Logan City Council
Managing Your Sports Turf
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Sports Field Auditing requires a scientific evaluation (i.e. agronomic assessment) of each sports field, along with analysis and reporting on each facility. Quality auditing of sports fields requires a team of highly qualified experts, with extensive industry experience and the capacity to deliver and analyse data specific to your individual fields.

The IVM Group is recognised as an industry leader in this field and has delivered over 500 audits across South East Queensland in recent years. The IVM Group takes pride in providing accurate information in a manner that is easy to understand and which can be used to effectively plan for the future maintenance requirements of a facility.

Sports field auditing;

- Provides detailed scientific analysis to the Asset Owner that will increase understanding on the condition of that regions sports fields;
- Delivers easy to understand summary reports for each field, including practical management advice, that will provide the Asset Owner or Lessee with information essential in the development of a proactive turf management program; and
- Provides a prioritised field improvement program, with potential costings, based on the data collected for each field.

When combined, this information can be used by the Asset Owner or Lessee to determine which activities should be undertaken within the available timeframes and budgets.

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The Technigro turf team share your passion for what you do and, being from similar backgrounds, they understand your problems and the need to come up with cost effective solutions to suit your budget. This is why we are confident you will find our sensible ‘value for money’ approach, refreshingly different.

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- Use top of the range branded products that deliver the most cost effective desired outcome and have a proven track record.
- Apply products with equipment that has been specifically developed, field tested and proven.
- Ensure your project is entrusted to qualified operators who know exactly what to do and how to do it.
- Provide you with the best guarantee in the business - we will do it right first time.

Councils, schools and open space managers all benefit from the technologies that Technigro use to manage turf.
Introduction

This document, commissioned by the Logan City Council (LCC), is intended to be a user-friendly guide for sports clubs regarding all aspects of managing sporting surfaces. It outlines best practice turf management strategies for maintaining sustainable sporting surfaces and provides advice on effective strategies that will ensure your club gets the best out of its turf surfaces.

This guide explores three critical areas of turf management: 1) Soil Amendment and Nutrition, 2) Weed Management and 3) Renovation and Re-Life. **Figure 1** highlights the importance of each of these management areas towards achieving the overall goal of a sustainable quality sporting surface. No one strategy can deliver the desired outcome alone, and all strategies must be implemented together to ensure the full potential of a sporting surface is realised.

![Figure 1. The Sustainable Sportsturf Strategic Model](image)
1. Soil Amendment and Nutrition Strategy

A Soil Amendment and Nutrition Strategy is critical to ensure that the soil profile beneath your sporting surfaces is suitably structures and balanced to support healthy turf growth, thus creating a suitable playing surface for your team.

In developing this strategy this section explores:

- Influences on soil structure;
- The importance of soil nutrient balance to structure;
- Recommended methodologies for identifying amendment requirements;
- Improving soil structure;
- Optimising soil nutrition; and
- Considerations when developing budget estimates for amendment and nutrition programs.

1.1 Influences on Soil Structure

1.1.1 Soil Organic Matter Content (Humus)

Organic matter is a critical component of good soil structure. Organic matter improves the water holding capacity of the soil, creating exchange sites for nutrients and water. Hence, it is desirable to measure the organic matter levels in a soil profile, and to maintain the soil’s ability to retain and exchange nutrient cations through the programmed addition of organic materials.

1.1.2 Total Exchange Capacity (TEC)

The Total Exchange Capacity (TEC) of the soil is the ability of the soil to retain and exchange nutrient cations. TEC analysis is recommended as it takes into account exchange sites occupied by hydrogen and other cations, which are not assessed in a CEC analysis. Therefore, the chemical soil analysis undertaken as part of this program needs to test TEC, and through the programmed application of amendments such as Zeolite, TEC levels need to be maintained at a level that is adequate to sustain turfgrass.

1.1.3 Calcium

Calcium is the most important cation for turfgrass growth and maintenance. This is highlighted by its many functions in the soil and plant, the most important being to displace and leach the destructive cation Sodium and in turn maintain good soil structure. Appropriate Calcium amendments, such as Lime or Gypsum, should therefore be applied in an on-going program to maintain the concentrations of both nutrients to sufficient levels required for turfgrass.

Optimum turf growth is achieved on soils with adequate pore space, which provides air and water and space for the root system. Soils with high Calcium (Ca\(^{2+}\)) content have good structure because particles cling together, or aggregate, providing pore space. A high Sodium (Na\(^{+}\)) level is detrimental to soil structure because particles disperse or repel each other, leading to a tight structure with no pore space. This combined with high traffic causes serious compaction and reduced drainage.
1.1.4 Water Quality

Irrigating with poor quality water can contribute to poor soil structure. Bicarbonates in the water tie up Calcium and Magnesium, forming insoluble compounds, and allowing Sodium in the water to occupy sites on the soil surface causing dispersion of the soil particles.

1.2 The Importance of Soil Nutrient Balance to Structure

Turf grasses obtain thirteen of sixteen essential nutrients from the soil via the root system. Therefore, chemical soil analysis should be used to determine the nutrient status of the soil and determine whether more of a particular nutrient is needed for optimum turfgrass growth.

The chemical soil analysis regime recommended focuses on the balance of nutrients (or base saturation) within the soil profile. Base saturation refers to the fraction of the cation exchange capacity that is occupied by the basic cations (i.e. Potassium, Calcium, Magnesium, and Sodium).

The most common fluctuation in base saturation rates occurs as a result of an increase in the percentage of Sodium present. This may occur as a result of a loss in other cations, via leaching or the use of poor quality irrigation water. The soil pH will also increase due to Sodium accumulation offsetting Calcium ions. This increase in alkalinity then reduces the availability of the essential nutrients such as Iron, Manganese, Phosphorus and Boron.

Adverse physical conditions are then exhibited, because of Sodium’s ability to cause dispersion, with the change in soil structure leading to a domination of small pore spaces, which negatively affects infiltration, percolation and drainage capabilities.

Restoration of the base saturation percentage can be achieved by the addition of a readily available source of Calcium. This will displace Sodium from the exchange complex and lead to its leaching through the profile. Once this ideal ratio of basic cations has been re-established, the quality of turf will improve. Initially, the soil pH will return to a more favourable level (i.e. 6.0-7.0), and nutrients that were previously unavailable will return to forms that the turf can utilise.

Soil permeability also changes as a result of the flocculating ability of Calcium. This increases the ability of water, oxygen and roots to move within the profile. It also permits an increase in the soil oxygen status, allowing greater activity of soil micro-organisms. The result is the formation of more favourable by-products of metabolism, that allow a more efficient recycling of nutrients within the soil-plant system.

1.3 Soil Amendments

1.3.1 Gypsum

Soil amendments such as Gypsum (Calcium Sulphate, CaSO$_4$) are used to improve the structure of a soil. Gypsum supplies available Calcium which displaces Sodium on the soil particles. The Calcium provides aggregation of the soil particles, improving soil structure. The Sodium, now present as Sodium Sulphate in the soil solution, can be easily leached. Gypsum will not have a noticeable effect on pH.

1.3.2 Lime

Lime and Dolomite also supply Calcium, but are used to increase the pH of an acid soil. The carbonate ions supplied by the Lime are responsible for increasing the pH. The Calcium itself does not influence pH.
1.3.3 Calcium Chloride

Calcium Chloride ($\text{CaCl}_2$) is an alternative soil amendment that is also used to treat excessive Sodium concentration within the soil. This material is a concentrated solution of readily available Calcium which acts rapidly to displace Sodium from soil particles. This rapid reaction produces Sodium Chloride, therefore increasing salinity in the soil solution until it is leached by clean water. If poor irrigation water is the cause of high Sodium levels within the soil, adding a soil amendment such as Calcium Chloride that reacts immediately will only serve as a short term fix.

1.4 Methodology for Identifying Amendment Requirements

The following analytical tools can be utilised by clubs to gather the required information to assess the amendment and nutrition requirements for the soil profiles beneath their sporting surfaces.

1.4.1 Soil Nutrient Analysis

Soil nutrient analysis is utilised to determine the level of specific soil nutritional components that are required to be assessed for maintaining turfgrass. Indicators required in the soil nutrient analysis for turfgrass include:

- $\text{pH},$
- TEC (Total Exchange Capacity rather than Cation Exchange Capacity) for more accurate determination of the number of soil exchange sites,
- organic matter percent (humus),
- major cations and anions (Ca, Mg, K, Na), Phosphorus and essential minor nutrition determination, and
- essential minor nutrients and Hydrogen for more accurate calculation of cation base saturation percentages.

The latest technology in nutrient extraction methods uses Mehlich III extraction for determination of all nutrient levels. This method is most suited to analysing turfgrass soils and is designed to be applicable across a wide range of soil types.

This methodology has been widely adopted in the United States by consumers and research institutes alike, as it has been found to provide more reliable and accurate results. The concentration of each cation is offered in parts per million (ppm).

