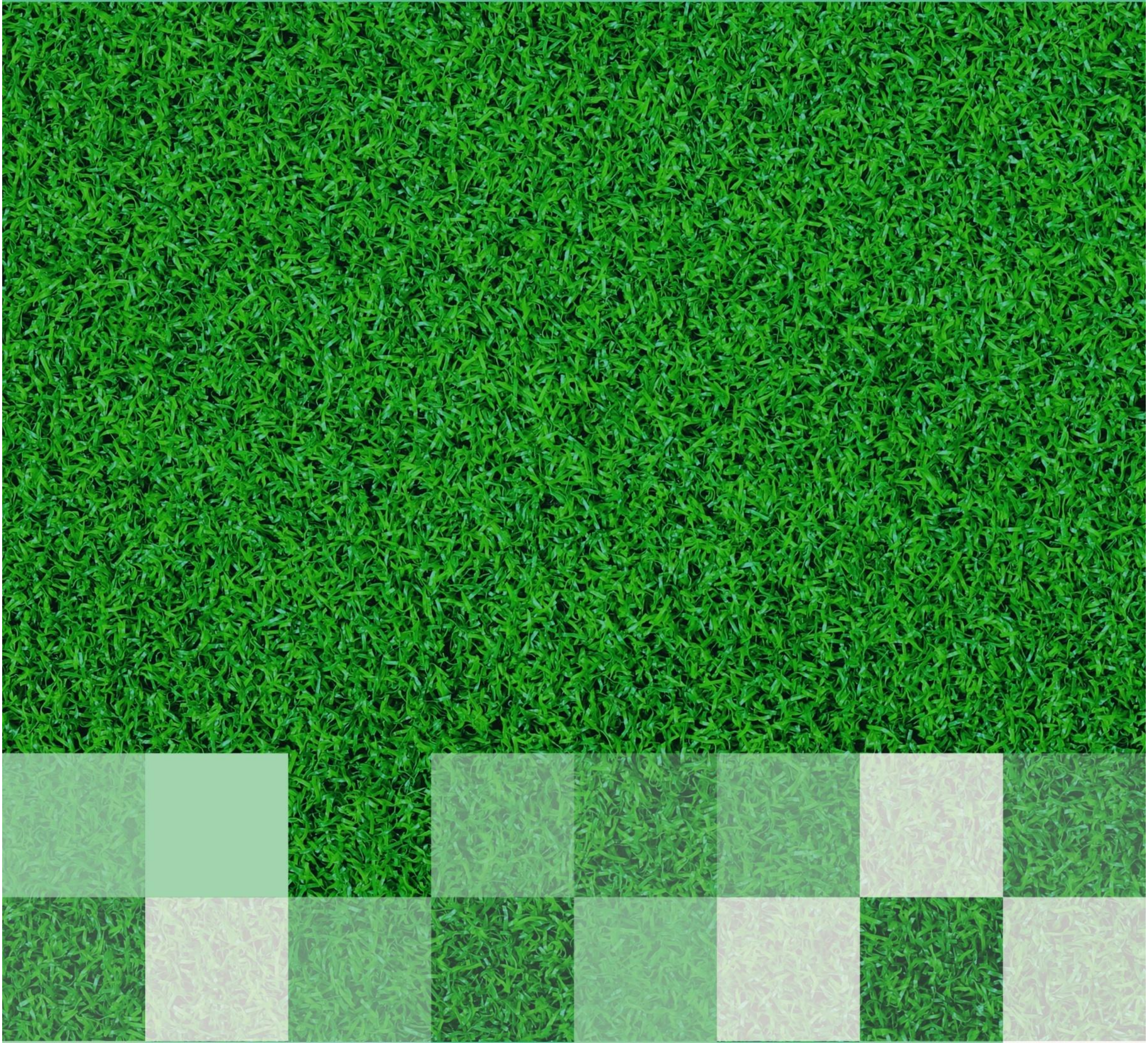


SALGRSN – GUIDE 3

SYNTHETIC SPORTS SURFACES

ENVIRONMENTAL SUSTAINABILITY OPPORTUNITIES

ACKNOWLEDGEMENTS

Acknowledgement of Country

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

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

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

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

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

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

Guidelines Structure

The SALGRSN Guidelines refers to a library of documents including:

Synthetic Sports Surfaces Guidelines for Decision Makers

Technical Guides

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

Toolbox

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

Quality Policy Template

UN's SDG Guidelines – For Synthetic Turf

Natural v Hybrid v Synthetic Surface infographic

Government of South Australia Office for Recreation, Sport and Racing
CITY OF ONKAPARINGA
PORT ADELAIDE ENFIELD
City of Charles Sturt
CAMPBELLTOWN CITY COUNCIL
CITY OF MITCHAM
Gawler

CONTENTS

1. Embracing Environmental Sustainability for Sports Surfaces

1.1 Introduction

In the face of rising urban populations, shrinking passive green spaces, and increasing participation in both traditional and informal sport, synthetic sports surfaces have emerged as a critical enabler for sustainable recreation infrastructure. Once viewed as environmentally problematic, the next generation of synthetic sports surfaces has transformed significantly embracing environmentally responsible design, construction, and lifecycle management.

Photo: 1 Paris Olympic/Paralympic Games had the First Carbon Neutral Hockey Turf, where 80% was Made From Sugar Cane Polymers and Reduced Water by 60% Compared to London 2012.

Strategic advancements in technology, regulation, and environmental policy have reshaped synthetic sports surface systems to align with global sustainability goals, including the United Nations Sustainable Development Goals (UN SDGs), Australia's climate resilience strategies, and local government triple-bottom-line frameworks. Today's synthetic systems are designed to be smarter, cooler, safer, and far more ecologically sound than their predecessors.

There are many different kinds of synthetic surfaces from best practice to a cheaper mass produced market. It is therefore critically important in the planning, design and procurement stages of a new or upgraded sports fields or surface that the quality requirements are considered and specified. Not all synthetic surface options will be environmentally positive. This Guide aims to highlight the key considerations for the reader.

Governments will continue to create healthy places by balancing open space provision between passive parklands and active spaces. As the population increases, active spaces are already struggling to cope with the growth in demand for places to exercise, play, recreate, and participate in community sports. The growth and intensity of usage may create burdens on natural surfaces that even science and good management practice cannot meet.

To that end, embracing some technological advances could result in alternative surface types being considered where appropriate. These alternatives could include:

- **Hard surfaces** – acrylic for recreational spaces, 3-on-3 basketball, tennis, 5-a-side, fitness and recreational spaces.
- **Synthetic (short) grass** – for tennis courts, recreation areas, bowls greens, hockey 5's and more.
- **Rubber surfaces** – for jogging, running, exercise areas and playgrounds.
- **Synthetic grass (long-pile)** – for football codes of soccer, rugby union, rugby league, Australian rules and more.

Some sports only ever want engineered solutions as an alternative to natural grass, including:

- **Netball** – acrylic hard surfaces are their key choice
- **Hockey** – hockey turf is engineered specifically for the sport and how the game has been played since 1970's
- **Athletics** – track and field athletics, since the 1960s have used rubber tracks for both safety and performance reasons.

