smart connection consultancy

SMART GUIDE TO SYNTHETIC SPORTS SURFACES

(Long and short pile grasses, hybrid grass, acrylic & rubber surfaces)

Fourth Edition: October 2025

Acknowledgements

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Without their support, we would not be able to achieve our goal of enhancing the industry's knowledge of synthetic sports surfaces. We would also like to thank our colleagues, clients, and organisations for which we have completed work in the sports industry. Your appetite for change and progress makes our job so rewarding.

About the Author

Martin Sheppard, Managing Director, Smart Connection Consultancy

Martin has worked in the sport and active recreation industry for over 40 years, managing a diverse portfolio of facilities, including leisure centres, sports facilities, parks and open spaces, athletic tracks, synthetic sports fields, golf courses and a specialist sports and leisure consultancy practice.

He clearly understands the strategic and political environment of sport while also providing tactical and innovative solutions. Martin is an international speaker whose expertise is recognised for aligning synthetic surfaces and facility development with player pathways, supply and demand forecasting, and participation growth strategies.

Martin is the Chair of The Internation Association for Sport and Leisure Facilities (IAKS) Expert Panel on Outdoor Sports Surfaces and Technical Consultant for Australia's leading football codes, including:

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Disclaimer

Smart Connection Consultancy does not accept liability for the accuracy of the information provided. All material and information provided by third parties is done so in good faith to assist organisations in understanding the key issues around synthetic sports surfaces. We will continually update the Smart Guide to attempt to keep the industry updated.

Purpose of the Guide

Smart Connection Consultancy is committed to sharing knowledge and learnings with the industry and has produced the Smart Guide to Synthetic Sports Surfaces.

At the back of this Smart Guide we have provided a self-assessment questionnaire to assist with your thinking regarding the planning, design, procurement and delivery, the management and end of life stages of a sports surface.

Once completed Smart Connection Consultancy will provide an hour of complimentary support and review the questionnaire for you. Send to Martin on martins@smartconnection.net.au and book a time for an informal 30 mins free consultation.

smart connection consultancy

Suite 40, 204-218 Dryburgh Street

North Melbourne, Victoria, Australia 3051

t: +61 (0)3 9421 0133

e: martins@smartconnection.net.au
w: www.smartconnection.net.au

WELCOME

In the past 15 years since the first Smart Guide to Synthetic Surfaces was published, Australia's population has increased by over 5 million people and our children are still not active enough or have enough places and spaces to participate in.

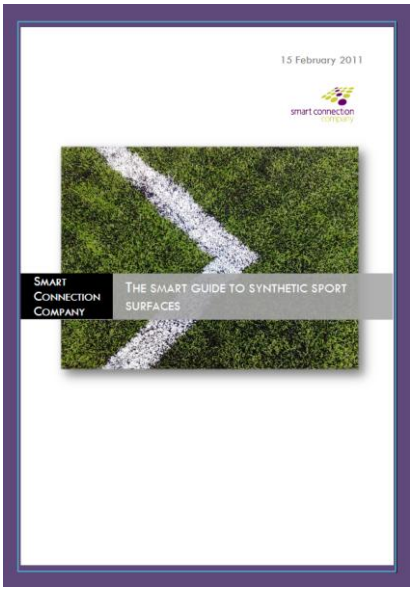


Figure 1: Smart Guide to Synthetic Sports Surfaces was first published in February 2011.

The population growth has placed significant challenges on sports fields, courts and surfaces as local government and sport continues to try and cope with the increasing demand for the team sports of Football, Australian Rules, Rugby Union and Rugby League. In addition, as many cohorts of the community are not aligning these days with the traditional sports and seeking other experiences such as Touch Rugby, Oz Tag, 5-a-side and more, this is placing further pressure on the fields.

As many local inner city communities are expanding, they don't have their own 'backyard' to play in and so expect that from their local parks. This pressure for both passive parkland and active parks means that in addition to the traditional team sports needs, the casual usage is now becoming significant.

Many local governments are working hard with sport and natural grass specialists to improve the infrastructure of natural grass with excellent results. This investment still struggles with the demands that are being placed on the natural turf, when demand exceeds 30 hours per week. Many of the Councils are now investing in technology to strategically support some of these needs, with hybrid turf technology and the next generation of synthetic sports turf, which is far more durable and environmentally responsive.

The call from the community for synthetic turf technology has been embraced by the manufacturers and if a purchaser asks for the right turf system the vast majority of the community perceived concerns can be designed out.

Over the next decade, we as an industry need to ensure that sustainability is considered holistically. This Guide explores a multiple bottom line lens towards sustainability, including:

- **People** (community) lens – how can we create spaces and places that encourage more people to be active and the surfaces can cope with the demand. This is critical to address sedentary lifestyles and reduce the health impacts we are facing as a society.
- **Planet** (environmental) lens – we need to reduce our negative impact on the planet, so that we can leave the environment in the best condition possible for our future generations. The way we plan, design and manage the facilities need to embrace this.
- **Prosperity** (economic) considerations – that explore the whole of life costs associated with the capital costs, ongoing maintenance and replacement. Comparing this to the hours of use, will provide a true comparison.
- **Performance** (fit for purpose) – ensuring the surface is fit for purpose for Australia's climate conditions and is not aspirational of a specific clubs needs.

Photo 0.1: The level of Australian sedentary lifestyles in children is one of the worse in the world

This Smart Guide focuses on how sports surfaces are being created to satisfy the demand of participants by embracing technology. The new technology is now embraced holistically.

CONTENTS

SECTION 1: INTRODUCTION TO CONTEMPOARY SPORTS SURFACES

Growing participation will support the community in being more active and healthier. To do that they need environments to exercise, play, recreate and participate in community sport.
With the increased inner city population growth, natural turf fields are under significant pressure to meet growing demands.
Where they can't, synthetic technology should be considered to supplement natural fields to satisfy demand.

1. Introduction To Contempoary Sports Surfaces

1.1 Introduction

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 surface infrastructure nationwide.

In the modern era, where sustainability is a common phrase the importance of a strategic lens around how sports surfaces impact and can be impacted by a sustainability lens needs to be fully comprehended. The Smart Guide to Synthetic Sports Surfaces (Smart Guide) has adapted a multiple bottom line to sustainability, similar to that used by local governments across Australia, we call the 4P's:

- **People** (community) lens – changing demographics impacting surface options
- **Planet** (environmental) lens – reducing the impact of the surface on the environment
- **Prosperity** (economic) lens – the whole of life costs influences price and economic management
- **Performance** (fit for purpose) – ensuring the surface is fit for purpose.

1.2 **People** - Changing Demographics Impacting Surface Options

Demand is further compounded by changes in how sport is played. Across Australia and particularly in urban inner cities, there has been a rapid increase in the popularity of modified and small-sided sports formats such as 3-on-3 basketball, Pickleball, Touch Rugby, 5-a-side Football, Viva Rugby, and Hockey 5's etc, particularly among younger players and culturally diverse communities. These formats often involve more frequent turnover and higher player density on surfaces. 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 surface wear and raises the question of how to sustainably meet this new demand profile.

1.2.1 Changing demographics

Australian population historic growth[1] (33%) coupled with the expected population in the next 15+ years will rise to over 31 million[2] (approx. 40% increase), which will seriously impact sports facility provision and accessibility in many cities around Australia.

This demand will continue to place significant pressure on sports facility infrastructure around key cities in Australia, where demands for additional playing fields and facilities, and additional hours per field continue to exceed the hours available for natural surfaces.

1.2.2 Societal changes

The demographics of western societies are changing significantly, impacting how we plan for facilities and strategic priorities, as we consider the following:

1. **General Population Growth**

- Australia's 2022 population statement reflects the impact of Covid-19 on the population, resulting in smaller and older estimation population growth prior to the pandemic. It still expects growth over the decade from 25.7 million (2021) to 29.9 million by June 2033 and is projected to grow to 39.2 million by 2060/61.

- The greatest long-term demographic challenge is the ageing population, with the number of over 65s doubling in the last 70 years. This cohort will continue to increase, from 16.8% (2020/21) to 19.9% (2032/3) and 23.1% by 2060/61.

- The largest geographic growth areas are still around capital cities, as urbanisation continues to grow, although during and post-Covid, the move away from the capital cities has nearly doubled, but still relatively low overall.

- With considerable proportions of society already demonstrating sedentary tendencies as they grow older, today's sedentary children will be tomorrow's sedentary adults, who, when they, in turn, have children, are likely that their children will also be sedentary. So, the health impact could be catastrophic. The research consensus identifies the need to focus on children to encourage them to be more active.

2. **Ageing Society**

- As Australia's population grows older, society will need to have the infrastructure in place to cope with the additional growth in chronic physical (and mental) health conditions that impact the health departments at the Commonwealth and State levels.

[1] ABS, Australian Demographic Statistics (cat. no. 3101.0), data extracted 21 December 2024 http://abs.gov.au/ausstats/abs%40.nsf/94713ad445ff1425ca25682000192af2/1647509ef7e25faaca2568a900154b63?OpenDocument

[2] ABS, http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/3222.0

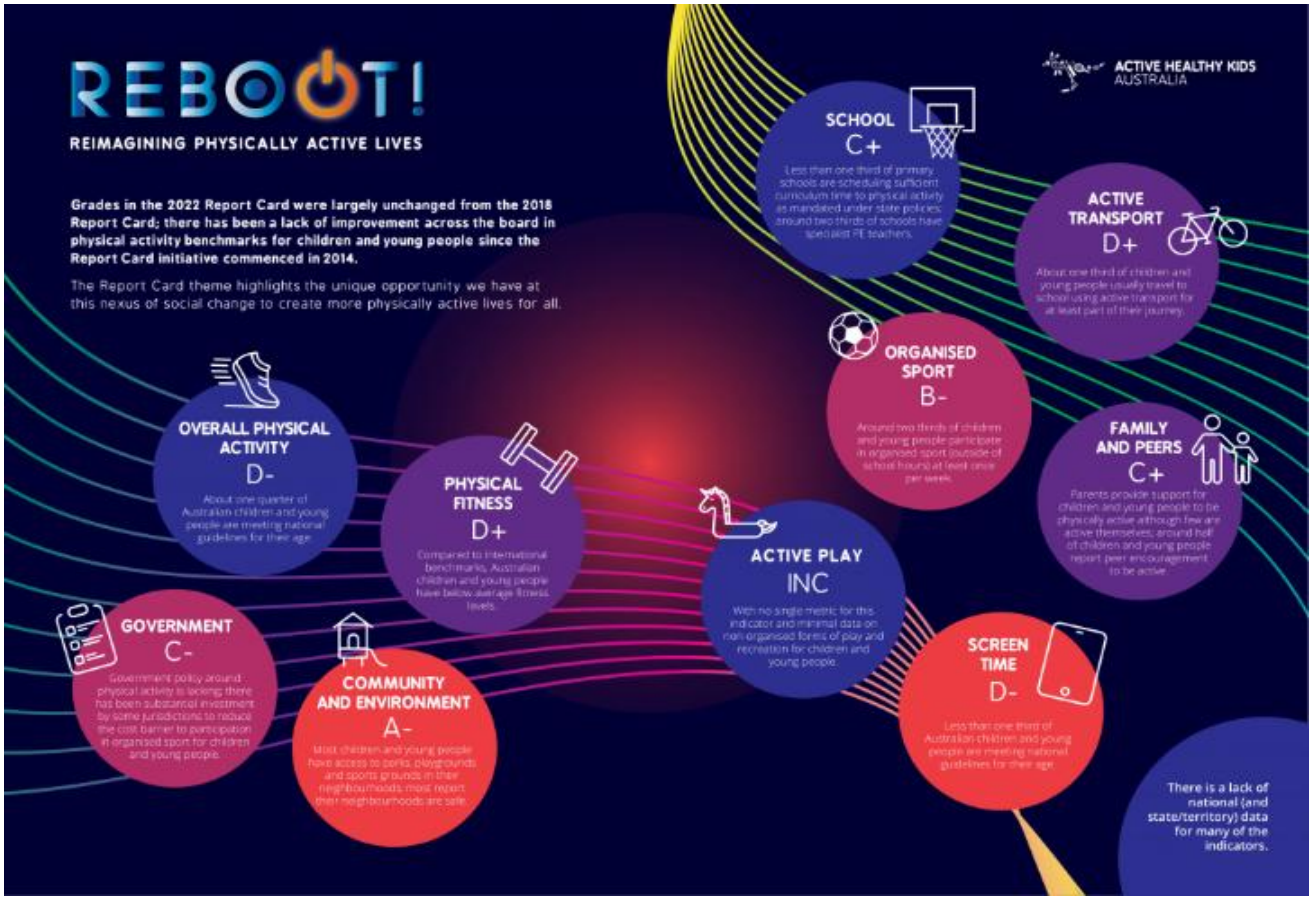


Figure 1.1: Active Health Kids Australia only gives Australian children a D- for overall activity levels.

- The burden of the ageing society will be felt economically at both State/Territory and Commonwealth levels. With reduced young workers, older people may be encouraged to stay or re-join the workforce to keep the Country functioning.
- Without appropriate taxes on the older population (e.g. GST) that go to the Commonwealth Government, compared to the States currently, there will not be adequate income to invest in long-term infrastructure needs.
- Significant opportunities exist for the community sport and recreation sectors, including additional volunteers, a new clientele of newly retired people with disposable income, and increased numbers of physical and mental health activities and programs.
- As healthy Australian's age, their participation preferences will change and move from competitive to participatory, and so more options need to be provided.

3. Children and Youth

- The recent (2021) publication of the Global Active Kids Score Card[3] gave Australian young people a "D-", which was the same as two years ago.
- Childhood obesity affects growth and development, and the biggest increase in weight gain is from childhood to early adulthood[4]. 1 in 4 young children (2-4 years old), 1 in 4 children (5-17) and 1 in 2 young people (18-24 years old) are already living with being overweight or obese.
- There are 4.7 million children (0-14 years of age) living in Australia (19%) compared to 3.5 million in 1968 (29% of the population), which demonstrates the continued drop as our population grows[5] 70% of children (2-17 years) do not meet the physical activity guidelines, and only 2% of teenagers (13-17 years) meet the guidelines.
- Many young people have moved away from traditional sports clubs and are joining other 'Play and Pay' options, where the emphasis is on fun, still competitive and less on pathway development.

[3] https://achper.vic.edu.au/achper/public/news/news-items/2022-Australian-Physical-Activity-Report-Card-released.aspx
[4] National Obesity Strategy (2022-2032) (Health Ministers Meeting 2022) (https://www.health.gov.au/resources/publications/national-obesity-strategy-2022-2032?language=en)
[5] Australia's children: in brief – AIHW (2019) (https://www.aihw.gov.au/reports/children-youth/australias-children-in-brief/summary)

- Increased sedentary lifestyles are becoming the norm with younger people, who may be missing guidance from parents/guardians due to their own sedentary lifestyle choices.
- School and Higher Education settings are critical to encouraging young people to be 'active enough'.
- School curriculum will impact the level of participation if this continues to fall, children's health will continue to decline.
- Children's behaviours need to be understood when designing exercise, recreation, and entry-level sports programs to have a considerable emphasis on fun, mateship and physical literacy.
- Adaptive sports programs are needed for children and young people and delivered in a manner that understands needs and encourages retention.
- The design of future facilities needs to accommodate these adaptive programs as younger people move away from traditional participation in sports.
- The emphasis on technology in young people's lives needs to be embraced by sport/recreation providers and not seen as a competition all of the time.
- There will need to be greater emphasis on physical literacy for children. If they do not develop this, then as adults, they will struggle with common daily physical literacy tasks and their ability to participate in sport with confidence. Therefore their likely retention will be low.

4. Diverse Demographic

- Australia continues to embrace multi-culturalism across its planes, with 7.5 million (29.1%) of the population born overseas[6], ranking Australia 9th against the United Nations international comparison. The largest populous countries are UK (967,000), India (710,000) and China (596,000).
- Demographic profiles, definitions, and characteristics are changing, and how they expect to be communicated, interacted with, and engaged with will continue to evolve as well. Understanding these changing demographics is critical for future planning and provision.
- The life expectancy in Australia continues to increase at the last census (2021) at 81.3 years for males and 85.4 for females, an increase of 1.6 years for males and 1.2 for females. Interestingly, life expectancy in the USA has been on the decline over the past couple of years, reducing from 79 years (2019) to 77 in 2020 and 76 in 2021. This is expected to be the norm in many Western Countries as the sedentary lifestyle takes hold. This generational problem is everyone's challenge for the future.

5. Inclusion and Inequalities

- The Australian cultural profile continues to diversify rapidly7 and this will influence our social, cultural and political systems over the future decades and impact their expectations for participation opportunities in play, exercise, recreation and sport. By 2060, 74% of the population growth is expected to come from overseas migration8.
- Australia's proportion of First Nations people is increasing, from 2.3% (2001) to 3.2% (2021) and is expected to grow faster than the general population, to reach 1 million by 2027.
- Sport can bridge the cultural divide at community levels by being a vehicle for introducing new arrivals into their community by creating strong, diverse community clubs.
- The gender gap is still apparent across sport, with men historically receiving greater support and opportunities to participate, represent their country, be featured in the media and have more success in administration. The last few years have seen some rebalancing of these inequalities with many State/Territory governments supporting sports to embrace these inequalities and rebalance this gender divide.
- Opportunities for all abilities have started to be embraced but do not reflect that people with a disability comprise around 18% of the community, including disabilities relating to sensory and speech, intellectual, physical, psychosocial, head injury, stroke or acquired brain injury or other restrictions in everyday activities due to other long-term conditions or ailments9.
- These and other inequalities impact sport and how sport needs to consider creating a fairer, more just and inclusive society. By sport considering a more inclusive approach, then the way the industry plans, provides, and measures success will also have to change.

Section 4 explores the surfaces for each sport and participation activity.

[6] ABS/GOV/AU/People/australia's-population-country-birth/2021
[7] ABS (2022) Migration: statistics on Australian International Migration, International migration and the population by Country of Birth
[8] Australian Government (2021) Intergenerational report (Treasury)
[9] AIHW (2022) People with disability in Australia 2022

1.3 **Planet** – Reducing The Impact Of The Surface On The Environment

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 single sport surfaces, like asphalt tennis and netball courts that are only used seasonally, or for limited hours, are now being changed to multi-use so that there is usage each day and throughout the year, by broader cohort of users.

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 turf) and then full synthetic technology (e.g. rubber running tracks, acrylic courts, hockey fields and football turf).

With the technological advances in design, manufacturing, construction and management, there should be greater emphasis on reducing the negative impact on the environmental footprint.

Most local governments are planning and designing sports and recreation spaces and places that encourage people to be active through exercise, play, recreation and participation in community sport in a manner that doesn't put stress on the local environment. This way we can manage and maintain an ecological balance in the worlds natural environment, protecting future generations from climate change and material scarcity.

To achieve this, many local governments and sports are considering the following principles:

i. **Reduce** – reduction in energy consumption, carbon footprint, natural waste etc.
ii. **Reuse** – extend the lifespan of products, repurposing components of a sports surface system etc.
iii. **Recycle** – converting used materials into new products or taking components back to their raw state so they can be used again and again (circular economy).
iv. **Rethink** – calling on local government and sport to question traditional practices, re-evaluating business models, programming approaches and create 'lower environmental impacts'. This could include the need for less tennis, netball courts by programming over a whole long weekend and not just a single day.
v. **Refuse** – choosing not to purchase or consume unnecessary and unsuitable products (e.g. one with a high environmental footprint or ones that cannot be recycled at the end of life).
vi. **Repair** – fix broken or damaged sports surfaces as opposed to replacing them. This needs to be part of the maintenance strategy – Repair Early to Save Money and Extend Life.

Section 3 of this Guide explore the environmental lens in more detail.

1.4 **Prosperity** – The Whole Of Life Costs Influence Price And Economic Management

It is important that the economic value of the facility development is considered from a capital and whole-of-life (WOL) costs perspective to identify how the 'asset' programming needs to be maximised to create a positive community Return on Investment.

Identify the WOL costings for the design and construction of the facility (Capital cost), the ongoing management (OPEX) and replacement cost (Sinking fund) to ensure that the 'price of use' point reflects the 'recovery' strategy that the Council or asset user agrees to.

The WOL costs can be calculated considering the following:

- Capital costs of the design, procurement and construction,
- Maintenance costs, and
- Replacement costs of facility components.

This should provide a total over an agreed life expectancy. If the surface is designed for 30 years, the shockpad shouldn't need a full replacement, the carpet will be replaced at years 10 & 20 (estimated) and the pavement may after year 30 need some repairs depending on the building strategy.

The annual monetised costs can then be identified and possibly broken down more to hourly rates, depending on scenarios of usage (e.g. Average usage of 20,30,40,50,60 hours per week), which will provide an hourly fee needed to cover the WOL costs. (Suggest based on 50 weeks usage).

The owner may then consider their 'financial cost recovery strategy',

- Scenario 1: Full WOL recovery
- Scenario 2: WOL % recovery (e.g. 20%)
- Scenario 3: Maintenance & sinking fund recovery

By exploring the difference between all surface types we can review the sustainability options.

1.5 **Performance** – Ensuring the Surface is Fit For Purpose

Ensuring that the surface is 'Fit for Purpose' means that a number of aspects should be considered to have a holistic and 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 and hybrid grass surfaces don't normally need to be aligned with many of the standards, yet the non-natural surfaces all have 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 durability and life expectancy.
- Smart Sustainability standards – to embrace environmental, community, economical and performance best practices.

Within each of these levels (standards), there will be specific standards against specific Multiple-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).

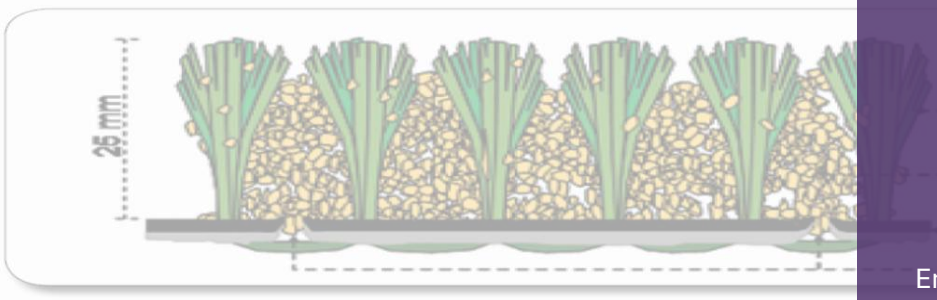
This matrix approach should be explored to identify what is appropriate for each project.

A full comparison between natural turf, hybrid reinforcement and the three levels of synthetic turf can be seen in Appendix 4.

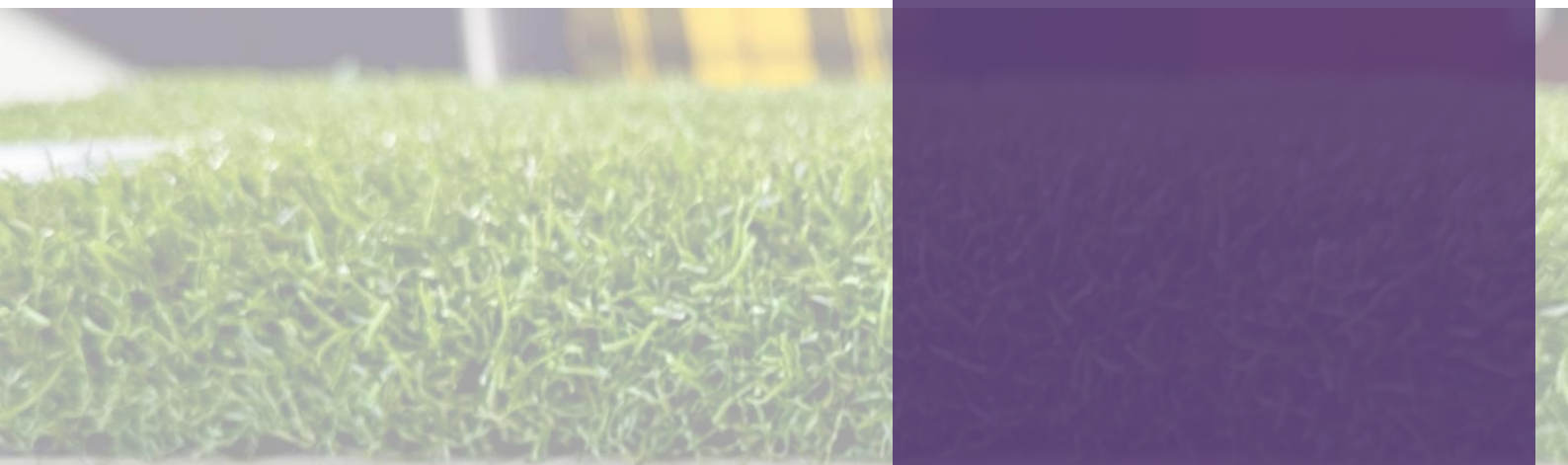
	Performance Standards	**People/ Community standards**	**Planet / Environmental standards**	**Prosperity / Economic Standards**
Sustainable & Smart Standards	Holistic best practice that helps with sustainability of club & parkland.	Increased patronage & with multi–use & inclusive programming.	Environmental 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, premium fields to meet next level of play intensity.	Expected 60 hours with significant durability requirements for 60 people per hr. Health standards high.	Environmental concerns are addressed within the Field of Play.	Capital $1.5m
Entry Level Standards	International Federation for community usage.	Standard hours of 42p.w. & durability for 50 pl per hr.	Construction & drainage standards for expected 10-12 years.	Capital $1.2m

Table 1.1: Matrix of standards for synthetic turf

1st Generation Artificial Gras
© Loughborough University; www.sportsurf.lboro.ac.uk
• 10 – 12 mm fibre length, integral shock pad developed 1960s, nylon, unfilled, hard, abrasive
• Used for hockey at the 1976 Montreal Olympics



2nd Generation Artificial Gras
© Cranfield University 2008 www.cranfi
• 20 – 35mm fibre length, monofilament or fibrillated polypropylene, w
• Developed late1970s, initially n
• UK professional soccer – banned 1980s for b



SECTION 2: THE EVOLUTION AND NEXT GENERATION OF SPORTS SURFACES

Embracing technology for sports surfaces has rightly evolved from purely functional to now be holistically sustainable.
It needs to reflect and reduce environmental impacts, meet community intensity demands, ensure economic best value for rate payers and be fit for purpose.

2. The Evolution And Next Generation Of Sports Surfaces

2.1 Evolution Through History

Synthetic sports surfaces have developed dramatically since the 1960s, evolving from simple nylon carpets to sophisticated multi-sport systems designed for durability, performance, safety, and sustainability.

- **1960s:** First-generation nylon turf introduced (1964), with the first Olympic synthetic athletics track at Mexico 1968. Useful for TV but not as safe for athletes, leading most football and baseball fields to revert to grass.
- **1970s–1980s:** Second-generation turf (sand-filled polypropylene) offered durability but poor ball behaviour and skin abrasions. Widely used for community 5-a-side football and hockey, though UEFA banned it for elite soccer. Hockey embraced synthetic turf in Montreal Olympics in 1976.
- **1990s:** Third-generation (3G) turf developed using softer polyethylene yarn with sand and rubber infill, better replicating natural grass. This innovation attracted football, rugby, AFL, and cricket. FIFA demanded performance standards aligned with natural turf.
- **2000s:** Major sports bodies (FIFA, World Rugby, FIH, ITF, AFL, etc.) established standards, testing, and accreditation schemes, legitimising synthetic fields for elite and community play.
- **2010s:** Systems became more durable, multi-sport capable, and environmentally improved (removal of heavy metals, organic infill evolution, heat management).
- **2020s:** and beyond: The focus is on sustainability — reducing microplastics, recycling end-of-life systems, whole-of-life cost strategies, multi-use precinct planning, and developing next generation surfaces to address intensity of use, environmental issues and performance needs.

2.2 Modern Day Benefits and Concerns

There are both benefits and perceived concerns to the use of natural grass alternatives, whether that be synthetic grass, hard surfaces, rubber surfaces or combinations. These are considered through this Guide and include:

2.2.1 Benefits

- Allows for significant intensity usage that natural grass cannot sustain, between 60-80 hours per week.
- Consistency of surface (e.g. ball bounce, ball roll, safety of surface etc) that a natural turf could not guarantee with the intensity of use required.
- Relatively low maintenance, compared to natural grass and especially per hour of usage.
- Greater tolerance to poor weather conditions (especially rain events).
- Allows greater programming ability – sweat the asset to maximise usage and Return on Investment.
- Potential multi-usage, synthetic grass can be used for all football codes on the same field, Hockey Turf can accommodate Hockey, Hockey 5's, Tennis, Netball and more, Acrylic can be used for Netball, Tennis, Volleyball, 3-on-3 basketball, basketball and more.
- Cleaner to play compared to wet natural grass (mud etc).
- By having a field strategically placed within a larger park or in a central location can complement the other natural turf fields.

2.2.2 Perceived concerns

- Higher capital costs (see Section 4).
- Heat retention of traditionally designed fields (see Section 3).
- Single facilities, more likely to be single use (see Section 4).
- Fencing precludes community usage (see Section 7).
- Will increase microplastics in local waterways and on land (see Section 3).
- Perceived that Whole of Life costs are more expensive (see Section 4).
- Perceived injury increases on surface compared to natural grass (see Section 5).
- Negative impact on environmental footprint (see Section 3).
- Creates Urban Heat Island impact to local community (see Section 3).
- Perception of negative health impacts (see Section 5).
- Potential for pricing differential between natural and synthetic surfaces (see Appendix 4).
- Increased usage will negatively impact the local community (see Section 5).

All of these concerns are often raised by local community groups who have a negative voice with regards to open spaces, with all of the issues being able to be addressed through strategic planning, contemporary design, best practice delivery, good management practices and planning early for end of life.

2.3 Decision-Making Process to Surface Type

Objective Decision Making

This Guide has embraced a number of reference guides and frameworks for recreation planning, decision making for facilities and for synthetic surfaces. This provides an objective and logical format for the five key stages of PLANNING, DESIGNING, PROCURING, MANAGING, and END OF LIFE considerations for the delivery of a synthetic sports surface.

These five stages include:

PLAN

Consider the holistic approach to reflect community needs, how the facility will be used, during and at the end of its life. Consider the 4P's of People, Planet, Prosperity & Performance so that the design, procurement and management stages are clear.

DESIGN

Design for 30 years plus, embracing good practice from industry peak bodies for landscape design, sports performance, environmental good practice to ensure it meets the performance standards required for these specific needs.

PROCURE

Understanding how to procure and project deliver the facility is critical. Only design and ask what is possible and not what is aspirational. Ensure that you can afford what you are asking for. The procurement process should ensure that the provider can achieve the environmental, economic and performance goals you require.

MANAGE

Good management balances the performance, usage, maintenance and end of life requirements equally as the surface progresses through its life. Understanding what to look for is critical as you monitor and evaluate its ongoing surface delivery.

END OF LIFE

Embracing a circular economy, understanding how to plan, design, procure and manage the surface to ensure its end-of-life replacement is achievable.

PLAN

The first step is the most important aspect as the PLANNING stage needs to bring together all of the external and internal influences and priorities. The planning stage needs to reflect every stage of the facility or surface and include:

- Strategic Plan:
  Could be a feasibility study, sports fields plan etc, which brings together open space strategy, recreation/sports plan, sports field strategy etc, Councils asset management plan and/or Councils funding strategy. The siting options should be considered at this stage including, heritage overlay.
- Sports Field Plan:
  Could include exploration of supply and demand to justify need and/or change from current surface. Should explore capacity and availability together with the options of natural grass improvements, use of hybrid technology for high wear areas before automatically assuring that a synthetic field is the only answer. Consideration to it being a multi-sport and/or multi-use should be part of this stage. The plan needs to connect the 4p's of sustainability in detail at this stage.
- Community Consultation:
  An engagement plan to identify the users and non-users of the field of play, exploring the consequences of a change of surface type together with the impact (perceived and actual) onto them. A broad range of the community should be contacted and not just the normal respondents to ensure that the wider community has the option to respond.
- Management Plan:
  For any sports or parkland, a management plan should be developed that explores the Principles of use between active and passive participation, management responsibility for programming, wayfinding, maintenance, annual renovation, parking, budgets, including sinking fund and the end-of-life replacement.

DESIGN

The design stage interprets the planning scope into the delivery ready for procuring the best value surface that is fit for purpose.

The importance of this stage is to ensure that all aspects of the site are considered to create the best outcome for the surface and the parkland. It is possible as the early stage of the DESIGN process that when the site assessments are completed (e.g. Geotech

engineers assessment and /or environment assessment) that this preferred site is deemed not appropriate. Due to this, some councils complete these two components in the planning stage as part of the specific parkland assessment.

