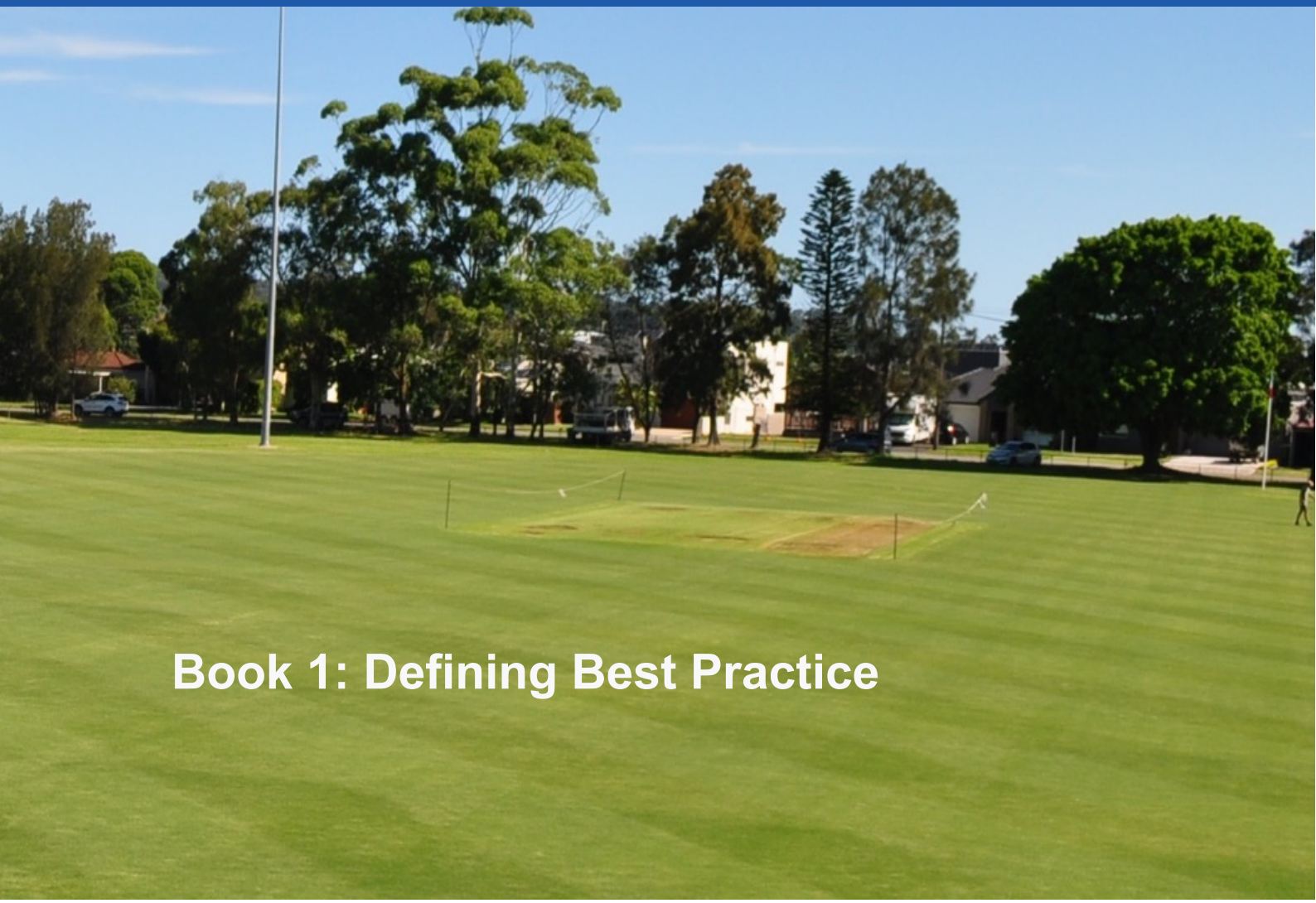
Best Practice Sporting Fields

A guide for turf surfaces in the Lower Hunter



Book 1: Defining Best Practice

Cover Picture: Feighan No. 1 Oval Warners Bay

Published by Hunter Water

36 Honeysuckle Dr, Newcastle West 2300, Australia

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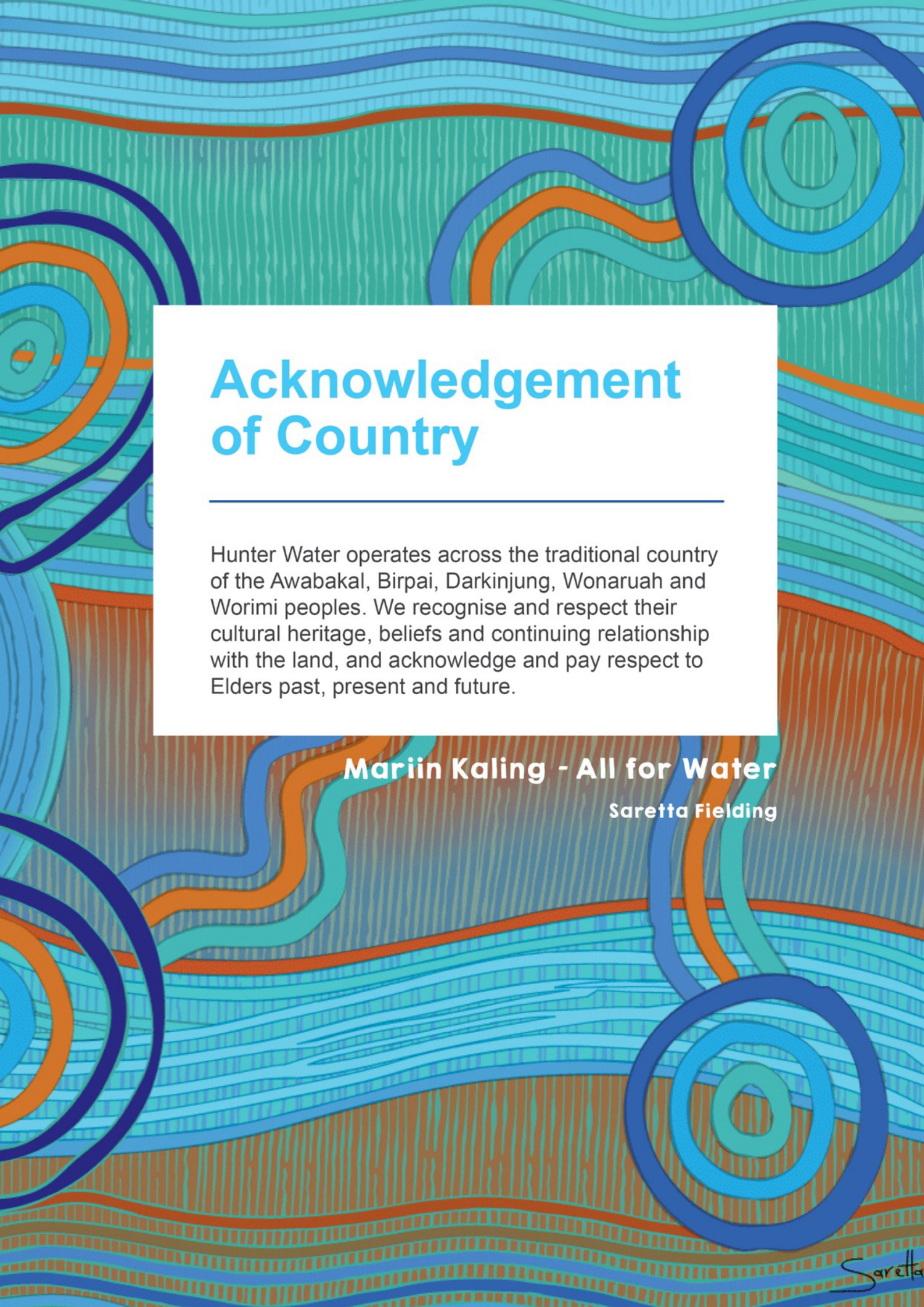

ACKNOWLEDGEMENTS

These guidelines were developed as part of an EPA Waste Less Recycle More grant, with Hunter Water commissioning and co-funding the project. The guidelines describe the best practices needed to construct, amend and maintain turf sporting fields and open space within the Lower Hunter.

The authors wish to acknowledge the contributions to these guidelines from the reviewers as well as industry leaders and representatives such as:

- Graeme Logan (Head Curator at Bankwest Stadium)
- Chris Chapman (President, NSW Sports Turf Association)
- Matthew Plunkett (Turf NSW).

The guidelines have also been enhanced through the direct and indirect contributions of our colleagues in the sector, including many current and former Council staff.

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Brief biographies for authors and reviewers are contained in Appendix A of this book.