1.2 The Importance of Sustainability

The main reasons for choosing a non-natural surface is predominantly due to the capacity of the natural surface, where normally grass is unable to cope with the intensity of usage required to satisfy demand. The second reason is that a number of sports do not want natural turf due to it not being fit for purpose.

The environmental benefits of considering a synthetic surface include:

- Significant saving on water usage
- Significant reduction in the use of herbicides and pesticides
- Reduction of maintenance to the surface and the subsequential reduction in operations on the environmental footprint.
- Water harvesting for the rest of the parkland.
- Reduction of over usage that would normally be associated with natural grass.

To embrace sustainability emphatically it is critical that a balanced perspective is used, for this Guide we have used the United Nations, Sustainability Development Goals (SDG's).

Photo 2: Synthetic Football Field in Norway, One of the Globes Most Sensitive Environmental Eco-systems

The key SDG's that are applicable to sports environments and surfaces have been assessed and have been aligned with local governments Triple Bottom Line of environmental, community and economic perspectives, plus an addition of performance. This allows a multiple-bottom line perspective against a 4P rationale with the SDG goals and aligned targets identified in brackets:

- **Community (People)**: Understanding the impact of the decision-making on the whole community.
  - SDG 3: Good health & wellbeing (3a)
  - SDG 10: Reduce inequalities (10.3 & 10.4)
  - SDG 11: Sustainable cities & communities (11.7)
- **Environment (Planet):** Enhancing the environmental footprint where possible and protecting the landscape for current and future generations.
  - SDG 6: Clean water & sanitation (6.3 & 6.4)
  - SDG 12: Responsible consumption & production (12.2, 12.4, 12.5 & 12.7)
  - SDG 13: Climate action (13.1 & 13.3)
  - SDG 14: Life below water (14.1)
  - SDG 15: Life on land (15.5)
- **Economical (Prosperity):** Ensuring best value affordability for the capital and ongoing management and replacement costs.
  - SDG 9: Industry, innovation & infrastructure (9.1)
- **Performance:** to ensure that the design, construction and management are 'Fit for Purpose'

When deciding on what surface to invest in, there are many variables and the decision process should be developed to encourage a holistic and structured approach to ensure everything has been considered.

Photo 3: Circular Economy Starts in the Planning and Design Stage NOT the Post Life Stage

Good practice decision making should explore four stages in the life of a project, Planning, Design, Procurement and Management. In addition it should consider views from a Multiple Bottom Line framework with the 4 Ps, People (community), Planet (environment), Prosperity (economic) and Performance (fit for purpose).

Therefore, it is critical that technology is embraced in strategic locations to reduce the impact on passive open space by containing and enhancing the ability of active open space to meet current and future demands.

This Guide has studied many global reports on the impact of climate change on sport, the UN's Sustainability Development Goals, The NSW Chief Scientist and Engineers Report, European guidance, publications from peak bodies such as the Sport Environment Alliance, Sport England, The European Sports Turf Council and IAKS Expert Circle on Outdoor Surfaces.

This has allowed us to consider a "***Framework for Environmental Sustainability for Sports Surfaces***" based around the vision and focus in Section 3.

1.3 Sustainability at Each Stage of the Surfaces Life Cycle

This Guide has embraced a 5-Phase Lifecycle Framework, to ensure that every sports facility and surface is strategically conceived, sustainability designed, efficiently delivered, responsibly managed and just as committed to a sustainable end of life.

These 4-Phases include:

- **Planning** – laying the foundations for smarter, more sustainable sport and recreation facilities.
- **Design** – turning vision into functional, enclosure and sustainable facility changes.
- **Procurement** – ensuring the right procurement process delivers the best outcomes.
- **Manage** – maximising facility performance through smart management and maintenance practices.

2. Challenges – Perceived and Actual FAQ's

2.1 Introduction

There are community groups or alliances that have expressed concerns about the use of non-natural surfaces for sport and may not appreciate the full technical research around some of their concerns. This section addresses their concerns and typical questions and explores the reality and how any mitigations can be embraced to reduce risk to the environment or people using the surface.

2.2 Concerns, Challenges and Reality

The main questions asked or perceptions made are:

1. Is water polluted from the synthetic surface with leaching and heavy metals?

This should not be the case. Synthetic fields with recycled car tyres (crumbled/SBR) are often identified as causing leaching into the local water system and environment. There has been significant research globally on the impact of recycled SBR on local ecosystems. These research projects[1 2] 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[3] by the Ministry of Environment, Traffic, Energy and Communications. The study was on the Environmental Compatibility of Synthetic Sports Surfaces which explored the secretion of synthetic surfaces from disintegration by UV radiation, mechanical destruction by abrasion, and diffusion of ingredients and washing off by rainwater.

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

Contemporary synthetic grass only use organic infills, which have no PAH's or heavy metals.

The new European Standard, EN 15330-5 Surfaces for sports areas – Synthetic turf and textile sports surfaces – Part 5: Specification for infill materials (Sept. 2025) addresses the possible toxicology of infills by:

- Polycyclic organic hydrocarbons (PAH) content
- Migration of chemical elements through accidental human digestion, and
- Leaching of chemical elements through immersion in water

These standards should be adopted in all Australian specifications moving forward, as Smart Connection Consultancy has been for a number of years.

2. Are heavy metals from the grass colouring dangerous to the environment

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[4] for all sports turf on a voluntary basis by all the major manufacturers.

The European standards, require infills to satisfy the thresholds of CEN/TS 16384: 2021 Annex A: (EN 12457.4), tables 6 & 7, mainly:

- Mercury ≤ 0.001 mg/l,
- Lead ≤ 0.025 mg/l,
- Cadmium ≤ 0.005 mg/l,
- Chromium ≤ 0.008 mg/l,
- Zinc ≤ 3.0 mg/l, and
- Tin ≤ 0.04 mg/l.

It is recommended to mitigate any perception of environmental impact that synthetic systems that are procured should, therefore, meet these or the 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 measure the possible heavy metal migration of material that may be hazardous if ingested. We recommend that all turf procured in Australia adopts this standard.

3. Isn't the carbon footprint impact greater with synthetic grass?

Concern has been voiced that the reduction of natural grass by the synthetic sports surface, reduces carbon sequestration with the loss of natural grass. This is true and the greenhouse gasses calculated as part of research by Carbonneutral.com.au states that:

[1] 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

[2] Hofstra, U. (March, 2009). Zinc in drainage water under artificial turf fields with SBR. Summary ITRON Report. agp_-_listing_of_independent_research_and_reports_1998-2014_-_artificial_grass.pdf

[3] 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

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

- Natural grass generates -2T. C0^2
- Sbr infill for synthetic turf – 89T C0^2
- EPDM infill -118T C0^2
- TPE infill -180T CO^2

That said with the next generation of planning, the EU has dedicated that all products need to now be able to demonstrate their carbon and environmental footprint. These Product Environmental Footprint Category Rules (PEFCR) have been developed by the European Sports Turf Council, the trade association for the synthetic turf industry in the EMEA region. There is a calculator that they have established and been approved by the E.U. Commission.[5]

In Australia, it is recommended that the key approaches to lowering the environmental footprint include:

- Consideration of the whole of parks environmental footprint and not just the 'field of play' surface.
- Expansion of the tree canopy for the whole park
- Reduce impact, retain as much of the natural grass and fauna on site (e.g., spectator mounds, or reshaping of parkland).
- Ensure 'Circular Economy' products are chosen.
- Embrace Green Engineering for the construction of the sports surface, pathways etc.
- Water harvest the rain water from the surface to water the whole parkland.
- Utilise as much recycled content in the performance surface and the civil engineering solution.
- Utilise organic infill for the sports fields
- Embrace heat reduced technology for sports surfaces.