The Design process should include:

- Site Evaluation:
  The site needs to have all services detailed and this should include a detailed site survey (3D – CAD files), Geotech assessment, environmental assessment, DBYD, stormwater and drainage assessment etc.
- Community Engagement:
  As detailed in the planning stage.
- Civil/Construction Design:
  Schematic drawings working upto 50/80/100% design drawings depending upon the Tender Contract strategy. These should address the drainage drawings, any irrigation, pavement base, fencing, paths, lighting etc.
- Landscape Design:
  To address various environmental considerations, such as the tree canopy, landscaping around the field of play, relocation of 150mm of turf/top-soil, new viewing rounds, water harvesting, fauna and flora etc.
- Performance Surface:
  To ensure that the surface is designed to meet the sports design overlays, including aspects such as field of play sizes, run-offs, surface type, shade structures, coaches boxes etc.
- Stormwater & Drainage Strategy:
  To ensure that, working backwards that the stormwater exit can work with the amount of water that needs to be accommodated with the strategic Annual Rain Intensity.
- Environmental Considerations:
  To address any specific aspects for the site and especially lighting spillage, fauna and flora design etc.

Associated Tools	Links
• Rugby & Climate Change – Projected Impact on Rugby in a +2°c World	Rugby for Nature | World Rugby
• SAPIA Code of Practice – Construction, surfacing and maintenance of sports courts	SAPIA-Code-of-Practice-for-Sports-Courts-1.pdf
• Bowls Green – Construction Guidelines	Bowling_Green_Guidelines
• Hockey Australia Guides (x6)	Information Hub - Hockey Australia
• DDA Compliance	D.D.A. guide: The ins and outs of access | Australian Human Rights Commission
• Access 4 all abilities in design	Design for accessibility and inclusion | Style Manual
• Design for gender neutral facilities	Gender Neutral Work-Space Design and Certification.
• Wayfinding Guides	Wayfound Victoria - A free resource to improve the consistency of wayfinding signage across Victoria.
• Climate Positive Design: Vol 1: Action Plan for Australian Landscape Architects (A12A)	Climate Positive Design

Table 2.1: Design associated tools and links

PROCURE

The procurement and delivery of the project should reflect the design considerations with the procurement and project management to ensure that the field of play is delivered.

This process should be aligned with key internal dates of the organisation to make the decision, which could include Council meetings, organisation board meetings, etc.

- Design & Procurement Documentation:
  The final design drawings need to be aligned with the Request For Tender, Conditions of Contract, RTF Schedules and the Specification (Performance Surface and Construction).
- Procurement Process:
  There should be a skilled team to evaluate the submissions from the tender process, with key evaluation criteria should include, price, quality of offer, their experience, capability & capacity of the tenderer, project plan and methodology.
- Construction & Project Management:
  Identifying the Critical Hold Points and Witness Points through a strong communications process between all parties. The construction stage should also address the Traffic Management Plan, OHS, Environment Management Plan etc. There should be a Project Manager appointed by the organisation to ensure weekly meetings

between all parties can be delivered within budget and on time.

- Certification & Handover:
  If the field of play surface is to be certified by an independent organisation (e.g. Hockey – FIH, Football – FIFA, Rugby – World Rugby etc) that should be addresses in the project plan. There needs to be a comprehensive handover documentation that addresses the As Built drawings, 3D designs, all documentation from equipment, warranties, etc.
- Dilapidation Period:
  An agreed dilapidation period should be agreed as part of the tender documents initially.

MANAGEMENT

The management of the surface will be influenced by different stages of the life plan of the surface and should include both the programming, maintenance and renovation, end-of-life considerations and the asset management.

- Programming:
  The programming of the field should consider rotation of routine usage or drills to reduce the impact on the surface. The programming should be linked to the maintenance obligations for the surface.
- Maintenance & Renovation Roles:
  Defined maintenance roles should be specified between all parties, including what needs to be completed after game days and routine drills. Clear definitions between the users, council/sport and the specialist contractor are needed.
- Asset Registration, Monitoring & Review:
  An annual update for the asset registrations and a conditional assessment to ascertain the likelihood of achieving its life expectancy (10 years).

END OF LIFE

To ensure that the process for a successful End of Life transition a number of key aspects need to be considered, including:

- Planning, Design And Procurement To Ensure Easy Transition:
  During the planning, design and procurement process the method of recycling needs to be considered to ensure its ease of achievement, including the way the surface is fixed to not complicate its removal, or damage the base. Careful thought in the design of the base is critical here, as to ensure that the procurement specification requires the purchased products to be recyclable.
- The Uplift Process:
  The design of the surface system should have a layered approach to assist with the ease of uplift and to cope with the weight of the machinery used at this stage. This should include the pavement base, shockpad and drainage cell as well as the carpet and infill.
- Transport Logistics To The Recycling Plant:
  When the old surface is uplifted, it is classified as waste and therefore needs to be transported as waste with appropriate classification requirements. This may be different in each State/Territory.
- The Recycling Process:
  The process that is engaged needs to separate the infill (rubber & sand) and then address the yarn and carpet backing. There are different approaches to this globally.
- Payment:
  The payment for the recycling should be withheld until key milestones have been achieved. This may include, transportation from the field of play, certification of receipt, certification of recycling (100% of components).

The components then could be reused for the landscape (e.g. sand), construction (sand, rubber and carpet/yarn) and back into the synthetic sector (sand, infill) and other sectors using the plastic (P.E) could be used for park benches etc.
Certification for some recyclers is available and should be encouraged.

2.4 Types Of Surfaces For Each Sport

2.4.1 Range of surfaces

Australia has a number of surface types that can be used for a number of sports, each with its own benefits

and playability requirements, depending upon how you are going to use the surface.

The surface types include: See Table 3 below.

	Football (soccer)	Rugby Union	Rugby League	Touch Football	Australian Rules	Cricket	Hockey	Hockey 5s	Basketball	Track & Field	Netball	Tennis	Basketball	3on3 Basketball	Volleyball	Pickleball	Padel Tennis	Multi-sport	5aside Football
Natural / Hybrid Turf	■	■	■	■	■	■				■		■						■	■
3G Long Pile turf	■	■	■	■	■	■			■									■	■
4G Med Pile turf	■			■					■									■	■
Hockey Turf – Hybrid							■	■	■		■	■						■	■
Hockey Turf - wet							■	■	■		■	■						■	■
Tennis Court								■	■			■						■	■
Cricket Mat						■													
Rubber Tracks										■									
Acrylic									■		■	■	■	■	■	■	■	■	■

Table 2.2: Alignment of surface type for each sport

2.4.2 Performance surfaces

Each sport has different performance levels that can be used for training, competition, or stadium level. Some are the same level with only one standard (e.g. Rugby Union) others have 2-5 standards depending upon the usage. These are all covered in Section 4 in detail.

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.

2.4.3 Synthetic grass systems (Football turf / long pile)

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.

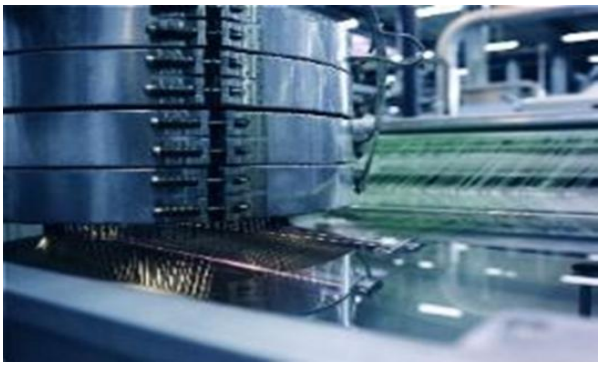


Photo 2.1: Extrusion Process producing mono-filament yarn

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 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.

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 2.3: 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, 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 recommended
Rugby Union	60mm recommended
Tennis	10mm - 25mm
Australian Rules	50mm - 60mm
Hockey	10mm - 45mm
Cricket Wicket	9mm - 12mm

Table 2.4: 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.

Although Rugby Union allows 50mm length, we believe this should only be for a stadium, controlled field where the infill can be brushed after each game. We would therefore recommend a 60mm system as a minimum for open parkland sports areas.

- 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.
- ***Dual yarn system*** – most 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 the new "4G" sports surfaces and 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.

2. 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 strategies 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.

We are now recommending additional holes in the carpet to allow the water to pass through quicker for all organic infills.

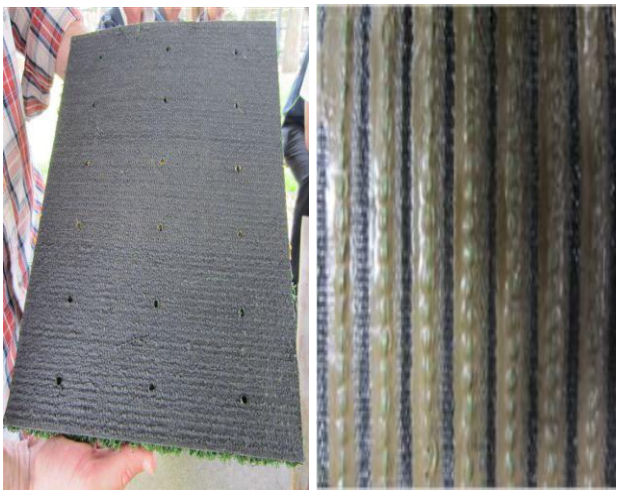


Photo 2.2: Examples of Backing Surface

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 – 2024) 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 2.3: Example of seam failure

3. Infill

Not all synthetic sports surfaces have infill, with the infill playing a dual role, providing a ballast for the carpet and a performance infill which ensures that the surface achieves the performance level of that sport.

For instance, in sand-dressed bowls, carpets, tennis courts and multi-sport fields for hockey, the surface is 'sand-dressed' (between 10-20%) of the length of the carpet yarn. In the older traditional tennis courts, they would be within 10mm of the top of the yarn, and some of those courts lasted 10-15 years.

With the various football codes that use long-pile grass, the third generation (3G), which surfaced in the early 2000, uses sand and originally rubber (SBR) or plastic (TP) and over the past few years, a move to organic infill has been embraced.

Each manufacturer will have a range of infills for each system they offer, as each option has to have an independent laboratory assessment to ensure it can achieve the International Federation performance standards (e.g. World Rugby, FIFA, ITF, NRL, AFL, etc).

The various infills currently available include, and some may have brand names:

- Cork infill,
- Cork/coconut husk,
- Corn husk,
- Walnut husk,
- Olive pips
- Wood fibre

It is worth considering that if the organics are lighter than water, then the drainage strategy becomes more important, to ensure the porosity through the carpet and that there is no ponding in the carpet, which would increase the probability of the infill to float.

4. Shockpad

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."[10]

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

[10] Press Release – European Synthetic Turf Organisations Recommend Shockpads for Synthetic Sports Fields, 2014

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).

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.).

Photo 2.4: 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[11] said they would recommend a shockpad is used for their fields every time.

Photo 2.5: Insitu shockpad being laid (source: Polytan)

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.

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.

Reuse of shockpad

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

[11] NZRA Turf Conference (June 2013)

warranty, the pad needs to be able to demonstrate key performance characteristics. According to the FIFA Quality Manual (2024) 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 180m/h for football + 500ml for Rugby and AFL when tested in accordance with EN 12616.

2.4.4 Rubber surfaces (Track and Field Athletics)

Athletics was an early adopter of synthetic technology and in 1968 athletics installed its first synthetic athletics track for the Mexico 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.

Photo 2.6: 1968 Olympic Games Synthetic Track – Mexico

Types of rubber surfaces

There currently exists a range of synthetic surface systems for athletics facilities approved for use by the IAAF. 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.

In-situ resin bound rubber crumb system

The resin bound rubber crumb ('structural spray') system consists of a primary layer of coarse rubber crumb, which is then coated with two coats of a coloured polyurethane paint.

The key benefit of this system is its low cost. It is also a permeable surface, which conceals some unevenness and prevents some ponding by allowing surface water to drain into the pavement.


Photo 2.7: Application of spray coat

The manufacture of this product requires the use of raw materials for the upper layer, but the base layer is made from recycled rubber.

The advantages of this system are:

- Low cost
- Permeable surface which will conceal some unevenness.

The disadvantages of this system are:

- Least durable due to very thin wearing course (i.e. will require respraying more frequently).
- Performance is inferior to other option.
- Requires still conditions during installation for consistent application.
- Any adjacent structures will need to be protected to avoid from spray.

In-situ composite system

The composite ('sandwich') system is a hybrid system designed to achieve similar performance to the full polyurethane ('full PUR') system at a lower cost. A base layer of coarse rubber crumb is laid on site and a solid elastomer layer is then cast on top. The surface is also finished with EPDM rubber broadcast across the surface to provide the textured finish.

The surface is indistinguishable from the 'full PUR' surface and performance is similar. It is less expensive than the 'full PUR', however, due to the use of cheaper coarse rubber in the base course.

Compared with 'full PUR', durability is slightly lower, and force reduction and vertical deformation tend to be slightly higher (i.e. softer).

The advantages of this system are:

- Economic alternative to the full depth cast surface because of its identical appearance and similar performance characteristics.

The disadvantages of this system are:

- System is typically not considered for elite track facilities.

Photo 2.8: Application of wearing layer over rubber base mat

In-situ cast elastomer system

Cast elastomer ('Full PUR') surfaces are poured on-site as a free-flowing liquid to form a full depth of solid cast polyurethane rubber. Coloured EPDM (ethylene propylene diene monomer) rubber is then broadcast across the surface for the final finish.

The advantages of this system are:

- High strength and durability.
- Good performance characteristics.

The disadvantages of this system are:

- High cost due to the thickness of the cast polyurethane layer.
- If incorrectly installed can lose the 'cushion' feel underfoot.

Prefabricated sheet synthetic surface

Prefabricated sheet surfaces are constructed by manufacturing rolls of rubber surface in a factory and bonding it to an asphalt base on site using adhesive. It is commonly the preferred system for high performance competitions.

Photo 2.9: Rolling-out prefabricated synthetic surface

The advantages of this system are:

- Consistent adherence to performance requirements such as force reduction, friction, thickness and colour due to manufacturing in a controlled environment.

The disadvantages of this system are:

- Any imperfections in evenness and slope of the base will be replicated on the surface, therefore requiring tighter construction tolerances.
- A high degree of skill is required to achieve smooth joints and a good bond with the base.
- Installation of this type of system involves the use of weather-sensitive adhesives.

2.4.5 Hard courts (Tennis, Netball, Volleyball, Multi-sport)

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.

Standards and requirements

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

Photo 2.10: 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.

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

1. 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.

2. 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 2.11: 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, although some companies offer cold weather solutions.
- Rubber cushioning may require topping up when resurfacing occurs.

3. 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 2.12: Installation of prefabricated mat system

4. 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 2.13: Application of gel system

2.4.6 Hybrid Football turf (all football codes)

Hybrid Sports Grass is simply the combining a small amount of synthetic grass technology to natural sports turf to provide additional strength and durability, into a single sports turf system.

This aims to 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 each week
- Stability of surface and root zone
- Load bearing capacity improvement
- Durability of the natural grass
- Consistent playing performance characteristics
- Agronomic performance, (stability and uniformity)
- Bio-mechanical performance improvements
- 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.

Photo 2.14: Eclipse Stabilised Hybrid "Ready to Play Turf" (picture courtesy of HG Sports Turf) has worked well in Sutherland Shire

Types of Hybrid Sports Turf

Predominantly there are three types of hybrid sports turf systems to consider enhancing the 'natural fields of play', including:

1. **Mat System** also known as 'Ready to Play', where they are normally grown off-site at a nursery and then transported to site where they are then installed and the roots 'grown in' to the medium profile.

   This system is normally a mat, carpet or grid backing which is knitted, tufted or woven, allowing the natural grass roots to become embedded around the synthetic yarn and through the base of the carpet, providing surety for the grass with anchorage. Some of the backings are fully or part bio degradable.

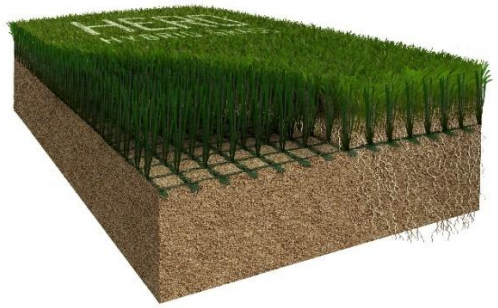


Photo 2.15: HERO Hybrid Grass

The finished surface presents itself as a mixture of synthetic grass fibres (c. 5%) and the rest (95%) 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.

Photo: 2.16. Hybrid turf used in high wear area at Karela Oval Sutherland Shire

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.

At a local level, many councils are now installing the technology in high-wear areas, including, Casey, Monash, Hume, Port Phillip, Whitehorse, Wyndham and the Shire of Sutherland.

There are a number of these hybrid grass systems including, Hero, Xtragrass, Desso and Extreme Grass.

2. **Permanent System** - insitu, where the mat system is placed insitu and the growing medium (e.g. sand) is applied and built up to the levels for the grass to be seeded, allowing the grass to grow accordingly. Similar to the needs of natural grass it is important that adequate time is provided for it to grow in.

Photo: 2.17. Hybrid turf in high wear areas

3. **Stitched System** – where the synthetic yarn fibres are injected and stitched into the natural grass field. This results in not needing any backing. The stitched system normally needs 200-300mm of good growing medium and if much less could cause problems for the machines.
   Many stadiums globally have this type of system. Now the original patent has run out on the Desso Grassmaster, other companies are offering similar technology.

Photo 2.18: Desso GrassMaster System which is the first global 'stitch I' system, mainly used for stadium but now a more portable unit can be used for local government fields

Advantages

- Increased stability of surface and root zone.
- Uniformity and consistent playing characteristics from site to site, sport to sport, country to country.
- Increase playing capacity (5-10 hours pw) up to 30-35 hours per week.
- It 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.

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.

Durability and Ability to Cope with Intensity of Use

With the roots being reinforced and more stable, it also seems to provide warmth to the root system, allowing the natural turf roots to not only be stronger (thicker) but to be anchored. This is very important for natural

turf fields that see a great deal of usage in high wear areas such as goal mouths, running lines, etc.

This profile stability allows the fields to receive two benefits, firstly an additional 5-10 hours usage per week (e.g. 30/35 hours) before the grass shows significant stress. Secondly, is the ability of the root system to recover quicker and recuperate at the end of the season. The impact normally means fewer major renovations and increased savings.

Weather Resilient

When the grass is 'stressed' through poor weather conditions of extreme rain or summer heat the hybrid sports turf supports the profiles stability and root strength to cope with both of these events. It is still critical to have a fit for purpose drainage and irrigation system as well.

On some fields where the natural grass has been 'worn away' in the winter months, the fields still look green, as they have the synthetic fibre left. This normally means that the soil doesn't get as compacted and certainly as the seasonal weather changes and the field continues to be irrigated, many sports field curators indicate that the fields bounce back to life quicker.

In winter when the natural summer grasses are slow to recover or don't grow, resulting in bare patches, the synthetic grass protects the 'summer grass' and provides a more stable platform for the sports to play on. The old style 'scalloped' ground around the 6-yard boxes is now seen as the past! A reduction of closed grounds, injuries is seen as beneficial.

Maintenance and Renovations

The weekly maintenance and repairs seem to be significantly reduced with greater stability of the grass surface.

The rest of the years maintenance program matches that of natural grass, until the renovations at year end. This would include 'de-thatching' the summer grass thatch that shows the synthetic fibres are upright again, ready for winter usage.

Overall the trials at Sutherland Shire have demonstrated that there is a lower requirement for maintenance and repairs throughout the winter seasons.

Enhanced Playability

The global stadium turf, which allows the field to look 'green' all year round is now available to each and every local government. The use of hybrid turf with the increased stability is enhancing the playability for players through:

- less stress to the grass, providing a more stable and firmer running surface,
- less dirt and bare grass areas and therefore reduced risk of injuries,
- a soft surface in the summer due to less compaction and greater grass coverage,
- improved traction, uniformity of the surface,
- consistency playing surface, for the ball and boot interaction with the payers,
- increased time and intensity of use of the playing field.

Economic Benefits

The economic benefits associated with hybrid turf are viewed from a number of lenses, including:

- ***Increased Hours of Play = Higher Utilisation***
  - Hybrid turf typically delivers 20-30% more playable hours compared to natural turf increasing from 25hrs to 32.5 hours.
  - Fewer weather-related closures mean clubs avoid cancellations, maintaining participation numbers and associated revenue streams (registrations, facility hire, canteen/bar turnover).
- ***Reduced Maintenance and Renovation Costs***
  - Goal areas reinforced with hybrid mats reduce the need for repeated patching and top-dressing, cutting staff time and material costs. That said if the wear of the natural grass is significant the end of year renovations is still significant.
  - Over a 10–15 year period, lifecycle savings can be substantial — councils in Europe have documented 20–30% lower annual maintenance costs compared to natural turf.
- ***Extended Playing Season and Event Hosting***
  - Hybrid fibres trap warmth and support growth in cooler months, keeping surfaces greener and safer for longer.
  - Councils benefit economically through which means longer hire seasons, accommodation of season creep easier and reduced reputational risk from poor playing conditions.
- ***Social and Health ROI*** (Economic Multipliers) more playable hours equates to increased participation, which has a well-documented public health and social value.

  Studies (e.g., Sport England, Australian Sports Foundation) quantify the economic return on sport participation at up to $3–$7 for every $1 invested, through reduced health costs, improved productivity, and stronger community cohesion.

Hybrid turf therefore delivers indirect but significant economic multipliers, since fewer cancellations mean participants stay engaged year-round.

- ***Bottom Line for Local Government Benefits***
    - Short-term ROI: Avoided resurfacing and reduced maintenance.
    - Medium-term ROI: Increased capacity without building new fields.
    - Long-term ROI: Deferral of multi-million-dollar synthetic turf projects, as community demand continues to grow but not enough to warrant a full synthetic solution.

Environmental Impacts

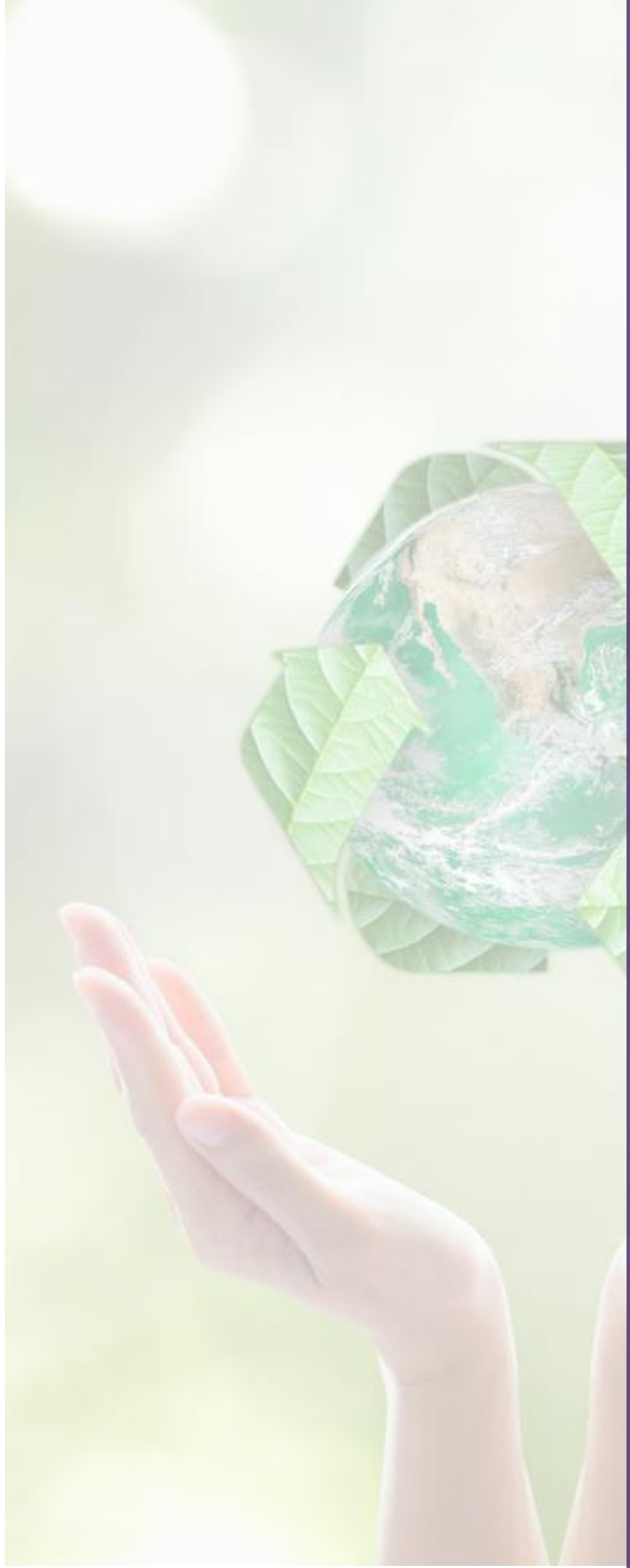
After the past four years of trials the following environmental benefits have been identified as:

- greater sustainability of the grass, so less need for renovation with raw materials such as additional seeds of grass, transport to/from for installation,
- longer life grass, allowing for greater CO_2/O_2 transformation,
- prevention of soil erosion,
- reduction in nutrients, as grass is not as stressed.

2.5 Glossary Of Terms

To assist in the understanding of terminology used, Appendix 1 has a detailed Glossary of Terms to support the reader to understand the conversations they may have to be involved in.

SECTION 3: ENVIRONMENTAL SUSTAINABILITY FOR SPORTS SURFACES



We all have a duty of care to the next generation of participants as community custodians of our planet and as leaders, we need to plan now to reduce the impacts on tomorrow.

3. Environmental Sustainability For Sports Surfaces

3.1 Commitment To A Sustainable Future

Many local and state governments, together with national and local sports organisations, have embraced environmental sustainability in their planning, design, delivery, and management of sports surfaces. This section of the Guide explores some of the key issues and opportunities around sports surfaces, including:

- Climate change and the impact on sports
- Migration of microplastics
- Flooding
- Urban Heat Island impact
- Leeching and heavy metals in water
- Sustainability planning and frameworks to consider

3.2 Climate Change And The Impact On Sport

What climate change is—and why it matters for sport

Climate change refers to long-term shifts in average weather and extremes driven by greenhouse gases. Climate change is now considered the most pressing environmental challenge of the 21st century, with sport both affected by and capable of contributing to climate solutions. According to the Intergovernmental Panel on Climate Change[12], global surface temperatures have already risen by more than 1.1°C above pre-industrial levels, resulting in more frequent extreme weather events.

Sport is vulnerable to heatwaves, flooding, drought, and poor air quality, especially for community sports played outdoors on exposed surfaces. World Rugby (2024) states: “We are seeing the direct impact of climate change on our ability to safely host competitions and train future generations of players.”

Insights into the impacts on sport

Climate change is affecting major sporting events worldwide. Extreme heat has prompted scheduling changes for the Olympic Games and international football tournaments, while floods and storms have forced cancellations in cricket, rugby, and athletics. Integrating global event learnings such as heat protocols from Tokyo 2020 and air-quality monitoring from recent wildfire seasons into Australia’s community sport operations will future-proof facilities and programs.

World Rugby’s landmark study[13] models climate impacts in a +2 °C world, drawing from IPCC projections, field experts, and data across 10 nations including Australia. Key findings included:

- **Extreme Heat**: 60% of studied countries could face 10+ additional days per year above 35 °C, rendering sport unsafe.
- **Droughts**: In half the nations, frequency and severity of droughts are expected to worsen.
- **Rainfall & Flooding:** 80% of nations face increased heavy rainfall and flash floods, leading to field waterlogging.
- **Submersion:** 1 in 10 major stadiums could be submerged annually under flood or sea-level rise scenarios.
- **Cyclone Exposure**: One-third of stadiums studied are in cyclone zones, with rising wind risks.
- **Humidity**: Most regions will experience higher humidity risks for players, officials, and fans.

Many local governments urge stakeholders to integrate climate risk into planning, adjust regulations, and apply guidelines for turf adaptation under warmer or wetter conditions. It includes recommendations on governance, regulations, and turf design through its Environmental Sustainability Plan 2030.

Changing weather patterns in Australia

Australia is already experiencing clear signs of climate change: rising average temperatures, more frequent extreme heat events, shifting rainfall cycles, and deteriorating air quality. By 2050, the nation is projected to face a significant increase in days exceeding 35 °C, placing both athletes and sports surfaces under greater stress.

Rainfall is becoming more variable, with some regions experiencing prolonged drought while others face more intense flooding events. These episodic patterns amplify surface wear and damage, reduce the reliability of natural turf, and disrupt competition schedules.

Bushfire smoke, prolonged heatwaves, and air quality decline pose increasing risks to outdoor activity, affecting both elite and community sport. These changes align with global hazard concerns identified by international sporting federations but require national-scale adaptation to safeguard participation and infrastructure across Australia.

Impacts on sportsgrounds and facilities

Local governments have over several years integrated climate action mitigation strategies, as they are aware of some of the challenges facing participation in sport

[12] (IPCC, 2023),

[13] https://www.world.rugby/news/934601/landmark-report-examines-future-climate-change-impacts-on-rugby

for the various surface types. These challenges include:

Natural Turf Fields

- Heat Stress & Irrigation Pressures: Turf dries, compacts, and becomes injury-prone during extended heatwaves and drought. Irrigation demand spikes amid water restrictions.
- Intense Rain: Flash flooding can damage fields and subgrades rapidly leading to pooling and costly repairs.

Synthetic & Acrylic Surfaces

- Heat Amplification: Surfaces can retain heat if the latest design and manufacturing technology has not been adopted, making play unsafe during extreme conditions, framing the need for cooling strategies drawn from World Rugby's thresholds.
- Storm Drainage: If not designed to the appropriate rain or storm event then the drainage may not be able to cope with the rain fall and play could be interrupted and or ponding could occur on the surface, leading to downtime and material degradation.

Scheduling & Events

- Heat & Air Quality Protocols: Triggered for cooling breaks or postponement via HSI and AQI thresholds, plus formal lightning protection plans.

Council strategies & recommendations

Some local government has embraced a Four Piller approach to this challenge, including:

- **Planning**

Before deciding on the surface type explore and justify all surface options (Natural, hybrid, hard and synthetic to ascertain a Fit for Purpose approach) to meet the sports demands.

Assess the local region for the best location that can accommodate the best surface type into the natural landscape to minimize the impact on the local environment and reduce the impact of climate change.

Consider climate resilience assessments as part of planning approvals (e.g. projected surface temperature modelling with mitigation strategies).

Responsive policies: Embed climate hazards in facility planning and risk frameworks.

- **Design Mitigation Strategies**

Embrace a holistic sustainability design strategy against a Multiple Bottom Line approach, including:

  - **Performance (fit for purpose)** surface – Reflecting the International Sports Federations sustainability standards for each sports surface.
  - **Planet (environment**) – Embracing environmental standards (civil and landscape) that provide a lifetime solution and aims to reduce the environmental footprint and impact on climate change.
  - **People (community)** – Focused on how the solution can embrace the opportunities for more people to play, recreate and participate in community sport, while reducing climate change impact.
  - **Prosperity (economic)** – Understanding the whole of life decisions around the economic considerations.

This can be achieved by strategies including:

- Maximise vegetated areas (natural grass, trees, bioswales) around synthetic, rubber or acrylic surfaces to provide evaporative cooling and shade.
- Consider water harvesting of rain collection to be used in parkland to irrigate the natural vegetation
- Use adjacent vegetated zones, such as turfed buffer strips or rain gardens, to support evaporative cooling.
- Deploy climate-resilient planting and urban greening strategies to reduce temperature extremes around parks and sports fields
- Integrate shade trees, tree canopy and shade structures (such as tensile canopies) over and around playing fields and seating zones.

Select cool materials and finishes use high-albedo synthetic turf, organic infill, and porous base layers that reduce heat absorption.

- **Procurement & Delivery**

The procurement process allows the Government to ensure that they a will be partnering with an organisation that has a thorough understanding of Climate Change and similar environmental alignment as their own. Key procurement strategies should include:

  - Ensure that any consultants engaged to design and develop the specification understand and have experience of environmental best practice around climate change mitigation strategies.
  - Use procurement guidelines that include climate-resilient outcomes, such as tree canopy offsets or on-site water harvesting systems.

Request the Environmental Footprint data from the Tenderers on their approach and system they are proposing.

- **Management**

Councils and sports should continually explore good management practices around the way they manage their fields and sports surfaces including:

  - Water – the use of water and exploration of water harvesting on major projects from the surfaces and roofs of buildings.
  - The use of water resilient turfs, fauna and flora.
  - Event protocols: Adopt threshold-based trigger tools (e.g., for heat or lightning) across community sports venues.

Local sport in the Australia is already feeling climate pressures. But with frameworks like World Rugby's rigorous hazard thresholds and turf adaptation guidance, councils can take meaningful action. By pairing proactive operational responses (heat, smoke, lightning) with infrastructure investment in turf and scheduling, sport can remain safe, inclusive and resilient into a warming future.

