The

SMART GUIDE

To

SYNTHETIC SPORTS SURFACES

Volume 4: Challenges, Perceptions and Reality

Issue: v1.01

smart connection consultancy

Date: November 2019

Acknowledgements

Smart Connection Consultancy is extremely grateful to the sport peak bodies, valued suppliers and manufacturers who have provided information, photographs and case studies for this Smart Guide to Synthetic Football Fields.

Without their support, we would not be able to achieve our goal to enhance the knowledge of the industry on synthetic sports turf fields. We would also like to thank our colleagues, clients and organisations that we have completed work for in the sports industry. It is your appetite for change and progress that makes our job so rewarding.

ISBN: TBC

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

About the Smart Guide to Synthetic Sports Surfaces
Smart Connection Consultancy is committed to sharing knowledge and learnings with the industry and has produced a number of volumes of the Smart Guide to Synthetic Sports Surfaces which can be downloaded free of charge from our website www.smartconnection.net.au.

The volumes of the Smart Guide to Synthetic Sports Surfaces include:

- Volume 1: Surfaces and Standards (2019)
- Volume 2: Football Turf – Synthetic and Hybrid Technology (2019)
- Volume 3: Environmental and Sustainability Considerations (2019)
- Volume 4: Challenges, Perceptions and Reality (2019)
- Volume 5: Maintenance of Synthetic Long Pile Turf (2019)

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Welcome and Purpose

The popularity of synthetic sports surfaces used by many sports, local governments and within the education sector in Australia has significantly grown in the last two decades to complement their natural turf fields. This enables the local community to participate in sport when the demand on natural fields cannot be accommodated.

There are some community groups who have concerns about aspects of the synthetic sports surface systems having a negative impact on the players, the environment and the community. Media raised these concerns, yet a gap in their coverage is the lack of facts, with the story based on specific internet based issues which may be historic and not updated.

The aim of this Smart Guide is to address this gap and provide objective evidence from around the globe to assist organisations with their decisions to embrace the technology to supplement their natural turf fields. It is anticipated that this should guide community groups in appreciating the benefits and reality around the challenges of such investments.

Smart Connection Consultancy is passionate about working with organisations that are keen to encourage their community to be more active. Sport is one of the vehicles to achieve this and provides many physical, community and health benefits.

Smart Connection Consultancy has embraced the use of sports field technology, whether that be natural, hybrid, synthetic or alternative sports surfaces to complement natural fields, as a vehicle to promote and provide the community with opportunities to be more active more often.

This Smart Guide will continually be updated, and this Issue embraces the latest research findings from the European Chemical Agency – ECHA (Feb. 2017 and Aug. 2018); The Dutch Government (Dec. 2016 and 2018) and the Washington State Department of Health (April 2017).

Photo 1: Recycled SBR from Car Tyres (Source: TigerTurf)

Photo 2: Organic Infill - Cork and Coconut Husk (Source: Limonta)

Photo 3: Silica Sand (Source: www.flexsand.com)

Photo 4: EPDM 'Bionic' infill (Source: MILOS)

Photo 5: TPE Pellets for Field

1 Introduction

The growth of the Australian population over the past 21 years has seen an increase of over six million[1] (33%) from approx. 18 million to 24 million people. The expected population in the next 15+ years will rise to be over 31 million[2] (approx. 40% increase) and this will seriously impact on sports field provision and accessibility in many cities around Australia.

The ability to cater for the growing demand of natural playing fields is causing concern to many inner city local governments. These natural turf fields are under greater capacity pressure and this results in increased stress levels to the natural turf. Many local governments are embracing the synthetic sports turf technology to complement natural turf and satisfy community need.

Photo 6: NSW Council field in typical mid-season condition for their natural turf field

The benefits of synthetic sports turf technology cater for increased playing capacity, often more than 60 hours a week, and offering a consistency that is not detrimentally impacted by drought or excessive rain. Most football codes in Australia benefit from this technology and the growth in synthetics fields for Soccer, Rugby (Union and League), AFL and multi-sports fields, continues to increase.

These synthetic sports fields have evolved over the past 50 years and are now known as the Third Generation fields, or 3G pitches.

These 3G pitches use sand and a performance infill, which is normally a rubber infill. Historically, this rubber was made from recycled car and truck tyres, which is a very durable material and saves millions of used tyres from being dumped in landfill sites globally.

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 7: Field after being converted (Hornsby Council NSW)

At times there is a perception that if the surface is not natural grass, it is not safe. 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.

[1] ABS, Australian Demographic Statistics (cat. no. 3101.0), Data extracted on 21st December 2016 http://abs.gov.au/ausstats/abs%40.nsf/94713ad445ff1425ca25682000192af2/1647509ef7e25faaca2568a900154b63?OpenDocument

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

The key concerns for health and safety are predominantly:

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

This Smart Guide aims to provide the reader with information to appreciate the science behind the perceptions and a balanced view.

2 Player Safety and Injuries

2.1 Perceptions

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[3] 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 8: Field with markings for several sports (Source: TigerTurf)

2.2 Independent Sports Studies

2.2.1 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[4]. The study yielded a slightly lower risk of muscle injuries but showed slightly higher risk on ligament injuries with rate of knee injuries being the same between both surface types (see Table 1). However, the study did not analyse the influence of footwear when playing on both surfaces.

Table 1: Number of Injuries per 1,000 hours' exposure

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

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 Spain, the Netherlands and Norway.[5] For purposes of consistency, all players used the same boots with rounded studs (Adidas Copa Mondial). The study focused on player-surface interaction and player-kicking dynamics using 500Hz high-speed video analysis. During the player-surface interaction a 'single-cut' move (see Photo 9) was analysed in terms of turning time, exit speed and slip pattern.

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

[3] Fact Sheet: Crumb-Rubber Infilled Synthetic Turf Athletic Fields (2008) (NYS DOH Factsheet)
[4] Ekstrand, J., Timpka, T., Haegelund, M.; British Journal of Sports Medicine; 40; 975-980; 2006

[5] Nokes, L.; FIFA Study into Player-Surface Interaction on Natural Turf and Football Turf; 2010

standing foot (#4) as well as the upper body positioning (#5) were analyzed. As performance measures, heart rate, blood lactate levels and movement analysis of the players were used.

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

Photo 9: Single Cut Move

2.2.2 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[6]. 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.

