAS Number	Substances which appear in Part 3 of Annex VI to Regulation (EC) No 1272/2008 classified as carcinogen category 1A or 1B (Table 3.1) or carcinogen category 1 or 2 (Table 3.2) (Mg/Kg)
BENZO[a]ANTHRACENE	56-55-3	1000
CHRYSENE	218-01-9	1000
BENZO[b]FLUORANTHENE	205-99-2	1000
BENZO[k]FLUORANTHENE	207-08-9	1000
BENZO[j]FLUORANTHENE	205-82-3	1000
BENZO[a]PYRENE	50-32-8	100
BENZO[e]PYRENE	192-97-2	1000
DIBENZO[a,h]ANTHRACENE	53-70-3	100

Figure 16: REACH Regulations

Due to community concern regarding the perceived health and safety issues of recycled SBR infill the European Commission asked ECHA to explore whether there is any remaining health risk posed by the substances within the rubber and whether further restrictions are needed.

In February 2017 ECHA published their findings:

"A number of hazardous substances are present in recycled rubber granules, including polycyclic aromatic hydrocarbons (PAHs), metals, phthalates, volatile organic hydrocarbons (VOCs) and semi-volatile organic hydrocarbons (SVOCs). Exposure to these substances through skin contact, ingestion and inhalation was considered."

Photo 46: Rugby Union Field at Randwick City Council (NSW)

[70] Lead Chromate in Synthetic Turf, Though Safe for Kids per CPSC, was Discontinued in 2009 (Posted by Terrie Ward, STC Marketing and Education Director, March 20, 2015: https://syntheticturfcouncil.site-ym.com/news/222483/Lead-Chromate-in-Synthetic-Turf-Though-Safe-for-Kids-per-CPSC-was-Discontinued-in-2009.htm

[71] Tire Crumb and Synthetic Turf Field Literature and Report List as of Nov. 2015 (Source: https://www.epa.gov/chemical-research/tire-crumb-and-synthetic-turf-field-literature-and-report-list-nov-2015.)

[72] ESTO Crumb Rubber Infill FAQ Sheet (source: http://www.theesto.com/images/ESTO-Publications/Crumb%20Rubber%20infill%20-%20Frequently%20Asked%20Questions.pdf)

Based on the information available, ECHA concludes that there is, at most, a very low level of concern from exposure to recycled rubber granules:

- *The concern for lifetime cancer risk is very low given the concentrations of PAHs typically measured in European sports grounds;*
- *The concern from metals is negligible given that the data indicated that the levels are below the limits allowed in the current toy's legislation;*
- *No concerns were identified from the concentrations of Phthalates, Benzothiazole and Methyl Isobutyl Ketone as these are below the concentrations that would lead to health problems; and*
- *It has been reported that volatile organic compounds emitted from rubber granules in indoor halls might cause irritation to the eyes and skin.*

In the studies that ECHA evaluated, which are listed in the report, the concentrations of PAHs in recycled rubber granules were well below the limits set for carcinogenic, mutagenic and reprotoxic (CMR) substances for consumers in REACH.

In addition, ECHA recommends that players using the synthetic pitches should take basic hygiene measures after playing on artificial turf containing recycled rubber granules.

The Dutch National Institute for Public Health and the Environment (RIVM) in cooperation with ECHA, states that although the levels of PAH's are safe in the current REACH standards that are used for synthetic surface infills, they wish to be extra careful. Therefore, they have requested that the general concentration limits set under REACH regulations for the eight carcinogenic PAHs in Mixtures are insufficient for protecting those who come into contact with the granules and mulches while playing at sports facilities and playgrounds.

In its assessment, RIVM considers the human health risks for professional football players (including goalkeepers), children playing on the pitches and playgrounds, and workers installing and maintaining the pitches and playgrounds.

The proposal suggests a combined concentration limit for the eight PAHs of 17 mg/kg (0.0017 % by weight). The current concentration limits applicable for supply to the general public are set at 100 mg/kg for two of the PAHs and 1,000 mg/kg for the other six.