3.3 Microplastics Migration

3.3.1 Why we're talking about microplastics and sport?

Sport is a huge part of our community life, bringing people together, keeping us healthy, and supporting local pride. In recent years, synthetic sports fields have become more common, offering all-weather, durable playing surfaces. But with these benefits comes responsibility. Tiny particles called microplastics can escape from synthetic fields into our waterways and landscapes. We need to commit to elimination of this.

Synthetic turf fields have historically generated microplastics through two main pathways:

1. **Intentionally added microplastics** – such as rubber crumb or SBR infill.
2. **Field-derived microplastics** – arising from the breakdown of grass fibres over time.

The traditionally designed synthetic fields didn't consider microplastic migration in any series manner, its only been in the past couple of years it has become more important, and rightly so.

It is possible now with good planning, design and management to reduce the impacts of microplastics by more than 95%. Firstly lets explore more about microplastics.

3.3.2 What are microplastics?

Microplastics are extremely small pieces of plastic—often less than 5mm in size. In synthetic sports fields, they can come from the plastic turf fibres, rubber infill, or other components that wear down over time. Because they're so small, they can be carried away by wind, rainwater, or even on players' shoes and clothing.

Microplastics come from many different sources in our daily lives. The largest contributors in the Western world are vehicle tyre wear, which produces tiny rubber fragments, and synthetic clothing fibres that shed microplastics during washing.

Other common sources include plastic packaging breakdown, paints, and road markings. In comparison, synthetic sports turf infill is a smaller but can still be a still be an important sources we need to address, especially where the design hasn't embraced modern practices and the Australian Standards.

While it ranks below tyres and clothing in total volume released into the environment, it is a highly visible source that communities can actively manage through targeted solutions. It is an easier target than vehicles and clothes we use everyday.

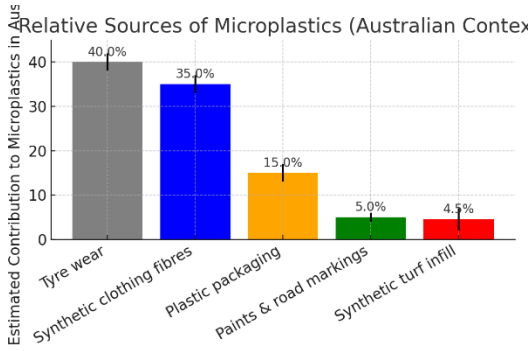


Figure 3.1: Relative sources of Microplastics in Australia

3.3.3 How microplastics can escape?

Microplastics have been able to migrate from the historically and traditionally designed synthetic sports fields into the environment in several ways:

- Rainwater washing particles off the field into open-surface drains and waterways.
- Ball splash and wind carrying lighter particles outside the field of play.
- Players and equipment transferring particles off-site after games or training.
- Wear and tear of the surface over time, especially if not well maintained or maintained poorly.

These can now be stopped or reduced significantly by adopting a triple mitigation strategy, namely:

- Reduce the amount of microplastics intentionally added to a synthetic sports field initially, by using organic infills (≥95% reduction).
- Design the field with a containment strategy in place to reduce migration off the field of play (2%).
- Enhance the quality of the surface to reduce the amount of microplastics caused deterioration of the surface (2%).

Combined this should reduce contamination of microplastics by 99% compared to the historic and traditional design and procurement approach.

Reduction of Intentionally Added Microplastics

The simplest way is to move away from plastic and rubber infill and use organic infill. Most contemporary fields are now having organic infill, which could be cork, wood fibre, corn husk, olive pits, walnut husks to name a few.

There is now a "Fourth Generation" field surface which although not yet able to get a FIFA, World Rugby or AFL certification it won't be long for some of the sports to adopt these new approaches. Some of these fields do have 'low infills' of sand and organic and have passed the FIFA testing.

If the field is to have rubber infill included then the use of a quality shockpad has seen the reduction of the rubber infill from approximately 25kg/m2 to 4-5kg/m2. A reduction of over 80%

Designed Containment Strategy

The second strategy is to reduce the migration of microplastics by ensuring the design is to SA TR CEN 17519: 2021 Surfaces for Sports Areas - *Synthetic turf sports facilities - Guidance on how to minimize infill dispersion into the environment*.

In addition to this standard the carpet and yarn system should be a Dual Yarn system (Monofilament and Tape) that is designed to capture the infill so that there is limited or no ball splash or migration of the infill. The five most important aspects for this strategy are:

- Adoption of the AS Standard
- All drainage is sub-surface so no microplastics can enter the drainage system
- Requesting a Dual Yarn system
- Ensure that the porosity of the carpet and the drainage strategy results in no ponding on the surface which reduces the likelihood of migration of infill across the field of play
- Conduct appropriate maintenance on the field of play and surrounding paths to ensure no migration of infill

Enhanced Quality of the Surface

It is critical that the quality of the surface is aligned with the needs for Australia. The International Federations (FIFA, World Rugby etc) all have quality performance criteria, but not all are designed for the harsh UV climates in Australia. So additional performance criteria need to be required, including the durability of the yarn and carpet, the porosity of the system, the UV radiation stabilizer type and quantity used.

3.4 Heat Stress Impact

Natural turf has a significant component make up of water, so in hot weather the water evaporates from the natural grass and can act as a cooling agent. There is no such mechanism in the synthetic sports turf for long pile fields.

That said, once the natural turf has lost all of its 'water' to evaporation in long periods of warm weather, the grass is often lost through wear and tear. The soil is then very dry and often turns to dust. These natural turf fields are then/can be very hard to play on safely.

The temperature of artificial surfaces rises significantly more than natural turf surfaces, especially on a hot sunny day (20-40 percent hotter). The key challenge is not so much the heat, but the level of Ultraviolet Radiation (UV Radiation). The UV Radiation is shown as High to Very High depending on which part of Australia and this will impact on the use of hard surfaces, whether that be for sport, play, or indeed walking and rubber, acrylic and grass surfaces will have similar impacts.

It is important to consider heat stress as a holistic approach for weather stress. In the same manner that owners of natural grass fields have to close many grass fields in the wet weather to protect both the field of play and the players, it may be similar to consider a similar approach for synthetic surfaces. Whether that is rubber (athletic tracks), acrylic (Tennis, Netball or Basketball) or synthetic grass (Hockey, Football codes), a heat policy by the sport is normally used to determine an appropriate level of heat (and humidity) for people to play in. Sports Medicine Australia produce a Hot Weather guideline that has been adopted by many sports in the development of their own Heat Policies[14].

Reported surface-to-air temperature ratios are approximately one for both natural turf and artificial turf under overcast conditions[15]. According to one research on synthetics the mean (range) of ratios for natural grass was 1:41 (1.38 to 1.44) whilst the mean (range) for artificial turf was 1:62 (1.3 to 1.81).

[14] https://sma.org.au/resources-advice/policies-and-guidelines/hot-weather/

[15] Milone and Macbroom, Environmental Effects of Synthetic Turf Athletics Field (2008)

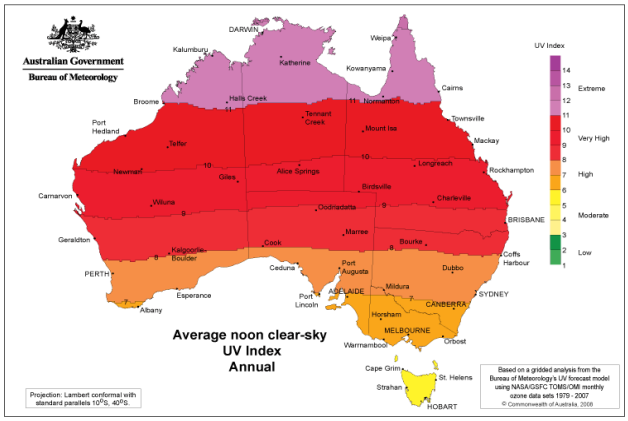


Figure 3.2: Average Solar Ultraviolet (UV) Index (source: BoM)

In Australia, the industry has been introducing innovations for a number of years, including:

- Cool grass technology (5% reduction of heat).
- Acrylic coating heat technology (30% reduction in heat) for acrylic surfaces.
- Use of dual yarn grass technology (FIFA heat index reduced by a 0.5 score 10%).
- Organic infill, as opposed to rubber/plastic (10% reduction in heat).
- Shade sail, over smaller areas (e.g. bowls areas, courts etc.) have been found to reduce heat by 30% on high U.V. days.
- Vertical draining on grass systems allows the base to stay moist longer, and by reverse osmosis, the infill and carpet stay a little cooler.
- Tree canopy near to the surface provides shade and also the leaves evaporate cooling effect helps.
- Water harvesting into a 'wetlands' close to the surface helps, especially if the sports surface is 'down-wind' of the wetlands.
- There is also recommendations that water bubblers are installed close to the pedestrian gates, to provide opportunities for players to rehydrate on hot days.

3.5 Urban Heat Island Impact

An Urban Heat Island (UHI) occurs when urban areas due to dense built materials, reduced vegetation, and compact surfaces become significantly warmer than surrounding rural or vegetated regions. This phenomenon results from high solar absorption, low evapotranspiration, and limited shading. UHI intensifies during heatwaves and can lead to nocturnal warming, which is particularly challenging for public health, energy use, and overall liveability.

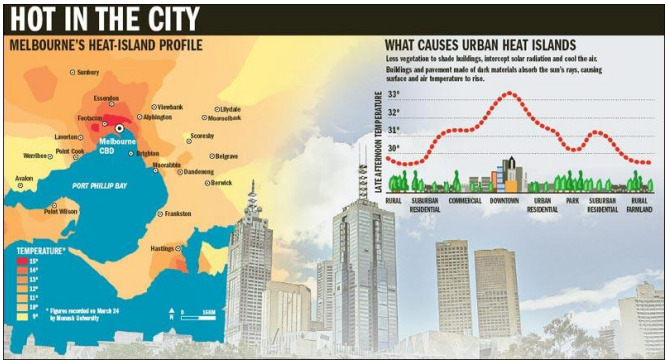


Figure 3.3: The Urban Heat Island effect around Melbourne (Source Friends of Drouin s Trees)

Health impacts include increased heat stress, worsening of cardiovascular and respiratory conditions, and heightened risk of dehydration especially in vulnerable populations such as children, the elderly, and outdoor-sport participants.

Key Causes of UHI (Ranked by relative impact)

Exposed impervious surfaces (asphalt, concrete, and traditionally designed and aged synthetic turf) these absorb solar energy and raise surface and air temperatures.

- Lack of vegetation (shade-providing trees and grass) reduces evaporative cooling and shade.
- Building density and form tall buildings and narrow streets reduce airflow and trap heat.
- Anthropogenic heat (cooling systems, vehicles, industrial processes) adds to local thermal load.
- Reflective heat from adjacent infrastructure (roofs, parking lots) contributing to microclimatic heating.

In the context of synthetic sports fields, the primary factors are synthetic turf surfaces that absorb heat through the black rubber infill, the lack of water evaporation and drainage strategy when compared to natural grass and absence of natural cooling vegetation.

In essence, if the surface (rubber, concrete, acrylic or grass) will adsorb the heat, the heat is then released in the cool of the night. So the focus is to design the system so that it reflects the hat. This emphasis has been embraced by many of the manufacturers. The use of organic infill will significantly reduce the UHI impact.

Synthetic Sports Fields And UHI: Evidence from NSW Chief Scientist's Report

Many organisations are embracing synthetic technology in parks, sports fields and playgrounds to allow the surface to be able to cope with the intensity of use that the densification of inner cities are creating.

Photo 3.1: Synthetic Sports Surfaces Provides Additional Hours For Children to Play When Natural grass can't cope with 60+ hours as week

This additional and more durable solution for surfaces can also create challenges to the environment if not planned and designed effectively. A new generation of thinking is now embracing environmental sustainability practices to compliment performance and people sustainability for these surfaces. The outcomes is that by embracing these holistic sustainability outcomes that the economic benefit is actually increased across the whole of life of a sports surface.

The NSW Chief Scientist & Engineer's 2022 final report stated that the impact of synthetic sports surfaces on UHI is low and localised, and certainly in comparison of all the other built forms in a municipality the size of impact of these synthetics is marginal at best. That said with better planning of the site and location of synthetic surfaces (acrylic, rubber and grass) the local impact can still be reduced.

On hot days (mid-30 °C air temperature), synthetic turf surface with black rubber crumb infill with traditional designs and ageing fields, temperatures can be higher than nearby natural grass often times reaching 70 °C to over 90 °C at peak sunlight hours. Understanding the design and planning is critical for embracing low heat retention and design of the whole parkland and not just the field of play.

How Natural Grass Helps Offset UHI

Irrigated natural grass offers several cooling functions:

- Evapotranspiration cooling: grass and soil release moisture, significantly reducing ambient air temperature.
- Lower surface temperatures: grass surfaces typically remain 30–40 °C cooler than synthetic turf on very hot days.
- Shading and reflective albedo: grass reflects more solar radiation and absorbs less heat.
- Enhanced air flow: vegetated surfaces support better microclimates and improve comfort for users.

When grass fields or hybrid systems (mixing grass with synthetic reinforcement) are integrated, they mitigate the thermal burden posed by some traditionally designed or ageing synthetic surfaces.

That said with grass fields that are not irrigated the thermal benefits decrease significantly and are more compatible with synthetic sports surfaces.

UHI Mitigation Strategies For Synthetic Sports Surfaces

To reduce UHI impact where synthetic fields are installed, the following strategies are recommended:

Planning Strategies

Informed, evidence-based planning helps mitigate UHI before synthetic fields are even approved.

1. Explore and justify all surface options (Natural and hybrid) before concluding that synthetic surface is the best option
2. Assess the whole of region for the best location that can be integrated best into the natural landscape to reduce UHI and allow for upgrade of natural mitigation strategies to offset any UHI impact
3. Adopt a risk-based decision framework for synthetic turf approvals, prioritising health, thermal risk, and urban greening outcomes.
4. Implement minimum landscape buffer requirements for synthetic fields e.g. tree canopy zones, natural grass edges, or bioretention systems.
5. Consider climate resilience assessments as part of planning approvals (e.g. projected surface temperature modelling with mitigation strategies).
6. Use the NSW Government's 2025 guidelines on synthetic surfaces to inform land-use zoning, field siting, and environmental impact statements.

Photo 3.2: Aeriel Photo of Centennial Parklands synthetic sports field surrounded by parkland thus reducing UHI effects locally

7. Include community engagement as a prerequisite for project approval to surface local concerns about UHI, tree removal, and access to green space.
8. Embrace a holistic Sustainability assessment of location and surface options based on the UN's Sustainability Goals and the Multiple Bottom

Line approach that many local governments use, including:

- **Performance** surface – Reflecting the International Sports Federations standards for each sports surface.
- **Planet** (environment) – Embracing environmental standards (civil and landscape) that provide a lifetime solution and aims to reduce the environmental footprint.
- **People** (community) – Focused on how the solution can embrace the opportunities for more people to play, recreate and participate in community sport.
- **Prosperity** (economic) – Understanding the whole of life decisions around the economic considerations.

Design Strategies

These strategies embed cooling and sustainability outcomes into the physical design of the sports space and the surrounding parkland.

9. Maximise vegetated areas (natural grass, trees, bioswales) around synthetic fields to provide evaporative cooling and shade.
10. Consider water harvesting of rain collection to be used in parkland to irrigate the natural vegetation
11. Use adjacent vegetated zones, such as turfed buffer strips or rain gardens, to support evaporative cooling.
12. Deploy climate-resilient planting and urban greening strategies to reduce temperature extremes around parks and sports fields
13. Integrate shade trees, tree canopy and shade structures (such as tensile canopies) over and around playing fields and seating zones.
14. Select cool materials and finishes—use high-albedo synthetic turf, organic infill, and porous base layers that reduce heat absorption.

Photo 3.3: Organic infill options from one company, Fieldturf, other options include: woodchip, walnut husk, Pine chips and more. All reducing the UHI effect on local communities

15. Consider hybrid systems (e.g. stitched grass/synthetic turf reinforcement) for high-wear zones to preserve natural cooling elsewhere if natural grass is considered
16. Incorporate landscape-led drainage solutions (e.g. tree pits, rain gardens) to cool surfaces and improve stormwater retention.

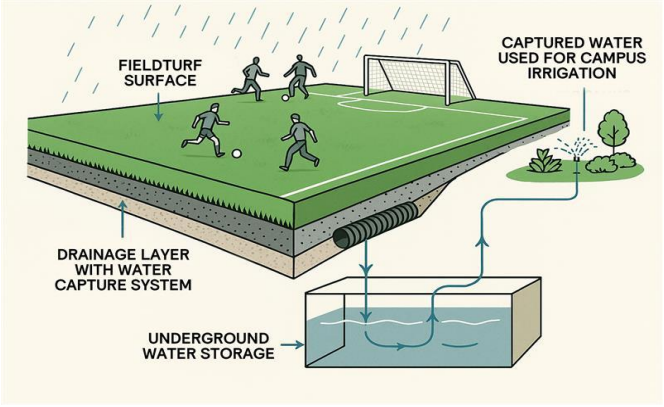


Figure 3.4: Water harvesting system for a synthetic sports field (source Fieldturf) to then irrigate the local landscape and trees reducing the UHI effect and increasing the amenity value for local residents

Procurement Strategies

The procurement process allows the Client to ensure that they a will be partnering with and organisation that has similar environmental alignment as their own. It allows for clarity on product selection, design practices that will produce a reduction in UHI impact after the sports fields have been constructed. Key procurement strategies should include:

17. The Procurement Strategy should be based around either a Detailed Design strategy or a Design Finalisation strategy to ensure that the required design components to reduce the UHI are embedded in the design.
18. Ensure that any consultants engaged to develop the Specification understand and have experience of such designs to reduce the impact of UHI on the local community.
19. Specify thermal performance requirements for synthetic turf e.g. max surface temp under 35°C ambient conditions by using the FIFA Heat Guide etc
20. Require Environmental Product Declarations (EPDs) and life-cycle assessments for turf systems, including UHI metrics.
21. Prioritise suppliers who offer recyclable, low-heat, or bio-based infills over crumb rubber or dark plastic-based products.
22. Use procurement guidelines that include climate-resilient outcomes, such as tree canopy offsets or on-site water harvesting systems.
23. Request the Environmental Footprint data from the Tenderers on their approach and system they are proposing.

Management & Operational Strategies

Effective day-to-day use and maintenance of the facility can mitigate UHI exposure for users, and this is influenced by the design and the procurement of the right design and materials. In addition further

management strategies can offset the impact of UHI on the local parkland and community, including:

24. Consider misting systems off the surface in the spectator areas etc that the players and spectators can use to cool down in extreme hot weather areas.
25. Adjust usage schedules to avoid high-heat periods (typically between 11 am and 4 pm in summer).
26. Monitor surface temperatures regularly using handheld or fixed sensors and implement thresholds for safe play.
27. Irrigate, maintain and replant surrounding vegetation, including grass edges and tree canopy, as part of seasonal field maintenance.
28. Engage local clubs and users in thermal safety training and heat health alerts for scheduled activities.

Whole Of Life Economic Considerations

By exploring the cost considerations for capital, maintenance and replacement (Whole of Life) costs, the majority of time the cheaper surfaces to purchase will not meet the more durable and environmentally friendly surface option. At the back of this publication there is a comparison of natural, hybrid and various synthetic turf to explore the environmental and other sustainability lens.

Conclusion

UHI impact on local communities is primarily created by the exposed impervious surfaces (asphalt, concrete, intense housing and in smaller localised areas, traditionally designed and aged synthetic turf)—these absorb solar energy and raise surface and air temperatures. This is normally shown through areas with a lack of vegetation, building density and form, and where anthropogenic heat adds to local thermal load.

Natural grass naturally mitigates UHI via evapotranspiration when moist, shading, and lower reflective heat. To responsibly incorporate synthetic surfaces, governments, planners, architects, and sports bodies should adopt a balanced, landscape-led approach combining grass buffers, climate-positive design, and operational cooling measures. The Australian Institute of Landscape Architects provides valuable frameworks for this, emphasising nature-based solutions and co-benefits for people and ecosystems.

Photo 3.4: Lane Cove Council installed Blackman park with synthetic turf and Brock infill (woodchip) and the temperature is significantly cooler

By combining scientific insights, landscape-informed design, and community-centric policies, stakeholders can manage UHI effects effectively allowing synthetic sports facilities to coexist with healthy, resilient, and liveable urban environments.

3.6 Leeching And Heavy Metals In Water

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.

The conclusions are best summarised by the Swiss Study[16] 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,

[16] Muller, E. (2007). Results of a Field Study on Environmental Compatibility of Synthetic Sports Surfaces. Swiss Ministry of Environment, Traffic, Energy and Communication Authority of Environment Section Water

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.

Photo 3.5: Swiss Study collecting rainwater through various synthetic sports surface systems

3.7 Water and Irrigation Needs for Synthetic 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[17] 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.

3.8 Flooding

Many local governments and sports consider investing in the use of synthetic sports surface technology across a city to satisfy the growing demand for sports as the population increases. Some sports fields are built on a floodplain, which means we will never be able to prevent flooding. Storms and flooding are a natural part of living in that area during winter months.

Organisations should consider as to whether these flood types would most likely impact or even preclude synthetic surfaces being installed and flooding challenges may curtail the ability to install and manage a synthetic sports field and what mitigation should be considered by themselves and community clubs and organisation's as part of their site feasibility and prior to any investment.

The key consideration is that organisations who are interested in embracing the technology need to appreciate the position on when a known flood risk or site identified as being contaminated, poses too high a risk for a synthetic field project.

With modern technology and ongoing flood modelling, Councils are able to better understand risk and respond appropriately and has developed tools to support organisations in their knowledge and decision making.

3.8.1 Types of and impacts of flooding

Some councils have invested significant resources to assist with understanding the impact of flooding on property and provides detailed resources for them to read and appreciate. Council and State Governments have identified the various types of flooding that would typically be expected, including:

- **Overland flow flooding**

Overland flow is excess rainfall runoff from homes, driveways and other surfaces. Overland flow flooding

[17] FNSW: Football Facilities – Drainage and Irrigation

is water that runs across the land after rain, either before it enters a creek or stream, or after rising to the surface naturally from underground. Overland flow flooding tends to affect localised areas rather than the whole city at once. Overland flow flooding can be unpredictable, and its severity will depend on the amount of rainfall.

It is critical to understand overland flow flooding by exploring the natural overland flow path through each specific site or property and taking appropriate steps to prepare and protect the site, where possible.

- **Creek flooding**

During rainfall, water from roofs, driveways, parks, footpaths and other surfaces makes its way to the underground stormwater pipe network. The rain runoff exits the stormwater pipe network into creeks and waterways.

The combination of rainfall, rain runoff and the existing water in the creek causes creek levels to rise. How high the creek level rises depend on the amount and duration of rainfall. Heavy rainfall can cause the creek level to exceed its capacity. This is when creek flooding occurs. Floodwaters may flow over the banks into properties, roads and parks. Storm surge can also cause creek levels to rise. Creek flooding is difficult to forecast, as floodwaters can rise and fall quickly without warning.

- **River flooding**

River flooding happens when widespread, prolonged rain falls over the catchment area of the river. As the river reaches capacity, excess water flows over its banks, causing flooding. This can occur hours after the rain has finished. The level of flooding depends on the speed and volume of water carried in the river.

The frequency of river flooding depends on the severity of weather. The impact on sports fields depends on how close they are to the river and how high the fields are built above ground level.

- **Storm tide flooding**

Storm tide flooding happens when a storm surge creates higher than normal sea levels. A storm surge is caused when a low atmospheric pressure meteorological system and strong on-shore winds force sea levels to rise above normal levels. Flooding can also occur from king tides in some parts of Australia, where the tides occur regularly throughout the year and are noticeably higher than regular tides. King tide information is predictable and readily available in tide books and online.

3.8.2 Flooding and drainage considerations for synthetic fields

Introduction

Synthetic sports fields are designed to manage the typical rainfalls that are expected in the geographical area, to ensure that there are no flood waters that interact with the sports system, as flooding can seriously damage the performance surface (grass) and the pavement base.

To minimize this possible effect of flooding impacting on the surface, the aim of any design must be to:

- Ensure that there is no water seeping into the base in a manner that would impact the integrity of the pavement base which the performance surface sits upon, failure to do this could result in the integrity of the pavement/sub-base and movement of the base which would therefore mean the field not meeting its performance standards against the International Federation playing standards
- Move the rainwater flows through the synthetic sports field by designing the best drainage strategy to the storm water discharge to meet the International Federations porosity standards (e.g. FIFA is 180 ml/hr) and to a specific Annual Rain Intensity (ARI) event (e.g. 1 in a 10-year ARI etc.)
- Ensure that the storm water discharge is capable of discharging the ARI agreed flow rates and if not design a retention strategy until it can discharge that rate of water.

Flooding Considerations

Flooding is normally defined as “a situation in which an area is covered with water, especially from rain”. This normally means that the level of water or rain cannot be released with the normal drainage discharge channels. In relation to synthetic sports fields the four council defined flood scenarios impact as follows, and may include:

- ***Drainage back-fill*** – where the drainage pipes, whether around the field or the storm water discharge pipes can cope with the level of water that its holding. If it cannot, then the water will back up firstly through the pipes and then through the grass systems before puddling and then flooding. Once the water can be discharged the flooding will decrease, normally leaving a maintenance issue for rectification. The field performance infill, which is normally lighter than water will float and can be blown around the field. This is a maintenance issue and can be rectified prior to the next use.
- ***Flood basin*** – some sports fields are designed to collect and retain excess water from an area in the event of a significant rain event especially in local

government owned sites. These are not good for the surface of the sports fields and an option is to raise the field and develop a retention base under the field through either storage cell/basin or in the design of the field pavement being made with stone aggregates (which have void spaces up to 40%). This solution is easy to design and holding the water under the field should have no impact on the playing surface.

- ***Flood path*** – this is the most troublesome of the three scenarios' as the flood path normally brings dirt with it and crosses a field and so disrupts the base if not designed to cope with the movement of the water and also the surface. Again, a solution is to encourage the water through a drainage strategy and under the field before possible retention and discharge.
- ***Wear*** – the impact of flooding on or across the surface of the synthetic playing field could be detrimental to the systems pavement integrity, the carpet and infill. This could also negate any warranty (normally 5 years for the system), as the majority of warranties preclude flooding being covered.
  It is critical then that the design embraces any likelihood of floods, so that appropriate mitigation can be addressed. Failure to design around this or if a Design and Construct specification, would most likely negate any obligation on the contractor and their warranties.
- ***Impacts of standing water*** – the likelihood of water pooling would be due to drainage back-fill which meant that the water cannot drain away quick enough. The consequence is that there could be a level of standing water on the field of play until the drainage an accommodate the discharge of water. The impact on the surface will be linked to the time standing and the amount of water on the field. It is highly unlikely that this would be for long if the drainage strategy has been developed accordingly. Normal challenges when this happens, and the consequential actions include:
  - **Playing environment** – this would probably be unsafe and so games/training should be cancelled
  - **Infill** – whatever infill is lighter than water, that will float, if there is a wind while the infill is lifted from within the carpet to be resting on top, then it could be blown across the field and rectification maintenance would be needed. Although this may be time consuming, it is unlikely to be detrimental to the system
  - **Carpet** – the carpets are normally not glued to the base as they are either sewn or glued together, if sewn there should be no impact. The adhesive is waterproof and so the water should not have a significant impact, if the water is standing for a long period of time (unlikely) then this may release some if the adhesive properties. I am not aware of any research conducted to provide accurate guidance on this.
  - **Pavement base** – the impact on the pavement base could be nil. If the design ensures that it does not impact on the pavement's integrity. Normally an impermeable sheet is used to stop water seeping into the sub-base etc. Depending upon the level of water, this should not create a negative problem with the weight.
  - **Impacts of flowing water** – this would be the most significant challenge that a field would have and the most likely to cause problems for the whole system if mitigation is not designed into it. The flowing water, similar to the 'standing water' would impact on infill migration and pavement base considerations.
  - The added challenges are:
    - ***Silt transfer*** – if silt is brought from outside the field of play and across the synthetic system it would leave a train of sand and silt, that when it dries actually creates a 'crust' level on top of the system and can clog up drainage portals. This can destroy the system, resulting in the whole system being replaced. At best when this happens the major manufacturers would suggest keeping it wet so that they have an opportunity to vacuum it up. If it goes dry and hard the carpet will most likely be destroyed.
    - ***Mitigation of infill*** – it is possible that the infill will be moved with the pace of the water. This is a maintenance rectification issue and as with the standing water scenario earlier, this should only be a maintenance issue and not a major rectification issue. The operator would normally use a specialist brush (e.g. a SMG Grass Master brush system, which is towed behind a small ride on machine). If it were to settle in the local creek there is no evidence that this would be detrimental to the environment.
    - ***Water under the carpet*** – sometimes if water is under the carpet on some synthetic surfaces (e.g. bowls and water-based hockey fields) round bubbles occur after water is trapped under the surface. If the design of the synthetic field is correct, then this should not be an issue on 3G long pile surfaces as the weight of

the surface (normally 30 - 40kg/m^2) would keep it stable. In addition, if the drainage is working the under carpet will lie flat and dry out as the water recedes.

Synthetic sports fields can be significantly damaged from flooding and careful consideration needs to be sort if there is any likelihood of them being impacted by a flood event.

There are two flooding scenarios that can impact synthetic sports fields:

i. **Standing Water Flooding** – where the water cannot leave the field due to the storm water drainage system not being able to cope with the level water on the field. This can be caused by creek and river flooding or storm water flooding where they block the drainage exit strategy. To mitigate this would consider options such as a retention pavement (using aggregate with void space etc.) or retention tank under the field to cope with the expected rain and volume.
ii. **Overland Flow Flooding** – where the water levels would rise and pass over the synthetic field and with it the water would contain silt and or be at a flow rate that would damage the pavement and or lift the carpet. This is the most dangerous and should be avoided at all costs as the likelihood that this could, depending on the level and speed of movement destroy the pavement and carpet beyond use. This mitigation for this scenario could include:
    - Build above the probable flood levels
    - Re-route the water flow path around the field
    - Build the field elsewhere

The risk of flooding and impact needs to be considered prior to any request for Council and appropriate mitigation strategies identified. These mitigation strategies will impact on the cost of the field and so need to be considered early to establish its affordability. There are very few sites that would be precluded due to flooding, but the impact would be financial and possibly considerate.

3.8.3 Flood planning considerations for synthetic sports surfaces

When planning for a future synthetic field an organisation should consider the following prior to determine the probability of a site that may be prone to flooding:

Step 1: Flooding probability – Does the site have a history of flooding, or the probability of flooding in the future and use Council information and knowledge.

Although there are mitigation solutions for most flood scenarios the cost implications would significantly increase as the Residential Flood Level (RFL) increases which would make them unviable economically. It is therefore suggested that this should be considered immediately and any flood level over Councils recommended minimum RFL would mean a significant investment that most likely would preclude a viable economic solution being sought.

Step 2: Type of flood – What type of flood would it be prone to? Explore the type of floods, namely overland flow, river and creek floods and storm tide. From these four types appreciate the impact on the field surface to ascertain if the field can have mitigation strategies applied in a manner that is affordable and workable for that site.

Step 3: Mitigation – If an organisation at this stage is still considering synthetic fields in such an area then they would need to engage with a specialist sports surface engineer or Hydrology Engineers (https://www.engineersaustralia.org.au/Communities-And-Groups/National-Committees-And-Panels/Water-Engineering) and consider the mitigation opportunities as listed below.

Step 4: Consultation with Council – If mitigation is possible and the organisation can afford the solution the solution would meet Council planning guidelines, explore the appetite with Council staff to verify this prior to any substantial work and investment being committed to the opportunity.

- **Mitigation Strategies**

Council can mitigate these scenario's (left column) by embracing proven design solutions (right column), such as these below:

Drainage back-fill

- Calculate the level of water needed to discharge in an hour from the agreed ARI event, 90% of fields in Australia are aligned with this simple procedure.
-
- Design drainage strategy (size of pipes, level of retention etc.) that will be needed to move that amount of water through the synthetic sports surface system.
- Ensure that the storm water discharge can cope with the volume of water, if not build a retention/holding tank.

Flood basin

- Calculate the level of water that would expect to be held and for how long in a typical flood that is experienced (e.g. 1,000mm of water for 3 days etc.) and identify that as cubic meters of water that needs to be retained.

- Identify if the field can be built up and the retention space (aggregate base or tank) so that this can hold the water.
- Ensure that any flood flow is curtained by having drains on outside of path and field of play to take the water under the field etc.
- Example (below) of Gore Hill NSW which was designed to cope with a 1m flood annually – under the field.