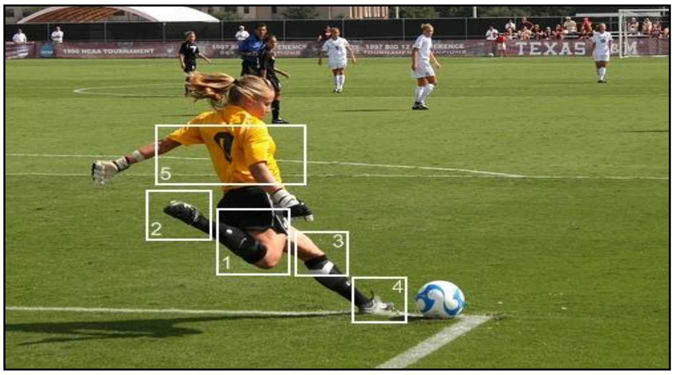


Photo 10: Kicking Dynamics

2.2.3 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.

Table 2: American Football Injuries (Surveillance Program 2004-2009)

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

A five-year study of American high schools[7] 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 rates of injury on artificial grass compared to natural grass. Similar findings were concluded by Hershman et al[8] 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

[6] Fuller, C., Clarke, L., Molloy, M.; Journal of Sports Sciences; Vol 28; Issue 5; 2010
[7] Meyer, M., Barnhill, B.; The American Journal of Sports Medicine; Vol 32; No. 7
[8] 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

NFL does NOT have the comprehensive play and performance standards that Soccer, Rugby or AFL do.

Table 3: American High-School Football Injuries

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 %

2.2.4 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 at comparing 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 the 2004 throughout the 2007 season. An injury was registered if the player was unable to 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. Individual exposure, injuries (time loss) and injury severity were recorded by the team of medical staff. 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 youth 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.

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

Photo 11: ELS Hall AFL/Soccer field with cork infill (Ryde City Council and Turf One installation)

One of the key safety considerations is the potential for head injuries from contact with a synthetic surface, which have 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.

2.3 Summary of Findings

Of the various independent studies[9] [10] [11] [12] 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 ability of the studies to detect differences in the injury rates was limited by the small number of injuries reported, the studies 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.

One of the key safety concerns that have been expressed by sport organisations is the potential for head injuries from contact with a synthetic surface. This concern is assessed by determining the ability of the surfaces to absorb impact using one of two test methods and provides the acceptable level of playing surface for specific sports. By comparison, a recent study of community and stadium natural surface fields in Sydney[13] 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)[14] 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

[9] Ekstrand J, Nigg B. Surface-related injuries in soccer. Sports Medicine 1989; 8:56-62.
[10] Arnason A, Gudmundsson A, Dahl H. Soccer injuries in Iceland. Scandinavian Journal of Medicine & Science in Sport 1996; 6:40-45.
[11] Stanitski CL, McMaster JH, Ferguson RJ. Synthetic turf and grass: A comparative study. Am J Sports Med 1974;2(1):22-26.
[12] Engebretsen L. Fotballskader og kunstgress. Tidsskrift for den Norske lægeforening 1987;107(26):2215
[13] UST study of NSW community natural grass standards (2011) by Acousto Scan
[14] FIFA Medal Assessment and Research Centre (2006)

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 there was no evidence of greater injury risk when playing soccer on artificial turf when compared with natural turf in the Swedish Premier League. The researchers did report an increased incidence in 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.

3 Surface Playability

3.1 Playability Studies Commissioned by International Sports Federations

3.1.1 FIFA – 2006

Probably the most comprehensive studies on playability of any sport comparing artificial surfaces versus natural grass have been commissioned by FIFA. In 2006, FIFA commissioned UK-based Prozone to analyse data from UEFA Cup matches played on both surfaces using a video-based performance analysis system[15]. The aim of the study was to analyse the potential impact that artificial turf may have on the pattern of a game and therefore performance and playability[16]. UEFA cup matches between Red Bull Salzburg and Blackburn Rovers were analysed using the Prozone Match Viewer system.

The analysis yielded that games played on the artificial surface at Red Bull Salzburg and the natural grass surface at Blackburn Rovers showed no significant differences in terms of performance and playability. The number of total passes played was very similar (703 on artificial turf versus 720 on natural grass) with a success rate of more than 80 percent passes completed on both surfaces. In addition, the number of tackles, interceptions, clearances, and the shooting accuracy were similar on both surfaces.

Table 4: Tactical Events Red Bull Salzburg vs. Blackburn Rovers

	Artificial Turf			Natural Turf		
Event	Red Bull	Rovers	Total	Total	Rovers	Red Bull
Total Passes	336	367	703	720	405	315
Completion	78 %	81 %	80 %	83 %	85 %	81 %
Tackles	21	23	44	43	17	26
Interceptions	127	113	240	233	126	107
Clearances	16	33	49	44	19	25
Shooting Accuracy	39 %	50 %	43 %	43 %	43 %	44 %

Similar technical studies have been extended by FIFA to cover Champions League, Dutch Football, the U20's World Cup and the Russian League. The five Studies show similarities between games played on artificial turf and natural grass. To eliminate a potential home-team bias, only the events for the away team were included in these subsequent studies.

Table 5: FIFA 5-Study Technical Overview

Event	Artificial Turf	Natural Grass
Passes	314	313
Passes completed	78 %	80 %
Passes forward	145	148
Balls received	351	353
Headers	64	64
Interceptions	125	118
Tackles	30	28
Crosses	12	13
Shots	14	13

3.1.2 Dutch Professional Coaches Survey

The European Synthetic Turf Organization (ESTO) commissioned a survey of members of the Dutch Professional Coaches Association. Even though natural turf in excellent condition remains the preference, the responses given were positive towards artificial playing surfaces.

Table 6: Survey of Dutch Professional Coaches Association

Question	Yes	No
Are players able to develop better technical skills by training on synthetic turf?	62 %	38 %
Longer term, will players' techniques be better developed by playing and training on synthetic turf?	57 %	43 %
Does training and playing on synthetic turf improve skill acquisition amongst players?	69 %	30 %
Would you like your team to play passing football, and if yes, is this easier to implement on an artificial pitch?	71 %	29 %
Do you see synthetic turf as being the future of the game?	64 %	36 %

[15] Di Salvo, V., Collins, A., McNeil, B., Cardinale, M.; International Journal of Performance Analysis in Sport; 6; 108-119, (2006)

[16] FIFA Technical Study with Prozone, (2006)

3.1.3 Study commissioned by Rugby Union

When reviewing the artificial turf specification and in particular the pile height requirement of World Rugby Regulation 22, (Formally IRB) commissioned biomechanical studies of the rugby scrum. During machine scrumming, scrum engagement, techniques for effective and safe scrumming and injury risks were reviewed. The study concluded that scrumming on artificial turf is safe and similar to natural grass and as a result the minimum pile height requirement for artificial turf could be lowered from the original 65mm down to 60mm[17].