1.4.2 The Saturated Soil Analysis

A Saturated Soil (or Paste) Analysis is utilised to determine what nutrients are present in soil solution. This is an important diagnostic tool to assess if the nutrients analysed in the soil analysis are actually available in soil solution. Certain irrigation waters and soil types (calcareous) tie up essential soil nutrients, and it is important to determine that there are sufficient nutrient levels in soil solution to meet turf requirements in these situations.
1.4.3 Irrigation Suitability Analysis

The quality of water used for irrigation can dramatically affect turfgrass health and performance, as well as the characteristics of the soil. If a soil is irrigated with a given water quality over an extended period of time, the soil will assume the characteristics of that irrigation source. If the water quality is poor, soil structure, nutrient availability and ultimately turf quality will be affected.

There are many types of analysis that can be performed on water, however only a fraction of these are relevant to maintaining turfgrass. The water analysis utilised to determine suitability for use in such situations must provide specific information that is relevant to turfgrass managers. This requires a comprehensive chemical and nutrient analysis that assesses the impact of an irrigation source on the soil profile, soil nutrition and turf quality.

Therefore, irrigation suitability analysis should include the major cations (Calcium, Magnesium, Potassium, Sodium) and anions (Carbonate, Bicarbonate, Chloride and Sulphur), determined and reported in p.p.m., meq/L and as a percentage. Reporting the percentage of each cation or anion highlights which salts are dominant and this is a major consideration when assessing irrigation water quality.

pH, electrical conductivity should also be measured and the essential turfgrass indicators Sodium Absorption Rate (SAR), Adjusted SAR and pHc need to be calculated and reported.

1.5 Improving Soil Structure and Optimising Soil Nutrition

1.5.1 Chemical Soil Analysis

Chemical soil analysis should be undertaken on an annual basis to assess the soil profile and determine the amendment requirements for the following season. The chemical soil analysis measures each soil profile against the following key turfgrass indicators as described in Table One.

Table One: Key Turfgrass Indicators: Chemical Soil Analysis

<table>
<thead>
<tr>
<th>Chemical Soil Analysis</th>
<th>Ideals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Saturation - Calcium</td>
<td>68 - 72%</td>
</tr>
<tr>
<td>Base Saturation - Magnesium</td>
<td>13 -16%</td>
</tr>
<tr>
<td>Calcium / Magnesium Ratio</td>
<td>4.25 - 5.5</td>
</tr>
<tr>
<td>Base Saturation - Potassium</td>
<td>3-5%</td>
</tr>
<tr>
<td>pH range of soil</td>
<td>6.5 - 7.0</td>
</tr>
<tr>
<td>Base Saturation - Sodium</td>
<td>&lt;3%</td>
</tr>
<tr>
<td>Base Saturation - Hydrogen</td>
<td>4.50%</td>
</tr>
<tr>
<td>Base Saturation – Other elements</td>
<td>5%</td>
</tr>
<tr>
<td>Organic Matter ( Humus)</td>
<td>3 - 5 %</td>
</tr>
</tbody>
</table>

Application of amendments with the aeration of surfaces will not only relieve compaction, but will also aid the movement of air, water, amendments and applied nutrients into the profile.

1.5.2 Irrigation Suitability Analysis

Irrigation water sources should be tested on an annual basis to assess their suitability for use on turfgrass. Where town water is utilised, a single annual test for suitability should be conducted.
Table Two details the desirable chemical concentration threshold limits in a water specifically used for irrigating turfgrass, providing that the following parameters are recognised:

- Sodium comprises no more than 40% of the total cations
- Calcium is greater than 50% of the total cations
- Bicarbonate comprises no more than 40% of the total anions
- Chloride comprises no more than 60% of the total anions
- Electrical Conductivity (mmhos/cm) exceeds 0.28

<table>
<thead>
<tr>
<th>Irrigation Suitability Analysis</th>
<th>Ideals</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5 – 8.4</td>
</tr>
<tr>
<td>Conductivity (mmhos/m)</td>
<td>0 - 1.5</td>
</tr>
<tr>
<td>Sodium Adsorption Ratio (SAR)</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Adjusted SAR</td>
<td>0 - 7</td>
</tr>
<tr>
<td>pHc</td>
<td>8.4 or above</td>
</tr>
<tr>
<td>Total Alkalinity (as CaCO₃)</td>
<td>1 – 100mg/l</td>
</tr>
<tr>
<td>Bicarbonates</td>
<td>1 - 100</td>
</tr>
<tr>
<td>Chloride</td>
<td>0 - 130</td>
</tr>
<tr>
<td>Sulphate</td>
<td>0 - 414</td>
</tr>
<tr>
<td>Sodium</td>
<td>50ppm</td>
</tr>
</tbody>
</table>

**1.5.3 Assessment of the Water Quality for Irrigation Purposes**

Assessing the chemical components of irrigation water is essential, as its characteristics will have an inherent effect on the chemistry of the soil. When assessing irrigation water in terms of its suitability for irrigation purposes, it is not only the total salts (TDS) and pH of the water that is the concern; it is the make up of the salts within the water. It is the make up of key salts that will determine how it will react with the soil and alter its nature, which will in turn affect plant growth. It is common for poor quality irrigation waters to contain elevated or high levels of at least one of the detrimental salts; sodium, chloride and bicarbonate.

**Sodium** has the potential to break down soil structure, reduce water percolation, and damage plant tissue. This is a low risk with these irrigation waters.

**Chloride** has the potential to damage fine root hairs if it accumulates in the soil solution, and can potentially cause direct leaf burn. This is a low risk with these irrigation waters.

**Bicarbonate** has the potential to lock up key soil nutrients, primarily calcium. The reaction of bicarbonate with the soil often creates hard/ compacted surfaces. This is a significant issue with most of these irrigation waters and its effects will be discussed in detail later in the report.

The favourable attributes of the Logan City potable supply are represented in Table Three:

<table>
<thead>
<tr>
<th>Threshold Characteristic</th>
<th>Threshold Level</th>
<th>Town water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>50ppm</td>
<td>9ppm</td>
</tr>
<tr>
<td>Chloride</td>
<td>130ppm</td>
<td>17ppm</td>
</tr>
<tr>
<td>Bicarbonate (as HCO₃)</td>
<td>100ppm</td>
<td>25ppm</td>
</tr>
<tr>
<td>Total Dissolved Salts</td>
<td>1000ppm</td>
<td>103ppm</td>
</tr>
<tr>
<td>pH</td>
<td>Ideal 6.5-8.4</td>
<td>7.2</td>
</tr>
</tbody>
</table>
1.6 Soil Amendment and Nutrition Management

1.6.1 Prioritisation of Amendment Requirements

The strategy to improve soil structure involves a number of decisions which have been prioritised to ensure that the appropriate course of action is taken. Therefore, prioritisation of the most common soil balance issues for turfgrass has been determined as follows:

- Minimising the impacts of Sodium and Chloride on the soil profile
- Maintaining the soil pH within a range that promotes turfgrass health and vigour,
- Establishing the optimum ratio of basic cations (base saturation) for turfgrass
- Ensuring organic matter levels are appropriate for turfgrass

Prioritisation of these aspects of managing a soil profile ensures that soil profiles requiring significant amendment can be remediated to ensure the best outcomes possible from amendment activities.

The proposed timing of the activities listed in this program is detailed in Table Four.

### Table Four: Proposed timing for Soil Amendment and Nutrition Management

<table>
<thead>
<tr>
<th>Month</th>
<th>Activity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>Soil and Water Analysis</td>
<td>Water analysis if recycled water is in use</td>
</tr>
<tr>
<td>May</td>
<td>Develop Amendment Program</td>
<td>Based on findings from soil analysis</td>
</tr>
<tr>
<td>June - Aug</td>
<td>Apply Soil Amendments</td>
<td>Combine with renovation activities</td>
</tr>
<tr>
<td>Sept - Dec</td>
<td>Apply CRN (N to K ratio 2:1)</td>
<td>Dependant on health of turf</td>
</tr>
<tr>
<td>Feb</td>
<td>Apply CRN (N to K ratio 2:1)</td>
<td>Option: combine late summer feed with herbicide</td>
</tr>
<tr>
<td>May</td>
<td>Apply CRN (N to K ratio 1:1)</td>
<td>Fertiliser to sustain turf through winter</td>
</tr>
</tbody>
</table>

1.6.1.1 NPK Application Regime

The following application ratios have been developed for clubs utilising the Nitrogen (N) to Potassium (K) ratios of the CRN fertilisers.

The N to K ratio simply refers to the relative relationship between these two primary nutrients, rather than the specific number of kilograms of each in a fertiliser blend.

High Nitrogen Ratio – apply high Nitrogen to Potassium ratio fertilisers (2:1 or higher) when:

- The turf to be fertilised is in overall good condition
- The desired result is consistent and/or accelerated top growth
- Applying in spring when no fertiliser was applied in winter

Balanced Ratios – apply 1:1 Nitrogen to Potassium ratios when:

- Turf is in good condition and general maintenance is desired
- Stressful periods such as high traffic and wear situations
- A reduction in top growth is desired
1.6.2 Controlled Release Nitrogen

Nutrition programs implemented by Turf Managers over recent years have seen a move away from agricultural fertilisers to superior controlled release nitrogen (CRN) fertilisers.