Adopting these strategies can increase and improve the environmental outcomes of a parkland and especially with reduction of the environmental footprint impact.

4. Do synthetic turf fields create a significant urban heat island impact?

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

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

Figure 1: WSROC Turn Down The Heat – Strategy and Action Plan

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

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

The NSW Chief Scientist and engineer stated in her report (2023) that **the impact from synthetic sports fields is likely to be very low and localised**. That said we should still be looking at how this small impact can be elevated through good design planning. This can include the adoption of initiatives such as:

- Expansion of tree canopy around the field of play to provide shade and greater tree evaporation to cool the area
- Water harvesting to use on the rest of the parkland
- Use of organic infill as opposed to black rubber infill
- Procurement of a dual yarn technology system (monofilament and tape) to reduce the heat impact
- Increase of landscape performance to offset any reduction of natural grass
- Create shaded areas around the field of play

Placement of the fields and UHI strategy can create a positive impact here.

[5] www.estc.info/knowledge-centre/product-environmental-footprint

5. Do synthetic surfaces create heat stress on a player?

A key component of many community concerns is the heat of non-grass surfaces, which on warm or sunny days increases greater than on most wet fields. The heat on concrete or asphalt sports courts is significantly warmer, where the U.V radiation is high.
Synthetic grass also has a prosperity to get warmer if using a black infill. All these surfaces lack the water component of natural grass, when it is watered and not dried out. The industry has invested significantly over the past decade in the manufacturing of heat reduced acrylic surfaces, heat reflected grasses and lighter coloured rubber surfaces that do not absorb the heat.

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

- Cool grass technology (5% reduction of heat).
- Acrylic coating heat technology (30% reduction in heat) for hard surfaces.
- Use of dual yarn grass technology (FIFA heat index reduced by a 0.5 score).
- Organic infill, as opposed to rubber/plastic (3% reduction in heat).
- Shade sail, over smaller areas (e.g. bowls areas, courts etc.) have been found to reduce heat by 30% on high U.V. days.
- Vertical draining on grass systems allows the base to stay moist longer, and by reverse osmosis, the infill and carpet stay a little cooler.
- Tree canopy near to the surface provides shade and also the leaves evaporate cooling effect helps.
- Water harvesting into a ‘wetlands’ close to the surface helps, especially if the sports surface is ‘down-wind’ of the wetlands.
- Water on hockey fields

It is important to consider heat stress as a holistic approach for weather stress. In the same manner that owners of natural grass fields have to close many grass fields in the wet weather to protect both the field of play and the players, it may be similar to consider a similar approach for synthetic surfaces. Whether that is rubber (athletic tracks), acrylic (Tennis, Netball or Basketball) or synthetic grass (Hockey, Football codes), a heat policy by the sport is normally used to determine an appropriate level of heat (and humidity) for people to play in. Sports Medicine Australia produce a Hot Weather guideline that has been adopted by many sports in the development of their own Heat Policies[6].

It is recommended that to reduce the heat stress on players that at the planning and design stage, strategies such as the ones listed below are considered:

Design and Plan to Cool the Created Environment

- Ensure that the design integrates into the broader environment to create opportunities for additional cooling designs, including additional trees, water harvesting into wetlands etc.
- Explore Green Engineering technology and blue and green infrastructure building methods into each project
- Explore how the drainage strategy can replace water into the soil as opposed to storm water to keep the ground close to the field moist
- Develop light coloured paths, rooves and other hard standing areas to reduce the propensity to capture heat radiation from the normal black surfaces
- Landscaping to reduce solar radiation
- Encourage innovation from the contracts to drive opportunities

Cool with Green Space and Water

- Invest in water harvesting and keep as much water on site for alternative uses
- Increase the tree canopy in the area around the parkland to provide both shade and other green benefits to the environment
- On hockey surfaces use water cannons to help with speed of play and heat reduction
- Include water bubblers around the field to reduce heat impacts on players
- Water sensitive urban design (WSUD)

It is recommended that the infill surface temperature (during exposure to infrared energy) is measured against the EN 15330-5 standard and procure systems with a class 1 (<50°c) or class 2 (50 - 65°c).

6. Are intentionally added microplastics from synthetic fields are dangerous to the environment?

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

There are two forms of microplastics, intentionally added microplastics and secondary microplastics. The intentionally added microplastics is the SBR/crumb rubber that was historically used as infill for 3G grass, or rubber on the top of athletics tracks or playground soft fall areas. The secondary microplastics are seen with ageing of the fields as the end of the grass yarn break off.

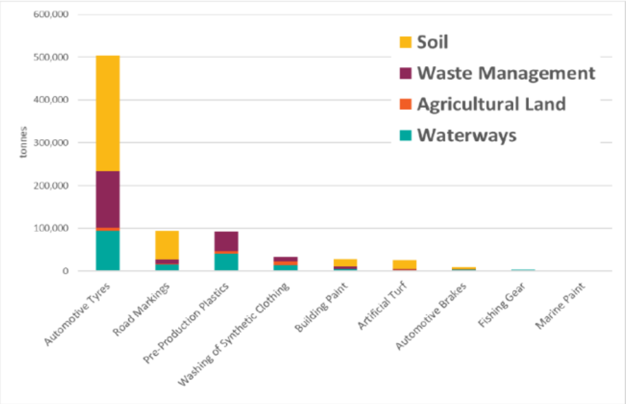
The European Commission received a report (DG Environment) in February 2018[7] which explores this in detail and provides the most extensive study to date. It

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

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

specifically explores synthetic sports surfaces as part of a broader sector of microplastics.

Synthetic fields are "…a relatively small source…"[8] as shown in the table below.



Source: Eunomia modelling

Figure 2: Sources of microplastics found in Europe

The migration of microplastics off the field of play into waterways of the adjacent soil is the concern of the community. This can be addressed simply by a number of design considerations, namely:

- Do not use and 'intentionally' added microplastics – use organic infill for 3G fields,
- Design a sub-surface drainage system so that no microplastics can enter the waterways through the drainage,
- Create an upstand barrier around the field to contain the secondary microplastics,
- Procure a grass system that is exceptionally durable and has a U.V stabiliser to reduce the level of breakage with age. These fields should be dual yarn (tape and monofilament) and be tested to Lisport (2012) of our 200,000 reps.

7. Doesn't flooding will destroy synthetic surfaces?

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

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

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

With modern technology and ongoing flood modelling, councils are able to better understand risk and respond appropriately, and the developed tools support them in their knowledge and decision making on the levels to place sports surfaces.

A detailed overview of flooding impacts on surface is shown in Appendix 3.

The key recommendations for considering flooding include:

- Identify the Annual Rain Intensity (ARI) event level that the organisation wants the drainage strategy to achieve so that the drainage pipework can cope with that discharge level.
- If overload flood risk, consider the pathways for the water and how to mitigate this, so that the water does not enter the field of play.