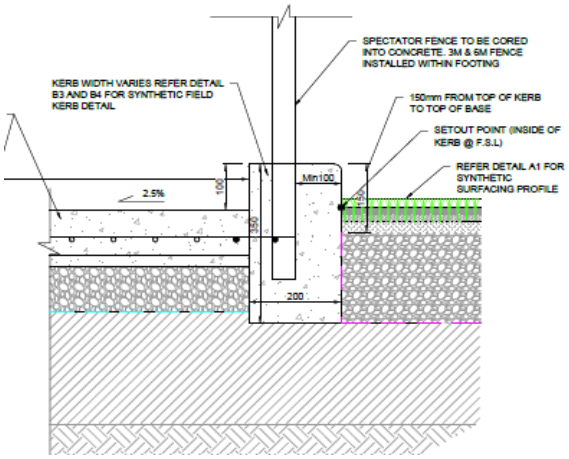


Figure 3.5: Flood Flow

Flood path

- Create a drainage strategy by taking the water away from the field of play before it gets there
- If can't redirect by using banks, then capture the water and take under the field of play
- ELS Hall Park and the water was taken off the hill (north west) and designed to go under the field to reduce any impact on the field of play
- Lip on side of paths and also sandstone blocks used to redirect

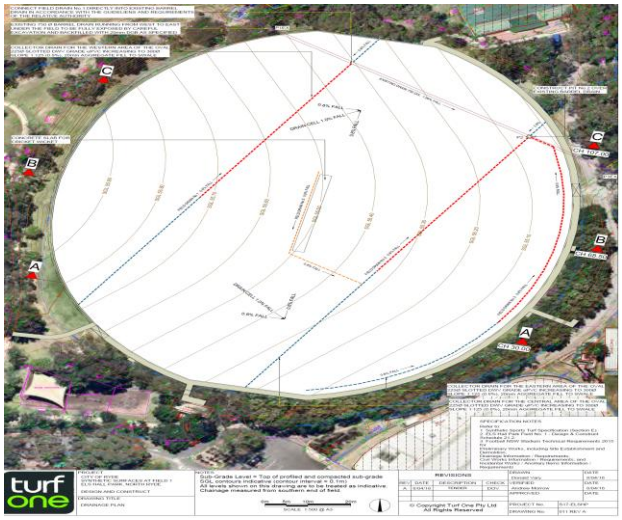


Figure 3.6: Typical Design for an Overland Flood Scenario by Redirecting the Flood Path Under the Field of Play (source: Turf One)

3.9 Sustainability Planning Frameworks

3.9.1 Range of frameworks

As part of sport and governments commitment to environmental sustainability, there is normally an alignment to a recognised policy or framework.

These frameworks include

- United Nations Sustainability Development Goals (SDG's)
- UN's framework Convention on Climate Change (UNFCC)
- International federation's sustainability framework/ policy or strategies
- Australian Olympic Committee climate action plan
- State government or local government environmental action plan/ strategy.

By exploring any or all of these frameworks it's important that if your organisation embraces any of these, that they are integrated into your own planning framework and cycle and not the other way around.

Smart Connection Consultancy has reviewed the 17 SDG's From the UN, specifically in relation to their relevance to the planning, design, procurement, management and end of life of sports services. These are listed below/ appropriate for each of the Multiple Bottom Line that most local and state governments embrace.

3.9.2 UN's SDG's

The UN's Sustainable Development Goals has 17 goals, which has shown to create a sustainable approach to society, balancing the ecology of an area, region or country. This Guide has explored the 17 components and each of the 169 targets to align 9 Goals and 15 Targets applicable for sports surfaces. We have packaged these against the 4 P lens, as shown below:

PLANET LENS (Environmental Impact)

SDG 6: Clean water & Sanitation

6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, while substantially increasing recycling and safe reuse.

6.4: Substantially increase water-use efficiency and ensure sustainable withdrawals and supply of freshwater to address water scarcity across whole of parkland

SDG 12: Responsible Consumption and Production

12.2: Achieve the sustainable management and efficient use of natural resources

12.4: Achieve environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse

12.7: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

SDG 13: Climate Action

13.1: Strengthen resilience and adaptive capacity of the field of play and the whole parkland to mitigate climate-related hazards and impacts

13.3: Integrate climate change measures into national policies, strategies and planning

SDG 14: Life Below Water

14.1: Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

SDG 15: Life on Land

15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, protect and prevent the extinction of threatened species

PEOPLE LENS (Community Impact)

SDG 3: Good Health & wellbeing

3a: Provide opportunities for the reduction of national and global health risks - specifically through physical activity

SDG 10: Reduce Inequalities

10.3: Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard

10.4: Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality

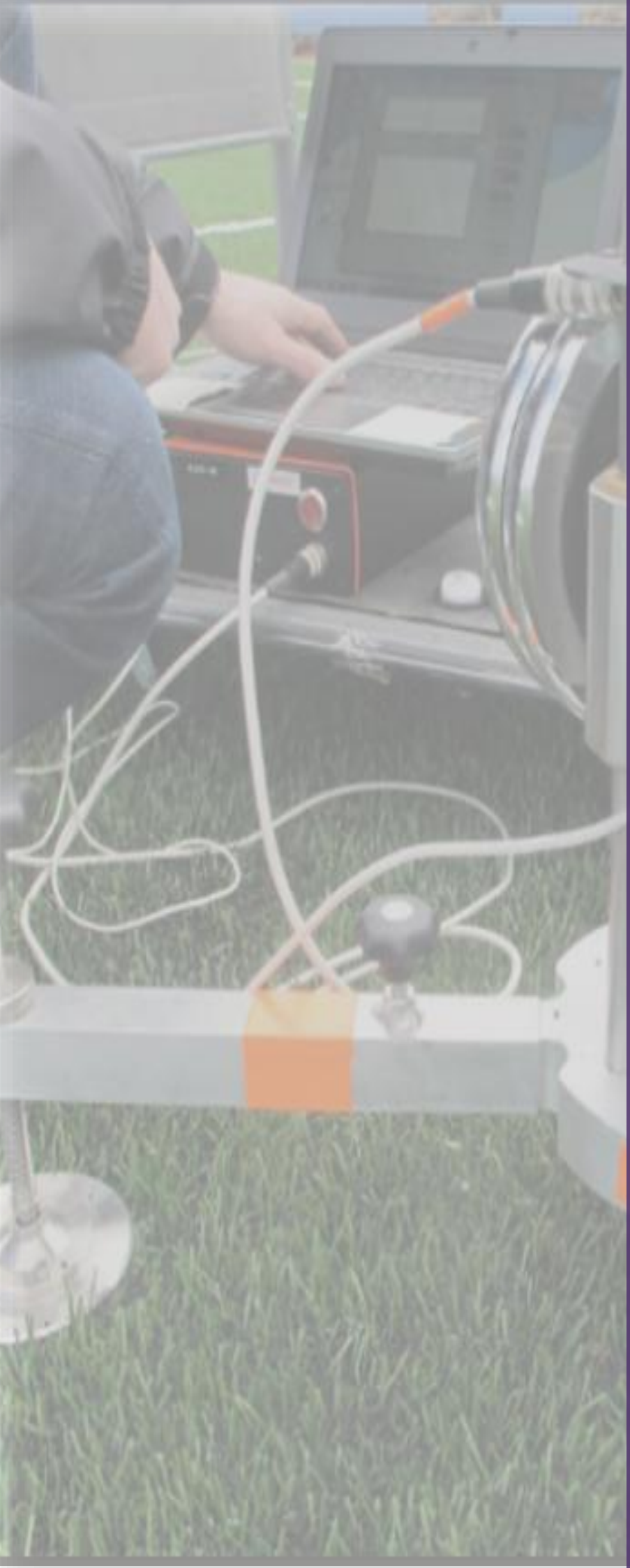
SDG 11: Sustainable Cities & Communities

11.7: Provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

PROSPERITY LENS (Economic Impact)

SDG 9: industry, Innovation and Infrastructure

9b: Support domestic technology development, research and innovation, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities



SECTION 4: PERFORMANCE STANDARDS FOR EACH SPORT

Understanding performance expectations between community, pathway and elite or stadium sport will ensure that the planning, design, procurement, and management is fit for purpose.

4. Performance Standards For Each Sport

4.1 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 Aust	N/A	Community

Table 4.1: 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.

4.2 Athletics

Athletics was an early adopter of synthetic technology and in 1968 athletics installed its first synthetic athletics track for the Mexico 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.

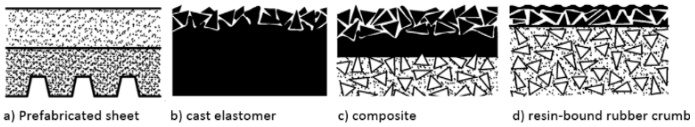


Figure 4.1: Synthetic surface types for athletics tracks

4.2.1 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

4.2.2 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.

Photo 4.1: Paralympian on a rubber track

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

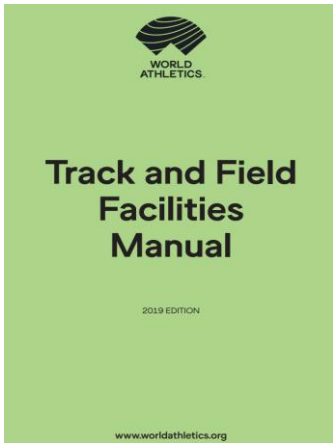


Figure 4.2: WA Track and Field Facilities Manual 2019[18]

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.

4.2.3 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 4.2: Overview of the expected life cycle for an acrylic surface

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 4.3: Typical costs for an acrylic surface

4.3 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 assist in increased participation rates, reduce injuries and allow more people to play more often.

4.3.1 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[19] 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 4.2: AFL/Cricket and Football at ELS Hall Field, Ryde City Council NSW (source: Turf One)

[18] https://www.worldathletics.org/about-iaaf/documents/technical-information

[19] Ballarat University (now Federation University)

4.3.2 Australian rules standards

The results of the study enabled the development of standards for Artificial Turf for AFL and Cricket[20]. 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[21]. 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[22] 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 4.3: Standards for the use or Artificial Turf for Australian Football and Cricket

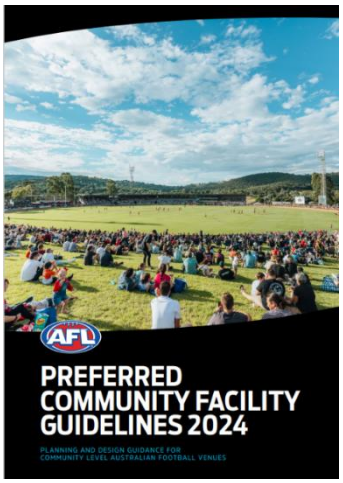


Figure 4.4: AFL Community Facility Guidelines 2024

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 acrylic 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 4.4: Overview of the expected life cycle for an acrylic surface

4.3.3 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 $35,000. Replacement expectation based on 50 hours per week on medium intensity would be approximately 10 years.

4.4 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[23], 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)[24].

4.4.1 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,

[20] 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
[21] Australian Football League and Cricket Australia Handbook of Testing for Synthetic Turf (Sep 2013 www.aflcommunity.com.au)

[22] 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
[23] Reference: Letter to LGA's in Victoria – dated 2010
[24] http://www.aflcommunityclub.com.au/fileadmin/user_upload/Manage_Your_Club/Facilities/AFL_Venue_Guidelines_2019_-_FINAL.pdf

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[25].

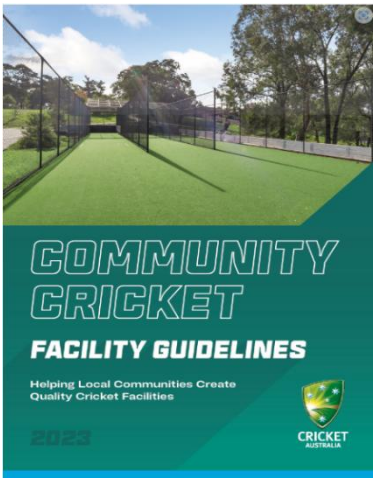


Figure 4.5: Crickey Australia Facility Guidelines 2023

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.

4.4.2 Costs

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

4.5 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.

4.5.1 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.

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

Figure 4.6: 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.

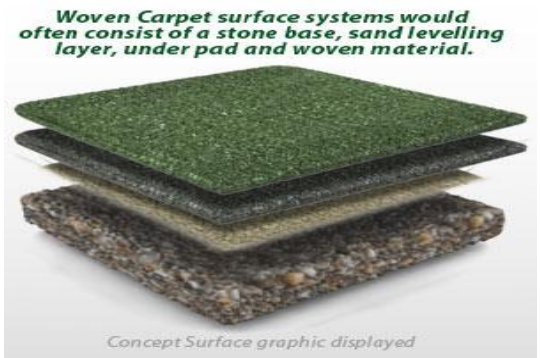


Figure 4.7: Woven Carpet Bowls Green (source: ABS Sport Surfaces)

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

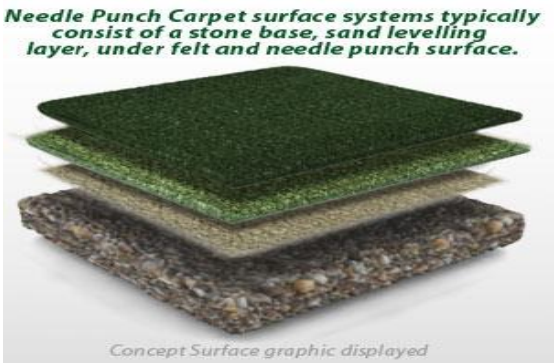


Figure 4.8: Needle Punch Carpet (source: ABS Sport Surfaces)

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

4.5.2 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 4.5: an overview of the expected life cycle for a Needle Punched carpet bowling green surface.

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.

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.

Figure 4.9: Bowling Greens Construction Guidelines

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

Bowls Australia has developed a Bowling Greens Construction Guidelines[26]

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			$535,425

Table 4.6: Cost of Needle Punch Carpet

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

Replacement Costs

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

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 4.7: Replacement costs for two Needle Punch Carpeted greens

4.6 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.

Photo 4.3: Kareela Oval, two Football Fields (Sutherland Shire Council, NSW)

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[27]. These guidelines were updated and re-issued in 2024 and are constantly updated with various versions[28].

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.

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

Figure 4.10: FIFA Quality Concept for Football Turf – Test Manual 1

[27] FIFA Quality Concept for Football Turf – Handbook of Requirements (October 2015: v3.1 16.03.2020)

[28] Inside FIFA

Figure 4.11: FIFA Quality Concept for Football Turf – Test Manual 2

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

4.6.1 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 4.8: Whole of life costs

This can be broken down as follows:

Initial Capital Costs

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	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 & project management	$100,000.00		$100,000.00
Disposal of spoil	$50.00		
Sub grade works	$40.00		$340,000.00
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
Synthetic sports surface and infill	$43.00		$365,500.00
Shock pad installation	$24.00		$204,000.00
Other (if required)	$0.00		$0.00
Pitch Sub total			$1,379,500.00
5. Synthetic Field Indirect Costs			
Field fencing / gates	$150.00		$54,000.00
Field lighting	$175,000.00		$175,000.00
Player benches / shelter	$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%*		$234,999.36
PM Costs	3.0%		$58,749.84
Total investment			$2,252,077.20

Figure 4.12: Capital Cost for a 3G Field to achieve FIFA Quality mark, with shockpad and SBR infill

Maintenance Costs

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 Fiel	$37,000	$39,000	$44,000
Total cost for Field (from row 27) to match usage	$44,000		

Figure 4.13: Maintenance costs

Replacement Costs

Replacement costs for each expected replacement (10 yrs.)			
Component	**Aus. $ (no CPI)**		
Pitch Costs	**After 10 years**	**After 20 years**	**After 30 years**
Field planning and procurement	$ 55,500.00	$111,000.00	$166,500.00
Site establishment, documentation & project management	$100,000.00	$200,000.00	$300,000.00
Removal & disposal of existing synthetic turf surface	$75,000.00	$150,000.00	$225,000.00
Base rectification	$25,000.00	$50,000.00	$75,000.00
Synthetic surface installation	$365,500.00	$731,000.00	$1,096,500.00
Shock pad replacement should be every 20-25 years or allow 10% for upgrade inbetween	$20,400.00	$ 40,800.00	$204,000.00
Drainage system, pavement base and other civil works (assuming life expectancy of 30 years & 50% needs replacing)			$355,000.00
Pitch Sub total	$641,400	$1,282,800	$2,422,000
Ancillary Costs			
Fencing (replace chainmesh - allowed 33% replacement)	$17,820.00	$35,640.00	$54,000.00
Lighting (allowed 40%)	$70,000.00	$140,000.00	$210,000.00
Other (e.g. drinking water etc.)	$500.00	$1,000.00	$1,500.00
Mobile Equipment (allowed 100%)	$18,000.00	$36,000.00	$54,000.00
Fixed Equipment (allowed 20%)			
Ancillary costs Sub-Total	$106,320.00	$212,640.00	$319,500.00
Contingency costs (15%)	$112,158.00	$224,316.00	$411,225.00
Total Replacement Costs for Field of Play	$859,878.00	$1,495,440.00	$2,741,500.00

Figure 4.14: Replacement costs

4.7 Gridiron / American Football

In 1969, Franklin Field, University of Pennsylvania, switched from grass to artificial turf. Over the past 40 years, some National Football League (NFL) teams have switched back to natural grass, with some also deciding to reinvest in the latest generation of synthetic technology. The University of Pennsylvania is one example that switched from synthetic (2nd generation) to natural grass before reverting to a 3rd generation pitch.

In Canada, all eight stadiums in the Canadian Football League (CFL) use synthetic sports turf.

There are no standards for gridiron / American football except the Clegg Hammer Test, which measures hardness. If an organisation were to consider this in Australia / New Zealand, it is recommended that they consider the World Rugby or AFL/Cricket Australia standards, especially due to the critical head-fall criteria.

4.8 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 4.4: London Blue Hockey Field, as it is now known (source: Polytan)

In their latest handbook for synthetic surfaces[29] 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

[29] Handbook of Performance, Durability and Construction Requirements for Synthetic Turf Hockey Pitches

- 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.

4.8.1 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 surfaced 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[30].

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.

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.

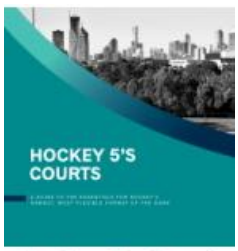
4.8.2 Costs

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.

4.8.3 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, offering the following Guides.

The Hockey Revolution



Hockey 5's Courts

[30] Handbook of Performance, Durability and Construction Requirements for Synthetic Turf Hockey Pitches (FIH – May 2013)

Figure 4.15: Hockey Australia Guides

4.9 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 4.5: 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.

4.9.1 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.

Product Licensing

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

4.9.2 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			**9,120m²**
3. Field Planning and Procurement Costs	**per m² / 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 4.9: Capital costs

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 4.10: WoL costs

4.10 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 4.6: 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.

4.10.1 Rugby Union standards

To ensure the quality and consistency of the surface, World Rugby developed the Artificial Rugby Turf Performance Specification[31], in consultation with FIFA. This standard was integrated into the Game Regulation

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

22[32] 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"[33]
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.

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.

4.10.2 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).

4.11 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.

4.11.1 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[34] and are summarised in the below table.

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
J	Other	e.g. Modular systems (tiles), wood, canvas

Table 4.11: ITF Approved Tennis Balls, Classified Surfaces and Recognised Courts

[32] Regulation 22: Standard relating to the use of artificial rugby turf
[33] Rugby for Nature | World Rugby
[34] www.itftennis.com/technical

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[35]

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 4.7: 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[36] 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. 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[37] 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.

[35] https://www.itftennis.com/en/about-us/tennis-tech/recognised-courts/

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

[37] ITF Court Surface Assessment Program

- 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[38].

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).

4.11.2 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 4.12: Estimated costs

[38] ITF Court Surface Assessment Program (pg. 6)

4.12 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 4.8: 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.

4.12.1 Multi-sport standards

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

1) 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 Riles, 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[39]

2) 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)

[39] https://playerwelfare.worldrugby.org/?subsection=78

allows for the integration of these key short pile surfaces to meet the needs of the sports.

This can be sourced from: http://www.fih.ch/inside-fih/fih-quality-programme-for-hockey-turf/facility-guidance-resources/

3) 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 4.9: 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 4.10: 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 and the specific sports are specified.

SECTION 5: SAFETY & HEALTH PERSPECTIVES

As we encourage more children and young people to be active and play on these sports surfaces, it is our duty and commitment to the next generation that we are protecting their health and creating safe places to play.

5. Safety & Health Perspectives

5.1 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 5.1: 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.

5.2 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[40] 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 5.2: Field with markings for several sports (source: TigerTurf)

5.2.1 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[41]. 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 21). 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 5.1: Number of Injuries per 1,000 hours exposure

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

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

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

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 5.3: Single Cut Move

5.2.2 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[42]. 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.

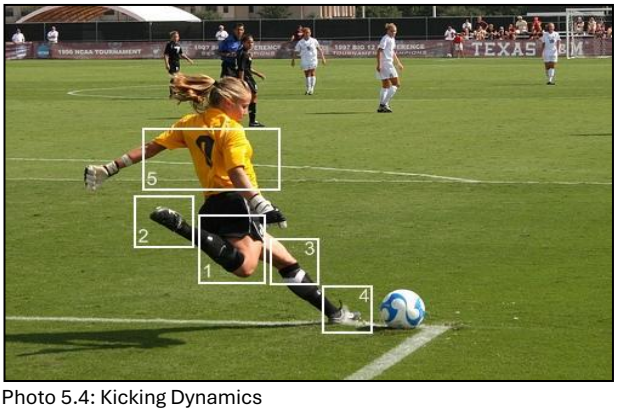


Photo 5.4: Kicking Dynamics

5.2.3 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 5.2: American Football Injuries (Surveillance Program 2004-2009)

A five-year study of American high schools[43] 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[44] 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.

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 5.3: Injury percentages

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

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

[44] 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

5.2.4 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 5.5: 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.

5.2.5 Summary of findings

Of the various independent studies[45] [46] [47] [48] 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.

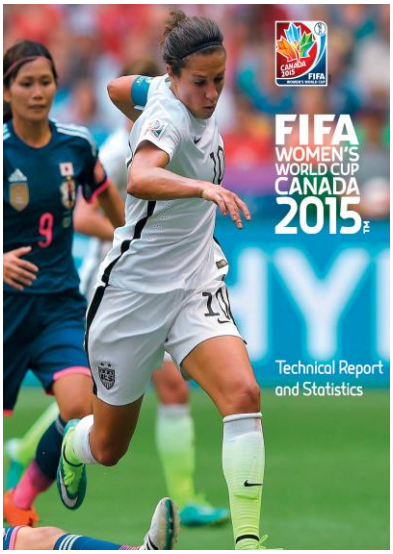


Figure 5.1: FIFA Women's World Cup technical report

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

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

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[49] 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)[50] 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.

5.3 Health Concerns & Perceptions

5.3.1 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.

5.3.2 Infill concerns

With the move from virgin and recycled rubber to organic infills the perceived health concerns associated with this are removed.

5.3.3 Heavy metals

The majority of quality sports fields, Football or Hockey Turf that use colouring, voluntarily removed heavy metals two decades ago. There are a number of global/European standards that ensure this is the case and they should be specified at the procurement stage.

In addition, Smart Connection Consultancy always requires the infill/yarn to be tested against European standards for Toy Ingestion, amongst other aspects that can identify the level, if any, of heavy metals and to ensure that if a child ingested infill or yarn it will safely pass through their system.

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

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

SECTION 6: PLANNING

The importance of planning shouldn't be neglected and should include a Review of Environmental Factors (REF) for all opportunities.

By exploring a whole of municipality approach, this will assist in identifying the best location for sports fields, irrespective of the surface type.

The planning process should reflect how the surface will be used, managed and replaced at the end of life. The results of this stage should impact the design and procurement process.

6. Planning

6.1 Introduction

The first step is the most important aspect as the PLANNING stage needs to bring together all of the external and internal influences and priorities. The planning stage needs to reflect every stage of the facility or surface usage from the

- Strategic planning – to reflect internal and external priorities, location and community needs and aspirations.
- Field of play key considerations.
- Sustainability lens (4P's)
- Life cycle considerations
- Community consultation

It is critical that the planning stage strategically explores every stage of the projects life to ensure that all aspects can warrant such an investment. The feasibility stage should then consider the five stages of the project (Plan, Design, Procure, Manage and End of life).

6.2 Needs assessment

The following needs to be considered to justify the need:

Conduct area identification
Has a need been established within the local government area and has this been agreed by the sport e.g. State Sports Association (SSA), local Council &/or state government.

Existing facilities audit
Has local facilities in the area been audited by council, the sport or other organisations to demonstrate specific needs for this request. This may include SSA or NSO facility audits / state strategies or local council recreation policies etc.

Demographic analysis for current and future growth needs
Does the local demographic profile align with the facility request and programming ability. The demographic analysis should be able to justify any gaps between the needs and wants of the project.

Participation data collected to determine needs
Have you embraced demographic data currently and for the future (25 years plus) this should allow for the collection of information on population density, age and gender structure, income and household profiles, and ethnicity. Expectations for growth or demographic changes are needed.

Alignment of sport and recreational needs analysis.
Does the local participation data provide the supply and demand modelling to justify the needs of any future facility.
Does the demand justify the level of provision, whether that be local, district, regional, state or national level. This data should provide the reality, not the aspiration of needs.

Stakeholder alignment
Has stakeholder and community consultation been conducted to support the project in an open and transparent manner.

6.3 Provision assessment

When considering the site assessment you need to explore and access the following:

- Justification that the current site cannot accommodate the current or future demand without such technological improvements.
- A council/regional-wide geographical assessment should consider which is the best site to encourage broad community usage.
- Number of synthetic fields of play in the area and how does the proposed one complement others and are part of a network solution to address capacity issues in the area.
- Exploration of other options (e.g. natural surface upgrade with drainage & irrigation system improvements or use of hybrid technology).
- Exploration of flooding, bushfire, environmentally or residentially sensitive areas prior to the agreement of the site

In addition, an assessment that compares demand against supply should include:

- A need to quantify current and future needs for participants and this will allow clarity on the surface type needed.

- Explore sports provision and capacity by completing a demand assessment analysis, agreed with the Sports SSA, to justify the need for new facilities and/or upgrade existing ones. This should consider recreational needs, training, and competition needs.

- Consultation at an early stage to reflect the whole community, including all (potential) users, key stakeholders, and the community who may be impacted by the development potentially from increased usage, traffic, noise, or lights.

6.4 Policy And Strategy Alignment

Organisational alignment
Does the project consider the open space, recreation needs, and sporting facilities strategies as well as the SSA needs studies.

External alignment of policy and strategies

Consult and confirm any strategic needs and how this planning request will fit into state/territory, commonwealth, and local government strategies, both within this location and the neighbouring ones.

Approved masterplan
Is there a masterplan or identified need by council for the facility as this site that has been agreed by council that you can align to.

6.5 Sports Specific Needs

Aspirations
How does the organisations aspirations align with the demographic and sporting needs for the future.

Specific technical needs for surface
Certain sports have requirements for the surface types and performance criteria and most are linked to the level of play, from multi-sport to training, community, regional, state, national, and international; play requirements.

Work with local SSA to identify the actual standards and type of surface needed for the field of play, not just the aspirational needs.

Surface type
A decision should be made that clearly justifies why a specific surface type is decided upon, whether that be natural grass, synthetic or hybrid grass, acrylic surface, rubber track or specialist surfaces for each sport (e.g. woven carpet for bowls etc).

Sport specified surface
Does the sport specify a specific type of surface, such as Hockey, Athletics, Netball etc that means it will not be played on natural grass.

Standards of play
Are the standards of surface clearly defined, fit for purpose and meets the Australian weather challenges.

Risk mitigation strategies

Has all risk mitigation strategies been considered for the proposed surface, including:

i. Environmental aspects,
ii. Community usage,
iii. Economic considerations.

Technology usage
How can technology be used to assist with the management of the facility (e.g. Tennis Australia's Book A Court platform, Lighting software, Intelligent Play etc).
Program needs & management.
Does this new surface allow for greater programming and usage without detrimental impact on the surface.

Replacement strategy
Has a replacement strategy and funding fund been considered.

6.6 Management Considerations For Future Proofing

Site management Strategies
Has the owner of the facilities (e.g. local council) agreed how the site should be managed (e.g. lease, license, Council management etc) and will this impact the management of the proposed facility.

Maintenance responsibilities and strategies
Is there an agreement (MoU/Lease agreement etc) that clearly identifies the maintenance, repair, restoration and replacement of the surfaces being requested.

Usage levels
Is there clearly modelled (& conservative) projected usage of the proposed surface and will that surface be able to cope with the demand modelling.

6.7 Environmental Considerations

When considering the Whole of Parkland the following needs to be assessed and embraced:

Exploration of a whole of parkland masterplan should be considered to ensure that any field of play design is aligned with the strategic needs of the site.

Impact of the field of play for the whole site - including tree canopy, fauna, flora, water harvesting, parking, lights, etc).

Placement of field of play – to minimise the impact of the field on other environmentally or community-sensitive areas (e.g. waterways, bushfires, etc).

Climate change impact - has the design embraced the Australian Institute of Landscape Architects, Climate Positive Design (Vol 1-3) Guidance.

Tree planting – to reduce climate challenges and carbon sink and possible impacts to Urban Heat Island (UHI) impacts.

Active, Passive recreation impact – will the new facility have a significant impact on passive recreation in the area? Will it significantly impact the hours of play in a manner that will impact the local community.

Accessibility – Consider whether the new facility will impact people using the site, accessing the site and whether will it be perceived as being safe and accessible by all.

The importance of the Civil Engineering solutions needs to consider the following to ensure a 20-30 year solution is developed:

Site geotech report - to ascertain the ability of the site to accommodate the pavement base, and in what form to ensure that it can be built for a minimum of 20 years.

Site environment assessment – to consider all soil health issues.

Flood report – that may impact the site longevity and ability to construct as flooding needs strategic engineering solutions for certain types of flooding.

Site survey – to be able to design and build the site to its optimal performance.

Tree management report – in relation to any trees impacting the field of play and also how the tree canopy can be expanded with the careful planting of additional trees, for shade, reduce surface heat, and offset any UHI impact. Need to consider new legislation - Urban Forest Act 2023.

Review of the whole of site access – to ascertain pedestrian and vehicle travel around the site from the development and during the development, reducing the impact on the community.

Site overlays – has the site any overlays such as heritage importance, restrictive zoning, previous landfill, existing easements etc.

Pavement base - 20-year minimum design and preference is for 30 years to ensure that the investment can make a difference to generations of children and sports players.

Geotech site assessment is needed to ascertain the ability of the site to accommodate the pavement base, and in what form to ensure that it can be built for a minimum of 20 and preferably 30 years.

Drainage strategy – to address a 1 in 20-year ARI event of approx 20 mins is allowed for and preferably 1 in 50-year ARI.

It is important that the drainage can disperse the water after heavy rainfall and for the sport to resume within an acceptable period.

Water harvesting – where affordable should be considered to provide a benefit back to the whole parkland.

Planning approval - may need to be sought, depending on the site or at least a Review of Environmental Factors (REF) in NSW.

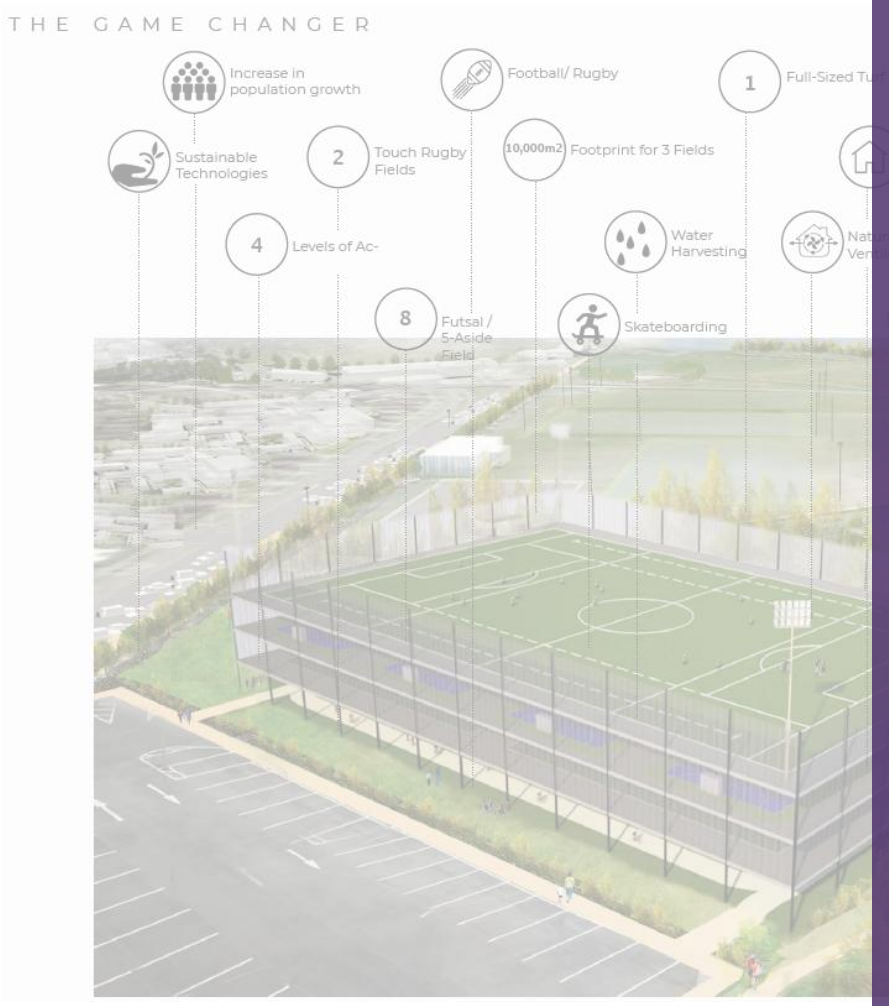
New facilities, where a Development Application, is required will need to adhere to the local council obligations, which includes a range of statutory documents and additional reference documents (e.g. District and Zone policies, Technical Specifications, Design Guides, District Strategies).