Photo 12: Blackman Park, Lane Cove - allowing Rugby, Football, Cricket and AFL to be played

3.1.4 Study commissioned by Australian Rules Football

Due to the limited number of facilities with artificial playing surfaces, there is currently no detailed study regarding playability available for AFL activities. It should be noted that a study conducted by the University of Ballarat[18] was utilised to assist in the development of standards for the use of artificial turf for Australian Football and Cricket. The AFL/Cricket Australia standards were reviewed in 2017 and reissued with some minor improvements in 2018.

4 Environmental Considerations

4.1 Introduction

The key concerns around the environmental impact of installing synthetic sports surfaces are based around the communities' desire for the generational protection and health of their parklands and waterways.

4.2 Safety and the Impact on the Environment

There has been significant research globally on the impact of recycled SBR on local ecosystems. These research projects[19] [20] including those representing the California Environmental Protection Agency, the Norwegian Institute of Public Health, the French National Institute of Environment and Risk, and Auckland Council, all have similar conclusions.

The conclusions are best summarised by the Swiss Study[21] by the Ministry of Environment, Traffic, Energy and Communications. The study was on the Environmental Compatibility of Synthetic Sports Surfaces which explored the secretion of synthetic surfaces from disintegration by UV radiation, mechanical destruction by abrasion, and diffusion of ingredients and washing off by rainwater.

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

[17] IRB Regulation 22, Artificial Rugby Turf Performance Specification, One Turf Technical Manual, (2012)
[18] Twomey, D, Otago, L., Saunders, N.; Development of Standards for the Use of Artificial Turf for Australian Football and Cricket; University of Ballarat; (2007)
[19] Humphrey, C., & Katz, L., (2000). Water-Quality effects of tire shreds placed above the water table: Five-year field study. Transportation Research Record: Journal of the Transportation Research Board, 1714, 18-24. DOI: http://dx.doi.org/10.3141/1714-03http://dx.doi.org/10.3141/1714-03
[20] Hofstra, U. (March, 2009). Zinc in drainage water under artificial turf fields with SBR. Summary ITRON Report. http://c.ymcdn.com/sites/syntheticturfcouncil.site-ym.com/resource/resmgr/Docs/Zinc_in_Drainage_Water_-_200.pdf
[21] 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.

which were all lower than the required European safety levels.

4.3 Heavy Metals in the Infill or Yarn

Historically Lead Chromate was used for pigment colouring in yarn, and after research was conducted in 2008 the use of Lead Chromate as a pigment for the grass was stopped in 2009[22] for all sports turf on a voluntary basis by all the major manufacturers.

The use of heavy metals is not common in the infill, although some cheaper yarns or infills may use lead chlorate as colouring.

Photo 13: Swiss Study collecting rainwater through various synthetic sports surface systems

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.

Synthetic systems purchased, should therefore meet these standards. An alternative standard, European Standard 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). In the US, the equivalent is the ASTM F3188 – 16:

Both the European and US alternative standards measures the possible heavy metal migration of material that may be hazardous if ingested.

4.4 Impact on Carbon Sequestration

The basic principles of carbon sequestration is simple; plants, grass and trees through photosynthesis convert Carbon Dioxide from the environment into Oxygen. The "Carbon" is initially then 'stored' in the plant as sugars and then they convert to Carbon and normally are stored in the plant (depending on size) or more likely into the soil. The carbon is then transferred into the soil as a sink, or what is known as a carbon sink.

There is significant confusion as to the level of opportunity that grass has in creating a carbon sink, as there are a number of variables to consider which have not been clarified in the research reports. These variables include grass type; the heat in the area, which impacts on the level of oxygen created; whether the grass has had time to convert the sugars to carbon in the roots of the soil before being cut, which then releases the carbon back into the environment; the soil type or sand depending upon the level of carbon can be held in the growing medium (soil or sand).

Growing forests produce a net gain of oxygen because they store carbon in wood in the trees themselves. Whereas grass stores carbon in the form of sugars, starches and cellulose. However, the important point is that natural grass is often cut - particularly on a playing field - which releases the carbon as the grass breaks down and rots, plus the reduction in blade length reduces the amount of absorption. This is compared with trees, which drop leaves while the wood

[22] STC: Lead Chromate in Synthetic Turf, Though Safe for kids per CPSC, was discontinued in 2009 (20/3/2015 - STC Website)

components are more likely to stay intact. It should be noted that plants continue to release carbon dioxide and water into the atmosphere through the process of cellular respiration. Therefore, the net production oxygen in grass is very small in comparison to trees and bushes.

Greenhouse gas emissions from natural turf production and maintenance is greater than the amount of carbon that can be stored in the grass. This study found that athletic sports fields do not store as much carbon as ornamental grass due to soil disruption by tilling and resodding. However, this methodology of research has since been reviewed and modified to suggest that it is a net sequester of carbon dioxide. Essentially, the difference is to do with the ability to counter balance emissions through the carbon sink[23].

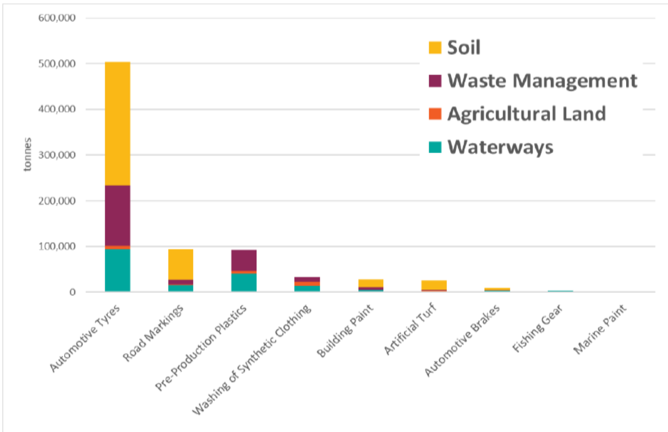
In 2010, the BASF Corporation Eco-Efficiency Analysis[24] compared synthetic fields with professionally installed and maintained grass fields. It concluded that the use of synthetics can lower consumption of energy and raw materials and the generation of solid waste, depending on field usage. BASF also found that the average life cycle over 20 years of natural grass fields are 15 per cent higher than the synthetic alternatives.

From the research there is not imperial evidence to the actual differences due to different grass types, the level of play and the amount of maintenance on the field including grass cutting. The counter argument is the reduced level of maintenance and use of fossil fuels for maintenance of natural grass. Further work is needed in this area.

4.5 Micro-plastics

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

The European Commission received a report (DG Environment) in February 2018[25] which explores this in detail and provides the most extensive study to date. It specifically explores synthetic sports surfaces as part of a broader sector of micro-plastics. Synthetic fields are "…a relatively small source…"[26] as shown in the table below.



Source: Eunomia modelling

Figure 1: Sources of microplastics found in Europe

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

[23] TurfGrass Producers International, 2010. "Natural Grass and Artificial Turf: Separating Myths and Facts' published by Turf Grass Resource Centre, www.TurfResourceCentre.org viewed August 2011.