PREFACE

Every authority which is responsible for the provision and maintenance of recreational space will have overarching strategic plans, policies and programs that span the whole organisation. Recreational areas will be a designated sector within these plans. Historically, this sector has always played poor cousin to other sectors within the overall budget provisions.

There is no hope for natural playing fields to provide for the recreational needs of the community if there is no budget for carrying out the proper construction, care, and maintenance they need. One-off ex gratia grants for building new synthetic recreational areas are not the answer to the problems arising from greater demand for use. The assumption behind these grants is that it is impossible for natural fields to carry the workload required by the community. This is not only false, but it is used by the purveyors of synthetic turf as part of their mantra for pushing for these installations.

Natural turf properly constructed and maintained as fit for purpose can carry as much load as synthetics with far fewer environmental negatives. In many cases, what has been notably lacking is the quality of the knowledge, immediately available, in house, to adequately plan, deliver and maintain these facilities in an environmentally and economically responsible manner.

These best practice publications are an attempt to provide some useful guidelines to the planning for this sector to rise to better heights, with better use of natural turf and water resources into the future. The information in these pages is presented with the background of using Best Practice guidelines to produce ‘fit for purpose’ playing fields. What this means in practice is that these fields can be used safely and efficiently without fear of being injured. Evaluation of the playing field can be done by the facility manager or an independent third party. The evaluation of the field needs to be based on the assessment of the following:

- turf cover
- hardness
- evenness
- quality of traction
- waterlogging
- performance under water restrictions and the total sport use for the field.

Peter McMaugh AM

Industry leader, 60 years of experience

Turf breeder and Agronomist

Turfgrass Scientific Services Pty Ltd

Turf industry doyen Peter McMaugh receiving his Member of the Order of Australia (AM) at a special investiture ceremony held on 17 May 2019 at Government House in Sydney.

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THE GUIDELINES IN A NUTSHELL

These guidelines were developed as part of an EPA Waste Less Recycle More grant, with Hunter Water commissioning and co-funding the project. The guidelines describe the best practices needed to construct, amend and maintain turf sporting fields and open space areas within the Lower Hunter.

What is the current situation in the Lower Hunter?

Assessments of sporting fields across the Lower Hunter found that:

- 64% of 256 fields were in marginal (23%) or poor (41%) condition. Acceptable playing surface standards for community fields (local, district, regional) are described in Table 3.1 (Chapter 3)
- 77% of fields receive low levels of wear, with only 6% receiving high wear levels (Chapter 2, Figure 2.3). Field condition was not linked to wear, with some high wear fields performing well
- 54% of fields were compacted. Other soil issues included low fertility, layering, lack of soil depth and too sandy (Figure E.1). Book 2 describes techniques for addressing soil problems
- 35% of fields have waterlogging issues. Book 3 has techniques for overcoming these problems
- not all fields have an automatic irrigation system. Irrigation performance assessments at 60 sites (94 fields) found more than two thirds have design flaws, with 70% having been poorly installed. Best practice irrigation is described in Book 4.

Figure E1: The impact of soil on the performance of five kikuyu fields. All fields receive low levels of wear, similar applications of fertilisers and none of the sites have an automatic irrigation system.

What are the key characteristics of best practice sporting fields?

The guidelines adopt a principles-based approach, rather than providing a generic formula. This means that the application of the guidelines will vary based on the individual site characteristics. However, best practice sporting fields and open spaces have common characteristics that enable them to meet the best practice functionality benchmarks. The characteristics of best practice turf sporting fields and open spaces are described in Table E.1. Adequate budget for appropriate construction and required maintenance is crucial.

Table E.1: Characteristics of best practice sporting fields

Characteristic	Description (or measures to be implemented)
Can handle sport wear levels (Books 1, 2, 5, 6, 7)	Field meets playing surface benchmarks throughout the year, with the field having adequate carrying capacity to handle the sport usage levels. To achieve this the field will need to have: • a turf cultivar that can tolerate the foot traffic (wear) levels at the site • soil that does not restrict turf growth • an appropriate level of maintenance
Field has healthy soil (Books 1, 2, 6, 7)	• adequate soil depth (>200mm topsoil, deeper required on some sites) • soil is moderately friable and does not set hard (i.e., is well structured) • soil has acceptable nutrient balance and holding capacity • topsoil and subsoil have appropriately matched characteristics • soil is appropriately amended so it does not limit the performance of the field or increase the irrigation requirements. Note: it is usually more cost effective (and environmentally responsible) to amend site soil rather than import soil
Excess water is effectively managed (Books 1, 2, 3, 6, 7)	After rain the fields return to play within an acceptable timeframe (Table 3.1). To achieve this typically requires: • no surface water runs onto the field from upslope areas • excess water that falls on the surface is removed as run-off by ensuring field has sufficient crossfall (1 in 70 to 1 in 100) and slope lengths less than 70 m. Alternatively, a slit drainage system can remove this water at a rate of at least 8 mm/hr over the entire field area • downward movement of water in the rootzone is not impeded by soil layers • excess water reaching the base of the rootzone is removed at a rate of at least 2 mm/hr by the subsoil and/or a subsoil drainage system
Water efficient (Books 1, 2, 4, 6)	Field meets irrigation water use benchmarks. To achieve this the: • soil has been amended to allow the field to meet the water use benchmarks • irrigation system has been designed to a performance standard • irrigation system has been accurately installed • irrigation system has been adequately maintained • appropriate irrigation scheduling has been used
Drought resilient (Books 1, 2, 5, 6)	Soil has been amended and an appropriate turf cultivar has been used to ensure the field not only survives the drought, but has less than 10% loss in carrying capacity under severe water restrictions
Field receives appropriate maintenance (Books 1, 7)	• weeds are controlled • sufficient fertiliser is applied (sites receiving higher wear need more) • adequate aeration occurs to overcome compaction at each site • wetting agents applied at sites prone to becoming water repellent • routine maintenance and minor repairs are undertaken in a timely manner
Effective management of foot traffic (Books 1, 7)	Users spread wear evenly (for example, don't train in game day goals, train on the other side of the field)

What represents best practice planning?

Current approach

Recently there has been a trend to base sports strategies on a comparison of booked hours with an hourly “limit” for playing fields. This approach is not scientifically valid and leads to errors because:

- booked hours significantly overstate usage hours (clubs overbook to “reserve” their field)
- booked hours are not related to wear levels (sport code, player ages, player numbers, etc.)
- carrying capacity is not a single number and varies widely between sites (Figure E.2).

Figure E.2: Even though these two fields have the same turf cultivar, their carrying capacities differ greatly.

Best practice planning

Best practice planning involves using an independent, technical expert in natural turf to compare wear levels and carrying capacity at each site (or a representative sample). The expert should identify the works, and costs needed to increase carrying capacity, so all fields can handle the existing and future wear levels. The sport strategy should:

- ensure all sport fields can meet best practice benchmarks with the available resources (e.g. budgets, maintenance personnel, water)
- mitigate the risk and impact of drought
- be developed in collaboration with internal and external stakeholders and the community
- align with organisational goals, such as sustainability and social inclusion objectives.

What is involved in delivering best practice open spaces?

To comply with best practice the design, procurement and construction of sporting fields all need to be aligned with best practice benchmarks and the objectives of council’s integrated sports strategy. Furthermore, best practice involves ensuring there is adequate time for the project to be delivered.

Separate design from construction (avoid design and construct)

Best practice is to separate the design and construction processes. Historically, processes such as “design and construct” have not delivered best practice outcomes in the Lower Hunter. They have resulted in poorer playing surfaces which have higher watering requirements, minimal drought resilience and lower carrying capacities (Figure E.3).

The design of the sports field and its supporting infrastructure (e.g. irrigation and drainage) should be undertaken by a design team that is independent of any parties that may potentially be involved in the construction process, and to the performance standards outlined in these guidelines.