This will ensure that appropriate environmental standards and strategies are considered:

- What environmental strategies should be considered, this may include, Open space, tree canopy, strategies, urban heat island impact reduction strategies or circular economy policies, to name but a few.
- What environmental standards need to be considered such as mitigation of microplastics etc.

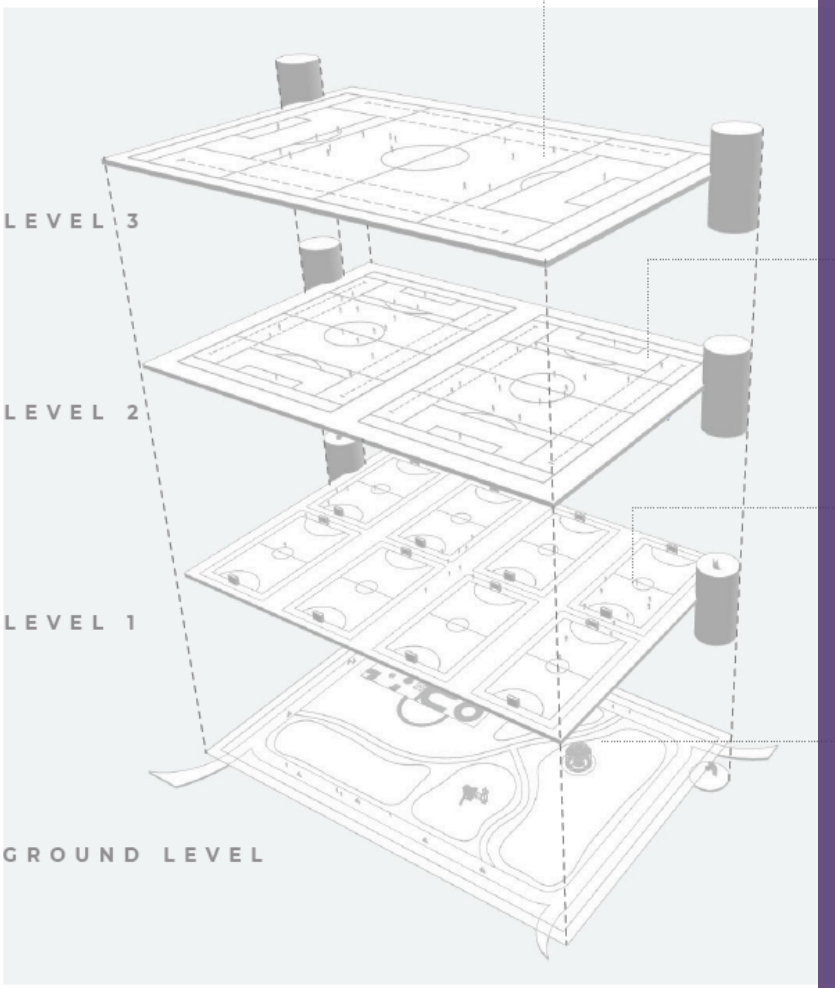
SECTION 7: DESIGN

THE GAME CHANGER



The design must be contemporary and address how the field of play will reduce its impact on the environment, meet the intensity of use and is fit for purpose.
This is more than an engineering design. It will impact how the field is managed, used and recycled at the end of life over the next 30 years, if designed well.

CONCEPT DIAGRAM



7. Design

7.1 Introduction

The design stage interprets the planning scope into the delivery ready for procuring the best value surface that is fit for purpose.

The importance of this stage is to ensure that all aspects of the site are considered to create the best outcome for the surface and the parkland. It is possible as the early stage of the DESIGN process that when the site assessments are completed (e.g. Geotech engineers assessment and /or environment assessment) that this preferred site is deemed not appropriate. Due to this some councils complete these two components in the planning stage as part of the specific parkland assessment.

The Design process should include:

- Site evaluation
- Community engagement (if not as part of the planning stage)
- Civil/construction design – concept and detailed design
- Landscape design
- Performance surface design
- Stormwater and drainage strategy
- Environmental considerations, including biodiversity

7.2 Performance Standards for Surface

The design stage is critical to ensure that your organisation can procure what is needed, its fit for purpose and will achieve the various standards and life expectancy.

It is therefore important to consider the following:

- Sports performance levels/standards
  The surfaces should be designed according to the International Federation standards for community sport, namely:
  - Football – FIFA, Quality mark
  - Rugby Union – World Rugby, Regulation 22
  - Rugby League – NRL, Community Standard
  - Australian Rules – AFL/CA Community Standard
  - Hockey – FIH National Standards
  - Athletics – World Athletics, Category 2

The International Federation surface standards are the starting point and additional performance standards are needed for Australia due to our intensity of use, the environmental conditions, and the community's concern about health and safety.

- Size of playing area
  Ensure that the field size is linked to the level of play that is going to be held on the field, as the difference for an aspirational-sized field may add a further 25% to the costs.

- Surface design specified
  Line marking - The line marking should meet the appropriate sports standards (e.g. state, national sports organisation, and that of the International Federation) depending upon the jurisdiction.

  System design – Yarn - Dual yarn of monofilament and fibrillated tape with additional durability testing (Lisport test 2012 – over 100,000 cycles) to allow it to stand up to the intensity of use in Australia.

  Reduce ball splash and migration of infill - more durable combination and reducing the maintenance needs.

  Also reduces the likely migration of infill outside of the field of play.

  The design of the Field of Play needs to be designed to achieve AS TR CEN 17519:2021 Surfaces for Sports Areas – Synthetic turf facilities – Guidance on how to minimise infill dispersion into the environment.

  System design – infill - Organic infill options with a preference for limited floating.

  Heat level of 1-2 on the FIFA scale as opposed to rubber was 2.5 to 3 (40% heat reduction).

  It is environmentally positive as it removes the rubbers from the system and the possible migration from the field.

  It will reduce the heat impact significantly and positively impact the perceptions of the community.

  This will address the perceived issue with some of the community who fear the rubber may have negative health impacts – which although not proven at any level – will stop this narrative.

  Shockpad - Every system should have a shockpad that meets the European standard (EN 15330-4 (2022) Surfaces for sports areas (Part 4) and has been tested to the Sports International Federation standard.

  The shockpad should have a manufacturer (not supplier) warranty of a minimum of 20 years and for a minimum of 60 hours and not the normal 40 hours per week that some offer.

  The environmental preference is for the shockpad to be constructed from recycled products.

- Certification standards
  Is certification needed by the sport for compliance (Rugby Union, AFL only), if not does the sport require it?
- Additional standards
  Additional standards for porosity and U.V. durability should be considered at this stage.

7.3 Planet (Environmental) Standards

Environmental sustainability should be built into the design and needs to explore that its aligned with any Open Space or site masterplan.

- Surface environmental standards
  The following SMART standards should be embraced for environmental good practice:
  - Infill and yarn should be tested to AS/NZS 2111.18 (1997) AS/ISO 9239-1 Flammable / melting point is acceptable
  - The Heat Indices (FIFA Quality manual) should be within a 1-2 score
  - All drainage should be under the field of play and achieve the AS Standards for Mitigation of Microplastic's
  - European REACH regulations, Annex. XVIII entry 50: 2021 if rubber infill used
  - EN71.1 Safety of Toys – part 3 Mitigation of Certain elements, table 2 – category III (Scraped off material) or US standard ASTM F3188-16

  The carpet system needs to be tested for additional durability for Australia (FIFA 2012 Quality manual – Lisport test with a minimum of 200,000 cycles and the higher the better, with some systems now offering over 300,000 cycles.

- Climate action design alignment with good practice
  Has the design embraced the Australian Institute of Landscape Architects, Climate Positive Design (Vol 1-3) Guidance.

- Civil engineering standards
  Has the pavement design been designed for 30 years.

- Drainage strategy
  Has the drainage been designed to accommodate and Annual Rain Intensity (ARI) of at least 1 in 20 year plus event.

- Water harvesting
  Can your design embrace water harvesting to water the rest of the parkland.

- Lighting strategy
  What lighting do you need for the fields (e.g. 50/100l lux) and what Australian Standards are needed.

  The light system should be LED, and have smart technology that allows for various settings including 'warmup/down', training, and competition (Various levels) to optimize costs and performance needs

  The standards should be specified against the various Australian Standards and aligned with the various sports needs

  - AS 2560.1 Sports Lighting, Part 1: General Principles
  - AS 2560.2 Sports Lighting Part 2: Specific Applications

  AS/NZS 4282:2019 Control of obtrusive effects of outdoor lighting (general and specifically appendix C).

- Fence / netting standards
  Fencing and netting need to balance the role between safety (keeping the ball within the field of play and reducing the opportunity of interaction with spectators or passers-by) and keeping spectators out of the field of play while balls are being used.

  AS 1725.5 – 2010 (reconfirmed 2020) Chain link fabric fencing Sports ground fencing – general requirements

  Higher fencing should be considered at key points around the field of play to reduce the ball entering roads, high-use pedestrian areas and to protect other buildings, etc.

- Maintenance and renovation
  Has the maintenance and renovation program been aligned with the life of the surface, with clear roles and responsibilities defined.

7.4 People (Community) Standards

The design needs to meet the expectations of usage both from an intensity perspective and a performance lens. The key designing aspects should include:

- Durability and intensity of use
  If the facility is being used over 40 hours per week additional intensity usage standards need to be designed in.

- Parking and transport
  Public transport should be considered for access to fields. If this is difficult then there should be adequate parking for peak times and turnover of participants etc.

  Conversion of current facilities needs.

  Ensure adequate parking is available.

  Explore the ease of public transport.

Lighting in parking areas to ensure that there is safety of users.

Access to site and around whole of parkland

Are there good paths around the parkland to key local areas, including parking, toilets and amenities.

The width of the paths should be sized to their usage, 2.5-3m in high use areas.

- Way finding
  Has the way finding signage been developed and tested on people.

- Pedestrian and vehicle access points onto surface
  Access points need to be DDA compliant and on a level to the paths with NO step down.

- Equipment standards
  International and SSA Sports standards need to be embraced.

  Goal posts should be procured as aligned with the Australian standards compliance obligations, AS4866.1: Playing Field Equipment – Soccer goals.

  Identify the standard of play that the field is primarily used for (not the aspirational level) and align the size of posts (e.g. AFL, Rugby, etc) as the post heights differ between local, district, and state-level competition.

- Accessibility for public casual usage
  How will the site be designed to allow access for casual usage, so fences/gates are open for public use.

7.5 Prosperity (Economic) Standards

The costing of the investment needs to include Whole of Life and the following:

- Whole of life costings
  Has whole of life costings been calculated in a manner that includes capital costs, maintenance/renovation and replacement costs at the end of life.

- Warranty's
  The performance system should have a manufacturer (not a supplier) warranty of 8 years (min) against a minimum of 60 hours of usage per week for 50 weeks a year (3,000 hours per annum).

- Operational budget expectations
  Operational costs for management, maintenance, replacement of infills (synthetic grass or sand) and repainting should be considered.

SECTION 8: PROCUREMENT

To procure the best tenderer will depend on the way your organisation writes the documentation and the information you request is returned through your schedules.
A Design and Construct tender has been superseded due to substantial technical problems found down the line.
It is recommended that a Design Finalisation and Construct is the best approach or a Detailed Design.

8. Procurement

8.1 Introduction

The procurement and delivery of the project should reflect the design considerations with the procurement and project management to ensure that the field of play is delivered.

The stage of this process is normally:

- Design and procurement documentation
- Procurement process
- Construction and project management
- Certification and handover
- Dilapidation period

This process should be aligned with key internal dates of the organisation to make the decision, which could include Council meetings, organisation board meetings, etc.

8.2 Design & Procurement Documentation

A procurement program is needed to ensure transparency and rigor to secure fit for the for-purpose field of play.

Council procurement program should be used where possible to ensure transparent and rigorous procurement protocols are followed.

The final design drawings need to be aligned with the Request For Tender, Conditions of Contract, RTF Schedules and the Specification (Performance Surface and Construction).

The common Design and Construct (D&C) procurement strategy is fraught with dangers and although may present as a cheaper option in the short term will be more costly in the whole of life of the field. Choose either a Design Finalisation and Construct (DF&C) or a Detailed Design (DD) strategy.

The development of the specification needs to consider the performance surface that is fit for purpose, the construction process and standards, environmental expectations, timelines and details from the client side to ensure that the tenderers have a complete understanding of the site history, current condition and how it will be used.

It is imperative that the writer is knowledgeable of all standards and needs. Encourage innovation in the system options to demonstrate best value for the community and user.

8.3 Procurement Process

There should be a skilled team to evaluate the submissions from the tender process, with key evaluation criteria should include, price, quality of offer, their experience, capability & capacity of the tenderer, project plan and methodology.

The tenderer chosen must have experience in the construction of these standard fields and the surfaces must be certified and approved by the Sports International Federation.

Tenderers/suppliers of such sports surfaces must be a licensed or preferred provider of the International Federation or an Agent of such an organisation and can supply a sports system that has been tested and has been certified by them to meet the IF's performance standards

The evaluation strategy should consider a weighted system that explores, the experience and capability of the tenderer, their capacity and availability for your timelines, the costs (whole of life recommended), the product you are purchasing and the methodology they will employ to construct and install it.

The procurement time lines need to explore the tendering timelines (4-5 weeks), the evaluation and decision-making process (4+ weeks), the negotiation period (2-4 weeks), the project management of the design finalisation, manufacturing process, construction, installation and certification process.

Certification to the International and A**ustralian** Sports standards once complete and ongoingly. All sports fields need to be procured in a manner that ensures that the International Sport Federations' performance standards are achieved as a minimum, plus Australian-specific needs as per the Design Guide (e.g. UV radiation, water porosity, etc).

8.4 Construction & Project Management

Assuring the quality is crucial throughout the project and once it has been installed.

Identifying the Critical Hold Points and Witness Points through a strong communications process between all parties. The construction stage should also address the Traffic Management Plan, OHS, Environment Management Plan etc.

There should be a Project Manager appointed by the organisation to ensure weekly meetings between all parties can be delivered within budget and on time.

A detailed project plan will bring together all parties and ensure an aligned timeline that reduces the probability of overrun and additional costs.

8.5 Certification & Handover

If the field of play surface is to be certified by an independent organisation (e.g. Hockey – FIH, Football –

FIFA, Rugby – World Rugby etc) that should be addresses in the project plan.

The Contractor shall provide a Handover Manual to the Principal in both hardcopy (PDF) and electronically (Word) as described below, prior to Practical Completion. The objectives of the Manual for the Principal are to:

- Have sufficient detail so that if all of the principal's staff change during the life expectancy of the project's life, that there is complete Intellectual Property detail available to them,
- Understand the technicalities of the project in detail,
- Appreciate who to contact from the Tenderer, Certification company, Maintenance provider and who to contact if there is a problem,
- Understand their own obligations to the management and maintenance of the field of play; and
- Be able to refer to all management guarantees for the workmanship and system warranties for the life expectancy of the project.

This manual should consider the following sections;

- Company details
- Project overview
- As Built drawings
- Warranties and Guarantees
- Operational and maintenance manual
- Operational conformance

The field should be certified by an approved International Federation approved assessment company to ensure that the surface performs to the levels specified.

8.6 Dilapidation Period

An agreed dilapidation period should be agreed as part of the tender documents initially.

SECTION 9: MAINTENANCE OF SPORTS SURFACES

Maintenance for synthetic sports surfaces is the proactive and planned care that keeps the surface safe, consistent and match ready, preventing small issues becoming costly failures. It extends the life of the field, safeguards warranties, reduces whole of life costs and maximises the return on the original capital outlay.

9. Maintenance of Sports Surfaces

9.1 Why Maintain a Sports Surface?

Photo 9.1: Multi-sport Football / Cricket field at Chatswood High School. Source: Polytan.

It is critically important that all sports surfaces are designed, manufactured, installed and maintained in a manner that will achieve its life expectancy and provide a safe and consistent playing surface. The life expectancy of the sports surface is dependent upon the type of surface (rubber, acrylic, grass), the intensity of usage (hours and number of users), the quality of the surface (is it Fit for Purpose) and the maintenance employed. The external factors will include weather (rain, U.V., wind etc), location, quality of the civil engineering works, equipment, and footwear used on the surface.

The benefits of a good maintenance program include:

- Ability to maintain certification of the International Sports Federation (I.F.)
- Compliance with manufacturing warranty,
- Consistent playability and performance,
- Increased probability of achieving life expectancy,
- Reduces risk of injuries and impact on players,
- Aesthetically optimised performance,
- Reduced the need for major renovations and ongoing infill top-ups, reducing overall costs.

With most International Federations' requirements, the installer/manufacturer must provide performance surface maintenance manuals for the surfaces to guide the owners on their roles and responsibilities for maintenance and upkeep.

9.2 Surface Maintenance Etiquette

There are common principles that should be followed regardless of the surface type to maximise life expectancy, ensure surface performance, and reduce risk to users.

i. Appropriate Footwear
   - Good quality sports shoes and boots should be used that are designed specifically for the surface type.
   - Running spikes for rubber tracks shouldn't be too long, as this will tear the rubber.
   - Flat-soled shoes are not recommended for long-pile grass fields.
   - High heeled shoes are not recommended as they can puncture the grass and scratch the other surfaces.
   - Smooth soled shoes are not good for acrylic surfaces when wet or slippery.
   - Appropriate studded or pimpled shoes for long and short pile grass.

The wrong footwear on some surfaces, apart from damaging the surface, could quickly invalidate the manufacturer's warranty. Do ensure that if flat soled shoes are going to be used on 'long-pile' grass that the manufacturer/installer is aware as they should guide you to an alternative solution. This could be a 'Tape Yarn' as opposed to a monofilament system.

It may be appropriate to have a mat at the exit point of a field or court that stimulates the sand, infill, rubber, etc., to leave the base of the shoes or boots.

ii. Overhanging Trees

Trees can cause significant challenges to a surface, including:

- Tree roots aggressively undermining the surface flatness
- Leaves falling and causing increased maintenance to keep them clear of the court or to stop breakdown on a grass field.
- Dripping water off the trees, which could make the surface slippery
- Shade, which can encourage algae to grow
- Bird and bat dropping, which can cause damage, especially to acrylic surfaces
- Secretions of aphids can coat courts and fields, which may impair footholds.

iii. Equipment and Furniture

The surfaces are not designed to have equipment dragged across them, such as goal posts, which will damage the acrylic courts, short/long-pile grass, and rubber.

If the equipment is on wheels, they should be rubber type wheels.

Normal seats have a tendency to mark the courts, leave indents in rubber and can puncture grass fields.

Some hard surfaces can be designed for roller skating/blades and this needs to be explored with the installer/manufacturer to ensure the surface type will not be impacted.

iv. Harmful Substances

The following substances should not be used around sports surfaces:

- Chewing gum – as when this hardens it is very difficult to remove.
- Cigarettes – likely to create a fire hazard and leave unsightly burn marks.
- Petrol/Solvents—These will seriously damage most surfaces, and machines that use petrol/diesel need to ensure that there are no leaks. If they need to be filled up, this should be done off the court/field. If any is spilt, it is recommended to use copious amounts of water/detergent quickly to remove it.

Salt/de-icing agents should not be used as they can be unpredictable and may leave a residue as they dry out, which may damage the surface or make it slippery for users.

v. Weeds

It is common to find weeds in long-pile grass fields where birds have dropped seeds, or they have been blown into the field or court and germinated. The extent to which the weeds are a nuisance is dependent upon the surface type, where you may see many weeds situated along the fence line or in areas that may not receive strong traffic from users, etc. The weeds should be treated on a frequency of growth, the more weeds, the greater the treatment. Use a suitable weed killer that doesn't cause problems to the surface type and won't leave a residue that could impact users, especially small children. Seek advice from the installer/manufacturer for approved solutions.

9.3 Maintenance Strategy Specific to Site and Surface

9.3.1 Introduction

It is important that each site and surface within the site has its own maintenance strategy. As part of the strategy, there needs a number of aspects to be considered, including:

- Responsibilities of roles at the site between the sports club, Council/sport and any contractor or workforce.
- Equipment available, for each of the maintenance tasks, which may mean that specialist equipment is needed from external organisations.
- Surface type, will mean that each surface will be maintained differently, including, rubber, long and short-pile grass and acrylic surfaces.
- Age of surface type.
- Frequency and intensity of use.
- Warranty requirements.

9.3.2 Roles and responsibilities

As there are many stakeholders involved in many of the sports facilities, it is imperative that each understands that they have a role to play in ensuring that the surfaces are maintained well. This may include:

- Asset Owner – Council or sports club, who mainly purchased the synthetic surface and has the overall responsibility in ensuring that the surface reaches its expected life expectancy, is safe for users and performs to the expected level. They should develop the maintenance specification to ensure that all stakeholders do their part.
- Sports club – normally, the users should check that the surface is clean and safe to use before they physically use the surface. They should be expected to leave it in the same standards after they finish, taking away any rubbish, replacing equipment and doing any operational tasks, such as drag mat over sandy tennis courts, refilling the penalty spot on a long-pile football field, brushing the sand back into the long jump pits from the track etc.
- Maintenance organisation – whether inhouse or contracted in, the maintenance for each surface should be clearly articulated with an agreed specification that will address routine, planned, reactive and scheduled maintenance renovations.
- Specialist maintenance – there may be times when specialist equipment and expertise is needed such as decompaction for long-pile turf, or high pressure water cleaner for tracks and this needs to be programmed in.

9.3.3 Equipment availability

It is critical that the right equipment is used for the appropriate tasks, and by the right skilled people. The equipment needed for each surface type and task is listed against each identified surface.

The key equipment components include;

1. High Wear Area Maintenance of 3G Fields

For synthetic long pile surfaces, a bucket full of the agreed infill sand and performance infill is needed for the club to use around high wear areas such as the penalty spot, corner flags and coaches boxes.

- The plastic, wide angled rake should be softly used to bring the yarn upright.
- Slowly, by hand, spread the sand evenly and walk on it to compact the sand.

Repeat this task until the sand is compacted and levelled with the rest of the infill levels. Add a small amount pf performance infill on top.

2. Long-pile Brushing of 3G Fields

Brushing of the long-pile turf has a number of aims, including;

- To brush the flattened yarn back upright
- To remove vegetation from the top of the carpet
- To brush back any performance infill that has migrated across the field during play and therefore returning the overall field to the levels of free pile height that will protect its ageing process and performance characteristics.

With many different types of brushes on the market the key ones that perform different tasks include:

- Sweeping brush – to sweep field back to infill levels.
- Drag mat – to collect debris and is essential that this is not a hard abrasive mat. It is preferably not to be used as the field ages. A Friction Sweeper is a better option.
- Oscillation Brush Machine – These are hydraulically controlled, rotating forward and in reverse. These brushes are especially effective for raising the yarns in high wear areas.
- Decompaction Tines – used to decompact the performance infill, normally before and after the main season. As the field ages or the intensity of usage increases (e.g. small-sided games), the field will need decompacting. This should be completed slowly with a specification machine.

3. Maintenance of Sand-filled Tennis / Sports Courts

Most sand filled tennis and sports courts are filled within 5mm-10mm of the yarn height. As the court is played on the silica sand acts both as a ballast and to protect the yarn from falling over and U.V. degeneration.

It is important that the sand is kept clear and even across the court for safety, performance and aesthetics.

Most tennis courts use a leaf blower to remove the leaves before they breakdown and a yard brush.

The Friction Sweeper can be used across a number of courts and/or brush to weed behind a small machine.

Both of these approaches will reduce the sand movement and improve the performance of the surface.

Moss and algae can build up and can be seen at certain parts of the year, mainly in areas that have shade and not used, around fence lines etc. This can then become slippery and damaging to the court. This needs to be treated and a non-oil based product approved by the manufacturers should be sought.

If the courts haven't been used or maintained for a long period they may need some more remediation by a deep clean with options around pressure water, vacuum clean and replacement of some of the sand.

4. Maintenance of Acrylic Surfaces

It is important to keep the acrylic or hard court surfaces clean, free from dust, dirt, rubbish and any other detritus.

Depending upon usage and their location it may be beneficial for the surface to be pressure washed as part of regular cleaning. This can be completed by a specialist contractor who would be able to do this over a number of courts in a day.

5. Maintenance of Rubber Surfaces

Typically rubber athletics tracks should be brushed annually with a specialist brushing machine and especially around the long/triple jump pits.

In addition, the following should be considered;

- Deep pressure hose clean (every 1-2 years)
- Movement of the javelin throw area and high jump beds to reduce the damage of athletes using the same area each jump or throw.

9.3.4 Design to reduce intensity of maintenance

By understanding how the Football Turf system works, the design can significantly reduce the level of maintenance needed and the frequency. The approach may include:

- Shockpad installation: By having a quality shockpad (warranty over 20 years and made to EN 15330-4:2022 the amount of infill needed has been reduced significantly. An infill level without a shockpad would typically be 25kg/m^2 sand and 20kg/m^2 rubber/organic. With a shockpad, it would be expected that the performance infill only needs to be 5-8kg/m^2.
- Yarn combination: By moving away from a monofilament yarn system to a tape or tape/monofilament dual yarn carpet, the infill splash is reduced significantly (estimated to be greater than 75%). This should reduce the frequency of the need to brush infill 'back into' the centre of the fields.
- Yarn and carpet structure: High quality thicker pile yarns are significantly more resistant to pile splitting and flattening. Carpets with

higher stitch rates are more resistant to pile flattening, yarn splitting, and infill dispersion;
- Synthetic turf systems incorporating shockpads or elastic layers generally suffer less from infill compaction than systems without.
- Removal of spoon drains: Remove all surface drainage and design this to be subsurface under the carpet to ensure no infill migration into waterways.
- Microplastic migration mitigation: Adoption of Standards Australia / European Standards "SA TR CEN 17519:2021. Surfaces for sports areas. Synthetic turf sports facilities, Guidance on minimising infill dispersion into the environment". This provides design advice on how to contain microplastics (including infill) within the field of play.
- Player and vehicle entry points: To reduce the migration of the infill and dirt brought onto the fields by boots, shoes, and vehicle tyres, have brush trays for pedestrians and vehicles.
- Facility Equipment: Secured rubbish bins positioned next to entrance gates and upstands at the base of the fence line (200mm min) to alleviate wind-blown rubbish, leaves, etc, onto the field through the fence.
- Drainage strategy: To reduce infill floatage with a severe rain event, consider the drainage strategy sufficient to cope with an intensity level in excess of the norm (suggest 1 – 50 year ARI with an intensity for 20 mins). This will reduce the probability of water pooling. By asking for double the normal holes in the latex backing or use of a mesh backing this will increase the porosity of the carpet. This should be considered for organic infill significantly as it floats easier than some rubber options.
- Pavement / Drainage strategy: Consider a vertical draining strategy sub-carpet with a flat surface and the drainage mechanics in the shape of the sub-base and pavement. The lack of on field gradient will ensure no lateral surface movement of the water as all the gradient is in the pavement and sub-base. So, the porosity of the carpet/infill and shockpad is critically important.

9.3.5 Maintenance strategy specific for the field of play

It is critical that the owner of the field of play appreciates that there are differing long pile systems available on the market, some with greater infill or less, some with a single monofilament, and others with dual yarns, all needing a small change in the maintenance ways. It's important that the field owner receives a manual that is developed for their specific field system.

Too often, asset owners are provided with a generic maintenance specification and manual that has probably been used globally and is not specific to a site. In many manuals, even the standard design pictures show only a monofilament grass, yet the majority of educated asset owners do not purchase these systems for open parkland fields anymore, yet the maintenance manuals still show them. There is an acknowledgment that this standardised approach needs to change.

The expected site specifics should include the following:

- Carpet type, dual yarn system.
- Layout of site, especially goal area and type of goals used.
- Infill type.
- High wear areas, especially penalties, corner areas, gate access points, coaches boxes, etc.
- The change in maintenance practices as the carpet ages – as the needs will change.
- Intensity of usage and where each type of maintenance should be carried out.
- Roles and responsibilities: who will do what maintenance.
- Renovation strategy (e.g. infill top-ups etc).

9.3.6 Resource availability

The alignment of resources, skills and experiences is crucial to successfully managing the maintenance function. Section 4 explores the options in more detail. The key principles need to be:

- The type of maintenance needed and the machinery/equipment needed, whether that is a plastic rake to add infill around the penalty area or machines needed for brushing and deep cleaning.
- The in-house skills and experience, or should it be contracted out to a third-party contractor.
- Time needs to be considered and programmed into the schedule of the field.
- Funding is critical for success within the annual budget. It should include routine maintenance (e.g., brushing), programmed maintenance (e.g., deep cleans), and end-of-season renovation (e.g., seam corrections and infill top-ups).

9.3.7 Monitoring and reviews of performance

Within the maintenance, there needs to be regular monitoring and an annual review to ensure that the surface and surrounding areas are being well managed. Section 4 explains the detail and should include:

- Pre and post-match monitoring, including specifically after drills in a specific area that may need a top-up (e.g. penalty areas).
- Regular maintenance (e.g. brushing) and a record kept of what's been done.
- Annual or post-season review before the renovation to prepare the field for the next 12 months and include any changes needed to ensure it reaches its age expectations.

9.4 Purpose of Maintaining Long-Pile (3G) Fields

Maintenance can be scheduled into a seasonal or annual program linked to usage, with regular maintenance (suggest one hour) linked to every 10 hours of play. It is recommended by some commercial operators[51] to have two to three hours of maintenance weekly for every 30 hours of use for long (3G) grass usage. Although FIFA suggest weekly[52], our view is that it needs to be linked to:

- The level of use per week;
- The type of usage (e.g. adult, junior);
- Intensity of the area used (e.g. 5-a-side needs more than 11-a-side);
- Available budget and resources, and
- The type of sports activity (e.g. Rugby scrums will impact surface displacement).

9.4.1 Initial maintenance and settling in period

After the installer/builder hands over the field, the infill needs approximately 40 hours of play to 'settle the system in'. This normally allows the infill to be firmed up and reduced in height as it receives a gentle compaction with the initial usage. Many clients invite the local school children to play on it for a few days to get their feet running over it.

This may mean that the fields' initial look may look a little overfilled on handover, but with the initial usage, this should settle down accordingly.

The independent Test Institute shouldn't come and test until after this 'settling in period' to ensure the test results are more accurate.

A handover meeting on the field attended by all stakeholders is critical. It allows for a Q&A session, a maintenance demonstration, and a consensus agreement on who will be responsible for what.

9.4.2 Routine maintenance

1. Guidelines on frequency

Whatever the circumstances, a regular monitoring inspection will identify the routine needed for each specific field. Table 1 provides some guidelines. When developing a maintenance specification many of these tasks can be rolled into one visit, thus saving on the costs of addressing them individually.

Photo 9.2: Thomson park, Willoughby City Council using different grass types which meets the community needs and will need different maintenance approaches for long and short pile

[51] Long Pile Synthetic Sporting Surfaces Maintenance Manual (2014) - Grassports

[52] FIFA Maintenance Guide (FIFA Maintenance Portal – sourced Nov 2014)

Suggested Routine Tasks	Playing Hours Per Week		
	<20hrs	20-40hrs	≥40hrs
Pitch inspection monitoring	Daily	Daily	Daily
Litter removal	Daily	Daily	Daily
Refilling high-wear areas	Weekly	Weekly	2 times a week**
Drag brushing heavily used areas - monofilament	Monthly	Fortnightly	Weekly
Drag brushing heavily used areas – dual yarn	Monthly	Monthly	3-4 weeks
Rotating Brush – high-wear areas	Quarterly	Monthly	Weekly to Fortnightly
Osculating Brush – high wear areas	Quarterly	Monthly or as needed	Monthly or as needed
Rotating Brush – whole pitch	Six monthly	Quarterly	Monthly or as needed
Weed/moss/algae treatment	Annually	Annually	Annually
Seams inspection	2 weeks	2 weeks	2 weeks
Surface de-compaction	Seasonally	Seasonally	Quarterly or 6 monthly***
Renovations (e.g. Infill top-ups, seam movement, flag holder changes, remarking of lines)	Seasonally	Seasonally	Seasonally

Table 9.1: Guidelines for Maintenance

** *we would strongly recommend that after heavy use, e.g. training or end of matches the high-wear areas are topped up and brushed in.*

*** *if dual yarn carpet*

2. Daily maintenance and monitoring checks

Prevention is the best science for prolonging the life of a field. This starts each day when someone should walk the field of play to ensure that it is safe for the next user and identify any simple maintenance rectifications needed (e.g., penalty spot top-up).