The proposal of the Netherlands, available on ECHA's website[73], outlines that the suggested reduction in the concentration limit would:

- ensure the cancer risk from PAH exposure remains very low for those coming into contact with the granules and mulches;
- decrease societal concerns about the negative health impacts caused by the PAHs;
- lead to no major additional administrative burdens on public authorities in terms of costs for implementing the lower concentration limit; and
- cause relatively limited and affordable societal costs.

ECHA's committees are now checking whether the restriction dossier conforms to REACH's requirements. If so, a six-month consultation will begin in September 2018. ECHA's scientific committees will assess the proposal and formulate their opinions, which will be submitted to the Commission.

In the light of the recent clarification by the Dutch authorities of the scope of the EU restriction on infill and timing for submitting the proposal and progress of the ERASSTRI (EU Risk Assessment of Synthetic Turf Rubber Infill) study, there are other working on this subject. One of them includes European Standardization Organizations, International Recycling Organizations, Investigation Companies, Managing Systems of ELT, Recyclers, Tyre producers, etc., which met at the end of June in Brussels to exchange views and reach a possible consensus on how to contribute to the next regulatory steps. The final recommendation is expected to confirm the limit the sum of the 8 PAHs of 20mg/kg.

Smart Connection Consultancy in Australia has adopted a strategy of providing recommendations to clients who are procuring fields:

- Specify that the infill, if affordable should be an appropriate organic infill;
- If recycled SBR from tyres is considered the most economical option, then the shredded tyres should be sourced from a REACH compliant country source with a certificate of conformity to the new proposed standards; (20mg/kg);
- The performance criteria standards of the sports International Federation are adopted; and
- There are no heavy metals in the yarn in accordance with EN 71.3: 2013.

[73] https://echa.europa.eu/-/lower-concentration-limit-proposed-for-pahs-found-in-granules-and-mulches

3. Perception of goalies in America contracting cancer

The University of Washington Women's Assistant Head Soccer Coach Amy Griffin became concerned about the amount of cancer among soccer players in Washington State and compiled a list of soccer players with cancer. Coach Griffin was especially concerned about the number of goalkeepers she identified with cancer and wondered whether exposure to crumb rubber infill in artificial turf might be causing it. The list included 53 people, most of whom played soccer and in the goalkeeper position.

Due to heightened public concern and the large number of people on the list, public health officials at the Washington State Department of Health and researchers from the University of Washington School of Public Health formed a project team to investigate following the Department of Health Cluster Guidelines and published their findings in April 2017.[74]

The overall purpose of the investigation was to explore whether the information from Coach Griffin's list warranted further public health response. The main goals of the investigation were to:

1) Compare the number of cancers among soccer players on the coach's list to the number that would be expected if rates of cancer among soccer players were the same as rates among all Washington residents of the same ages.
2) Describe individuals reported by the coach in terms of their demographics, factors related to cancer, and history of playing soccer and other sports.

The findings identified the different cancers that the players had contracted and compared that number against the average (standard deviation of 95%) and found that the occurrence rate was within the range expected for that size of population. This is shown in the image below.:

Table 1. Observed cancers from coach's list and expected cancers: soccer players ages 6–24 years diagnosed during 2002–2015

	Observed cancers from coach's list	Expected cancers	Ratio of observed to expected	95 percent confidence interval
All soccer players				
All types of cancer	28	1,384	0.02	0.01-0.03
Leukemia	6	131	0.05	0.02-0.10
Hodgkin lymphoma	5	147	0.03	0.01-0.08
Non-Hodgkin lymphoma	6	89	0.07	0.02-0.14
Goalkeepers	14	153	0.09	0.05-0.15
Select/premier soccer players	15	284	0.05	0.03-0.09

Figure 17: Observed Cancers from Coaches List 2002-2015

The overall conclusion from the WSDOH report stated:

This investigation did not find increased cancer among the soccer players on the coach's list compared to what would be expected based on rates of cancer among Washington residents of the same ages. This finding is true for all soccer players on the coach's list, as well as soccer players on the list at the WYS-defined select and premier levels, and goalkeepers on the list. The variety of fields and residences suggests that no specific field or geographic residence is problematic in terms of soccer players getting cancer.