Agricultural fertilisers used on an ad-hoc basis, result in an over-abundance of nutrient during the initial fourteen days after application without the longevity required to sustain optimal growth patterns. This type of process results in accelerated turf growth, causing excessive clippings and weak turf that is susceptible to pest and disease damage. Once nutrients are exhausted and reapplication does not occur when required, weakened turf develops.

The use of a controlled release Nitrogen (CRN) source has proven to be a cost effective strategy to optimise soil nutrition without the need for fertiliser applications every four to six weeks during the growing season. In sand profiles, where nutrients are more difficult to retain, the result is leaching of nutrients out of the reach of the turfgrass, often into areas where they are not needed or wanted.

With a wide variety of technologies available at an affordable cost, the use of CRN fertilisers has become prevalent with Local Government in Australia. The most widely used technology offered is the Sulphur Coated Urea (SCU) technology. Since its development, SCU has become the most widely used controlled-release nitrogen source in turf care. With technological improvements such as an enhanced coating process, sulphur-coated urea delivers the most cost effective performance under the widest variety of conditions of any controlled release nitrogen source currently available.

A wide selection of product choices with varying NPK ratios, particle sizes and particles coated allows far greater fertiliser efficiency over differing turf growing regimes and conditions. CRN fertilisers will control the release of Nitrogen for up to sixteen weeks maintaining growth habit and reducing mowing frequency, clippings and pest & disease problems.

1.6.2.1 Understanding CRN

Due to imperfections in the coating, including particle breakage, manufactures cannot claim 100% coating.

For example:

In the 100% coated Lesco Poly Plus SCU product (39-0-0)

35.1% of the 39% Nitrogen in the product will be slowly available,

Meaning it is a 90% (35.1% ÷ 39% = 90%) CRN product.

In a 100% coated Scotts Poly S SCU product (40-0-0)

27.2% of the 40% Nitrogen in the product will be slowly available,

Meaning it is a 68% (27.2% ÷ 40% = 68%) CRN product.

This knowledge is critical when assessing the value for money being offered by the suppliers of the SCU products. The cost of the CRN component of the product on offer must always be the calculation made when assessing which product to purchase.
1.7 Soil Remedial Recommendations

Analysis of your soil nutrient analysis should be undertaken by a suitably qualified person with experience in turfgrass nutrition. This will ensure that the amendment programs are appropriately developed following a comprehensive analysis of the soil nutrition information gathered through Soil Nutrient Analysis.

1.7.1 Rectifying Calcium Deficiencies

It should be noted that, while the concentration of Calcium required for plant growth may be adequate in your field, often the field will be deficient in terms of percentage (soil balance) which will have an adverse affect on soil structure. In order to create optimal soil conditions, this needs to be rectified.

1.7.2 Other General Recommendations

- Plan in advance and document all nutrient and amendment applications. Set up a system for planning and recording applications. This is essential for an effective monitoring program.

- Monitor the soil conditions regularly to assess the affect of nutrient / amendment applications, and the impact of the irrigation water and rainfall on soil conditions. This will provide the intelligence of how to adjust and implement appropriate management programs. Regular soil analysis will provide the platform for soil monitoring. Conduct soil analysis at least once per year just prior to developing your annual turf management program.
2. Weed Management Strategy

The purpose of this section of the guide is to define the best practice strategies that can be implemented to manage weed populations in the sporting surfaces you manage.

This strategy, when implemented as recommended, will ensure a cost effective, pro-active regime of measures that will assist in improving the playing surfaces for the various sporting activities that are conducted at these facilities.

Another benefit of this program will be the reduction in the chemical usage over time, returning savings through fewer applications and a reduction in repair costs to these surfaces. In developing this strategy this guide explores:

- A review of the desirable and undesirable species prevalent in the LCC sporting surfaces;
- The most suitable technologies available for use by LCC in the management of sporting surface weeds;
- Implementation and timing issues associated with the successful achievement of the strategy;
- The effects of renovation practices and high usage on the program; and
- Estimated costs associated with the implementation of a weed management program.

2.1 Desirable and Undesirable Species

2.1.1 Desirable Species

The predominant desirable species present on the LCC sporting surfaces include:

- Kikuyu (Pennisetum clandestinum)
- Queensland Blue Couch (Digitaria didactyla)
- Common Green Couch (Cynodon dactylon)
- Green Couch hybrids (Cynodon cultivars)

It should be noted that, due to many fields being predominantly Kikuyu based fields or a mixture of both Kikuyu and/or blue couch varieties; there are significant limitations in the products available for broad acre control of the dominant grass weed species of Wiregrass, Crowsfoot and Summer Grass and Paspalum. Therefore, a pro-active regime utilising pre-emergent controls in conjunction with post emergent controls has been developed.

2.1.2 Undesirable Species

Inspections of the LCC sporting surfaces reveal the following major weed species are prevalent:

- WIRE GRASS (Eragrostis tenuifolia)
- CROWSFOOT (Eclusine indica)
- SUMMER GRASS (Digitaria sanguinalis)
- PASPALUM (Paspalum dilatatum)
- BAHIA GRASS (Paspalum notatum)
- WINTER GRASS (Poa annua)
- SEDGES (Cyperus spp.)
2.1.2.1 Wiregrass

Wiregrass (Eragrostis spp) is a summer growing perennial grass. Wiregrass produces abundant seeds that germinate successively from early spring to late autumn. Seedlings grow to form dense tussocky swards that impact on the turf’s aesthetic appearance. While its main growing period is in summer SEQ’s winters allow it to persist year round. These attributes make control more difficult.

Wiregrass requires less Nitrogen and can tolerate greater levels of compaction to couch. Hence, by correcting soil conditions (reducing compaction problems) and by implementing a nutrition program, a better environment is provided for desirable grasses such as couch to compete more effectively with the wiregrass. The clumping nature of this weed significantly impacts on the safety and usability of the sporting surface.

Control of this weed is best undertaken via wick wiping with Glyphosate.

2.1.2.2 Crowsfoot

Crowsfoot (Eluesine indica) is a summer growing grass that tolerates close mowing and compacted wet or dry soils. Crowsfoot competes aggressively with turf species and germinates in spring after rain, when temperatures reach 15 – 18°C.

An effective management strategy is to improve turf-growing conditions by alleviating soil compaction and reducing excessive moisture. In Australia, the currently registered pre-emergence controls include Pendimethalin, dithiopyr, and oxidiazon. These herbicides should be applied when soil temperatures at 10cm deep remain above 15°C for 24 hours. This is usually from early August in Logan (seasonally dependant).

The clumping nature of this weed significantly impacts on the safety and usability of the sporting surface. Post emergence control can be achieved with repeat applications of Diclofop methyl. Diclofop methyl is only effective on Crowsfoot up to the 4th tiller stage and in temperatures below 24°C. This means a narrow window of opportunity to treat with Diclofop methyl in early spring and early autumn.

2.1.2.3 Summergrass

Summergrass (Digitaria sanguinalis, Digitaria ciliaris) is a summer growing annual with branched stems that root at the lower nodes. The leaf blade is longer than 5cm and is usually hairy on both surfaces of the leaf. It also possesses a membranous ligule.

Summergrass generally germinates in areas of low turf density whereby it competes aggressively with the host turf species. Pre-emergence control includes Pendimethalin, dithiopyr, and oxidiazon. Pre-emergent applications should be applied in early spring.

Summergrass germinates in August to October following rain, at soil temperatures of 12-15°C (10cm depth). Dithiopyr (Dimension) can be used as a post emergent herbicide up to the 2-tiller stage. Post emergent control can be achieved with repeat applications of MSMA on the Green Couch fields in Logan.

However, when treating Summergrass in Kikuyu or blue couch, control is more difficult due to the susceptibility of these species to the available herbicides. Therefore, hand removal may be the safest option.
2.1.2.4 Paspalum

Paspalum (Paspalum dilatatum & P. distichum) is a tufted perennial monocot that grows most actively from November to March. Paspalum favours moist, heavy textured soils. Large quantities of seed are produced when it flowers, arising from rapid growing seed spikes. Their clumpy nature provides an unsightly appearance, and severely disrupts playing surface uniformity. Cultural practices that can be implemented to lessen Paspalum incidence include surface aeration and topdressing, which assists in limiting seed germination.

Post emergent control can be achieved with repeat applications of MSMA on the green couch fields in Logan. On the Kikuyu and blue couch surfaces, control is best achieved via hand weed wiping with Glyphosate.

Pre-emergent control is the best option and can be effectively achieved using Pendiimethalin, dithiopyr and oxadiazon.

2.1.2.5 Sedge sp. (Nutgrass and Mullumbimby Couch)

Sedges such as Nutgrass and Mullumbimby Couch are spring-summer growing weeds that inhabit poor draining turfgrass areas. Nutgrass has poor seed viability but spreads via vegetative underground tubers.

It is suspected that sedges release root exudates that are allelopathic (toxic) to turfgrass roots. Increased drainage through soil amendment is one way of limiting this weeds competitive ability.

Post emergence control can be undertaken with Trifloxysulfuron (Monument) in green couch and Halosulfuron methyl (Sempra) in Kikuyu.