8. Isn't crumb rubber not only bad for the environment but unsafe on users?

Concern has historically been raised that the crumb rubber (SBR) is carcinogenic, which would be very concerning if true. The concern is that these chemicals (PAH'S) can be leached into the environment, or cause cancer for people playing on the surface.
The amount of PAH's varies in the compounds that are used for the rubber infills, and from the tyres. The European Chemical Agency has worked with the EU Government (REACH) to identify a safety level of these PAH's which are found in rubber tyres. These are encased within the rubber anyway and need a chemical reaction to release them.

There are two aspects for consideration:

- How to ensure that the rubber being used is within a safety level agreed by the EU Chemical Agency (this isn't addressed in Australia).
- To ensure if children swallow the infill it is not harmful.

It is therefore recommended that

i. All rubber is tested to the EN REACH Guidelines, DIN 1803.5 parts 687/ESM105 and REACH standards.
ii. That all rubber has been tested to EN 71.3 Safety of Toys – Part 3 Mitigation of Certain Elements, Table 2, Category 3.

9. Is the circular economy ready in Australia?

There has historically been concerns that the sports surface (grass, rubber etc) could not be recycled. Australia now has it's own specialist recycling and repurposing plant in Barnawartha and has already been processing the carpets and infills since 2024.

[8] Section E1.1. Estimating Microplastics

10. Are synthetic surfaces full of PFAS?

No they are not**.** To explain and provide some context. Per- and polyfluoroalkyl substances (PFAS) are a broad class of hundreds to thousands of synthetic fluorinated chemicals that have been manufactured since the mid-20th century for their ability to repel heat, oil, water and stains. Because of their strong carbon-fluorine bonds, many PFAS are extremely persistent in the environment and resist degradation, earning them the informal name “forever chemicals.”

They have been used in a wide range of industrial and consumer product, including firefighting foams, non-stick cookware, waterproof textiles, food packaging, and personal care items and have been detected throughout soil, water, air, and living organisms globally.

PFAS may travel long distances in the environment, accumulate in animals and humans, and have been linked in some studies to health effects such as immune disruption, reproductive harm, and increased cholesterol, although the strength of evidence varies by chemical type and exposure level.

In Australia, both the Commonwealth and state/territory governments are progressively strengthening their approach to managing PFAS contamination and reducing future risks. A key national framework is the PFAS National Environmental Management Plan (NEMP)**,** which is jointly maintained by the Commonwealth and states and sets out consistent guidance for investigating, assessing and managing PFAS contamination in the environment. At the federal level, the Industrial Chemicals Environmental Management Standard (IChEMS**)** now lists key PFAS like PFOS, PFOA and PFHxS on its highest-risk category, meaning their industrial use, manufacture and import is now prohibited except in specific circumstances, bringing Australia closer to implementing obligations under the international Stockholm Convention.

The Australian Government also updates health-based guideline values for PFAS in drinking water through the National Health and Medical Research Council’s Australian Drinking Water Guidelines, and commissions research to refine understanding of exposure and health outcomes. In New South Wales, government agencies are actively responding both to legacy contamination and ongoing monitoring needs. The NSW Environment Protection Authority (EPA) is undertaking a statewide PFAS investigation program to identify and assess potential contamination at high-use sites such as airports, firefighting training areas and industrial zones, with the aim of better understanding how PFAS is distributed in soil and water. NSW Health has convened expert advisory panels to review the evidence on health effects and guide communication and public health advice, and the NSW Government has aligned its drinking water monitoring and risk-management practices with updated national guidelines, confirming that public supplies currently meet these standards. Additionally, state parliamentary inquiries have reviewed gaps and recommended improvements in monitoring, risk communication and interagency cooperation.

A useful distinction in PFAS regulation and product management is between intentionally added PFAS and what might be described as *secondary* or unintentionally present PFAS. *Intentionally added PFAS* refers to PFAS chemicals that manufacturers deliberately incorporate into products for a defined purpose, such as providing stain-resistance in textiles or surfactant properties in certain formulations. These PFAS are a functional component of the product and their continued presence is intended in its design or performance.

In contrast, *secondary* or unintentionally present PFAS can arise as trace contaminants, by-products of industrial processes, or through environmental transformation of precursor substances into other PFAS (for example, certain fluorotelomer compounds breaking down to form perfluorooctanoic acid, PFOA). These are not added to confer a property to the product but nonetheless may be present and contribute to environmental and health exposure. In regulatory terms, controlling intentionally added PFAS focuses on phasing out their use where feasible; managing secondary PFAS often involves addressing contamination sources, environmental pathways and transformation processes to limit exposure.

Within the synthetic surface manufacturing context the majority of key companies have committed to removing all PFAS from their manufacturing process in the next couple of years. That said many of their components are recycled (shockpad, organic infill) and may have secondary PFAS associated with them in an earlier life, this will be harder to control, but over the next decade we will see that the sports surface market will continue to reduce any PFAS connected to the surfaces.

11. Is the dust or infill dangerous to the environment and if users inhales or ingest it, by accident or through a child’s curiosity?

If there is dust from the infill all surfaces being procured should be tested to EN 15051 Part 2: Measurements for the dustiness of bulk materials – Part 2: Rotating Drum Method and the infill should be classified as either ‘very low’ or ‘low’. In relation to possible migration of chemicals through accidental digestion, the infill and yarn should be able to satisfy the requirements for Category 3, Table 1 of EN71.3: 2019 – A2 IN 2024. (Safety of Toys – Part 3: Migration of certain elements).

3. Environmental Sustainability Gameplan

3.1 Introduction

When considering the development of a new synthetic sports surface, whether that be an acrylic surface, rubber tracks or synthetic grass, an environmental impact reduction strategy should be considered at the planning, design, procurement and management stages.

This section has embraced the UN's SDG's, The NSW DPHI Guidelines and good practice from the industry in the development of the following strategies.

3.2 The Smart Environment Strategy Framework

The Smart Framework has embraced all of these focuses and pragmatically developed strategies on how an organisation who is embracing sustainability (The 4P's) should address the planning, design, procurement and management of new sports surfaces.

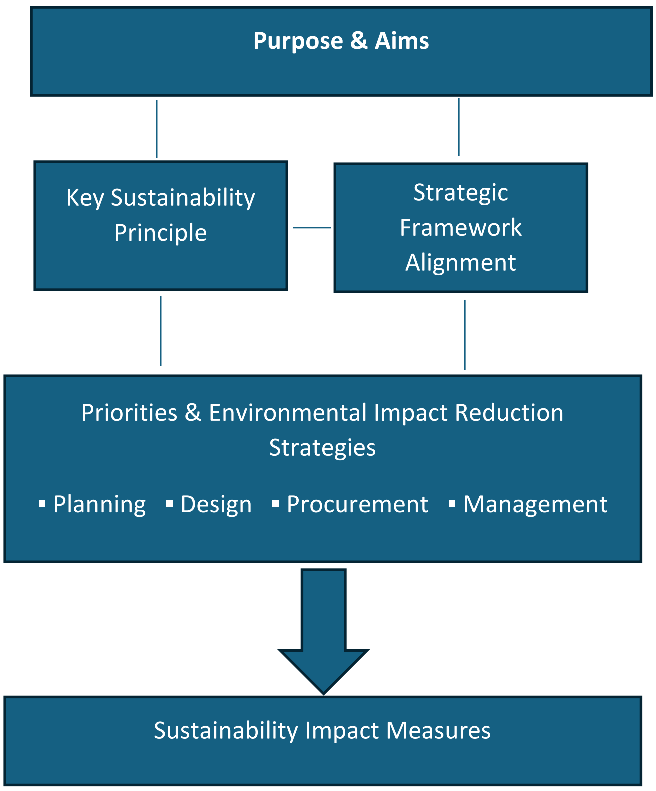


Figure 2: Smart Framework

3.3 Strategic Focus

1. Purpose

To embrace environmental sustainability into the planning, design, procurement and management of synthetic sports surfaces.