In addition, the currently available research on the health effects of artificial turf does not suggest that artificial turf presents a significant public health risk. Assurances of safety, however, are limited by lack of adequate information on potential toxicity and exposure. The Washington State Department of Health will continue to monitor new research on health and environmental impacts of crumb rubber.

Thus, the Washington State Department of Health recommends that people who enjoy soccer continue to play irrespective of the type of field surface.

4. Link with rubber infills and Leukaemia or other cancers

According to recent research in 2015 and 2016 and in response to significant community concern during 2016 in the Netherlands the Dutch Governments' research results[75] states:

"No indications were found in the available literature of a link between playing sports on synthetic turf fields with an infill of rubber granulate and the incidence of leukemia and lymph node cancer. Moreover, it is clear from the composition of the rubber granulate that the chemical substances that are capable of causing leukemia or lymph node cancer are either not present (benzene and 1,3-butadiene) or are present in a very low quantity (2-mercaptobenzothiazole).

[74] Investigation of Reported Cancer among soccer Players in Washington State (Washington State Dept. Health: 2017) http://www.doh.wa.gov/Portals/1/Documents/Pubs/210-091.pdf [75] National Institute for Public Health and the Environment (RIVM) Ministry of Health, Welfare and Sport, Netherlands, report on 'Playing sports on synthetic turf fields with rubber granules' 20-12-2016

[75] OomenAG, de Groot GM (RIVM Summary Report 2016 – 0202) accessed on 22nd December 2016: http://www.rivm.nl/en/Documents_and_publications/Common_and_Present/Newsmessages/2016/Playing_sports_on_synthetic_turf_fields_with_rubber_granulate_is_safe

Photo 47: Multi-Sports Field at St Kevin's College, Toorak (Source: Tuff Group)

Since the 1980's, a slight rise has been observed in the number of people aged between 10 and 29 who get leukemia. This trend has not changed since synthetic turf fields were first used in the Netherlands in 2001."

In response to community interest in the USA, leading toxicologist Dr Laura Green pragmatically considered and addressed a series of concerns raised by a Principal of Jonesport Elementary School in Main (USA). This response is potentially the most detailed explanation of the perceived links of recycled SBR tyres to cancer, found by the author of this FAQ Fact Sheet[76]. In brief, her conclusion states:

"Overall, then, the evidence on crumb rubber and rubber mulch does not suggest, let alone demonstrate, that rubber poses a significant risk to the health of children and others. As such, I believe that Principal Lay can rest assured that the mulch in her playgrounds has not put her students at risk of developing cancer."

In 2006, the Norwegian Institute of Public Health published their report,[77] the investigators noted:

"Worse case calculation based on air measurements carried out…… does not cause any increased risk of leukaemia as a result of benzene exposure or anyelevated risk as a result of exposure to Polycyclic Aromatic Hydrocarbons (PAH's).

[76] Dr Laura Green Memorandum, June 29, 2015 Re: Comments on CPSC Report #20150608-22F81-2147431268 Assessment of the risk of cancer posed by rubber mulch used in playgrounds http://c.ymcdn.com/sites/www.syntheticturfcouncil.org/resource/resmgr/Files/Rubberecycle_-_Dr._Green_let.pdf

Photo 48: Multi-Sports Field (Moore Park, NSW)

6.4 Conclusion

There are no Australian or New Zealand health and safety standards directly for synthetic sports fields. The Europeans have adopted this EN Standard EN – 15330-1: 2013 Surfaces for Sports Areas, which considers the health and safety playing characteristics of:

- Players – surface interaction (e.g. hardness, turning, grip etc);
- Ball – surface interaction (e.g. bounce, splash, roll etc);
- Material quality and durability; and
- Build quality – levels, straightness etc.