2.1.2.6 Broadleaf Species

Broadleaf species are a common problem on the LCC sporting surfaces. These can be managed via appropriately timed treatments of Spearhead or Millennium as required. Pre-emergent control can be effectively achieved on many species using dithiopyr.

2.1.3 Recommended Control Methods for Weed Species

Table Six and Seven detail the predominant weed species prevalent on LCC sporting surfaces, the control methods available for these weeds, along with the most appropriate pre emergent and post emergent product options.

---

**Table Six: Predominant weed species and the recommended control method options**

<table>
<thead>
<tr>
<th>Weed Species</th>
<th>Control Method Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIRE GRASS (Eragrostis tenuifolia)</td>
<td>Weed Wipe Glyphosate</td>
</tr>
<tr>
<td>CROWSFOOT (Eleusine indica)</td>
<td>Spray/Granular application Pre and or Post</td>
</tr>
<tr>
<td>SUMMER GRASS (Digitaria sanguinalis)</td>
<td>Spray/Granular application Pre and or Post</td>
</tr>
<tr>
<td>PASPALUM (Paspalum dilatatum)</td>
<td>Spray/Granular application Pre and or Post</td>
</tr>
<tr>
<td>KHAKI WEED (Alternanthera pungens)</td>
<td>Spray application Post</td>
</tr>
<tr>
<td>GOMPHRENA WEED (Gomphrena celosioides)</td>
<td>Spray application Post</td>
</tr>
<tr>
<td>CREEPING OXALIS (Oxalis corniculata)</td>
<td>Spray/Granular application Pre and or Post</td>
</tr>
<tr>
<td>WHITE CLOVER (Trifolium repens)</td>
<td>Spray application Pre and or Post</td>
</tr>
<tr>
<td>BAHIA GRASS (Paspalum notatum)</td>
<td>Spray application Pre and or Post</td>
</tr>
<tr>
<td>SEDGES (Cyperus spp.)</td>
<td>Spray application Post</td>
</tr>
</tbody>
</table>
Table Seven: Predominant weed species and the recommended pre emergent and post emergent treatment options

<table>
<thead>
<tr>
<th>Weed Species</th>
<th>Control Method - Recommended Products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre emergent</td>
</tr>
<tr>
<td>WIRE GRASS (Eragrostis tenuifolia)</td>
<td></td>
</tr>
<tr>
<td>CROWSFOOT (Eleusine indica) in couch</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>CROWSFOOT (Eleusine indica) in Kikuyu</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>SUMMER GRASS (Digitaria sanguinalis) in couch</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>SUMMER GRASS (Digitaria sanguinalis) in kikuyu</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>PASPALUM (Paspalum dilatatum) in couch</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>PASPALUM (Paspalum dilatatum) in kikuyu</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>BAHIA GRASS (Paspalum notatum) in couch</td>
<td>Daconate</td>
</tr>
<tr>
<td>BAHIA GRASS (Paspalum notatum) in kikuyu</td>
<td>Weed Wipe Glyphosate</td>
</tr>
<tr>
<td>KHAKI WEED (Alternanthera pungens)</td>
<td>Spearhead</td>
</tr>
<tr>
<td>CREEPING OXALIS (Oxalis corniculata)</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>BINDII (Soliva pterosperma)</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>WHITE CLOVER (Trifolium repens)</td>
<td>Dimension or Barricade</td>
</tr>
<tr>
<td>SEDGES (Cyperus spp.) in green couch</td>
<td>Monument</td>
</tr>
<tr>
<td>SEDGES (Cyperus spp.) in kikuyu or blue couch</td>
<td>Sempra</td>
</tr>
</tbody>
</table>

2.2 Proactive Weed Control using a Pre-emergent Herbicide

With less than optimal conditions for turfgrass health and vigour in the winter sporting period, weeds can become prevalent, even in situations where water volume is low. Many common weed species will outperform turfgrass in unfavourable conditions, resulting in major infestations during long periods of heavy usage.

Both Dimension and Barricade are premium products for broad-spectrum pre-emergent weed control. This is due to the range of weeds controlled, the length of control, and the flexibility of application.

The benefits of this product can be summarized as follows:

- Excellent pre-emergent control of the majority of weed species in LCC sporting surfaces;
- UV stable does not breakdown in sunlight;
- Longest residual activity of the pre-emergent products available;
- Season long control in just two applications per annum;
- Will not damage or inhibit turf recovery of desired species; and
- Reduction of seed bank resulting in improved control as the program progresses.

A pre emergent herbicide application forms the backbone of a strategic weed management program, due in part for its ability to work in synergy with many of the post emergent products available today and the fact that it binds so readily to the soil to form an excellent barrier. Dimension herbicide is known to effectively provide pre emergent control of the following weed species in addition to those key weed species it has been registered to control in Australia.

Table Eight: Monocot and Dicot Weeds Controlled by Dimension (Dithiopyr)
Monocot Weeds Controlled | Dicot Weeds Controlled
---|---
✓ Hordeum spp. Barley | ✓ Brassica spp. Indian Mustard
✓ Echinochloa crus-gali Barnyardgrass | ✓ Oxalis pes-caprae Oxalis, buttercup
✓ Poa annua Wintergrass | ✓ Matricaria matricarioides Pineapple Weed
✓ Bromus spp. Brome grass | ✓ Amaranthus retroflexus Pigweed
✓ Digitaria sanguinalis Large Summergrass | ✓ Alchemilla arvensis Parsley-piert
✓ Digitaria ciliaris Summergrass | ✓ Portulaca oleracea Common Purslane
✓ Digitaria ischaemum | ✓ Veronica arvensis Corn Speedwell
✓ Dactyloctenium aegyptium | ✓ Euphorbia hirta Garden Spurge
✓ Paspalum dilatatum Paspalum | ✓ Euphorbia humistrata Prostrate Spurge
✓ Eleusine Indica Crowsfoot Grass | ✓ Euphorbia maculata Spotted Spurge
✓ Setaria verdi Green Foxtail | ✓ Oxalis corniculata Creeping Oxalis
✓ Setaria faberi Yellow Foxtail | ✓ Oxalis stricta Yellow Woodsorrel
✓ Pennisetum clandestinum Kikuyugrass | |
✓ Avenua fatua Wild Oats | |
✓ Lolium perenne Perennial Ryegrass | |
✓ Lolium multiflorum Annual Ryegrass | |
✓ Sporobolus indicus Smutgrass | |

### 2.2.1 Other Pre Emergent Herbicide Options

Two other registered pre emergent herbicides have been mentioned in the document. These products are explored below with limitations defined.

#### 2.2.1.1 Pendimethalin

This product is a selective pre emergent herbicide for the control of many annual grasses and some broadleaf weeds. The product acts by inhibiting seedling development and will not control established weeds. If established weeds are present they should be controlled with another suitable herbicide.

Soils containing a high percentage of organic matter can result in poor control. It is recommended that application to soils containing a high percentage of organic matter (> 6%) be avoided. Limitations include:

- Root pruning (clubbing) can occur
- Limited spectrum of control (but useful in providing 12 months control in association with Dimension)
- Limited window of activity (six to eight weeks)

#### 2.2.1.2 Oxadiazon

A pre-emergent herbicide which kills weed shoots as they emerge through the treated soil surface. It controls certain weeds in woody ornamental shrubs and trees in nurseries. Limitations include:

- High cost per hectare to apply
- Must be irrigated in
- Limited control on some of the most common broadleaf species and limited activity period (8 wks)
2.3 Reactive Weed Control using Post Emergent Herbicides

2.3.1 Crowsfoot

Crowsfoot is one of the most significant weed issues clubs have in their sporting surfaces. Post emergence control of Crowsfoot is extremely difficult and repeat applications of Diclofop methyl is the only post emergent option registered for use.

Diclofop methyl is only effective on Crowsfoot up to the 4\textsuperscript{th} tiller stage and in temperatures below 24°C. This means a narrow window of opportunity to treat with Diclofop methyl in early spring and early autumn.

The product needs to be applied to weeds between the seedling and tillering stage for best results. Use lower rates for seedlings and higher rates for established grass weeds. Repeat applications are essential and best results are seen when applied under good growing conditions and weeds have sufficient leaf area i.e. 2 to 3 days after mowing.

Diclofop methyl is currently the only post emergent option for Crowsfoot. However, the efficacy of the product demands strict adherence to both temperature and timing issues.

In summary Diclofop offers:

- Post emergent control on Crowsfoot only with no Pre emergent activity
- Limited to 1L/ha application rates on sports turf where Kikuyu or Blue Couch present
- Diminished efficacy when temperature is above 24°C
- The potential of damage to desired species
- Potential resistance issues over time
- The need for multiple applications
- No reduction of seed bank.

2.3.2 Paspalum and Summergrass

Paspalum and Summergrass are also prevalent in the LCC sports turf. Successful post emergent control can be achieved with repeat applications of Daconate (MSMA) on the green couch fields in Logan.

In summary Daconate offers:

- Good post emergent control of Paspalum and Summergrass in green couch fields
- Excellent “second attack” product after pre emergent application,
- Sound post emergent control if applied professionally over multiple applications

However, as many fields are either Kikuyu or a mixture of Kikuyu and/or blue and green couch varieties, there is no registered product available for broad acre control of these weeds.