- To create environments that encourage people to be active, exercise, play, recreate and participate in community sport in a manner that reduces the impact on local environments
- To design environments in a manner that allows us, as custodians of the land to manage and maintain an ecological balance of the local environment
- To protect and where possible enhance the environmental value of the area protecting future generations from climate change and material scarcity

2. Key sustainability principles

To achieve these aims we will promote the following principles.

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

3. Key framework alignment

The environmental framework has embraced global and national key frameworks to ensure a strategic and holistic approach, namely:

- UN's SDG's – appropriate for sports surfaces
- NSW Decision Makers Guidelines for Synthetic Turf (May 2025)
- Multiple Bottom-Line lens (4 Ps)
- Environmental Sustainability Principles

This allows us to identify against the 4Ps which of the UN's SDG's are aligned, the targets to embrace and how to do that practically in each stage of Planning, Design, Procuring and Management.

4. Priorities and environmental impact reduction strategies

Embracing the NSW DPHI Guidelines for structure the following priorities and strategies are identified:

Planning stage

Planning is critical to identify the best site, alignment with policy, procuring the right design and surface while also ensuring the long term use of the site (30 plus years) will have a reduced impact on the environment.
The following strategies are considered:

1. Policy & strategic alignment: Align with government policies and environmental strategies, including carbon policies, waste policies, sustainable transport, sustainable materials, clean water, land use/wildlife etc.
2. Consider the sports facilities being placed in the right location geographically to ensure that the surfaces compliment others in the municipality or region.
3. Embrace and plan for the circular economy in the design, procurement, management and recycling of the surfaces stages.
4. Consider the siting of the sports facilities closeness to waterways, bushland, historical and residential hotspots, wildlife etc.
5. The impact on the identified parkland in relation to environmental considerations such as size of footprint as percentage of parkland, sub-surface considerations (old rubbish tip, contaminated land, high water table etc), impact on residents, tree canopy, water harvesting to improve water to the rest of the parkland, lighting impact, drainage, infrastructure, flood modelling etc.
6. The opportunity to enhance the parklands environmental value with strategies such as, increase the tree canopy, water harvesting for the rest of the parkland, improved car-parking, cycle and walkways, landscape enhancement etc.
7. Centralisation of synthetic surface in a 'Hub & Spoke' model that will encourage greater use of synthetic surfaces, whilst reducing impact on natural turf surfaces by reducing the demand for training, enhancing environmental impact across municipality.
8. Centralisation of synthetic surface should also reduce the need to change passive parkland into active parklands, as the synthetic field will be able to host three times more intensity of usage.
9. Consider the use of natural noise and light barriers such as trees, shrubs and fauna to reduce environmental impact on local residents.
10. Consider developing whole of parkland masterplans allowing a holistic approach to environmental planning to offset any impact of a synthetic sports surface. This should include expanding tree canopy, flora & fauna, water harvesting, lights, parking, Urban Heat Island impacts, site accessibility etc.

11. Understand the civil engineering considerations for the whole site, by commissioning site assessments including,
    a. Geotech report – to ascertain how the ground conditions can build a pavement base of 30 years
    b. Environmental assessment – to understand soil health issues and any mitigation strategies needed
    c. Flood report – to explore any risks and mitigation strategies
    d. Tree management report – considering an tree impact, loss of canopy and ability to develop a strategy that expands tree canopy to provide shade, reduce Urban Heat Island (UHI) impact and provide evaporative cooling
    e. Site overlays – for heritage, environmental, existing easements, restrictive zoning etc
    f. Drainage strategy – to address at least a 1 in 50 ARI event and the ability to disperse the water in the current storm-water network. The use of drainage for water-harvesting can have a significant environmental benefit to the whole parkland.

Design stage strategies

The design stage needs to consider key aspects of the project, the environment, the location and its management to ensure that the design is fit for purpose. These aspects include:

1. Planning considerations: The siting, design and management process and outcomes need to be embraced (e.g. 30 year pavement life, ARI of 1 in 50 years, community sports usage of 60 plus hours etc).
2. Connection with park location is critical for the design, early access for pedestrians, cyclists, transport (cars and public) as well as spectator access to maximise the experience of the users (and passive users).
3. Civil engineering: must be driven by the technical gas-etch assessment to design the civil engineering solution for 30+ years and to accommodate the drainage strategy needed. This should include the pavement base needed for the surface, whether that be concrete court surfaces), asphalt (courts, tracks and hockey fields) or roadbase (mainly 3G fields). These designs must be able to meet the International Federation (e.g. World Athletics, FIH, FIFA etc) detailed levels.
   The use of recycled content and environmentally friendly concrete etc to build the facility is critical.
4. Performance surface: two considerations fit for purpose design for the primary sport and any secondary usage complementary sport or casual usage (e.g. 3-on3 basketball hoops on tennis courts) will ensure that the asset is used intensely. Consider the size of the footprint, does the sport always need 20 courts, or can it change its management practices of only playing one day of a weekend and need only 10 or 12 courts. Ensure that the surface can be used for a number of hours and type of usage (70+ hours p/w).
5. Technology: as this is progressing quickly, specify the outcomes you want it to achieve and not the name of a single branded surface type, as all the surfaces are propriety to different manufacturers. This can improve the design impact significantly.

6. Design around the principles of a circular economy for each stage of the process and to reduce the environmental footprint of the design.
7. Field of play orientation: to ensure that there is maximum usage throughout the day.
8. Lighting considerations to optimise the players experience on the surface, embracing International Federation and/or Australian standards for the lighting at training and competition level. Consider embracing the Australian standards for 'Control of Obtrusive Effects of Outdoor Lights'-AS4282. Most software packages now allow the lights to have a range of lighting levels, e.g. competition at 200 lux, training at 50 lux and walk-off at 20 lux etc.
9. Design mitigation of microplastic migration into waterways and landscape by embracing the following strategies to address cause (not effect) of microplastic challenges:
    - Only purchase a synthetic grass system with organic infill, this reducing all 'intentionally added microplastics'.
    - All drainage to be sub-surface (i.e. no spoon drains) so that and breakage of yarn (microplastics) do not enter waterways.
    - Design a 200mm hob around the field, using recycled products to 'contain' any yarn in the field of play, until it can be removed as part of the maintenance program.
    - Install show and vehicle grates to ensure any infill or microplastics do not leave the field of play.
    - Install a shockpad to ensure that the amount of performance infill is significantly reduced.
    - Request only systems that are exceptionally durable and therefore less likelihood of breaking the yarn tips, which should pass the Lisport (2012 test) to at least 200,000 repetitions (as opposed to FIFA requirement of 20,200).
    - Only use a 'Dual Yarn' system which is a monofilament/fibrulated tape option that will encapsulate the infill and significantly reduce the migration of infill and increase durability.
    - Request high U.V stabiliser in the yarn to ensure that in the southern hemisphere that as the field ages the yarn doesn't break down so quickly.
10. Explore the use of wide canopy trees close to the filed of play, with vertical root systems (as opposed to more horizontal and shallow root systems) placed around the filed of play with appropriate root barriers to reduce long-term impact on the field. This should act as both a shade coolant and evaporative catalyst in hot weather.
11. For hard courts, design the facilities with heat resistant technology to reflect the heat, cooling the area and reducing UHI impact of a night.
12. Design the surface so that when it is replaced it is easy to recycle or re-use.