Each of the International Federations of Sport (e.g. FIFA, World Rugby, FIH etc.) have used the EN Standard as the basis of developing their own Performance Standards. All of these standards have been adopted in Australia by the key sports, including:

- Football (Soccer) – FFA has adopted the FIFA Quality Manuals two standards of FIFA Quality mark (for 60+ hours) and the FIFA Quality PRO mark (for c. 20 hours);
- Rugby Union – Rugby Australia has adopted the World Rugby's Regulation 22 standard;
- Rugby League – the NRL has adapted the English RFL's two standards for Australia and produced their own two standards for community fields and stadium use;
- Hockey – Hockey Australia has embraced the FIH three standards for fields, with Global, National and Multi-use; and
- Australian Rules Football – the AFL has developed their own standards for community fields.

[77] Dye, C.; Bjerke, A.; Schmidbauer, N.; Mano, S. Measurement of Air Pollution in Indoor Artificial Turf Halls, Report NILU OR 03/2006. Norwegian Institute for Air Research: Kjeller, Norway, 2006.

7. Sustainability Standards

7.1 Introduction

To ensure that any development has minimal negative impact on the natural environment, a vision for a sustainable sports venue needs to be created. This discussion has explored several frameworks around sustainability and has embraced the 'One Planet' initiative.

Their vision is based on the international standard ISO 20121:2012 Event Sustainability Management System[78] as well as the principles of Green Engineering[79] and the business of AS Environmental Management Standard 14000 and the Australian Governments Environmental Sustainability Policy.

A summary of how these and other initiatives should be embraced in the design, development, procurement and management of such projects include:

The 'One Planet Sport' initiative provides a simple and coherent statement of what genuine environmental sustainability really means for sports organisations and planning. Many of the initiatives were embraced by the London 2012 Olympic and Paralympic Games and have been built on since.

Their vision is for a world in which we are living happy, healthy lives within the natural limits of the planet. They have 10 principles, which are used as a framework to examine the sustainability challenges faced and develop appropriate solutions. Building on this the implementation for a sports hub/field, pavilion and infrastructure may include:

- **Zero Carbon** – making buildings more energy efficient and delivering all energy with renewable technologies

Minimising demand through efficiency savings reduces costs and has an essential role to play in ensuring that supply can meet future demand. Meeting remaining energy demand through renewables has the potential to provide a clean and secure source of energy that is not dependent on finite resources. This can help to prevent average global temperatures from rising by more than 2°C, causing dangerous climate change.

Renewables should include wind turbines, solar panels and embracing and the planning of more trees to offset any reduction of vegetation or increase in the built footprint.

- **Zero Waste** – reducing waste arisings, reusing where possible and ultimately to send zero waste to landfill

Waste management systems should be designed around the waste hierarchy, prioritising waste prevention above all else; followed by reuse, recycling and composting, then lastly efficient energy recovery to avoid all but unavoidable disposal to landfill. Smart Connection Consultancy are working with some clients and the industry to develop a 'Cradle to Cradle' solution.

- **Sustainable Transport** – encouraging low carbon modes of transport to reduce emissions, reducing the need to travel

Facilitating and promoting walking, cycling, and public transport use among participants, staff, and spectators. Where vehicles are required, these should be highly efficient and run on renewable fuels. Cleaner and more active travel benefits both our health and the environment. The siting of playing areas in each community can significantly reduce the need for travel.

- **Sustainable Materials** – using sustainable products that have a low embodied energy

The aim is to use goods – for construction or consumption – that are made from renewable or recycled materials. These goods are produced in a clean[80] and ethical[81] manner. Green Engineering needs to be the basis of a Cradle to Cradle solution for synthetic sports facilities.

- **Local and Sustainable Food** – choosing low impact, local, seasonal and organic diets and reducing food waste

Working with large caterers and small businesses to provide healthy, ethical, local, seasonal, and organic produce that meets dietary and cultural requirements. Transparent purchasing systems need to be established to ensure that food is responsibly sourced and does not contribute to deforestation, overfishing, or pollution.