Label restrictions determine that MSMA cannot be used on Qld blue couch (Digitaria spp.), bent, fescue, blue grass, kikuyu or dichondra lawns or turf as severe damage or death can occur.

Weed wiping with Glyphosate can be undertaken providing there is adequate separation between desirable and undesirable species and the applicator is experienced in weed wiping techniques. Glyphosate in a non selective herbicide and significant damage can occur where wiping activities come into contact with the desirable species.
2.3.3 Broadleaf Weed Control

Chipco Spearhead is a herbicide that has been widely used within Local Government over the past few seasons. Spearhead provides outstanding control of the major broadleaf weeds of turf including white clover, creeping oxalis and bindii. It is a unique 3 way mixture (20 g/L Clopyralid, 15 g/L Diflufenican, 300 g/L MCPA) that provides extended weed control, providing extended control in most situations. Spearhead is safe to use, has no smell, and can be used on the majority of turf species present in Logan. Spearhead is;

- An excellent broad range herbicide for broadleaf weeds
- Safe to use on the majority of turf species
- Effective as a single application versus multiple applications of other products

2.3.4 Control of Sedge Species

Monument is a herbicide for the early post emergent control of Wintergrass, Clover, Burr Medic and Sedge species in common Couch, Hybrid couch, Zoysia and QLD Blue Couch. Monument is;

- Superior control in areas where sedges and many broadleaf weeds are present
- Excellent safety on warm season turf
- Low rate applications required with long term control in a single application

However, as many fields are either Kikuyu or a mixture of Kikuyu and/or blue and green couch varieties, Sempra is the only registered product available for broad acre control of these weeds.

2.4 Other Considerations

2.4.1 Application Timing

Timing of application is critical to the success of any weed management program. Factors such as soil temperature, diurnal temperature range and daylight hours influence the breaking of seed dormancy and germination. The proposed application activities consider these factors and offer recommended application timeframes that must be followed to ensure the success of the program.

2.4.2 Surface Disturbance

Due to the fact that a chemical barrier is formed by Dimension or Barricade, where the product is held within in the top 50mm of the soil profile, normal wear and tear of sporting events will not adversely effects its performance.

Renovation practices carried out in the normal manner should have little or no effect on the product. This is because normal scarification practices do not remove a significant amount of soil as this practice is designed to remove the thatch layer and not soil.

Aeration will also have little effect if verti-draining with solid tynes to a depth of 150mm. Although the barrier has been broken the weed seed will not be able to germinate and survive at this depth.

Topdressing with imported material could have a significant effect on the performance of the chemical barrier formed by the pre emergent. This is due to the fact that the imported topdressing material may be contaminated with weed seeds and the fact that it is being applied above the barrier where no protection can be offered. This is only an issue when contaminated topdressing material is utilised.
2.5 Proposed Weed Management Program

Due to the diversity in the sporting fields within Logan City it is clear that no single plan will have an exact fit with each sporting surface under the management of a wide variety of clubs.

However, the importance of pre emergent control in the program has been recognised. Whilst other technologies can be utilised to suit the variance in desirable and undesirable species, a product such as Dimension or Barricade will form the backbone of the weed management strategy recommended for sporting surfaces.

Weed control treatments, using the herbicides recommended in the program, must be tailored to suit the needs of each field. As described in this document, most require multiple treatments and applications of more than one post emergent product to control the broad spectrum of weeds experienced throughout the year.

With this in mind the post emergent spray regimes must be flexible to meet the individual needs of each site, yet the pre emergent regime must be non negotiable and applied at the right time. Table Nine and Ten detail suggested pre-emergent and post emergent treatments regimes for your sports field.

<table>
<thead>
<tr>
<th>Month</th>
<th>Product</th>
<th>Rate</th>
<th>Target Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>Barricade</td>
<td>3 L / ha</td>
<td>Listed grass &amp; broadleaf species</td>
</tr>
<tr>
<td>February</td>
<td>Barricade</td>
<td>3 L / ha</td>
<td>Listed grass &amp; broadleaf species</td>
</tr>
</tbody>
</table>

Estimated Base Program Investment - $ 1,500 per hectare

<table>
<thead>
<tr>
<th>Month</th>
<th>Product</th>
<th>Rate</th>
<th>Target Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>July - August*</td>
<td>Spearhead</td>
<td>5 L / ha</td>
<td>Bindii / Broadleaf Species</td>
</tr>
<tr>
<td>September</td>
<td>Monument</td>
<td>20 g / ha</td>
<td>Sedges and Burr medic</td>
</tr>
<tr>
<td>August - September*</td>
<td>Diclofop Methyl</td>
<td>2.5L / ha</td>
<td>Crowsfoot grass</td>
</tr>
<tr>
<td>November - January*</td>
<td>Daconate</td>
<td>5L / ha</td>
<td>Paspalum, Summergrass</td>
</tr>
<tr>
<td>November - February*</td>
<td>Weed Wipe</td>
<td>As rqd</td>
<td>Elastic Grass / wire grass</td>
</tr>
<tr>
<td>January</td>
<td>Weed Wipe</td>
<td>As rqd</td>
<td>Elastic Grass / wire grass</td>
</tr>
<tr>
<td>March - May*</td>
<td>Diclofop Methyl</td>
<td>2.5L / ha</td>
<td>Crowsfoot grass</td>
</tr>
<tr>
<td>April</td>
<td>Monument</td>
<td>40 g / ha</td>
<td>Kikuyu suppression</td>
</tr>
</tbody>
</table>

Estimated Post Emergent Program – $ 1, 600 per hectare

The Post emergent program allows for on average four post emergent applications per annum. This would allow for the predominant weed species to be targeted as required to meet the needs of each individual field. These activities would be in addition to base program activities. The flexibility of such an approach, in conjunction with the base program, would ensure a significant reduction in weed numbers over the period the strategy is employed.

**IMPORTANT NOTE** - Prior to the commencement of any weed management activities, the club should engage the services of a turf professional to develop your weed management program. Herbicide application following an incorrect identification of either desirable turf species or undesirable weed species could cause significant damage and / or death to your playing surface. Further to this, implementation of a successful weed management strategy is contingent on the desirable species being able to take over when undesirable species are removed.
3. Turf Management and Renovation

Quality turf is desirable on a sporting field as it provides a safe surface for recreational and sporting activities. When conditions for desirable turf species become unfavourable, resulting in an unacceptable decline in quality, turf managers need to improve turfgrass areas.

This section of the document identifies the reasons why turf areas fail and the importance of a proactive maintenance regime in extending the timeframe before a full re-establishment of the sporting surface is required.

The renovation and re-life strategy detailed in this document has been developed to ensure that, through implementation of proactive turf management strategies, cost effective, quality sporting surfaces can be achieved.

3.1 Reasons for Turfgrass Failure

Critical to proactive turf management is to identify the causes that have resulted in damaged or thinned turf. A turfgrass stand may decline for many reasons including:

- Inappropriate cultural practices, including improper mowing height or frequency, or excessive or insufficient fertilisation, irrigation, and pest control regimes;
- Undesirable physical soil conditions like compaction, rock layers, severe soil layering, or poor drainage;
- Drought, heat, or cold stresses;
- Excessive thatch accumulation;
- Use of species or cultivars that are not adapted to the site;
- Chemical soil conditions such as acidity, alkalinity, or salinity;
- Severe damage by diseases, insects, nematodes, or the toxic effect of chemicals, or
- General neglect, abuse, or overuse.

Often, a number of these factors may be impacting on the turfgrass. Therefore, auditing surfaces using a range of analytical and diagnostic tools exploring chemical soil analysis, irrigation water suitability and pest and disease identification becomes essential in understanding the appropriate remedial action.

3.2 Diagnostic Tools

3.2.1 Soil Nutrient Analysis

A comprehensive, turf specific soil analysis quantifies the levels of all major cations, phosphorus, essential minor nutrients and organic matter in the soil. This type of analysis quantifies soil nutrient deficiencies and recommends remedial actions, based upon scientific calculations. This greatly assists in enhancing the performance and cost efficiency of corrective programs, whilst balancing the soil for optimum fertiliser performance.

3.2.2 Physical Soil Analysis

Soil physical measurements are numerous, depending on the objective of the study for agricultural or horticultural purposes. The measurements for turf generally include particle size analysis; sand, silt and clay evaluation; sand/gravel suitability, porosity analysis and soil moisture retention curves.

3.2.3 The Saturated Soil Analysis

A Saturated Soil Analysis determines what nutrients are present in soil solution, quantifying pH, soluble salts, major cations, ammonium, nitrate, sodium absorption ratio and bicarbonate levels. The saturated soil analysis is an
important diagnostic tool that provides a true account of nutrition taking into consideration the interactions between soil and irrigation water. This identifies nutritional levels within soil solution to determine any factors limiting turf growth.