Procurement stage strategies

The procurement process aims to specify, procure and deliver the project in a manner that is best value for the organisation and will consider key aspects of timelines, affordability, fit for purpose, environmental impact etc. There are a number of considerations including:

1. Reject a Design & Construct (D&C) Contract Tender – as this often is open and only relates to a small number of criteria (e.g. FIH Global or FIFA Quality surface) it doesn't embrace the performance characteristics and standards for environmental aspects. Consider the Design Finalisation and Contract (DF&C) or Detailed Design (DD) contracts as more holistic and less risky to the organisation.
2. Detail the best practice construction standards for each part of the project delivery, to ensure there is clarity of expectation, especially around environmental aspects and best practice.
3. Project management is critical at the key stages of Critical Hold Points, Witness Points and Testing/Assessment points, by an experienced and qualified team. This will reduce the amount of rework needed over the length of the assets life and therefore will reduce the environmental impact.
4. Handover is critical at the end of the project, with details of the 'As Builts' drawings, the warranties, the maintenance manual and product details etc.
5. Purchase only sports surfaces that can meet all of the environmental standards required (see Design section) and have a proven track record.
6. The establishment and management of the construction site shall embrace best practice in relation to environmental management.
7. Comparing each tender against the Environmental Footprint (calculated by the ESTC tool, Product Environmental Footprint).
8. Embrace Value Engineering, to encourage each tender to create beneficial environmental outcomes.

Management stage strategies

Ensuring that the surface achieves its life expectancy and the performance needs of the sport three aspects need to be considered:

1. Programming – to optimise the Return on Investment the surface intensity of usage should be understood (from the design) and then programmed to maximise the facilities usage (sweating the asset).
2. Maintenance and renovation – to ensure a quality experience the surface should have an agreed maintenance program, including brushing, cleaning, top-up and an annual remediation program.
3. Monitoring and review of performance – the International Federation stipulates the testing regime for their surfaces and level of play which could be embraced. After year 5 it is suggested that the surface is also independently checked for remediation needs, life expectancy and any dilapidation that may have occurred.

5. Sustainability impact measures

It is critical that as part of this strategy that there is a measurement process to assess impact of what is being planned, designed, procured and managed.

The approach with this Guide is to measure impact against a multiple-bottom line set of criteria. These should include the following criteria:

i. People (community) lens
   - Hours usage per week/year (hrs pr wk/yr)
   - Intensity of usage per week / year (people pr wk/yr)
   - People per field of play (field / 1,000 population)
   - Members per club (N° members/club)

ii. Planet (environment) lens
   - Water used per week/year (L/ml)
   - Water saved per week/year (L/ml)
   - Bad weather days closed per year (wet/hot)
   - Maintenance needed per week/year (hrs/wk & hrs/yr)
   - Pesticide & herbicide used (L per wk/yr or times p/w or p/y)
   - Pesticide & herbicide saved (L per wk/yr or times p/w or p/y)

iii. Prosperity (economic) lens (per 8,500m² field)
   - Capital cost ($ million)
   - Maintenance cost ($k per annum)
   - Whole of Life cost (per annum over 30 yrs)
   - WoL costs per hour of usage ($/hr over 30 yrs)

iv. Performance (fit for purpose) lens
   - Playing standards
   - Additional safety, health, usage standards
   - Consistency of performance
   - Expected closure for renovations annually (days/annum)

An example multiple-bottom line sustainability comparison infographic is shown on the next page between five surface types:

(i) Natural turf field – community standard – sand profile with warm season grass over sown with winter grass (30 hours expected play with 30 people per hour intensity).
(ii) Hybrid reinforced turf field – community standards on a natural turf field (i) with reinforced areas around goals, running lines and centre circle (35 hours expected play with 30 people per hour intensity).
(iii) Entry level synthetic field – FIFA Quality with shockpad and monofilament 3G field (42 hours expected play with 40 people per hour intensity)
(iv) Smart synthetic turf field – FIFA Quality with additional standards around durability, porosity, U.V binder and dual yarn system (60 hrs p.w and 60 people per hour of intensity).
(v) Best practice sustainable synthetic field – As a Smart synthetic field with a whole of parkland strategy integrated with the UN's SDG's.

NATURAL V HYBRID V SYNTHETIC SURFACE LEVELS

smart connection consultancy

MULTIPLE BOTTOM LINE SUSTAINABILITY COMPARISON

	NATURAL TURF FIELD Community standard Sand profile with warm season grass over sown with winter grass	HYBRID SPORTS TURF REINFORCEMENT Community standards Natural turf plus reinforced areas around the goals, running lines & centre circle	ENTRY STANDARD SYNTHETIC TURF FIELD FIFA Quality FIFA Quality with shockpad with monofilament 3G Turf	SMART SYNTHETIC TURF FIELD FIFA Quality with shockpad and additional durability and performance dual yarn 3G Turf	BEST PRACTICE SUSTAINABLE SYNTHETIC FIELD As Smart Synthetic Turf with a whole of parkland integrated, holistic view based around the UN's SDG's
PEOPLE (COMMUNITY) LENS					
Hours Usage (week/year)	30 hrs/week 1,200 hrs/year	35 hrs/week 1,400 hrs/year	42 hrs/week 2,100 hrs/year	60 hrs/week 3,000 hrs/year	60 hrs/week 3,000 hrs/year
Intensity of usage (PEOPLE PER HOUR/YEAR)	**30 ph** 36,000 annually	**30 ph** 42,000 annually	**40 ph** 84,000 annually	**60 ph** 180,000 annually	**60 ph** 180,000 annually
PLANET (ENVIRONMENT) LENS					
Water used – weekly annually (based on 25 weeks at 150k L pw)	150,000 L 3.750 Million/L	150,000 L 3.750 Million/L	0 Zero	0 Zero	0 Zero and water harvested for the rest of the natural assets in the parkland
Bad weather days closed	**c. 15 days** 10 WET/ 5 HEAT	**c. 15 days** 10 WET/ 5 HEAT	**c. 10 days** 10 HEAT IF RUBBER	**c. 5 days** 5 HEAT IF ORGANIC	**c. 5 days** 5 HEAT IF ORGANIC
Maintenance needed (HOURS PER WEEK)	3 HRS	3 HRS	2 HRS	1.5 HRS	1.5 HRS
Pesticide/herbicides used	▪ x2-3 herbicide applications ▪ x1 insecticide ▪ x4-6 fertiliser applications	▪ x2-3 herbicide applications ▪ x1 insecticide ▪ x4-6 fertiliser applications	Reduced annually with spot sprays	Reduced annually with spot sprays	Reduced annually with spot sprays
Acceptance by Community as Active Parkland	Excellent acceptance (as long as not too busy!)	Excellent acceptance (as long as not too busy!)	Sporting community excellent. Passive usage can struggle if too busy or if fenced off.	Sporting community excellent. Passive usage can struggle if too busy or if fenced off.	Sporting community excellent. Passive usage can struggle if too busy or if fenced off.