Either ground staff or a club representative should walk the field and maintain the surface, including:

- Removing any sharp objects from the surface, e.g. glass, syringes, metal, plastics, etc.
- Remove large pieces of organic matter, e.g. twigs, spoil by the gates, etc.
- Top-up areas around the penalty area, corner flags, line out areas with performance infill and sand
- Check the equipment – such as the goalposts, nets, and interchange boxes ensuring that equipment is safe and not damaged

When applying 'top-up' infill, it is suggested that the applicator should use a medium stiff brush or general plastic leaf rake to agitate the yarn before sowing the infill into the carpet, then rake over and then sow again in the evening in the depleted area. Gently do this enough times until the infill stands slightly proud of the rest of the infill around it. Then, walk across it a few times to softly compact it until it is at the same level as its surrounding infill. Lastly, the soft brush is applied to bring the fibres upright again.

3. Groom the surface

Regular brushing is an important function that must not be overlooked or neglected. Brushing helps to maintain uniform infill levels, keep the grass fibres upright, remove debris, and improve the field appearance.

Photo 9.3: Brushes towed behind a small tractor machine is better than a drag mat

Conversely, the flattening of grass fibres will increase the pace of the surface; consequently, the field no longer plays like a natural turf field, increases the risk of carpet burns when players slide on flattened piles and can create a possible acceleration of wearing of the playing surface, thus shortening its life.

Use only synthetic fibre bristles of recommended stiffness. Do not use metal or wire bristles. Ensure the bristles are set to the correct depth so they do not:

- Snag the pile tufts and pull them out of the carpet backing;
- Tear the backing of the synthetic turf carpet; and
- Pull the stabilising sand layer from the bottom of the infill to the surface.

The brushes can be mounted to a specialist plant or behind a general tractor (or mini-tractor) unit. To avoid the risk of contaminating the playing surface, the tractor should only be used on synthetic turf surfaces. The use of six-wheel vehicles is not recommended.

Do not use maintenance equipment before receiving proper use and safety training. Use equipment and vehicles that are approved by the field builder.

Frequency: Ask your manufacturer for the recommended grooming frequency. In general, the frequency will be related to the intensity of use; however, excessive brushing can damage fibres, which will compromise the field's performance characteristics and longevity over time.

Method: An average all-purpose vehicle that brushes a standard sized football field will take about an hour and a half. The vehicle speed should be low, and sharp turns must be avoided.

Direction of Brushing: The surface should be brushed in several directions, alternating the direction for each maintenance programme, but generally in the direction of the individual panels to avoid crossing over the main seams. On different days, start at different locations so as to alternate the brushing direction for each panel (see Section 2).

Photo 9.4: Modern machine providing height options for the tines to be used into the turf by an experienced operator

Brush Height Setting: The optimum brush height setting will depend on the model and type of equipment and what the aim of using tines is. It is important to engage professionals to assist with these deep cleans so that there is no damage to the turf and the seams.

Time: It will typically take around two hours to thoroughly walk, check the field, and then groom a full-size football/rugby field.

9.4.3 Ageing surface

As the Football Turf ages the users will probably notice more:

- Seams starting to spilt, especially if infill levels are not kept high;
- Compaction, especially on high wear areas and need to decompact
- Fibrillation of the yarn: the greater the fence height and the lower the infill, the more you will see.
- Need for greater infill top-up across the whole field

If a dual-yarn system is used, the need for continual brushing (fortnightly) should be reduced. This could mean moving from fortnightly to monthly.

9.4.4 Scheduled maintenance

Over the life of the synthetic turf system, the system will need further scheduled maintenance and remediation. The 'tell-tale signs' of this may include the following points and may be noticed more frequently in the regular monitoring inspections:

- Yarn becoming significantly bent, flattened and not standing upright;
- Playing surface becoming hardened and more compacted;
- Dirt and debris accumulating within the infill and between the yarn despite the routine maintenance being performed;
- Seams are becoming loose, and
- Infill levels are becoming more uneven and stay in this position for a longer period.

Photo 9.5: Vandalism can entail a whole section being cut out and replaced

Photo 9.6: The yarn has been exposed to UV and the tips are breaking down and covering the maintenance machine

These are signs that specialist work needs to be performed and may include:

- Professional field inspections – development of a corrective action plan that identifies the effect and the cause, with strategies to address the problems;
- Decompaction of infill – using specialised equipment (e.g. SMG SportChamp) designed to decompact the infill, which will assist with the playing performance of the system with the ball and the player's boots;
- Major rejuvenation – measuring the infill depth against the supplier's recommendations and then redistributing or 'topping-up' in key areas;
- Deep cleaning – using specialist equipment to brush and vacuum the contaminants from the infill and
- Removal and reinstallation—If the field has become significantly impacted, specialist machines can remove key amounts of infill, clean it, and then replace it by removing embedded contaminants and decompacting the system, thus improving performance and drainage.

Metal Removal

Use a magnet attached to the maintenance equipment to remove ferrous metal objects from the field.

Photo 9.7: Machinery, including the metal magnet at rear (Source: Sports Clean)

9.4.5 Replacement of higher wear areas

High wear areas (penalty spots and corner markings) are likely to wear more rapidly than the surrounding field, especially if infill levels are not regularly topped up. If left unattended, these areas will eventually tear and become a safety hazard to players.

Localised patching can be conducted when these areas show signs of significant wear. To reduce the rate of wear, consider using a strong tuff lock carpet. Over time, the yarn height may reduce, so an appropriate-sized matched piece should be used. To minimise colour differences, it is suggested that samples of carpet for patching be obtained when the field is initially laid.

Photo 9.8: Replacement penalty spot due to excessive wear

9.4.6 Static electricity

In hot dry conditions, static electricity can cause the infill to stick to the pile yarns and increase infill migration. Surfactants like liquid laundry fabric softeners can be applied to the surface to reduce static electricity.

9.4.7 Microplastics

Microplastics (infill migration and now fibre wear) are receiving increasing media and political attention in Europe. Much of this is due to poor maintenance practices when moving snow, but equally, migration through the dispersion of clothing, flooding, etc., is a cause.

In Australia, we have seen several strategies being recommended to reduce the breakdown of the fibre and loss of the infill, including:

- Grates and carpets at the entry and exit points around the field of play to reduce the level of infill leaving the field;
- Use of barriers (normally 200m high) around field of play;
- Basket strainers pre the stormwater exits to capture any movement;
- Using soft drag mats as on older fields, the UV component mix is not as high, and the tips of the

yarn have been slowly damaged and broken with the heavy rubber ones, and
- Increased UV testing for the yarn in Australia

9.4.8 Maintenance log

The Field Supplier should provide the Maintenance Log and is normally linked to the field's Warranty. This means that completion of this Logbook is critical not only when you first receive the field but for every day, week, and month until the field is replaced. It is also a condition of the FIFA certification program, and it is good practice to show that the field is being maintained.

Typically, a logbook records the following information, and a more sophisticated form can be seen below.

Synthetic turf field maintenance log				
Usage			Maintenance	
Date	Hours of play	No. of players	Maintenance activity	Operator
12/6/13	4	22	Field inspection, localised infill top up	GW
13/6/13	6	3 x 16		
14/6/14	7	3 x 16	Field inspection, localised infill top up & grooming and drag mat	FS
15/6/14	5	22		
16/6/14	4	3 x 16	Field inspection, localised infill top up	GW
17/6/14	7	2 x 16		
18/6/14	6	3 x 16	Field inspection, localised infill top up & grooming and drag mat	GW

Figure 9.1: Typical logbook record

9.4.9 Annual review

To conduct an annual review of the field, walk the field approximately every 3-5m apart and with a dozen passes, key issues should be identified.

Smart Connection Consultancy normally walks by sliding our shoes along, enabling the feel of anything underfoot. Work shoes are better than trainers.

What items to look for:

- Flattened grass in high-wear areas;
- Seam joins parting and in need of regluing together;
- Trip hazards around penalty spots, corner flags or areas where a high build-up of infill has been displaced from the middle of the field;
- Compaction of infill;
- Additional wear areas, such as goal lines, white lines, goal box, etc.;
- Any defibrillation of yarn fibres in high-wear areas such as goal mouths, line referees on the side of the field etc.; and
- Displacement of infill from high-wear areas.

Key issues can be identified and compared annually by taking a scaled drawing during the field walk.

The drawing will also act as evidence to develop a strategy for any repairs or increased maintenance regime.

Smart Connection Consultancy can complete these on behalf of clients and ensure that the field can have the best chance of achieving its life expectancy.

9.4.10 Impact of system on maintenance

Adopting the suggestions within this Guide should impact the frequency of maintenance throughout the year and life expectancy. This should be reflected in the specification used to procure a price and quote and the maintenance manual provided by the manufacturer and installer.

To summarise, the following should be considered

Routine Maintenance	Rubber Infill		Organic Infill	
1st Year	Monofilament	Mono/ Tape Dual Yarn	Monofilament	Mono/ Tape Dual Yarn
Brushing – cleaning/litter removal	Weekly	Fortnightly after tape 'opens up'	Weekly	Fortnightly after tape 'opens up'
Grooming / Drag brushing to return infill	2 weeks	4 weeks	2 weeks	4 weeks
Clean up outside of fence /microplastics	2 weeks	4 weeks	2 weeks	4 weeks
High wear area decompaction	3 months	6 months	3 months	6 months
Weed/ moss/ algae treatment	Annually	Annually	Annually	Annually
Infill top-up	High-level end of season	Low-level end of season	Very high-level end of season	High-level end of season
Years 2-5				
Brushing – cleaning/litter removal	2 weeks	4 weeks	2 weeks	4 weeks
Grooming / Drag brushing to return infill	4 weeks	6 weeks	4 weeks	6 weeks
Clean up outside of fence / microplastics	2 weeks	4-6 weeks	2 weeks	4-6 weeks
High wear area decompaction	3 months	6 months	3 months	6 months
Weed/ moss/ algae treatment	Annually	Annually	Annually	Annually

Routine Maintenance	Rubber Infill		Organic Infill	
1st Year	Monofilament	Mono/ Tape Dual Yarn	Monofilament	Mono/ Tape Dual Yarn
Infill top-up	Very high-level end of season	Low-level end of season	Very high-level end of season	High-level end of season
Years 5 - 10				
Brushing – cleaning/litter removal	2 weeks	4 weeks	2 weeks	4 weeks
Grooming / Drag brushing to return infill	4 weeks	6 weeks	4 weeks	6 weeks
Clean up outside of fence/micropl astics	2 weeks	4 weeks	2 weeks	4 weeks
High wear area decompaction	3 months	6 months	3 months	6 months
Weed/moss/al gae treatment	Annually	Annually	Annually	Annually
Infill top-up	Very high-level end of season	Low-level end of season	Very high-level end of season	High-level end of season

Table 9.2: Maintenance requirements

9.5 Hockey Field Maintenance

9.5.1 Introduction

As with other surfaces it is important that the surfaces being used for Hockey are safe, perform against expectations and achieve their life expectancy. The maintenance regime will ensure that this happens.

As there are a number of Hockey Surfaces, their maintenance will need to be aligned slightly differently. The maintenance should be linked to:

- The intensity of usage weekly – number of hours and number of people
- The type of usage – Training and/or competition, full or part field.

Surface type – Water-based, sand dressed or sand filled.

9.5.2 Initial maintenance and settling period

Once installed the surface needs time to settle in, including;

- Sand-filled – although not many of these are seen any more, they should be brushed after 100 hours of usage and ensure that the sand has compacted enough so that it is not slippery or has a feel of movement under the field.
- Sand dressed fields – commonly known as 'hybrid Hockey Turf' it is important to play and use the fields to ensure the sand has worked its way through the yarn to perform its purpose as a ballast. There shouldn't be much sand on the top of the carpet once 'settle in'.

Water-based fields are the easiest, with no infill. Once the cannons have been used for the first few times, this should be okay.

9.5.3 Routine maintenance

The routine maintenance should include:

- Brushing (hybrid and sand-filled) and grooming to remove rubbish and dirt.
- Leaf blowing.
- Decompaction (sand-filled) and as field ages.

Inspections for repairs.

9.5.4 Scheduled maintenance

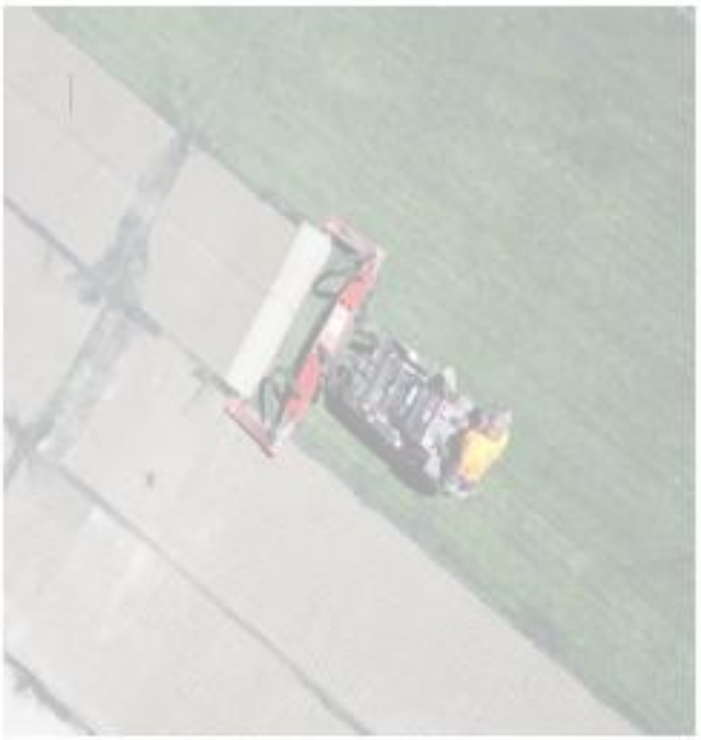
Annual and bi-annual cleaning should be considered including:

- Algae / weed spraying
- Deep clean (with water) to remove any impurities in the carpet by a specialist organisation.
- Seam repairs.

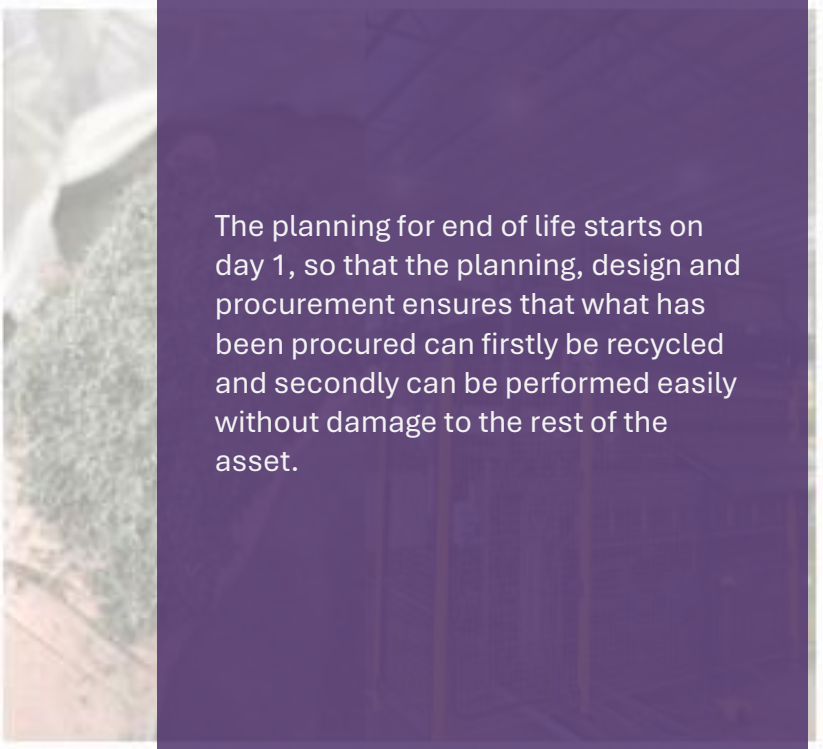
9.5.5 Replacement of high wear areas

This is not as common as long-pile grass, but areas around the 'd' should be monitored and replaced as needed.

It is probably better to use a piece of carpet or the run-off area of the field to align the colours more accurately. Then the 'off-field' area can have the newer grass, which may be a deeper colour than the original grass.



SECTION 10: END OF LIFE



The planning for end of life starts on day 1, so that the planning, design and procurement ensures that what has been procured can firstly be recycled and secondly can be performed easily without damage to the rest of the asset.

10. End Of Life

10.1 Circular Economy

Synthetic sports fields are vital community assets, delivering year-round access, durability under heavy use, and consistent playing quality. However, they also represent a significant investment in materials and energy. Without a circular economy approach, these assets risk generating waste and environmental impacts at each stage of their lifecycle.

When considering the five phases of planning, design, procurement, management and end of life, circular economy principles should be considered at each stage.

10.1.1 Planning phase

The aim is to consider a more holistic approach to reflect community needs, how the facility will be used, during and at the end of its life. Consider the 4P's of People, Planet, Prosperity & Performance so that the design, procurement, management and end of life stages are clear. This phase should consider:

- Needs-based approach: Install synthetic fields only where natural turf cannot meet demand, minimising unnecessary material consumption.
- Whole-of-life costing: Business cases must include lifecycle emissions, recyclability, and end-of-life recovery, not just upfront construction costs.
- Policy alignment: This approach should support State/Territory Government approach to circular economy and/or waste management.

10.1.2 Design phase

The design focus should consider 30 years+ life expectancy strategy, embracing good practice from industry peak bodies for landscape design, sports performance, and good environmental practice to ensure it meets the performance standards required for these specific needs. Include:

- ***Organic infill only:*** Projects will exclusively use organic infill, eliminating rubber crumb and its associated microplastic concerns. This is consistent with environmental leadership and community expectations.
- ***Long-life infrastructure***: Shockpads, drainage cells, and base aggregates will be designed for 30 years of use, meaning only turf carpet (8–12 years) and infill require renewal.
- ***Design for disassembly***: Carpets, infill, and shockpads will be specified for separation at end-of-life, ensuring each material has a recovery pathway.
- ***Drainage systems***: Closed collector drains with sand and geotextile filtration will prevent microplastic and fibre migration, ensuring water discharged to stormwater network is clean.

10.1.3 Procurement phase

The client needs to understand how to procure and project deliver the sports facility is critical. Only design and ask what is possible and not what is aspirational. Working with sport we will ensure that our partners can afford what is being asking for. The procurement process should ensure that the provider can achieve the environmental, economic and performance goals required by:

- ***Extended producer responsibility*** (EPR): Procurement contracts will require suppliers to provide take-back schemes for carpets and infill at end-of-life.
- ***Recycled, reuse and recyclable content:*** Preference for products with recycled and recyclable componentry as well as aspects that last longer than the 8-12 years of the grass performance surface. This could include use of polymer backings, locally recycled aggregates in base construction, shockpad and drainage cells with manufacturer warranties of 25 years.
- ***Low-carbon delivery:*** Contractors will be incentivised to adopt low-emissions practices, supporting net zero target
- ***Policy alignment***: Embeds sustainability into procurement in line with Government Sustainable Procurement Policy.

10.1.4 Management phase

Appreciating how the management impacts on the extended life of a synthetic surface is critical and should consider good management balances for performance, usage, maintenance and end of life requirements equally as the surface progresses through its life. Understanding what to look for is critical as you monitor and evaluate its ongoing surface delivery, including:

- ***Surface programming*** – to ensure that the drills and use of key aspects are rotated around the field to reduce high wear areas fast tracking ageing of the field surface
- ***Linking maintenance with usage intensity*** – to ensure that the daily, weekly, quarterly and annual maintenance is defined for all partners and is completed to maximize the life of the asset

- ***Infill and fibre capture***: Filtration baskets at stormwater points will capture any displaced infill or fibres.
- **Monitoring:** Annual and end of season monitoring of the synthetic surfaces will track condition, age, and recycling pathways.

10.1.5 End of Life phase

The end of life strategy should be built into the other four phases to optimize the opportunities for reducing the burden on the environment for future generations. This should also consider:

- ***Deconstruction not demolition***: Fields will be dismantled in layers to allow separation of carpets, infill, shockpads, and base materials.
- ***Recycling pathways:***
    - Carpets → recycled into new turf products, shockpads, parks plastic furniture or construction materials.
    - Infill → reused where appropriate.
    - Shockpads & bases → retained in situ for reuse across multiple turf cycles (up to 30 years).
- ***Innovation***: Explore advanced R&D of the manufacturers, including Bio-polymers, polymer recovery methods (e.g. pyrolysis, chemical recycling) to maximise material value.
- ***Policy alignment:*** Delivers on the State/Territory Circular Economy Strategy commitments.

10.2 Recycling of the Surface

Since 2024, Australia has had a specialist recycling plant for synthetic turf carpets and infill located in Barnawartha, Victoria, near the NSW border. The company RE4ORM, can uplift the current sports surface (Hockey, Football, Tennis etc), roll it up, bag it and that should be considered, including:

10.2.1 Deciding when to change

The condition of the surface will tell you when the surface needs to be replaced, with badly worn carpets, infill, complaints more common and a pragmatic review indicates you cannot keep 'patching' the surface due to risk. If unsure, contact us and we can provide an independent assessment, which we carry out for many local Councils from approximately year 7 of the field, with a scope of how we can extend the life of the surface.

Once a decision has been made then the stepping stones should be to ensure:

i. That the Specification stipulates that the surface (carpet & infill) needs to be resurfaced within Australia, as opposed to repurposing it to someone else, e.g. local sports clubs, equestrian centre etc, so that environmental leadership is shown.
ii. Request that all certification of the process stages is confirmed with certificates for the amount/weight of the infill and the carpet (input and output).

10.3 Outputs

The desired output is for the recycling plant to be able to recirculate the recovered materials into industries that need raw products. This would include:

- Recovered sand – cleaned, bagged and ready to be reused.
- Recovered rubber – to be reused in fields if quality is good enough, used for shockpads and for the construction industry.
- Recycled yarn – turned back into PP/PE pellets for plastic furniture, such as park benches, microplastics kickboards etc.

Appendix 1: The Smart Guide Synthetic Surface Glossary of Terminology

Term	Explanation
A	
Abrasiveness	That property of a synthetic turf which causes material in moving contact with the turf surface to wear away. See ASTM F-1015 for a recommended test method to measure the relative abrasiveness of sports surfaces.
Abrasion resistant	The ability of a carpet or other surface to resist wear from the rubbing of other surfaces.
Accessibility	Ease of access into and from an area - specifically dealing with accessibility as defined by the various Governments Disabilities Act.
Acrylic	A quick drying thermoplastic used for coatings and adhesives.
Adhesives	Viscous materials that are used to stick materials together, permanently, (see glue). Adhesives must be selected under various specification criteria; moisture, temperature variances, backing and flooring materials, indoor or outdoor use, conditions of installation, hazardous handling conditions, flammability, contact time frame. Always ask for a MSDS (Materials Safety Data Sheet).
Aggregate	Aggregate base materials consist of several different sizes and/or types of crushed quarry rock and dust. Larger, courser gravels can range from 0.25 inch to over 1.5 inches in average size (radius) and the materials will always be mixed with quarry fines (also known as crusher dust). When used as imported base materials, compaction should occur at every 2 to 4 inch lift or as base materials change.
Anti-Static	The ability of the fibres to disperse electrostatic charges and reduce the build-up of static electricity.
Anti-microbial	Yarn or surface materials chemically treated to reduce the growth of common elements. Additives treat specific challenges such as bacteria, fungi, yeast, mould and mildew.
Appearance retention	Appearance retention, or the ability to remain visually attractive during its expected life, is directly affected by factors such as turf construction, performance of pile yarns, and the appropriateness of the turf selected for the end-use.
ASTM	The American Society for Testing and Materials, the world's largest organization for the development of consensus standards and recommended standard specifications and practices for the testing and characterization of products and materials.
Attached cushion	A cushioning material, such as foam, rubber or urethane, adhered to the backing fabric side of the turf to provide additional dimensional stability, thickness and padding for fall zone safety.
B	
Backings	The materials that make up the underside of finished turf. The primary backing anchors the pile yarns, while the secondary backing provides extra dimensional stability and locks in the stitches.
Base	All synthetic surfaces require a compacted level base. Surfaces can also be laid over structural base options such as asphalt or concrete when required, but this is not ideal. The preferred option is an open, free draining aggregate base over a drainage collector system
Base materials	Imported job materials that will be used to construct the foundation over existing sub-base (native soils or other surfaces) and under the final installation of synthetic grass surface materials. Base materials may be comprised of, but not limited to, the use of crushed, clean gravel mine rock and fines; compactable aggregates and road base.
BCF	Bulk Continuous Fibre. Continuous strands of synthetic fibres that are spun into yarn and texturised to increase bulk and cover.
Bobbin	Yarn fibres are wound around the bobbin to store it then mounted on the tufting machine, the bobbin holds the yarn in place while it is fed into the process.

Term	Explanation
Bonded urethane cushion	A urethane foam product, granulated and bonded to form a porous foam sheet, frequently used as an extra cushion or padding.
Breaking strength	The resistance expressed as pounds of force applied to one inch width in both the direction of the warp and the filling yarn.
Broadloom	A term used to define turf materials and other woven items that are produced in widths greater than six feet wide.
Brooming	Another term for de-fibrillating or brushing-up the blades of grass or to describe the use of a broom to work infill materials into the surface (brooming in the infill - brooming up the turf fibres).
Buckling	A condition of wrinkling, bubbling, or ridging of turf following installation. Changes in humidity, temperature or base materials can sometimes affect conditions. Buckling can also be a manufacturing defect such as contamination.
Butt-fit (cross) seam	This seam is set across the width of the materials. Lines of stitches from both pieces are set together to continue the lines of stitches between pieces. The stitch lines are offset, so this seam may show.
C	
Carpet	Almost all forms of long pile carpet are based on tufted carpets. The pile is formed by looping yarn through a backing material and cutting it to the required length (usually between 35mm and 65mm). The back of the backing material is coated with latex or polyurethane, which assists in holding the tufts in place and provides structural stability to the carpet. Holes are pierced through the backing to assist with drainage. Carpets can vary in terms of the type of yarn used and its density (stitching rate). Most carpets use a single form of yarn whilst some may use a mixture. The yarn is generally made from either polyethylene (PE), which is soft and less abrasive, or from polypropylene (PP), which is stronger and is often used for low impact sports such as tennis. Generally the denser the carpet the better wearing it is. The synthetic grass is produced in rolls ranging from 3.6m to 4.6m wide and is laid loose on top of the gravel drainage layer and relies on the weight of the infill for anchorage. The rolls are either sewn or glued together.
Carpet construction	Defined by stating the manufacturing method (tufted, woven, knitted, etc.) and the final arrangement and content of materials achieved by following specifications.
Cars	If fencing is not constructed, there is the potential for vehicles to drive on the surface. The friction caused by the spinning or skidding of wheels on a synthetic surface is likely to melt the yarn. Additionally, the infill medium is likely to be dislodged which will cause surface unevenness. A synthetic surface will not be suitable for use as a car park. The pressure of vehicular weight on the surface and base is generally not a concern (up to two tonne for most surfaces) but governing driver performance on a car park and the potential damage to the surface from excessive wheel spin and turning is the major consideration and concern.
Chalk and chalk line	Chalk is used either in solid form or in powder form for marking. Powder forms of chalk, in various colours, are added to a chalk line to be used to snap a straight line across a surface.
China marker	Used to mark porcelain pottery and dishware, a "china marker" is a grease pencil that can be used to mark the backing of the synthetic grass materials and fabrics used in construction.
Clay soils	An earthy soil that retains moisture and when moist can almost be the consistency of putty. When dry, clay soils are notably dusty, hard and unworkable. Devoid of any organic materials, clay soils generally percolate slowly, if at all. Saturated surfaces can rut and compact under heavy weight loads.
Colorants	Additional elements introduced into the yarn fibre during manufacturing to add colour to the finished yarn.
Combination	A term that refers to yarns or fibres that are combined; one yarn is composed of two or more yarn fibres having the same or different fibres or twists: e.g. one yarn may have a low twist and the second yarn little or no twist at all.
Commercial Match	Matching of colours within acceptable tolerances, of with a colour variation that is barely visible to the naked eye.

Term	Explanation
Compaction	The act of compressing the surface materials to reduce air content, decrease percolation and increase surface stability. Compaction should happen at every 2 to 4 inches of lift and at every change of material used. It is recommended never to attempt to compact 6 or more inches of lift; you will find that compaction is extremely ineffective and poor results make the area settle in time.
Compressional strength	The amount of resistance to compression from surface weight.
Conditioning surfaces	Any synthetic turf surface can produce a static charge. New blades can be the typical cause; larger areas and roof-top installations generally need some assistance. When materials are exposed to outdoor elements, over time, the grass tends to lose the ability to create or hold static in any way. To eliminate any potential for static charge or to alleviate a problem, simply condition the area with a 5 to 10% solution of fabric softener and water sprayed generously across the surfaces. We recommend an unscented liquid, biodegradable where possible. Leave the materials on overnight and then rinse. You may need to repeat the application in a few weeks. Generally, after the first winter, the grass blades are grounded and can't hold a static charge due to the accumulation of materials on the blade surfaces.
Contamination	Most synthetic pitches have a surrounding fence which allows players to enter the field at only one or two access points. Boot cleaning facilities are normally provided at these access points to reduce contamination of the playing surface from mud and other material from outside the playing area. If the synthetic surface is not fenced there will be a high potential for contamination from players and other park users walking across the surface (mainly from debris in shoe soles). This will necessitate a high level of maintenance and cleaning to prevent the formation of a drainage inhibiting 'skin' within the surface and the establishment of algae and moss.
Continuous filament	A single, continuous, strand of synthetic fibre extruded in yarn form.
Cover	The degree to which the backing is concealed by the face yarn.
Crimping	The processing of yarn, by heat or air pressure, to fix a wavy texture into the yarn and increase bulk. This process produces knit de knit.
Critical Radiant Flux -	The level of incident heat energy on a floor covering material at its most distant flame-out point when tested in the Flooring Radiant Panel tester per ASTM E-648 (NFPA 253). Practically, the amount of heat energy that must be added to maintain combustion of a previously ignited surface system
Cross seam	Seams made by joining the ends of two pieces of synthetic grass together (AKA a butt-fit seam).
Cross section	The shape of an individual filament or fibre when cut at right angles to its axis. Manufactured fibres used for various turf types can have several solid shapes including; round, trilobal, pentagonal and may even be hollow.
Cross-dyed	Multi-coloured effects are produced when turf is tufted using more than one colour of yarn fibre.
Crumb rubber	Granules of new or recycled rubber materials used for infill or top dressing on synthetic grass materials. Granules are specified as new (EBDM) or recycled (SBR) rubber and are sized by the smallest and largest average radius of the granules contained in the packaging. Size of granules used will depend on the application; putting green surfaces require a smaller grain size than lawn areas.
Crushed gravel	Gravel that does not contain small particles or fines.
Crush bands	Marks that appear width wise in the turf pile due to wrinkles in the fabrics, created during rolling or due to the flattening of the turf roll during shipping and storage.
Crushing	This refers to crushing of the pile, whilst the grass is rolled, which is irreparable. Once it is rolled out and exposed to sunlight it recovers.
Crush recovery	Crush recovery describes the ability of the synthetic grass surfaces to rebound back upright after being walked on or having weight from furniture or other elements on it. To encourage good recovery, all synthetic grass surfaces made for lawn and landscape will benefit from some amount of infill materials, which provide horizontal and vertical stability as well as UV protection for blades and backings.
Culvert	An enclosed pipe or pipeline used to carry run-off water, generally under roads and buildings.
Cushioning (or Foam Cushioning)	Polymeric foam material used to assist in attenuating the forces developed in player impacts or foils. 1. Open-cell foam: A cushioning material consisting of a matrix of elastomeric material having connecting cells similar to a sponge, deriving its cushioning properties from the cell walls alone.