[24] Submission for Verification of Eco-efficiency Analysis Under NSF Protocol P352, Part B Synthetic Turf, Eco-Efficiency Analysis Final Report – August 2010. BASF Corporation, NJ.

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

[26] Section E1.1. Estimating Microplastics

The report suggests that the level of infill that needs topping up over a year would equate to 1-4% of the total infill installed initially. Although some of that is caused from compression other is lost to the environment. From assuming that on a typical mid-ranged football field (7,500m^2) with a typical infill of 10kg per metre^2 this would equate to 75 tonnes, with a range of 0.8 tonnes to 3 tonnes per annum. It is envisaged that the 'loss' of infill can be seen to migrate as follows:

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

To counter this Smart Connection Consultancy, recommend the following design and management changes to reduce the probability of increased micro-plastics from a synthetic field:

i.) Explore tape systems or a mix of monofilament and tape yarn system that encapsulates the infill, reduces ball splash and infill migration across and off the field

Photo 14: Containment strategy example 1: Curb to reduce the infill being dispersed outside of the field of play

ii.) Design a plinth for the fence line to fit into which is approximately 100-150mm above the pile height to reduce the probability of the infill migrating from the field of play

iii.) At pedestrian gates ensure that there is a brush carpet that is large enough (two strides) for people who leave the field of play to capture infill from boots etc.

iv.) Vehicle gates are also fitted with a grated system to capture infill from the field of play from the vehicle tyres

Photo 15: Containment strategy example 2: Pedestrian gates mates that capture the infill

v.) The drains should have filters in to capture any infill before it progresses to the storm water outlets

Photo 16: Containment strategy example 3: Drains fitted with filter

Regular maintenance of the field of play and the areas surrounding the field to reduce the level of migration off the field of play.

4.6 Conclusion

As long as the design of the field will ensure that quality systems are installed with good drainage systems there is every confidence that the infrastructure will have no negative impact on the community. The quality of the yarn and infill should be paramount, and the specified standards are needed to ensure that heavy metals are within the acceptable limits.

5 Health Concerns for Players and Users

5.1 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.

5.2 The Purpose and Types of Infill

A significant amount of the concern is centred on infill and various types. The infill within the 3G long pile grass synthetic turf system aims to provide a consistency between the ball, player and surface interaction that allows the synthetic system to perform to the required standards.

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

- Type of infill for the surface;
- Depth and height of the infill compared to the yarn; and
- Amount of infill.

5.2.1 Purpose of Infill

The infill is needed to assist the performance of the whole grass system, which ensures that the yarn plays a similar role as the soil in natural grass fields.

The infill aims to hold the yarn upright, provides a degree of shock absorption and allows the football boot studs to penetrate the yarn, sitting on the top of the performance infill, similar to natural grass and its growing medium.

5.2.2 Type of Synthetic Grass Systems

The different types of grass surfaces and infill considerations commonly categorised are:

1) Unfilled

Although the first nylon pitches in the 1960's were unfilled, today the pitch systems are far more sophisticated. Water is used; predominantly for hockey's premium standard - global. Water is applied through an irrigation system immediately prior to play, increasing the speed of the ball interaction with the surface. Technology is now looking for unfilled fields that have similar playing conditions as traditional water based pitches. However, many are sand-dressed. It is unlikely that for any of the football codes that unfilled systems would be used from both a performance and safety perspective.

2) Sand-Dressed

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

Photo 17: Example of a mixed profile of sand and rubber infill

3) Filled Fields

The aim of the filling is to replicate the growing medium in a natural pitch where the grass/synthetic yarn is held upright. The filling can be compiled from rubber, plastics, sand or organic infills. The amount of fill is normally determined by the manufacturer, when they consider the length of grass yarn, the performance outcomes, the shock pad and purpose of the field.

For instance, rugby union is to be at least 60mm yarn and an expected 40mm of infill. In Australia we specify that the minimum length for a football (soccer) field should be 50mm – which means that the infill would be approximately 30-35mm depending on the manufacturer. We have found that anything less than a 50mm yarn would suffer in the public domain from the infill being "kicked out" in the high wear areas.

5.2.3 Type of Infill

Depending on the manufacturers' systems, there will always be a choice for the purchaser depending upon the affordability and philosophical standing. Some local governments do not like the idea of using recycled types (SBR) due to community perceptions, although these perceptions have been proved unfounded by independent research. In essence, there are five types of infill, offering slightly different options, but with the same outcome, namely the performance standards stipulated by the sport(s). The key options are:

1) Crumbed Rubber (Recycled SBR)

Recycled SBR from car and truck tyres is the most popular infill in the Asia Pacific region, historically due to the cost-effective price point. Derived from recycled truck and car tyres that are ground up and recycled. The recycled rubber is metal free, and according to the United States Synthetic Turf Council's (STC) Guidelines, which represents the manufacturers and suppliers of synthetic sports turf in the USA, the crumb rubber infill should not contain liberated fibre in the amount that exceeds 0.01 percent of total weight of crumbed rubber.

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

The black rubber has been, according to the UK's Sport and Play Construction Association's (SAPCA) independent Consultant polymer chemist, Dr Bryon Willoughby, "selected to offer optimum performance in a demanding application which requires strength, fatigue and abrasion resistance".[27]

The ambient and cryogenically shredded SBR rubber can be coated with light coloured obscurants, sealers or anti-microbial substance if required. This approach provides a great aesthetic appeal, but the additional cost may not be justifiable for many Local Government Authorities (LGA's). Many manufacturers find that over time these coatings wear off and so have migrated from this technological solution.

The recycled SBR infill is the most economically viable proposition compared to a premium virgin rubber or organic infill, adding another $100,000 to a typical rectangular football field. Over the past two years in Australia, there has been a move for purchasers to invest more in the infill and select a virgin rubber or organic option.

2) Sands

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

[27] Twenty Questions on Rubber Granulate: SAPCA: 2007 – Dr Bryon Willoughby - http://www.murfittsindustries.com/wp-content/uploads/New-copy-of-20-questions.pdf

Photo 18: Silica Sand used on a playing field in Melbourne (Source: HG Sports Turf)

It can be used by itself, or in combination with rubber or organic infills. It is important that the Silica sand has a high purity of grains of more than 90 percent as recommended by the STC. This sand can also be coated with either a firm or flexible coating which is normally elastomeric or acrylic, forming a coating that allows for different sizes depending on the system's needs. It is normal for these coatings over time to wear off during the life of the carpet.

3) TP Family (Thermo Plastics)

This is a relatively new material, which is heated and compressed into grains or various shapes for performance. Once cooled, it retains its new shape, is elastic in nature and can also be recycled. It has a long life and shows durability according to various manufacturers.