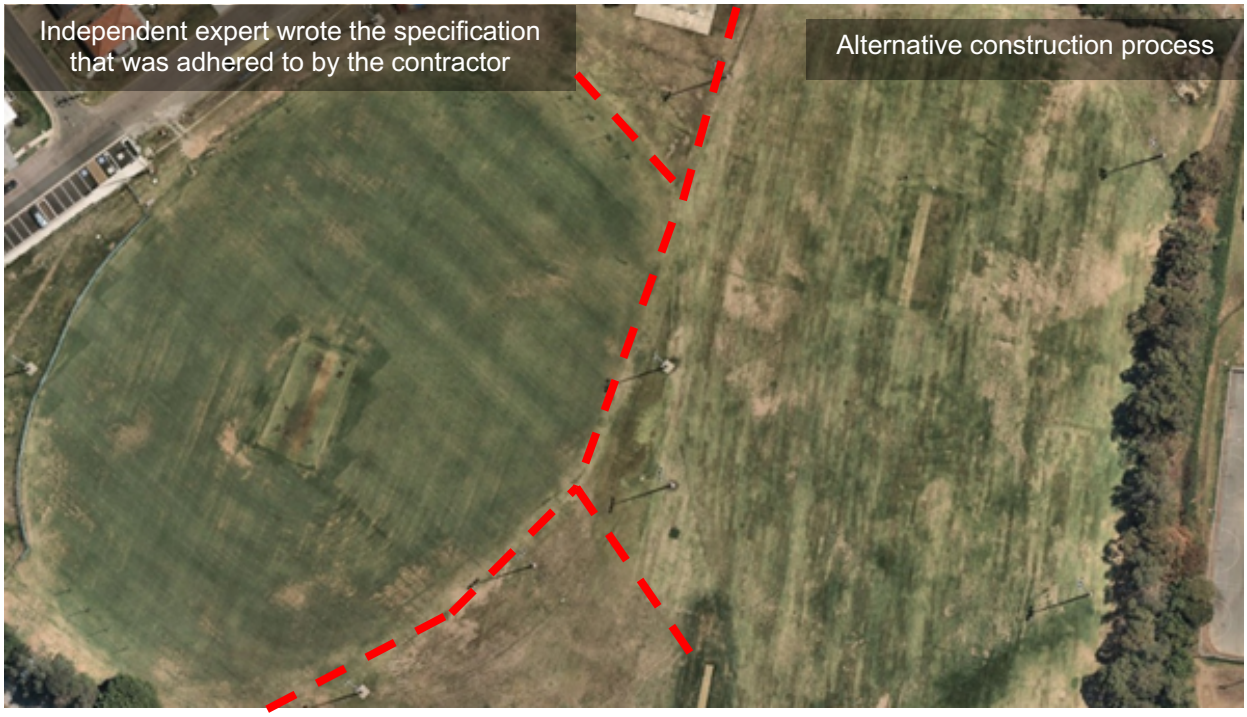

Figure E.3: Contrasting outcomes of two methodologies used to construct adjacent fields. The field on the left was rebuilt first according to best practice and performed above expectations. The field on the left has a superior playing surface, and 70% more carrying capacity during drought (Nearmaps image).

Best practice procurement

In general, best practice procurement involves identifying potentially suitable contractors through an Expression of Interest (EOI) process. Based on their capacity to comply with the specification, contractors are shortlisted and then invited to quote on the works. A preferred contractor can be engaged following evaluation of quotations. In situations where budget shortfalls exist, liaise with the independent expert on potential cost savings or investigate options to increase the budget.

What does best practice construction involve?

Best practice involves ensuring the works are completed according to the design. Quality control throughout construction is crucial. During the recent construction of eight fields, modifications to the design reduced the carrying capacity by 30-70%. Best practice is to ensure there is suitably qualified, independent technical support to the project manager during the construction phase.

What maintenance practices represent best practice?

Without appropriate maintenance, all sporting fields will deteriorate, regardless of their construction type. Best practice involves performing tailored maintenance activities to address only the issues that are limiting sporting field performance at the site in question. For example, frequent aeration is crucial on most sites, but is rarely required on some fields in the coastal areas of Port Stephens. The most common maintenance issues on sporting fields in the Lower Hunter include:

- weeds: pre-emergent herbicides would address many of these problems
- lack of fertiliser, with this exacerbated by the lack of soil amendment during construction
- water repellency: wetting agent application is required
- unsuitable topdress materials: these are typically too sandy and result in thin turf cover

Many sites require monthly aeration, but this seldom occurs due to lack of resources (equipment, budget, etc.). As result, the fields are very hard and have limited carrying capacity. However, annual aeration would have been sufficient if the soil had been amended during construction.

How can the clubs help look after their home ground?

Users and clubs can dramatically improve the condition of their sporting fields by spreading wear more evenly (Figure E.4), cleaning out drains, hand chipping weeds and performing repairs to worn areas at the end of the football season. Council may lack the labour force to perform these tasks.

Figure E.4: The club would have a better playing surface if wear was spread more evenly at this site. This could be achieved by undertaking more training on the field used less on game day (Nearmaps image)

Best practice is financially responsible

Sporting fields constructed and maintained according to best practice have a very high carrying capacity (some sites in Sydney can handle more use than is required by clubs on weeknights and weekends). When both lifecycle costs and carrying capacity are considered, natural turf fields built to best practice are at-least two to three times more cost effective than alternative options (Figure E.5). Budgets for constructing and maintaining fields are described in Book 5, Chapter 15.

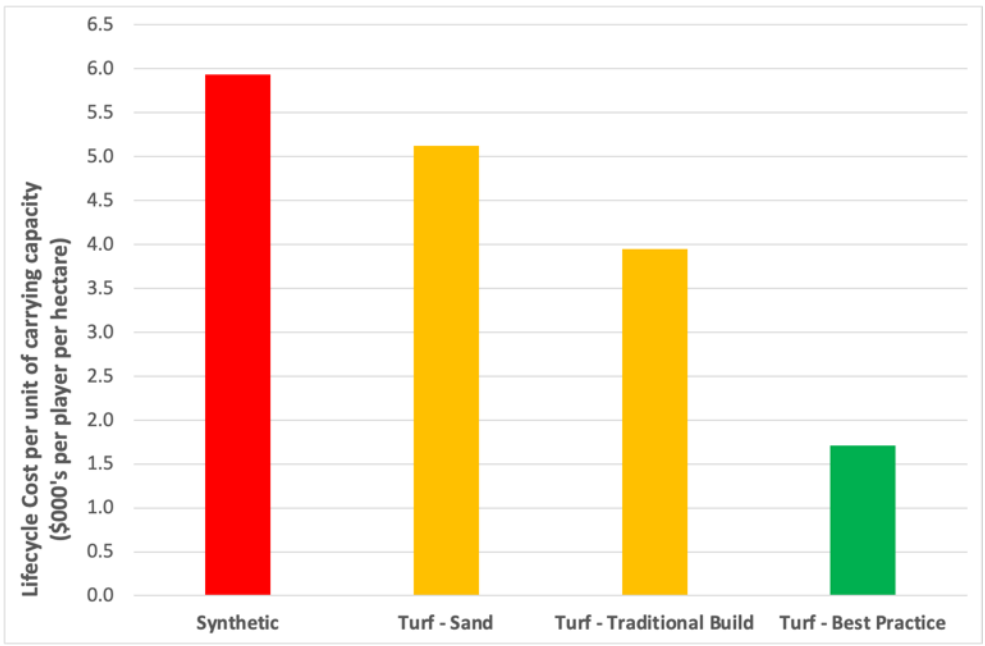

Figure E.5: Lifecycle costs per unit of carrying capacity for different types of field construction

CHAPTER 1: INTRODUCTION

These guidelines were developed as part of an EPA Waste Less Recycle More grant, with Hunter Water commissioning and co-funding the project. The guidelines describe the best practices needed to construct, amend and maintain turf sporting fields and open space areas within the Lower Hunter.

It includes parks and sporting fields in the Lower Hunter that are within the Hunter Water Area of Operations (Figure 1.1) including fields in the Council areas of Cessnock, Dungog, Lake Macquarie, Maitland, Newcastle and Port Stephens.