Term	Explanation
	2. Closed-cell foam: A cushioning material consisting of a multiplicity of individual cells filled with a mixture of gases, and deriving its cushioning properties from both the mechanical properties of cell walls and the pneumatic properties of the enclosed gases. 3. Elastic layer: A cushioning system consisting of a mixture of rubber or other elastomeric particles, mineral aggregate, and a synthetic adhesive bonding material, usually a polyurethane adhesive. Elastic layers may be formed in-situ or manufactured in a factory.
Cut pile	A finished turf surface in which the face is composed of cut ends of pile yarn.
Cut and loop pile	A finished turf surface in which the face is composed of a combination of cut ends of pile yarns and loops of other fibres.
D	
Delamination	Separation of the secondary backing or attached cushion from the primary backing of the turf.
Degradate, degradation	The "wearing out" or weakening of a system or substance. The effectiveness of UV protection, the strength of fibres, backing and the porosity of a surface might degradate during the life of the turf.
Denier	The weight in grams of a single textile fibre or yarn 9,000 meters long. The commonly used unit for the size of a fibre, yarn or filament. New units of measure:
Dimensional stability	Refers to the ability of the finished turf surface to retain its original size and shape.
Direct or double glue down	The installation method whereby the turf is adhered to the floor using adhesives. A Double glue down refers to the installation of a cushion direct to the flooring and the turf to the cushion.
Dogs	Dog urine will not stain the surface but any dog droppings will need to be picked up manually as they will not break down. Dogs may also cause surface unevenness by digging and disrupting the level of the infill (although it is not anticipated that this will cause extensive or permanent damage).
Double-glued seams	Double-glued seams attach turf to bare floor to prevent delaminating and edge ravel. Installers should double-glue seams to prevent fuzzing.
Durability	Durability is a measure of how long something will last under a series of conditions. Synthetic grass materials are extremely durable and stand up to a great deal of traffic, extremes of outdoor conditions, high and low UV factors, use and abuse. Each component of the turf system is engineered with durability in mind and as a system, is designed to bring together the best components to deliver the highest durability available.
E	
Environmental	The potential environmental impact of filling the synthetic surface with rubber granules is the subject of much on-going debate in Europe (particularly Germany and Switzerland). The main concern relates to the potential leaching of contaminants (especially zinc and heavy metals) from the rubber infill into local ground water. The risk is considered greatest where rubber granules (derived from shredded car tyres) are used due to the unknown source or composition of the rubber being recycled. Some countries have banned the use of rubber granules as infill. The main counter argument put forward is that thousands of tons of rubber are abraded and dispersed into the environment every year as tyres are worn on road surfaces. It is also argued that the use of recycled tyres is in itself environmentally friendly as it reduces the huge quantities of worn tyres that are scrapped each year. The other environmental consideration is that when a surface is replaced, if it cannot be re-used (e.g. training venues, kindergartens, playgrounds etc) it will need to be disposed of in a landfill site. As it takes many years to break down the rubber particles. A synthetic surface offers several environmental benefits including eliminating the need for fertilisers and reducing the use of herbicides and other pesticides that are required for the maintenance of natural turf. There are also significant water savings as there is no need to irrigate, although water may be required for cleaning and for cooling the surface in hot climates.
Epidemiology ·	The study of the incidence, distribution and control of disease or injury within a population
Extrusion	Melting the mixture of selected polymers, pigments, process stabilizers and additives used in making yarn fibres.

Term	Explanation
EPDH	Ethylene Propylene terpolymer – virgin rubber infill used in 3G synthetic grass systems.
F	
Fabric	Materials used under and throughout the construction of a synthetic grass project. Woven and non-woven, commercial grade materials provide additional horizontal and vertical stability to every install. See underlayment fabric.
Face	Also known as the nap or the pile of the surfaces of turf. It describes the total visible surface of the finished turf materials.
Fading	Loss of colour. Caused by actinic radiation, such as sunlight or artificial light; atmospheric gases, including ozone, nitric oxide and hydrogen sulphide; cleaning and bleaching chemicals, such as sodium hypochlorite and other household and industrial products; chlorine chemicals for swimming pools; and other factors. Commercial installations in areas where such exposures occur require extreme care in selection of colourfast turf.
Fadeometer	A laboratory device for determining the effects of light on the properties of yarns, fibres, fabrics, turf, plastic and other materials. It uses a standard light source to simulate the approximate spectrum of sunlight. Generally used for measuring fade resistance of turf colours, which are rated according to the number of units of exposure required to produce visible loss of colour.
Feathering	Using a soft, gentle motion, base materials can be "feathered" into one another; one pile of materials into another pile, during base construction. The action of feathering is to achieve a smooth transition between piles or types of materials over the site. You can also "feather" infill materials into a surface where infill may need to be added. The word describes a "light touch" to whatever action you choose.
Fencing	The choice of surrounding fencing is usually dictated by the sport(s) to be played, site constraints and budget. The two basic functions are to retain balls and other projectile objects within the playing area and to allow spectators to view the game safely. Another consideration may be security and the need to keep out animals.
Fibre	Fibre is the fundamental component of turf. Turf fibres are made from nylon, polypropylene or polyethylene, colorants, stabilisers and other enhancements to provide features such as low-slip, UV protection, anti-static, anti-microbial surfaces.
Fibre material	Yarn fibres can be manufactured from various natural and synthetic materials. Synthetic grasses and artificial turf are typically made from one or a combination of nylon, polypropylene or polyethylene.
Fibre style	A fibre's style can be made up of several specifications: fibre weight, fibre colour, fibre length, etc.
Fibre thickness	A fibre's thickness is measured by its height on the edge of the fibre. Fibres are processed in several steps and a fibre's finished thickness can vary from its original measure (much like a 2 x 4 piece of timber is not 2 inches by 4 inches when finished and sold for use in construction). The number of blades per stitch need to be taken into account when reviewing the value of a fibre's thickness for lawn and landscape use unless the project is under extreme traffic or weight loads.
Fibre width	The width of the fibre is measured across its "face" and can affect the colour, shine, vertical recovery and durability of the fibres under extreme conditions; especially field applications.
Filament	A single, continuous strand of fibre, whether natural or synthetic.
Filling Yarn -	Yarns running across a woven or knitted fabric and used with the chain or warp yarns to bind the pile tufts to the backing yarns.
Film Yarn (or Cut-Film or Slit-Film Yarns)	Yarn composed of one or more continuous narrow strips of manmade film (usually slit film, but strips may be included), or incorporating one or more strips as a major component.
Fire retardant	Additive to enhance the fire retardancy of the synthetic grass fibres; generally, most fibre materials will not combust, however they will melt at temperatures exceeding 500 degrees (F). Each synthetic grass material will be different and if needed for purposes of liability or accountability, manufacturers are required to have this information on file - ask for the MSDS (Materials Safety Data Sheet) for your product.
Fire Test, Large Scale	A test in which the experimental sample is subjected to combustion sources in a building simulating the geometry of its projected usage (in the case of sports surfaces, a simulated stadium or fieldhouse).

Term	Explanation
Flexural strength	The amount of bend or flex something exhibits against pressure.
Float	To float materials is to gently and smoothly spread them across the installation site. The objective is to leave the surfaces without ruts or bumps so that the surface is level in all directions.
Flooring Radiant Panel Test	A method for measuring the amount of heat ("Critical Radiant Flux") required to keep a previously ignited floor covering material burning. The test was developed by the National Bureau of Standards (now National Institute of Science and Technology) and published as ASTM E-64B
Footwear	A synthetic surface is generally forgiving to most footwear including studded football boots. Some players prefer to wear dimple-soled shoes when playing sport on synthetic surfaces. The only type of footwear not suited to a synthetic long pile surface is metal footwear (running spikes and baseball cleats), which can cause excessive surface damage. This type of footwear is generally banned for soccer due to potential injuries to players. The wearing of flat-soled shoes (especially school shoes) will cause significant wear and reduce life expectancy. High heeled shoes will damage some surfaces but only after long term use. A footwear policy will ensure consistent management and limit damage to the synthetic.
G	
G' (or G-Force)	'A dimensionless number relating the apparent weight of an accelerating object to its weight at rest under the force of gravity. Practically, a measure of the intensity of an impact, sudden start, sudden stop or change of direction.
Gage (or Gauge) -	The distance between adjacent needle points in a tufted or knitted carpet expressed as a fraction of an inch.
Glue down	The need to glue the turf materials to the flooring. Adhesives are selected for indoor or outdoor use, moisture, temperature variables, flooring and turf backing materials, use and function.
Goal options	In general, permanent goals are used when the surface is being provided for one sport only, or in an area where security may become a concern with portable goal systems. In every other case portable goals are the recommended option, where sleeves are inserted into the field for different goals and capped with carpet plugs. One supplier warned that when using sleeves the infill can fall into the sleeve making goal removal difficult over the longer term. If a pitch is fenced, goals can be built into the fencing and folded away into cage style storage incorporated into the fencing design.
Grab Tear Strength Test -	A test for fabric strength in which only a part of the width of the test specimen is gripped in the clamps of a testing machine. See ASTM D-1682, Section 16.
Granulated rubber	Rubber materials that have been processed into small grains of rubber for use in a variety of finished goods including synthetic grass infill materials. See crumbed rubber and mesh.
Grip Index	The ratio between the applied vertical load and the horizontal force required to initiate forward motion to a loaded shoe on a given surface. Practically, a measure of the traction properties of a given shoe/surface system in linear motion.
H	
Hard edge	Hard edges are perimeter edges of a synthetic grass installation project that touch elements that will not or cannot move: walkways, driveways, walls, patios, fences, buildings, foundations, etc. Synthetic grass materials must be hand-trimmed to these edges.
Heat	Most synthetic turf surfaces radiate temperature at approximately 1.8X ambient temperature where as natural turf radiates 1.3X ambient temperature.
Heat-setting or crimping	Heat-setting is the process of heating or steaming yarns to hold their twist. Most nylon, olefin, and polyester cut pile turfs are heat-set.
Horizontal stability	Horizontal stability is the ability for the sub-base, base and turf systems to work together to keep the installation from stretching, shrinking or collapsing. Horizontal stability is engineered into the project by the selection of the site, base materials, edging, trim elements, base construction, drainage and final grade. Horizontal stability in a synthetic grass material refers to the stability of the primary and secondary backing materials to keep the synthetic grass surfaces from stretching, shrinking or buckling over time.

Term	Explanation
Hygrometer	A device used to measure the moisture content of concrete prior to turf installation.
I	
Infill	The infill is normally a combination of rubber and silica sand or rubber only, and its function is to hold the surface in place, support the pile of the carpet, help the pile to remain vertical and contribute to the playing and cushioning qualities of the surface (ball rebound, shock absorption and vertical deformation). Some infill systems use stratified and segregated layers of rubber and sand granules, and others a mixture of sand and rubber. There are a number of different types of rubber used as infill; SBR rubber granules are made from shredded black tyres from vehicles and industrial waste rubber. EPDM (Ethylene Propylene Terpolymer) granules are produced from sheets of rubber that are specifically manufactured for granulation. Green-coloured EPDM rubber is specially manufactured for sport, has better stability under UV radiation, and absorbs less heat from sunlight than SBR rubber granules but is more expensive. In Australia, all rubber infill is currently derived from shredded car tyres. The approximate depth of infill is 66% of the pile length, which generally leaves 10mm to 20mm of grass-like leaf blades.
Impact strength	The amount of force, abruptly administered (such as striking a surface with a hammer) that it can handle without damage.
Impact of nearby trees	The performance of all synthetic grass surfaces can be compromised by the ingress of surface tree roots. Root barriers are one solution and are usually installed to varying depths around the field perimeter. However, the removal of some trees may be required if they are very close to the field and may directly interfere with its construction.
Installation	The installation of a complete synthetic surface system, including the construction of a fully designed base / drainage system, will normally take around 16 weeks (2-4 weeks for earthworks, 6-8 weeks for base works, 2 weeks for a shock pad and 2-3 weeks for the carpet and infill). The surface can be used immediately once installation is complete, however it is common that the surface will not perform at its optimum level until a settling-in period of 8 to 12 weeks is complete and final surface grooming has been carried out.
Irrigation	In most cases a synthetic soccer pitch will not require an irrigation system, unlike some synthetic carpets used in hockey and lawn bowls which require watering to speed up the surface. However, some surfaces become particularly hot in climates that experience extreme heat (not so much in Australia). Irrigation in these cases can be used to cool the surface down, but this can also increase surface humidity.
K	
Knitting	A method of fabricating a carpet in a single operation in which surface and backing yams are looped together with a stitching yarn on machines with a large number of needles.
Knitted Carpet -	Carpet mode on a machine which loops together the backing yarn, stitch yarn and pile fiber, tieing them together into a mechanically strong and stable structure. The machine used is generally of the Raschel type.
L	
Latex	A milky, rubbery fluid found in several seed plants and used to seal the back of carpet or for lamination of secondary backings. Synthetic rubber latex is now frequently used in place of the natural material.
Life expectancy & usage	The life expectancy of a synthetic surface depends on the following factors: ▪ Quality of manufacturing of the carpet and the fibres used ▪ Quality of the base works and the surface installation ▪ Local climatic conditions ▪ Frequency of use, and ▪ Maintenance undertaken The following typical signs of wear appear after several years of use: ▪ Unravelling of the artificial turf fibres ▪ Hardening of the infill material (compaction of the rubber granules and silica sand)

Term	Explanation
	▪ Reduced surface drainage, and ▪ Reduction in the height and density of the fibres. As with natural turf, the areas of artificial turf that are most likely to show the first signs of wear are those located where the majority of the action takes place – around the goal mouth and the penalty areas. Outrageous claims have been made by synthetic manufacturers in the past concerning usage – 24 hours a day /7 days a week usage does not exist. High use of synthetic surfaces is deemed to be approximately 3,000 hours per year (60 hours per week). Most suppliers estimate a life expectancy of six to eight years based on five to six hours use per day, which equates to around 40 hours use per week. To ensure player safety and longevity of the surface, FIFA has set recommended levels of maximum usage at 42 and 48 hours per week for their FIFA 2 Star and 1 Star accredited pitches respectively.
Lift	A lift describes the raising of the base materials. A lift of two inches will raise the construction site by two inches above the previous level, generally with imported materials. Compaction should happen at every two to four inches of lift and at every change of material used. Never attempt to compact six or more inches of lift, as you will find that compaction is extremely ineffective and poor results make the area settle in time.
Line marking	There are several options available for marking synthetic surfaces: Tufted: Lines can be tufted (woven) in during the manufacturing process. More than one set of lines or type of field marking can be incorporated, using a variety of colours (e.g. white - soccer and yellow – rugby) with a green water based paint used to disguise one set. Inlaid: Synthetic surfaces can be laid with no line markings initially and lines cut into the surface at a later date Painted: Surfaces can be installed with no lines and marked in paint. Special machinery is required to apply and remove the paint. Painting of lines is only temporary and generally lasts for up to six months, but provides options for marking for different sports Velcro: There is also the option of Velcro line insertion with some synthetic surfaces which allows easy change over from one set of line markings to another by peeling out the redundant set of lines, inserting green (overall field colour) strips in their place and then peeling out green strips that lie where the new set of lines are to go, and then inserting the alternate coloured strips. If long-term consistent markings are preferred, permanent inlaid or tufted-in lines are the best methods and the most cost effective. Logos can also be provided for permanent inclusion. For frequent marking changes the painting of lines onto the surface is the most cost effective method.
Lisport & Lisport XL test	A sport field standardised test used in the field industry to determine wear in tufted materials.
Loom	A machine in which yarn or thread is woven into a fabric by a crossing of the warp (lengthwise) and chain, weft or filling yams (crosswise) at right angles to the warp threads.
Luster	The brightness, sheen or shine of fibres and yarns. Synthetic fibres are produced in various luster classifications including bright, semi bright, semi dull and dull. Bright fibres usually are clear (have no white pigment), whereas the duller designations have small amounts of white pigments, such as titanium dioxide. Luster of finished turf also depends upon yarn heat-setting methods, dyeing and finishing. In high-traffic, or for commercial areas using turf products, duller turf fibres are often preferred for soil-hiding ability.
M	
Matting	Matting is the usually irreversible adhesion of turf yarn caused by traffic or dirt. Matting can be minimised by exercising the turf with either power brushes or manually “raking” it back to height.
Maintenance	Synthetic surfaces are not maintenance free and appropriate maintenance is of vital importance if the surface is to continue to perform, and remain safe and durable. Even when the surface is not used it still requires maintenance so as not to deteriorate and reduce life expectancy. The main aim of the maintenance program is to ensure the following: ▪ Playing surface is kept clean ▪ Playing surface remains level and consistent so that it gives a true and predictable game ▪ Infill materials are evenly distributed over the surface and do not become over compacted and hard.

Term	Explanation
	▪ Drainage of surface water is maintained throughout the life of the pitch. ▪ Facility looks attractive and well-kept at all times. The key maintenance requirements are regular cleaning of the surface and grooming (brushing) to prevent pile lean and flattening. The removal of litter, leaves, pine needles, twigs and other debris can be undertaken as required using a blower vacuum or stiff bristled broom; however care must be taken not to significantly disturb the infill. If leaves and pine needles etc are allowed to remain on the surface for any length of time they will rapidly rot forming a drainage-inhibiting 'skin' within the surface and a growing-medium for algae and moss. In certain situations and in some seasons, algae or moss can establish on the surface and may require treatment with an algaecide and/or moss-killer. Substances such as sports drinks, soft drinks, gum, oil and paint are potentially harmful to artificial surfaces and normally need to be removed with cleaning products. Normal usage will move some infill (via kicking, running, turning and tackling), which may result in the depth of infill being uneven in some places. Brushing levels the infill so that a uniform surface is maintained, keeps the pile upright (which becomes flattened through normal play) and counteracts compaction of the infill and any tendency to form an impervious surface skin that might impair drainage. The localised topping up of fill material (e.g. goals, centre, penalty spot, corners etc.) may also be required. Manufacturers recommend that surface grooming is undertaken on a monthly basis, but more frequent brushing may be required if usage levels are high due to infill moving more. It is important that synthetic surfaces are not over-groomed as the yarn may split, thus reducing the life of the surface. Surface grooming is normally conducted by a contractor. An annual surface treatment is also recommended and involves raking the integrity of the carpet, repairing seams and line markings etc, cleaning out and redistributing the infill (relieves compaction), reinvigorating the fibres and cleaning the surface. Synthetic Surfaces requires a lower investment in time and cost for maintenance than a natural turf surface. It would be likely that the staff at the facility could undertake the role of regular cleaning and brushing, and topping up infill in localised areas. More significant surface treatment requires special machinery, which would not be a viable purchase unless you had several synthetic pitches. Therefore, a large component of maintenance would need to be outsourced to a qualified contractor. Vehicle Access is required to access the synthetic to allow for maintenance by special machinery if required. No matter how much care is taken, weeds may occasionally appear on the surface, usually as a result of wind-blown seeds. Small numbers of weeds can be removed by hand without damaging the surface. Localised areas of weed seedling infestation can be treated with domestic weed-killers without causing damage to the surface.
Missile	A calibrated falling object used to measure the impact attenuation properties of a playing surface system or component
Monofilament	- A unitary filament large and strong enough to be used directly in making textiles by any established process.
Monomer	A chemical compound capable of being reacted with itself to form long chain compounds (called "'polymers") having improved higher molecular weight and improved properties.
Multifilament	Yarns made of many filaments by plying or spinning them together. The finer the filaments spun together, the softer and more luxurious the yams and textiles made from them, and conversely, the greater their tendency to absorb and hold water or soilage.
MSDS	A Materials Safety Data Sheet or MSDS is created by the manufacturer to provide details regarding the components and ingredients of products manufactured or imported into Australia. Your manufacturer or representative should have a copy of the MSDS on all products included in your project plan. For Commercial projects, keeping MSDS on file for each component is critical as many solution providers may use contact glues and adhesives that require special handling disposal, fire control or safety issues.
N	
Native soil	We refer to the natural conditions of the soils of the installation site; native soils can be clay, lawn, sand, peat, etc. Native soil conditions and local rainfall, snow and watershed/drainage aspects of the installation must be weighed against project use goals when engineering a synthetic grass design.

Term	Explanation
Nylon (PA)	A synthetic thermoplastic material made of synthetic polyamides made from carbon, hydrogen, nitrogen and oxygen derivable from petroleum, air and water which is adapted for extrusion into filaments of extreme toughness, strength and elasticity. **Nylon 6** -A specific type of nylon made by reacting caprolactam monomer to form long chain polymers suitable for fibre formation. **Nylon 6,6** -A specific type of nylon formed by the reaction and condensation polymerization of adipic acid and hexamethylene diamine to form a long chain polymer characterized by high melting point, high glass transition temperature, and excellent strength and elasticity. Nylon 6,6 is the strongest, toughest and most elastic type of nylon that is commercially available.
O	
Olefin	A long chain polymer composed of at least 85% by weight of ethylene, propylene or other olefinic monomers. Olefins contain only carbon and hydrogen atoms.
Other event infrastructure	Synthetic turf may be used for non-sporting events (e.g. concerts), however the surface must be adequately protected with covers/boards to prevent damage to the carpet and contamination of the infill. Special maintenance procedures are required once the covers/boards are removed to assist with standing the pile up again. The erection of tents and marquees on the surface is not recommended. The use of tent pegs or stakes on a synthetic surface will cause damage and, depending on the type of peg or stake, the base underneath the synthetic surface is also likely to suffer damage.
Organic material	Any material that can decompose over time, such as bark, amended soils, chips, shells, and other mulch materials; weeds, root systems, natural fibres such as jute, unwanted grasses and plants, etc.
P	
Performance issues	Of paramount importance to the success of any synthetic surface is its playing qualities and ability to retain acceptable properties for a reasonable length of time. The design (carpet, infill etc), base construction, surface installation and ongoing maintenance are critical to the performance and longevity of any synthetic surface system. Artificial surfaces that carry the FIFA Recommended mark should resemble natural grass in appearance and playability. The main Australian suppliers of long pile carpets are FIFA licensees and have FIFA recommended installations. This gives a high degree of confidence in the performance of their products. From a player's perspective the latest generation of synthetic surfaces: ▪ Have a similar ball-roll and rebound to that achieved on a natural playing surface. ▪ Have less risk of incurring graze injuries, improved stability and safer stopping compared to the previous generations of synthetic surfaces. ▪ Have a playing surface soft enough to absorb impacts and shocks. ▪ Enable player's boots to sink into the infill material in a way similar to the soil under natural turf, and ▪ Enable studded football boots to rotate in the turf without any effort. FIFA has conducted several studies to determine whether the game changes when played on artificial turf. The company ProZone used video technology to analyse game play of over 100 matches on both FIFA Recommended 2 Star pitches and top quality natural turf pitches. They found that the game did not dramatically change on artificial turf compared to natural turf and there were no significant differences in the frequency of dribbles, tackles, clearances, blocks, number of possession transitions & interceptions, passing success rates and forward, backwards and sideways passing of short, medium and long passes. There was also no difference in playing characteristics for defenders, midfielders or attacking players. Artificial surfaces seemed to encourage a higher incidence of attacking play (including more final third entries, penalty area entries, shots and goals).
Perforations	Perforations define the holes drilled or heat punched into the backing of some synthetic turf materials. The perforations provide relief for watershed through the surfaces to accommodate percolation.
Perimeter	The outer edge of the installation site of the synthetic grass area. Each area of synthetic grass has its own perimeter.
Permeable	Permeable means that a surface will allow liquids to flow through itself - how permeable a surface is can be determined by a percolation test. Clay soils will be the least permeable and lome, sandy soils will typically be the most permeable (porous).

Term	Explanation
Pigment	Highly coloured, insoluble, powdered substance used to impart colour to other materials. White pigments, e.g., titanium dioxide, are dispersed in fibre-forming polymers to produce delustered (semi-dull and dull) fibres.
Pile	A pile is the visible surface of a finished product, often called the face or nap of the turf.
Pile crush	Loss of pile thickness by compression (matting) and blending of tufts caused by high traffic or heavy weight. Grooming turf surfaces will often lift the pile back to original height. All turf will crush to some degree during its life expectancy.
Pile density	The number of pile tufts in a unit area of a carpet or rug, usually one square inch. In tufted carpets it is calculated by dividing the number of stitches per inch by the gauge. For knitted carpets it is calculated by multiplying the stitches per inch by the needles or wales per inch..
Pile length or height	The length of the extended tufts measured from the primary backing top surface to their tips. Pile tufts should be gently extended but not stretched during this measurement.
Pile reversal	Pile reversal or shading is a feature of cut pile turf. Traffic bends the turf fibre in different directions creating an impression of light and dark areas. Regular grooming can create a uniform shade.
Piled Yarns	Two or more strands, ends or plies of yarn either twisted or otherwise cohesively combined, intermingled or entwined to form a heavier yam.
Pill test	Flammability test for turf to determine its ease of ignition by a small incendiary source, e.g., methenamine timed burning tablet.
Polyester	A manufactured fibre in which the fibre forming substance is any long chain polymer containing at least 85% by weight of an ester of a dihydric alcohol and terepthalic acid.
Polymer	In synthetics, the basic chemical unit from which fibres are made. It is made of large complex molecules formed by uniting simple molecules (monomers) into a chain-like structure.
Polymid (PA)	Nylon is the most well known polymid used in manufacturing today.
Polypropylene (PP)	Synthetic, thermoplastic polymer used for moulded items, sheets, films and fibres. The polymer is made by stereo specific polymerization of propylene. Most polypropylene turf fibre is solution dyed and sometimes contains ultraviolet stabilizers or outdoor use. The turf fibre is available as both bulked continuous filament yarns and staple for spun yarn production. Slit-film polypropylene is used in woven turf backing.
Polyurethane	Material used as a secondary backing on the underside of synthetic grass materials. Applied as a viscous coating, the polyurethane is sprayed across the surface to help lock in the fibre stitches and increase the horizontal stability of the synthetic grass materials. The secondary backing process is one of the last in the line of steps to producing finished synthetic grass goods.
Porous	Porous describes the ability of a surface to allow liquid to flow through it. How porous a surface area is depends on many factors and can be determined by the percolation test.
Powerbroom or brush	A tool used during the construction and grooming of synthetic grass installations, a powerbroom or brush was developed for use as concrete and asphalt sweepers and adopted by the synthetic turf industry as a tool to help defibrillate (or bloom) synthetic grass surface materials and help to distribute infill materials across the surfaces. A powerbroom can also be helpful to groom surfaces.
Primary backing	A component of tufted turf consisting of woven or nonwoven fabric into which pile yarn tufts are inserted by the tufting needles. It is the carrier fabric for the pile yarn. Most primary backing is either woven or nonwoven polypropylene.
Propylene	A high molecular weight parafinic fibre made by polymerization of propylene monomer (FTC Classification 'Olefin' fibre)
R	
Recycling	The sand and granular mix can be cleaned and recycled. The majority of the infill is already from recycled tyres.
Release Coefficient	The ratio between applied vertical load and horizontal torque required to twist a loaded shoe on a given surface. The shoe is usually twisted in the toe-in direction.
Relief cuts	Cuts made into synthetic grass materials that will help alleviate any tension in the turf while positioning it and trimming it against hardedges that are curved or odd shaped. Relief cuts can simply be straight

Term	Explanation
	cuts from the hard edge outward to the end of turf, they can be shaped in the form of an H or a T to help wrap surface materials around obstacles such as trees, or "pizza slices" can be made into the turf that is located directly on top of a landscape element such as a large rock, to allow the turf materials to be "slipped" over the obstacle and trimmed off at a later time. Relief cuts can streamline cutting surface materials to fit and help fit materials around obstacles in the landscape.
Resilience	The capability of the turf to bounce back to its original appearance after being used. How well a turf can handle high traffic or compressive force is determined by several factors, including resilience of fibres and yarn materials, denier (dtex) and infill system of the turf system.
Ribbon Yarn (or Ribbon)	A continuous filament yarn having an essentially flat cross section with an aspect (length to width) ratio of more than 5 or 6 to 1.
Rippling	Heat and humidity can cause ruffles or waves in some turf. A professional installer may be able to reset the turf to fix the problem.
S	
SBR	SBR is manufactured from recycled tire and other rubber products. It has been used as a major component in turf infill systems, resurfacing of sports activity areas, parks, field & track surfaces, horse tracks and a variety of other coatings and formed rubber products such as mats, bumpers and flooring products for restaurants, day-care and the hospitality industry.
Seams seaming	The line formed where two pieces of turf are joined. The action of setting the turf and seaming using one or more methods including adhesives, sewing and tacks.
Secondary backing	Backing material laminated to underside of turf for additional dimensional stability and body. Usually latex foam, jute, polypropylene, vinyl, urethane, or E.V.A.
Selvage	Additional backing materials at the outer edges on the width of the turf materials. Selvage is most commonly used when seams are sewn and is cut off when glued.
Shading	Shading is the same as pile reversal. Shading is the change in the appearance of the turf due to localized distortions in the orientation of the fibres. Shading is not a change in the colour or hue, but a difference in light reflection which can cause the turf to appear a different colour and seams to show. Orient turf in the same direction when installing to avoid shading.
Shedding	New turf appears to shed blades after installation. Many of these blades were cut away during normal installation and were hidden during job site cleaning. They work their way to the surfaces during use. Regular blowing and grooming will quickly resolve this problem.
Shock Absorbency	The ability of a cushioning system to attenuate the force (and damage potential) of a blow or impact.
Shock pad	If required, a shock-absorbing layer is placed over the base. It is used to provide a degree of comfort to players and to create defined playing characteristics for specific sports. Benefits of a shock pad include more protection and a more comfortable surface for the player and delaying wear of the synthetic grass fibres to extend the performance life of a surface. However, with advances in infill media, some suppliers state that a shock pad is not required and can actually reduce the performance of a synthetic surface. The two main types of shock pads are: in-situ: hot mix of rubber shreds/crumbs bound with polyurethane and laid using a highway paving machine, and pre-formed: supplied in rolls and fixed in place by gluing. A shock pad will significantly increase the cost of installing a synthetic surface but will last for several surface replacements (e.g. 15~20 years).
Shrink	Synthetic grass surface materials, like most woven products can shrink or shift under certain conditions. Where temperature variances can change from extreme cold to extreme heat, synthetic grass surfaces can expand and contract. A minor amount of "shrink" can occur on surfaces as they age, however the shifting of turf surfaces can be mis-identified as shrink.
Snap line	A snap line is a small box-like device, filled with chalk powder that has a long string line wound around the inside where the powder can coat it – the chalked snap line is used to mark a straight line.
Special clothing	Special clothing is not required whilst using long pile synthetic surfaces. The synthetic fibres are designed to be softer and less abrasive than past-generation synthetic surfaces. Players can tackle; slide etc without experiencing carpet burns or abrasions. Rubber infill mediums will not cause abrasion

Term	Explanation
	any more than natural grass. Carpets made from polyethylene yarns are softer and have an improved slide factor than carpets made from polypropylene yarns.
Specific Gravity	- The ratio of the weight of a given volume of a fibre forming polymer to the weight of an equal volume of water taken as standard at a specified temperature.
Split Film Yarn (or Split Filament Yarn)	A yam made by extruding a relatively wide film and then slitting it at various points across its width so as to break apart in the course of textile processing to yield multiple filamentary segments.
Stitches	The number of yam tufts in lengthwise direction of a tufted or knitted carpet.
Sporting use	If a synthetic pitch is not fenced then this will, to some degree, limit what sports can be played on the surface. For example, it would be too dangerous to allow hockey to be played on the surface as the ball could enter traffic, hit parked cars or other park users. Competition hockey requires a surface that is shorter and faster than a long pile synthetic grass, thus individual practice or informal hockey would be the only forms of the sport that could be played. Lacrosse is a sport that is played outdoors on a field of similar dimensions to a soccer pitch (100m x 55m). Given the similar running nature to soccer, it is anticipated that a surface acceptable for soccer would also be appropriate for lacrosse. Being developed to perform like a natural grass sports surface, long pile synthetic grass can be used for a range of outdoor ball sports and recreational activities.
Sprouting	Sprouting occurs when higher turf fibres appear on turf surfaces. Simply cut the sprouts with sharp scissors.
Stability	Horizontal (left to right & reversed) and vertical (up to down and reversed) stability is important to a synthetic grass installation. Turf materials, their backings, the base and sub-base construction of the job all relate to standards of horizontal and vertical stability. A project's sub-base and base construction should maximize horizontal stability to carry weight load. The primary and secondary backing materials on a synthetic turf pitch allow the turf system's surface materials to provide additional horizontal stability. To achieve vertical stability, synthetic turf systems are assisted by the use of infill materials and in some areas (eg lines) are glued to the surface to enhance stability and reduce movement.
Static electricity	Cold and low humidity often create isolated motionless charges of electricity. Some turf products may provide static resistance. Humidifiers also limit static electricity build-up when used indoors. To alleviate static charge on any synthetic grass surface, condition the synthetic grass surfaces with a 5 to 10% solution of fabric softener and water, sprayed generously across the surfaces. We recommend an unscented liquid. Leave the materials on overnight and then rinse. You may need to repeat the application in a few weeks.
Stretching	During several steps, the extruded polymer mixture is pulled and stretched to align the molecules and build in strength - much like an ironsmith works metals to build them up, by pounding and folding and reheating, again and again.
Style	A set of specifications that describes a component of or the finished construction of turf materials. Style specifications are designated for yarns, backings and finished tufted materials.
Sub-base	Materials that lie under the surface of the synthetic surface. Native soils, concrete, asphalt and other surfaces can all be referred to as the "sub-base" - subterranean base or foundation.
Surface fading	All synthetic yarns are stabilised against the damaging effects of ultra violet radiation. Despite the UV stability of a yarn, it is likely that the surface will fade slightly over a period of 10 years. The surface will generally become lighter in appearance over time due to the fibrillation of the yarn. Carpets made from polypropylene fibres are more resistant to UV radiation than polyethylene fibres. Lack of maintenance of a synthetic surface is far more likely to cause the appearance of fading. Synthetic yarns will become dirty over time and the longer left without cleaning, the more difficult the task of cleaning will be. This re-emphasises the importance of a well-designed maintenance program. Most surfaces come with a five to seven year warranty on excessive fading and UV degradation.
Surface repair	Synthetics can be damaged in several ways: ▪ Cigarette burns are not considered a problem as isolated burn marks are relatively indistinguishable from the overall appearance of the surface. The pile will smoulder rather than catch on fire

Term	Explanation
	▪ Small cuts in the surface are unlikely due to the thickness of the sand and rubber infill ▪ Vandalism via car 'burnouts' or cutting can be repaired either by re-gluing or alternately, removing and replacing a damaged section. The longer pile surfaces are more resistant to damage than shorter pile options. It is more difficult to damage synthetic surfaces filled with sand and rubber than products predominantly filled with rubber. The cost of repairing a long pile artificial surface varies dependant on the following: ▪ Extent of damage of a given area (i.e. can the area be repaired or does it require replacement?) ▪ Extent of damage (in terms of the number of square metres) ▪ Cost of the type of surface installed ▪ Whether or not any parts of the damaged surface can be recovered, and ▪ Whether or not there is any damage to the base The cost of re-surfacing is approximately $75-$ 100 per metre squared inclusive of labour. For example a 20m2 section can be re-laid in a day and will cost approximately $1,500- $2000. It is important to note that each batch of grass produced is likely to have a slightly different dye lot to other batches. Therefore repairs that utilise materials from a variety of dye lots are likely to differentiate in colour more than repairs using the same batch of material.
Swale	A swale is typically used as an open channel to direct water run-off from rain and watershed.
System components	Third generation synthetic surface systems constitute several components, including a structural base, an optional shock absorbing layer, long pile carpet and an infill system. The structural base is similar for all synthetic installations and the grading, composition and depth of infill materials are carefully selected by the manufacturer to ensure the combination of the carpet pile and infill materials gives the type and level of performance required from the surface.
T	
Tamp and tamper	A tamper is a hand tool used to compact small areas of soil or base materials. To tamp or tamping is the process of using the tamper to compact the area.
Tape	Seaming tapes are materials used under the edges of two pieces of synthetic grass, as a part of a seaming system to attach the two pieces of synthetic grass together.
Taber Abrader	A device for testing the abrasion resistance of fabrics or plastics by subjecting them to a pair of rotating abrasive wheels.
Tenacity -	The amount of stress required to produce a particular elongation in a fibre. The breaking tenacity is the stress required to elongate the fibre to its breaking point.
Tensile Strength	Breaking strain of yarns or fabrics.
Tensile strength	The amount of stretch the material exhibits before it breaks due to the pressure of pulling on it.
Texture	The visual and tactile (touch) characteristics of the turf's pile. Texture includes luster, yarn twist, pile "hand", and pile effects such as cut, cut-uncut, high-low loop, and level loop.
Texture retention	Texture retention or turf memory is the ability of tufts to retain their shape under traffic. Caring for turf will help texture retention.
Torsional strength	The amount of strength exhibited when the material is twisted under pressure.
Total Weight	The weight per specified area of the total carpet system, including pile fibre, primary and secondary backing materials, and coatings.
Traction	That property of a sports system which includes the athlete's shoe and the playing surface in contact with the shoe which permits the athlete 10 walk, run, turn start or slop with adequate agility and speed for the game in which he is participating.
Trim and trim elements	Trim is the material or method used to edge the synthetic grass project where trim elements are the actual materials selected for the edging treatment.
Tufts	The cut or uncut loops of a pile fabric.