This 'virgin plastic' infill is non-toxic, chemically stable, and the higher quality resits fading and is long lasting. It can also provide the benefit of being recycled at the end of the "grasses life". Providing a wide range of colours, TPE or similar sister products such as TPV, EVA etc., which are often used in playgrounds, athletic tracks and for field infills. It has elastic properties; uniform shape and its virgin rubber and filling provide a high-performance infill option.

4) EPDM Infill (Ethylene Propylene Diene Monomer)

This type of infill is produced from a polymer recovered from three monomers: Ethylene, Propylene and Diene. Common colours are red, green and brown and it is odourless and offers consistent quality. It is often used for playgrounds, on athletic tracks as well as for synthetic field infill.

There has been some concern that cheaper made EPDM and Thermo Plastic products may be more likely to lose their integrity in fields at higher temperatures, which would compromise the performance of the synthetic system.

Photo 19: EPDM infill being used at Chatswood High School (Source: Willoughby City Council)

5) Organic Infill

There has been experimentation using organic or natural infill's by a small number of companies. The basic offerings are:

i. Cork infill – allowing cork to be stripped from trees (every nine years) then used as an infill. The marketing rationale from a key supplier states that it has 12 million air cells per cubic cm. A few fields are being installed in Australia currently and much interest is being shown on how they perform in the hot dry weather in Australia.

ii. Cork/organic infill – allowing less cork with other plant/organic compounds such as coconut husk etc.

There seems to be some concerns about both of these options due to:

- The plant/organic compound breaking down quickly from the typical level of use that Australian LGA's programme their pitches (e.g. 60+ hours);

- Additional cost of maintenance due to compaction and possible organic growth with natural substance;
- Additional cost of continual replacement and top-up, due to breaking down of natural products; and
- This option, in Australia's climate also needs to be watered regularly as it will turn to dust with the breakdown of the natural fibres, which may indicate that a hybrid stabilised turf/grass solution should also be considered.

Photo 20: Organic Infill – Cork being used at ELS Hall by Turf One, Ryde (Source: Smart Connection Consultancy)

5.2.4 Amount of Infill

The amount of infill used in a field will depend on how the manufactured systems work and against what sports performance standards are chosen. The mix of silica sand and infill is being used with a yarn of 50mm allowing 15-20mm for the fibre to be left above the infill.

The import aspects to consider are the structure of infill or square meter and the thickness of the yarn fibres to allow the yarn to stay upright.

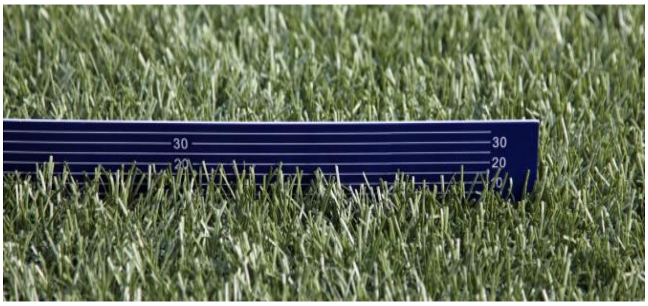


Photo 21: EPDM (Virgin Rubber) Infill allowing around 20mm of grass above the infill

5.3 Virgin Rubber and Recycled SBR Rubber

5.3.1 Chemical Make-up of Rubber

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

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

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

For vehicle tyres, there are also other compounds added to increase the durability for the needs on the roads. This provides a significant added benefit to the crumb rubber in synthetic fields as the infill is extremely durable.

Although Styrene and Butadiene are identified carcinogens in their natural state, when combined they, with other chemicals, form polymers which result in these chemicals being locked within the polymer chain. The latest independent research from the Dutch Government (2016) states *"…the effect of these substances on human health is virtually negligible."* [28]

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

Interestingly both Styrene and Butadiene are also identified by the Gum Base Ingredients Approved for Use by the U.S. Food and Drug Administration (2016), as two substances are also combined in Chewing Gum[29] that is sold to millions of people globally each day.

Photo 22: Australia's Institute of Sport has embraced the sports turf technology and invested in EPDM infill as opposed to recycled SBR

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

5.3.2 Research around recycled SBR infill health impacts

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

Photo 23: SBR Recycled Rubber granular infill for a synthetic surface in Northbridge, NSW by Turf One (Source: Willoughby City Council)

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

The STC reviewed related research on inhalation toxicity (34 articles); ingestion toxicity (45 articles); dermal toxicity (27 articles); and links to cancer (11 articles). The findings were STC '*unequivocally failed to find any link between recycled rubber infill and cancer or any other human health risk'*.[30]

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

In March 2016, the STC issued a statement on the 'Available Recycled Rubber Research'[31]. This was in

t/Newsmessages/2016/Playing_sports_on_synthetic_turf_fields_with_rubber_granulate_is_safe

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

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

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

response to the increased public interest in potential health effects of recycled rubber in sports fields.

Other independent European research in 2013[32] involved a Tier 2 environmental – sanitary risk analysis, on five synthetic sports turf fields in Italy, Turin. It explored the exposure to adults and children from the projected three opportunities of exposure to any harmful components of the recycled rubber: direct contact; rainwater soaking; and inhalation of dust and gases. The results of the research for all exposure opportunities, was based on the cumulative risk proved to be lower than one in a million.

Photo 24: Coated Sand being used in synthetic sports fields

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

For adults and children, the conclusion of the report states: *"the inhalation of atmospheric dusts and gases from vehicular traffic gave risk values of one order of magnitude higher than those due to playing soccer on an artificial field".*[33]

Additional independent research conducted between 2009-2013 have found similar results[34 35 36].

- Over a 12-year period, Simon[37] reviewed impacts of crumb rubber in artificial turf. Results showed: "*ingestion of a significant quality of type shared did not elevate a child's risk of developing cancer, relative to the overall cancer rates of the population[38]".*
- *Cardno Chemrisk found: "regular exposure (e.g. regular play on ground rubber infilled fields) to ground rubber for the length of one's childhood does not increase risk of cancer above levels considered by the state of California to be de minimus (i.e. lifetime excess cancer risk of 1 in a million")[39].*

5.3.3 Surety of what chemicals and components are in the recycled rubber

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

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

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

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

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

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

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

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

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

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

vehicle tyres. The US has a voluntary code[40] ASTM D5603 – 01 (2015) which focused on rubber compound materials and Europe has very strict compulsory legislation[41] which has placed restrictions on the use of substances that may be cacogenic in their raw form in any product being brought into Europe for sale. This is commonly known as the REACH Regulations, which was introduced in 2010. Unfortunately tyres before that cannot be verified.

Photo 25: Synthetic fields are being used for both full-side games and the intensity of training on small areas that natural turf could not accommodate

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

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

Presently, Australia does not have a similar code.