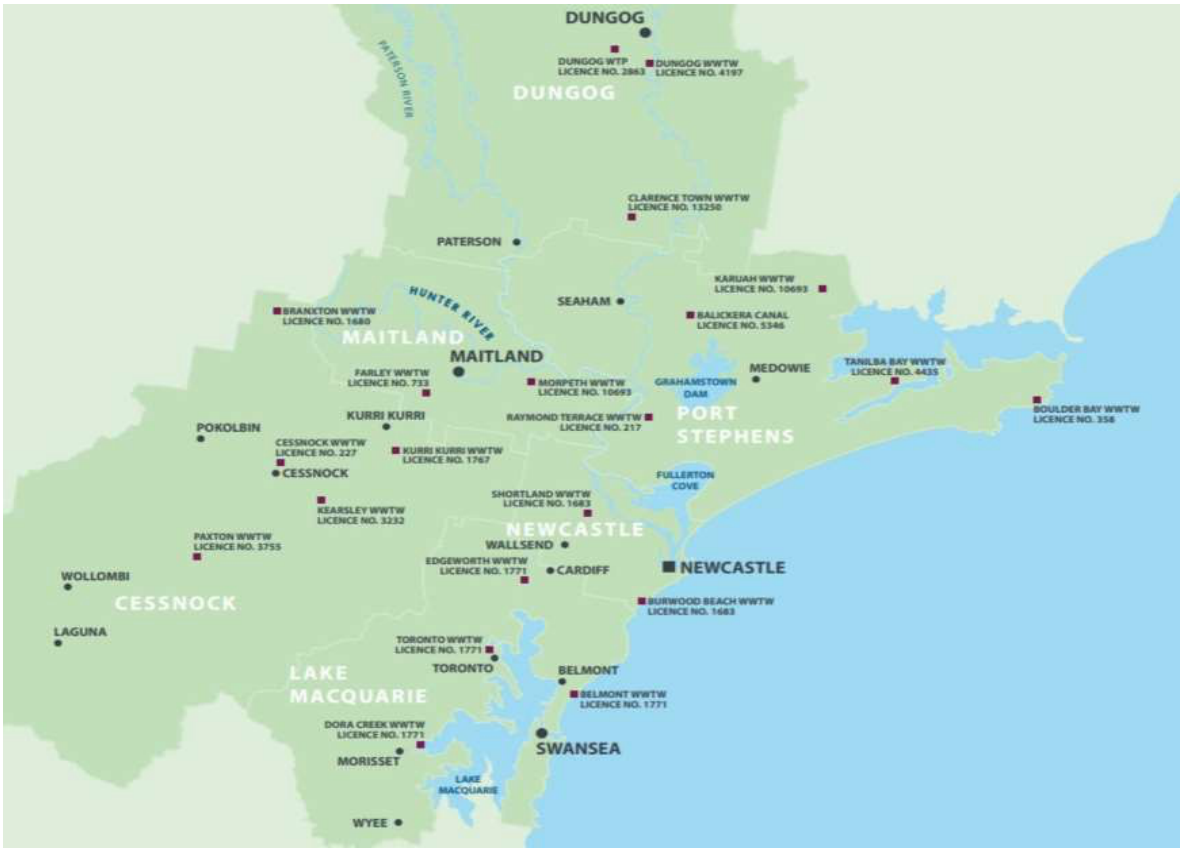

Figure 1.1: Areas in the Lower Hunter region where the guidelines are focussed.

There are 7 books in the series, with Book 1 (this document) introducing the best practice guidelines and describing the current state of play in the Lower Hunter. The guidelines are based on detailed assessment of the irrigation systems at more than 90 playing fields, as well as the soil, playing surface, microclimate and sport usage levels at over 250 playing fields in the Lower Hunter. As such they provide comments that are specific to the soils, climate and typical sport usage levels observed in the Lower Hunter.

Broadly speaking the Lower Hunter can be divided into the coastal zone which typically has milder winters and summers (Figure 1.2) but receives significantly more rain than the inland zone (Figure 1.3). It is important to note that from Figure 1.3, the major differences in rainfall between the coastal and inland zones are between March and September, which is when turf growth rates are at their lowest.

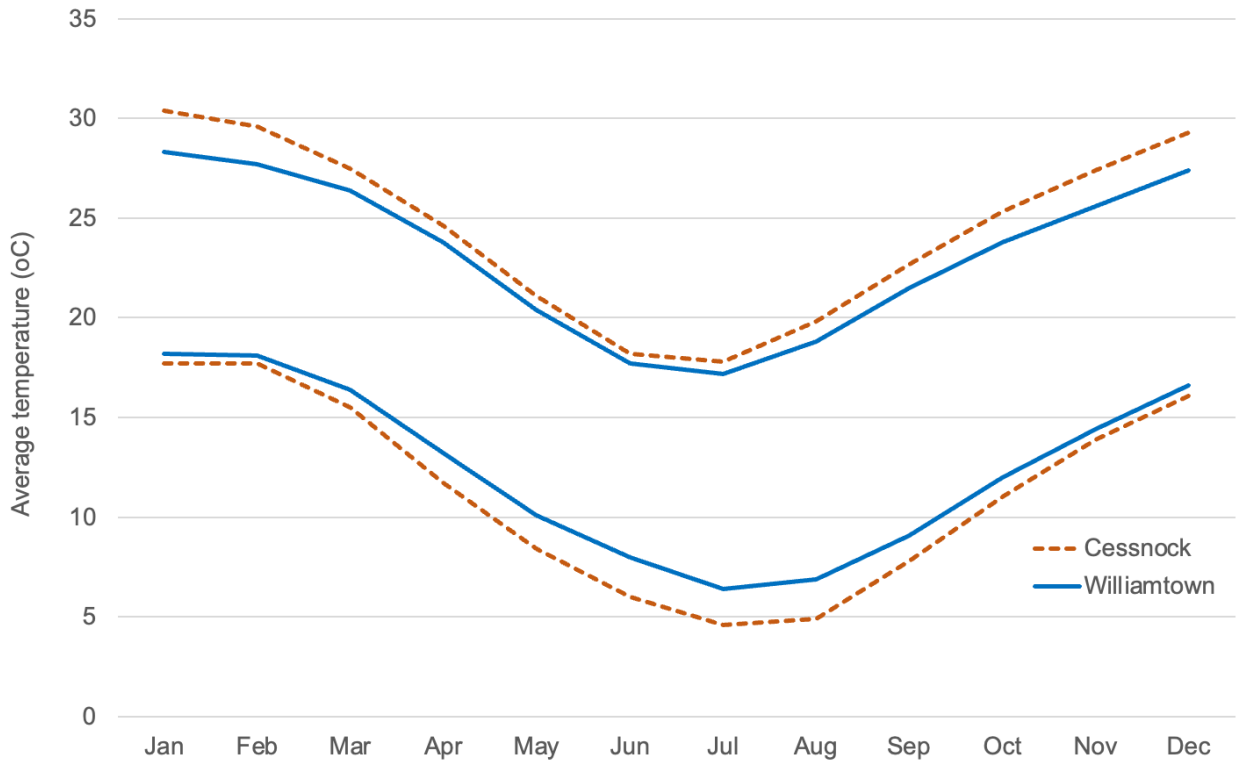

Figure 1.2: Average minimum temperature (lower lines) and average maximum temperature (upper lines) for different parts of the Lower Hunter.

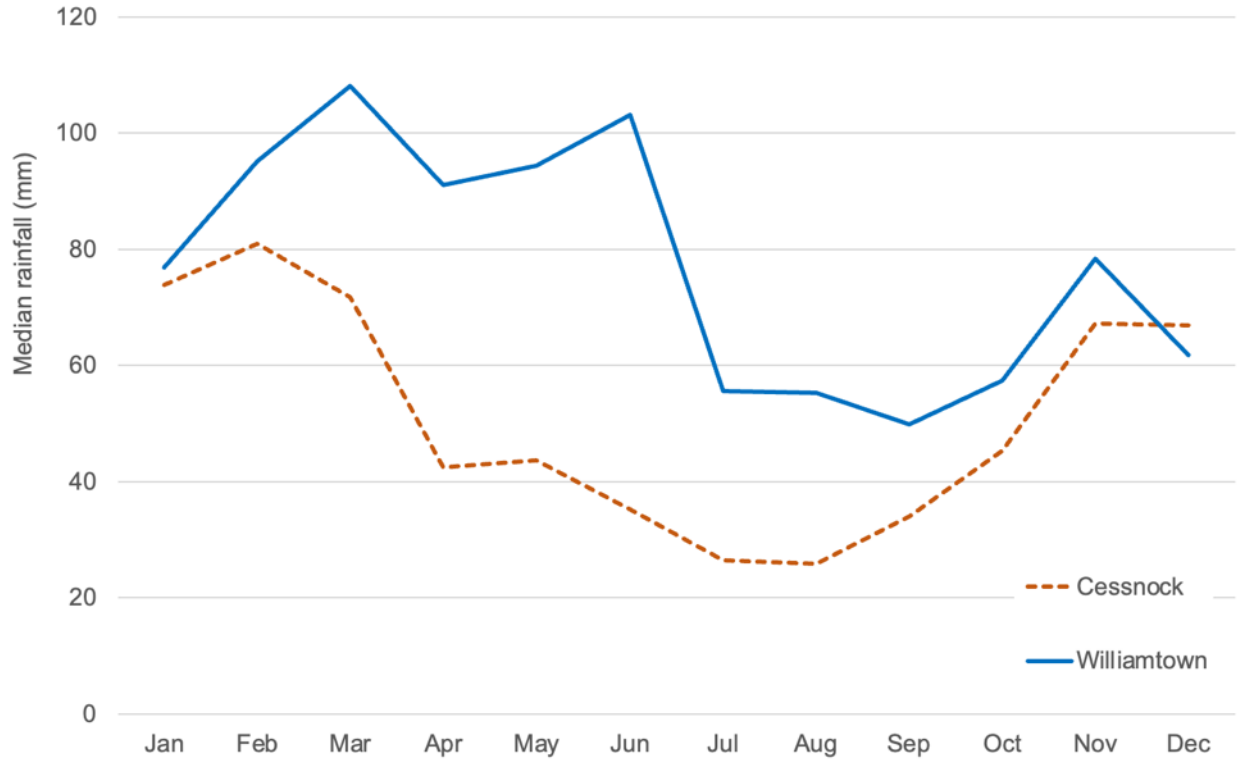

Figure 1.3: Median rainfall in different parts of the Lower Hunter.