- **Sustainable Water** – using water more efficiently in buildings and in the products we buy; tackling local flooding and water course pollution

Water consumption and discharge must respond to regional and local sensitivities on issues such as water

[78] ISO 21012:2012 specifies requirements for an event sustainability system for any type of event or event-related, and provides guidance on conforming to their requests

[79] $1.4m capital cost v $0.8m natural turf for 3,000 v 1,000hrs with only 40 people playing per hour, the costs are $11.66 (syn) and $20 (natural)

[80] Low embodied carbon, non-polluting and non-toxic

[81] Under fair and safe working practices

stress and flood risk. Opportunities should be sought to enhance aquatic environments. Awareness campaigns can be introduced to engage people in responsible water usage, this includes water harvesting for the facilities (e.g. toilet flushing) and watering local natural fields from water collected off synthetic fields.

- **Land Use and Wildlife** – protecting and expanding old habitats and creating new space for wildlife

Leading ecologists recommend biologically productive land to be left for wildlife. With this in mind, leading sporting organisations and events should look to showcase their contribution to this global target by facilitating the establishment or enhancement of valuable wild space and biodiversity value on-site or elsewhere.

- **Culture and Community** – reviving local identity and wisdom, support for and participation in, the arts

Striving to develop a thriving sense of place and building connectedness. Through working together with local communities to build networks of shared values and understanding, sustainable sports and events can facilitate cooperation and build social capital. Research has shown that this improves health and educational achievement, increases employment and cuts crime rates. The importance of local 'Places' for people to play and recreate is critical and not always building regional facilities at the cost of the local provision.

- **Equity and Local Economy** – inclusive, empowering workplaces with equitable pay; support for local communities and fair trade

Organisations can demonstrate their commitment to equity and local economy through exemplary procurement and supply chain policies; this includes policies which ensure the workforce of suppliers are treated properly and have their rights respected. Consideration should be given to ensuring equality with respect to gender, ethnic diversity, sexual orientation and disability, in terms of both of physical access, employment and volunteering opportunities. Many of our projects request that local people are used in the project build.

- **Health and Happiness** – encouraging active; sociable, meaningful lives to promote good health and wellbeing

Sports organisations and events have a unique opportunity to encourage, inspire and support people in leading more active and healthy lifestyles, in fun and enjoyable ways. Sporting organisations and local government also have the responsibility to support the health and happiness of their employees, volunteers and events participants. The use of synthetic surfaces can provide in excess of 3,000 hours usage per annum, compared to 1,000 hours for an equivalent natural turf field.

7.2 Sustainable Design Considerations

1. Introduction

For any organisation, whether that be a Council, education establishment or sport organisation, who is considering embracing the synthetic surface technology there is a need to appreciate how the technology can be integrated into the whole project and not just the field of play. This will ensure that the technology systems are designed and procured to be fit for your project's specific purpose.

To ensure the location, site and design considerations are fit for purpose, four key strategic stages are recommended for the project, namely:

Planning - Review Council's, State Government and SSO's strategies, priorities and Council's Key Principles to ensure alignment to maximise support for opportunity

Design - Embrace best practice recommendations to inform design, management and replacement for sustainable whole of life considerations. Utilise the self-assessment checklist to review the design, placement and management against Council's Synthetic Sports Surfaces Key Principles and Focus

Procurement - Build or renew the surface in a manner that meets Council's procurement principles ensuring quality and asset sustainability

Management- Continually review and provide feedback to asset owner on the success of the investment

The self-assessment process is designed around these four stages with this section providing guidance to assist the organisation through the process.

7.3 Green Engineering

The principles of Green Engineering are based on the design, processes and products used, the sustainability of the product and protection of human health without sacrificing economic viability and efficiency.

When considering Green Engineering in association with synthetic sports surfaces one should consider the following aspects:

1. Recycled components

How much of the 'new' project can be created from recycled products in the construction and installation of the surface.