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

*Whole of Life Costings based on Capital cost, maintenance costs over 30 years, and replacement of synthetic carpet at years 10 & 20. Natural having the sand replaced and turf replaced at 20-30 years. **Depending on usage, location, and maintenance/renovation needs.

Appendix 1: Key Contacts

1. SA Specific Industry Contacts

Office of Recreation, Sport and Racing
145B Railway Terrace
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w: www.orsr.sa.gov.au

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

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

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

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

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

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

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

2. Independent Advisory Services

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e: martins@smartconnection.net.au
w: www.smartconnection.net.au
Consultant to all Football Codes in Australia

3. Key Sports

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

National Rugby League Limited (NRL)
John Wilson, Acting Executive General Manager - Participation
Rugby League Central, Driver Avenue
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p: (02) 9359 8500
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Rugby Australia (RA)
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Touch Football Australia
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Australian Oztag

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w: www.oztag.com.au

Appendix 2: Reduction of Microplastics Entering the Environment

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

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

In Australia, the Australian Standards Committee published the global standard as SA TR CEN 17519: 2021 *Surfaces for sports areas - Synthetic turf sports facilities - Guidance on how to minimize infill dispersion into the environment.*

This standard is found on intentionally added microplastics allows councils to quote this standard in their tender documents, so the dispersion of infills can be reduced. This is positive information we can give to councils and show that the industry is doing something to mitigate the issue.

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

Smart 21-Point Guide to Reduction of Microplastics

Smart Connection Consultancy has developed this guide at looking at the five stages of a typical synthetic sports field, namely:

- Design – Performance Field
- Design – Civil Engineering
- Management and maintenance
- Construction
- Replacement

By adopting this 21-point plan, Smart Connection Consultancy believes that the probability of Microplastics will be reduced for sports fields that it will not be of material significance.

Design – Performance Field

By embracing the opportunities at the first stage will have a significant impact on how the field can be managed and reduce the level of infill.

1. **Yarn** – to reduce the amount of ball splash – embrace systems that only use dual yarn (monofilament and tape combination systems) or tape systems. Do not use monofilament as the infill will have a tendency to migrate significantly more
2. **Yarn UV Stabilising Levels** – ensure that the UV levels will provide the durability needed to ensure that as the yarn agers the tips of the yarn will not break down due to the UV radiation levels in Australia
3. **Durability of Yarn and Infill** – ensure that the system can cope with the intensity of usage and the yarn and infill will not breakdown with aged usage. Using the FIFA Lisport Test – the system needs to be able to provide a result in excess of 100,000 cycles (5 times that of FIFA requirement)
4. **Shockpad** – this will significantly reduce the level of infill needed in the carpet system and therefore reduce the chance of infill migration
5. **Infill Type** – consider the use of organic infill and not just rubber, therefore reducing the level of microplastics significantly
6. **Infill Quality** – the infill needs to be of a quality that does not leech, and certain recycled rubbers may have a greater tendency to leech heavy metals or indeed PAH's. We recommend adopting the REACH Safety Standards to ensure that if any microplastics enter the environment they will be safer and have minimal impact on the environment

Design – Civil Engineering

7. **Drainage Design** – to ensure that the drainage can cope with the Annual Rain event expects (e.g. 1 in 10 years) as this will ensure that the infill doesn't migrate on top of the field etc.
8. **Sub-Surface Drains** – ensure that all drains are sub-surface and not the older type of spoon drains around the surface levels
9. **Non Porous / Impermeable Layer** – below the drainage level or pavement base to ensure that no water or infill can penetrate the subsurface. This layer should also be wrapped around the Collector Drains to ensure a 'closed system'.
10. **Drainage Filter** – the drains should have filters to capture any infill before it progresses to the storm water outlets

Photo 4: Containment strategy: Drains fitted with filter.

11. **Field of Play Perimeter Curb** – design a plinth for the fence line to fit into which is approximately 200mm above the pile height to reduce the probability of the infill migrating from the field of play, with a 100mm depth to insert the fence posts

Photo 5: Containment strategy example 1: Curb to reduce the infill being dispersed outside of the field of play

12. **Access /Egress Gates** – at pedestrian and vehicle gates ensure that there is brush mats that are large enough (two strides for pedestrian gates) for people who leave the field of play to capture infill from boots etc. These need to be removable and cleanable to ensure that they do not allow infill captured to migrate into the environment. Vehicle gates are also fitted with a grated system to capture infill from the field of play from the vehicle tyres

Photo 6: Containment strategy example 2: Pedestrian gate mats that capture the infill

13. **Equipment Sleeves** – all field equipment sleeves including goals, posts, and flags should ensure that the bottom does not allow infill to seep into the sub-environment. Each needs to be capped
14. **Boot Cleaners** – each field should have a boot brush cleaner at the exit gates around the field with players encouraged to use them

Management and Maintenance

15. **Maintenance Brush** – the maintenance should be conducted in a manner that does not break off the tips of the yarn, therefore heavy rubber mats should not be used and only a firm brush or appropriate machine

Photo 7: Maintenance brushing

16. **Cleaning of Brushing** – all brushes and machines should be sprayed cleaned before leaving the field of play and any infill returned to the field of play
17. **Clean all Drainage Channels** – all drainage channels should be cleaned during each maintenance operation and findings recorded
18. **Clean all Gate Mats** – at each access and egress points
19. **Monitor Infill Levels** – to record and monitor expected levels

Construction

20. **Stockpile of Infill Bags** – the area is to be quarantined with impervious membrane under bags to ensure no spillage into the environment and all bags are to be cleaned before being taken away. The quarantine area to be cleaned prior to the area being returned to its original function or relandscaped.

Replacement

21. **Recycling** – the procurement must stipulate that all new fields procured can be recycled at the end of life, including a strategy for recycling of the carpet and yarn and the rubber infill. The sand should be reused and the shockpad and where possible, the rubber infill should be procured where they can be reused 2-3 times thus reducing the level of microplastics needed for the system over the whole of life of the field.

Appendix 3: Flooding and Impact on Sports Surfaces

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

Overland flow flooding

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

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

Creek flooding

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

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

River flooding

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

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

Storm tide flooding

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

Flooding and drainage considerations for synthetic fields

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

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

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

Flooding Considerations

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

Drainage back-fill – where the drainage pipes, whether around the field or the storm water discharge pipes can cope with the level of water that its holding. If it cannot, then the water will back up firstly through the pipes and then through the grass systems before puddling and then flooding. Once the water can be discharged the flooding will decrease, normally leaving a maintenance issue for rectification. The field performance infill, which is normally lighter than water will float and can be blown around the field. This is a maintenance issue and can be rectified prior to the next use.

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

Flood path – this is the most troublesome of the three scenarios' as the flood path normally brings dirt with it and crosses a field and so disrupts the base if not designed to cope with the movement of the water and also the surface. Again, a solution is to encourage the water through a drainage strategy and under the field before possible retention and discharge.