Purpose of the best practice guidelines

There is an urban myth that most sporting fields struggle because of overuse. This is rarely the case in the Lower Hunter, with many of the sporting fields receiving low levels of wear. Instead, lack of budget, combined with poor construction and/or maintenance practices are generally the reason why the turf struggles. A lack of understanding of key principles often results in such poor outcomes and practices such as:

- failing to amend the soil, so the playing field is dangerously hard and the turf struggles to grow
- constructing a new sporting field with very sandy soil which then used almost 9 ML/ha of water in the first year and struggles during water restrictions (insert of Figure 1.4)
- patching the same area repeatedly with a turf cultivar that cannot handle the site wear levels
- installing a synthetic field (costing millions) at a site where natural turf could easily have handled the sport usage levels if the field had been amended correctly (costing hundreds of thousands)
- laying turf rolls with clay soil over sand slit drains so the slits no longer function.

The purpose of these best practice guidelines is to provide the science and evidence to improve the planning, design, construction and management of sporting fields and open space areas so that turf surfaces can perform well with limited resources, e.g. water.

The guidelines are meant to provide practical information for use by all those involved in sporting fields and turf open space including recreational planners, landscape architects, club volunteers, project managers, managers allocating budgets and resources, greenkeepers and grounds staff.

Figure 1.4: Despite having the same turf cultivar, these two irrigated fields performed very differently during the level 1 water restrictions due to important differences in soil type and preparation. Apart from requiring more water, the imported sand field poses a risk to council and the site users as it might struggle to even survive during level 2 or level 3 water restrictions.

Importance of the guidelines

There are numerous studies that have identified many benefits from having healthy turf in public open spaces. These benefits can be broadly categorised into economic, social, health and environmental. The quantified benefits include (Hort Innovation 2019)[1]:

- Avoided costs of home cooling from lower temperatures in the local environment
- Greenhouse gas sequestration, each square metre of turf can capture about 0.5 kg CO_2 each year
- Public turfed greenspaces serve as community focal points for recreation, socialisation and improve physical and mental health for neighbourhood residents. These benefits are reflected in the willingness of households to pay for publicly accessible turfed green spaces
- Avoided costs of synthetic turf, which (Football NSW and Northern NSWF, 2017)[2]
    - costs around $1.3 million per soccer field to construct (roughly double the per hectare cost of the 2014 MCG playing surface replacement project[3])
    - over $58,000 per year in maintenance and replacement costs over its lifecycle
- Stormwater management, as turf provides a surface where rainfall can infiltrate
- On a hot day, healthy turf can be more than 30°C cooler than a bitumen road or synthetic turf (Figure 1.5).

These guidelines provide benchmarks for playing fields and irrigation systems along with recommendations on how to construct and maintain them according to best practice. If this occurs then the guidelines will not only reduce the resources needed to maintain playing fields, but by improving the condition of the fields will encourage sport participation with the associated health and environmental outcomes.

Healthy turf (34.5°C)

Less healthy turf (48.1°C)

Road in full sun (65.0°C)

Synthetic grass (69.3°C) – white crumb infill (not as hot as black rubber infill)

Figure 1.5: In addition to removing carbon dioxide from the atmosphere, natural turf can play a key role in combatting urban heat islands as shown by these temperatures taken on a 38°C day.

Limitations of the guidelines

The guidelines cover fundamental principles pertaining to soil, turf and irrigation from a practical perspective. Though many of the principles directly apply, these open space guidelines have not been written for:

- elite stadium fields such as McDonald Jones Stadium (home of the Newcastle Knights)
- single purpose turf areas such as lawn tennis courts, bowling or croquet greens
- specialised areas such as turf cricket wickets, golf greens or turf farms
- turf areas used for dog or horse sports (racing, polo and polo cross)

Whilst these guidelines focus mostly on sporting fields, the principles apply to recreational parks.

Layout of the best practice guidelines

The guidelines have been divided into seven books, with chapters as follows:

Book 1 **Defining Best Practice**	1. Introduction 2. State of play in the Lower Hunter 3. Benchmarks for best practice sporting fields
Book 2 **Soils and Turf**	4. Suitable soil for a sports field 5. Amending soils 6. Selecting an appropriate turf cultivar
Book 3 **Drainage**	7. Waterlogging on Lower Hunter sporting fields 8. Removal of excess water 9. Slit drains
Book 4 **Irrigation**	10. Water supply 11. Irrigation design and installation 12. Irrigation maintenance and operation
Book 5 **Planning**	13. Identifying over used fields 14. Developing an integrated strategy 15. Budget requirements for best practice sports fields
Book 6 **Project Delivery**	16. Project planning and procurement 17. Construction management
Book 7 **Maintenance**	18. Renovation works 19. Routine maintenance activities 20. Activities to improve turf appearance 21. How clubs can make a difference

CHAPTER 2: STATE OF PLAY IN THE LOWER HUNTER

There are about 400 public playing fields in the Lower Hunter, with schools, TAFEs, universities and private organisations also having playing fields. Dr Mick Battam (certified professional soil scientist) assessed 256 of these playing fields (generally at the end of the winter sport season) and found:

5% (13 fields) were in good condition

31% (79 fields) were in acceptable condition

23% (59 fields) were in marginal condition

41% (105 fields) were in poor condition

Players and spectators often focus on ground cover when commenting on the condition of the fields. However, from a risk management perspective, the emphasis should be on those factors that impact on health and safety such as hardness and trip hazards. Organisations that ignore these elements do so at their own peril (Peter McMaugh AM, 2021).

Do the fields have reasonable turf cover?

Acceptable benchmarks for turf cover on playing fields are described in Chapter 3 (Table 3.1). Of the 256 fields assessed in the Lower Hunter, 51% had unacceptable turf cover on the central playing corridor and outfield areas. Even worse cover was observed in high wear areas such as goal boxes.

Whilst large areas of bare ground were observed on a few sites (Figure 2.1), weeds were generally the reason for poor cover. Common weeds in the Lower Hunter and their control are discussed in Book 7.

Are the sporting fields too hard?

A 2.25kg Clegg Hammer is a widely adopted, current method for measuring surface hardness on natural turf fields. The hardness of fields in the Lower Hunter has been recorded using the third drop, consistent with widely adopted measures in the Australian context. Internationally, there is ongoing debate on the appropriate number of drops to be used, with one drop being preferred in the USA and three drops in Australia (Twomey 2014[4], ASTM 2002[5]). Australian research has shown the third drop correlated most closely with perceptions of hardness from Australian rules football players (Twomey 2014[4], Aldous 2005[6], Chivers 2003[7]). Given the debate, it is critical to use a consistent approach and report the methodology used, as it is inappropriate to compare first drop measurements against hardness benchmarks for the third drop.

The measurements of hardness on Lower Hunter fields were compared with those required for safe play in Table 3.1. For the 256 sporting fields assessed in the Lower Hunter it was found that:

- 44% of goal areas were very hard, with 13% marginally hard; and
- 30% of outfield areas were very hard, with 13% marginally hard.

The hardness results are consistent with other findings, as compaction is a significant issue on 54% of playing fields in the Lower Hunter. At numerous sites hardness readings often greatly exceeded safety limits (Figure 2.1). These sites require either intense and frequent aeration or soil amendment with suitable amenders such AS 4454 composted garden organics.

In their current state, to maintain acceptable levels of hardness, most fields require aeration 6 to 12 times annually. This is costly and beyond the available maintenance resources for most councils and clubs. To deal with surface hardness, additional irrigation has sometimes been used and/or requested by clubs. Using irrigation to manage surface hardness on sporting fields with a soil growing media is not best practice. It is a practice fraught with danger during the autumn and winter months, as waterlogging and use of the field while wet is likely to cause even more damage.

Figure 2.1: A third drop Clegg hammer reading of less than 120 is required for safe play on local sporting fields (Table 3.1). However, this field had readings ranging from 220 to 430, with the bitumen road having a value of 600. The incorporation of large quantities of organic matter is needed to address the hardsetting nature of many of the soils in the Lower Hunter. The reasons why soils in the Lower Hunter set hard are outlined in Book 2.

Do the fields have acceptable evenness and traction?