5.3.4 Global Investigations on Infills

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

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

"adjusting the standard for rubber granulate to one that is closer to the standard applicable to consumer products. Rubber granulate is required to satisfy the legal requirements for 'mixtures'. The standard for consumer products is far more stringent: it allows far lower quantities of PAHs (10 to 100 times lower) compared with the standard for mixtures. The quantity of PAH in rubber granulate is slightly higher than the standard for consumer products." [42]

The European Chemicals Agency (ECHA) published their research to determine a suitable standard for rubber granules February 2017 [43] which stated:

Photo 26: Synthetic football field in NSW used by a university, schools and local community

"*ECHA has evaluated the risk of substances in recycled rubber that is used on artificial sports pitches. Based on*

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

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

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

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

the evidence, ECHA has concluded that the concern for players on these pitches, including children, and for workers who install and maintain them is very low."

The US Federal government has requested their Environmental Protection Agency (EPA), the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (ATSDR), and the U.S. Consumer Product Safety Commission (CPSC), to investigate key community concerns around environmental and human health.[44]

The video explaining the research can be seen on https://www.youtube.com/watch?v=O5Gk_bP39LQ. The investigation is transparent and has an informative website (http://www.epa.gov/TireCrumb), and the report is due late 2020. The government's website refers to further research completed in the USA by their Environmental Protection Agency[45].

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

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

In Europe, there are comprehensive regulations known as Registration, Evaluation, Authorisation and restriction of Chemicals (***REACH***) addressing the chemical industry and anything made from chemicals.

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

In the European Synthetic Turf Organisation (ESTO) Crumb Rubber (SBR) infill FAQ Sheet[46], it states that REACH:

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

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

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

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

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

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

In February 2017 ECHA published their findings:

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

Photo 27: Rugby Union field at Randwick City Council (NSW)

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

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

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

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

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

In its assessment, RIVM looks at the human health risk for professional football players (including goalkeepers), children playing on the pitches and on playgrounds, as well as workers installing and maintaining the pitches and playgrounds.

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

The proposal of the Netherlands, available on ECHA's website[47], outlines that the suggested reduction in the concentration limit would:

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

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

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

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

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

5.3.5 Industry safeguards for virgin rubber infills?

Exploring key safeguards for rubber infills the following should be considered:

- ***For Heavy Metal Concerns*** – Ensure the infills have been tested against EN 71.3 (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). In the US, an equivalent standard for heavy metals is the ASTM F3188 – 16. In addition, the European Standard DIN 1803.5 parts 6 & 7 / ESM105 are advised. These tests are harder to achieve in the recycled rubber as the source is not always known;

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

- ***For PAH Concerns* –** ensure that the sourced tyres have been certified to the European REACH regulation Annex XVII. This can also be used for the virgin rubber infills as well; and
- ***For UV Concerns* –** the infill should be tested using the Extended Test Method for FIFA Quality Manual (2015) or the AFL Community Facility Manual for UV test of 5,000 hours. The UV testing should be linked to the level of UV for the region. Over the next two years Smart Connection Consultancy will be encouraging all suppliers to Australia to have UV tests of 10,000 hours and a tenacity test of ≥75%.

5.3.6 Regulations addressing what can be used as infill

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

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

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

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

5.4 Specific Health Concerns

5.4.1 Perception of Goalies in America contracting cancer

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

Due to heightened public concern and the large number of people on the list, public health officials at the Washington State Department of Health and researchers from the University of Washington School of Public Health formed a project team to investigate following the Department of Health Cluster Guidelines and published their findings in April 2017[48].

The overall purpose of the investigation was to explore whether the information from Coach Griffin's list

[48] Investigation of Reported Cancer among soccer Players in Washington State (Washington State Dept. Health: 2017) http://www.doh.wa.gov/Portals/1/Documents/Pubs/210-091.pdf

warranted further public health response. The main goals of the investigation were to:

1) Compare the number of cancers among soccer players on the coach's list to the number that would be expected if rates of cancer among soccer players were the same as rates among all Washington residents of the same ages.

2) Describe individuals reported by the coach in terms of their demographics, factors related to cancer, and history of playing soccer and other sports.

The findings identified the different cancers that the players had contracted and compared that number against the average (standard deviation of 95%) and found that the occurrence rate was within the range expected for that size of population. This is shown in Table 1 below.

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

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

The overall conclusion from the WSDOH report stated:

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

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

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

5.4.2 Link with rubber infills and Leukaemia or other cancers

According to recent research in 2015 and 2016 and in response to significant community concern during 2016 in the Netherlands the Dutch Governments' research results[49] states:

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

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

Photo 28: Multi-sports field at St Kevin's College, Toorak (Source: Tuff Group)

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

In response to community interest in the USA leading toxicologist Dr Laura Green, pragmatically considered and addressed a series of concerns raised by a Principal of Jonesport Elementary School in Main (USA). This response is potentially the most detailed explanation of the perceived links of recycled SBR tyres to cancer, found by the author of this FAQ Fact Sheet[50]. In brief her conclusion states:

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

In 2006, the Norwegian Institute of Public Health published their report,[51] the investigators noted:

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

Photo 29: Multi-sports field (Moore Park, NSW)

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

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

6 Heat and UV Issues in Australia

6.1 Heat consideration

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.

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 each 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 plyers, 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 polity 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[52].

Reported surface-to-air temperature ratios are approximately one for both natural turf and artificial turf under overcast conditions[53]. 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).

Various studies are available that look at heating of artificial turf systems and natural grass in warm weather. TURI, Nov 2016 (US focus, Physical and biological hazard) reviewed a number of studies looking at the heat of artificial turf systems. Increased temperatures of 35-42F (average) and 102F (peak) have been reported at the surface. Peak surface temperature of 156F (69°C) was reported for the artificial grass fibers itself (polyethylene and polypropylene) and 200F (93°C) on a 98F (37°C) day for artificial turf. The highest surface temperature observed for natural grass was 60F (16°C).