This may include aspects such as:

- Sub-base and Pavement – explore how much of the pavement and sub-base could be used from recycled products, including recycled concrete, recycled asphalt etc.
- If using a drainage cell could this be sourced from a recycled source?
- Is the shockpad made from recycled rubber as either an insitu shockpad or a pro-forma pad. Use of a shockpad may reduce infill between 30-50%
- Has the sand ballast been used in other systems and is recycled into this system?
- Is the performance infill from a previous field, re-tested and recycled for this project?
- Some manufacturers are developing yarn from some components of recycled yarn polymers

2. Recyclable components

Ideally, to reduce waste, the system components should be able to be reused or recyclable after their initial primary use. This could include:

- Yarn to be broken down into its core polymer and reconstructed as yarn for another field or as pellets for other rubber/plastic products
- Carpet backing – this should be able to be stripped from the yarn and infill and the secondary baking, whether latex or PU reused to minimise the waste
- Infill – as this is over 75% (by weight), the sand ballast should be recycled for other systems or other uses, such as in concrete, etc. The rubber should look as being recycled as well
- The shockpads need to be recycled

3. Re-use components

By extending the life of key components of the system will significantly reduce the waste associated with the surface. Key aspects for consideration would be:

- Shockpad – over the last five years shockpad guarantees have increased from 15 to 23-30 years. Realistically three cycles of the pad should be expected. It is important after the 23-30 years expected that the pad is then recycled.
- Infill – Australia has seen two 3G fields have some of the performance infill re-used, with quality infill. It is expected that if the sand and infill can be separated that will allow nearly 75% of the system to be re-used for 10-20 years at least
- Re-use the topsoil on site and do not take it to the tip
- Repurposing - Some companies are "repurposing" the carpet and yarn for other projects, such as golf driving ranges or schools. This is just shifting responsibility from one client to another, who needs to address it at a later date. Many responsible clients are now taking the responsibility themselves and, therefore, do not want repurposing options.

8. Key Contacts

8.1 SA Specific Industry Contacts

Office of Recreation, Sport and Racing
145B Railway Terrace
Mile End, SA, 5031
p: 1300 714 990
e: ORSR.Enquiries@sa.gov.au
w: www.orsr.sa.gov.au

Sport SA
Military Road,
West Beach, SA, 5024
p: 08 8353 7755
e: admin@sportsa.org.au
w: www.sportsa.org.au

Football SA
ServiceFM Stadium
Matildas Drive (Cnr Briens Road)
Gepps Cross, SA, 5094
p: 08 8340 3088
e: info@footballsa.com.au
w: www.footballsa.com.au

Bowls SA
583A Anzac Highway
Glenelg North, SA, 5045
p: 08 8234 7544
e: reception@bowlssa.com.au
w: www.bowlssa.com.au

AFL SA
PO Box 606
North Adelaide, SA, 5006
p: 08 8234 7544
w: www.sanfl.com.au

South Australia Cricket Association
Adelaide Oval, War Memorial Drive,
North Adelaide, SA, 5006
p: 08 8300 3800
e: sacareception@saca.com.au
w: www.saca.com.au

Hockey SA
Main N Road,
Geeps Cross, SA, 5094
p: 08 8349 4044
e: admin@hockeysa.com.au
w: www.hockeysa.com.au

SA Local Government Sport & Recreation Forum
Craig Hobart
Asset Planner
Assets and Technical Services
P: (08) 8384 0666
M: 0466 922 661
www.onkaparingacity.com

8.2 Independent Advisory Services

Smart Connection Consultancy
Martin Sheppard, Managing Director
Suite 40, 204-218 Dryburgh Street
North Melbourne VIC 3051
p: (03) 9421 0133
e: martins@smartconnection.net.au
w: www.smartconnection.net.au
Consultant to all Football Codes in Australia
Key sports

8.3 Key Sports

Football Australia (Football)
Locked Bag A4071, Sydney South, NSW, 1235
p: (02) 8020 4000
e: reception@footballaustralia.com.au
w: www.footballaustralia.com.au

National Rugby League Limited (NRL)
John Wilson, Acting Executive General Manager - Participation
Rugby League Central, Driver Avenue Moore Park
NSW 2021
p: (02) 9359 8500
e:lellis@nrl.com.au
w: www.nrl.com