Surface evenness was assessed for 256 playing fields in the Lower Hunter and compared with acceptable benchmarks in Table 3.1. It was found that:

- unacceptable levels of evenness were observed on 5% of fields
- marginal levels of evenness were observed on a further 20% of fields.

Low levels of traction were observed on about 8% of fields, with this value about 20% in goal mouths.

Do the fields remain waterlogged after rain?

The time to return to play after significant rainfall events was assessed for 256 playing fields in the Lower Hunter, with waterlogging found to be a:

- major problem on 8% of fields
- significant problem on a further 27% of fields.

Waterlogging is discussed in Book 4.

Figure 2.2: Water lying in a depression due to a combination of compaction and unevenness, with the rest of the field relatively dry.

Can the fields handle the sport wear levels?

Sport participation data was assembled for 256 playing fields based on participation numbers provided by regional sporting bodies (e.g. Northern NSW Football), sporting clubs and council sport booking officers. During the winter sport season 17% of fields in the Lower Hunter receive moderate levels of wear, with only 6% receiving high levels of wear (Figure 2.3). The distinction between use, wear and carrying capacity is crucial and is discussed further in Book 5.

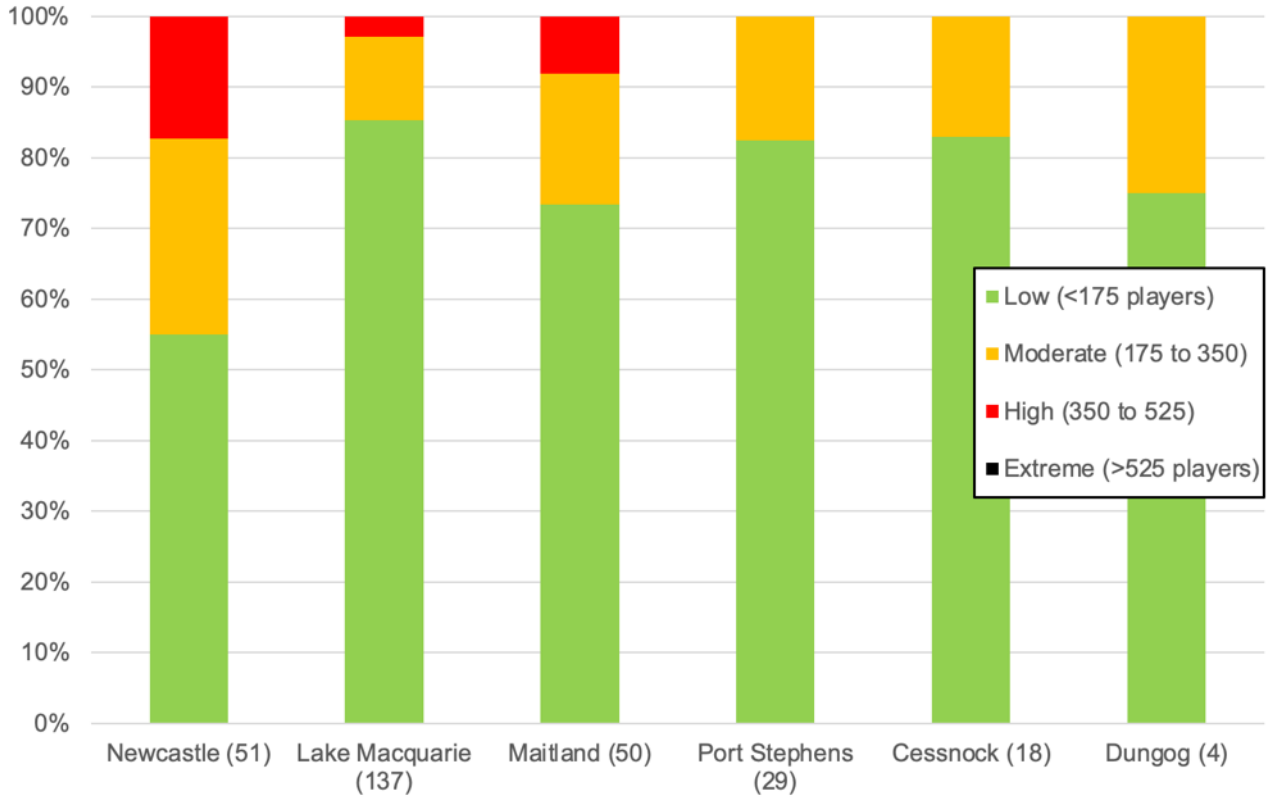

Figure 2.3: Percentage of sporting fields receiving low, medium, high and extreme levels of wear based on registered players (2018 and 2019 data). Results based on the evaluation of 256 sporting fields in the Lower Hunter (AgEnviro Solutions, 2019).

Figure Notes:

[1] Values refer to either a full-sized soccer, rugby league, rugby union or AFL field. Player numbers provide only an indicative guide to wear with detailed calculations required to determine exact wear levels for individual fields.

Despite 77% of fields receiving low levels of wear, many of these sites cannot handle small amounts of wear due to issues with the soil, waterlogging, weeds and/or other items. If amended according to best practice, then:

- 94% of fields could meet acceptable playing surface benchmarks throughout the year (Table 3.1)
- the remaining 6% would meet district level benchmarks for 9 to 11 months of the year, with the sites still suitable for hosting community level sport (Figure 2.4). Aesthetic considerations such as turf colour often play a role in the community's perception of the field.

These findings are consistent with the performance of sporting fields in other areas that have been constructed and maintained according to best practice and handle high levels of wear (Figure 2.4).

Figure 2.4: Sporting field that was previously a dust bowl (upper). It was rebuilt according to best practice (lower) and now handles 550 players per week and recovers without turf patching (insert). Whilst the turf is dull and thin by the end of the soccer season, it remains functional as a local field and rapidly recovers (insert). This site receives more intense wear then any field in the Lower Hunter and would perform even better if more fertiliser was applied and other measures were implemented.

How many fields could handle Level 2 water restrictions?

If Level 2 water restrictions were in place during the warmer months, then the impact on fields with automatic irrigation systems is likely to be a:

- 45% reduction in the number of players these fields can handle relative to their current carrying capacity
- 20% of these sporting fields would deteriorate to the point at which they struggle to survive and will likely require reconstruction or intense irrigation to recover.

There are numerous examples of rainfed fields in the Lower Hunter that routinely survive extended periods with minimal summer rainfall and irrigation. These fields generally receive low levels of wear and have not been constructed using a sand based growing media (Figure 2.5). Therefore, by constructing fields correctly and reducing wear, the turf can better handle the lack of water.

A complimentary drought management strategy is to use non-potable water sources at strategic locations where usage could be concentrated to relieve pressure on sites with very limited or no water availability. However, the water quality of the non-potable water source needs to be carefully reviewed to ensure it doesn't detrimentally affect the health of the soil or the turf.

Figure 2.5: An imported sandy mix was used to construct a football field in the centre of Edgeworth athletics field. This soil is so poor that almost all the turf has died, with the adjacent sandy loam area (natural soil) performing reasonably well in January 2020 despite receiving no irrigation and only 6 mm of rain in the 70 days prior to this photo being taken.

Do the irrigation systems meet best practice benchmarks?

Across the Lower Hunter, around 60 irrigation systems have been assessed, covering 5 parks and 94 sporting fields (numerous systems cover multiple sports fields). Most of these do not meet best practice benchmarks, with:

- 67% having design flaws (e.g. uneven watering, inadequate separation of specialist areas)
- 70% having poor installation practices (e.g. inaccurate placement of sprinklers, wiring issues, unstable/uneven valve boxes, inappropriate material in trenches)
- nearly all fields not having a proactive, regular maintenance regime. Irrigation maintenance tends to be reactive, dealing with obvious issues only (e.g. pipe bursts, sprinklers not turning). The lack of regular, visual inspections has become clear during formal assessments with faults such as sprinklers being too low, tilted or having incorrect arcs being frequently observed. Numerous broken sensors have been observed, with the sensor frequently found not being wired into the controller or placed into bypass mode
- irrigation scheduling has been highly variable, with rules of thumb being used in many cases. Based on the characteristics of the systems assessed, the scheduled run times were incorrect for most systems.

There has been some substantial progress in parts of the Lower Hunter between 2010 and 2020, with many Councils now having central irrigation control systems to better manage numerous sites. Furthermore, since 2014, many new irrigation designs have been completed to best practice. However, this progress is not guaranteed to continue, with some recent new irrigation designs not meeting best practice benchmarks.

Given the findings above, there is considerable scope for improvement in the performance of irrigation systems on sporting fields in the Lower Hunter.