Wear – the impact of flooding on or across the surface of the synthetic playing field could be detrimental to the systems pavement integrity, the carpet and infill. This could also negate any warranty (normally 5 years for the system), as the majority of warranties preclude flooding being covered.

It is critical then that the design embraces any likelihood of floods, so that appropriate mitigation can be addressed. Failure to design around this or if a Design and Construct specification, would most likely negate any obligation on the contractor and their warranties.

Impacts of standing water – the likelihood of water pooling would be due to drainage back-fill which meant that the water cannot drain away quick enough. The consequence is that there could be a level of standing water on the field of play until the drainage an accommodate the discharge of water.

The impact on the surface will be linked to the time standing and the amount of water on the field. It is highly unlikely that this would be for long if the drainage strategy has been developed accordingly. Normal challenges when this happens, and the consequential actions include:

- **Playing environment** – this would probably be unsafe and so games/training should be cancelled
- **Infill** – whatever infill is lighter than water, that will float, if there is a wind while the infill is lifted from within the carpet to be resting on top, then it could be blown across the field and rectification maintenance would be needed. Although this may be time consuming, it is unlikely to be detrimental to the system
- **Carpet** – the carpets are normally not glued to the base as they are either sewn or glued together, if sewn there should be no impact. The adhesive is waterproof and so the water should not have a significant impact, if the water is standing for a long period of time (unlikely) then this may release some if the adhesive properties. I am not aware of any research conducted to provide accurate guidance on this.
- **Pavement base** – the impact on the pavement base could be nil. If the design ensures that it does not impact on the pavement's integrity. Normally an impermeable sheet is used to stop water seeping into the sub-base etc. Depending upon the level of water, this should not create a negative problem with the weight.
- **Impacts of flowing water** – this would be the most significant challenge that a field would have and the most likely to cause problems for the whole system if mitigation is not designed into it. The flowing water, similar to the 'standing water' would impact on infill migration and pavement base considerations.
- The added challenges are:
    - ***Silt transfer*** – if silt is brought from outside the field of play and across the synthetic system it would leave a train of sand and silt, that when it dries actually creates a 'crust' level on top of the system and can clog up drainage portals. This can destroy the system, resulting in the whole system being replaced. At best when this happens the major manufacturers would suggest keeping it wet so that they have an opportunity to vacuum it up. If it goes dry and hard the carpet will most likely be destroyed.
    - ***Mitigation of infill*** – it is possible that the infill will be moved with the pace of the water. This is a maintenance rectification issue and as with the standing water scenario earlier, this should only be a maintenance issue and not a major rectification issue. The operator would normally use a specialist brush (e.g. a SMG Grass Master brush system, which is towed behind a small ride on machine). If it were to settle in the local creek there is no evidence that this would be detrimental to the environment.
    - ***Water under the carpet*** – sometimes if water is under the carpet on some synthetic surfaces (e.g. bowls and water-based hockey fields) round bubbles occur after water is trapped under the surface. If the design of the synthetic field is correct, then this should not be an issue on 3G long pile surfaces as the weight of the surface (normally 30 - 40kg/m^2) would keep it stable. In addition, if the drainage is working the under carpet will lie flat and dry out as the water recedes.

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

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

i. **Standing Water Flooding** – where the water cannot leave the field due to the storm water drainage system not being able to cope with the level water on the field. This can be caused by creek and river flooding or storm water flooding where they block the drainage exit strategy. To mitigate this would consider options such as a retention pavement (using aggregate with void space etc.) or retention tank under the field to cope with the expected rain and volume.

ii. **Overland Flow Flooding** – where the water levels would rise and pass over the synthetic field and with it the water would contain silt and or be at a flow rate that would damage the pavement and or lift the carpet. This is the most dangerous and should be avoided at all costs as the likelihood that this could, depending on the level and speed of movement destroy the pavement and carpet beyond use. This mitigation for this scenario could include:
   - Build above the probable flood levels
   - Re-route the water flow path around the field
   - Build the field elsewhere

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

Flood planning considerations for synthetic sports surfaces

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

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

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

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

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

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

Mitigation Strategies

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

Drainage back-fill

Calculate the level of water needed to discharge in an hour from the agreed ARI event, 90% of fields in Australia are aligned with this simple procedure.

Design drainage strategy (size of pipes, level of retention etc.) that will be needed to move that amount of water through the synthetic sports surface system.
Ensure that the storm water discharge can cope with the volume of water, if not build a retention/holding tank.

Flood basin

Calculate the level of water that would expect to be held and for how long in a typical flood that is experienced (e.g. 1,000mm of water for 3 days etc.) and identify that as cubic meters of water that needs to be retained.
Identify if the field can be built up and the retention space (aggregate base or tank) so that this can hold the water.
Ensure that any flood flow is curtained by having drains on outside of path and field of play to take the water under the field etc.
Example (below) of Gore Hill NSW which was designed to cope with a 1m flood annually – under the field.

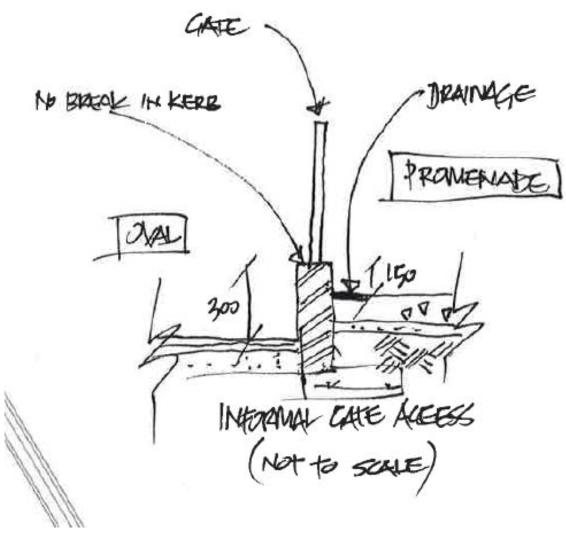

Figure 3: Flood Flow

Flood path

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

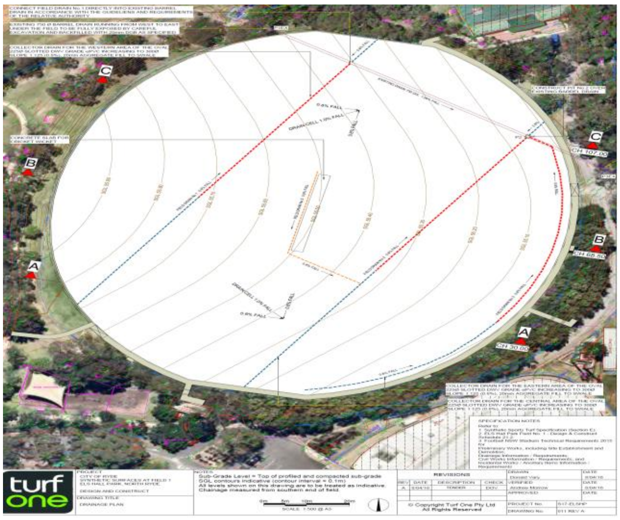

Figure 4: Typical Design for an Overland Flood Scenario by Redirecting the Flood Path Under the Field of Play (source: Turf One)