Rugby Australia (RA)
Michael Procajlo, General Manager Community Rugby
Rugby Australia Building
Cnr Moore Park Road and Driver Ave Moore Park
NSW 2021
p: (02) 8005 5555
eMichael.Procajlo@rugby.com.au
w: www.rugbyaustralia.com.au

Australian Football League (AFL)
Amber Koster, Planning & Investment Lead AFL House,
140 Harbour Esplanade Docklands VIC 3008
p: (03) 8341 6085
e:Amber.Koster@afl.com.au
w: www.afl.com.au

American Football Australia
Wade Kelly, Chief Executive Officer
1/21 Waterloo Road
Collingwood, VIC, 3066
e:info@americanfootball.org.au
w:www.americanfootball.org.au

Touch Football Australia
Marcus Ashcroft, Chief Executive Officer
6 Makin Place, Deakin ACT 2600
p: (02) 6212 2800
e:marcus.ashcroft@touchfootball.com.au
w: www.touchfootball.com.au

Australian Oztag
Bill Harrigan, Chief Executive Officer
PO Box 703, Cronulla NSW 2230
p: (02) 9562 8633
e: info@oztag.com.au
w: www.oztag.com.au

8.4 International Sports Federations

Football/Soccer – FIFA - Quality Program for Football Turf
FIFA Quality Programme for Football Turf

Rugby Union – World Rugby - Rugby Turf Program
http://playerwelfare.worldrugby.org/rugbyturf

Hockey – International Hockey Association (FIH) FIH Quality Programme

APPENDIX 1 – Cost Tables

Initial Capital Costs of Synthetic Surface Installation

Table 11: Initial Capital Cost of Synthetic Surface Installation			
1. Type of synthetic field of play (sports name)			**Football (Soccer)**
2. Size of area of field			**8,500**
3. Field Planning and Procurement Costs	**Variable costs (per m^2 / lin. Metre)**	**Fixed costs**	**Total cost of field**
Detailed site survey		**$12,000.00**	**$12,000.00**
Geotechnical investigation		**$14,000.00**	**$14,000.00**
Technical Specification and Design Package		**$55,000.00**	**$55,000.00**
Procurement		**$20,000.00**	**$20,000.00**
Project Management		**$60,000.00**	**$60,000.00**
Approvals i.e. Development Approval		**$10,000.00**	**$10,000.00**
		Field Planning and Procurement Costs Sub-total	**$171,000.00**
4. Synthetic Field Direct Costs			
Site establishment, documentation & project management		**$100,000.00**	**$100,000.00**
Disposal of spoil	**$75.00**		**$75,000.00**
Sub grade works	**$30.00**		**$255,000.00**
Drainage, gutters and concrete works		**$200,000.00**	**$200,000.00**
Base pavement (e.g. road base)	**$20.00**		**$170,000.00**
Additional costs to offset site challenges (see Part 2 Section 6)	**$0.00**	**$0.00**	**$0.00**
Synthetic sports surface and infill	**$55.00**		**$467,500.00**
Shock pad installation	**$30.00**		**$255,000.00**
Other (if required)	**$0.00**	**$0.00**	**$0.00**
		Pitch Sub-total	**$1,522,500.00**
5. Synthetic Field Indirect Costs			
Field fencing / gates	**$150.00**		**$54,000.00**
Field lighting		**$175,000.00**	**$175,000.00**

Player benches / shelter		**$24,000.00**	**$24,000.00**
Equipment (i.e. shoe cleaning)		**$4,000.00**	**$4,000.00**
Retractable Netting	**$0.00**	**$0.00**	**$0.00**
Spectator Seating	**$0.00**	**$0.00**	**$0.00**
Pathways	**$85.00**		**$75,480.00**
Goals		**$4,000.00**	**$8,000.00**
Maintenance machinery		**$18,000.00**	**$18,000.00**
Marketing and Communications		**$0.00**	**$0.00**
Other (e.g. drinking water etc.)	**$0.00**	**$0.00**	**$0.00**
		Ancillary costs Sub-total	**$358,480.00**
		Investment without Contingency (Pitch + Ancillary costs)	**$1,880,980.00**
Contingency Allowance	**0.0%**		**$0.00**
PM Costs	**0.0%**		**$0.00**
Total investment			**$2,051,980.00**
6. Less Grants Expected / Income Available			
1. State Government Grant Aid			$0.00
2. Other Grant Aid			$0.00
3. Self-funded money available			$0.00
4			$0.00
5			$0.00
Total revenue expected to offset initial capital costs			**$0.00**
Net Capital Cost			**$2,051,980.00**