CHAPTER 3: BENCHMARKS FOR BEST PRACTICE SPORTING FIELDS

The purpose of these best practice guidelines is to facilitate the amendment of turf areas in the Lower Hunter so they can perform to an acceptable standard using a modest amount of water and budget. There is no single recipe for constructing or amending sporting fields. This is because sites vary with regards to:

- growing conditions (soil, climate and microclimate)
- wear levels
- available maintenance budget.

As such, a practice that might be crucial at one site is not required at another. For example, aeration is essential on most sites, but minimal aeration is required for fields on the Tomago sands. In this chapter we describe benchmarks that define best practice sporting fields. These not only consider industry standards, but also the growing conditions in the Lower Hunter. Based on the assessment of 256 fields it was found that:

Fields built to best practice can easily handle the wear from sport currently played on 94% of sites in the Lower Hunter. As such, these fields should be in good condition throughout the year.

For the remaining 6% of fields that receive higher levels of wear, acceptable turf cover could be maintained by building the field according to best practice. Whilst the turf on these fields will become thinner near the end of the football season, they should remain in acceptable condition for local facilities and recover with minimal turf patching if correctly maintained.

Figure 3.1: Despite receiving more wear than 92% of sporting fields in the Lower Hunter, Kahibah Oval no.1 soccer field maintains good cover even at the end of the soccer season. As such, if all fields in the Lower Hunter were built and maintained according to best practice then most of the irrigated fields should look no worse than Kahibah Oval. Photo taken in August at the end of the soccer season. The works at Kahibah Oval are still not complete, with the site requiring a drain to prevent water running onto the field and a closely spaced slit drainage system that is not required on many other sites.

Best practice fields remain in an acceptable condition

Sporting fields need to be maintained in an acceptable condition to ensure safe play and encourage participation in sport. Many Councils and/or sporting groups have developed procedures to describe the condition of fields, with more than 65 characteristics commonly used.

The parameters that rank highly on these lists and directly measure factors that can affect play include:

- surface hardness: with injuries more likely when fields are too hard or too soft
- traction (grip): if there is no grip then players will slide when they attempt to stop which is not only more dangerous, but can cause more damage to the turf
- surface evenness
- turf cover: as distinct from bare ground and weed cover
- timeframe in which the field should be playable after significant rain.

Table 3.1 provides minimum requirements for each of these parameters for local parks through to regional fields, including those regional facilities which are aiming for more elite level playing surfaces. Those sites that host representative sport may choose to also adopt other sport specific parameters such as ball bounce and roll. Field condition should be carefully interpreted as it will vary with position on the field, weather conditions, time of the year and sport usage patterns.

Table 3.1: Acceptable playing conditions (Adams and Gibbs, 1994[8], Canaway, 1990[9]; Winterbottom, 1985[10], Peter Martin pers com.)

Category		Safe play requirements				Time after significant rain play can resume without damage [4]	Examples
		Turf Cover [1]	Evenness [2]	Hardness [3]	Traction		
Sporting Fields	Major stadiums	Beyond the scope of this document					MacDonald Jones
	Regional (Elite)	95 %	8 mm	80 to 100	>25 Nm	30 mins	Maitland No. 1 National Park No. 1
	Regional Fields	95 %	10 mm	80 to 100	>25 Nm	3-6 hours	Cessnock Sportsground, National Park No. 2, Cahill
	District Fields	90 %	12 mm	60 to 110	>20 Nm	6-12 hours	Turner Park (Hornets), Cooks Square Park, Jack McLaughlin, Lyall Peacock, Passmore,
	Local	85 %	12 mm	60 to 120	>20 Nm	12-24 hours	Most Fields
Passive Rec. Areas	Priority	90 %	12 mm	60 to 110	Achieved by turf cover criteria	6-24 hours	Speers Point Park, Newcastle Foreshore
	General	80 %	12 mm	60 to 120		24-48 hours	

Table Notes:

[1] Turf Cover assumes no localised bare areas exceeding 300 mm in diameter. Excludes high wear areas such as the goal keeping box

[2] Evenness defined as the standard deviation of level from the mean, but single deviations not to exceed twice this figure

[3] Hardness defined as gravities as measured with Clegg Impact Soil Tester ("Clegg hammer") used in accordance with the manufacturer's instructions. Hardness values are for the third drop. First drop values can be around 20% lower than third drop values (Twomey 2014[4]), with larger differences observed in the Hunter. It is inappropriate to compare first drop values to third drop benchmarks, so upper limit benchmarks for the first drop would be substantially lower.

[4] Significant rain in the Lower Hunter is defined as 40mm of rainfall. The impact and likely recurrence of any individual rainfall event on return to play will depend on context, such as prevailing conditions (e.g. a prolonged period of consistent rainfall in winter) and the timeframe over which rainfall occurs (e.g. 15 minutes versus 6 days)

Best practice fields can handle their sport wear levels

Foot or vehicle traffic causes injury to turf by tearing leaves, stems, stolons, rhizomes and/or roots. As a result, some regrowth is needed to repair the damaged tissue to maintain the playing surface condition following use. The distinction between use, wear and carrying capacity is crucial and these terms are often confused. These elements are discussed in more detail in Book 5, but in broad terms:

- Use (or utilisation) refers to how many hours per week a field is played on (as opposed to booked) by users
- Wear refers to how much damage is caused by use, to a field in a standard condition, with multiple factors affecting wear including age of players, type of sport, standard of sport, number of players training per hour
- Carrying capacity refers to the amount of wear that a sporting field can handle whilst maintaining an acceptable playing surface (as defined in Table 3.1).

Carrying capacity depends on:

- site geographic location, size and microclimate
- turf species/variety/cultivar
- soil and drainage characteristics
- type of sport, number and age of players
- field maintenance practices
- field usage management (spreading of wear) and training patterns used by the clubs.

As a general guide for the Lower Hunter, a well-constructed and maintained football field with a wear tolerant turf cultivar, can tolerate more than 400 players (training and playing) each week during the winter sport season (Figure 3.1). At some sites, especially if wear is spread evenly, it is possible to handle more than 600 football players per field without the need to turf patch. The higher levels of use typically result in thinner turf for a few months at the end of the winter sport season (Figure 2.4), but the field is still suitable for playing non-representative sport.

To prevent the turf from deteriorating, best practice is to ensure all sporting fields are constructed and maintained so they have a carrying capacity that is sufficiently greater than the current wear levels to account for some future growth.

Best practice fields adhere to irrigation benchmarks

Based on detailed water balance modelling in the Lower Hunter, if a sporting field and its irrigation system are constructed and maintained according to best practice then acceptable turf cover can be achieved using the volumes of water defined in Table 3.2.

Table 3.2: Annual water use benchmarks for sporting fields in the Lower Hunter (ML/ha).

Sport wear levels per full size football field[1]	Median year	Very dry year
Low (<175 players per week)	2.1	2.4
Moderate (175 to 350 players per week)	2.3	2.6
High (>350 players per week)	2.6	2.8

Table Notes:

[1] Values refer to either a full-sized soccer, rugby league, rugby union or AFL field. Player numbers are a very approximate guide only, as detailed wear calculations including soil analysis and microclimate evaluation are needed to determine exact limits for individual fields. Booked usage hours are not an appropriate indicator of wear.

Readers that regard these watering benchmarks as low, should consider the numerous examples of sporting fields that perform well despite not having an irrigation system (Figure 3.2). These sites often have a soil that is a loamy sand to light clay texture and is not compacted. In contrast, sand-based fields can struggle in dry weather, even when watered twice per week (Figure 1.4).

Poorly constructed fields often wear out rapidly if they host more than 150 players per week during the winter sport season. As such, they typically require more watering in spring to recover from wear damage.

By contrast, fields that are not constructed according to best practice can have irrigation water use three to four times higher than those in Table 3.2.

Figure 3.2: Despite not having an automatic irrigation system, Keith Barry No. 2 field at Toronto easily survived the 2019/2020 summer when less than 6 mm of rain fell over a 70-day period. Due to water restrictions limited irrigation was permitted in the centre corridor during this period, with this photo taken 3 months later.

Best practice fields are drought resilient

Under the Lower Hunter Water Security Plan (2022)[11], during water restrictions in a drought there is a ban on the use of sprinklers. Under the Plan, Hunter Water may grant exemptions to Councils and managers of turf open space areas, however, there will be limits on the amount of water that can be applied. Ideally, open space managers will have identified reliable alternatives to potable water for use on as many sites as possible so there is minimal impact during water restrictions.

Inspection of 25 sites during the 2019/2020 drought found some fields deteriorated badly during level 1 restrictions (Figure 3.3), whilst others remained lush and green (Figures 1.4, 3.3). The Lower Hunter Water Plan states that under Level 3 water restrictions, no potable water can be used outdoors[11]. The findings of 2019/20 drought inspections were combined with turf stress modelling to determine the minimum imported (non-potable) water requirements to maintain acceptable turf cover under Level 3 restrictions and facilitate recovery after breaking rain.