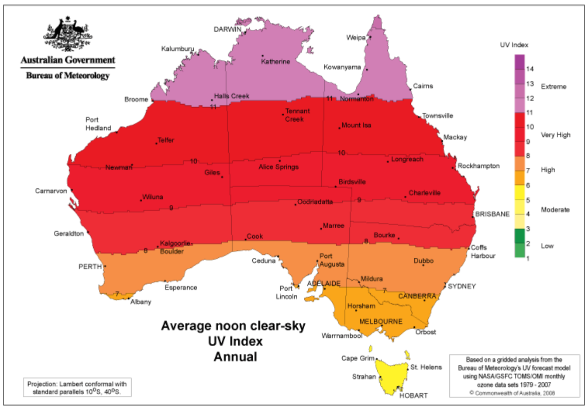


Figure 2: Average Solar Ultraviolet (UV) Index (source: BoM)

Synthetic turf reaches higher temperatures than natural grass, regardless of the type of infill material used (Turi, 2016). Studies however differ in whether types of infill used affect the heating effect of artificial turf. Irrigation is said to be able to reduce the temperature increase on artificial turf, however, this effect was not maintained for the length of an average sport event. Heating of the surface is said to lead to heat stress and skin injuries (blisters and burned skin). (TURI, Nov 2016). Jim, 2017 (Asian study) shows that on a sunny day artificial turf materials heat to over 70°C, attained at noontime and maintained in the early afternoon. The retained heat is in turn transferred to near-ground air by conduction and

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

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

convection to raise air temperature to above 40°C. Their joint impact on athletes can induce heat stress to exceed the safety threshold and harm their health and performance. It is important to therefore evoke the sports own heat policy at these points.

Currently, technologically advanced cool climate synthetic products which claim to reduce surface temperature of synthetic turf are available. Petrass et al., 2015 (Australia) compared surface temperatures of typical third-generation synthetic turf with a cool climate product and to natural grass. Mean surface temperatures were significantly lower (40.79°C) on a cool climate pitch compared to a typical third-generation pitch (44.91°C), although both synthetic pitches were considerably warmer than natural grass at the same venue (by 12.46°C at the metropolitan venue and 22.15°C at the regional venue). Villacañas et al., 2017 says that improvements in third generation of artificial turf are still unable to prevent the turf from reaching higher temperatures than natural grass.

In this study, the results of the temperature measurements obtained from the fields studied in Connecticut indicate that solar heating of the materials used in the construction of synthetic turf playing surfaces does occur and is most pronounced in the polyethylene and polypropylene fibres.

Maximum temperatures of approximately 68.9°C were noted when the fields were exposed to direct sunlight for a prolonged period of time. Rapid cooling of the fibres was noted if the sunlight was interrupted or filtered by clouds. Significant cooling was also noted if water was applied to the synthetic fibres in quantities as low as one ounce per square foot. The elevated temperatures noted for the fibres generally resulted in an air temperature increase of less than five degrees, even during periods of calm to low winds.

The rise in temperature of the synthetic fibres was significantly greater than the rise in temperature noted for the crumb rubber. Although a maximum temperature of 68.9°C was noted for the fibres, a maximum temperature of only 38.3°C, or approximately 9 degrees greater than the observed ambient air temperature, was noted for the crumb rubber.

FIFA as the International Federation for Football has introduced a heat standard for be classifying the heat of synthetic surfaces, so that the consumer and purchaser can relate to the heat risk from a particular purchase.

There are heat categories (1-3) with half categories in between, namely 1.0; 1.5; 2.0; 2.5 and 3.0.

The heat issue is being considered by many of the synthetic grass manufacturers with a number of initiatives being promoted, including:

i. Yarn and cool grass technology

A number of synthetic yarn manufacturers are using specific polymers to offer cool grass technology that can (according to their marketing) reduce heat by up to 5 percent compared with traditional synthetic grass. The author is not convinced that this is making a huge difference that is material.

It seems that the turf systems that have some fibrillated tape that encapsulates the dark infill reduces the amount of UV radiation that is captured by the black SBR and therefor the surfaces remain slightly cooler.

ii. Water on grass

The has been discussion for a number of years as to the benefits of spraying the long pile grass fields with water to cool it down. The impact is normally immediate cooling, which lasts for 20 minutes on a warm day depending on ambient temperature and level of UV radiation. The water also evaporates quickly, and this causes very humid areas which is very dangerous to young people as the humidity mainly stays at around a 1m height above the surface. So, the consensus is not to embrace this short-term cooling strategy.

iii. Infill

There was a clear move from many infill suppliers to provide options that move away from the very cost effective black SBR (*Styrene-Butadiene-Rubber)*. The move to infill's such as coated SBR coated and/or cryogenically frozen infills, EPDM (*Ethylene-Propylene-Diene-Rubber)*, TPE (*Thermoplastic Elastomers*) and natural organic infills. The Penn State research project explored the heat issue and identified that the coolest to hottest types are listed as:

Surface temperatures of various infill after 1 hour under heat lamp

Infill	Surface Temperature (F)
Black Rubber	156.0 a†
Tan Rubber	153.4 a
Green Rubber	147.9 b
Ecofill	141.6 c
TPE	136.4 d

†Temperatures that do not share the same letter are significantly (statistically) different

High surface temperatures can lead to heat stress related conditions, especially in children. In hot climates artificial surfaces are often watered to reduce the surface temperature; however, this can increase the humidity, which is not desirable for participants. A heat policy (e.g. restrict play when surface temperatures reach a certain level) may be required in hot climates.

There is some technology available where a wetting agent is used to capture the water (rain etc.) and then slowly releases it into the system over a week. The wetting agent can be applied post installation but needs to be 'charged' weekly to be effective in hot weather. The supplier of this has indicated that this will reduce the heat by 25%. This has not been verified at all and then are doing this currently. The challenge is that this wetting agent needs to be 'charged' every 4-7 days and in the public parks this may be a challenge. In addition, the agent has a warrantee of four years and is approximately \$9-\$10pm^2 which equates on a typical AFL field (18,000m^2) would add a further \$180,000 for each application.

Organic solutions have been introduced into Australia over the past 5-6 years and we have seen field with the following options:

- Cork and coconut husk as the early option – the coconut husk has a tendency to break down and needs to be kept damp to maximise its performance. In Sydney (APIA Stadium) this is accepted by the Football (Soccer) fraternity as being one of the best fields. The coconut husk does breakdown significantly and needs continual top-up and regular spraying with water.

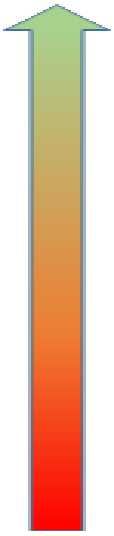
- Cork infill – in the recent 2 years we have seen a manufacturer introduce organic infills and when damp they are very well received by all players as they embrace the water. If there is a larger amount of hot and dry days over a period, say 3-4 weeks the fields are being monitored to see if there are any adverse effects, such as harshness and breakdown of the cork.

- Wetting Agent where the wetting agent collects the water, as explained previously) and has been applied in Brisbane to University of Queensland and is being independently tested in Australia currently by the supplier.

Hybrid Surfaces – this is being explored by many local governments and the City of Casey (Vic) has just installed the first two community sports fields and with the additional durability of adding 8-10% of synthetic fibre should increase the durability. That said is still cannot meet the hours that the synthetic sports surface technology can achieve.