Annual Maintenance Costs

Table 12: Annual Maintenance Costs			
Maintenance costs compared to usage expectations			
Component	**Aus. $ cost**		
Field of Play Maintenance Costs	**under 40 hours**	**40 - 60 hours**	**Over 60 hours**
Routine grooming	**$13,000**	**$15,000**	**$17,000**
Professional service grooming	**$9,000**	**$9,000**	**$9,000**
Algaecide / Herbicide application	**$3,000**	**$3,000**	**$3,000**
Visual inspection	**$2,000**	**$2,000**	**$2,000**
Field performance testing	**$0**	**$0**	**$0**
Other (please list)	**$0**	**$0**	**$3,000**
Pitch Sub-total	**$27,000**	**$29,000**	**$34,000**
Ancillary Costs			
Fencing	**$4,000**	**$4,000**	**$4,000**
Field lighting	**$3,000**	**$3,000**	**$3,000**
Irrigation (if required)	**$1,500**	**$1,500**	**$1,500**
Goals	**$0**	**$0**	**$0**
Equipment (i.e. shoe cleaning)	**$0**	**$0**	**$0**
Retractable Netting	**$0**	**$0**	**$0**
Machinery maintenance	**$1,500**	**$1,500**	**$1,500**
Staff costs including staff training (if required)	**$0**	**$0**	**$0**
Other (please list)	**$0**	**$0**	**$0**
Ancillary costs Sub-total	**$10,000**	**$10,000**	**$10,000**
Total Annual Maintenance Cost For Field	**$37,000**	**$39,000**	**$44,000**

Whole of Life Replacement Costs

Table 13: Whole of Life Replacement Costs			
Replacement costs for each expected replacement (every 10 yrs.)			
Component	**Aus. $ (with CPI)**		
Pitch Costs	**After 10 years**	**After 20 years**	**After 30 years**
Field planning and procurement	**$76,200.00**	**$163,068.00**	**$228,600.00**
Site establishment, documentation & project management	**$100,000.00**	**$214,000.00**	**$300,000.00**
Removal & disposal of existing synthetic turf surface	**$75,000.00**	**$160,500.00**	**$225,000.00**
Base rectification	**$25,000.00**	**$53,500.00**	**$75,000.00**
Synthetic surface installation	**$467,500.00**	**$1,000,450.00**	**$1,402,500.00**
Shock pad replacement should be every 20-25 years or allow 10% for upgrade in between	**$25,500.00**	**$54,570.00**	**$255,000.00**
Drainage system, pavement base and other civil works (assuming life expectancy of 30 years & 50% needs replacing)			**$312,500.00**
Pitch Sub-total	**$769,200**	**$1,646,088**	**$2,798,600**
Ancillary Costs			
Fencing (replace chainmesh - allowed 33% replacement)	**$17,820.00**	**$38,134.80**	**$54,000.00**
Lighting (allowed 40%)	**$70,000.00**	**$149,800.00**	**$219,800.00**
Other (e.g. drinking water etc.)	**$0.00**	**$0.00**	**$0.00**
Mobile Equipment (allowed 100%)	**$18,000.00**	**$38,520.00**	**$54,000.00**
Fixed Equipment (allowed 20%)	**$0.00**	**$0.00**	**$0.00**
Ancillary costs Sub-total	**$105,820.00**	**$226,454.80**	**$327,800.00**
Contingency costs (15%)	**$131,253.00**	**$280,881.42**	**$468,960.00**
Total Replacement Costs for Field of Play	**$1,006,273.00**	**$1,872,542.80**	**$3,126,400.00**