It was found that if a sporting field and its irrigation system are constructed and maintained according to best practice, then under Level 3 restrictions they will typically require up to 1.0-1.5 ML/ha per year to prevent them from significantly deteriorating. The exact amount depends on the microclimate, soil, usage levels, turf cultivar, irrigation efficiency and irrigation management.

In contrast, fields constructed with soils that have a low water holding capacity typically struggle in dry periods, even when they are watered twice a week (Figure 3.3). If unirrigated fields are constructed with sand-based mixes, then they may almost completely die off in dry periods (Figure 2.5).

Figure 3.3: These fields performed very differently in the 2019/2020 drought even though both were being watered twice a week. The turf in the upper picture would likely have not survived had level 2 restrictions been implemented earlier during the drought.

Best practice fields receive appropriate levels of maintenance

All sporting fields require maintenance practices be performed to ensure the site remains in an acceptable condition as defined by benchmarks in Table 3.1. Maintenance practices are discussed in Book 7 and include activities such as:

- mowing
- repairs to watering and irrigation systems
- fertiliser application
- herbicide, pesticide and fungicide application
- minor turf repairs (patching, plugging, etc.)
- aeration on sites prone to compaction
- wetting agents on sites prone to becoming water repellent
- topdressing (as required to address issues such as unevenness, thatch, soil amendment, etc.)
- other works such as cleaning out drains

All playing fields will deteriorate if appropriate maintenance practices are not implemented, even those constructed according to best practice. Best practice maintenance involves performing only those activities that each field requires to remain in an acceptable condition (it will differ between the sites).

To prevent sporting fields from deteriorating it is essential that there is adequate maintenance budget available, with this discussed in Book 5.

Figure 3.4: High wear sporting field that was rebuilt according to best practice and performed well for 3 years. However, due to limited weed control, a less wear tolerant turf species is spreading across the field. This will greatly reduce the carrying capacity of this field.

Best practice fields have addressed the underlying causes of poor turf performance

Natural turf fields can struggle due a range of issues such as:

- lack of soil depth and/or fertility
- poor soil structure
- competition from weeds
- inappropriate turf cultivar
- heat and/or water stress
- waterlogging
- poor water quality resulting in injury to the turf or soil
- uneven watering
- toxins in the soil
- high density of weeds
- herbicide or fertiliser injury
- pests (insects, nematodes, mites, etc.) and diseases
- water repellency
- tree roots
- shade
- a combination of these factors.

Best practice involves addressing the underlying cause(s) of the problem so it does not reoccur in the future. For example, a site covered in weeds may benefit from the application of an appropriate herbicide, but this will only address the symptoms if the turf continues to remain thin due to other issues (Figure 3.5).

Figure 3.5: Thin turf along the side of Jack Lane playing fields due to a combination of tree roots, uneven irrigation and water repellency (insert). However, the soil is marginally too sandy which is the reason why it is so prone to becoming water repellent. All issues need to be addressed to grow healthy turf using a modest budget.

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FIGURE AND TABLE CREDITS

Rex Sullings (Aqueduct Consultancy): Cover Photo

Dr Mick Battam (AgEnviro Solutions): Figures E.1, E.2, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, 3.2, 3.3, 3.4, 3.5 Table 3.2. Field condition photos (page 12), Organic matter photo (page 31).

Dr Paul Lamble (Peak Water Consulting): Figures E.3, E.4, E.5, 1.2, 1.3, Table E.1, 3.2.

Hunter Water: Figure 1.1

Table 3.1 – References 7-9 above, Peter Martin, Mick Battam, Paul Lamble.

APPENDIX A: GUIDELINE AUTHORS AND REVIEWERS

Guideline Authors

The guidelines were written by:

Dr Mick Battam (Principal Soil Scientist, AgEnviro Solutions P/L)

Mick is a certified professional soil scientist and irrigation agronomist. He has 25 years industry experience and has provided amendment and/or water saving advice for more than 2000 sporting fields, 25 golf courses (incl. NSW GC), 50 feature parks (incl. Barangaroo, Hyde), 5 botanic gardens (incl. Royal BG), racetracks (incl. Royal Randwick) and 100 farms.

Mick was a primary author of the:

- Love Your Garden water saving program applied to 26,000 residential houses
- Best practice guidelines for wholistic turf management in Sydney
- Sporting field wear and carrying capacity calculator
- Healthy home lawn factsheet and best practice sporting field videos such as “Improving the condition of local sports fields”

Dr Paul Lamble (Certified Irrigation Designer, Peak Water Consulting P/L)

Paul is a certified irrigation designer with 16 years experience in the water industry. This experience encompasses local, and state government as well as private consulting work.

While at Lake Macquarie City Council, Paul delivered numerous sports field irrigation and reconstruction projects, so he has practical, first-hand experience in these types of projects and the challenges involved.

Paul was primarily responsible for developing and delivering the Lake Macquarie Sports Field Improvement Program. This program won the 2016 Australian Water Association NSW Branch Program Innovation Award.

Guideline Reviewers

These guidelines have been peer reviewed by:

Peter Mc Maugh AM BSc.Agr.FAIAST (Turfgrass Scientific Services P/L)

Peter has over 60 years experience in sports turf and was the first scientist in Australia to work full time and permanently in turf. He is considered an industry icon, with his achievements including:

- Bred the industry staple couch grasses Wintergreen and Windsor Green and named Sir Walter buffalo. He is still breeding new grasses at age 85
- Designed the innovative technique of Sprig Planting
- Ran commercial turf farm for 30 years & designed commercial turf washers
- Built the first sand profile stadium field in Australia, North Sydney Oval
- Ran a Research and Advisory company for 14 years
- Has built a multitude of golf courses, stadiums and racetracks
- Has contributed hugely to the education of the industry
- Is a past president of the International Turfgrass Society

Dr Peter Martin ED, PhD, FLS. (Peter M. Martin & Associates P/L)

Peter has over 55 years experience and is probably best known in the Australian turf industry as the co-founder and principal teacher in the Master's Degree in Turf Management at the University of Sydney from its inception in 1992 until its closure in 2012.

He has had a long career in urban horticulture and holds an international reputation as teacher, researcher and consultant in sports turf and urban trees. He was:

- Involved in the design and construction/reconstruction of the arenas of six major stadiums: Wembley Stadium (UK), Stadium Australia (Olympic Stadium, Homebush), Lang Park (now Suncorp), Parramatta, Docklands (now Marvel) and Campbelltown
- Past editor-in-chief of the Research Journal of the International Turfgrass Society
- Expert witness in many court cases involving profile design and/or turf management
- Carried out major research project on the sustainability of turf farming
- Conference and seminar speaker with emphasis on the environmental aspects of the turf industry.

Rex Sullings (Certified Irrigation Designer, Aqueduct Consultancy)

Rex has over 40 years' experience in the irrigation industry as a contractor and designer. Rex's expertise is in the design and management of sports turf irrigation. He was the contractor responsible for installing the irrigation system on high profile sites such as The Australian Golf Course Bonnie-Doon, and Newcastle Golf Course.

Rex has surveyed, assessed, designed and scheduled irrigation and provided advice for more than 200 playing fields, 30 golf courses and 50 recreational parks. Some of the high-profile sites include Belmore Oval, OKE Jubilee, Sydney Showground, RAAF Darwin, RMC Duntroon, and Barangaroo.

Steve Garland (Principal, Steve Garland Landscapes)

Steve is a professional Landscape Designer with over 40 years' experience. He was a horticultural researcher for Burke's Backyard and Backyard Blitz TV series.

Steve has Master of Landscape Architecture degree, is a qualified Horticulturist, and is licensed for Structural Landscaping and Urban Irrigation. Steve co-authored and delivered the Landscape Assessor Training Package for the Sydney Water Love Your Garden Program.

He was also a member of Sydney Water's Irrigation Working Group. He has surveyed hundreds of gardens in Sydney as well as numerous irrigation systems in Canberra as part of the ACT Water Smart program.

Gerard Young (Active Open Spaces and Parks Operations in Local Government)

Gerard holds qualifications in Horticulture and Sports turf Management with 20 years experience in Local Government Parks Operations, Open Space and Sports turf management.

Throughout his Local Government Career, Gerard has worked across a broad range of projects in Public Open Spaces and Recreational facilities. His experience spans numerous Councils including Port Stephens, Cessnock, Lake Macquarie, and Rockhampton.

Gerard is a current committee member of the Queensland Sports Turf Association (STA), having previously served on the committee of the NSW Sports Turf Association.

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August 2022