Research from results to date:

- Natural Turf - irrigated
- Geo infills requiring watering
- Cork infills – subjected to watering
- Lightly coloured EPDM infill treated with a polymer coating & watering
- Cork infills – without watering
- Lightly coloured EPDM or TPE infills
- Black SBR treated with a polymer coating
- Coated SBR
- Black SBR



To mitigate these concerns, it is suggested that the following be considered in the design:

- Light colour infill and cool grass technology for the yarn
- Shade structures around for spectators
- Adopting the sports heat codes for the facilities of when the facilities are used
- Aligning water bubblers to pedestrian access gates allowing users to access cooler water while playing
- In Europe and the USA, a number of organic combinations including:
  - Cork and olive tree pips
  - Cork and TPE
  - Walnut husk
  - No infill
  - Composite

Civil Engineered Solutions

The engineered base according to some manufacturers can anecdotally provide some benefit, the suggestions that have been put forward include:

- An aggregate vertical draining base (which has up to 40% voids) can hold the water and then stays damp and if damp when the ambient temperature increases can offer some cooling by the moisture evaporating through the system
- Use of a drainage cell with large vertical channels that hold a little water can be used as above to a lesser extent
- The shockpad being kept damp in the same manner as above also offering the same benefit

6.2 High UV in Australia

Due to the intensity of UV over Australia, the infill and yarn is tested using the Extended Test Method. This has been adopted by the majority of International Federations to at least 5,000 hours as some infills have been found under the Australian heat and UV, to lose its performance properties.

The AFL introduced this UV standard in 2009 as part of its Quality Manual for synthetic turf being used for community Australian Rules Football fields[54]. FIFA has followed in recognising this level in the 2015 Quality Manual for the football turf performance standards[55]. There is a view that in Australia where the UV is strongest that these 5,000 hours should be a base level and we should be exploring the impact of the testing number being much higher. Further research is needed to ascertain that standard.

[54] AFL and Cricket Australia Handbook for Testing of Synthetic Turf (2013) page 21: http://www.aflvic.com.au/wp-content/uploads/2013/10/AFL-CA-Testing-Manual_September-2013.pdf

[55] FIFA Quality Program for Football Turf, Handbook of Requirements (Oct 2015) http://quality.fifa.com/globalassets/fqp-handbook-of-requirements-2015.pdf

Useful Contact Details:

- Smart Connection Consultancy

www.smartconnection.net.au

Global Peak Bodies for Synthetic Turf

- Synthetic Turf Council

www.syntheticturfcouncil.org

- European Synthetic Turf Organisation

www.theesto.com

- Sports and Play Industry Association (Aus)

www.sapia.org.au

- Sports and Play Contractors Association (UK)

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

International Sports Federation

- FIFA Quality Program for Football Turf

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

- World Rugby - Rugby Turf Program

http://playerwelfare.worldrugby.org/rugbyturf

- FIH Quality Program for Hockey Turf

http://www.fih.ch/inside-fih/fih-quality-programme-for-hockey-turf/

7 Conclusion

7.1 Summary of Research

To date, independent studies have shown there is limited health risk, if any, of playing on surfaces with recycled rubber (SBR).

The community may have a perception that as some tyres are made from chemicals that have been shown to cause cancer, that they or their children would be more susceptible to contracting cancer themselves. What is critical is exposure (skin contact, inhalation and ingestion etc.) and the potential dose someone may be exposed from.

The latest research from Washington State Department of Health (April 2017) stated in their research into the number of soccer players with cancer in Washington, USA: *"The available research suggests exposures from crumb rubber are very low and will not cause cancer among soccer players. The Washington State Department of Health recommends that people who enjoy soccer continue to play regardless of the type of field surface."*

In all other research listed throughout this Smart Guide there has been no health issue to field users, objectively proven to be linked to the SBR infill used in sports fields.

That said, by taking proactive steps, government, education, and sports purchasers of synthetic sports fields with infill have a number of options should be considered to ensure quality standards are achieved.

7.1 Specified Standards to Mitigate Risk

Smart Connection Consultancy when providing advice, continually research the latest global trends and research. Based on the findings our recommendations are updated accordingly. Presently the following advice regarding procuring synthetic field infills is provided.

1. Infill – request two options as part of the procurement process – one should be a recycled SBR, the other a non-recycled and premium infill. If resources allow, investing in a virgin rubber technology that has been tested to the latest European standards for 'Toy Ingestion' and PAH levels. Explore if organic infills are appropriate for the climate and use the field will have. Normally in 'open fields' they will not be appropriate.
2. If the recycled SBR is the most economic option, explore if the tyres have been sourced from a supplier that can demonstrate key health and safety processes around:
    a. Reduced heavy metals that may be in the tyres which have been tested against EN71.3 Table 2 Category III;
    b. UV standards are achieved; and
    c. PAH reduction to acceptable levels in the source tyres which have been tested against the REACH Annex XVII – Entry 28 regulations (20mg/kg) less than or equal to.

These options should assist alleviate this perceived concern from the community.

8 About 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 skills 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 FFA, the NRL, and the Australian Rugby Union for Synthetic Surfaces.

Field of Expertise

In collaboration with industry experts, we provide our clients with high level quality service that is offered for a very affordable investment.

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.

Our Services Include:

Feasibility and Funding Advice and Solutions

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

Masterplanning and Design Solutions

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

Procurement and Project Management Support

Over 20 years' experience in procurement and in collaboration with SportEng, we provide the detailed civil engineering hold points to ensure that every step of the installation meets the appropriate civil and performance standards.

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 (FFA, NRL, ARU, AFL (NSW/ACT), Golf Australia, ASC, Hockey ACT etc.)
- Local Governments – More than 100 local governments with fields worth over Aus $150 million, in most States/Territories.

"Over the last four years the relationship the City has built with Smart Connection Consultancy has become integral to the development of our public open space planning, most notably the Ellenbrook District Open Space, which includes four synthetic playing fields.

Smart Connection Consultancy has contributed in many ways including various studies, reports and research tours that we continue to use today. The work has been outstanding: on time, on budget and most importantly of a very high quality.

Martin has been very accommodating in its approach to our requirements and continues to go out of their way to help us where necessary – always going that extra mile."

Wayne Stuart, Facilities Planning Coordinator, Asset Management – City of Swan

SYNTHETIC SPORTS FIELD HEALTH CHECK

Review your field, understand risks and extend life expectancy

Australia's leading synthetic sports surface consultancy is now offering the **Smart 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 sports fields developed and installed in Australia in the past five years. We work closely with our clients to maximise their usage and life expectancy of their fields.

The **Smart 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; and
- ✓ Predicting life expectancy.

Assessment Report provided within 48 hours of 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.

SPORT INSPIRES A NATION

Synthetic & Hybrid Sport Surfaces Create Opportunities for The Next Generation

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