3.2.4 Irrigation Suitability Analysis

A turf specific irrigation water suitability analysis measures pH, Hardness, Conductivity, Sodium Absorption Ratio, Adjusted SAR, pHc, Cations (Calcium, Magnesium, Potassium, Sodium, Iron) Alkalinity, Anions (Carbonate, Bicarbonate, Hydroxide, Chloride, Sulphur) and Total Dissolved Salts. This analysis identifies potential hazardous elements present in the irrigation water that may ultimately affect turf growth. By understanding these hazards corrective strategies can be implemented to address these concerns.

3.2.5 Clegg Hammer Assessments

The main objective of these analyses is to assess the surface hardness and compaction levels present on the sporting surfaces assessed and to determine the required remedial actions via coring activities.

The Clegg Impact Soil tester device measures the surface hardness by dropping a weight with an integral accelerometer that measures the gravities of deceleration applied to the weight as it hits the surface. The hammer is dropped three times in each spot from a height of 300mm and the value of the first and third drops was recorded. Three measurements are taken from each area tested.

The Sureplay Project, an initiative undertaken in co-ordination with Horticulture Australia, the Qld Department of Primary Industries and AFL have determined that up to a Gmax of 150 is acceptable. 200 Gmax and above is considered to run the risk of serious concussion. The Sureplay recommendations are summarised below;

<table>
<thead>
<tr>
<th>g = gravities</th>
<th>Minimum, g</th>
<th>Maximum, g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable limits</td>
<td>10</td>
<td>150</td>
</tr>
</tbody>
</table>

For the purposes of this assessment the first drop is taken as representative of the surface hardness as experienced by players running on or falling onto the surface. The player impacts the surface without penetrating it. Therefore a single drop of the clegg hammer should replicate playing conditions better than subsequent drops.

The difference between the first and third drop would give an assessment of the potential for further compaction of the ground..

It must be noted that the surface hardness varies with the vertical thickness of grass cover and with changes in the moisture content of the ground. The volumetric moisture content of the ground and turf height must be assessed at the time of taking Clegg Hammer readings.

3.2.6 Penetrometer Readings

The Penetrometer device measures sub surface compaction by determining the resistance to a 300 psi force exerted. The penetrometer is designed to mimic a plant root.

In studies conducted at the US Department of Agriculture, root penetration decreases linearly until almost no roots penetrate into a soil with a penetration resistance of 300 psi (Duiker, 2002). Readings taken with the penetrometer are called the cone index.

The penetrometer rod is driven in the soil at a rate of approximately 2.5cm per second. As the penetrometer was pushed into the soil, the depth at which the 300 psi level was exceeded was recorded.
Results of the Penetrometer resistance measurements should be interpreted via the following guidelines:

<table>
<thead>
<tr>
<th>% of Measuring Points with Cone Index</th>
<th>Compaction Rating</th>
<th>Aeration Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;30 psi in top 75mm of soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>Little - None</td>
<td>No</td>
</tr>
<tr>
<td>30 – 50</td>
<td>Slight</td>
<td>No</td>
</tr>
<tr>
<td>50 – 75</td>
<td>Moderate</td>
<td>Yes</td>
</tr>
<tr>
<td>&gt;75</td>
<td>Severe</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Adapted from Murdock et al, 1995.

3.2.7 Disease Diagnosis

Disease Diagnosis is aimed at providing a more visual and comprehensive review of the disease activity within the plant, identifying disease occurrence and quantifying the severity of each pathogen's infection. This provides the turf manager with the knowledge and means to make effective disease management decisions.

3.2.8 Pest Diagnosis

Accurate pest identification is essential when managing plant protection issues, as is an understanding of the pest and how environmental, cultural factors affect their occurrence. Once the pest has been identified, control programs can be developed to limit future problems to make management of the pest less complex.

3.2.9 Species Composition

A species composition assessment provides a quantitative analysis of both desirable and undesirable species composition. This analysis provides guidance when developing weed management programs as it determines whether a field can be rehabilitated through implementation of a turf management program or whether a re-life strategy is required.

3.3 Turf Improvement Programs

Once the cause/s of turf decline is identified, a turf management program can be established that will best upgrade the turf whilst taking into consideration the existing conditions, budgetary constraints and the desired turf quality. In the majority of situations, a turf management program would fall into one of the following categories:

- Initiation of a program of sound cultural practices.
- Renovation of the turf by planting into existing live vegetation
- Total re-establishment of the turf area.

In each program, the turf grasses, soil conditions, thatch levels, environmental conditions, and existing perennial grass weeds must be evaluated.

3.3.1 Initiation of a Program of Sound Cultural Practices

Many turfgrass areas can be brought to acceptable quality levels by simply altering turf management practices. Turf grasses that can be improved in this fashion have many acceptable characteristics, but are in an undesirable condition due to improper mowing, irrigation, fertilisation, pest control practices and/or overuse.
For a program of this type to work effectively, the existing turf area must be comprised of a desirable turfgrass species and/or cultivars, have adequate density (or be capable of becoming more dense), have acceptable soil conditions, have a moderate thatch level, and have undesirables such as perennial grass weeds in manageable quantities. To implement a program of this type, the following process is implemented:

- Analytical tests are completed to evaluate amendment and nutrition requirements,
- A tailored amendment and nutrition plan is developed that suits the turfgrass being managed,
- Amendments are applied to balance the soil for optimum fertiliser performance
- Current management practices are evaluated and modified to promote healthy, vigorous turf, integrating mowing, irrigation, fertilisation, and pest control practices with existing environmental conditions and turf species to bring turf into desired condition,
- Prioritised renovation activities are completed within budgetary constraints, and
- Annual assessments are completed to evaluate progress and realign management strategies.

Programs of this type are usually carried out in spring and summer to maintain a healthy turfgrass environment. However, the disruption and inconvenience caused to asset users, such as sports clubs undertaking summer sports, has often forced this practice to the extreme ends of the season where it is least likely to cause interference. However, such decisions are detrimental to turfgrass health, leading to increased disease pressure in particular, due to a lack of turf vigour and the restricted period of turf recovery.

Therefore, renovation timing should be more closely tied to the patterns of plant growth. The optimum growth and development of every turfgrass species is restricted to a specific temperature range. Temperatures outside of optimum, limit to an increasing extent the amount of turfgrass activity and the recovery time after renovations. Soil temperatures in particular, govern the rate of turfgrass growth.

In such situations, where the turf asset is only available for a short period of time, aeration and soil amendment practises can be moved to the autumn period, allowing for activities where the surface is affected to be carried out in the warmer months. This strategy ensures the turf receives all the required remedial actions without the risk of time preventing critical activities from being completed.

### 3.3.1.1 Safety and Liability

Generally, the surface needs to be even and clear of rocks and trips such as grass weed tussocks. The top surface needs to consist of a uniform covering of grass that will minimise abrasion injuries while avoiding locking footwear when twisting. The overall structure needs to be soft enough to minimise injuries due to falls/tackles but be firm enough to provide a secure footing.

### 3.3.1.2 Playability or Playing Quality

Different sports place different importance on the playing quality of the surfaces on which they play. The surface needs to offer adequate grip and perform consistently across the playing surface.

Examples include:

- A cricket pitch needs to provide good ball rebound and spin as well as being even, the outfield fast ball run;
- Rugby, Rugby League and AFL all need to have good traction and be played on a firm surface; and
- Soccer requires fast ball run and consistent ball bounce.
Often, due to the fact that different sports will use the surface during different times of the year, a surface must be maintained in such a way as to ensure the best outcome for all users of the surface.

### 3.3.2 Appropriate Use

Sports turf surfaces that are used at inappropriate times or in inappropriate ways will also have a significantly reduced life-span before a relief program is required. Key aspects to extending the life of sporting field such as hours of use, use during wet weather and training events are under the clubs direct control and should be carefully managed.

#### 3.3.2.1 Hours of Use

A generally accepted current guide on appropriate wear of grass on sports turf surfaces would be three training sessions per week and three games over a weekend. Currently usage hours for many of the LCC sporting surfaces are well in excess of the recommended usage figure.

Further to this, with many sporting surfaces being used for multiple sports throughout the year, often recovery times for the turf surfaces is significantly reduced. In such situations, the ability for renovation activities to be completed can be significantly hampered.

Sports turf surfaces that are over-used will require additional maintenance inputs and will need to be rebuilt far sooner than a single use facility. Therefore, where usage exceeds the abovementioned usage guide, careful attention to the implementation of sound cultural practices is essential.

#### 3.3.2.1.1 Wet Weather

Turf surfaces used in periods of wet weather will suffer significant damage. Such damage experienced during the cooler months will not recover appropriately until the warmer months. Therefore, it is a high priority for Council to ensure that such damage is minimised, thus reducing the risk of injury or high repair costs.

#### 3.3.2.1.2 Training on Turf Surfaces

Sports club training practices have a significant impact on the health of turf surfaces. Examples of strategies that can be implemented include not using the main playing surface for practice, using temporary goals to reduce wear in goal mouths, and training in different places on the field rather than next to change rooms.

### 3.3.3 Pest Management

The best defence against any pest is healthy turf. If there are problems on the sports field, the turf management program has probably not been adequate as sound turf management will help reduce pest problems.