Term	Explanation
Tuft bind	Force required to pull a tufted blade out of the backing.
Tufted	Term used to describe the process of manufacturing turf by the insertion of tufts of yarn through a backing fabric, creating a pile surface of cut and/or loop ends.
Turf and turf systems	Turf is a flooring fabric made from a variety of layers and types of materials. Fibres and backings can vary from product to product. Turf products are generally specified by density, face weight, pile height, stitch gauge and colour. Turf Systems are developed by manufacturers who select a synthetic grass mat, infill medicure (eg. jard, rubber and natural infill) together with their own approach to seaming the lines and carpet base together and the sub-base a drainage employed.
Twist	Twist is the winding of the yarn around itself. More twist improves turf performance (especially in cut pile).
Twisting	The fibrillated yarns are twisted into a constant number and sent straight to packaging or on to another process called texturing.
U	
Underlay	Materials installed directly under the turf; generally thick pads for additional cushion, fall zone safety and other enhancement.
Underlayment fabric	Fabrics used under and/or in between layers of base materials in the construction of a project.
Urethane (or Polyurethane)	An elastomeric material formed by the chemical reaction of a diisocyanate and a polyol, frequently used in adhesives or in foam cushion as carpet backing. As a general rule polyurethane foams are open celled.
UV Degradation	The degradation of materials due to exposure to the ultraviolet rays in sunlight or any other source.
V	
Vehicle use	See ‘cars’.
W	
Warp	A series of threads or yams running in the lengthwise direction of a fabric.
Weatherometer	A laboratory device for testing the effects of exposure of fabrics or other materials to intense illumination under alternating wet and dry conditions
Wheelchairs and riding of bikes	Using wheel chairs and riding bikes across a synthetic surface will generally not cause damage, however the surface may be difficult for the user (due to the relative sponginess of the surface).
Waste	The amount of surface materials remaining after the completion of the installation. Waste materials are generally recycled or reused (where possible), however a certain amount of waste is to be expected. Also known as “cut loss”.
Woven	Interlacing strands of fibre into a yarn forms woven turf.
Woven Carpet	A carpel mode using one of the three traditional weaving processes - Axminster, Wilton or Velvet, in which the backing and pile surface are jointly fabricated on a loom wherein a filling yarn passes the full width of the fabric between the crossed warp threads and at right angles to them, and the pile fibre is inserted alongside the warp threads. Prior to the early 1950's this was the principal method of carpet fabrication
Y	
Yarn	A continuous strand of fibre(s) for use in tufting, knitting, weaving or sewing: (1) Continuous filament yam: Yam formed into a continuous strand from two or more continuous filaments. (2) Spun yam: Yam formed from relatively short lengths of staple fibre by spinning or twisting into a single continuous strand

Appendix 2: Key Contacts

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 Hockey Australia & all Football Codes in Australia

Key Sports

Football Australia (Football)

Level 9, 1 Shelley Street

Sydney NSW 2000

p: (02) 8020 4021

w: www.footballaustralia.com.au

National Rugby League Limited (NRL)

Luke Ellis, Participation, Pathways and Game Development Head

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

e: Michael.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

Jamie O'Connor, Chief Executive Officer

6 Makin Place

Deakin ACT 2600

p: (02) 6212 2800

e: jamie.oconnor@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

Suppliers and Agents

ABS Sport Surfaces

3 Cochrane Street

Mitcham VIC 3132

p: (03) 9873 0101

e: daarons@berrysportsurfaces.com.au

w: www.abs-sportsurfaces.com.au

FieldTurf Australia

Warehouse C
2 Kookaburra Rd North
Prestons NSW 2170

e: info@fieldturf.com.au

w: www.fieldturf.com

- FIFA Preferred Producer
- World Rugby Preferred Provider
- AFL Approved Manufacturer

Grassports Australia

1/38 Green Street

Doveton VIC 3177

p: (03) 9792 0622

e: info@grassports.com.au

w: www.grassports.com.au

Grassports Australia and ABS Sports Surfaces are an agent for Polytan, who are:

- FIFA Preferred Producer
- World Rugby Preferred Provider
- AFL Approved Manufacturer

HG Sports Turf Australia

Suite 2, Level 1, 526 Whitehorse Road

Mitcham VIC 3132

p: (03) 9329 8154

e: info@hgsportsturf.com.au

w: www.hgsportsturf.com.au

They provide a range of Hybrid solutions for local government, sport and stadia

Polytan

Factory 3, Dunlopillo Drive

Dandenong South VIC 3175

p: (03) 8792 8000

e: enquiry@polytan.com.au

w: www.polytan.com.au

- FIFA Preferred Producer
- World Rugby Preferred Provider
- AFL Approved Manufacturer

Sports Clean

6/5 Hudson Avenue

Castle Hill NSW 2154

p: (02) 9420 1200

e: info@sportsclean.com.au

w: www.sportsclean.com.au

Synergy Turf Manufacturing

165 Prospect Highway

Seven Hills NSW 2147

p: 1300 796 100

e: help@synergyturf.com.au

w: www.synergyturf.com.au

Synergy Turf is the agent and Australian manufacturer for Greenfields, recognised as:

- FIFA Preferred Producer
- World Rugby Preferred Provider

TigerTurf Australia

15 Macquarie Drive

Thomastown VIC 3074

p: 1800 802 570

e: auinfo@tigerturf.com

w: www.tigerturf.com

TigerTurf is a FIFA Licensee

Tuff Group

58-60 Sunmore Close

Heatherton VIC 3202

p: 1800 887 326

e: enquiries@tuffturf.com.au

w: www.tuffturf.com.au

Tuff Turf is an agent for the Co-Creation Grass (CCG) products. CCG is:

- FIFA Preferred Producer
- World Rugby Preferred Provider

Turf One / Bild

Unit 12/89 Simcock Avenue

Spotswood VIC 3015

p: (03) 9719 1900

e: info@turfone.com.au

w: www.turfone.com.au

Turf One is an agent for the FieldTurf products. FieldTurf is a:

- FIFA Preferred Producer
- World Rugby Preferred Provider
- AFL Preferred Manufacturer

Independent Testing Institutes

Acousto-Scan

44/59-69 Halstead Street

South Hurstville NSW 2221

p: (02) 8385 4872

e: admin@acoustoscan.com.au

w: www.acoustoscan.com.au

Labosport Australasia

52 Raby Esplanade

Ormiston QLD 4160

p: (07) 3286 2237

e: keith.mcauliffe@labosport.com

w: www.labosport.com

Global Peak Bodies for Synthetic Turf

Synthetic Turf Council (STC, USA)

www.syntheticturfcouncil.org

European Synthetic Turf Council (ETSC, Europe)

www.estc.info

Sports and Play Industry Association (SAPIA, AUS)

International Sports Federations

Sports and Play Contractors Association (SAPCA, UK)

www.sapia.org.au

http://www.sapca.org.uk/

International Association for Aquatics and Leisure Facilities (IAKS)

https://www.iaks.org/

Football/Soccer – FIFA - Quality Program for Football Turf

http://quality.fifa.com/en/About-the-programme/

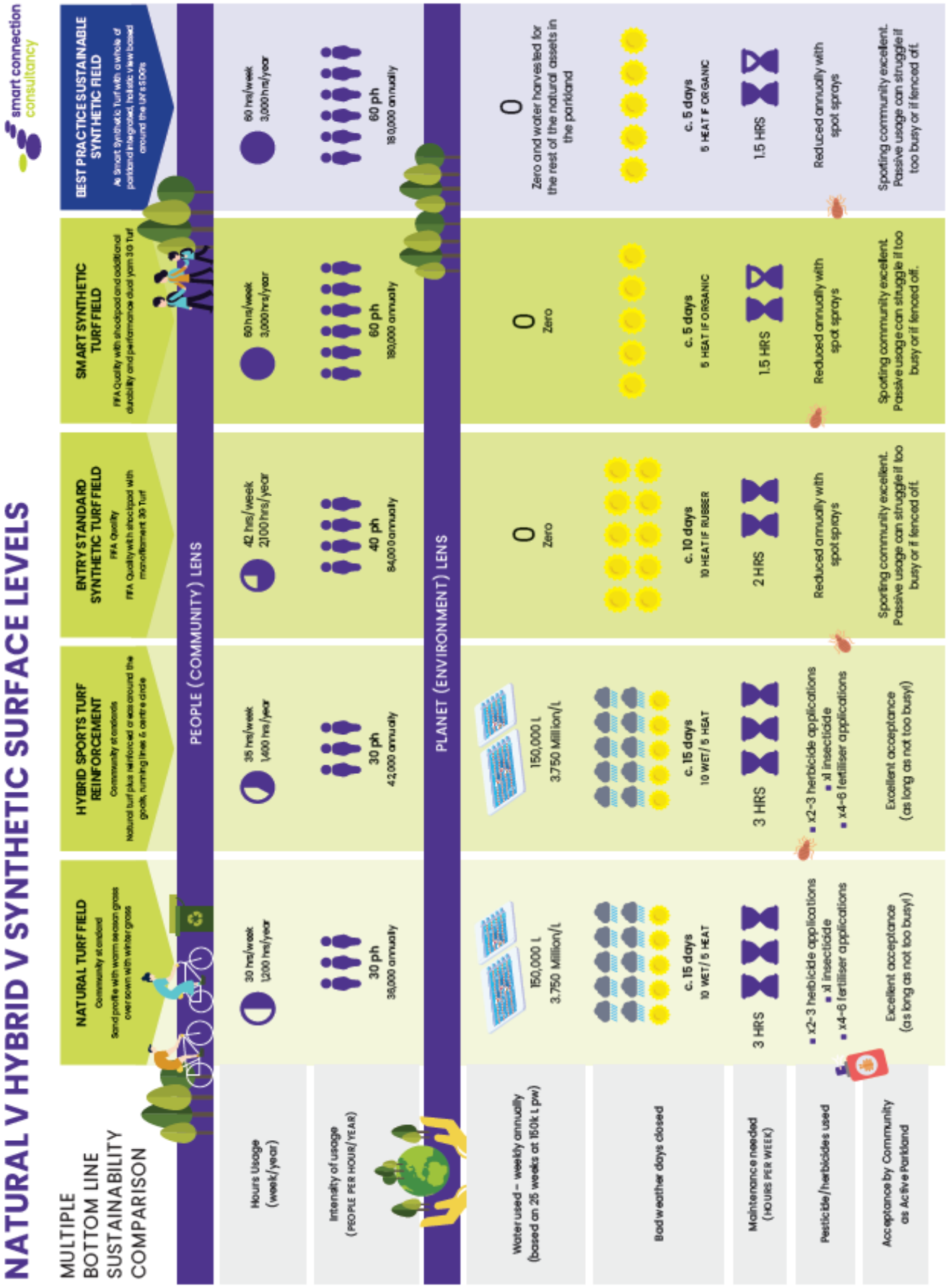
Rugby Union – World Rugby - Rugby Turf Program
http://playerwelfare.worldrugby.org/rugbyturf

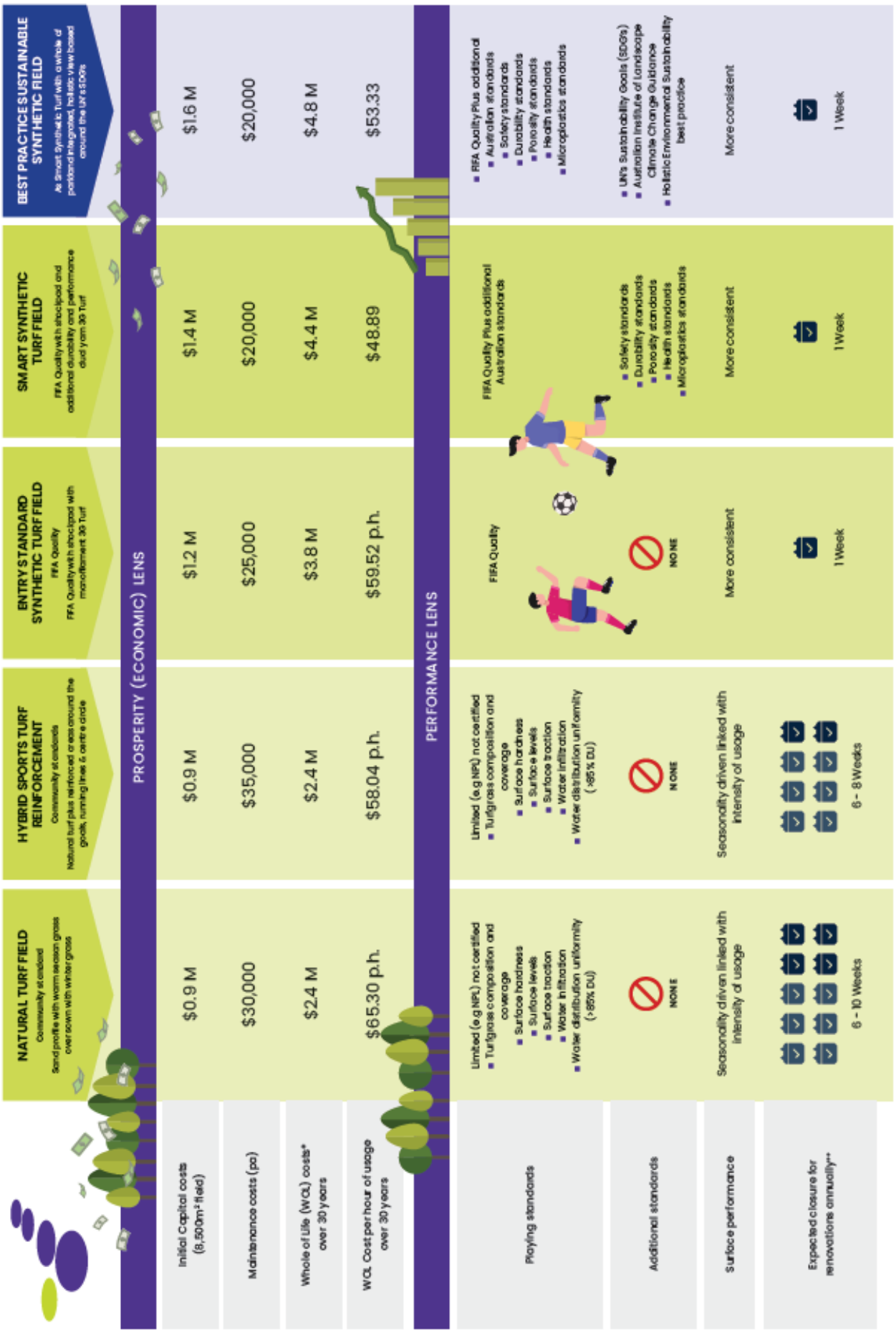
Appendix 3: Smart Synthetic Sports Field Inspection and Maintenance Report

Smart Synthetic Sports Field Inspection and Maintenance Report

Field & Client Details:			
Name of field			
Address of field			
Client organisation			
Client contact		Contact Tel	
Date of visit		Time of visit	
Notes re field			
Contractor Details			
Contractor org. name			
Operators name		Operators Tel	
Inspection Details			
Outstanding issues			
Condition of field on arrival			
Details of maintenance carried out			
Key Findings (Write findings against each category)			
Surface		Contaminants / rubbish	
Infill		Penalty spot/ high wear areas	
Seams		Hazards	
Gates/fencing		Sports equipment	
Rectifications recommended			
1			
2			
3			
4			
5			
6			
Impacts if rectifications are not followed?			
Contractor signed		Client signed/dated	

Appendix 4: Multiple-Bottom Line Comparison Infographic




NATURAL TURF FIELD
Community standard
Sand profile with warm season grass over sown with winter grass
HYBRID SPORTS TURF REINFORCEMENT
Community standards
Natural turf plus reinforced grass around the goals, running lines & centre circle
ENTRY STANDARD SYNTHETIC TURF FIELD
FIFA Quality
FIFA Quality with shockpad with monofilament 3G Turf
SMART SYNTHETIC TURF FIELD
FIFA Quality with shockpad and additional durability and performance dual yarn 3G Turf
BEST PRACTICE SUSTAINABLE SYNTHETIC FIELD
As Smart Synthetic Turf with a whole of portfolio integrated, holistic view based around the UN's SDGs
PROSPERITY (ECONOMIC) LENS
PERFORMANCE LENS
Initial Capital costs (8,500m² field)
$0.9 M
$0.9 M
$1.2 M
$1.4 M
$1.6 M
Maintenance costs (pa)
$30,000
$35,000
$25,000
$20,000
$20,000
Whole of Life (WOL) costs* over 30 years
$2.4 M
$2.4 M
$3.8 M
$4.4 M
$4.8 M
WOL Cost per hour of usage over 30 years
$65.30 p.h.
$58.04 p.h.
$59.52 p.h.
$48.89
$53.33
Playing standards
Limited (e.g NPL) not certified
Turfgrass composition and coverage
Surface hardness
Surface levels
Surface traction
Water infiltration
Water distribution uniformity (>85% DU)
Limited (e.g NPL) not certified
Turfgrass composition and coverage
Surface hardness
Surface levels
Surface traction
Water infiltration
Water distribution uniformity (>85% DU)
FIFA Quality
FIFA Quality Plus additional Australian standards
FIFA Quality Plus additional
Australian standards
Safety standards
Durability standards
Porosity standards
Health standards
Microplastics standards
Additional standards
NONE
NONE
NONE
Safety standards
Durability standards
Porosity standards
Health standards
Microplastics standards
UN's Sustainability Goals (SDG's)
Australian Institute of Landscape Climate Change Guidance
Holistic Environmental Sustainability best practice
Surface performance
Seasonality driven linked with intensity of usage
Seasonality driven linked with intensity of usage
More consistent
More consistent
More consistent
Expected closure for renovations annually**
6 - 10 Weeks
6 - 8 Weeks
1 Week
1 Week
1 Week

SMART CONNECTION CONSULTANCY

Smart Connection Consultancy offers an innovative approach that delivers outcomes to enhance the experience of participation in physical activity, recreation and sport in local communities.

We specialise in the planning, development, management and procurement of synthetic sports surface technology. We see this technology as complementing natural grass and encouraging more people to be active, play and achieve success in sport because of its extended durability.

By embracing the skill sets and knowledge of our collaborative consultants, we can provide an integrated and holistic approach to our client's projects.

Smart Connection Consultancy is the Technical Consultants for Hockey Australia, Rugby Australia, Football Federation Australia, and the National Rugby League and sits on the AFL technical committee.

"Smart Connection Consultancy has been an invaluable source of information for both the federation and our affiliated clubs. Martin specifically has responded to requests at short notice, provided valuable insights and produced quality pieces of work that haves allowed the football community to achieve deadlines and desired outcomes – we will certainly be using him again".

Football Victoria

Field of Expertise

In collaboration with industry experts, we provide our clients with high-level quality service at an affordable price.

We work with synthetic and natural surfaces for the following sports facilities:

- Australian Rules Football Ovals
- Athletics Tracks
- Cricket Fields and Wickets
- Football (11-a-side, Futsal and 5-a-side)
- Hockey Fields
- Multi-sports Areas
- Rugby Union Fields
- Rugby League Fields
- Tennis Facilities

Commitment to Knowledge Building

We are committed to providing leading edge advice and knowledge so that the industry and our clients can appreciate how synthetic sports turf can complement their natural turf options.

We offer the industry and our clients advice, mentoring, and knowledge sharing so they can contextualise the opportunity and strategically consider options. Our approach provides rigor, and we use independent research as a base to ensure that the most appropriate options are determined.

These services include:

- Knowledge sharing master classes
- Planning and facility development workshops
- Business case workshops linked to Whole of Life Asset management costing strategies and income generation strategies
- Sports participation growth strategies linked to synthetic surfaces
- Synthetic field installation tours - Practical reality
- National Sports Convention

Feasibility and Funding Advice and Solutions

Completing a Business Case to justify the need for a synthetic surface can be streamlined by using our *Smart Whole of Life Costing Model*. We support clients in developing financial strategies and funding applications and, where applicable, offer funding packages with major financial institutes. Our offering includes:

- Financial strategy development to address WOL costings
- Funding applications for government grants
- Funding solutions with major lending institutes

We understand the use of supply modelling by using demographics of the local community, the needs and the opportunities for activating and retaining them in active recreation and sport which is paramount for a Feasibility Study or Business Case.

Our supply and demand modelling is critical in determining the needs for sports facilities, including:

- Supply and demand analysis
- Community consultation options

Master planning and Design Solutions

We will work with you to explore the site parameters and constraints, together with the opportunities, to ascertain the best design and management options for your park or venue.

Smart Connection Consultancy has partners for all aspects of the project to provide the civil engineering aspect of each design and procurement project. Our collaboration can offer:

- Stakeholder consultation and technical approval
- Concept design options and strategy
- 3D design and fly-through options
- Geotech analysis and assessment

- Council presentations
- Cost estimate for concept design

We can mentor your team to understand how to best manage the facilities once built, as this is vital if the funding is based on your organisation's ability to generate revenue.

We can support program development and provide advice on how to maximise the balance between club, school, commercial and your own programs, including:

- Program development strategies
- Price benchmarking
- Performance reviews

Photo 1: Moore Park Multi-sports field (NSW)

Procurement and Project Management Support

With over 20 years of experience in procurement and in collaboration with our engineers, we offer a full procurement service. These services include:

- Procurement strategy development
- EOI and RFT document development
- Design & Construct or Detailed Design options
- Tender evaluation facilitation
- Comprehensive tender evaluation tools to ensure a rigorous and transparent process to procure the best product that is fit for purpose and achieves the best value for the community

Collaborating with our partners, we provide detailed civil engineering hold points to ensure that every step of the installation meets the appropriate civil and performance standards, including:

- Site inspections and reports
- Witness and critical hold points
- Respond to construction RFI's
- Attend practical completion and defect inspections
- Site assessments and conditional audits

Photo 2: Chatswood High School NSW

Our Clients

We have successfully completed a significant number of sports performance standards reviews, sports strategies, master plans, feasibility studies, business cases and procurement projects. Our client base includes:

- International Federations – FIH, FIFA & World Rugby
- National and State Sports Organisations – NRL, AFL, Hockey Australia, Football Australia, and State bodies
- Local Governments in Victoria, NSW, ACT, Qld, WA.
- Universities and Schools across the Country

Additional Organisations include – Mariners FC, Macarthur Football Association, Delfin Lend Lease, Veneto Club, Monash University, Southern Cross University, Queensland University of Technology and University of Queensland.

SMART SYNTHETIC SPORTS FIELD HEALTH CHECK

Review your field, understand risks and extend life expectancy

Australia's leading synthetic sports surface consultancy is offering the **Smart Synthetic Sports Field Health Check**, for clients who wish to find out what condition their synthetic fields are in and what is the probable life expectancy.

Smart Connection Consultancy has been involved in over 70% of all the synthetic football fields (all codes) developed and installed in Australia in the past decade. We work closely with our clients to maximise the usage and life expectancy of their fields.

The Smart Synthetic Sports Field Health Check consists of:

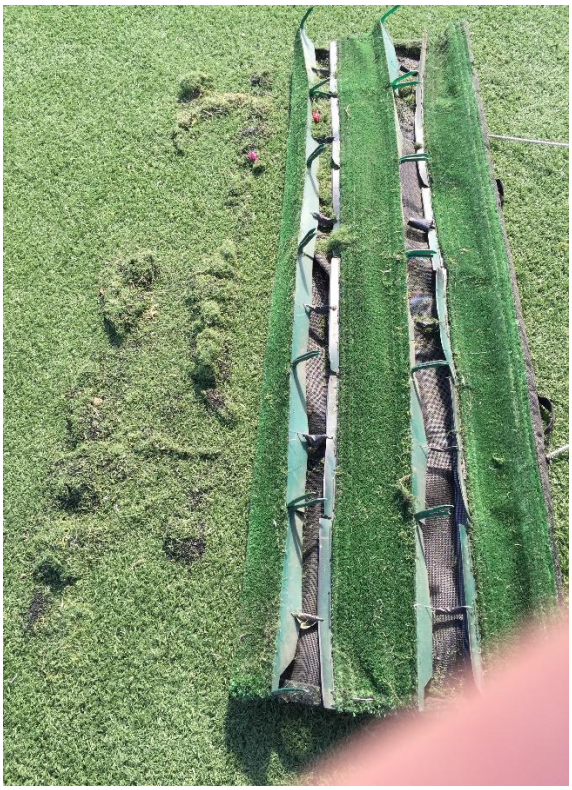
- Conducting a site analysis and field review to ascertain its current status;
- Assessing current maintenance practices to explore if this can extend the life of the field;
- Reporting on findings with improvement strategies;
- Risk assessment with mitigation strategies;
- Predicting life expectancy; and
- Replacement costings and modelling.

An Assessment Report is provided within 48 hours of the field assessment.

"The Smart Sports Field Health Check allowed us to appreciate the challenges we had, reduce our risks by adopting the risk mitigation strategies identified and we believe that we have extended the expected life by two years by adopting the recommendations for remediation and maintenance."

(Mick Roberts, Sports Grounds Manager, ACT Government)

Call (03) 9421 0133 and talk to Martin Sheppard or email martins@smartconnection.net.au to find out how the Smart Sports Field Health Check can extend the life of your synthetic sports field.



Appendix 5 – Self Assessment Questionnaire

Introduction

The aim of this simple self-assessment is to provide an organisation of the fundamental considerations when considering exploring and alternative surface to grass, once this has been completed the Smart Guide should be embraced to guide you through the process.

Sports Surface Component Considerations	Benchmarked Solution and Preferences	Self- assessment Result
1. PLANNING		
Scope of Brief Confirmation		
Scope	Is there clarity on the scope of the brief to ensure it meets the criteria and benefits to the broader community	
Needs Assessment	Can you document evidence that there is a need for these proposed facilities, including demographic analysis showing catchment assessment compared to current facilities and growth needs. Have you agreement with your local sports association and council and SSA for your sport.	
Provision Assessment	Does the current site justify a new surface and has that been aligned with supply and demand in the municipality to demonstrate need and value this investment will make to the whole community and not just the club. Have you considered the impact on community residents in the planning stage.	
Policy & Strategy Alignment	Does the site development align internally and with key stakeholders, such as Council, State Government and your sports Strategy and priorities for this area. IS this reflected on a masterplan for the Site	
Sports Specific Needs	Has a technical assessment been completed for the site to ensure alignment and ability to install the facility surface	
Management Considerations for Future Proofing	How are you looking to Future Proof the facility surface from a participation, environmental and economic lens while also ensuring its Fit for Purpose	
Environmental Considerations	Have you identified how to embrace a Whole of Parkland strategy that provides environmental benefits while the civil engineering considerations for the next 30 years and meet any compliance or DA needs	
2. DESIGN		
Performance Standards for Surface	What has been considered regarding size, position of the surface, performance levels, additional environmental and usage needs specially for Australia and the level of certification required	
Planet (Environmental) Standards	How have you identified the key environmental considerations including, whole of parkland impact, surface standard, climate impact, drainage strategy, water	

Sports Surface Component Considerations	Benchmarked Solution and Preferences	Self- assessment Result
	harvesting opportunities, lighting strategy, accessibility and maintenance considerations	
People (Community) Standards	How has your planning considered the usage of the facility and if the surface can achieve this intensity and those impacts on parking, traffic, wayfinding, DDA compliance, and access around the whole parkland as well as an open access policy for the site to encourage greater usage	
Prosperity (Economic) Standards	Has whole of life costings been calculated in a manner that includes capital costs, maintenance/renovation and replacement costs at the end of life. Has this been recognised in the management and manufacturer guarantees	
3. PROCUREMENT		
Procurement Process	How will the procurement process ensure a transparent process, alignment of suitability, that reduces risk associated with the construction and installation of the surface. Who will assist you in the process to ensure that best practice is embraced for the surface to last 30 years plus and that the manner that the tender is evaluated and awarded is fair and equitable	
Construction Project Management	How will you ensure that the construction and installation is project managed to assure quality control of the project	
Handover	What expectations do you have for the handover of the facility to ensure that your organisation 'owns' all the intellectual Property at handover Who will support you in the Dilapidation period	
4. Management		
Facility Management	How will the facility be managed and maintained to ensure the life expectancy can be achieved by clearly defining all parties roles and responsibilities.	
Maintenance	How are you going to program the maintenance into daily, routine, programmed and seasonal requirements between the skills inhouse and external specialists	
Surface Programming	How can you best manage the demand for programming and usage between broader community usage, club/association needs and time to maintain the surface	
Measuring Impact	How have you identified how you are going to measure the impact and outcomes of the new facility surface	

SPORT INSPIRES A NATION

Synthetic Sports Surfaces Create the Opportunities for All Generations

smarter synthetic solutions

smart connection consultancy

Suite 40, 204-218 Dryburgh Street
North Melbourne VIC 3051

Tel: +61 3 9421 0133
Email: martins@smartconnection.net.au

www.smartconnection.net.au

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