Pesticides are an effective way to control diseases and insects when pest populations are high enough to cause turfgrass decline. The goal should be to properly identify the pest problem in the early stages; determine if the pest population would significantly alter turf function; and develop a plan to reduce the pest population. Routine pesticide application as a preventative measure of pest control is not cost effective for Clubs and is recommended for premier sports fields only.

When pest control is needed, have a professional service provider;

1. identify the pest problem,
2. select the chemical recommended to control the pest,
3. be sure the turfgrass will tolerate the chemical, and
4. apply the chemical according to label recommendations.
Have the pest treated curatively by a turf professional once it has been observed; and preventively only when the field is a premier sports field or you have had prior outbreaks and have good reason to suspect a recurrence.

3.3.3.1 Diseases

Specific turf diseases can be managed with fungicides and cultural practices such as mowing, watering, and fertilising.

If clubs are experiencing routine loss of turf from disease, it is time to review the turf program or seek the advice of a turf specialist. Occasionally a disease that has the potential to kill sports turf may appear. If disease is suspected, get an accurate diagnosis via a disease test from a turf specialist.

3.3.3.2 Insects

Sub-surface feeding insects are of major concern because they feed on roots, cause turf to be easily dislodged, and result in poor footing. Insecticides can give a quick kill once you know where and when a pest is present. Insecticide application should be undertaken by a specialist service provider following an accurate diagnosis.

3.3.4 Appropriate Turf Maintenance

Any high use sports turf surface requires the highest level of maintenance to ensure the asset can tolerate the stresses of the wear experienced from training and games.

3.3.4.1 Mowing Regimes

Mowing frequency ranged from weekly to monthly over the growing season with mowing heights ranging from 15 to 30 mm. Under restricted watering conditions, a strategic mowing program involving the ‘one third’ rule is preferred. This rule involves the removal of no more than one third of the grass blade at any one mowing. This rule helps to maintain maximum turf root growth as it has been shown that removing more than one third of the grass blades may cause root growth to cease while the leaves and shoots are regrowing.

Key mowing principles include increasing the mowing height as this leads grasses to develop a deeper root system, and ultimately improve the depth at which water can be extracted. Higher mowing heights also shade the crowns and the soil from solar radiation. In the case of mowing regime changes, longer grass will affect playability for certain sports where Kikuyu is the current desirable species.

3.3.4.1.1 Mowing Top Tips

- Mowing increases turf density so fields should be mowed as regularly as time and budget will allow.
- The field should be mowed in a different direction each time.
- Fields without irrigation should be mowed at the higher end of the optimum range.
- The lower you mow the higher the input costs will be to sustain a quality turf surface.

3.3.4.2 Grow Regulators

Grow regulators can be successfully used to reduce the mowing requirements during peak times in the growing season. Application rates vary significantly with turf species however the use of growth regulators on couch species can prove very cost effective for sports where a good ball roll is required. For kikuyu, the use of growth regulators is prohibitively expensive for most turf managers.
3.3.4.3 Aeration

Aeration of turfed sports surfaces should be carried out on a regular basis. Under restricted watering conditions, strategic aeration for couch grass and kikuyu grass sports surfaces is called for and may best be done prior to irrigation or when a rainfall is pending. Aeration reduces surface compaction as well as improving water, air and fertiliser moving into the soil profile.

Effective aeration can also improve the soils physical properties, particularly in relation to infiltration rate, and will maximise the effectiveness of rainfall and irrigation. Research has found that aeration, to a depth of 275 to 300 mm can also be used effectively to leach out sodium and excess salts, as well as permit the entry of water, air and fertiliser into the root zone.

3.3.4.4 Topdressing

When aerating use hollow tines which remove plugs of soil. These plugs may be worked back into the turf by dragging or shattering and thus serving as topdressing. If importing material, ensure high quality “weed free” topdressing sand is utilised. Topdressing is generally only required to address surface levelness or assist with soil physical properties.

3.3.4.5 Soil Wetting Agents

If implementing a water management plan the introduction of a soil wetting agent which prevents water repellency from developing, may be appropriate.

Using a quality product at the recommended rates ensures the long lasting water attracting “head” of the molecule in the product continues to attract water for twelve to sixteen weeks. By overcoming hydrophobic conditions, water and soil applied chemicals are evenly distributed through the soil profile, therefore water savings will result.

The tank mix flexibility of a quality wetting agent ensures the product can be applied in combination with other products such as pre and post emergent herbicides, Plant Growth Regulators, soluble or liquid fertiliser applications and fungicides.

3.3.4.6 Soil Balance and Amendment

Turf grasses obtain thirteen of sixteen essential nutrients from the soil via the root system. Therefore, the nutrient status of the soil is critical in ensuring that the appropriate level of nutrient is available to ensure the sports turf has optimal growing conditions. A turfgrass growing in a well balanced soil will outperform undesirable weed species and will be more capable of tolerating the stresses experienced during the sporting season.

3.3.4.7 Fertiliser Regime

The use of CRN fertilisers has been discussed in detail earlier in this document. A wide selection of product choices with varying NPK ratios, particle sizes and particles coated allows far greater fertiliser efficiency over differing turf growing regimes and conditions. CRN fertilisers will control the release of Nitrogen for up to sixteen weeks maintaining growth habit and reducing mowing frequency, clippings and pest & disease problems.

3.3.4.8 Thatch Management

Excessive thatch accumulation is a problem on many turfgrass sites. Thatch is a layer of organic material consisting of tightly intermingled, living and dead plant tissues derived from crowns, stems, and roots. These parts of a turfgrass plant have relatively high lignin content.
Lignin is an organic compound that is highly resistant to microbial breakdown. Accumulation of a thatch layer occurs when the production of organic material (such as lignin) exceeds the rate of decomposition within the zone between green leaf tissue and the soil surface.

To assess thatch accumulation, remove a section of grass and soil from the turf using a knife or shovel, and measure the depth of accumulated thatch. Depths greater than 12mm indicate that corrective measures may be needed to reduce the thatch layer. Measurements from several locations through the turf area are needed because of the variable nature of thatch.

If the thatch layer is thicker than 12mm inch turf vigour can be reduced. Thatch can also be reduced by vertical mowing. Vertical mowing should be done when the turf is actively growing and should be avoided during periods of temperature and moisture stress. At this time, slow growth will reduce the recuperative capacity of turf and increase weed encroachment.

3.3.4.9 Line Marking

Line marking is a time consuming and costly activity. Over the years many different ways to extend the life of painted lines have been tried, many of which resulted in environmental hazards and dangerous situations for players.

The best way to get longevity from your line marking is mix a turf growth regulator in with the paint. For example, Primo MAXX can extend the duration of marking visibility when applied with marking paints.

Example: Spraying equipment output should be known.

Total area to be painted:

Line width (m) x total line length (m) = y m²

E.g. 0.15 x 400 = 60 m²

Primo MAXX rate: y/100 x 32 mL/100m²

E.g. 60/100 x 32 = 19.2 mL Primo MAXX in enough mix as per sprayer output.

Primo MAXX should be mixed with water first when using latex-based marking paints. Refer to paint mixing instructions for further details.

3.3.5 Irrigation Audits

Irrigation audits consist of three main activities: site inspection, performance testing and irrigation scheduling. Each activity in itself can result in improved turf quality along with significant water and cost savings.

Together, these activities provide the turf manager with a customised irrigation program based on site specific conditions and irrigation system performance.

3.3.5.1 Site Inspection

Over time, even the most efficiently designed irrigation system will begin to break down. In the absence of a regular maintenance program, minor operation and performance problems can continue for months resulting in excessive water use and poor efficiency, which can reduce turf quality. Sunken sprinkler heads that do not “pop-up” properly, misaligned spray patterns that throw water onto the wrong areas, and broken or missing sprinkler heads resulting from vandalism or mower damage can result in significant water waste and a poor sports field presentation.
Performance problems are often inherent in an irrigation system resulting in poor water distribution. In order to compensate for this poor uniformity, the system is often set to operate longer, which in turn over-waters many areas of the field. Insufficient or excessive operating pressure will also lead to high water loss through wind drift or poor coverage.

Low water pressure is generally caused by insufficient static pressure and/or high pressure losses through valves, meters, piping and other components of the irrigation system. Visual indications of low water pressure include large water droplets and short sprinkler throw.

High water pressure, on the other hand, indicates an absence of proper pressure regulation devices. High pressure is generally characterised by excessive misting of water that is easily evaporated or carried by the wind.

### 3.3.5.2 Performance Testing

Sports field pops up sprinklers are designed to operate within specific operating pressures and head spacings. Manufacturer’s specifications catalogues rate the performance, mainly flow rate (in litres per minute) and precipitation rate (in mm per hour), based on these parameters.

Commonly, the rated performance listed in the catalogues does not accurately represent actual performance. For example, insufficient or excessive operating pressure and improper head spacing will significantly increase or decrease precipitation rate.

For irrigation scheduling purposes, the most accurate determination of precipitation rate is achieved by conducting catch can tests. Catch can tests measure the amount of water that actually hits the ground at various points within the field, and also serves to measure application uniformity.

Since irrigation systems commonly use different types and brands of sprinklers, it is important to conduct catch can tests for each individual zone or “station” on an irrigation system.

The following is the suggested approach to conducting catch can tests:

1. Turn on the irrigation system, one zone at a time, to locate and mark sprinkler heads.

2. Starting with zone 1, layout catch cans only on the part of the field covered by zone 1. Catch devices should be placed in a grid-like pattern throughout the zone to achieve an accurate representation of sprinkler performance. Note: Try not to place catch devices too close to sprinkler heads to avoid altering spray patterns.

3. Turn on zone 1, allowing water to fill the catch cans. Keep track of the number of minutes that the zone is allowed to operate.

4. After a measurable amount of water has fallen, measure the depth of water (in millimetres) contained in each device using a ruler. Record these values on a data sheet. Also record how long (in minutes) the zone was operated.

5. Repeat steps 1-5 above for each remaining zone on the system.

Using the data from catch can testing, we can now determine the precipitation rates for each individual zone on the irrigation system.
The simple equation for calculating precipitation rate is given below:

\[
\text{Precipitation rate} = \left(\frac{\text{average catch can depth}}{\text{number of catch cans}}\right) \times 60
\]

Where: \(\text{Precipitation rate} = \text{millimetres per hour}\) and \(\text{Average catch can depth} = \text{millimetres}\)

### 3.3.5.3 Irrigation Scheduling

When water supplies are limited, it becomes even more important that every drop of water is utilised to the fullest. Audits replace many of the assumptions made in irrigation scheduling. With irrigation auditing, the irrigation schedules are customised based upon catch can results, site-specific soil conditions and turf water requirements. Rather than using the long time recommendation of “fifteen minutes per zone, three times per week”, turf managers are able to adjust run times for individual zones based on measured precipitation rate.

Determining when to irrigate should be based upon the depth of the plant’s root zone and the type of soil therein. Together, root depth and soil type define the amount of water that is available for plant use. A 200mm clay soil, for example, will hold more water than a 200mm sand profile. Thus, the number of irrigation cycles per week will be less in the clay, though the amount of water the plant needs will remain the same. Root depth also influences irrigation frequency.

Shallow rooted turfgrass, for example, will require more frequent irrigations than will a turfgrass with a deeper root zone.

The first step in determining how long to irrigate is to first determine how much water you should apply for each irrigation event. Turf water requirements vary significantly in sports fields due to the variety of plant species, maintenance practices in place and microclimates experienced. Water requirements also vary with climate trends and rainfall patterns.

Turfgrass, which is generally assumed to be the highest water user, requires up to 25mm per week during the summer with less in the spring and autumn. Due to limited water storage capacity in the plant’s root zone, two or three irrigations per week may be required. Once it is determined how much water (in millimetres) is needed each irrigation cycle, the conversion to zone run time is simple. The following equation is used to determine zone run times:

\[
\text{Run time per irrigation cycle} = \left(\frac{\text{Targeted irrigation depth}}{\text{zone precipitation rate}}\right) \times 60
\]

Where: \(\text{Run time per irrigation cycle} = \text{minutes}\), \(\text{targeted irrigation depth} = \text{millimetres}\) and \(\text{zone precipitation rate} = \text{millimetres per hour}\).

### 3.3.5.4 Plant Protection

When turf is under stress it is more susceptible to damage by insects and pathogens. A proactive pest control regime should be implemented to counter the risk of pest attack during times of the year when the sports turf is vulnerable to attack.

Also, during period of heavy wear, bare areas allow for ingress of foreign weeds. A proactive regime for the control of weeds in sports turf has been detailed earlier in this document.
3.4 Renovation

The renovation process can be as simple as amending the soil environment back into the favour of desirable species, along with aeration and weed control, or as complicated as completely removing the existing vegetation and then re-establishing the turf area (re-life).

Intermediate between these two options is changing the dominant species of turfgrass grown or replacing the turf that has died by planting new plant material into existing live or dead turf.

In this section the overplanting process and total re-establishment will be discussed.

3.4.1 Renovate Turf by Planting New Grass (overplanting) into Existing Live Vegetation

In some situations poor turf requires more than improved cultural practices to reach an acceptable quality. In such cases, planting into existing live or dead turf can be beneficial. This program can upgrade turf by bettering turf appearance, density, disease resistance, wear tolerance, and shade and drought tolerances.

To overplant into live existing turf, proper soil balance, drainage/aeration, pH, and fertility should exist, thatch levels should be minimised, and undesirables such as perennial grass weeds should only be present in manageable numbers.

When the area in need of improvement has large populations of perennial grass weeds, selective herbicides can be used to kill undesirables, followed by overplanting to repopulate areas with desirable turf species.

As in establishing turf from stolons, there is one period when renovating by overplanting is most successful. In Queensland, the best time of the year to overplant is from September through to February.

Overplanting during this period allows warm-season grasses to develop adequate root systems before the onset of the winter months where many warm season grasses become dormant. Optimum root growth of most warm season grasses occurs within the range of 24 - 29°C.

Root formations at temperatures below optimum are much slower and tend to be shorter and less branched. Therefore renovations performed too early in spring on a warm-season turfgrass will extend the recovery period and thereby increase the possibility of an infection over such time.

To overplant successfully, adequate water must be available from the time of overplanting through completion of root development. Newly over planted areas should not dry out completely once overplanting has been completed.

Initially, maintain a constantly moist soil profile with frequent waterings of short duration. As newly planted stolons begin growth, the watering frequency is decreased, with watering duration increased to encourage deep rooting.

Once the new desirable species has been grown in, regimes can be implemented to selectively remove the previous desirable species if required.

A budget estimate for an overplanting activity would be $1.00 - $1.80 m² dependant on the area being overplanted, the turf grass used, the planting rate, the level of preparatory work required at the site to reduce competition with the new desirable, and whether regulation or removal of the previous desirable is required.
3.4.2 Total Turf Re-Life

In some cases, existing turf areas are in such poor condition or the physical soil conditions are so unsuitable for supporting turfgrass growth that it is necessary to go through a process of completely re-establishing the turf area.

This method of turf improvement is also necessary when the desirable turf species is not suitable and should be replaced.

General re-establishment steps include the following:

1. Use a non-selective herbicide to kill existing turf and weeds.
2. Correct soil pH, drainage, irrigation, levelness and/or fertility problems.
3. Select and plant new turf by stolonising or returfing the area.
4. Implementation of establishment and ongoing maintenance programs to extend the life of the asset.

Total turf re-establishment is an expensive process. Establishment of sound turf management practices can dramatically improve the usability of a turf asset and extend the timeframe between reestablishment events.

However, the management program must encompass all aspects of turf management to ensure the turf can withstand the stresses associated with the usage it receives.

A budget estimate for a re-life activity via stolonisation would be $2.30 - $2.80 m² dependant on the turf grass used, the planting rate, the level of preparatory work required at the site to amend soil and prepare the surface.

If solid turfing the area a budget of $4.30 - $6.00 m² would be required, dependant on the turf grass used, the planting rate, the level of preparatory work required at the site to amend soil and prepare the surface.
### 3.5 Program Calendar

| Month                  | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Planning               |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Soil Nutrition Amendments | As identified in soil analysis (e.g. zeolite, lime, kieserite) |     |     |     |     |     |     |     |     |     |     |     |     |
| Fertilisers           |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Match Nitrogen to supplement growth required | Match N and K |
| Turf Renovation Activities | As identified in audit (e.g. scarification, aeration, top-dressing) |     |     |     |     |     |     |     |     |     |     |     |     |
| Soil Wetting Agents   |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Apply continually all year round (on a programmed schedule not exceeding product longevity) |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Turf Growth Regulators |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Black beetle (larvae) |     | Insecticide |     |     |     |     |     |     |     |     |     |     |     |
| Black beetle (adults) |     |     |     |     |     |     |     |     | Insecticide |     |     |     |     |
| Funnel ants           | Insecticide |     |     |     |     |     |     |     |     |     |     |     |     |
| Armyworm               |     | Insecticide |     |     |     |     |     |     |     |     |     |     |     |
| Sod webworm           | Insecticide |     |     |     |     |     |     |     |     |     |     |     |     |
| Weeds                 |     |     |     |     |     | Pre-emergent Herbicide | Pre-emergent Herbicide |     |     |     |     |     |
| All Species           | Pre-emergent Herbicide |     |     |     |     |     |     |     |     |     |     |     |     |
| Crowsfoot             |     |     |     |     |     |     |     |     |     | Selective Herbicide |     |     |     |
| Paspalum              | Selective Herbicide |     |     |     |     |     |     |     |     |     |     |     |     |
| Summer grass          | Selective Herbicide |     |     |     |     |     |     |     |     |     |     |     |     |
| Diseases              |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Brown Patch           |     |     |     |     |     |     |     |     |     |     |     | Fungicides as required |     |
| Pythium               |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Helminthosporium      |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Anthracnose           |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Dollar spot           |     |     |     |     |     |     |     |     |     |     |     |     |     |

Note: Treatment timing will be variable as it is dependant on environmental factors such as seasonal conditions including soil temperature, diurnal temperature range and daylight hours that influence the breaking of seed dormancy and germination.